Application Cover Sheet

Cape Cod Commission
3225 Main Street, PO Box 226
Barnstable, MA 02630
Tel: (508) 362-3828 • Fax: (508) 362-3136

For Commission Use Only

Date Received:
Fee ($):
Check No:
File No:

A Type of Application (check all that apply)

- ☐ DRI Exemption
- ☐ Request for Joint MEPA/DRI Review
- ☑ Development of Regional Impact (DRI)
- ☐ Hardship Exemption
- ☐ Decision Extension
- ☐ DRI Scoping
- ☐ Jurisdictional Determination
- ☐ Decision Modification

B Project Information

Project Name: Algonquin Gas Transmission, LLC - Cape Cod Canal Pipeline Relocation Project

Total Site Acreage: 210.2 acres construction workspace

Project/Property Location: Multiple locations in the Town of Bourne

Zoning: Multiple

Brief Project Description:

Include total square footage of proposed and existing development, gross floor area, number of lots existing or to be created, specific uses, description of existing conditions, as applicable (attach additional sheets if necessary).

The Project will modify existing interstate natural gas transmission facilities to accommodate the planned replacement of the Bourne and Sagamore Bridges by the Cape Cod Bridges Program.

The Project will remove, abandon, and relocate portions of existing natural gas pipelines and associated metering and regulating facilities that currently interact with bridge-supported and bridge-adjacent infrastructure,

while maintaining uninterrupted natural gas delivery to National Grid delivery points serving Cape Cod.

C Owner(s) of Record

List the following information for all involved parcels. Provide copies of each Deed and Purchase and Sale Agreement and/or evidence of leasehold interest, if applicable, for all involved parcels. Proof of ownership/legal rights for Applicant(s) to proceed with the proposed development must be documented prior to the Commission deeming any application complete. List the local, state, or federal agencies from which permits or other actions have been/will be filed (attach additional sheets if necessary).

Map/Parcel	Owner's Name	Lot & Plan	Land Court Certificate of Title #	Registry of Deeds Book/Page #
Multiple - See Attachment 13 for proof of ownership/legal rights.				

There **ARE/ARE NOT** (circle one) court claims, pending or completed, involving this property (if yes, please attach relevant information).

Is there an existing CCC Decision for the Property? ☐ yes ☑ no (if so, recording information for decision, please attach relevant information).

D Certification

I hereby certify that all information provided on this application form and in the required attachments is true and accurate to the best of my knowledge. I agree to notify the Cape Cod Commission of any changes on the information provided in this application, in writing, as soon as is practicable. I understand failure to provide the required information and any fees may result in a procedural denial of my project.
NOTE: For wireless communication facilities, a licensed carrier should be either an applicant or a co-applicant.

APPLICANT

Applicant(s) Name: Algonquin Gas Transmission, LLC Attn: Brian Colabella Tel: 267-894-6117 Fax:

Address: 890 Winter Street, Suite 300 Waltham, Massachusetts 02451

Signature: Brian Colabella Date: 7/24/2026

CO-APPLICANT

Co-Applicant(s) Name: Tel: Fax:

Address:

Signature: Date:

CONTACT

Contact: SWCA Environmental Consultants Attn: Richard Paquette Tel: 207-520-4614 Fax:

Address: 8 Science Park Road, Scarborough, ME, 04074

Signature: Richard C. Paquette Jr. Date: 7/24/2026

PROPERTY OWNER

Property Owner: Multiple - See Attachment 13 Evidence of Applicant's Standing for proof of ownership/legal rights Tel: Fax:

Address:

Signature: Date:

BILLABLE ENTITY

Name: Algonquin Gas Transmission, LLC Attn: Brian Colabella Tel: 267-894-6117 Fax:

Address: 890 Winter Street, Suite 300 Waltham, Massachusetts 02451

Development of Regional Impact Application

Cape Cod Canal Pipeline Relocation Project

Bourne, Massachusetts

JULY 2026

PREPARED FOR

Algonquin Gas Transmission, LLC

PREPARED BY

SWCA Environmental Consultants

SWCA®
ENVIRONMENTAL CONSULTANTS
Sound Science. Creative Solutions.®

8 Science Park Road, 2nd Floor
Scarborough, Maine 04074
www.swca.com

July 24, 2026

Jeff Ribeiro, Regulatory Planner
Cape Cod Commission
3225 Main Street, P.O Box 226
Barnstable, Massachusetts 02630

RE: Cape Cod Commission Development of Regional Impacts Application
Algonquin Gas Transmission, LLC
Cape Cod Canal Pipeline Relocation Project, Bourne, Massachusetts

Dear Jeff Ribeiro and members of the Cape Cod Commission:

SWCA Environmental Consultants, on behalf of Algonquin Gas Transmission, LLC (Algonquin), is submitting this Development of Regional Impact (DRI) application for the Cape Cod Canal Pipeline Relocation Project (Project) in the Town of Bourne, Barnstable County, Massachusetts. The Project is a utility relocation and replacement project required to accommodate the planned replacement of the Bourne and Sagamore Bridges through the Cape Cod Bridges Program. The Project includes modifications to Algonquin's existing interstate natural gas pipeline system to relocate infrastructure that conflicts with the bridge replacement program while maintaining uninterrupted natural gas service to National Grid.

The Project is subject to review by the Federal Energy Regulatory Commission (FERC) under the Natural Gas Act (15 United States Code 717, et seq.). Algonquin initiated FERC review through the pre-filing process under Docket No. PF25-4-000 and subsequently filed its certificate application under Docket No. CP25-552-000. FERC issued an Environmental Assessment for the Project on May 29, 2026. The Project has also undergone review under the Massachusetts Environmental Policy Act (MEPA) as EEA No. 16947. The Secretary of the Executive Office of Energy and Environmental Affairs issued a Certificate on the Final Environmental Impact Report on June 29, 2026 determining that the Project adequately and properly complies with MEPA and its implementing regulations.

This application provides the Commission with a description of the Project, including its purpose and need, alternatives analysis, existing conditions, anticipated impacts, avoidance and minimization measures, mitigation commitments, and consistency with the applicable goals and objectives of the Cape Cod Regional Policy Plan. The DRI fee was calculated in accordance with the FY 2026 Fee Schedule by adding the base fee of $14,173 to the utility and other linear development fee of $0.70 per linear foot for 33,422.4 feet of new pipeline, for a total fee of $37,568.68. Algonquin hand delivered the DRI application fee to the Cape Cod Commission office and submitted the appropriate abutter labels on self-adhesive sheets via FedEx.

Algonquin respectfully requests the Commission's review and approval of the DRI application.
If you have any questions or require additional information, please contact me at (207) 520-4614 or richard.paquette@swca.com or Brian Colabella at (267) 894-6117 or brian.colabella@enbridge.com.



Richard Paquette
SWCA Environmental Consultants
Planning Technical Director - Northeast

cc: Algonquin Gas Transmission, LLC: Brian Colabella, Senior Advisor Environment

CAPE COD CANAL PIPELINE RELOCATION PROJECT

DEVELOPMENT OF REGIONAL IMPACT APPLICATION

Prepared for

Cape Cod Commission
3225 Main Street, P.O. Box 226
Barnstable, Massachusetts 02630

Prepared by

SWCA Environmental Consultants
8 Science Park Drive
Scarborough, Maine 04704
www.swca.com

On behalf of

Algonquin Gas Transmission, LLC
890 Winter Street, Suite 300
Waltham, Massachusetts 02451

SWCA Project No. 65956

July 2026

CONTENTS

1 Executive Summary 1
2 Introduction and Regulatory Framework 7
2.1 Application Purpose 7
2.2 Project Overview 7
2.2.1 Project Schedule 8
2.3 Regulatory Framework 8
2.4 Outreach and Prior Public and Agency Input 11
2.4.1 FERC Public Outreach 11
2.4.2 Agency and Municipal Coordination 11
2.4.3 MEPA and Cape Cod Commission Review 11
2.4.4 Tribal and Cultural Resource Consultation 11
2.4.5 Ongoing Stakeholder Engagement 11
2.5 Application Organization 12
3 Project Purpose, Need, and Description 13
3.1 Purpose and Need 13
3.2 Proposed Facilities 13
3.2.1 New Pipelines 13
3.2.2 Removed and Relocated Pipelines 14
3.2.3 Relocated Aboveground Facilities 15
3.2.4 New Aboveground Facilities 16
3.2.5 Access Roads 17
3.2.6 Contractor Ware Yards 17
3.3 Construction Methods 18
3.3.1 Pipelines 19
3.3.2 Aboveground Facilities 27
3.3.3 Construction Equipment and Refueling 28
3.3.4 Dewatering 28
3.3.5 Traffic Management 29
3.3.6 Air Quality 29
3.3.7 Noise 30
3.3.8 Erosion and Sediment Control 31
3.3.9 Solid Waste Management 33
3.3.10 Safety and Protection of Existing Utilities 34
3.3.11 Environmental Compliance 35
3.3.12 Construction Hours and Schedule 35
4 Alternatives Analysis 36
5 Regional Policy Plan Consistency 38
5.1 Regional Setting 38
5.2 RPP Placetype Designation 39
5.3 Natural Systems 40
5.3.1 Water Resources 41
5.3.2 Ocean Resources 51
5.3.3 Wetlands Resources 54

5.3.4 Wildlife and Plant Habitat 57
5.3.5 Open Space 70
5.4 Built Systems 77
5.4.1 Community Design 78
5.4.2 Coastal Resiliency 80
5.4.3 Capital Facilities and Infrastructure 83
5.4.4 Transportation 86
5.4.5 Energy 90
5.4.6 Waste Management 91
5.4.7 Climate Change 94
5.5 Community Systems 97
5.5.1 Cultural Heritage 97
5.5.2 Economy 100
5.5.3 Housing 101
6 Conclusions 103
6.1 Project Benefits 103
6.2 Summary of Mitigation Commitments 103
6.3 Summary of RPP Consistency 104
7 References 105

Attachments

Attachment 1 Figures
Attachment 2 Alignment Sheets, Typical Construction Examples, and HDD Profile
Attachment 3 Algonquin Erosion and Sedimentation Control Plan and Spill Protection, Control, and Countermeasure Plan
Attachment 4 Algonquin Best Drilling Practices, Monitoring, and Clean-up of Horizontal Directional Drilling Inadvertent Returns Plan
Attachment 5 Stormwater Management Reports
Attachment 6 Traffic Management Plan
Attachment 7 Algonquin Dust Control Plan
Attachment 8 Waste Management Plan
Attachment 9 Nighttime Construction Plan
Attachment 10 Wetland Protection Act Resource Areas, Buffer Zones, and Isolated Vegetated Wetland Alterations
Attachment 11 Landscape Screening Plan
Attachment 12 Quantitative Carbon Analysis
Attachment 13 Evidence of Applicant's Standing
Attachment 14 Abutter Information

Tables

Table 1-1. Project at a Glance 2
Table 1-2. Regional Policy Plan Consistency Matrix 3
Table 2-1. Permits and Approvals 9
Table 3-1. Contractor Ware Yards for the Cape Cod Canal Pipeline Relocation Project 18
Table 3-2. Water Requirements by Facility 23
Table 5-1. Total Acreage of Placetypes Present in the Project Area 39
Table 5-2. Placetype Impacts in Project Area 40
Table 5-3. Existing Natural Resource Setting Summary 40
Table 5-4. Wellhead Protection Areas and Placetypes Crossed by the Project 43
Table 5-5. Project Overlap with PPWSAs and 400-foot Zone I Radii 44
Table 5-6. Estimated Construction Water Requirements 44
Table 5-7. New Impervious Acreage and Type 46
Table 5-8. Summary of Forest Resource Impacts 61
Table 5-9. Anticipated Impacts to Priority Habitat 62
Table 5-10. Anticipated Impacts to Estimated Habitat 62
Table 5-11. Anticipated Impacts to the Herring River Watershed ACEC 62
Table 5-12. Significant Habitat Areas Project Overlap (acres) 66
Table 5-13. Placetype Impacts in Open Space 72
Table 5-14. Area of Development Impact for Project (permanent) 77
Table 5-15. Total Acreage of Impacts to 150-foot Buffer to Coastal Bank 83
Table 5-16. Transportation-Related Impacts by Placetype 87
Table 5-17. Construction and Demolition Material Plan 93
Table 5-18. Existing Cultural Resources 97
Table 6-1. Summary of Mitigation Commitments 103

Abbreviations

ABC	asphalt, brick, and concrete
ACEC	Area of Critical Environmental Concern
ACM	asbestos-containing material
ADI	Area of Development Impact
Algonquin	Algonquin Gas Transmission, LLC
ATWS	additional temporary workspace
BLSF	Bordering Land Subject to Flooding
BMP	best management practice
BVW	Bordering Vegetated Wetland
CAP	Contributing Area to Ponds
CCBP	Cape Cod Bridges Program
CFR	Code of Federal Regulations
CMP	Conservation and Management Permit
CMR	Code of Massachusetts Regulations
Commission	Cape Cod Commission
CVP	certified vernal pool
DEIR	Draft Environmental Impact Report
DRI	Development of Regional Impact
E&SCP	Erosion and Sedimentation Control Plan
EEA	Executive Office of Energy and Environmental Affairs
EH	Estimated Habitat
ENF	Environmental Notification Form
FEIR	Final Environmental Impact Report
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FERC Plan	FERC's *Upland Erosion Control, Revegetation, and Maintenance Plan*, May 2013 version
FERC Procedures	FERC's *Wetland and Waterbody Construction and Mitigation Procedures*, May 2013 version
GIS	geographic information system
HDD	horizontal directional drilling
IBA	Important Bird Area
ILSF	Isolated Land Subject to Flooding
IPMP	Invasive Plant Management Plan
IVW	Isolated Vegetated Wetland
IWPA	Interim Wellhead Protection Area
JBCC	Joint Base Cape Cod
LSCSF	Land Subject to Coastal Storm Flowage

LUO	Land Under the Ocean
M&R	metering and regulating
MassDEP	Massachusetts Department of Environmental Protection
MassDOT	Massachusetts Department of Transportation
MassGIS	Massachusetts Bureau of Geographic Information
MDFG	Massachusetts Department of Fish and Game
MEPA	Massachusetts Environmental Policy Act
MESA	Massachusetts Endangered Species Act
MHC	Massachusetts Historical Commission
MP	milepost
NHESP	Natural Heritage and Endangered Species Program
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NRHP	National Register of Historic Places
NSF	National Sanitation Foundation
PAR	permanent access road
PH	Priority Habitat
PPWSA	Potential Public Water Supply Area
Project	Cape Cod Canal Pipeline Relocation Project
Route 25	Massachusetts Route 25
Route 28	Massachusetts Route 28
ROW	right-of-way
RPP	*Cape Cod Regional Policy Plan 2025*
RV	recreational vehicle
SHA	Significant Habitat Area
SPCC	Spill Prevention, Control, and Countermeasure
TAR	temporary access roads
USACE	U.S. Army Corps of Engineers
USC	United States Code
USDOT	U.S. Department of Transportation
WHPA	Wellhead Protection Area
WMA	Wildlife Management Area
WPA	Massachusetts Wetlands Protection Act

1 EXECUTIVE SUMMARY

Algonquin Gas Transmission, LLC (Algonquin), submits this Development of Regional Impact (DRI) application for the Cape Cod Canal Pipeline Relocation Project (Project) in Bourne, Massachusetts. The Project is a utility relocation and replacement project required to accommodate the Cape Cod Bridges Program (CCBP), which will replace the Bourne and Sagamore Bridges. Existing natural gas pipelines and associated metering and regulating (M&R) facilities that currently conflict with the bridge replacement program must be removed, abandoned, or relocated so that the regional transportation improvements can proceed while uninterrupted natural gas service is maintained for Cape Cod customers.

The Project does not increase interstate pipeline capacity or expand natural gas service to Cape Cod. Upon completion, Algonquin's design capacity to transport natural gas to National Grid delivery points will remain unchanged. The Project replaces existing bridge-attached and bridge-adjacent infrastructure with new facilities designed to provide the same service function from locations outside the CCBP construction conflict areas.

The proposed facilities include approximately 6.33 miles of new 16-inch- and 18-inch-diameter pipeline, removal of approximately 2.03 miles of existing pipeline, abandonment in place of approximately 1.44 miles of existing pipeline, relocation of the existing Bourne and Sagamore M&R Stations, construction of new Pave Paws Road and Bourne Rotary M&R Stations, and associated valve sites, launchers, receivers, access roads, and temporary construction support areas. The current design reflects refinements made through federal, state, regional, and local review, including the Federal Energy Regulatory Commission (FERC), Massachusetts Environmental Policy Act (MEPA), wetland, waterways, endangered species, cultural resource, and Cape Cod Commission processes.

The Project has been planned to avoid and minimize environmental and community impacts to the maximum extent practicable. Approximately 90 percent of the G-31 and G-32 pipeline rights-of-way (ROWs) are collocated with existing utility easements, reducing the need for new linear disturbance and limiting habitat fragmentation. The Cape Cod Canal crossing will be installed by horizontal directional drilling (HDD) beneath the canal, avoiding dredging, in-water trenching, fill placement, and direct disturbance to canal sediments, navigation, fisheries, and shellfish habitat. Project refinements have reduced tree clearing from approximately 66.0 acres evaluated in the Draft Environmental Impact Report (DEIR) to approximately 44.8 acres in the current design.

Potential impacts are primarily construction-related and temporary in nature. The "Project area" includes approximately 210.2 acres of construction disturbance and approximately 60.9 acres of permanent operational area. Temporary effects include construction workspace disturbance, vegetation clearing, limited wetland and buffer zone disturbance, temporary traffic and noise effects, and short-term construction activity within mapped Priority Habitat, Estimated Habitat, Wellhead Protection Areas (WHPAs), floodplain areas, open space lands, and portions of the Herring River Watershed Area of Critical Environmental Concern (ACEC). Permanent impacts have been minimized by the use of existing corridors, underground installation, restoration of temporary workspaces, and siting of aboveground facilities to avoid or reduce effects on sensitive resources and nearby communities.

The Project incorporates extensive avoidance, minimization, restoration, and mitigation commitments. These include implementation of erosion and sediment controls; spill prevention, control, and countermeasure (SPCC) procedures; environmental inspection and compliance monitoring; HDD best drilling practices and inadvertent return response procedures; wetland restoration; traffic management; construction noise controls; stormwater management at aboveground facilities; restoration of disturbed workspaces; and ongoing coordination with federal, state, regional, local, and Tribal reviewers.

Rare species and habitat impacts are being addressed through continued coordination with the Massachusetts Natural Heritage and Endangered Species Program (NHESP) and preparation of a Conservation and Management Permit (CMP). Species-specific protection and avoidance measures are expected to include turtle protection measures, rare plant protection and avoidance measures, clam shrimp protection and avoidance measures, invasive plant management, restoration using appropriate native seed mixes, and other permit-required monitoring and reporting. Algonquin has also proposed long-term habitat mitigation through acquisition and permanent protection of approximately 60 acres of undeveloped forestland adjacent to Joint Base Cape Cod (JBCC) and Camp Edwards Wildlife Management Area (WMA), providing regional habitat connectivity and conservation value beyond the immediate Project footprint.

The Project affects several Article 97-protected open space properties, including conservation, water supply, and wildlife management lands. Algonquin has coordinated with the affected landowners and state agencies to define the nature and extent of temporary and permanent interests required for the Project and to support the applicable Article 97 review and approval process. The Project's use of existing utility corridors, temporary restoration commitments, and proposed off-site habitat preservation are intended to minimize and mitigate impacts to protected open space resources.

Overall, the Project supports a critical regional transportation initiative, maintains existing energy reliability for Cape Cod, avoids an increase in pipeline capacity, and incorporates substantial environmental protection and mitigation measures. Based on the alternatives analysis, design refinements, mitigation commitments, and consistency review presented in this application, the Project is consistent with the applicable goals, objectives, and minimum performance standards of the *Cape Cod Regional Policy Plan 2025* (RPP) and represents a practicable, minimized-impact approach to resolving unavoidable conflicts between existing energy infrastructure and the CCBP (Cape Cod Commission 2025a).

Table 1-1. Project at a Glance

Topic	Summary
Project name	Cape Cod Canal Pipeline Relocation Project
Applicant	Algonquin Gas Transmission, LLC
Location	Town of Bourne, Barnstable County, Massachusetts, including areas north and south of the Cape Cod Canal and portions of JBCC.
Primary purpose	Relocate and replace existing natural gas pipeline and M&R infrastructure that conflicts with the CCBP while maintaining uninterrupted service to Cape Cod customers.
Capacity change	No increase in interstate pipeline capacity and no expansion of natural gas service to Cape Cod. The Project maintains the same service function as the existing infrastructure.
New pipeline facilities	Approximately 6.33 miles of new 16-inch- and 18-inch-diameter pipeline.
Existing pipeline removal and abandonment	Approximately 2.03 miles of existing pipeline removed and approximately 1.44 miles abandoned in place.
Aboveground facilities	Relocation of the existing Bourne and Sagamore M&R Stations; construction of new Pave Paws Road and Bourne Rotary M&R Stations; associated valve sites, launchers, receivers, access roads, and temporary construction support areas.
Construction disturbance	Approximately 210.2 acres of construction disturbance.
Permanent operational area	Approximately 60.9 acres of permanent operational area including permanent pipeline ROW, 4 M&R stations, and permanent access roads.
Tree clearing	Tree clearing reduced from approximately 66.0 acres evaluated in the DEIR to approximately 44.8 acres in the current Project design.
Utility corridor collocation	Approximately 90 percent of the G-31 and G-32 pipeline ROWs are collocated with existing utility easements.

Topic	Summary
Cape Cod Canal crossing	The G-31 pipeline crossing will be installed by HDD beneath the canal, avoiding dredging, in-water trenching, fill placement, and direct disturbance to canal sediments.
Key sensitive resources	Mapped Priority Habitat and Estimated Habitat; WHPAs; wetland resource areas and buffer zones; floodplain areas; Article 97-protected open space lands; and portions of the Herring River Watershed ACEC.
Primary avoidance and minimization measures	Use of existing utility corridors; HDD beneath the Cape Cod Canal; refined workspace limits; reduced tree clearing; wetland construction procedures; erosion and sediment controls; spill prevention procedures; and environmental inspection during construction.
Primary mitigation commitments	Wetland restoration; workspace restoration and revegetation; traffic management; construction noise controls; stormwater management at aboveground facilities; species-specific NHESP protection plans; invasive plant management; and monitoring and reporting required by permits.
Rare species mitigation	Continued NHESP coordination and preparation of a CMP, including species-specific avoidance, protection, restoration, and net benefit mitigation measures.
Open space and Article 97 mitigation	Coordination with affected landowners and state agencies regarding Article 97 approvals, combined with use of existing corridors, temporary restoration commitments, and proposed off-site habitat preservation.
Proposed off-site habitat preservation	Acquisition and permanent protection of approximately 60 acres of undeveloped forestland adjacent to JBCC and Camp Edwards WMA.
Primary regulatory reviews	FERC, MEPA, Cape Cod Commission DRI review, Massachusetts Wetlands Protection Act (WPA), Chapter 91, Section 401 Water Quality Certification, Massachusetts Endangered Species Act (MESA), Article 97, U.S. Army Corps of Engineers (USACE), Massachusetts Office of Coastal Zone Management, U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), and cultural resource consultation.
Regional benefit	Supports implementation of the CCBP, maintains existing energy reliability for Cape Cod, and resolves conflicts between existing energy infrastructure and planned bridge replacement construction.

1.1 Master RPP Consistance Matrix

The following matrix provides a consolidated summary of the Project's consistency with applicable Cape Cod RPP systems and related Cape Cod RPP Technical Bulletin topics (Cape Cod Commission 2025b). The matrix is intended as a reviewer roadmap and should be read together with the detailed existing conditions, impact assessment, mitigation, and RPP consistency discussions presented in the body of this application.

Table 1-2. Regional Policy Plan Consistency Matrix

RPP System / Technical Bulletin Topic	Applicability	Consistency Summary	Key Avoidance, Minimization, and Mitigation Measures	Primary Supporting Sections
Water Resources	Applicable because the Project occurs within the Cape Cod Sole Source Aquifer, mapped WHPAs, contributing areas to sensitive waters, wetlands, floodplain areas, and the Herring River Watershed ACEC.	The Project has been designed to protect groundwater, surface water, and watershed functions by avoiding Zone I WHPAs, limiting permanent disturbance, using HDD beneath the Cape Cod Canal, and implementing construction-phase controls to prevent sedimentation, spills, and water quality degradation.	Route refinement to avoid Zone I areas; phased and coordinated construction water use; erosion and sediment controls; SPCC procedures; controlled dewatering; HDD best practices and inadvertent return response; stormwater management at aboveground facilities; restoration of temporary workspaces.	Sections 3.3.1.2, 3.3.8, and 5.3.1

RPP System / Technical Bulletin Topic	Applicability	Consistency Summary	Key Avoidance, Minimization, and Mitigation Measures	Primary Supporting Sections
Wetlands Resources	Applicable because the Project includes work within or near coastal and inland wetland resource areas, floodplain resource areas, Isolated Vegetated Wetlands, and wetland buffer zones.	The Project avoids permanent wetland fill to the maximum extent practicable and limits wetland impacts primarily to temporary construction disturbance that will be restored following construction. The Cape Cod Canal crossing avoids direct in-water disturbance through HDD.	HDD beneath the canal; reduced workspace widths at wetland crossings; construction matting where needed; erosion and sediment controls; wetland restoration to preconstruction contours and hydrology; environmental inspection; compliance with FERC wetland procedures and federal and state permit requirements.	Sections 5.3.2 , 5.3.3, and 5.4.2
Wildlife and Plant Habitat	Applicable because the Project overlaps mapped Priority Habitat and Estimated Habitat and includes temporary and permanent disturbance to forested, shrubland, utility corridor, wetland, and open upland habitats.	The Project has minimized habitat impacts through collocation with existing utility corridors, reduction of tree clearing, restoration of temporary workspace, NHESP coordination, and development of species-specific avoidance, protection, restoration, and net benefit mitigation measures.	Approximately 90 percent collocation of G-31 and G-32 ROWs with existing utility easements; reduction of tree clearing from approximately 66.0 acres to approximately 44.8 acres; NHESP CMP process; turtle, rare plant, clam shrimp, and invasive plant management measures; native restoration seed mixes; proposed permanent protection of approximately 60 acres of off-site forestland.	Section 5.3.4
Ocean Resources	Applicable because the Project crosses beneath the Cape Cod Canal, a federal navigation channel and coastal waterway with associated coastal wetland and marine resource areas.	The Project avoids direct impacts to the canal, navigation, fisheries, shellfish habitat, and canal sediments by installing the G-31 pipeline beneath the canal using HDD rather than dredging or open-cut trenching.	HDD beneath the canal; no dredging; no in-water trenching; no fill placement in the canal; HDD monitoring and inadvertent return procedures; coordination with marine resource agencies; protection of public navigation and waterway functions.	Sections 5.3.2 and 5.4.2
Open Space	Applicable because the Project affects Article 97-protected open space, conservation, water supply, and wildlife management lands.	The Project minimizes open space impacts by using existing utility corridors and previously disturbed areas where practicable, restoring temporary workspaces, coordinating Article 97 approvals, and proposing compensatory long-term habitat preservation.	Coordination with affected landowners and state agencies; Article 97 review and approval process; use of existing utility corridors; restoration of temporary workspaces; proposed acquisition and permanent protection of approximately 60 acres of undeveloped forestland adjacent to JBCC and Camp Edwards WMA.	Section 5.3.5
Community Design and Visual Character	Applicable because aboveground facilities, construction workspaces, access roads, and vegetation clearing may temporarily or permanently affect local visual character.	The Project is generally compatible with the existing utility, transportation, military, and developed landscape context. Aboveground facilities have been sited and designed to avoid or reduce visual impacts, and temporary construction disturbance will be restored following construction.	Use of existing infrastructure corridors; siting of facilities away from sensitive residential viewpoints where practicable; preservation of existing vegetation buffers; restoration of disturbed areas; landscape screening and fencing treatments where needed.	Sections 5.4.1 and 5.5

RPP System / Technical Bulletin Topic	Applicability	Consistency Summary	Key Avoidance, Minimization, and Mitigation Measures	Primary Supporting Sections
Coastal Resiliency and Climate Change	Applicable because portions of the Project are near coastal resources, mapped flood hazard areas, and areas considered in regional climate resiliency planning.	The Project has been evaluated in relation to coastal flooding, sea level rise, stormwater, and long-term infrastructure resilience. The canal crossing will be installed below the canal bed, and aboveground facilities will incorporate stormwater management and resiliency considerations.	HDD below the canal; avoidance of permanent fill in flood storage areas; stormwater management at aboveground facilities; restoration of disturbed floodplain areas; evaluation of projected sea level rise and coastal flood risk; continued compliance with permit-required resiliency measures.	Sections 5.4.2 and 5.4.7
Infrastructure and Utilities	Applicable because the Project relocates and replaces existing natural gas infrastructure to accommodate the CCBP.	The Project directly supports regional infrastructure objectives by resolving conflicts between existing energy infrastructure and planned bridge replacement construction while maintaining existing service reliability and avoiding an increase in pipeline capacity.	Relocation of bridge-attached and bridge-adjacent pipeline facilities; removal, abandonment, and replacement of existing facilities; construction of new and relocated M&R stations; continued coordination with Massachusetts Department of Transportation (MassDOT), USACE, Eversource, National Grid, FERC, and other infrastructure stakeholders.	Sections 2.2, 3.2 and 5.4.3
Transportation	Applicable because construction will occur near regional roadways, the Cape Cod Canal transportation network, and CCBP work areas.	Transportation impacts are expected to be temporary and construction-related. The Project supports the long-term regional transportation benefit of allowing the CCBP to proceed while maintaining reliable energy service.	Traffic Management Plan; use of contractor yards near construction areas; traffic controls, signage, and flaggers where needed; coordination with MassDOT, Town of Bourne, JBCC, and other roadway authorities; scheduling to minimize disruptions where practicable.	Sections 3.3.5, 3.3.12, and 5.4.4
Energy	Applicable because the Project involves natural gas transmission infrastructure serving Cape Cod.	The Project maintains existing energy reliability and service continuity for Cape Cod while not increasing interstate pipeline capacity or expanding natural gas service. It replaces infrastructure that must be relocated due to the CCBP.	No increase in transportation capacity; replacement of existing service function; relocation of existing bridge-conflict facilities; compliance with federal pipeline safety requirements; coordination with National Grid and FERC.	Sections 2.2, 3.1, 3.2, 3.3, and 5.4.5
Waste Management	Applicable because construction and demolition activities will generate construction debris, removed pipe, vegetation, and other regulated or recyclable materials.	Construction waste will be managed through approved reuse, recycling, disposal, and demolition procedures in accordance with applicable federal, state, and local requirements.	Waste Management Plan; reuse or recycling of construction materials where practicable; off-site disposal at approved facilities; demolition notification where required; proper handling of removed pipe, construction debris, vegetation, and HDD residuals.	Sections 3.3.9 and 5.4.6

RPP System / Technical Bulletin Topic	Applicability	Consistency Summary	Key Avoidance, Minimization, and Mitigation Measures	Primary Supporting Sections
Cultural Heritage	Applicable because the Project has been reviewed for potential effects on archaeological and historic architectural resources.	The Project has undergone cultural resource review and consultation. Investigations have documented archaeological and historic architectural resources, and consultation has been conducted with the Massachusetts Historical Commission, Tribal representatives, FERC, and other consulting parties.	Section 106 consultation; archaeological surveys; historic architectural survey; Tribal consultation; post-review discovery procedures; avoidance or minimization of effects where practicable; continued compliance with cultural resource commitments.	Sections 2.4.4 and 5.5.1
Economy	Applicable because the Project affects regional infrastructure, construction activity, tax revenues, and the CCBP schedule.	The Project provides regional economic benefit by enabling the CCBP to proceed while maintaining existing energy service. Construction activity is expected to generate short-term local economic benefits, and operation may support continued tax and infrastructure reliability benefits.	Coordination with CCBP schedule; use of local and regional labor and materials where available; maintenance of energy reliability for homes and businesses; avoidance of service disruption that could adversely affect the regional economy.	Section 5.5.2
Housing	Applicable because construction workers, construction traffic, and infrastructure service reliability may relate indirectly to housing and residential community conditions.	The Project is not expected to create long-term housing demand or displace existing housing. Temporary construction workforce needs are expected to be accommodated within existing regional resources, and the Project maintains existing energy service to residential customers.	No residential displacement; coordination with affected landowners; construction access and traffic management near residential areas; restoration of disturbed residential or adjacent lands; maintenance of uninterrupted energy service.	Section 5.5.3

2 INTRODUCTION AND REGULATORY FRAMEWORK

2.1 Application Purpose

Algonquin submits this Development of Regional Impact (DRI) application to the Cape Cod Commission (Commission) for review and approval of the Cape Cod Canal Pipeline Relocation Project (Project), located entirely within the Town of Bourne, Barnstable County, Massachusetts. The Project is subject to DRI review because it exceeds the Commission's thresholds for DRI review as described in Barnstable County Ordinance 90-12, Chapter A, Sections 2 and 3.

The purpose of this application is to demonstrate that the Project has been planned, designed, and refined in a manner that is consistent with the goals, objectives, and minimum performance standards contained in the Cape Cod RPP. The application also demonstrates that the Project has incorporated extensive avoidance, minimization, restoration, and mitigation measures to reduce environmental and community impacts while providing important regional infrastructure benefits.

Importantly, the Project is a relocation and replacement project. Upon completion, Algonquin's existing design capacity to transport natural gas to National Grid delivery points will remain unchanged. The Project does not increase interstate pipeline capacity or expand natural gas service to Cape Cod. Rather, it replaces existing facilities that must be relocated as a result of the bridge replacement program.

2.2 Project Overview

On September 29, 2025, Algonquin filed an application with the FERC in Docket No. CP25-552 seeking authorization under Sections 7(b) and 7(c) of the Natural Gas Act to construct, operate, abandon, and modify certain interstate natural gas facilities as part of the Project. FERC issued its Environmental Assessment for the Project on May 29, 2026.

The Project is a critical infrastructure resiliency initiative that will maintain uninterrupted natural gas service to Cape Cod while accommodating the planned replacement of the Bourne and Sagamore Bridges through the CCBP. The bridges currently support critical natural gas delivery infrastructure serving Cape Cod, and replacement of these structures requires relocation of the existing bridge-mounted facilities. The CCBP is being implemented jointly by the Massachusetts Department of Transportation (MassDOT) and the U.S. Army Corps of Engineers (USACE), which owns and operates the Cape Cod Canal and both bridges.

The Project involves modifications to Algonquin's existing interstate natural gas transmission system within the Town of Bourne, Massachusetts, including:

- Installation of approximately 6.33 miles of new 16-inch- and 18-inch-diameter pipeline.
- Removal of approximately 2.03 miles of existing pipeline.
- Abandonment in place of approximately 1.44 miles of existing pipeline.
- Relocation of the existing Bourne and Sagamore M&R Stations.
- Construction of the new Pave Paws Road and Bourne Rotary M&R Stations.
- Improvements to associated valve sites, launcher and receiver facilities, access roads, and temporary construction support areas.

The existing gas delivery system serving Cape Cod relies on two National Grid high-pressure pipelines attached to the Bourne and Sagamore Bridges. Natural gas is delivered from Algonquin's interstate

transmission system to National Grid at the existing Bourne and Sagamore M&R Stations located north of the Cape Cod Canal. National Grid then transports gas across the Canal through bridge-mounted pipelines to customers throughout Cape Cod. Because these pipelines and associated facilities conflict with future bridge replacement activities, they must be relocated before bridge construction can proceed.

To address this need, Algonquin and MassDOT entered into an agreement under which Algonquin will construct replacement pipeline facilities capable of providing the same level of natural gas service currently available to Cape Cod. The Project will replace existing infrastructure with a modern underground system designed to provide the same operational capacity while improving reliability, maintainability, and long-term resiliency.

A key Project objective is to maintain uninterrupted natural gas service throughout construction and bridge replacement activities. To support the CCBP schedule, portions of the Project must be placed into service before bridge construction begins. Failure to complete the relocation would constrain implementation of the CCBP and jeopardize continued natural gas service to Cape Cod communities.

The Project has undergone extensive refinement through the MEPA process, FERC review, agency coordination, and stakeholder outreach. These refinements reduced overall land alteration resulting in an approximately 18.6-acre reduction in disturbed area and a 21.2-acre reduction in tree clearing, while incorporating enhanced stormwater management and environmental protection measures. The current Project footprint includes approximately 210.2 acres of construction disturbance and approximately 60.9 acres of permanent operational area.

Upon completion, the Project will maintain Algonquin's existing design capacity to deliver natural gas to National Grid and will continue operating at the same maximum allowable operating pressures as the existing system. The Project represents a replacement and relocation of existing facilities and will provide a more resilient long-term energy infrastructure solution while supporting one of the region's most important transportation improvement projects.

2.2.1 PROJECT SCHEDULE

To accommodate the CCBP construction schedule and maintain uninterrupted natural gas service to National Grid's distribution system, portions of the Project must be placed into service before construction of the replacement Sagamore Bridge begins. Project construction is scheduled to commence in January 2027, with primary facilities placed into service during the fourth quarter of 2027 and remaining restoration and facility retirement activities completed in 2028.

2.3 Regulatory Framework

The Project is currently undergoing review by multiple federal, state, regional, and local regulatory agencies (Table 2-1).

At the federal level, FERC serves as the lead federal agency and is responsible for reviewing the Project pursuant to the Natural Gas Act. Additional federal approvals include permits and consultations with the USACE, U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), and associated federal agencies.

At the state level, the Project has undergone review under MEPA (EEA No. 16947). Algonquin submitted a Final Environmental Impact Report (FEIR) to the MEPA Office on May 15, 2026 following issuance of the Secretary's Certificate on the DEIR. The FEIR incorporates Project refinements, mitigation commitments, permit status updates, and responses to agency comments received during environmental

review. The Secretary issued a Certificate on the FEIR on June 29, 2026 determining that the Project adequately and properly complies with MEPA and its implementing regulations.

The Project additionally requires approvals under the Massachusetts Wetlands Protection Act (WPA), Chapter 91 Waterways Program, Section 401 Water Quality Certification Program, Massachusetts Endangered Species Act (MESA), and Article 97 disposition process, among other state permitting programs. Regional review is being conducted through this DRI application to the Cape Cod Commission.

The Cape Cod Commission has participated throughout the MEPA process, including review of the Environmental Notification Form (ENF), DEIR, and FEIR. Algonquin respectfully requests that these materials be incorporated into the record of this DRI proceeding as supporting documentation for the Commission's review.

Table 2-1. Permits and Approvals[1]

Permit/Approval	Administering Agency	Status	Permit File Numbers
Federal and Tribal			
Natural Gas Act Section 7(c) – Certificate of Public Convenience and Necessity	Federal Energy Regulatory Commission (FERC)	Anticipated September 2026	CP25-552-000
National Environmental Policy Act – Environmental Assessment Review	FERC	Environmental Assessment issued on May 29, 2026	CP25-552-000
Section 404/10 Permit	U.S. Army Corps of Engineers (USACE) New England District	Application submitted October 2025; anticipated permit issuance September 2026	NAE-2024-02916
Section 14/408 Permit	USACE New England District	Application submitted October 2025; anticipated permit issuance September 2026	NAE-2024-02916
Real Estate Outgrant Permit	USACE New England District	Application submitted October 2025; anticipated permit issuance September 2026	
National Pollutant Discharge Elimination System General Permit for Dewatering and Remediation Discharges	U.S. Environmental Protection Agency	To be submitted approximately 60 days prior to hydrostatic test water discharges	
Endangered Species Act Section 7 Clearance	U.S. Fish and Wildlife Service	Initial information requested initiated December 2023; application submitted October 2025; approval issued June 25, 2026	2025-0132897
Endangered Species Act Section 7 Clearance	National Marine Fisheries Service	Submitted December 2025; approval issued July 9, 2026	GARFO-2026-01397
Section 106 Consultation	Massachusetts Historical Commission	Consultation initiated August 2023; consultation complete	

[1] Notwithstanding anything to the contrary set forth in this section, nothing stated herein shall be construed to indicate that any state, regional, or local agency referred to has the power to impose any requirement inconsistent with federal law or to refuse to issue or to unreasonably delay the issuance or processing of any state, regional, or local permit, license, certificate, approval, review, or other requirement, nor shall this document be construed to limit Algonquin's legal rights under the Natural Gas Act (15 United States Code [USC] 717, et seq.), Pipeline Safety Improvement Act (49 USC 60101, et seq.), or U.S. Constitution, including, but not limited to, the Supremacy Clause and the Commerce Clause.

Permit/Approval	Administering Agency	Status	Permit File Numbers
Section 106 Consultation	Massachusetts Board of Underwater Archaeological Resources	Consultation initiated August 2023; consultation complete	
Section 106 Consultation	Barnstable Historical Commission	Consultation initiated August 2023; consultation complete	
Section 106 Consultation	Mashpee Wampanoag Indian Tribe Tribal Historic Preservation Officer (THPO)	Consultation initiated August 2023; consultation complete	
Section 106 Consultation	Narragansett Indian Tribe THPO	Consultation initiated August 2023; consultation complete	
Section 106 Consultation	Wampanoag Tribe of Gay Head Aquinnah THPO	Consultation initiated August 2023; consultation complete	
Letter of No Objection	U.S. Department of Defense; U.S. Army	Submitted August 2025; anticipated approval June 2026	
State			
Environmental Notification Form (ENF) Certificate	Massachusetts Executive Office of Energy and Environmental Affairs (EEA)	ENF submitted April 30, 2025; Certificate received June 2025	EEA No. 16947
Draft Environmental Impact Report (DEIR) Certificate	EEA	DEIR submitted January 15, 2026; Certificate received March 2026	EEA No. 16947
Final Environmental Impact Report (FEIR) Certificate	EEA	FEIR submitted May 15, 2026; Certificate issued June 29, 2026	EEA No. 16947
Article 97	EEA	Anticipated legislative approval September 2026	
Federal Consistency Determination	Massachusetts Office of Coastal Zone Management	Submitted May 5, 2023; anticipated approval September 2026 with USACE permit	
Chapter 91 License – WW01 – Water-Dependent License	Massachusetts Department of Environmental Protection (MassDEP) – Boston Office	Application submitted July 2, 2026; anticipated approval September 2026	26-WW01-0100-APP
401 Water Quality Certification	MassDEP – Southeast Region	Submitted October 14, 2025; Permit issued July 10, 2026	25-WW10-0033-APP
Massachusetts Endangered Species Act Project Review and Conservation and Management Permit	Massachusetts Natural Heritage and Endangered Species Program	Consultation initiated February 2025; anticipated approval of the Conservation and Management Permit December 2026	
State Highway Access Permits	Massachusetts Department of Transportation (MassDOT) – District 5 Office	Road crossing/occupancy permit application submitted April 30, 2026 Curb cut permit applications submitted May 13, 2026	(MassDOT-Highway Access Permit Application # 5-2026-0466)
Regional			
Development of Regional Impact	Cape Cod Commission	Submitted July 24, 2026; anticipated approval December 2026	
Local			
Order of Conditions under the Massachusetts Wetlands Protection Act	Bourne Conservation Commission	Submitted July 1, 2026; anticipated approval August 2026	NOI-26-17

2.4 Outreach and Prior Public and Agency Input

Since 2023, Algonquin has conducted extensive outreach and coordination with regulatory agencies, municipal officials, Tribal representatives, landowners, community organizations, and other stakeholders to support development of the Project. Input received through these efforts has informed Project design refinements, reductions in temporary workspace, minimization of tree clearing, stormwater management improvements, and environmental protection commitments incorporated into the current Project design.

2.4.1 FERC PUBLIC OUTREACH

The Project entered the FERC pre-filing process in January 2025 (Docket No. PF25-4-000). As part of this process, Algonquin conducted a public open house in Bourne on March 4, 2025, and participated in a FERC public scoping meeting on April 23, 2025, to solicit feedback on Project facilities, environmental impacts, and construction activities. Algonquin subsequently filed its formal certificate application with FERC in September 2025, and FERC issued its Environmental Assessment on May 29, 2026. The 30 day public comment period on the EA ended on June 29, 2026.

2.4.2 AGENCY AND MUNICIPAL COORDINATION

Algonquin has coordinated extensively with federal, state, regional, and local agencies throughout Project development, including FERC, USACE, MassDOT, Massachusetts Department of Environmental Protection (MassDEP), NHESP, the Massachusetts Historical Commission (MHC), the Massachusetts Office of Coastal Zone Management, the Cape Cod Commission, the Town of Bourne, and JBCC. Coordination has focused on Project design, environmental review, utility relocation, construction sequencing, resource protection, and permitting requirements. Particular emphasis has been placed on coordination with MassDOT and USACE to ensure compatibility with the CCBP and maintain uninterrupted natural gas service during bridge replacement activities.

2.4.3 MEPA AND CAPE COD COMMISSION REVIEW

The Project has undergone comprehensive review under MEPA, including preparation of an ENF, DEIR, and FEIR. Comments received from agencies, stakeholders, and the Cape Cod Commission during the MEPA process contributed to Project refinements and mitigation commitments reflected in the current design. Information developed during the MEPA review, including alternatives analyses, technical studies, and responses to comments, supports this DRI application.

2.4.4 TRIBAL AND CULTURAL RESOURCE CONSULTATION

In coordination with FERC and MHC, Algonquin conducted consultation with the Mashpee Wampanoag Tribe, Wampanoag Tribe of Gay Head (Aquinnah), and Narragansett Indian Tribe regarding cultural resources and areas of traditional significance. Tribal representatives participated in archaeological investigations and site visits conducted during 2024 and 2025 and provided input that informed cultural resource studies and Project planning. Additional coordination occurred with state and local historical and archaeological review agencies as part of the Section 106 process.

2.4.5 ONGOING STAKEHOLDER ENGAGEMENT

Algonquin will continue to coordinate with agencies, municipalities, landowners, Tribal representatives, and other stakeholders throughout permitting, construction, restoration, and operation of the Project. Ongoing outreach will focus on construction schedules, traffic management, access coordination,

environmental protection measures, restoration activities, and implementation of permit commitments to ensure timely communication and continued stakeholder involvement throughout Project execution.

2.5 Application Organization

This DRI application has been organized to provide the Cape Cod Commission with a comprehensive evaluation of the Project and its consistency with the 2025 RPP. The application incorporates information developed through the FERC review process, MEPA process, technical resource studies, agency consultation, and ongoing Project design refinements.

The application is structured as follows:

- Section 1 – Executive Summary
- Section 2 – Introduction and Regulatory Framework
- Section 3 – Project Purpose, Need, and Description
- Section 4 – Alternatives Analysis
- Section 5 – Regional Policy Plan Consistency
- Section 6 – Conclusions
- Section 7 – References

Supporting technical reports, environmental studies, permit application materials, agency correspondence, mapping, figures, and other reference documents are provided as attachments. Together, these materials document how the Project has been planned, designed, and refined to avoid, minimize, and mitigate impacts while maintaining critical energy infrastructure necessary to support Cape Cod's communities and the implementation of the CCBP.

3 PROJECT PURPOSE, NEED, AND DESCRIPTION

3.1 Purpose and Need

The purpose of the Project is to remove, abandon, and relocate segments of Algonquin's existing infrastructure to accommodate the requirements of the CCBP and to continue providing uninterrupted natural gas service to National Grid by replacing National Grid's two existing bridge-attached pipelines with new natural gas infrastructure designed to meet the same capacity requirements. The Project is needed because bridge-attached utilities cannot be reinstalled on the replacement Bourne and Sagamore Bridges and must be relocated.

Natural gas supply is currently transported from the Algonquin interstate pipeline system to National Grid delivery points located north of the Cape Cod Canal. National Grid transports gas across the canal through high-pressure pipelines attached to the Bourne and Sagamore Bridges. These bridge-attached pipelines and associated M&R/take station infrastructure must be relocated to avoid conflicts with the CCBP. Following completion, Algonquin's design capacity to transport natural gas to National Grid delivery points will remain unchanged.

3.2 Proposed Facilities

3.2.1 NEW PIPELINES

The following pipeline facilities are proposed to replace National Grid's two existing 10-inch-diameter natural gas pipelines that are currently attached to the Bourne and Sagamore Bridges and supply National Grid's customers located on Cape Cod. The Project facilities described below are designed to maintain safe and reliable service to existing customers. The Project proposes 6.33 miles of new natural gas pipeline installation, with 3.47 miles to be removed or abandoned.

3.2.1.1 G-31 Pipeline

Algonquin's G-31 pipeline is proposed to replace National Grid's existing supply of natural gas that currently crosses over the Cape Cod Canal via National Grid's pipelines attached to the Bourne Bridge and Sagamore Bridge. The G-31 pipeline includes the installation of approximately 2.17 miles of 18-inch-diameter pipeline that will transport natural gas from the vicinity of an existing valve site located at the junction of Algonquin's multiple G-system pipelines southeast across the Cape Cod Canal to its terminus at the proposed Pave Paws Road M&R Station (Attachment 1, Figure 3.2-1). The G-31 pipeline crossing of the Cape Cod Canal will be the only crossing of the Canal for the Project and will be installed using HDD technology. See Section 3.3.1.2 for information on the HDD method.

3.2.1.2 G-32 Pipeline

Algonquin's G-32 pipeline is proposed to replace National Grid's existing supply of natural gas that currently crosses over the Cape Cod Canal via National Grid's pipeline attached to the Bourne Bridge. The G-32 pipeline includes the installation of approximately 3.07 miles of 16-inch-diameter pipeline. The G-32 pipeline will transport natural gas from the proposed Pave Paws Road M&R Station to the proposed Bourne Rotary M&R Station (Attachment 1, Figure 3.2-1). The G-32 pipeline will not cross the Cape Cod Canal; instead the natural gas will be delivered to the proposed Bourne Rotary M&R Station via an interconnection with the G-31 pipeline at the proposed Pave Paws Road M&R Station.

3.2.2 REMOVED AND RELOCATED PIPELINES

3.2.2.1 G-24 Pipeline Removal and Relocation

Approximately 0.49 mile of Algonquin's existing 18-inch-diameter G-24 pipeline will be removed and relocated starting approximately 125 feet east of U.S. Route 6 and ending at the east side of the Sagamore Bridge near the intersection of Hunters Brook Road and Canal Street (see Attachment 1, Figure 3.2-1). With the relocation of Algonquin's existing Sagamore M&R Station, this segment of the existing G-24 pipeline will no longer be required to distribute gas. Algonquin's decision to abandon or remove the applicable segments of the G-24 pipeline is based on existing easements and landowner directives.

The G-24 pipeline will be rerouted approximately 0.20 mile north of the current G-24 pipeline crossing of the Sagamore Bridge to avoid conflict with the workspace required to complete the CCBP. The relocated pipeline segment will be an approximately 0.68-mile-long, 18-inch-diameter pipeline. The portion of the relocated G-24 pipeline that intersects the Sagamore Bridge overpass will be installed using HDD technology to avoid interference with the CCBP. The relocated segment of the G-24 pipeline will connect to the proposed Sagamore M&R Station then proceed south adjacent to the eastern shoulder of Canal Street to tie in to Algonquin's existing G-24 pipeline system. Algonquin will require out grant permission (i.e., long-term easements) on USACE property for the newly located G-24 pipeline (and G-11 pipeline). Algonquin continues to work on finalizing the appropriate agreements.

3.2.2.2 G-11 Pipeline Removal

The G-11 Pipeline currently occupies the same ROW as the G-24 Pipeline, and they will also be collocated in the relocated design. Approximately 0.31 mile of Algonquin's existing 8-inch-diameter G-11 pipeline will be removed and relocated starting approximately 125 feet east of U.S. Route 6, similar to the G-24 pipeline relocation. With the relocation of Algonquin's existing Sagamore M&R Station at the end of the G-11 pipeline, this segment of the existing G-11 pipeline will no longer be required to distribute gas. After the relocation, the G-11 will now end at the proposed Sagamore M&R Station, while the G-24 will continue into Canal Street.

The G-11 pipeline will be relocated up to approximately 0.15 mile north of the current G-11 pipeline alignment to avoid conflict with the workspace required to complete the CCBP. The relocated segment of pipeline is an approximately 0.43-mile-long, 8-inch-diameter pipeline. The relocated segment of the G-11 pipeline that intersects the Sagamore Bridge overpass will be installed using HDD (bundled with the G-24 HDD) to avoid conflict with the CCBP. The relocated segment of the G-11 pipeline will terminate at the proposed relocated Sagamore M&R Station (see Attachment 1, Figure 3.2-1). Algonquin will require new permanent easement or out grant permission (i.e., long-term easements) on USACE property for the newly located G-11 pipeline, which will be a joint easement for G-24 and G-11 pipeline. Algonquin's decision to remove the applicable segments of the G-11 pipeline is based on existing easements and landowner directives (see Section 2.9). After the portion of the original G-24 pipeline is abandoned/removed, the ROW will be restored per Algonquin's Erosion and Sedimentation Control Plan (E&SCP).

3.2.2.3 G-8C and G-8L Pipeline Removal

Approximately 1.33 miles of Algonquin's existing 8-inch-diameter G-8C pipeline and approximately 1.33 miles of the existing 8-inch-diameter G-8L pipeline will be removed or abandoned in place between Algonquin's existing Bourne M&R Station site and the proposed relocated Bourne M&R Station (Attachment 1, Figure 3.2-1). With the relocation of Algonquin's existing Bourne M&R Station, currently located at the end of the G-8C and G-8L pipelines, these segments of the existing G-8C and G-8L pipelines will no longer be required to transport gas. The portion of the G-8C and G-8L pipelines scheduled for

removal is being done at the request of MassDOT to avoid conflicts with the CCBP. The portion of the pipelines to be abandoned in place is due to adjacent landowners to this stretch of the ROW. Pipeline removal in these locations would required tree cutting and extensive property disturbance.

Algonquin continues to coordinate closely with MassDOT regarding the removal of existing pipeline on MassDOT property within the G-8C/G-8L pipeline easement. Currently, Algonquin understands that MassDOT will require approximately 0.65 mile of each of the existing G-8C and G-8L pipelines to be removed from MassDOT's property to avoid conflict with the CCBP. After the portion of the existing G-8C/G-8L pipelines are removed and the ROW has achieved full restoration, Algonquin will finalize the agreement with MassDOT.

Algonquin has been coordinating with remaining landowners along the G-8C and G-8L pipelines regarding abandoning the pipelines in place. Currently, no landowners have objected to the in-place abandonment of the pipelines and Algonquin anticipates approximately 0.68 mile of each of the G-8C and G-8L pipelines will be abandoned in place. Landowner agreements have been negotiated and are in place for the G-8C and G-8L pipeline abandonment segments.

3.2.3 RELOCATED ABOVEGROUND FACILITIES

Algonquin proposes to remove and relocate the Bourne and Sagamore M&R Stations to avoid conflicts with the CCBP. To maintain uninterrupted gas service to National Grid's Bourne-Cape and Sagamore-Cape systems, Algonquin also plans to construct two new M&R stations: the Pave Paws Road M&R Station and the Bourne Rotary M&R Station.

Currently, Algonquin operates two M&R stations in the Project area: the Bourne M&R Station and Sagamore M&R Station, which both supply natural gas to National Grid. National Grid receives gas at these locations via take stations that feed into its distribution system, including two pipeline headers attached to the Bourne and Sagamore Bridges. At present, Algonquin does not have any M&R stations directly supplying National Grid's Bourne-Cape and Sagamore-Cape systems.

To accommodate the CCBP's utility exclusion zones, Algonquin will remove the existing Bourne and Sagamore M&R Stations and relocate them to new sites outside of the exclusion zones to continue serving National Grid's mainland customers.

Additionally, Algonquin is installing a new natural gas transmission pipeline (G-31) across the Cape Cod Canal, replacing the existing transport provided by National Grid's two high-pressure header pipes. As a result, Algonquin must construct two new M&R stations on Cape Cod to deliver gas into National Grid's system:

- The Pave Paws Road M&R Station will supply the Sagamore Service Area from the G-31 pipeline.
- The Bourne Rotary M&R Station will supply the Bourne Service Area from the G-32 pipeline.

These new stations will be strategically located near National Grid's two service areas to ensure reliable delivery. A discussion on the need for constructing two new M&R stations is provided in Section 3.2.3.

In summary, Algonquin is removing and replacing the two mainland M&R stations to facilitate CCBP construction and maintain service to National Grid's Bourne-Mainland and Sagamore-Mainland areas. Two additional Algonquin M&R stations are required on Cape Cod to deliver gas from the G-31 and G-32 pipelines into National Grid's Sagamore-Cape and Bourne-Cape distribution systems. Refer to Section 4 for additional details on M&R station alternatives.

3.2.3.1 Sagamore M&R Station

Algonquin's existing Sagamore M&R Station is located immediately adjacent to the Sagamore Bridge, currently associated with the existing G-24 and G-11 pipelines, and must be relocated to avoid conflict with the CCBP facilities. Facilities that are reusable from the existing Sagamore M&R Station may be relocated to the proposed location northeast of the Sagamore Bridge between Meetinghouse Lane and Canal Street (Attachment 1, Figure 3.2-1). All other above- and belowground infrastructure at the existing Sagamore M&R Station will be completely removed at the request of the landowner; new and/or revised agreements will be negotiated with the landowner to provide Algonquin with the rights needed for Project. All workspace necessary for the decommissioning and removal of the existing Sagamore M&R Station is shown in the alignment sheets in Attachment 2.

3.2.3.2 Bourne M&R Station

Algonquin's existing Bourne M&R Station is located immediately adjacent to the Bourne Bridge, at the terminus of Algonquin's existing G-8C and G-8L pipelines. This facility must be relocated to avoid conflict with the CCBP. Facilities that are reusable from the existing Bourne M&R Station may be relocated to the proposed location along Algonquin's existing 8-inch-diameter pipelines G-8C and G-8L between Massachusetts Route 25 (Route 25) and Heather Hill Road (Attachment 1, Figure 3.2-1). All other above- and belowground infrastructure at the existing Bourne M&R Station will be completely removed at the request of the landowner; new and/or revised agreements will be negotiated with the landowner to provide Algonquin with the rights needed for the Project. All workspace necessary for the decommissioning and removal of the existing Bourne M&R Station is shown in the alignment sheets in Attachment 2.

3.2.4 NEW ABOVEGROUND FACILITIES

3.2.4.1 Pave Paws Road M&R Station

The proposed Pave Paws Road M&R Station will be installed west of Pave Paws Road at the eastern terminus (milepost [MP] 2.15) of Algonquin's proposed G-31 pipeline and starting point of the proposed G-32 pipeline (Attachment 1, Figure 3.2-1). This M&R Station location was selected to transport natural gas to National Grid's high-pressure gas pipeline in the Sagamore area. Algonquin and National Grid collaborated to identify a location that minimizes impacts to the surrounding community and environment while also interconnecting with National Grid's existing natural gas distribution system.

3.2.4.2 Bourne Rotary M&R Station

The proposed Bourne Rotary M&R Station will be installed approximately 0.20 mile southeast of Massachusetts Route 28 (Route 28), southeast of the Bourne Rotary, at MP 3.07 of Algonquin's proposed G-32 pipeline (Attachment 1, Figure 3.2-1). This M&R Station location was selected to transport natural gas to National Grid's high-pressure gas pipeline in the Bourne area. Algonquin and National Grid collaborated to identify a location that minimizes impacts to the surrounding community and environment while also interconnecting with National Grid's existing natural gas distribution system.

3.2.4.3 Valve Sites

An existing valve site at the G-system interconnection with the proposed G-31 pipeline will be expanded as part of the Project. The valve site will be expanded primarily within areas already disturbed by pipeline construction and will be located primarily within Algonquin's existing permanent ROW. The location of the proposed valve site expansion is shown on alignment sheets provided in Attachment 2.

3.2.4.4 Launcher and Receiver Sites

A pipeline pig is an inline inspection device used to clean or inspect the pipeline. Pig launchers and receivers are aboveground facilities where pipeline pigs are inserted or retrieved from the pipeline. Pig launcher and receiver sites will be located primarily within the existing or proposed permanent ROW. A new launcher and receiver facility is proposed at the start and end of the proposed G-31 and G-32 pipelines. New receiver facilities will also be required at the reconfigured terminus points for the G-11, G-8C, and G-8L pipelines. Locations of proposed launcher and receiver sites are shown on alignment sheets provided in Attachment 2.

3.2.5 ACCESS ROADS

To the extent feasible, existing public and private road crossings along the Project will be used. Existing dirt and gravel access roads within the Project area created and frequently used by other utility companies will be used to the extent practicable. A total of 39 access roads will be used during construction of the Project. See Figure 3.2-2 in Attachment 1 for Project transportation details.

3.2.5.1 Temporary Access Roads

A total of 19 temporary access roads (TARs) will be utilized for the Project. The typical width for TARs during construction will be 25 feet wide. This 25-foot width will allow for equipment travel (approximately 20 feet) and upwards of 5 feet of space to stage equipment and/or materials on the side of the TARs. Any TARs utilized for the Project that will result in temporary land disturbances will follow appropriate mitigation measures implemented in compliance with Algonquin's E&SCP (Attachment 3), as well as the FERC's *Upland Erosion Control, Revegetation, and Maintenance Plan*, May 2013 version (FERC Plan) and *Wetland and Waterbody Construction and Mitigation Procedures*, May 2013 version (FERC Procedures), to prevent and minimize temporary impacts to surrounding areas (FERC 2013a, 2013b).

3.2.5.2 Permanent Access Roads

During construction, 20 PARs will be utilized. The width of the PARs will vary between 15 and 35 feet depending on site conditions and equipment requirements. During operation, PARs will be 20 feet wide. Any improvements made to the PARs (e.g., grading or installing gravel, if necessary) will be maintained by Algonquin's operations personnel to provide continuing access to the ROW and M&R station sites in these locations.

3.2.6 CONTRACTOR WARE YARDS

Seven contractor ware yards have been identified along the proposed G-24, G-31, and G-32 pipelines to accommodate construction. The currently identified contractor ware yards are shown in Attachment 1, Figure 3.2-1. Table 3-1 presents the land requirements for currently identified contractor ware yards proposed for temporary use during construction.

Algonquin evaluated potential contractor yard locations within the Project area, prioritizing previously developed open land and parcels used for commercial or industrial purposes. However, such suitable land in the Project area is extremely limited. Consequently, Algonquin has identified four yards for the G-31 pipeline within existing transmission line corridors in proximity to pipeline construction. This land is open and maintained in a non-forested condition, so tree removal is not anticipated to prepare the yards for use.

Locating the yards within the transmission line corridors enables Algonquin to significantly reduce construction vehicle and equipment traffic on public roads in the Project area. Because these yards are

adjacent to the construction workspace, equipment, vehicles, materials, and workers can safely and efficiently move between the yards and the workspace without traveling on public roads, except for crossing Bournedale Road. Additionally, utilizing these existing corridors positions much of the construction activity away from nearby residential areas, providing both visual and noise buffers.

Despite the availability of certain areas of the electric transmission line corridor for yards, Algonquin does require additional land for contractor yards outside these electric transmission line corridors for the construction of the G-32 pipeline. Due to the limited access points from public roads to the transmission line corridors for construction vehicles, equipment, and workers, Algonquin designed a construction plan that includes two contractor yards at the southern end of the proposed G-32 pipeline, east of the Bourne Rotary. These yards are on undeveloped land with direct access to Route 28 and the Bourne Rotary.

The primary and largest yard, designated G32-1, is a parcel historically used as a racetrack. This site consists of a mix of open, unvegetated land and patches of forest. The second yard, G32-3, is located on open land utilized for training by JBCC, positioned on the eastern edge of the transmission line corridor directly across from G32-1.

Anticipated improvements to contractor ware yards are identified in Table 3-1. Appropriate mitigation measures will be implemented in compliance with Algonquin's E&SCP, as well as the FERC Plan and Procedures, to prevent and minimize temporary impacts to surrounding areas.

Table 3-1. Contractor Ware Yards for the Cape Cod Canal Pipeline Relocation Project

Facility	Yard	Size (acres)	Existing Condition	Anticipated Improvements
G-24 Pipeline	G24-1	0.4	Residential lawn	None
G-31 Pipeline	G31-1	0.8	Existing utility easement	Vegetation clearing and grading
	G31-2	0.4		
	G31-3	6.1		
	G31-4	2.3		
G-32 Pipeline	G32-1	8.7	Open land, historic racetrack, forested land	Vegetation clearing, tree removal, and grading
	G32-3	4.3	Open land, JBCC training area	Vegetation clearing and grading
Total:		**23.0**		

Note: Totals may not sum exactly due to rounding.

3.3 Construction Methods

This section describes construction methodologies as well as the sequence of activities and addresses construction-related topics such as schedule, construction work hours, environmental compliance, monitoring, and mitigation. Project facilities will be constructed in compliance with applicable federal and state laws and regulations, and the specific requirements of required permits. Refer to Table 2-1 for a full list of regulatory requirements.

3.3.1 PIPELINES

3.3.1.1 General Construction Procedures

The following sections identify the general construction procedures for routine pipeline construction, as well as the specific construction techniques that will be used in environmentally sensitive areas for the Project :

Right-of-Way Survey

Before the start of construction, land surveys will be finalized, the pipeline centerline and construction workspace will be marked, and land or easement acquisitions will be addressed. The construction work area (e.g., construction ROW and additional temporary workspaces [ATWS]) will first be surveyed and staked. Sensitive resources will be located and marked to prevent accidental damage during pipeline construction. Landowners will generally be notified at least 3 to 5 days before the start of construction unless earlier notice is requested in the easement negotiations.

Clearing Operations

Initial clearing operations will include the removal of vegetation within the pipeline ROW and the temporary construction workspace either by mechanical means or hand-cutting. The limits of clearing will be identified and flagged in the field prior to any clearing operations. In wetlands, trees and brush will either be cut with rubber-tired and/or tracked equipment, or hand-cut. Unless grading is required for safety reasons, wetland vegetation will be cut off at ground level, leaving existing root systems intact, and the aboveground vegetation will be removed from the wetlands for chipping or disposal.

In uplands, tree stumps and rootstock will be left in the temporary construction workspace wherever practicable to encourage natural revegetation. Stumps will be removed from the ROW to approved disposal locations or made available to landowners upon request. Timber will be removed from the ROW to approved locations in a manner and quantity that will not adversely impact the establishment or growth of vegetation and will be sold for lumber or pulp. Brush and tree limbs will be chipped and removed from the ROW for approved disposal. Wood chips will be sold as fuel or other marketable products, spread in approved locations and used as mulch, or hauled off-site for disposal.

The cleared width within the ROW and temporary construction workspace will be kept to the minimum that will allow for spoil storage, staging, assembly of materials, and all other activities required to safely construct the Project. Closely following clearing and before grading activities, erosion controls will be installed at the required locations as outlined in Algonquin's E&SCP (see Attachment 3).

Right-of-Way and Temporary Construction Workspace Grading

The entire width of the construction ROW, including the temporary construction workspace, will be rough-graded as necessary to allow for safe passage of equipment and to prepare a work surface for pipeline installation activities. However, as stated above, tree stumps and rootstock in upland areas will be left in the temporary construction workspace wherever possible to encourage natural revegetation, unless grading is required for safety reasons.

Algonquin will attempt to minimize grading through wetlands to the extent practicable, but grading in wetlands may still be required. Prior to grading in wetlands, a topographic survey will be completed of the wetland to ensure the wetland is restored to preconstruction conditions and contours following the completion of the Project. Wetland vegetation will be cut off at ground level, leaving existing root systems intact, unless disturbance of the root zone is required for safety purposes. Typically, the grading of the

ROW will be completed with bulldozers. Excavators will be used in conjunction with bulldozers in areas where deep cuts exist or where boulders and tree stumps require removal.

Topsoil segregation methods will be used in residential areas, unless otherwise approved in writing by the landowner prior to the commencement of grading. An Environmental Inspector will measure depths of topsoil up to 12 inches and document preconstruction topsoil depths where topsoil segregation is performed to ensure that actual topsoil depths are replaced during restoration.

Topsoil will be stripped and stockpiled along the ROW from either the full work area or the ditch plus spoil area in residential areas to the extent practicable. The topsoil will remain segregated to prevent mixing with the subsoil during construction activities. For worker safety and pipeline integrity, topsoil will not be stripped off existing pipeline and electric transmission line corridors where they overlap with construction workspace. There may be some areas where the construction ROW is limited, and topsoil will need to be stockpiled in approved ATWS areas. Topsoil may be replaced, as necessary, should mixing of topsoil with subsoil occur.

The mixing of topsoil with subsoil will be minimized by using topsoil segregation construction methods in wetlands (except when standing water or saturated soils are present). Where applicable, the size, density, and distribution of rock left in construction work areas should be similar to adjacent areas not disturbed by construction, unless otherwise approved in writing by the landowner prior to the commencement of grading. Algonquin will ensure that any imported soils are free of weeds and other environmental contaminants.

Trench Excavation

A trench will be excavated to the proper depth to allow for the burial of the pipe. In general, the trench will be deep enough (approximately 6 feet deep) to provide for 3 feet of cover over the pipelines as required by 49 Code of Federal Regulations (CFR) Part 192 of the U.S. Department of Transportation (USDOT) regulations and Algonquin's specifications. If required by a landowner, the pipeline will be buried at a greater depth to accommodate the landowner's ongoing use of the property. Burial depth can also be increased in certain areas based on consultation with the collocated utility company and type of land use crossed.

During trenching, the excavated material will be placed next to the trench to avoid unnecessary movement of machinery across the terrain. Should it become necessary to remove water from the trench, it will be pumped to a filter fabric bag or siltation device in an off-ROW, stable, vegetated upland area (where practical). In certain cases where side slopes are leveled to make a safe work environment before trench excavation, the amount of cover over the pipe will be increased after the slopes are restored.

Blasting

Based on geologic conditions, Algonquin does not anticipate the need for blasting to construct the Project. If unrippable subsurface rock is encountered, blasting for ditch excavation will be necessary. In these areas, care will be taken to prevent damage to underground structures (e.g., cables, conduits, septic systems, electric transmission tower foundations), groundwater resources (e.g., springs, water wells, other water sources), or aboveground structures (e.g., homes, electric transmission towers). In the event blasting is required, a Blasting Plan will be developed.

Blasting mats or soil cover will be used as necessary to prevent the scattering of loose rock. All blasting will be conducted during daylight hours and will not begin until occupants of nearby buildings, stores, residences, places of business, and farms have been notified. Algonquin's contractor will comply with Algonquin's blasting plan and with all federal, state, and local regulations applying to blasting and blast vibration limits with regard to structures and underground utilities. With these measures, and the

implementation of the measures in Algonquin's E&SCP, impacts associated with blasting will be minimized to the extent practicable.

Stringing

Once the trench is excavated, the next process in constructing a pipeline is stringing the pipe along the trench. Stringing involves initially hauling the pipe by tractor-trailer, generally in 40- or 60-foot lengths, from the pipe storage yards onto the ROW. The pipe will be off-loaded from trucks and placed next to the trench using a sideboom tractor. The pipe joints are lined up end-to-end to allow for welding into continuous lengths known as strings.

Bending

Once the sections of pipe have been placed on the ROW, the pipe is bent as necessary, so the pipe fits the horizontal and vertical contours of the excavated trench. The bending engineer will survey the trench to determine the location and amount of each field bend. This information is marked on each piece of pipe so the bending foreman can make the appropriate pipe bends. Pipe is usually bent with a hydraulic pipe-bending machine. Pipe bends will be relatively long and gradual, which must be considered when the trench is dug.

Welding

All welding is performed in accordance with American Petroleum Institute Standard No. 1104 and Algonquin specifications. The individual joints of pipe are welded together in two steps. The front-end welding crew, or pipe gang, will perform the first step. This crew will clean and align the pipe bevels in preparation for welding and place at least the first two passes in the welding process. The back-end welding crew, or firing line, performs the second step, completing the welds started by the front-end welders. The pipe is welded into long strings to minimize the number of welds that need to be made in the trench (tie-in welds). Gaps in the pipe-welding process are often left by the welding crews at water/wetland crossings, road crossings, and other locations where access across the work area is required or when the pipe will be installed later in the construction process. Automatic welding may be used on some segments.

Nondestructive Weld Inspection

After welding, each weld is inspected to ensure its structural integrity is consistent with 49 CFR Part 192 of the USDOT regulations. Radiographs or ultrasonic images are taken and processed on-site for virtually instantaneous results. Those welds that do not meet the requirements established by the American Petroleum Institute Standard 1104 and Algonquin's specifications are marked for repair or replacement.

Weld Repair

The contractor may establish a weld repair crew, usually one welder and helper working independently, to follow the radiography crew to make any weld repairs that are required. All repaired and replaced welds are inspected to ensure proper repair and integrity.

Coating Inspection and Repair

The pipeline is coated to prevent corrosion. The pipe lengths will be coated (usually with a heat-applied epoxy) at a coating mill prior to being delivered to the Project facilities. The ends of each piece are left bare to allow for welding. Once welds have been inspected and accepted, the weld area is field coated by the coating crew. Because pipeline coatings are electrically insulating, the coating is inspected using equipment that emits an electric charge to ensure there are no locations on the pipeline where there is a defect in the coating.

Lowering-In

After a pipe string has been coated and inspected, the trench is prepared for the installation of the pipeline. The trench is cleared of loose rock and debris. If water exists in the trench, the water is pumped out into a well-vegetated upland area, except in wetland areas where the "push pull" installation may be required. In sandy soils, the trench is shaped to support the pipe. In areas where the trench contains bedrock, a sand bedding is placed on the bottom of the trench, and/or pads made of sandbags and/or clay are placed at regular intervals along the trench bottom to support the pipe. The lowering-in crew places the pipeline in the trench. Lowering-in is usually done with sideboom tractors.

Tie-Ins

Once the sections of pipe are lowered in, the tie-in crew makes the final welds in the trench. Additional excavations as needed, lowering-in, lining up, welding, nondestructive weld inspection, and coating the final welds are accomplished by this crew.

Backfilling

All suitable material excavated during trenching will be replaced in the trench. In areas where excavated material is unsuitable for backfilling, additional select fill may be required. If the soil is rocky, the pipe is padded with relatively rock-free material placed immediately around the pipe. This material may be obtained from commercial borrow areas in the region. Where suitable, the subsoil may be mechanically screened to produce suitable padding material. Padding of the pipe is usually performed with backhoes. If padding is obtained from an off-site source, it is normally placed in the trench by front-end loaders. In no case will topsoil be used as padding material. Once the pipe is padded, the trench is then backfilled with suitable excavated subsoil material.

During backfilling, Algonquin will minimize erosion potential by restoring the natural contour of the ground and surface drainage patterns as close to preconstruction conditions as practicable. The top of the trench may be slightly crowned to compensate for settling except in wetlands, where the crown could introduce hydrology issues, or paved areas, where standard compaction methods will be employed. The topsoil is then spread across the graded construction ROW when applicable. The soil will be inspected for compaction and scarified as necessary.

Cleaning

Once the pipeline's tie-ins are completed, it is internally cleaned with pipeline pigs. A manifold is installed on one end of the long pipeline section and a pig is propelled by compressed air through the pipeline into an open pig catcher. The purpose is to remove any dirt, water, or debris that was inadvertently collected within the pipeline during installation.

Hydrostatic Testing

After cleaning, the pipeline will be pressure tested in accordance with Algonquin's and the USDOT's requirements to ensure its integrity for the intended service and operating pressures. The pipeline is hydrostatically tested with water that will be obtained from municipal water sources, and Algonquin does not anticipate any additives will be required for the water source.

Hydrostatic test water is pumped from a water source into the pipeline, which propels a pig through the pipeline in a manner that fills the pipeline with water. Test pressure is obtained by adding water to the test section with a high-pressure pump. Test water will contact only new pipe along the G-31, G-32, G-24, and G-11 pipelines, and no chemicals will be added to the test water unless otherwise approved by FERC and applicable federal and/or state regulatory agencies. At the completion of the hydrostatic test, the pressure

is removed from the section of pipe and the water is released from the test section by propelling the pig with air, which forces the water from the pipeline. Additional drying pig runs are made, if necessary, to remove any residual water from the pipeline.

The water in the pipe will be pressurized and held for a minimum of 8 hours in accordance with the USDOT Pipeline and Hazardous Materials Safety Administration Office of Pipeline Safety requirements identified in 49 CFR Part 192 prior to being placed in service. Any loss of pressure that cannot be attributed to other factors, such as temperature changes, will be investigated. Leaks detected will be repaired and the segment will be retested.

Upon completion of the test, the water may be pumped to the next segment for testing, where practicable. The test water will be discharged through an energy-dissipation device in compliance with the E&SCP or permit conditions, if applicable (see Attachment 3). The discharge rate will be regulated using valves and energy-dissipation devices to prevent erosion. Algonquin will apply for agency approval for the discharge of hydrostatic test water.

Water required for hydrostatic testing and HDD activities will be obtained from local public water suppliers, including the Buzzards Bay Water District, North Sagamore Water District, and Bourne Water District. Algonquin will coordinate directly with each water district to review anticipated construction water demands and obtain any necessary permits or approvals prior to withdrawing water. If one or more water districts cannot approve or supply the requested water volumes, alternatives will be evaluated, including transporting water to the HDD workspace via water containment trucks from an approved mainland source. The total volume of water required for hydrostatic testing is estimated to be approximately 350,500 gallons (Table 3-2). Construction-related water use will be temporary and will occur incrementally throughout the construction period, consistent with testing and construction sequencing. As hydrostatic testing will be performed separately for individual pipeline segments, water withdrawals will occur in phases based on the contractors testing sequence, rather than as a single withdrawal event, allowing water use to be managed in accordance with each district's available capacity and operational requirements by the applicable water district. Algonquin will obtain the necessary agency approvals for upland discharge of hydrostatic test water, and final discharge locations will be developed in coordination with the construction contractor and consistent with the conditions of the applicable permit approval.

Table 3-2. Water Requirements by Facility

Pipeline Facility	Estimated Water Requirement (gallons)	Applicable Water District for Withdrawal
G-8L and G-8C	300	Buzzards Bay
G-11	6,000 HDD Pre-test 3,500	North Sagamore
G-31	140,400 HDD Pre-test 46,800	Buzzards Bay
G-32	153,500	Bourne

The Project will incorporate water conservation measures, including the reuse and recycling of hydrostatic test water between compatible test segments where practicable and consistent with construction, safety, and water quality requirements. Water used for HDD pre-tests will also be recycled for final hydrostatic testing where feasible, reducing overall demand on local water supplies. Any hydrostatic test water that cannot be reused will be discharged in accordance with applicable regulatory approvals and permit conditions.

Water required for HDD activities will be withdrawn separately on an as-needed basis and stored in frac tanks (portable aboveground water storage tanks) located at the G-31 and G-24/G-11 HDD workspaces. HDD water will be incorporated into drilling mud and recycled during drilling operations to the extent practicable. Upon completion of HDD construction, drilling mud will be removed from the site and transported to an approved disposal facility; therefore, HDD-related water will not be discharged on-site. If one or more water districts are unable to supply the required water volumes, alternative water sources will be evaluated, including transportation of water to the HDD workspace by water trucks from an approved mainland source. Collectively, these measures will minimize temporary demands on local public water supplies and help protect Cape Cod's sole-source aquifer.Once a segment of pipe has been successfully tested and dried, the test cap and manifold will be removed, and the pipe will be connected to the remainder of the pipeline. No desiccant or chemical additives will be used to dry the pipe. Algonquin will implement Section VII of the FERC Procedures regarding hydrostatic testing, as well as any specifications pertaining directly to hydrostatic test water discharge in applicable regulatory approvals.

Restoration and Revegetation

The clean-up crew completes restoration and revegetation of the ROW and temporary construction workspace. In general, every effort will be made, weather and soil conditions permitting, to complete final clean-up (including final grading) and installation of permanent erosion control measures within 20 days after the trench is backfilled. These restoration activities will be completed in residential areas within 10 days of backfilling. In conjunction with backfilling operations, any woody material and construction debris will be removed from the ROW. The ROW will be final graded to prepare for restoration. Permanent slope breakers will be constructed and maintained in accordance with the FERC Plan. Fences and stone walls will be restored or repaired as necessary.

Revegetation will be completed in accordance with federal, state, and local requirements, including regarding seeding mixes, rates, and dates and in accordance with Algonquin's E&SCP. The ROW will be seeded within 6 working days following final grading, weather and soil conditions permitting. Alternative seed mixes may be used that are specifically requested by the landowner or required by agencies.

3.3.1.2 Horizontal Directional Drilling

The Project involves two HDDs, one to install the G-31 beneath the Cape Cod Canal and the second to pass beneath U.S. Route 6 and Canal Street at the Sagamore Bridge. The HDD method involves boring a pilot hole beneath the waterbody to the opposite bank and then enlarging the hole with one or more passes of a reamer until the hole is the necessary diameter. A prefabricated pipe segment is then pulled through the hole to complete the crossing.

A successful drill generally results in no impact to the waterbody bed or banks of the waterbody being crossed. While the HDD method is a proven technology, there are certain impacts that could occur as a result of the drilling, such as an inadvertent release of drilling mud. Drilling mud is most often composed of naturally occurring materials such as bentonite. Inadvertent returns of drilling mud can be caused by pressurization of the drill hole beyond the containment capacity of the overburden soil material. Providing adequate depth of cover for the HDD installation can substantially reduce this potential impact. Returns could occur in the area of the mud pits or along the path of the drill.

Algonquin has developed a Best Drilling Practices, Monitoring, and Clean-up of Horizontal Directional Drilling Inadvertent Returns Plan that is based on its extensive experience with successful HDD projects. The effective construction management contingency procedures outlined in the Plan will minimize construction-period disturbances for nearby land uses and will minimize the already-remote potential for an inadvertent return of drilling fluid.

This plan will be implemented to avoid and minimize potential impacts associated with the HDD activities. See Attachment 4 for additional details.

In order to facilitate the HDD, Algonquin will require two landfall sites: one entry point for the HDD from the north side of the Canal and one exit point for the HDD on the south side of the Canal. The entry point for the HDD will be located within an abandoned gravel and sand pit located adjacent to an existing driveway leading toward a solar facility off Grand Army of the Republic Highway, and the exit point will be located just west of Jarvis Road within Eversource's existing utility ROW to its terminal at the proposed Pave Paws Road M&R Station. The HDD will be approximately 87 feet below the bed of the Cape Cod Canal.

Algonquin will use a construction travel lane from the HDD entry point to the northern bank of the Cape Cod Canal and from the HDD exit point to the southern bank of the Cape Cod Canal for monitoring during HDD activities. The travel lane on each side of the Cape Cod Canal will be 40 feet wide to allow for monitoring the HDD and allow Algonquin the space to respond to an inadvertent return should one occur during the HDD. The travel lane between the Sagamore Bridge HDD entry and exit point will be 10 feet wide. See Attachment 1 (Figures), Attachment 2 (Alignment Sheets), and Attachment 4 (Best Drilling Practices, Monitoring, and Clean-up of Horizontal Directional Drilling Inadvertent Returns Plan).

Algonquin anticipates that when applying the HDD method under the Cape Cod Canal, approximately 460,000 gallons of water will be used, and while applying it under the Sagamore Bridge, approximately 313,000 gallons of water will be used. All additives in the drilling mud will be National Sanitation Foundation (NSF) 60–approved and may include Bara-Kade Plus, Super Gel-X, Max Gel, AMC Gel, and SW-101. NSF approval means that any drilling fluid additives used with the HDD are safe for use in proximity to groundwater and drinking water supplies, including public water supply aquifers.

3.3.1.3 Wetland Construction Methods

Construction activities within the three IVWs occurring in the Project workspace will be performed in accordance with the applicable federal and state requirements, as well as Algonquin's E&SCP (see Attachment 3). Construction within these IVWs will be temporary and conducted in a manner designed to avoid permanent impacts to wetland functions and values, including hydrology, vegetation, and wildlife habitat. Following construction, all wetland areas will be restored to preconstruction contours and conditions to the extent practicable, with revegetation and stabilization measures implemented in accordance with applicable federal and state requirements. The wetland construction methods described below are intended to minimize disturbance during construction and ensure the full recovery of wetland resources following completion of Project activities.

Clearing crews will cut existing wetland vegetation outside of the trench to a height slightly above ground level to facilitate regrowth. No upland woody debris will be disposed of in wetlands. Stumps will only be removed from the ditch line or travel lane as necessary for safe working conditions. Excavated stumps may be turned over in place in the travel lane to stabilize the ROW and promote sprouting and revegetation or will be removed from the wetland and disposed of by chipping or transported to an approved disposal facility.

The amount and type of construction equipment that operates within a wetland will depend on the soil conditions at the time of construction. If the wetland soils are not saturated at the time of construction and can support both tracked and rubber-tired equipment (e.g., excavators, sideboom tractors, welding trucks) with or without supplemental support, the unsaturated trench soils will be excavated and the assembled pipe sections will be lowered into the trench using conventional construction techniques, thereby minimizing the length of time that topsoil is segregated and the trench is open. If necessary, weights or concrete-coated pipe will be used to provide negative buoyancy. If dewatering of the trench is necessary, it will be conducted

in a manner designed to prevent heavily silt-laden water from entering a waterbody or wetland. Topsoil segregation methods and locations are based on wetland saturation conditions. In wetland areas without standing water or saturated soils, up to 1 foot of topsoil will be stripped from the ditch line and stockpiled separately from trench spoil.

Supplemental equipment supports, such as construction mats (heavy timbers bolted or cabled together, or similar materials), provide temporary portable support for heavy construction equipment and will be used in wetlands to support the equipment and minimize soil compaction and/or soil mixing, as necessary. Additionally, construction mats may be deployed when mixing of topsoil with subsoil is beginning to occur or to facilitate equipment passage through a wetland. The decision to use matting is based on field conditions (e.g., soil saturation and potential for significant rutting) at the time of construction as well as the protection of sensitive resources. Environmental Inspectors will monitor site conditions and determine implementation of construction mats based on site conditions.

ATWS may be required in areas adjacent to wetlands to facilitate the pipeline construction. These work areas are in addition to the typical construction ROW and may be used for the assembly and fabrication of the pipe section that will cross the wetland area. The size of ATWS required at wetland crossings is based on the wetland size, water content of wetland soils (or presence of standing water), and other construction constraints. The work area will be limited to the minimum size necessary to safely construct the wetland crossing. Restricting the work area in this manner will minimize wetland impacts associated with pipeline construction.

3.3.1.4 Removal and Abandonment

Segments of Algonquin's existing G-8C and G-8L pipelines will be removed or abandoned, and segments of the G-24 and G-11 pipelines will be removed as part of the Project. Prior to pipe removal or abandonment, Algonquin will attempt to recapture 80 to 90 percent of the gas in the pipeline and any remaining gas in the pipeline that cannot be recaptured will be released to the atmosphere.

For pipe removal and abandonment, similar construction procedures as described in Section 3.3.1.1 will be executed for ROW survey, clearing operations, and ROW and temporary construction workspace grading. For areas of pipe removal, once the workspace is prepared, a trench will be excavated to expose the existing pipeline in Algonquin's easement. During trenching, the excavated material will be placed next to the trench to avoid unnecessary movement of machinery across the terrain. Should it become necessary to remove water from the trench, it will be pumped to a filter fabric bag or siltation device in an off-ROW, stable, vegetated upland area (where practical). In certain cases where side slopes are leveled to make a safe work environment before trench excavation, the amount of cover over the pipe will be increased after the slopes are restored.

Following trench excavation, the pipe to be removed will be taken out of the trench in sections for disposal at an approved facility in accordance with federal and state requirements. Following the removal of the pipe, the trench will be backfilled and restored as outlined in Section 3.3.1.1.

Abandoned pipe will be blown down and purged with nitrogen to clear the line. The abandoned pipe segment will then be cut and capped on each end with one 0.75-inch valve on each cap. Algonquin will then grout the line completely, remove the valves, and install plugs. The trench will be backfilled and the construction ROW will be restored to preconstruction conditions. Algonquin will adhere to the measures described in the FERC Plan and Procedures, its E&SCP, and any applicable federal or state requirements.

3.3.2 ABOVEGROUND FACILITIES

The proposed Project aboveground facilities will be constructed in compliance with the same federal and state legal requirements as the pipeline facilities, including the specific requirements of applicable federal and state permits. The construction and restoration methods and procedures in Algonquin's E&SCP will be followed, as applicable, for the aboveground facilities as well. Aboveground facilities have been sited to avoid cultural and natural resource impacts to the greatest extent practicable.

The general construction procedures for new M&R stations consist of clearing and grading the site, installation of foundations, installation of piping, installation of the structures and machinery, start-up, testing, and final clean-up and stabilization of the site. The general construction procedures described below are applicable to the relocated M&R stations (Sagamore M&R Station and Bourne M&R Station) as well as the new M&R stations (Pave Paws Road M&R Station and Bourne Rotary M&R Station).

Clearing and Grading

At each of the proposed M&R station sites, the amount of clearing of land will be limited to what is needed to construct the M&R station facilities. After the land is cleared, the construction access road to the site will be established. The site will then be graded, as necessary, to stockpile topsoil for use during site restoration and provide level surfaces for the building foundations and structures; the station facilities, which will contain piping, valves and stormwater runoff controls out to the perimeter fencing; and sufficient construction workspace. Installation of various erosion and sedimentation controls will begin before site grading to contain soil and potential runoff from migrating off-site. These will be designed, installed, and maintained in accordance with Algonquin's E&SCP and any stormwater studies and designs (Attachment 5). The permanent site roadways and parking areas will be rough-graded at this time as well. Large rocks displaced during grading or other excavation will be properly disposed of on-site or transported off-site for disposal in an approved area.

Foundations

Once the building sites have been graded, excavation will begin for the installation of building foundations and pipe supports. Once the ground surface area has been prepared, forms and reinforcing bars will be installed and high-strength concrete will be poured to the appropriate design levels. Algonquin has completed geotechnical investigations at the proposed M&R station sites. Blasting, although not anticipated, may be required at specific locations to install foundations and underground piping.

Piping

Installation of piping at the M&R stations will begin at about the same time as the foundation work. Trenches will be dug for the underground portions of the piping. The pipe will be welded, radiographed, coated, and placed in the trench and backfilled. Some portions of the station piping will extend above ground level. Any aboveground piping will be installed on concrete or metal pipe supports and painted. Acoustic insulation may be installed on some of the piping for noise control. Some of the piping, valves, and fittings are typically fabricated off-site at a fabrication shop and then transported to the site. As major parts of the piping are completed, each will be hydrostatically tested to ensure its integrity. Test water may be trucked to the site for the testing or obtained from on-site wells, and will be discharged in accordance with Algonquin's E&SCP or the Massachusetts Stormwater Management Standards at each site, as applicable (see Attachment 5). Dewatering is performed with proper erosion and sedimentation controls as set forth in Algonquin's E&SCP. Electrical conduit and telecommunication systems will be installed during this period.

Structures and Machinery

Once the foundations have been completed and have cured sufficiently, installation of the buildings and machinery for the station may begin. This is a highly coordinated activity as the machinery, buildings, and piping are all installed during the same time period. Various piping and electrical conduit systems are connected once the machinery is set. Electrical wiring is installed for power and instrumentation.

Start-Up and Testing

As the various systems and subsystems are completed, they will be tested and calibrated for proper operation. Use of new, computerized systems will allow much of the testing to proceed before gas is received at the site.

Facility Removal

All above- and belowground infrastructure at the existing Sagamore M&R Station and Bourne M&R Station will be completely removed and disposed of off-site at an approved facility. After removal and full restoration of the M&R stations, Algonquin plans to release the easement rights to the original owner(s) or sell the parcel. Algonquin continues to work on finalizing the appropriate agreements.

In accordance with 310 Code of Massachusetts Regulations (CMR) 7.15, the Project owner or operator will submit a Construction/Demolition Notification Form (BWP AQ 06) to MassDEP through the eDEP system at least 10 working days prior to the start of demolition, along with the required fee.

Final Clean-up and Stabilization

Clean-up and stabilization of the station sites will be an ongoing process throughout construction. Sections of station sites will be final graded, fertilized, seeded, and mulched as work is completed and as provided in Algonquin's E&SCP. Permanent erosion controls will be installed on a similar basis.

3.3.3 CONSTRUCTION EQUIPMENT AND REFUELING

Construction equipment will be well-maintained, checked daily for leaks, properly tuned, and operated on an as-needed basis to minimize combustion emissions from diesel and gasoline engines. Only standard construction equipment will be used in the construction of each M&R station, with no dynamic compaction or pile driving expected. Additionally, construction equipment will not be refueled within any wetland resource area or within 100 feet of any wetland resource area. Algonquin will implement construction practices designed to mitigate potential temporary impacts to groundwater resources as detailed in its E&SCP and SPCC Plan (see Attachment 3) and the FERC Plan and Procedures, as well as the environmental performance standards for the Cape Edwards Training Area and Upper Cape Water Supply Reserve on Massachusetts's National Guard Properties as outlined in the revised *Environmental Performance Standards* (Environmental Management Commission 2026).

3.3.4 DEWATERING

Construction activities that require pumping of groundwater are limited to dewatering of the pipeline trench and should only be necessary in areas where a high water table is encountered, which is anticipated to be limited due to the well-drained soils throughout the Project area. Algonquin has modified its pipeline routing and workspace design to eliminate onshore stream crossings and minimize wetland crossings, thereby minimizing the potential to encounter groundwater during construction. Additionally, phased pipeline construction activities within a particular location are typically completed within several days, and any lowering of localized groundwater from pumping and dewatering is expected to be minor and

temporary. In order to prevent silt-laden waters from flowing into streams and wetlands and to ensure aquifers are recharged, Algonquin proposes to discharge water from dewatering activities into well-vegetated upland areas, or into straw bale structures if vegetation is insufficient to minimize erosion in compliance with applicable federal and state requirements. Implementation of these procedures should minimize groundwater impacts during dewatering operations. Algonquin will conduct construction activities in accordance with its E&SCP to minimize potential impacts to groundwater in the vicinity of the Project.

3.3.5 TRAFFIC MANAGEMENT

The existing transportation system near the Project may be impacted by commuting construction workers and transportation of construction equipment and materials. Temporary increased traffic conditions may occur. To minimize disruption, equipment and materials will be strategically located at contractor ware yards with existing adequate roadway access to the pipeline construction sites. Where access to roadways may impede traffic flow, appropriate traffic control measures will be used. To the extent practicable, construction activities within roadways will be scheduled outside of peak commuting hours and school bus transit times to minimize regional traffic impacts. The Project will ensure continuous, safe accommodations for pedestrian and bicycle traffic at all intersections. Furthermore, HDD or boring techniques will be deployed at critical transportation crossings to mitigate infrastructure disruption. Algonquin will submit a Traffic Management Plan (Attachment 6) to MassDOT, the Town of Bourne, and JBCC to obtain necessary approvals. Since construction will move sequentially along the pipeline routes, traffic flow impacts that do arise will be temporary on any given roadway.

Interstate highways as well as state and county roadways will be used to transport heavy construction equipment to the pipeline ROW. After transport to the Project, this equipment will move along the ROW as construction progresses. Where it is necessary for equipment to cross a road, traffic flow may be temporarily interrupted. Traffic disruptions will be minimized to the extent practicable, and appropriate traffic control measures such as flag persons, signs, barriers, and flashing lights will be used as necessary. Section 5.4.4 discusses mitigation measures to reduce commuting and traffic impacts during the construction phase of the Project.

3.3.6 AIR QUALITY

Construction of the Project will generate temporary air emissions from construction equipment, worker vehicles, material deliveries, fugitive dust, and natural gas blowdown and purge activities associated with installation and removal of pipeline facilities. These impacts will be localized to active construction areas and will occur only during the construction period.

Construction equipment is expected to be the primary source of emissions, while blowdown and purge activities will account for most temporary methane emissions. Air quality analyses completed for the Project used conservative assumptions intended to represent upper-end construction conditions; therefore, actual emissions are expected to be lower than those estimated.

To minimize air quality impacts, Algonquin will implement a variety of construction best management practices (BMPs), including limiting engine idling in accordance with state requirements, using ultra-low sulfur diesel fuel, maintaining construction equipment in good operating condition, and implementing dust suppression measures where needed. Fugitive dust will be controlled through watering of exposed soils and unpaved surfaces, road maintenance, appropriate vehicle speed controls, and other measures identified in the Project's Dust Control Plan and E&SCP (Attachments 7 and 3). To further reduce emissions, blowdown and purge activities will be minimized to the extent practicable and recompression may be used where appropriate.

Construction-related air quality impacts are expected to be temporary, localized, and not significant. The Project is not expected to result in long-term degradation of regional air quality. Following construction, air emissions will be limited to minor operational emissions associated with the replacement facilities, which remain below applicable regulatory thresholds.

3.3.7 NOISE

Construction noise associated with the Project will be temporary and localized, occurring during installation of new pipeline segments, removal or abandonment of existing pipeline facilities, construction of relocated and new M&R stations, access road improvements, and HDD activities. Construction noise sources will include standard heavy equipment such as excavators, loaders, cranes, trucks, generators, compressors, pumps, and HDD-related equipment. Noise levels will vary by activity, equipment type, distance to nearby noise-sensitive areas, intervening terrain or vegetation, and whether equipment operates continuously or intermittently.

The highest temporary construction noise levels are expected during activities that require concentrated equipment use, particularly at M&R station construction areas and HDD entry/exit workspaces. HDD activities may require extended work periods during certain phases to maintain bore integrity and complete pullback operations, which could result in temporary nighttime or longer-duration noise at nearby receptors if such work is required. Pipeline construction along ROWs will generally progress linearly, so noise at any one location will be limited in duration. Construction noise will not represent a permanent change in the acoustic environment and will cease once construction is complete.

Operational noise will be limited primarily to aboveground facilities, including relocated or new M&R stations and associated flow-control equipment. The buried pipeline facilities will not be a meaningful source of operational noise. Operational sound from M&R stations is expected to be continuous but relatively low-level. M&R station equipment has been selected and configured to maintain compliance with applicable noise standards and avoid adverse long-term noise impacts.

Mitigation Measures

Noise mitigation will include a combination of construction-period BMPs and facility design measures:

- Limit construction to approved hours to the extent practicable, with any required extended or nighttime work coordinated with appropriate agencies and affected stakeholders.
- Use properly maintained equipment fitted with manufacturer-recommended mufflers, exhaust silencers, and engine covers.
- Minimize unnecessary idling of construction vehicles and equipment.
- Locate stationary equipment such as generators, compressors, pumps, and light plants as far as practicable from nearby residences and other noise-sensitive receptors.
- Use temporary noise barriers, shielding, or acoustic blankets where practicable for stationary or high-noise activities near sensitive receptors.
- Sequence work to reduce the duration of high-noise activities at any one location, particularly along pipeline ROWs near residences.
- Provide advance public notification for construction activities that may generate noticeable temporary noise, especially HDD, nighttime work, or work near residential areas.
- Establish a complaint response process so noise concerns can be documented, investigated, and addressed during construction.

- Evaluate HDD-specific controls such as equipment layout optimization, shielding of generators/pumps, and use of quieter equipment where feasible.
- Design M&R stations to meet MassDEP noise policy criteria, including equipment selection, enclosure or silencing of noise-generating components, and facility layout that uses distance and orientation to reduce sound at nearby receptors.
- Verify operational noise performance if needed through postconstruction sound monitoring at representative nearby noise-sensitive areas.

With implementation of these measures, construction noise impacts will be temporary, localized, and managed through standard best practices and site-specific controls. Operational noise will be limited to aboveground M&R station facilities and will be addressed through facility design, equipment selection, and compliance with applicable MassDEP sound-level criteria. As a result, the Project is expected to avoid significant long-term noise impacts while minimizing temporary construction-period disturbance to nearby receptors.

3.3.8 EROSION AND SEDIMENT CONTROL

Construction of the Project will involve temporary ground disturbance associated with pipeline installation and removal, HDD entry and exit workspaces, aboveground facility construction, access road construction or improvement, and contractor ware yards. These activities could temporarily expose soils and increase the potential for erosion, sediment transport, and stormwater runoff if not properly controlled. The risk will be greatest in areas with disturbed soils, sloped terrain, wetland and waterbody buffer zones, access roads, stockpile areas, and locations where construction occurs near drainage features or sensitive resource areas.

The Project will implement erosion and sedimentation controls in accordance with Algonquin's E&SCP, applicable permit conditions, and standard pipeline construction BMPs. Controls will be installed before or at the start of land-disturbing activities and maintained throughout construction until disturbed areas are stabilized. The measures are intended to minimize soil exposure, prevent sediment from leaving the workspace, protect wetlands and water resources, and restore disturbed areas promptly following construction.

During operation, erosion and sedimentation risks will be substantially reduced because the pipeline facilities will be buried, disturbed workspaces will be stabilized and revegetated, and permanent aboveground facilities and access roads will include stabilized surfaces and stormwater controls. Long-term erosion controls will focus on maintaining stable vegetation, drainage patterns, access road surfaces, and stormwater management features to prevent sediment transport and protect adjacent resource areas.

3.3.8.1 Construction-Period Practices

The Project will use a combination of structural, procedural, and restoration practices, including:

- Preconstruction installation of perimeter controls, such as compost filter socks, silt fence, straw wattles, or similar sediment barriers along downslope workspace limits and near wetlands, waterbodies, drainageways, and other sensitive resources.
- Clearly defined limits of work to minimize the area of disturbance and prevent unnecessary clearing, grading, or equipment movement outside approved workspaces.
- Stabilized construction entrances and access roads to reduce tracking of sediment onto public roads and adjacent paved surfaces.

- Topsoil segregation and stockpile management, where appropriate, with stockpiles located away from wetlands, waterbodies, drainage features, and steep slopes and protected with sediment controls or temporary stabilization.
- Temporary slope stabilization, including erosion control blankets, mulch, tackifier, seed, or other stabilization measures where disturbed soils could erode before final restoration.
- Temporary stormwater conveyance controls, such as water bars, slope breakers, check dams, diversion berms, and temporary sediment traps where needed to slow runoff and promote sediment capture.
- Wetland and water resource protection measures, including redundant sediment controls where appropriate, restricted equipment access, use of swamp mats or temporary construction mats in wetland areas, and prompt restoration of temporarily disturbed resource areas.
- Dewatering controls, including use of sediment bags, filter structures, straw bale dewatering basins, frac tanks, or other filtration practices before water is discharged to stable upland areas or approved discharge locations.
- HDD-specific controls, including management of drilling fluid, secondary containment around drilling equipment and fluids, monitoring for inadvertent returns, and implementation of HDD response and cleanup procedures if drilling fluid migration occurs.
- Good housekeeping and material management, including proper storage of fuels, lubricants, chemicals, concrete washout materials, and construction debris to prevent releases that could mobilize sediment or contaminants.
- Routine inspection and maintenance, especially before and after storm events, to confirm erosion and sediment controls remain functional and are repaired or replaced as needed.
- Prompt stabilization and revegetation of disturbed areas following construction, using seed mixes, mulch, erosion control blankets, or other stabilization methods appropriate to the site condition and permit requirements.
- Removal of temporary controls only after stabilization, once disturbed areas have achieved sufficient vegetative cover or other approved permanent stabilization.

3.3.8.2 Operation and Maintenance Practices

Following construction, erosion and sedimentation control will transition to long-term stabilization and maintenance. Operational practices will include:

- Maintaining permanent vegetative cover over restored pipeline ROWs and temporarily disturbed workspaces.
- Inspecting restored areas to identify erosion, settlement, rilling, bare soil, or failed stabilization.
- Repairing erosion features promptly and reseeding, mulching, or otherwise stabilizing disturbed areas as needed.
- Maintaining permanent access roads, culverts, drainage swales, stormwater management systems, and stabilized surfaces at M&R stations and valve sites.
- Keeping stormwater controls free of sediment accumulation, debris, and obstructions.
- Maintaining restored wetland and buffer zone areas consistent with applicable permit conditions and approved restoration plans.
- Limiting routine operation and maintenance activities to approved access routes and maintained facility areas to avoid unnecessary disturbance.

- Implementing additional erosion controls during any future maintenance activities that require soil disturbance.

With implementation of the Project-specific E&SCP, construction-phase BMPs, routine inspections, dewatering controls, HDD-specific protections, and prompt stabilization of disturbed areas, the Project will minimize erosion and sedimentation during construction. Long-term operation is not expected to result in significant erosion or sedimentation impacts because disturbed areas will be restored, permanent facilities will be stabilized, and access roads and stormwater controls will be maintained to protect wetlands, water resources, and adjacent upland areas.

The E&SCP complied by Algonquin specific to the Project can be viewed in Attachment 3.

3.3.9 SOLID WASTE MANAGEMENT

Construction of the Project will generate temporary construction-related waste associated with pipeline installation, pipeline removal and abandonment, HDD activities, aboveground facility construction, access road work, contractor ware yards, and restoration. Waste materials may include cleared vegetation, excess soil and rock, trench spoils not suitable for reuse, concrete, asphalt, scrap metal, pipe segments, packaging, spent construction materials, trash, and other construction and demolition debris. The Project may also generate limited quantities of regulated or special waste if contaminated soil, asbestos-containing material (ACM), coating debris, or other suspect materials are encountered during removal or demolition activities.

Construction waste will be managed in accordance with applicable federal, state, and local requirements, MassDEP solid waste regulations, Project permit conditions, Algonquin's Waste Management Plan (Attachment 8), and contractor-specific waste handling procedures. The overall approach will prioritize waste minimization, segregation of waste streams, reuse or recycling where practicable, proper characterization of regulated materials, and disposal only at appropriately permitted facilities.

Key construction waste management practices include:

- Waste minimization and source control. Contractors will minimize excess materials through efficient staging, material ordering, and construction sequencing. Work areas will be maintained in an orderly condition to reduce unnecessary debris generation.
- Segregation of waste streams. Construction debris, recyclable materials, scrap metal, vegetation, excess soil, hazardous or regulated materials, and general trash will be separated to the extent practicable to support proper handling and disposal.
- Reuse of suitable materials. Suitable excavated soils and trench materials will be reused for backfill and restoration where geotechnically appropriate and consistent with environmental requirements. Asphalt, brick, concrete, and metal materials will be recycled where feasible.
- Management of cleared vegetation. Cleared trees, brush, stumps, and other vegetative debris will be chipped, removed, reused, or disposed of in accordance with landowner agreements, municipal requirements, and applicable permit conditions.
- Pipeline removal materials. Removed pipe, valves, appurtenances, coatings, and related materials will be handled to prevent releases of residual material and will be recycled or disposed of at approved facilities based on material condition and characterization.
- Contaminated or suspect materials. If contaminated soil, petroleum impacts, ACM, lead-containing coatings, or other regulated materials are encountered, work will be stopped or controlled in the affected area, the material will be evaluated by qualified personnel, and handling, storage, transport, and disposal will occur in accordance with applicable regulatory requirements.

- HDD waste management. Drilling fluid, drill cuttings, and inadvertent-return cleanup materials will be contained, collected, tested if required, and either reused in the drilling process or transported to an approved disposal or recycling facility. Drilling fluids will not be discharged to wetlands, waterbodies, storm drains, or uncontrolled upland areas.
- Containerized storage and housekeeping. Waste will be placed in appropriate containers, roll-off boxes, tanks, or designated stockpile areas and protected from wind, stormwater runoff, and unauthorized access. Workspaces and contractor ware yards will be inspected regularly and kept free of loose debris.
- Hazardous materials and universal waste. Fuels, lubricants, solvents, batteries, lamps, aerosols, and other regulated materials will be stored and managed in accordance with the Project's spill prevention and waste management procedures. Hazardous waste, if generated, would be labeled, accumulated, transported, and disposed of in accordance with applicable requirements.
- Documentation and disposal tracking. Waste shipments will be documented through manifests, bills of lading, weight tickets, or disposal receipts, as appropriate. Records will identify the waste type, quantity, transporter, and receiving facility.
- Use of approved facilities. All waste requiring off-site disposal will be transported by properly licensed haulers to permitted recycling, treatment, transfer, or disposal facilities authorized to accept the specific waste stream.
- Final cleanup and restoration. Upon completion of construction, temporary waste storage areas, contractor ware yards, and construction workspaces will be cleared of debris, temporary containers will be removed, and disturbed areas will be stabilized and restored in accordance with permit requirements.

During operation, the Project will generate minimal waste. The buried pipelines will not routinely produce solid waste, and waste from aboveground facilities will generally be limited to small quantities associated with periodic inspection, maintenance, vegetation management, equipment repair, replacement of filters or components, and routine facility upkeep. Any operational waste will be collected, characterized as necessary, recycled where practicable, and disposed of at approved facilities. Maintenance activities involving soil disturbance or equipment replacement will follow the same applicable waste management, spill prevention, and material handling procedures used during construction.

With implementation of Algonquin's Waste Management Plan (see Attachment 8), contractor waste controls, material segregation, recycling and reuse practices, proper handling of regulated materials, and disposal at approved facilities, construction-related waste will be managed in a manner that protects public health, prevents releases to the environment, and complies with applicable MassDEP and federal requirements. Long-term operation of the Project will generate only limited waste associated with routine maintenance and is not expected to result in significant solid waste impacts.

3.3.10 SAFETY AND PROTECTION OF EXISTING UTILITIES

Prior to construction, existing utility lines and other sensitive resources identified in easement agreements or by federal and state agencies will be located and marked to prevent accidental damage during pipeline construction. Algonquin's contractors will contact the "One Call" system, or state or local utility operators, to verify and mark all underground utilities crossed by or along the Project workspaces to minimize the potential for damage to other buried facilities in the area. Where there is a question as to the location of utilities such as water, cable, gas, or sewer lines, they will be located by field instrumentation and test pits prior to initiation of trenching.

Algonquin conducts aerial patrols of its pipeline ROW on a weekly basis, which provide a bird's-eye view of the pipeline and surrounding community. During aerial patrols, pilots look for ground changes, construction activities, or other conditions that could affect pipeline integrity. Pedestrian and vehicle patrols of all pipeline facilities are performed annually, along with scheduled preventive maintenance. Any unusual situation or condition is reported and investigated immediately. Algonquin performs annual leak detection surveys of its pipeline facilities. The leak surveys are instrumental in early detection of leaks and can reduce the likelihood for pipeline failure. The Project facilities constructed by Algonquin will be subject to similar field survey procedures.

3.3.11 ENVIRONMENTAL COMPLIANCE

Environmental training will be given to Algonquin's personnel and to contractor personnel whose activities may impact the environment during construction (training protocol and content are outlined in Algonquin's E&SCP). The level of training will be commensurate with the type of duties of the personnel. All construction personnel from the chief inspector, Environmental Inspector, craft inspectors, and contractor job superintendent to loggers, welders, equipment operators, and laborers will be given the appropriate level of environmental training. The training will be given prior to the start of construction and throughout the construction process, as needed. The Project training will cover job-specific permit conditions, company policies, cultural resource procedures, threatened and endangered species restrictions, Algonquin's E&SCP and SPCC Plan (see Attachment 3), the FERC Plan and Procedures (FERC 2013a, 2013b), and any other pertinent information related to the job. In addition to the environmental inspectors, all other construction personnel are expected to play an important role in maintaining strict compliance with all federal and state permit conditions to protect the environment during construction.

3.3.12 CONSTRUCTION HOURS AND SCHEDULE

Algonquin plans to conduct construction activities between 7:00 a.m. and 7:00 p.m., Monday through Saturday, with work on Sundays on an as-needed basis due to permit requirements, "make-up" days caused by inclement weather or other construction delays. Construction delays may result due to several factors including, but not limited to, complications during the HDD process (such as hole collapse, broken tool retrieval, etc.), local or state work-hour restrictions dictating nighttime work, inadvertent release clean up during HDD, and/or military activities on JBCC property that could interrupt construction schedules. Algonquin's Project must be completed before the CCBP is scheduled to start. Construction delays during the execution of Algonquin's Project could impact the CCBP starting as scheduled, therefore any construction delays during Algonquin's Project must be compensated to the extent practicable. Algonquin will have to work continuously (24-hour work) as construction delays arise throughout the Project in order to keep CCBP on MassDOT's schedule. A Nighttime Construction Plan has been developed and is included as Attachment 9.

Although all construction activities may require continuous work (24-hour work), typical construction activities that require continuous work (24-hour work) and may extend beyond normal construction hours and into Sunday, as necessary, include hydrostatic and/or pneumatic pressure testing of HDD sections, pipeline, and facilities; welding activities; x-ray activities, including nondestructive testing of welds; depressurizing of pipelines; painting/coating of piping; dewatering and drying of test sections, conventional bore pits, and trench or bell holes ahead of mainline installation crews; maintaining water pumps through the construction crossing cycle at wetlands, water bodies, and residential construction to ensure public safety; aboveground facilities construction (including but not limited to electrical, welding, earth disturbance, and hydrotesting); trenching activities; drilling operations for pullback; holiday detection (jeeping the pipe); final pipeline tie-in; and commissioning, line purge, and line fill activities. Equipment maintenance and service activities may also occur before and after standard work hours.

4 ALTERNATIVES ANALYSIS

The Project alternatives analysis evaluated a range of feasible options to meet the Project's core purpose: relocating Algonquin's existing natural gas pipeline and M&R facilities out of conflict with the CCBP while maintaining uninterrupted natural gas service to National Grid's Cape Cod distribution system. Because the existing bridge-mounted natural gas pipelines and associated facilities must be removed to accommodate replacement or major rehabilitation of the Bourne and Sagamore Bridges, the analysis focused on identifying off-bridge solutions that maintain equivalent service capacity, avoid conflicts with the bridge replacement program, and minimize environmental and community impacts to the maximum extent practicable.

The alternatives analysis considered no-action alternatives, system alternatives, non-gas phasing alternatives, pipeline route variations, M&R station alternatives, replacement pipeline alternatives, and alternatives for removed, abandoned, and relocated pipeline facilities. Each alternative was reviewed for its ability to satisfy the Project purpose and need, maintain reliability, avoid conflicts with MassDOT and USACE bridge replacement work zones, provide constructability within the required schedule, reduce impacts to wetlands, water resources, Article 97 lands, Priority Habitat, ACECs, public water supply areas, residences, and other sensitive receptors, and maximize collocation with existing utility and transportation corridors.

The no-action alternative was not considered feasible because it would leave existing natural gas facilities in conflict with the planned bridge replacement work and would not provide a means to maintain uninterrupted natural gas service across the Cape Cod Canal. System alternatives and non-gas phasing alternatives were also dismissed because they would not reliably replace the existing bridge-mounted gas transportation function within the schedule required by the CCBP, would not provide equivalent operational reliability, or would not avoid the need to relocate facilities affected by bridge construction.

Pipeline route alternatives were developed to evaluate potential alignments for the G-31, G-32, G-24, G-11, and other affected pipeline facilities. The preferred routes generally emphasize collocation with existing utility corridors, including existing pipeline and electric transmission ROWs, to reduce new disturbance, avoid or minimize residential impacts, limit new permanent easement needs, and reduce conflicts with existing and planned infrastructure. Although some route refinements increased disturbance in previously disturbed utility corridors or mapped Priority Habitat, these refinements reduced other impacts, including forest clearing, wetland impacts, encroachment into public water supply protection areas, proximity to residences, and conflicts with the CCBP and Eversource facilities.

The alternatives analysis also evaluated multiple M&R station sites for the relocated Bourne and Sagamore M&R Stations and new M&R facilities. Preferred M&R station locations were selected based on their ability to connect to existing and proposed pipeline systems, maintain service reliability, avoid bridge replacement work zones, reduce residential proximity, improve constructability, and limit environmental impacts. For example, the Sagamore M&R Station was shifted to a previously developed commercial parcel near Commerce Way and Canal Street, reducing residential proximity and forest clearing while supporting the HDD crossing and connection to the G-24 pipeline. The Bourne M&R Station was relocated away from conservation land and nearby residences to a site within the existing G-8L/G-8C pipeline corridor.

The Cape Cod Canal crossing alternatives focused on identifying a feasible off-bridge crossing that avoids the bridge structures, maintains service capacity, and reduces impacts to canal resources and adjacent land uses. The preferred crossing approach relies on HDD technology to install replacement pipelines beneath the Canal and associated transportation infrastructure, thereby avoiding open-cut disturbance within the Canal, limiting impacts to marine and wetland resources, and maintaining compatibility with the bridge

replacement program. HDD was selected because it offers a technically feasible means to cross the Canal while minimizing direct disturbance to surface water, navigation, and shoreline resources.

Overall, the preferred alternative represents the outcome of an iterative siting and design process that balanced engineering, safety, service reliability, constructability, schedule, environmental protection, and community considerations. The preferred alternative will relocate facilities necessary to accommodate the CCBP, maintain the same natural gas transportation capacity currently provided to National Grid, avoid use of the future bridge structures for gas transmission facilities, reduce conflicts with existing infrastructure, and incorporate avoidance, minimization, and mitigation measures for unavoidable impacts. While some environmental impacts cannot be fully avoided, the selected alternative minimizes impacts to the maximum extent practicable through collocation, HDD construction, reduced residential proximity, avoidance of key sensitive resources where feasible, and implementation of Project-specific mitigation measures. A full alternatives analysis of the Project is in Section 2.0 in the DEIR.

5 REGIONAL POLICY PLAN CONSISTENCY

The Project is a critical public infrastructure and resiliency project that will maintain uninterrupted natural gas service to Cape Cod while enabling implementation of the CCBP. As discussed throughout this DRI application, the Project has been designed to avoid, minimize, and mitigate impacts to natural and community resources while improving the long-term resiliency of critical regional infrastructure.

The Cape Cod Commission's 2025 RPP, adopted through Barnstable County Ordinance 25-13 and effective December 29, 2025, establishes a comprehensive framework for guiding development, infrastructure investment, resource protection, and climate resilience throughout Cape Cod (Cape Cod Commission 2025a). The Project addresses several core RPP objectives, including the following:

- Maintaining and improving critical regional infrastructure and public utilities.
- Supporting climate adaptation and infrastructure resiliency.
- Protecting water resources and public water supplies.
- Minimizing fragmentation of wildlife habitat and open space through use of existing utility corridors.
- Protecting wetlands, coastal resources, and natural systems.
- Maintaining community character and transportation functionality.
- Restoring temporarily disturbed lands following construction.

To determine the Project's consistency with the RPP, Algonquin evaluated Project impacts against the Commission's technical bulletins (Cape Cod Commission 2025b). The technical bulletins address Natural Systems, including Water Resources, Ocean Resources, Wetlands Resources, Wildlife and Plant Habitat, and Open Space; Built Systems, including Community Design, Coastal Resiliency, Capital Facilities and Infrastructure, Transportation, Energy, Waste Management, and Climate Change; and Community Systems, including Cultural Heritage, Economy, and Housing. Discussions of the applicable goals, objectives, and methods identified in the technical bulletins are provided in Section 5.3 for Natural Systems, Section 5.4 for Built Systems, and Section 5.5 for Community Systems.

5.1 Regional Setting

The Project is located entirely within the Town of Bourne, Barnstable County, Massachusetts. The Project area extends from the mainland north of the Cape Cod Canal, across the Canal, and onto Cape Cod, including areas within and adjacent to JBCC. The setting is defined by a varied mix of utility corridors, transportation infrastructure, military lands, conservation and recreation lands, residential neighborhoods, commercial development, and industrial uses. Existing Algonquin interstate natural gas infrastructure is already present across much of the Project area and forms an important part of the existing utility context.

Existing conditions vary substantially along the corridor because the Project traverses the developed and undeveloped landscapes surrounding the Bourne and Sagamore Bridge approaches, the Cape Cod Canal, established roadway corridors, and protected open space. Within this broader setting, the Project area includes areas that are already shaped by transportation and utility infrastructure, as well as natural resource areas that support groundwater recharge, wetlands, wildlife habitat, and recreation.

5.2 RPP Placetype Designation

A central organizing principle of the RPP is the Placetype framework, defined by the Cape Cod Commission, which recognizes that growth, infrastructure development, conservation, and resource protection should be considered within the context of the surrounding landscape. The RPP categorizes land throughout Cape Cod into a series of Placetypes that reflect existing environmental conditions, development patterns, infrastructure, and conservation priorities. These Placetypes provide the basis for evaluating consistency with RPP objectives related to resource protection, habitat conservation, climate resilience, infrastructure development, transportation, and community character.

The Project traverses a variety of developed and undeveloped land uses recognized within the Cape Cod RPP framework, including transportation infrastructure corridors, utility corridors, open space lands, military lands, and developed community areas. Existing conditions vary considerably along the Project area, reflecting the diverse landscape surrounding the Bourne and Sagamore Bridge approaches and the Cape Cod Canal (see Figure 5.2-1 in Attachment 1).

Algonquin relied on available geographic information system (GIS) mapping, the Cape Cod Commission Regional Web Map, publicly available datasets, and the definitions contained within the RPP, to determine that lands within the Project area are predominantly characterized as Natural Areas, with smaller areas of other Placetypes (Cape Cod Commission 2025c). Natural Areas include lands that remain largely undeveloped and contain regionally significant natural resources, including Priority Habitat, Estimated Habitat, wetlands and wetland buffer areas, protected open space, public water supply protection lands, wildlife habitat, and other environmentally sensitive resources. Within these areas, the RPP emphasizes protection of ecological integrity, biodiversity, groundwater resources, open space networks, and climate resilience. The non–Natural Areas Placetypes include previously developed or altered landscapes such as transportation corridors, utility ROWs, roadway infrastructure, developed facilities, and other disturbed lands. Within these areas, the RPP supports infrastructure improvements and redevelopment that maintain public services while minimizing impacts to adjacent natural resources and community character.

A substantial portion of the Project occurs within JBCC, where extensive protected natural resources occur alongside existing utility and transportation infrastructure. To analyze the Project's consistency with RPP objectives in the context of both infrastructure development and natural resource protection, Algonquin has distinguished impacts occurring within JBCC and outside of JBCC, as well as impacts within previously disturbed areas (redevelopment) and undeveloped areas.

Table 5-1 and Table 5-2 summarize the distribution of Placetypes within the Project area and the temporary and permanent impacts associated with each Placetype. The following sections evaluate Project consistency with the applicable RPP goals, objectives, and technical bulletin performance standards and demonstrate how Project design, avoidance measures, mitigation commitments, and restoration activities support the long-term environmental, economic, and community goals of the Cape Cod Commission.

Table 5-1. Total Acreage of Placetypes Present in the Project Area

Placetype	JBCC Redevelopment	JBCC New Development	Non-JBCC Redevelopment	Non-JBCC New Development
Natural Areas	79.7	18.6	61.9	18.4
Non–Natural Areas	0.0	0.0	23.6	8.0
Total	**79.7**	**18.6**	**85.5**	**26.4**

Note: Totals may not sum exactly due to rounding.

Table 5-2. Placetype Impacts in Project Area

Land	Development	Temporary or Permanent Impacts	Placetype Impacts (acres)	
			Natural Areas	Non–Natural Areas
JBCC	Redevelopment	Permanent	20.4	0.0
JBCC	New development	Permanent	11.9	0.0
JBCC	Redevelopment	Temporary	59.3	0.0
JBCC	New development	Temporary	6.7	0.0
Non-JBCC	Redevelopment	Permanent	12.0	8.2
Non-JBCC	New development	Permanent	4.9	3.6
Non-JBCC	Redevelopment	Temporary	49.9	15.4
Non-JBCC	New development	Temporary	13.5	4.4
Total			**178.6**	**31.6**

Note: Totals may not sum exactly due to rounding.

5.3 Natural Systems

The 2025 RPP adopts goals to promote the values and purposes of the Cape Cod Commission Act and to protect Cape Cod's Natural Systems. An overview of the existing natural resources in the Project area is provided in Table 5-3 below.

Table 5-3. Existing Natural Resource Setting Summary

Resource Category	Key Existing Conditions	Resource Functions
Groundwater	Project area lies within the Cape Cod Sole Source Aquifer and includes public water supply recharge areas and WHPAs..	Primary drinking water source, public supply protection, recharge, and hydrologic support for wetlands, ponds, streams, and other aquatic resources.
Surface waters	Cape Cod Canal is the dominant surface water feature in the Project area; Nightingale Pond also occurs in the Project area.	Navigation, recreation, hydrology, aquatic habitat, stormwater conveyance, and watershed connectivity.
Floodplains	Coastal and inland flood zones occur along the Canal, Nightingale Pond, and low-lying areas; Federal Emergency Management Agency (FEMA) Special Flood Hazard Areas and state-regulated flood plain resources are present.	Floodwater storage, attenuation, conveyance, groundwater recharge, and coastal/inland resilience.
Herring Brook / Herring River Watershed ACEC	Portions of the Project vicinity occur within the Herring Brook / Herring River Watershed ACEC, a designated resource area recognized for significant wetland, water quality, wildlife habitat, fisheries, flood storage, and scenic values.	Provides regional resource-protection context for wetland systems, surface-water quality, floodplain function, wildlife habitat connectivity, and scenic/resource values within the broader Project setting.
Ocean Resources	The Cape Cod Canal is a tidally influenced federal navigation channel connecting Buzzards Bay and Cape Cod Bay, with associated coastal, shellfish, fisheries, and navigation resources.	Supports navigation, marine fisheries and shellfish habitat, tidal exchange, coastal water quality, sediment transport, public access and recreation, and regional coastal resource connectivity.
Wetlands	Coastal and inland wetland systems occur in association with the Canal, Nightingale Pond, and isolated depressions in the Project area.	Water quality protection, flood storage, groundwater recharge, wildlife habitats.

Resource Category	Key Existing Conditions	Resource Functions
Wildlife and plant habitat	Mapped NHESP Priority Habitat and Estimated Habitat occur in the Project area, including Priority Habitat #455 and #601 and Estimated Habitat #400.	Supports rare plants, invertebrates, reptiles, birds, and broader sandplain, shrubland, woodland, and wetland habitat values.
Open space and protected lands	Conservation areas, water supply protection lands, USACE Canal recreation lands, Massachusetts Department of Fish and Game lands including Camp Edwards Wildlife Management Area, Town of Bourne lands, and other Article 97-protected properties occur within or adjacent to the Project area.	Habitat conservation, groundwater protection, passive recreation, and regional open space connectivity.

5.3.1 WATER RESOURCES

5.3.1.1 Existing Conditions

Groundwater

The Project area is located within the Cape Cod Sole Source Aquifer, a federally designated aquifer that serves as the primary drinking water source for Cape Cod communities (Cape Cod Commission 2026). The aquifer is underlain predominantly by permeable glacial sand and gravel deposits, which facilitate groundwater recharge and support public water supply wells, private wells, freshwater wetlands, ponds, streams, and other groundwater-dependent resources (USGS 1980).

Portions of the proposed G-31 pipeline and construction workspace, existing G-8C/G-8L pipelines and workspace, and three contractor ware yards are located within Zone II WHPAs associated with Pump Station 2, Pump Station 3, Pump Station 4, and Well 5, all owned and operated by the Buzzards Bay Water District (Massachusetts Bureau of Geographic Information [MassGIS] 2024, 2025a).

Two public water supply wells associated with the former Sandy's Restaurant in Bourne (Public Water System ID: 4036007) have designated Interim Wellhead Protection Areas (IWPA). These IWPAs overlap with a short segment of the existing G-8C/G-8L pipelines and associated construction workspace for pipeline abandonment and removal (MassGIS 2025a) (See Figure 5.3-1, Sheet 8, in Attachment 1).

The Project area also overlaps with a Cape Cod Commission–designated Contributing Area to Pond (CAP) associated with Nightingale Pond. A CAP is defined as the combined Freshwater Recharge Area and upgradient 300-foot pond buffer, delineated based on groundwater flow and groundwater contours, and represents an area where land uses may adversely affect pond water quality and ecological integrity (Cape Cod Commission 2025b, 2025c).

The Cape Cod Commission also identifies Potential Public Water Supply Areas (PPWSAs) as areas suitable for water supply development.

Figure 5.3-1 in Attachment 1 illustrates the location of PPWSAs, WHPAs, and CAP-designated lands within the Project area.

Surface Waters

The dominant surface water feature within the Project area is the Cape Cod Canal, a federally maintained navigation channel operated by the USACE that connects Cape Cod Bay and Buzzards Bay. The Canal is approximately 755 feet wide at the proposed pipeline crossing location and has a maintained navigation depth of approximately 32 feet at mean high water. As one of the most prominent water resources on Cape

Cod, the Canal serves important navigational, recreational, ecological, and hydrologic functions and is influenced by strong tidal exchanges between Cape Cod Bay and Buzzards Bay.

In addition to the Canal, the Project area contains a variety of freshwater and coastal surface water resources, including Nightingale Pond, Isolated Vegetated Wetlands (IVWs), Bordering Vegetated Wetlands (BVWs), and associated floodplain systems.

Groundwater discharge contributes substantially to the flow, water levels, and overall health of ponds, wetlands, and streams throughout the region. As a result, surface water and groundwater resources are closely interconnected, forming an integrated hydrologic system that supports drinking water supplies, aquatic habitats, and ecological functions.

Figure 5.3-1 in Attachment 1 depicts the surface water resources and associated hydrologic features within and adjacent to the Project area.

Floodplains

Floodplain resources within and adjacent to the Project area include Federal Emergency Management Agency (FEMA)–mapped Special Flood Hazard Areas and state-regulated floodplain resource areas under the WPA, including Land Subject to Coastal Storm Flowage (LSCSF), Bordering Land Subject to Flooding (BLSF), and Isolated Land Subject to Flooding (ILSF). These areas are associated with both coastal and inland hydrologic systems and provide flood storage, conveyance, groundwater recharge, and related ecological functions.

Coastal floodplain resources are concentrated near the Cape Cod Canal in the Project area and adjacent low-lying shoreline areas, where flood hazards are influenced by storm surge, wave action, tidal fluctuations, and severe coastal storm events. This FEMA-mapped coastal floodzone is classified as LSCSF under the Massachusetts WPA.

Inland floodplain resources in the Project area are associated with freshwater wetlands, ponds, and low-lying areas. A FEMA-mapped 100-year flood zone associated with Nightingale Pond is within the Project area. This flood zone is regulated as BLSF under the Massachusetts WPA. Figure 5.3-2 in Attachment 1 depicts these mapped flood hazard and floodplain resource areas.

Herring River Watershed ACEC

A portion of the Project area overlaps within the Herring River Watershed ACEC along the Eversource transmission line corridor south of Bournedale Road. The ACEC designation recognizes significant ecological resources, including wetlands, water quality, wildlife habitat, fisheries resources, flood storage functions, and scenic values. The presence of the ACEC underscores the regional importance of the wetland, water quality, habitat, and floodplain resources located within the broader Project setting.

Figure 5.3-1 depicts the extent of the Herring River Watershed ACEC in relation to the Project area.

Certified and Potential Vernal Pools

Vernal pools are seasonally ponded, typically fishless wetlands that provide important breeding and life-cycle habitat for certain amphibians, fairy shrimp, and other wildlife. Two certified vernal pools (CVPs) occur in proximity to the Project area according to MassGIS mapping (MassGIS 2025b). One CVP is mapped within W3, an IVW located approximately 115 feet north of the proposed G-31 construction ROW near MP 0.7 along the Eversource transmission line corridor south of Bournedale Road. A second CVP, mapped within IVW W10, is located approximately 100 feet south of MP 2.7 of the proposed G-32 pipeline construction workspace on JBCC. See Attachment 1, Figure 5.3-4.

No potential vernal pools were identified within 300 feet of the Project area during desktop review or field investigations.

5.3.1.2 Impact Summary

Cape Cod has a highly sensitive water resource setting that includes sole source aquifers and high-quality drinking water (public water supply protection areas), as well as fresh and marine surface water resources (freshwater wetlands, floodplain resources, and marine waters) and CAP-designated areas (Cape Cod Commission 2023, 2025c; MassGIS 2020, 2025c). Construction activities associated with the Project have the potential to affect water resources, including water use during construction, dewatering events, and impacts to recharge areas of water resources through clearing and grading. Operation of the Project may impact stormwater runoff patterns at the M&R stations and PARs.

Surface water impacts are expected to be minimal and temporary. The Cape Cod Canal will be crossed by HDD, avoiding in-water work, dredging, fill, and direct alteration of the canal bed or banks. Construction-related risks such as erosion, sedimentation, dewatering discharge, stormwater runoff, or an inadvertent drilling-fluid return will be controlled through BMPs, erosion controls, spill prevention, environmental inspection, and the HDD Best Drilling Practices Plan. No permanent adverse impacts to surface waters or water quality are anticipated.

Portions of the G-31 pipeline and G-8C/G-8L pipeline workspace, as well as three contractor ware yards, are located within the Zone II WHPA associated with Pump Station 3, Pump Station 4, and Well 5 operated by the Buzzards Bay Water District. See Table 5-4.

The G-31 pipeline was specifically routed to avoid work within the Zone I WHPAs associated with Pump Station 3, Pump Station 4, and Well 5 public water supply wells on Bournedale Road. As a result, no impacts are anticipated to these public supply wells.

Two IWPAs associated with former Sandy's Restaurant wells slightly overlap with the G-8C/G-8L pipeline workspace. The construction workspace will occupy approximately 0.3 acre of the IWPA for these wells during construction. No new facilities are proposed for the G-8C/G-8L pipeline removal and relocation activities, resulting in a temporary impact of 0.3 acre to the Natural Areas Placetype within IWPA. Within Zone II WPHAs, the Project will permanently impact approximately 5.8 acres of Natural Areas Placetype and will temporarily impact approximately 18.9 acres of Natural Areas Placetype.

Table 5-4. Wellhead Protection Areas and Placetypes Crossed by the Project

WHPA Type (Zone I or II WHPA, IWPA)	Associated Well Facility	Operator	Acres Impacted Within Natural Areas	
			Permanent	Temporary
IWPA	Sandy's Restaurant (PWS ID: 4036007)	Sandy's Restaurant	0	0.3
Zone II	Pump Stations 2, 3, & 4/ Well 5 (PWS ID: 4036001)	Buzzards Bay Water District	5.8	18.9
		Total	**5.8**	**19.2**

Note: Totals may not sum exactly due to rounding.

Approximately 74.2 acres of the Project area overlap with PPWSAs or their 400-foot Zone I radii. Of this total, approximately 22.8 acres are located outside JBCC, including approximately 7.4 acres of permanent impact. Table 5-5 summarizes the Project's overlap with PPWSAs and associated 400-foot Zone I radii. See Figure 5.3-3 in Attachment 1.

Table 5-5. Project Overlap with PPWSAs and 400-foot Zone I Radii

Location	Permanent Overlap (acres)	Temporary Overlap (acres)
Outside of JBCC	7.4	15.4
Within JBCC	19.0	32.4
Total	**26.4**	**47.8**

Note: Totals may not sum exactly due to rounding.

Construction Water Use and Groundwater Withdrawal Management

Construction water demand will be temporary and limited to hydrostatic testing and HDD-related activities. Algonquin has designed the Project schedule and construction phases to avoid large water withdrawals from single sources. Construction water use will be phased over the construction period to limit stress on local water sources. Water use and needs will be coordinated directly with applicable local water suppliers, including the Buzzards Bay Water District, North Sagamore Water District, and Bourne Water District. If requested supplies are unavailable from local districts, alternate approved sources, including trucked water from mainland sources, may be used.

Estimated construction water requirements for each facility are summarized in Table 5-6.

Table 5-6. Estimated Construction Water Requirements

Facility	Estimated Water Requirement
G-8L/G-8C	300 gallons
G-11	6,000 gallons plus 3,500 gallons for HDD pre-testing
G-24	55,950 gallons plus 17,100 gallons for HDD pre-testing
G-31	140,400 gallons plus 46,800 gallons for HDD pre-testing
G-32	153,500 gallons

Algonquin will reduce construction water demand by reusing hydrostatic test water between compatible pipeline segments where practicable and by recycling HDD pre-test water for subsequent testing where feasible. Water required for HDD mud mixtures will be stored on-site in frac tanks and recycled during drilling to the extent practicable. Water that cannot be reused will be managed and discharged only in accordance with applicable permits and agency approvals.

Because construction water use will be temporary, phased, coordinated with water suppliers, and reduced through reuse and recycling where practicable, the Project will not measurably affect aquifer capacity, public water supply reliability, or long-term groundwater availability.

Although portions of the Project are located within mapped groundwater protection areas, the Project's use within these areas is limited to utility relocation, temporary workspace, permanent underground pipeline easement, and access infrastructure. The Project will not introduce wastewater disposal, vehicle maintenance, fuel storage, loading docks, fleet storage, or other permanent high-risk land uses within these areas.

Dewatering Management

Temporary dewatering may be required in limited areas during excavation. Any dewatering will be localized, temporary, and limited to active construction work areas. Dewatering discharges will be managed

in accordance with the Project's E&SCP and applicable permit requirements and will include sediment controls, energy dissipation, filtration, or other measures necessary to prevent erosion, sedimentation, or degradation of adjacent groundwater and surface water resources.

Dewatering will not constitute a long-term groundwater withdrawal and will not alter regional groundwater flow patterns or aquifer recharge conditions.

Clearing and Grading

Potential impacts to recharge areas of surface waters are primarily limited to construction-related activities and may include temporary increases in turbidity, sedimentation, and stormwater runoff associated with ground disturbance, excavation, dewatering, and restoration activities. Construction activities adjacent to water resources also have the potential to affect water quality through accidental releases of fuels or other materials. These impacts are expected to be temporary and largely confined to active construction areas. No significant long-term impacts to surface water quality, water quantity, or marine resource functions are anticipated following completion of construction and site restoration.

Potential effects on freshwater resources are primarily associated with temporary construction activities, including excavation, grading, temporary workspace, access road use, dewatering, equipment operation, hydrostatic testing, and work within or near regulated wetland and floodplain resource areas. Potential construction-period impact mechanisms include:

- temporary changes to soil stability and runoff patterns during active construction;
- temporary erosion and sedimentation potential from soil disturbance;
- temporary dewatering discharges associated with trench excavation;
- accidental spill risk from construction equipment or material handling;
- potential drilling-fluid inadvertent returns associated with HDD activities near sensitive resource areas;
- temporary water withdrawals and discharges associated with hydrostatic testing.

Permanent Stormwater Impacts

The Project has been designed to minimize land alteration and limit the conversion of pervious surfaces to impervious materials to the maximum extent practicable. Permanent Project features have been sited primarily within existing utility corridors, roadways, existing access areas, and previously disturbed settings. Temporary construction workspaces, including ATWS, will be restored following construction and will not result in permanent land conversion.

Where permanent access is required, Algonquin will use existing roads where practicable or design access roads with gravel or other pervious surfaces to maintain infiltration and minimize stormwater runoff. Stormwater management features will be incorporated where necessary to maintain existing drainage patterns, protect downgradient resources, and manage runoff from new impervious surfaces.

Algonquin has prepared stormwater drainage studies for the M&R stations that describe the proposed stormwater controls for areas of new impervious surface. The stormwater systems are designed to manage runoff from permanent facility areas and protect downgradient groundwater and surface water resources. See Attachment 5.

The Project will result in approximately 7.2 acres of new permanent asphalt impervious surface associated with the construction and operation of the M&R stations. The Project will create approximately 7.2 acres of permanent asphalt surface associated with the M&R stations and 1.8 acres of gravel surface associated

with permanent access roads. Most access road improvements will occur along existing utility corridors. Permanent surface impacts are limited in extent relative to the overall Project area and are required to support the long-term operation and maintenance of the Project. The majority of the proposed PARs are existing access roads that need only minor improvements, including gravel to fill potholes or road leveling. In most cases for the project construction, Algonquin is not creating new impervious surfaces on these existing roads.

These impacts are limited in extent relative to the overall Project area and are associated with the permanent utility infrastructure required for Project operation and maintenance. Table 5-7 shows the breakdown of impacts due to the proposed impervious surfaces. These areas are limited in scale relative to the overall Project area and are associated with necessary permanent utility infrastructure.

Table 5-7. New Impervious Acreage and Type

Surface Type	New Surface Area (acres)
M&R station impervious surface	5.3
Permanent access road surface (gravel)	1.8
Total:	**7.2**

5.3.1.3 Avoidance, Minimization and Mitigation Summary

Protection of water resources groundwater was a primary consideration throughout Project planning, routing, design, permitting, and construction planning. The Project incorporates a comprehensive set of avoidance, minimization, and mitigation measures intended to avoid impacts to sensitive water resources where practicable and minimize unavoidable construction-related effects.

The Project's overall water resource protection strategy focuses on 1) avoiding sensitive resources through route selection and facility siting, 2) minimizing the extent and duration of disturbance through construction methodologies such as HDD and BMPs, 3) restoring temporarily disturbed areas following construction, and 4) implementation of proper stormwater facility design at permanent aboveground facilities.

Resource Avoidance Through Route Selection and Facility Siting

Project facilities were sited to maximize the use of existing utility corridors, transportation corridors, roadways, and previously disturbed areas. This approach minimizes the need for new disturbance within wetlands, floodplains, groundwater protection areas, and other sensitive environmental resources. The Project has been designed to avoid Zone I WHPAs associated with public water supply wells to the maximum extent practicable and to minimize permanent impacts within Zone II WHPAs and Potential Public Water Supply Areas. Pipeline alignments, M&R station locations, access roads, contractor yards, and temporary workspaces were refined to avoid and minimize impacts to public water supply resources, freshwater wetlands, floodplain resource areas, and marine resources to the maximum extent practicable while maintaining the operational requirements of the Project.

Horizontal Directional Drilling

The Project incorporates HDD at the Cape Cod Canal crossing instead of conventional open-cut construction methods. HDD allows installation of the pipeline beneath sensitive fresh and marine resources without dredging, trenching, or direct disturbance of wetlands, surface waters, marine habitat, navigation

channels, shoreline resources, or Land Under the Ocean (LUO). As a result, direct impacts to these resources are substantially avoided.

All HDD activities will be conducted in accordance with Algonquin's Best Drilling Practices, Monitoring, and Clean-Up of Horizontal Directional Drilling Inadvertent Returns Plan (see Attachment 4). HDD monitoring procedures include drilling-fluid tracking, environmental inspection, inadvertent return monitoring, containment measures, reporting requirements, and response procedures designed to protect groundwater, wetlands, freshwater resources, and marine waters. Drilling fluids will be recycled and reused to the maximum extent practicable. Residual drilling fluids will be collected and transported off-site for disposal at approved facilities. HDD fluids will not be intentionally discharged to wetlands, groundwater, surface waters, or marine resource areas.

Best Management Practices

Construction activities within or adjacent to surface water resources will be conducted in accordance with applicable federal, state, and local permit requirements, including the FERC Procedures, the Project's E&SCP, and environmental inspection requirements. The following BMPs have been incorporated throughout the Project.

- Reducing work areas within and adjacent to sensitive resource areas where practicable
- Using temporary construction mats where appropriate
- Maintaining hydrology and natural drainage patterns
- Installing erosion and sedimentation controls prior to construction, including
    - silt fence and compost filter tubes;
    - sediment barriers and sediment traps;
    - stabilized construction entrances;
    - temporary drainage and diversion controls;
    - temporary and permanent soil stabilization measures;
    - prompt revegetation of disturbed areas;
    - routine inspection and maintenance of erosion controls; and
    - corrective actions where necessary.
- Minimizing the duration of temporary disturbance
- Restoring disturbed areas following construction
- Dewatering may include sediment controls, filtration systems, energy dissipation measures, or other water-quality protection measures as necessary
- Maintaining controls until disturbed areas achieve final stabilization

Construction activities will be also conducted in accordance with the Project's SPCC Plan and associated environmental compliance procedures (see Attachment 3).

- Fueling, equipment maintenance, material storage, and contractor operations will follow established spill-prevention requirements. Spill response materials will be maintained at active construction areas, and construction personnel will receive appropriate training regarding spill response and environmental protection requirements.
- Any accidental release of fuel, lubricant, hydraulic fluid, drilling fluid, or other regulated material will be immediately contained, reported, and remediated in accordance with applicable permit requirements and regulatory standards.

Restoration and Revegetation

Following construction, temporary workspaces, wetlands, buffers, floodplain areas, access areas, and other disturbed resource areas will be restored and revegetated.

Restoration measures include:

- removal of temporary construction materials;
- regrading disturbed areas to preconstruction contours where practicable;
- soil stabilization and decompaction where necessary;
- restoration of drainage patterns;
- revegetation using approved seed mixes and restoration methods; and
- monitoring and corrective action as required by permits and environmental commitments.

Restoration activities are intended to reestablish preconstruction hydrologic conditions, maintain groundwater recharge functions, preserve flood storage capacity, stabilize soils, and support recovery of wetland and habitat functions.

Stormwater Management

Permanent facilities have been designed to minimize impervious surface and maintain natural drainage patterns to the maximum extent practicable. Stormwater management systems are incorporated into the designs of relocated M&R stations in accordance with Massachusetts Stormwater Management Standards. Stormwater controls are intended to:

- manage runoff from new impervious surfaces;
- provide water quality treatment;
- promote groundwater recharge where appropriate;
- reduce erosion potential;
- maintain existing drainage patterns; and
- protect downgradient groundwater and surface water resources.

Where appropriate, stormwater systems serving areas with elevated contaminant exposure potential will include means to isolate or contain runoff in the event of a spill. Attachment 5 provides stormwater management reports for each of the four M&R stations proposed by the Project.

Summary

Through route selection, facility siting, HDD installation, erosion and sedimentation controls, spill prevention procedures, groundwater protection measures, stormwater management systems, dewatering controls, construction water management, environmental compliance monitoring, and postconstruction restoration, the Project avoids and minimizes impacts to water resources to the maximum extent practicable. Temporary impacts will be restored following construction, and no significant long-term adverse impacts to groundwater or surface waters are anticipated.

5.3.1.4 Consistency with RPP Goals and Objectives

Objective WR1 – Protect and preserve groundwater quality

The Project consists of the relocation of existing natural gas infrastructure and does not include residential, commercial, industrial, or wastewater-generating land uses. The Project will not generate sanitary wastewater, or permanent groundwater discharges. Therefore, the Project will not introduce a new long-term source of groundwater contamination or nitrogen loading.

Although portions of the Project occur within Zone II WHPAs and Potential Public Water Supply Areas, impacts within these areas are primarily associated with utility relocation, temporary construction workspace, and limited permanent utility infrastructure. The Project avoids Zone I WHPAs to the maximum extent practicable and minimizes permanent land disturbance within groundwater protection areas. As described in Section 5.3.1.3, the Project incorporates comprehensive groundwater protection measures including stormwater management, spill prevention procedures, construction-phase BMPs, and restoration commitments. Implementation of these measures limit potential adverse impacts to current resources, and placement of future wells.

These measures align with the methods outlined in the Water Resources Technical Bulletin to protect groundwater quality. Therefore, the Project is consistent with Objective WR1.

Objective WR2 – Protect, preserve and restore freshwater resources

Project planning prioritized the use of existing utility corridors, roadway corridors, and previously disturbed areas to reduce the need for new disturbance within or adjacent to natural areas including recharge areas for freshwater resources and CAP-designated areas. Where impacts could not be avoided, construction activities were designed to minimize the extent and duration of disturbance while maintaining the operational requirements of the Project. Impacts under the purview of WR2 are all considered temporary and minor.

As described in Section 5.3.1.3, the Project incorporates a comprehensive suite of protection measures, including resource area avoidance, erosion and sedimentation controls, dewatering management, HDD procedures, environmental monitoring, and postconstruction restoration. Algonquin will implement the SPCC Plan to avoid contamination of freshwater resources and CAP-designated areas.

These measures align with the methods outlined in the Water Resources Technical Bulletin to protect freshwater resources, including CAP-designated areas. Therefore, the Project is consistent with Objective WR2.

Objective WR3 – Protect, preserve and restore marine water resources

The Project's interaction with marine resources is limited to the crossing of the Cape Cod Canal by the G-31 pipeline. Because the pipeline will be installed beneath the Canal, no permanent impacts to marine habitat, navigation, fisheries resources, coastal resource areas, or water quality are anticipated. The Project will not generate sanitary wastewater, process wastewater, or routine groundwater discharges. Therefore, the Project will not introduce a new long-term source of groundwater contamination or nitrogen loading to marine water resources.

As described in Section 5.3.1.3, the Project incorporates HDD installation, drilling-fluid management procedures, spill prevention measures, environmental monitoring, and other resource protection commitments designed to minimize temporary construction-related impacts.

These measures align with the methods outlined in the Water Resources Technical Bulletin to protect marine water resources. Therefore, the Project is consistent with Objective WR3.

Objective WR4 – Manage and treat stormwater to protect and preserve water quality

Permanent Project facilities have been sited to be located within existing utility corridors, roadways, or previously disturbed areas, minimizing new land disturbance and reducing the need for extensive stormwater infrastructure. Temporary construction workspaces will be restored following construction and will not result in permanent land conversion. Permanent infrastructure is limited to the four M&R Stations, valve sites, pig launchers and receivers, and PARs.

Where permanent access is required, Algonquin will utilize existing roads where practicable or construct gravel access roads and other pervious surfaces to promote infiltration and reduce runoff. Algonquin has prepared project-specific stormwater management reports for each M&R station. The reports evaluate runoff from new impervious surfaces and identify stormwater control measures designed to manage peak flows, reduce erosion potential, and protect water quality. The stormwater systems have been designed in compliance with the Massachusetts Stormwater Handbook to maintain existing drainage characteristics and protect downgradient resources through a combination of vegetated conveyance systems, stormwater controls, and erosion protection measures. Low Impact Development (LID) techniques were incorporated as much as practicable. These reports are included in the Project's Stormwater Management Report (see Attachment 5).

The Project minimizes the creation of new impervious surfaces, incorporates project-specific stormwater management systems for permanent facilities, and utilizes erosion, sedimentation, and drainage controls that protect groundwater, wetlands, and other downgradient water resources. The Project has been designed to maintain existing drainage patterns to the maximum extent practicable while preventing degradation of water quality during both construction and operation. Following construction, disturbed areas will be stabilized and revegetated, allowing infiltration and recharge functions to be restored while minimizing long-term stormwater runoff.

Through site design, stormwater controls, erosion prevention measures, and postconstruction restoration, the Project will protect water quality and maintain existing hydrologic conditions to the maximum extent practicable. These measures align with the methods outlined in the Water Resources Technical Bulletin to manage and treat stormwater. Therefore, the Project is consistent with Objective WR4.

Objective WR5 – Manage groundwater withdrawals and discharges to maintain hydrologic balance and protect surface and groundwater resources

Water use associated with the Project is limited to hydrostatic testing and HDD activities during construction. Water will be obtained from municipal water systems operated by the Buzzards Bay Water District, North Sagamore Water District, and Bourne Water District, or from approved off-Cape sources if local supplies are unavailable. Water withdrawals will occur incrementally and in coordination with local water suppliers based on construction sequencing rather than as a single withdrawal event. As a result, the

Project will not create a concentrated demand that could adversely affect aquifer levels, public water supply reliability, nearby wetlands, or groundwater-supported surface waters.

The Project further minimizes water demand through reuse and recycling measures. Hydrostatic test water will be reused between compatible pipeline segments where practicable, HDD pre-test water will be reused for hydrostatic testing, and water used to prepare drilling mud will be stored in frac tanks on-site and recycled throughout HDD operations. These measures substantially reduce the volume of new water required during construction and minimize the need for additional withdrawals from public water supplies.

Any water that cannot be reused will be managed in accordance with all applicable permits and agency approvals. Hydrostatic test water will be discharged only to approved upland locations using methods designed to prevent erosion, sediment transport, and adverse impacts to groundwater and surface water resources. HDD drilling fluids will be recycled to the maximum extent practicable and transported off-site for proper disposal following completion of drilling activities. HDD fluids will not be intentionally discharged to wetlands, surface waters, or groundwater resources.

Operation of the Project facilities will not require water; therefore, groundwater withdrawals will be limited to the construction phase of the Project. Because Project water use is temporary, phased, and will be coordinated with municipal water suppliers, and supported by water reuse and recycling measures, the Project is not anticipated to measurably alter groundwater levels, affect wetland hydrology, reduce public water supply availability, or disrupt local hydrologic balance. These measures are consistent with the Water Resources Technical Bulletin's guidance for managing groundwater withdrawals and discharges. Therefore, the Project is consistent with Objective WR5.

5.3.2 OCEAN RESOURCES

5.3.2.1 Existing Conditions

The Cape Cod Canal is the primary ocean and coastal resource within the Project area. Constructed and maintained by the USACE, the Canal is a federally designated navigation channel connecting Cape Cod Bay and Buzzards Bay and serves important navigational, recreational, ecological, and hydrologic functions. The Canal supports active vessel traffic and provides a significant marine corridor between Massachusetts Bay and Buzzards Bay.

The Canal is a tidally influenced marine system characterized by strong currents, periodic tidal exchange, and coastal processes that influence surrounding shoreline habitats and adjacent coastal resources. State regulated coastal wetland resource areas associated with the Canal include LUO, LCS, Coastal Bank, and LSCSF as defined under the WPA.

The Massachusetts Division of Marine Fisheries has identified portions of the Canal as containing habitat suitable for shellfish resources, including blue mussel (*Mytilus edulis*). Although shellfish habitat occurs within the Canal, shellfish harvesting within the Canal is restricted by local regulations. The Canal and adjacent shoreline habitats also provide habitat for marine fish, estuarine species, migratory fish, coastal birds, and other wildlife associated with coastal environments.

Coastal flood hazard areas occur adjacent to portions of the Canal and are associated with storm surge, tidal flooding, and coastal storm events. In addition, portions of the Project area occur within or adjacent to coastal resource management jurisdictions and ACECs, including the Herring River Watershed ACEC. These coastal resources contribute to the ecological integrity, resiliency, and environmental value of the Upper Cape region.

Figure 5.3-4, Sheets 1, 3, and 4 in Attachment 1 depicts the Cape Cod Canal and associated coastal resource areas occurring within and adjacent to the Project area.

5.3.2.2 Impact Summary

The Project's only interaction with ocean resources is the G-31 pipeline crossing beneath the Cape Cod Canal, which will be installed using HDD. This construction method allows the pipeline to be placed beneath the Canal bed and banks without dredging, trenching, fill placement, or other in-water work, thereby avoiding direct impacts to Canal sediments, navigation, fisheries, shellfish habitat, and other ocean resources. The only potential construction-related pathway for interaction with the Canal is an inadvertent release of drilling fluid.

5.3.2.3 Avoidance, Minimization and Mitigation Summary

Protection of ocean resources was a key consideration throughout Project planning, design, and permitting. The Project incorporates avoidance, minimization, and mitigation measures specifically intended to protect the Cape Cod Canal, maintain marine habitat functions, preserve water quality, and avoid disruption of navigation and recreational uses.

The primary avoidance measure is the use of HDD to install the G-31 pipeline beneath the Cape Cod Canal; additionally, no temporary or permanent marine infrastructure will be located within the Canal. Therefore, no long-term changes to marine habitat, water circulation, or navigation are anticipated to occur.

To minimize potential construction-related impacts, the HDD crossing has been designed with sufficient depth below the Canal bed to reduce the potential for inadvertent drilling fluid returns. Construction of the crossing will be completed in accordance with Algonquin's Best Drilling Practices, Monitoring, and Clean-Up of Horizontal Directional Drilling Inadvertent Returns Plan, which establishes procedures for monitoring HDD operations, identifying potential drilling fluid releases, implementing containment measures, and conducting reporting and cleanup activities should an inadvertent return occur (see Attachment 4).

Additional minimization measures include implementation of spill prevention and response procedures, proper handling and storage of fuels and hazardous materials, environmental inspection and monitoring during construction, and adherence to all applicable federal, state, and local permit requirements. Construction activities will be managed to maintain existing navigation, boating, fishing, and recreational uses of the Canal throughout the construction period to the extent practicable.

Consultation with federal and state resource agencies further supports the conclusion that marine resource impacts will be minimal due to implementation of the HDD installation method. NMFS determined that the Project does not require Essential Fish Habitat consultation, reflecting the avoidance of impacts to federally managed marine species and habitats. Similarly, the Massachusetts Division of Marine Fisheries determined that no time-of-year restrictions or additional seasonal construction measures are necessary to protect marine resources.

Through the use of HDD technology, implementation of HDD monitoring and contingency procedures, adherence to environmental protection requirements, and ongoing construction oversight, the Project avoids direct impacts to ocean resources and minimizes the potential for temporary construction-related effects. Consequently, no compensatory mitigation is required, and no significant adverse impacts to ocean resources is anticipated.

5.3.2.4 Consistency with RPP Goals and Objectives

Objective OR1 – Locate Development Away from Sensitive Resource Areas and Habitats

As described in Section 3, Algonquin's proposed Project includes installing a new pipeline beneath the Cape Cod Canal to maintain natural gas delivery to National Grid. Even though a crossing of the Cape Cod Canal is still required, Algonquin is able to avoid habitat for rare marine species and their habitat through implementation of the HDD. By installing the pipeline below the bed and banks of the Cape Cod Canal and avoiding interaction with sensitive marine environments, the Project is located away from important ocean resource areas and habitats while meeting the Project purpose and need.

The implementation of HDD as an avoidance measure aligns with the methods outlined in the Ocean Resources Technical Bulletin to locate development away from sensitive resource areas and habitats. Therefore, the Project is consistent with Objective OR1. Additionally, the HDD and Project workspace occurs outside of the mapped Cape Cod Ocean Management Plan Exclusion Area (see Figure 5.3-5 in Attachment 1).

Objective OR2 – Preserve and Protect Ocean Habitat and the Species It Supports

Through implementation of the HDD beneath the Cape Cod Canal, the Project does not require dredging, in-water excavation, shoreline modification, or other activities that would alter marine habitat, affect benthic resources, interfere with fish passage, or impact whales or rare marine species. Consultation with federal and state resource agencies further supports the conclusion that marine resource impacts are not likely to be impacted due to implementation of the HDD installation method. NMFS determined that the Project does not require Essential Fish Habitat consultation, reflecting the avoidance of impacts to federally managed marine species and habitats, and sent confirmation of their findings on February 24 and June 5, 2026. Similarly, the Massachusetts Division of Marine Fisheries determined that no time-of-year restrictions or additional seasonal construction measures are necessary to protect marine resources. A final determination letter was sent to Algonquin on July 9, 2026 (ECO: GARFO-2026-01397).

As a result, marine habitat conditions within the Canal are expected to remain unchanged following construction. The implementation of HDD as an avoidance measure aligns with the methods outlined in the Ocean Resources Technical Bulletin to preserve and protect ocean habitat and species. Therefore, the Project is consistent with Objective OR2.

Objective OR3 – Protect Significant Human Use Areas and Vistas.

The crossing will be installed entirely underground, with no visible infrastructure located within the Canal corridor following construction. The Project will not impede navigation, restrict public access, or permanently affect recreational activities such as boating, fishing, bicycling, sightseeing, or tourism. Any temporary construction-related disruptions will be limited in duration and extent and will not alter the long-term character, visual quality, or public use of the Cape Cod Canal corridor. Consequently, the Project preserves the Canal's recreational, scenic, and navigational value while supporting a critical regional infrastructure improvement project.

The Project aligns with the methods outlined in the Ocean Resources Technical Bulletin to maintain the recreational, navigational, and scenic functions of the Cape Cod Canal, one of the region's most significant public resource areas. Therefore, the Project is consistent with Objective OR3.

5.3.3 WETLANDS RESOURCES

5.3.3.1 Existing Conditions

Wetland resources are scattered throughout the Project area and include coastal and inland wetland systems associated with the Cape Cod Canal, Nightingale Pond, and freshwater depressions within existing utility corridors (MassGIS 2017). Wetlands and other jurisdictional resource areas within and adjacent to the Project area are regulated under the WPA and 310 CMR 10.00. See Figure 5.3-4 in Attachment 1.

Coastal Wetland Resources

The Cape Cod Canal represents the dominant coastal wetland resource within the Project area. The Canal supports multiple wetland resource areas protected under the WPA, including LUO, LCS, Coastal Bank, and LSCSF.

LUO occurs throughout the Canal crossing area and consists of subtidal marine habitat extending beneath the navigational channel. Geotechnical investigations indicate that Canal sediments consist primarily of sand, gravel, and silt deposits overlying bedrock (GeoEngineers 2024a, 2024b).

LCS has been mapped within portions of the Canal by the Massachusetts Division of Marine Fisheries (MassGIS 2011). Although areas of suitable habitat for blue mussel (*Mytilus edulis*) occur within the Canal, shellfish harvesting is prohibited throughout the Canal by the Town of Bourne.

Coastal Banks occur along portions of the Canal shoreline and provide important storm damage prevention functions by protecting adjacent upland areas from wave action and coastal flooding.

LSCSF is present along low-lying areas adjacent to the Canal and generally corresponds to FEMA-mapped coastal flood hazard areas influenced by tidal flooding and coastal storm surge.

Inland Wetland Resources

Inland wetland resources in the Project area are associated with Nightingale Pond, IVWs, and BVWs. These resources provide flood storage, groundwater recharge, water quality protection, and wildlife habitat.

The inland wetland and floodplain resource areas identified in the Project area include BLSF, ILSF, IVWs, and regulated 100-foot Buffer Zones associated with the Inland Bank and BVW resource areas.

BLSF occurs in association with Nightingale Pond, where FEMA flood hazard mapping identifies flood-prone areas extending beyond the pond shoreline (FEMA 2024). The Nightingale Pond floodplain is mapped as Zone A (FEMA 2024). The surrounding landscape consists primarily of pitch pine–oak woodland communities typical of the Upper Cape region.

ILSF has been identified in association with one IVW (Wetland W5) located within an inactive sand and gravel quarry. This ILSF/IVW functions as an isolated flood storage area with no permanent surface water outlet.

The two other IVWs within the Project area are associated with low-lying depressional areas and utility corridor edges. IVWs consist of freshwater wetlands that are not directly connected to surface waters. These wetlands generally provide localized stormwater storage, groundwater recharge, sediment retention, nutrient uptake, and wildlife habitat functions.

Regulated 100-foot Buffer Zones in the Project area occur adjacent to two BVWs, Nightingale Pond, and the coastal banks of the Canal. These buffer zones consist of a mixture of maintained roadway shoulders,

utility corridors, landscaped areas, pitch pine–oak woodland, and other upland habitats that provide ecological transition zones between wetlands and developed areas.

5.3.3.2 Impact Summary

Bordering Land Subject to Flooding (BLSF)

Approximately 52 square feet of BLSF associated with Nightingale Pond will be temporarily disturbed during removal of the existing G-8L and G-8C pipelines. Impacts are limited to temporary construction disturbance for pipeline removal, backfilling, and restoration. No permanent fill, grading, impervious surface, or loss of flood storage is proposed. The area will be restored to preconstruction contours and stabilized following construction.

Isolated Land Subject to Flooding (ILSF)

The Project will temporarily affect Wetland W5, the only wetland that meets the WPA criteria for ILSF. Approximately 42,709 square feet of Wetland W5 will be temporarily disturbed to support construction of the G-31 pipeline HDD crossing beneath the Cape Cod Canal. Temporary impacts include HDD support workspace, staging activities, and construction matting. No permanent fill, grading, vegetation conversion, or loss of flood storage is proposed. The wetland will be restored to preconstruction contours and allowed to revegetate naturally following construction.

Bordering Vegetated Wetland (BVW) Buffer Zone

No direct impacts to BVWs are proposed. However, approximately 34,034 square feet of temporary disturbance and 4,095 square feet of temporary forest cover disturbance will occur within the 100-foot Buffer Zone of Wetland W14 during relocation of the Sagamore M&R Station, removal of existing facilities, and relocation of the G-24 and G-11 pipelines. Permanent impacts are limited to previously disturbed upland portions of the station site and easement area. Postconstruction stormwater controls will improve existing drainage conditions and protect adjacent wetland resources.

Inland Bank Buffer Zone

Approximately 41,389 square feet of temporary disturbance, including 5,197 square feet of temporary forest cover disturbance, will occur within the 100-foot Buffer Zone of Inland Bank associated with Nightingale Pond during removal of the G-8C and G-8L pipelines. No direct Inland Bank impacts are proposed, and disturbed areas will be restored and stabilized following construction.

Isolated Vegetated Wetlands (IVWs)

The Project will result in temporary disturbance of approximately 16,602 square feet of three IVWs (Wetlands W2, W5, and W12). Wetland W2 will be affected by the proposed G-31 pipeline trench excavation, Wetland W5 by temporary construction workspace associated with the G-31 HDD workspace, and Wetland W12 by temporary workspace needed for removal of the existing G-8C and G-8L pipelines. Disturbance activities may include temporary vegetation clearing, equipment access, installation of construction matting where necessary, soil disturbance from trenching, and restoration of preconstruction contours following completion of work. No permanent wetland fill, conversion, or loss is proposed. Attachment 10 of this DRI includes a summary table of all WPA resource area, buffer zone, and IVW alterations. This table also includes references to the WPA resource area locations shown on Figure 5.3-4 in Attachment 1.

5.3.3.3 Avoidance, Minimization and Mitigation Summary

Protection of wetlands and WPA-regulated areas was a primary consideration throughout Project planning, routing, design, permitting, and construction planning. Consistent with the Project's overall environmental strategy, Algonquin applied a hierarchy of avoidance, minimization, and mitigation measures intended to avoid wetland impacts where practicable, minimize unavoidable disturbance, preserve wetland hydrology and ecological functions, and restore temporarily disturbed resource areas following construction. All avoidance measures identified in Sections 5.3.1.3 and 5.3.2.3 also avoid and minimize impacts to wetland resources. Additional wetland-specific BMPs are described below.

Wetland Construction Procedures

Construction within or adjacent to wetlands will be conducted in accordance with applicable federal, state, and local permit requirements, including the FERC Procedures, the Project E&SCP, and permit-specific environmental commitments.

Wetland protection measures include:

- reducing workspace widths within wetlands where practicable;
- limiting vegetation clearing and grading to the minimum area necessary for safe construction;
- utilizing temporary timber matting where necessary to minimize rutting, soil disturbance, and compaction;
- maintaining existing wetland hydrology and drainage patterns;
- segregating and replacing soils where appropriate;
- minimizing the duration of construction activities within wetlands; and
- removing temporary materials following construction.

These measures are intended to preserve wetland hydrology, reduce disturbance to wetland vegetation and soils, and support recovery of wetland functions following construction.

Through route selection, collocation within existing infrastructure corridors, use of trenchless construction methods, implementation of wetland-specific construction procedures, erosion and sedimentation controls, dewatering management, stormwater controls, spill prevention measures, and postconstruction restoration, the Project has been designed to avoid and minimize impacts to wetlands and associated buffer areas to the maximum extent practicable. Temporary disturbances will be restored following construction, and no significant long-term adverse impacts to wetland resource areas, wetland hydrology, flood storage functions, or associated ecological resources are anticipated.

5.3.3.4 Consistency with RPP Goals and Objectives

Objective WET1 – Protect Wetlands and their buffers from vegetation and grade changes

The Project will not result in the permanent filling or loss of wetlands requiring replication. Operation impacts are limited primarily to underground utility infrastructure located within existing utility corridors, while the majority of wetland impacts are temporary and associated with construction activities. Following construction, temporarily disturbed wetlands and buffer areas will be restored to preconstruction conditions to the maximum extent practicable.

As described in Sections 5.3.1.3, 5.3.2.3, and 5.3.3.3, the Project incorporates a comprehensive suite of wetland protection measures, including route selection and facility siting to avoid sensitive resources, reduced work areas in wetland crossings, use of trenchless construction methods where appropriate, erosion and sedimentation controls, environmental monitoring, and restoration of temporarily disturbed resource areas.

The Project aligns with the methods outlined in the Wetlands Resources Technical Bulletin to protect wetlands and their buffers from vegetation and grade changes. Therefore, the Project is consistent with Objective WET1.

Objective WET2 – Protect Wetlands from changes in hydrology, including those associated with stormwater discharges

New impervious surfaces associated with relocated M&R stations and PARs represent a small portion of the overall Project area and will be managed through project-specific stormwater systems designed to maintain pre-development hydrologic conditions and protect adjacent water resources. Stormwater management measures are documented in the Project Stormwater Management Reports and supporting drainage studies.

As described in Section 5.3.1.3, the Project incorporates comprehensive measures to protect wetland hydrology and recharge areas during construction and operation, including erosion and sedimentation controls, dewatering management procedures, spill prevention measures, HDD monitoring protocols, stormwater management systems, and restoration commitments.

The Project will obtain permits for activities within wetland resources and buffer zones including an Order of Conditions from the Town of Bourne Conservation Commission, a Clean Water Act Section 404/10 permit from the USACE, and a Clean Water Act Section 401 Water Quality Certificate from MassDEP.

The Project is consistent with the methods outlined in the Wetlands Resource Technical Bulletin because it has been designed to maintain existing wetland hydrology and avoid long-term changes to drainage patterns, groundwater recharge, flood storage capacity, and surface water flow within wetland resource areas. Therefore, the Project is consistent with Objective WET2.

Objective WET3 – Promote the restoration of degraded Wetland resource areas

The Project does not include a wetland restoration component intended to restore previously degraded wetland resource areas and therefore Objective WET3 is not directly applicable. Although the Project is not a wetland restoration project, its restoration commitments ensure that temporary construction-related disturbances do not result in long-term degradation of wetland resources.

5.3.4 WILDLIFE AND PLANT HABITAT

5.3.4.1 Existing Conditions (Natural Resources Inventory)

Consistent with the requirements of the Cape Cod Commission's Wildlife and Plant Habitat Technical Bulletin (Cape Cod Commission 2025b), a Natural Resources Inventory (NRI) is provided here to describe the existing ecological resources within and adjacent to the Project Area. This NRI provides the foundation for evaluating potential effects on wildlife and plant habitat. The inventory characterizes the location, extent, and ecological significance of natural communities, wetlands, protected resource areas, rare species

habitat, vernal pool resources, open space connections, and other environmental features that contribute to regional biodiversity. The NRI is intended to inform project planning and design by identifying sensitive resources, supporting impact assessment, and demonstrating how the Project has been designed to avoid, minimize, and mitigate effects on wildlife and plant habitat in accordance with the RPP objectives and the Wildlife and Plant Habitat Technical Bulletin (Cape Cod Commission 2025a, 2025b).

The NRI incorporates field investigations, GIS mapping, rare species and natural community data, wetland resource delineations, and agency coordination to evaluate existing habitat conditions within the Project area and to identify opportunities to avoid or minimize impacts to sensitive environmental resources.

Overview

The Project area generally consists of low, gently sloping terrain characteristic of southeastern Massachusetts and Cape Cod. Elevations range from approximately 10 feet to 210 feet above mean sea level. Higher elevations occur predominantly north of the Cape Cod Canal, while lower elevations occur near the Canal and coastal areas. Surficial geologic materials consist primarily of glacially deposited sand and gravel associated with outwash plains and moraine formations. These unconsolidated deposits form the basis for the region's groundwater resources and contribute to highly permeable soil conditions throughout much of the Project area.

Portions of underlying soils within the Project area workspace are classified as prime farmland or farmland of statewide importance (Natural Resources Conservation Service 2025). However, there are no current working agricultural lands or agricultural land use within the Project area. The Project area contains a diverse mosaic of natural and managed habitats characteristic of the Upper Cape region, including pitch pine–oak forests, shrublands, utility ROWs, freshwater wetlands, coastal wetlands, transportation corridors, and maintained open lands. Habitat conditions vary across the Project area as a result of existing development, transportation infrastructure, military training activities at JBCC, utility corridors, and adjacent conservation lands.

The Project area is located within the Cape Cod Coastal Lowland and Islands Ecoregion, a landscape characterized by glacially derived sandy soils, acidic groundwater, maritime climatic influences, and vegetation communities adapted to nutrient-poor conditions. This ecoregion supports a variety of coastal plain and sandplain habitats that provide important ecological functions and habitat for numerous wildlife species, including several state-listed rare species.

Large portions of the Project area consist of pitch pine–oak woodland and scrub-shrub habitats that are common throughout Cape Cod and are recognized for their importance to rare plants, invertebrates, reptiles, and other wildlife. Existing utility corridors create open-canopy habitat conditions that support early successional vegetation communities, while wetlands, ponds, and riparian areas provide additional habitat diversity and wildlife movement corridors.

The Project area supports habitat for a variety of wildlife species typical of southeastern Massachusetts, including resident and migratory birds, amphibians, reptiles, small mammals, pollinators, and other invertebrates. Wetlands, ponds, and adjacent upland habitats contribute to regional habitat connectivity and provide breeding, foraging, sheltering, and dispersal functions for wildlife populations.

Rare Species Habitat

Portions of the Project area are located within habitats protected under the MESA. The NHESP has mapped both Priority Habitat and Estimated Habitat within the Project area, reflecting the presence of known rare species occurrences and potential habitat for state-listed species (Figure 5.3-6 in Attachment 1).

Approximately 116.0 acres of mapped Priority Habitat and approximately 83.8 acres of mapped Estimated Habitat occur within the Project area. NHESP has identified the following mapped habitat areas within the Project vicinity:

- Priority Habitat #455
- Priority Habitat #601
- Estimated Habitat #400

These habitat areas occur primarily within JBCC, utility corridors, pitch pine–oak woodlands, shrublands, and associated wetland systems (MassGIS 2021a, 2021b).

NHESP correspondence identified habitat for multiple state-listed species within the Project area, including rare plants, invertebrates, reptiles, and birds. Subsequent field investigations and habitat assessments documented habitat characteristics suitable for many of these species and confirmed the ecological significance of the Project area's sandplain grassland, shrubland, woodland, and wetland communities.

Vegetation Communities

Vegetation communities within the Project area reflect the region's sandy, well-drained soils and history of natural disturbance, land management, and utility corridor maintenance. Dominant upland communities include pitch pine–oak woodlands, scrub-shrub habitats, and managed grasslands within existing utility ROWs. Common shrub species include highbush blueberry, inkberry (*Ilex glabra*), sheep laurel, and coastal sweet pepperbush (*Clethra alnifolia*).

Open habitats within the Project area are largely associated with existing maintained utility ROWs. These maintained corridors predominantly support Sandplain grassland and Sandplain heathland, generally characterized by a dense shrub layer dominated by black huckleberry (*Gaylussacia baccata*), lowbush blueberry (*Vaccinium angustifolium*), sweet fern (*Comptonia peregrina*), sheep laurel, and scrub oak (*Quercus* spp.), with an understory of native grasses, sedges, ferns, and mosses adapted to dry, nutrient-poor sandy soils.

Forested habitats within the Project area are dominated by pitch pine–oak woodland communities with varying proportions of pitch pine (*Pinus rigida*), northern red oak (*Quercus rubra*), black oak (*Quercus velutina*), scarlet oak (*Quercus coccinea*), white oak (*Quercus alba*), eastern white pine (*Pinus strobus*), red maple (*Acer rubrum*), and black cherry (*Prunus serotina*). The understory was typically dominated by black huckleberry (*Gaylussacia baccata*) and hillside blueberry (*Vaccinium pallidum*), with a sparse herbaceous layer adapted to dry, acidic sandy soils. These habitats occur throughout portions of Bourne, JBCC, utility corridors, and conservation lands and provide important wildlife habitat, ecological connectivity, and ecosystem functions.

Wetland communities within the Project area include emergent marsh, scrub-shrub wetland, and forested wetland habitats dominated by species such as red maple, cattail (*Typha latifolia*), common woolgrass (*Scirpus cyperinus*), and other hydrophytic vegetation. These wetlands provide important ecological functions including groundwater recharge, flood storage, water quality protection, and wildlife habitat.

Habitat Connectivity and Regional Significance

The Project area forms part of a larger network of undeveloped and semi-natural habitats extending across northern Bourne and JBCC. These habitats contribute to regional ecological connectivity by linking protected open space, wetlands, coastal resources, and upland ecological communities. Utility corridors and managed open areas also provide habitat for early successional species and create movement pathways through otherwise forested landscapes.

Collectively, the upland, wetland, and rare species habitats present within the Project area represent an important component of the ecological resources identified by the Cape Cod Commission for the Upper Cape region and contribute to the biodiversity, habitat connectivity, and ecological resilience of the Cape Cod landscape.

5.3.4.2 Impact Summary

Construction and operation of the Project will result in temporary and permanent impacts to wildlife and plant habitats, including forested habitat, Significant Natural Communities, NHESP-designated Priority Habitat and Estimated Habitat, and portions of the Herring River Watershed ACEC. The Project has been designed to maximize use of existing utility corridors, transportation corridors, and other previously disturbed areas, thereby minimizing impacts to intact natural habitats. Nevertheless, construction and operation of the Project will result in unavoidable temporary and permanent habitat loss and alteration. As further detailed in Section 5.3.4.4, Project construction-related impacts within NHESP Priority Habitat and Estimated Habitat occur within areas categorized as Natural Areas under the Cape Cod Commission Placetype framework. Overall, impacts to both Priority Habitat and Estimated Habitat are concentrated within the Natural Areas Placetype and are predominantly associated with temporary disturbance for construction-related activities. Permanent impacts are associated with both redevelopment and new development categories and are limited to the footprint of required Project utility infrastructure.

Forest Resources

Project construction will temporarily impact forest habitat through vegetation clearing, workspace preparation, trench excavation, and restoration activities. Approximately 24.4 acres of tree clearing will occur within temporary construction workspaces, including portions of the Pitch Pine–Scrub Oak Woodland and Black Oak–Scarlet Oak Woodland Significant Natural Communities identified within the Project area.

Permanent impacts to forest habitat are associated with maintained pipeline ROWs, access roads, and aboveground facilities that require ongoing vegetation management for safe operation and inspection. Approximately 13.0 acres of forest will be permanently converted to maintained herbaceous or scrub-shrub vegetation within permanent ROWs, while an additional 7.4 acres will be converted to aboveground facilities and access roads. Permanent forest conversion will reduce canopy cover, remove mature trees, and maintain portions of the Project area in an early successional condition.

Forest impacts occur primarily within areas classified as Natural Areas Placetypes, particularly within JBCC lands where the Project traverses extensive undeveloped forest habitat. Forest resource impacts by development type and placetype are summarized in Table 5-8.

Temporary forest impacts will be restored following construction in accordance with applicable federal, state, and local permit requirements. Disturbed areas will be monitored for revegetation success for a minimum of two growing seasons.

Significant Natural Communities

Temporary construction activities will affect portions of two regionally Significant Natural Communities: Pitch Pine–Scrub Oak Woodland and Black Oak–Scarlet Oak Woodland. These impacts are primarily associated with temporary workspace clearing and use during construction. Restoration of temporarily disturbed areas will promote reestablishment of native vegetation over time, although recovery of mature forest characteristics will occur over a longer period.

Priority Habitat and Estimated Habitat

The Project will result in temporary and permanent impacts within NHESP-designated Priority Habitat and Estimated Habitat. These areas support habitat for several state-listed species, including eastern box turtle (*Terrapene carolina carolina*), eastern hognose snake (*Heterodon platirhinos*), Agassiz's clam shrimp (*Eulimnadia agassizii*), American clam shrimp (*Limnadia lenticularis*), purple tiger beetle (*Cicindela purpurea*), and 11 state-listed butterfly and moth species.

Temporary impacts are primarily associated with construction workspaces, contractor yards, and access roads, while permanent impacts are associated with maintained ROWs, access roads, and aboveground facilities. Through ongoing coordination with NHESP and the JBCC Natural Resources Land Management Program, potential impacts to rare species and habitats have been evaluated and incorporated into Project planning. Anticipated impacts to Priority Habitat and Estimated Habitat are summarized in Table 5-9 and Table 5-10, respectively.

Areas disturbed during construction within NHESP-designated habitats will be restored following construction in accordance with permit requirements and measures established through the MESA CMP.

Herring River Watershed ACEC

Portions of the Project are located within the Herring River Watershed ACEC, which was designated for its significant wetlands, groundwater resources, wildlife habitat, flood storage capacity, and watershed functions. Construction activities within the ACEC are concentrated within an existing utility corridor, maintained access roads, and previously disturbed areas, including an inactive sand and gravel quarry.

Although temporary and permanent disturbance will occur within ACEC boundaries, the Project has been designed to avoid and minimize impacts to the hydrologic and ecological functions that the ACEC designation is intended to protect. The Project is not expected to result in long-term degradation of ACEC resources or functions. Disturbance within the ACEC, categorized by placetype, is summarized in Table 5-11.

Overall Habitat Impact Summary

Although the Project will result in unavoidable temporary and permanent impacts to wildlife and plant habitats, most impacts occur within existing disturbed corridors, managed landscapes, and previously altered areas. Permanent habitat conversion has been minimized through route selection, facility siting, and Project design refinements completed during MEPA, NHESP, and agency review. Temporary disturbance areas will be restored following construction, and long-term mitigation measures will be implemented through permit-required restoration plans, habitat management commitments, and the MESA CMP. This combination of avoidance, minimization, restoration, and compensatory mitigation is intended to reduce habitat impacts while maintaining safe and reliable operation of the Project.

Table 5-8. Summary of Forest Resource Impacts

Land	Development	Temporary or Permanent Impacts	Natural Areas Placetype	Non–Natural Areas Placetype
JBCC	Redevelopment	Permanent	0.0	0.0
JBCC	New Development	Permanent	12.0	0.0
JBCC	Redevelopment	Temporary	0.0	0.0
JBCC	New Development	Temporary	6.7	0.0
Non-JBCC	Redevelopment	Permanent	0.0	0.0

Land	Development	Temporary or Permanent Impacts	Natural Areas Placetype	Non–Natural Areas Placetype
Non-JBCC	New Development	Permanent	4.9	3.6
Non-JBCC	Redevelopment	Temporary	0.0	0.0
Non-JBCC	New Development	Temporary	13.2	4.4
Total			**36.8**	**8.0**

Note: Totals may not sum exactly due to rounding.

Table 5-9. Anticipated Impacts to Priority Habitat

Asset	Temporary Impacts (acres)	Permanent Impacts (acres)
M&R stations	0.0	2.9
Pipeline ROWs	0.0	24.8
Access roads	4.3	15.3
Contractor ware yards	17.0	0.0
ATWS	51.7	0.0
Total	**73.0**	**43.0**

Note: Totals may not sum exactly due to rounding.

Table 5-10. Anticipated Impacts to Estimated Habitat

Asset	Temporary Impacts (acres)	Permanent Impacts (acres)
M&R stations	0.0	2.9
Pipeline ROWs	0.0	18.2
Access roads	3.7	11.3
Contractor ware yards	9.8	0.0
ATWS	37.8	0.0
Total	**51.3**	**32.5**

Note: Totals may not sum exactly due to rounding.

Table 5-11. Anticipated Impacts to the Herring River Watershed ACEC

Asset	Natural Areas (acres)		Non–Natural Areas (acres)	
	Temporary Impacts	Permanent Impacts	Temporary Impacts	Permanent Impacts
Access roads	0.9	0.8	0.0	0.3
Pipeline	0.0	1.6	0.0	0.8
Workspace	5.4	0.0	0.8	0.0
Totals	**6.3**	**2.4**	**0.8**	**1.1**

Note: Totals may not sum exactly due to rounding.

5.3.4.3 Avoidance, Minimization and Mitigation Summary

Algonquin applied a hierarchy of avoidance, minimization, restoration, and compensatory mitigation measures throughout Project planning, design, permitting, construction planning, and operations. These measures were developed through environmental review, agency consultation, and ongoing coordination with NHESP and JBCC resource managers to avoid and minimize impacts to wildlife habitat, rare species habitat, Significant Natural Communities, and other sensitive ecological resources within the Project area. Key measures are summarized below.

Avoidance

Avoidance of wildlife and plant habitat impacts was a primary consideration during Project routing, facility siting, and design. The Project was designed to maximize the use of existing utility corridors, transportation corridors, access roads, and other previously disturbed areas, thereby minimizing encroachment into undisturbed natural habitats.

Through Project refinements completed during MEPA and NHESP review, Algonquin reduced impacts to forested habitat, rare species habitat, Significant Natural Communities, and other ecologically important resources. These refinements reduced projected tree clearing from the approximately 66.0 acres evaluated during DEIR review to approximately 44.8 acres. Most vegetation disturbance will occur within existing corridors that are already subject to routine management and maintenance activities.

Additional avoidance measures incorporated into the Project include strategic facility siting and the use of trenchless construction methods, such as HDD, where practicable to avoid direct impacts to aquatic habitats, wetlands, and other environmentally sensitive resources.

Minimization

Where impacts could not be fully avoided, Algonquin incorporated numerous measures to minimize direct and indirect effects on wildlife and plant habitat during construction and operation.

General habitat protection measures include:

- Reduced construction workspaces in environmentally sensitive areas where feasible;
- Compliance with seasonal vegetation clearing restrictions to avoid impacts to migratory birds and protected bat species;
- Implementation of erosion, sedimentation, and water-quality controls to protect terrestrial and aquatic habitats;
- Environmental inspection and compliance monitoring throughout construction;
- Clearly identified no-disturbance areas around sensitive resources;
- Temporary exclusion fencing and protective barriers where appropriate; and
- Environmental awareness training for contractors and construction personnel.

In addition, Algonquin is finalizing species-specific protection measures in consultation with NHESP that will be incorporated into the Project's MESA CMP. These measures are anticipated to include:

- Turtle Protection Plan;
- Rare Plant Protection and Avoidance Plan;
- Clam Shrimp Protection and Avoidance Plan;

- Species-specific construction monitoring and environmental inspection; and
- Adaptive management measures developed in consultation with NHESP.

These measures are intended to minimize potential impacts to state-listed species and habitats within Priority Habitat and Estimated Habitat.

Restoration

Temporary construction workspaces and other temporarily disturbed areas will be restored following construction in accordance with applicable federal, state, and local permit requirements.

Restoration activities will include grading, stabilization, revegetation, and long-term monitoring to promote successful reestablishment of native plant communities. Native seed mixes appropriate to Barnstable County habitats will be used throughout the Project area. Within NHESP-designated habitats and other sensitive ecological areas, specialized seed mixes approved by NHESP and JBCC resource managers will be utilized where required.

Restoration efforts will be supported through long-term vegetation management commitments, invasive species control measures, revegetation monitoring, and adaptive management practices intended to maintain habitat quality and promote native species establishment.

Compensatory Mitigation

Permanent impacts to wildlife and plant habitat will be addressed through compensatory mitigation measures developed in coordination with NHESP and documented in the Project's MESA CMP.

As part of this effort, Algonquin is working to permanently protect approximately 60 acres of Priority Habitat adjacent to the JBCC/Camp Edwards WMA. Approximately 53 acres of this conservation land will satisfy MESA mitigation requirements (see Figure 5.3-7, Sheet 4, in Attachment 1), while an additional 7 acres will be preserved to satisfy Article 97 requirements.

In addition to land protection, the Project will provide a financial contribution to The Nature Conservancy's Eastern Box Turtle Mitigation Fund to offset Project-related impacts to eastern box turtle habitat.

Collectively, these compensatory mitigation measures are intended to provide a long-term net conservation benefit for affected state-listed species and habitats consistent with MESA requirements. The final mitigation package and associated commitments will be documented in the approved CMP.

Summary

Collectively, the Project's avoidance, minimization, restoration, and compensatory mitigation measures substantially reduce ecological impacts and are intended to protect and enhance wildlife habitat, rare species habitat, and other sensitive natural resources. Final mitigation commitments will be documented through the MESA CMP and other applicable permit conditions and will guide construction, restoration, and long-term habitat stewardship activities associated with the Project.

5.3.4.4 Consistency with RPP Goals and Objectives

Algonquin evaluated Project impacts in accordance with the Cape Cod Commission Wildlife and Plant Habitat Technical Bulletin. The Project overlaps several Significant Habitat Areas (SHAs) identified in the Cape Cod Commission Regional Mapper (Cape Cod Commission 2025b, 2025c). SHAs represent a composite of ecological resources that support wildlife and plant habitat, including ACECs, BioMap Core

Habitat, BioMap Critical Natural Landscape, Important Bird Areas (IBAs), NHESP Priority Habitat, NHESP Estimated Habitat, and other protected habitat resources.

Table 5-12 summarizes Project overlap with SHA designations and categorizes impacts based on natural resource mapping, development classification, disturbance type, and permanence.

Table 5-12. Significant Habitat Areas Project Overlap (acres)

	Natural Areas (acres)				Non–Natural Areas (acres)			
	Redevelopment Overlap		New Development Overlap		Redevelopment Overlap		New Development Overlap	
Area	**Permanent Impacts**	**Temporary Impacts**	**Permanent Impacts**	**Temporary Impacts**	**Permanent Impacts**	**Temporary Impacts**	**Permanent Impacts**	**Temporary Impacts**
ACEC JBCC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ACEC Non-JBCC	2.4	5.3	<0.1	1.0	1.1	0.8	<0.1	<0.1
Audubon IBAs JBCC	19.7	59.0	11.5	6.7	0.0	0.0	0.0	0.0
Audubon IBAs Non-JBCC	0.0	0.0	0.0	0.0	0.004	0.0	0.0	0.0
BioMap Core Habitat JBCC	20.3	59.3	11.9	6.7	0.0	0.0	0.0	0.0
BioMap Core Habitat Non-JBCC	9.5	27.7	3.7	7.5	0.0	0.0	0.0	0.0
BioMap Critical Natural Landscape JBCC	9.9	28.1	6.6	3.6	0.0	0.0	0.0	0.0
BioMap Critical Natural Landscape Non-JBCC	4.8	14.0	1.0	3.0	0.0	0.0	0.0	0.0
District of Critical Planning Concern JBCC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
District of Critical Planning Concern Non-JBCC	10.4	40.6	1.1	6.2	3.9	10.5	3.6	3.7
NHESP EH JBCC	18.8	54.1	10.3	6.6	0.0	0.0	0.0	0.0
NHESP EH Non-JBCC	0.6	1.8	3.6	6.2	0.0	0.0	0.0	0.0
NHESP PH JBCC	20.3	59.3	11.9	6.7	0.0	0.0	0.0	0.0
NHESP PH Non-JBCC	8.0	25.0	3.6	6.5	0.0	0.0	0.0	0.0
Individual Areas Totaled	*124.7*	*374.2*	*65.3*	*60.7*	*5.0*	*11.3*	*3.6*	*3.7*
All SHA JBCC (Dissolved)	**20.4**	**59.3**	**11.9**	**6.7**	0.0	0.0	0.0	0.0
All SHA Non-JBCC (Dissolved)	**11.6**	**42.7**	**4.7**	**12.6**	**3.9**	**10.5**	**3.6**	**3.7**

Note: EH = Estimated Habitat; PH = Priority Habitat. Totals may not sum exactly due to rounding.

As shown in Table 5-12, the majority of SHA overlap occurs within JBCC lands and other Natural Areas placetypes. Most impacts within SHAs are temporary and associated with construction workspaces, access roads, and pipeline installation activities. Permanent impacts have been minimized through route refinement, facility siting, and collocation within existing utility and transportation corridors.

Protection of wildlife and plant habitat was a primary consideration during Project planning, environmental review, and agency consultation. Algonquin developed the Project using a hierarchy of avoidance, minimization, restoration, and compensatory mitigation measures intended to reduce habitat fragmentation, protect state-listed species, restore temporary disturbances, and provide long-term conservation benefits. Key commitments include:

- Collocating facilities within existing utility and transportation corridors to minimize habitat fragmentation;
- Reducing projected tree clearing from approximately 66.0 acres to approximately 44.8 acres;
- Using HDD and other design measures to avoid sensitive resource areas where practicable;
- Implementing species-specific protection measures through the MESA CMP;
- Restoring temporary construction workspaces with native vegetation;
- Implementing invasive species prevention and management measures; and
- Providing long-term compensatory mitigation, including permanent land conservation adjacent to JBCC and contributions to species-specific conservation programs.

These measures form the basis for the Project's consistency with the Wildlife and Plant Habitat goals and objectives of the RPP.

Objective WPH1 – Maintain existing plant and wildlife populations and biodiversity.

The Project will result in temporary and permanent impacts to wildlife habitat, including forested habitat, Significant Natural Communities, NHESP Priority Habitat, and NHESP Estimated Habitat. However, Project refinements completed during MEPA and NHESP review reduced projected tree clearing from approximately 66.0 acres to approximately 44.8 acres, substantially reducing habitat disturbance and fragmentation compared to earlier Project configurations.

The Project maximizes the use of existing utility corridors, transportation corridors, and previously disturbed areas, thereby concentrating impacts within areas that are already managed or fragmented. Temporary disturbances will be restored following construction, and permanent habitat conversion has been minimized through route selection, facility siting, and construction planning.

Algonquin is coordinating with NHESP regarding a CMP that includes species-specific protection measures for state-listed species, construction monitoring, habitat management commitments, and compensatory mitigation requirements. Additional long-term mitigation measures include permanent conservation of approximately 60 acres adjacent to JBCC and contributions to species-specific conservation programs.

The Project is consistent with Objective WPH1 because it minimizes habitat loss and fragmentation, protects rare species habitat, restores temporary disturbances, and provides long-term conservation benefits that support biodiversity and wildlife populations.

Objective WPH2 – Restore degraded habitats through use of native plant communities.

Although the Project is not principally intended to restore previously degraded habitats, it incorporates extensive restoration measures designed to return temporarily disturbed areas to stable, functioning habitat conditions following construction.

Temporary construction workspaces will be regraded, stabilized, and revegetated using native seed mixes appropriate to Barnstable County habitats. Within Priority Habitat and other environmentally sensitive areas, restoration will utilize specialized seed mixes approved by NHESP and JBCC natural resource managers. Restoration activities will also include removal of temporary construction materials, restoration of wetland and upland hydrology, and monitoring of revegetation success.

The Project also includes habitat enhancement and invasive species management commitments. Algonquin will implement an NHESP-approved IPMP to prevent the introduction and spread of invasive species during construction and operation, improve habitat quality, and support the establishment and persistence of native plant communities. Restoration work within JBCC will be coordinated with JBCC environmental staff to ensure compatibility with ongoing habitat management and ecological restoration objectives.

The Project is consistent with Objective WPH2 because it restores temporarily disturbed areas using native vegetation and implements long-term management measures that support recovery and persistence of native plant communities.

Objective WPH3 – Protect and preserve Rare Species habitat, Vernal Pools, 350-foot buffers to Vernal Pools.

No Certified Vernal Pools (CVPs) or potential vernal pools occur within the Project area. Two NHESP-mapped CVPs occur within the 350-foot buffer area defined by the Wildlife and Plant Habitat Technical Bulletin; however, the Project does not include permanent development within these buffer areas. Temporary construction-related disturbances within the buffer will be restored following construction.

Portions of the Project occur within NHESP-designated Priority Habitat and Estimated Habitat and are subject to review under MESA. Through the CMP process, Algonquin is developing species-specific protection measures for state-listed species and habitat resources. These measures include rare plant protection procedures, turtle protection measures, clam shrimp protection measures, biological monitoring, environmental inspection, and restoration requirements.

The Project incorporates additional protection measures including seasonal clearing restrictions, reduced workspaces in environmentally sensitive areas, construction monitoring, and restoration of temporary disturbances using native vegetation communities.

The Project is consistent with Objective WPH3 because it avoids permanent impacts to vernal pools and their buffers, minimizes impacts to rare species habitat, and incorporates comprehensive protection, restoration, and mitigation measures developed in coordination with NHESP.

Objective WPH4 – Manage Invasive Species.

Algonquin is preparing an Invasive Plant Management Plan as part of the CMP process to provide a framework for invasive species prevention, monitoring, treatment, and long-term management. During construction, Algonquin will implement a variety of invasive species prevention measures consistent with its E&SCP, including:

- minimizing the duration and extent of exposed soils;
- stabilizing disturbed areas as quickly as practicable following construction;
- retaining and replacing existing topsoil where feasible to preserve native seed banks and reduce opportunities for invasive species establishment;
- cleaning construction equipment when moving between infested and non-infested areas to reduce the transport of invasive plant material and seeds;
- implementing erosion and sediment controls that prevent the movement of invasive species propagules with sediment;
- using clean, weed-free mulch and other revegetation materials; and
- restoring disturbed areas with NHESP-approved native seed mixes and vegetation appropriate to Barnstable County and JBCC habitat management objectives.

Following construction, disturbed areas and maintained ROWs will be monitored to assess revegetation success and identify invasive species populations. Where invasive species are identified, management actions may include mechanical removal, targeted herbicide treatment, or other control measures consistent with the approved IPMP and applicable permit requirements. These measures will be implemented with particular attention to rare species habitat, wetlands, and conservation lands to ensure that invasive species do not displace native vegetation communities or degrade habitat quality.

In addition to preventing new infestations, the Project provides an opportunity to improve habitat quality in portions of the Project area through active invasive species management and restoration with native plant communities. Restoration of temporary construction workspaces using native vegetation will support recovery of ecological functions, enhance habitat resiliency, and reduce the likelihood of long-term invasive species establishment.

The Project aligns with the methods outlined in the Wildlife and Plant Habitat Resources Technical Bulletin because it incorporates invasive species prevention, monitoring, control, and restoration measures designed to minimize the introduction and spread of invasive species during construction and operation. The Project's approach emphasizes avoidance of invasive species establishment, restoration with native vegetation, and long-term management of invasive populations within disturbed areas and maintained ROWs. The Project is consistent with Objective WPH4.

Objective WPH5 – Promote best management practices to protect wildlife and plant habitat from the adverse impacts of development.

The Project incorporates best management practices throughout planning, construction, restoration, and long-term operation. During Project design, Algonquin prioritized collocation within existing utility and transportation corridors, reduced projected tree clearing through route refinements, and incorporated HDD where practicable to avoid sensitive habitat areas.

During construction, the Project will implement environmental inspection and compliance monitoring, reduced workspaces in environmentally sensitive areas, construction timing restrictions, erosion and sediment controls, species-specific protection measures, exclusion fencing, and other resource protection measures developed through agency consultation.

Long-term habitat management commitments include restoration of temporary construction areas, invasive species management, habitat enhancement opportunities within maintained ROWs, permanent conservation

of approximately 60 acres adjacent to JBCC, and implementation of all protection, management, and mitigation measures required through the CMP.

The Project is consistent with Objective WPH5 because it employs a comprehensive hierarchy of avoidance, minimization, restoration, and mitigation measures that protect wildlife habitat, rare species habitat, and native plant communities throughout the life of the Project.

5.3.5 OPEN SPACE

5.3.5.1 Existing Conditions

Open space and protected lands are a prominent feature of the Project area and contribute significantly to the ecological, recreational, and water resource values of the Upper Cape region. These lands include conservation areas, water supply protection lands, WMAs, recreational corridors, and military lands that collectively support habitat conservation, groundwater protection, passive recreation, and regional open space connectivity.

Much of the Project area traverses undeveloped forested lands characterized by pitch pine-oak woodland communities typical of Upper Cape Cod. These lands provide important wildlife habitat, groundwater recharge areas, and ecological connections between larger conservation areas.

The largest protected open space resource in the Project area is the JBCC, including the Camp Edwards WMA, which contains extensive undeveloped forestland used for military training, habitat conservation, groundwater protection, and ecological research. Additional open space resources include conservation lands owned by the Town of Bourne, lands managed by the Massachusetts Department of Fish and Game (MDFG), properties protected for drinking water supply purposes by the Buzzards Bay Water District, and conservation lands owned by regional and municipal conservation entities.

Recreational Resources

The Cape Cod Canal is one of the region's most significant open space and recreational resources. The USACE maintains service roads on both sides of the Canal that are utilized for walking, bicycling, fishing, sightseeing, and access to Canal recreation areas. These facilities provide an important public recreational resource and regional transportation corridor for non-motorized users.

Bourne Scenic Park, located adjacent to the Cape Cod Canal, is a campground and outdoor recreation facility operated by the Bourne Recreation Authority. The park provides camping, recreational access, and visitor services within the Canal corridor and serves as an important recreational resource for the Town of Bourne.

Article 97 Protected Lands

Several Article 97-protected properties occur within or adjacent to the Project area (Figure 5.3-7 in Attachment 1). These lands are protected for conservation, recreation, water supply, habitat protection, or open space purposes and include:

Sacrifice Rock Woods Conservation Area

Sacrifice Rock Woods is an approximately 83-acre conservation property owned by the Bourne Conservation Commission. The parcel contains a network of recreational trails and is dominated by pitch pine–oak woodland habitat. Existing electric transmission corridors traverse portions of the property and create areas of maintained open vegetation within an otherwise forested landscape.

Buzzards Bay Water District Lands

The Buzzards Bay Water District owns and manages protected open space lands surrounding public water supply facilities, including Well No. 5 and Pump Stations No. 3 and No. 4. These lands provide groundwater recharge and drinking water protection functions and are characterized primarily by pitch pine–oak woodland. Existing utility corridors and water supply infrastructure occur within portions of the property.

Cape Cod Land Bank Property

This undeveloped parcel is owned and managed for land conservation and habitat protection purposes. The property consists primarily of forested uplands and contributes to the regional open space network and wildlife habitat corridor system.

Nightingale Pond Conservation Area

The Nightingale Pond Conservation Area is a Town of Bourne–owned conservation property consisting of forested uplands associated with Nightingale Pond and adjacent natural resources. The property provides natural resource protection, habitat functions, and passive recreation opportunities.

Massachusetts Department of Fish and Game Lands

The MDFG owns several protected parcels within the Project area. These properties are predominantly undeveloped and consist of forested upland habitat intersected by existing utility corridors. The lands contribute to wildlife habitat conservation and regional open space connectivity.

Camp Edwards Wildlife Management Area

Camp Edwards forms part of the larger JBCC reservation and encompasses extensive undeveloped forestland that supports military training, habitat conservation, groundwater protection, and ecological research. The Project area within Camp Edwards consists primarily of pitch pine–oak woodland interspersed with existing utility corridors, access roads, and electrical infrastructure. Much of the surrounding property is designated Priority Habitat and Estimated Habitat by the NHESP.

These protected properties collectively support passive recreation, habitat conservation, groundwater protection, and regional open space connectivity. Existing utility corridors, access roads, and other infrastructure occur within portions of several of these properties.

5.3.5.2 Impact Summary

Open Space Impact Overview

The Project will result in temporary and permanent impacts to protected open space resources, Article 97 lands, and recreational facilities located along the Project area. Consistent with the Open Space Technical Bulletin (Cape Cod Commission 2025b), open space impacts include effects on lands that provide natural resource, conservation, recreational, cultural, and water resource functions.

Most Project impacts occur within existing utility corridors, transportation corridors, access roads, and previously disturbed areas that already traverse protected open space lands.

Article 97 and Protected Open Space Lands

Algonquin evaluated impacts to portions of the Sacrifice Rock Woods Conservation Area, Buzzards Bay Water District lands, Cape Cod Land Bank property, Nightingale Pond Conservation Area, MDFG lands, Camp Edwards WMA, and other protected open space resources crossed by the Project.

Approximately 38.2 acres of Article 97 land will be subject to permanent easements associated with the operation and maintenance of Project facilities, including pipeline ROWs, access roads, and aboveground facilities. Additional areas of protected open space will be temporarily disturbed during construction.

Temporary impacts include vegetation clearing, establishment of construction workspaces, access road improvements, and short-term construction activities. Permanent impacts are primarily associated with maintenance of the pipeline ROW and access roads necessary to ensure safe operation and inspection of Project facilities, and the Pave Paws Road M&R Station.

Recreational Resources

Construction activities may result in temporary restrictions on public access within localized portions of the Cape Cod Canal recreation corridor and other recreational resources located adjacent to construction activities. Temporary impacts may include short-term access limitations, localized construction activity adjacent to recreational facilities, and temporary use of portions of recreational properties for construction support.

The Project will utilize a limited portion of Bourne Scenic Park as temporary construction workspace associated with removal of the existing Bourne M&R Station. Following construction, temporary work areas will be restored and returned to their previous recreational use.

The Canal service roads and associated recreational facilities will remain available for public use except where temporary restrictions are necessary to maintain public safety during active construction activities.

Open Space Connectivity and Conservation Functions

Although the Project traverses a substantial amount of protected open space, most impacts occur within existing utility and transportation corridors that already influence the surrounding landscape. Consequently, the Project is not expected to create substantial new fragmentation of open space resources or interrupt regional habitat and open space connections.

Permanent impacts are limited relative to the total acreage of protected lands crossed by the Project and will largely occur within previously disturbed utility corridors and maintained ROWs.

Table 5-13 summarizes open space impacts by Placetype and development classification.

Table 5-13. Placetype Impacts in Open Space

Land	Development	Temporary or Permanent	Natural Areas (acres)	Non–Natural Areas (acres)
JBCC	Redevelopment	Permanent	20.4	0.0
JBCC	New Development	Permanent	11.9	0.0
JBCC	Redevelopment	Temporary	59.0	0.0
JBCC	New Development	Temporary	6.7	0.0
Non-JBCC	Redevelopment	Permanent	6.7	0.0

Land	Development	Temporary or Permanent	Natural Areas (acres)	Non–Natural Areas (acres)
Non-JBCC	New Development	Permanent	0.9	0.0
Non-JBCC	Redevelopment	Temporary	26.2	0.0
Non-JBCC	New Development	Temporary	3.5	0.0
Total			**135.3**	**0.0**

Note: Totals may not sum exactly due to rounding.

Overall Impact Summary

Open space impacts associated with the Project consist primarily of temporary construction-related disturbance, permanent easements within existing utility corridors located on protected lands, and the Pave Paws Road M&R Station. While unavoidable impacts to Article 97 lands and other open space resources will occur, the Project has been designed to minimize fragmentation, maintain recreational access wherever practicable, and preserve the long-term conservation and open space functions of affected properties.

5.3.5.3 Avoidance, Minimization and Mitigation Summary

Avoidance

Avoidance of open space impacts was a primary consideration throughout Project planning and design. Route selection prioritized the use of existing utility corridors, transportation corridors, access roads, and previously disturbed areas to reduce impacts to protected open space lands and avoid the creation of new utility corridors through undeveloped conservation land.

Additional avoidance measures include:

- Collocation of Project facilities within existing utility and transportation corridors wherever practicable;
- Utilization of existing access routes and disturbed areas where feasible;
- Avoidance of Zone I Water Supply Protection Areas; and
- Project refinements that reduced proposed tree clearing, temporary workspace requirements, and overall land disturbance.

Minimization

Where impacts could not be avoided, Algonquin incorporated measures to minimize effects on open space resources, recreational facilities, and conservation lands.

Key minimization measures include:

- Reduction and consolidation of temporary construction workspaces, contractor yards, and access requirements;
- Reduction of temporary tree clearing through route refinements and workspace modifications;
- Limitation of permanent ROW widths in sensitive locations to the minimum width necessary for safe operation;
- Reduction of permanent corridor widths to approximately 50 feet in portions of certain Article 97 properties; and

- Use of temporary easements and revocable permits where feasible to reduce long-term land-use impacts.

Restoration

Following construction, all temporary work areas located within open space, conservation, and recreational lands will be restored to preconstruction conditions to the extent practicable.

Restoration activities will include:

- Removal of temporary construction materials and facilities;
- Regrading and stabilization of disturbed areas;
- Revegetation with appropriate vegetation communities;
- Restoration of temporarily disturbed recreational areas; and
- Monitoring and follow-up restoration measures as required by permits and agency commitments.

Compensatory Mitigation

The Project includes mitigation measures to address unavoidable impacts to open space and Article 97 lands. Algonquin is coordinating with EEA, affected municipalities, and Article 97 landowners to comply with the Open Space Act (M.G.L. c. 3, s.5A) and the EEA Article 97 Land Disposition Policy, including requirements related to permanent easements, replacement land, or other compensatory measures, as determined through the regulatory review process.

In addition, Algonquin is pursuing permanent protection of approximately 60 acres of undeveloped forest land adjacent to JBCC and the Camp Edwards WMA. Permanent protection of this property will expand protected open space, enhance habitat connectivity, support groundwater and natural resource protection, and provide long-term conservation benefits extending beyond the Project area.

Overall Mitigation Summary

Collectively, the Project's avoidance, minimization, restoration, and compensatory mitigation measures are intended to maintain the long-term recreational, conservation, ecological, and open space functions of affected properties while allowing construction and operation of critical energy infrastructure within existing transportation and utility corridors.

5.3.5.4 Consistency with RPP Goals and Objectives

This section discusses how Algonquin has taken action to conserve, preserve, or enhance a network of open space that contributes to the region’s natural and community resources and systems.

Objective OS1 – Protect and preserve natural, cultural, agricultural, and recreational resources.

The Project was designed to avoid and minimize impacts to natural, cultural, agricultural, and recreational resources through route refinement, collocation within existing infrastructure corridors, and implementation of project-specific avoidance and mitigation measures. As discussed in the Natural Systems section, Algonquin incorporated extensive avoidance, minimization, restoration, and compensatory mitigation measures to reduce impacts to wildlife habitat, wetlands, groundwater resources, and other ecological resources. Cultural resources were evaluated throughout the Project area and the Project is not anticipated

to adversely affect known archaeological or historic resources (see Section 5.5.1). The Project will not impact agricultural lands or agricultural resources with open space value.

One of the most significant recreational and open space resources in the Project area is the Cape Cod Canal corridor. The USACE maintains service roads on both sides of the Canal that support walking, bicycling, fishing, sightseeing, and access to Canal recreation areas. These facilities function as a regionally important recreational corridor and provide one of the most heavily used public open space resources on Cape Cod.

Protection of the Canal recreation corridor was a key consideration during Project design. The Project will utilize HDD beneath the Canal, avoiding direct impacts to the Canal itself and substantially reducing impacts to Canal recreation facilities and public access areas. A limited area of temporary construction workspace is proposed near the Sagamore Bridge and overlaps a portion of the Canal service road. Construction in this area may result in temporary access restrictions or temporary modifications to public use during active construction. However, these impacts will be localized, temporary in nature, and coordinated with the USACE to maintain public safety and recreational access to the extent practicable. Upon completion of construction, the affected area will be restored and the Canal service road will be returned to preconstruction conditions.

As a result, the Project avoids direct impacts to the majority of the Canal recreation corridor and maintains the long-term recreational and open space functions of one of the region's most significant recreational resources. Unavoidable open space impacts are therefore concentrated primarily within existing utility corridors located on Article 97-protected lands and other conservation properties. These impacts occur largely within previously disturbed or actively managed utility corridors and are subject to restoration, mitigation, and regulatory review requirements. In addition, Algonquin is coordinating with EEA, municipalities, and affected landowners regarding Article 97 compliance, replacement land requirements, and long-term conservation measures. The Project also includes permanent protection of approximately 60 acres of land adjacent to JBCC and Camp Edwards WMA, as well as additional replacement land near the proposed Bourne M&R Station.

The avoidance, minimization, restoration, and mitigation measures described in Section 5.3.5.3 align with the methods outlined in the Open Space Technical Bulletin, including corridor collocation, reduced impacts to protected lands, avoidance of major recreational resources through HDD, restoration of temporary disturbances, and compliance with the Open Space Act and EEA Article 97 Land Disposition Policy.

The Project is consistent with Objective OS1 because it protects and preserves natural, cultural, agricultural, and recreational resources through route selection, HDD avoidance of the Cape Cod Canal recreation corridor, restoration of temporary disturbances, and long-term conservation and open space mitigation commitments. In addition to avoidance of the Canal through HDD, temporary impacts to recreational resources, including the Canal service road near the Sagamore Bridge and a portion of Bourne Scenic Park, will be restored following construction and returned to their previous recreational use.

Objective OS2 – Maintain or increase the connectivity of Open Space.

One of the objectives of the Project design was to minimize fragmentation of undeveloped lands. To achieve this objective, the Project was routed within or adjacent to existing utility corridors, transportation corridors, access roads, and previously disturbed areas to the maximum extent practicable. By collocating facilities within existing linear infrastructure corridors, the Project avoids creating substantial new clearings through contiguous protected open space and minimizes fragmentation of forested landscapes.

The majority of permanent impacts occur within existing utility corridors that already influence the surrounding landscape. As a result, the Project does not introduce new barriers that would substantially interrupt regional open space connections, wildlife movement patterns, or ecological linkages between protected lands. Large blocks of contiguous forest and upland habitat will remain connected following construction, particularly within and adjacent to JBCC and Camp Edwards WMA, where extensive undeveloped lands will continue to support habitat connectivity and open space functions.

Permanent impacts associated with the Pave Paws Road M&R Station and a short segment of new G-32 pipeline ROW southeast of the Bourne Switchyard will result in localized conversion of forested habitat to maintained utility facilities and ROW. However, these impacts occur adjacent to existing transmission corridors and previously disturbed areas and therefore do not create meaningful new fragmentation of the surrounding open space network. Similarly, operation and maintenance of the Project will occur primarily within existing managed corridors, limiting long-term effects on the connectivity of protected lands.

The Project also maintains recreational connectivity within the Cape Cod Canal corridor. The Canal service roads provide an important regional recreational and non-motorized transportation corridor connecting recreational destinations along the Canal. The use of HDD beneath the Canal avoids direct impacts to most of this recreational corridor and preserves its long-term connectivity and public use. Although temporary construction workspace is proposed near the Sagamore Bridge and overlaps a portion of the Canal service road, impacts will be localized and temporary, and the affected areas will be restored following construction.

The avoidance, minimization, restoration, and mitigation measures described in Section 5.3.5.3 further support maintenance of open space connectivity through corridor collocation, restoration of temporary disturbances, reduced workspace widths, and protection of adjacent conservation lands. Collectively, these measures ensure that open space resources continue to function as an interconnected network supporting habitat conservation, recreation, groundwater protection, and ecological resilience.

The Project is consistent with Objective OS2 because it maintains regional open space connectivity, minimizes fragmentation through collocation within existing utility and transportation corridors, preserves recreational connections along the Cape Cod Canal corridor, and restores temporary disturbances following construction.

Objective OS3 – Provide protected Open Space appropriate to context.

The Open Space Technical Bulletin evaluates permanent impacts to open space resources through an Area of Development Impact (ADI) analysis. The ADI methodology assesses permanent Project impacts within each applicable Placetype and establishes mitigation requirements based on the ecological value and context of the affected open space resource.

The Project overlaps protected open space resources within both Natural Areas and non–Natural Areas Placetypes. Most permanent impacts occur within existing utility corridors, access roads, and previously disturbed areas located within protected open space lands, thereby avoiding the creation of new corridors through intact conservation lands. Although these impacts affect open space resources, they are concentrated within existing infrastructure corridors and do not substantially alter the overall open space character, ecological value, or conservation function of the surrounding landscape.

Table 5-14 summarizes the Project's permanent ADI and associated open space mitigation requirements under the Open Space Technical Bulletin.

Table 5-14. Area of Development Impact for Project (permanent)

Placetype	JBCC Developed	JBCC Undeveloped	Non-JBCC Developed	Non-JBCC Undeveloped	ADI Ratio	Mitigation Target
Natural Areas	20.3	11.9	12.0	4.9	3:1	50.7
Non–Natural Areas	0.0	0.0	8.1	3.6	1:1	11.8
Total Acreage	**20.3**	**11.9**	**20.1**	**8.5**		**62.5**

Note: ADI ratios are assigned in accordance with the Cape Cod Commission Open Space Technical Bulletin and are based on Placetype designation. Excluding JBCC lands, Natural Areas are subject to a 3:1 mitigation ratio and non–Natural Areas Placetypes affected are subject to a 1:1 mitigation ratio.

As shown in Table 5-14, excluding JBCC lands, the Project includes approximately 16.9 acres of ADI within Natural Areas Placetypes and 11.8 acres of ADI within non–Natural Areas Placetypes. Application of the applicable mitigation ratios results in an Open Space mitigation target of approximately 50.7 acres within Natural Areas and 11.8 acres within non–Natural Areas Placetypes, for a combined mitigation objective of approximately 62.5 acres.

To satisfy this mitigation objective, Algonquin is pursuing permanent protection of approximately 60 acres of undeveloped forest land adjacent to JBCC and the Camp Edwards Wildlife Management Area. Protection of this property will expand the region's protected open space network, strengthen habitat connectivity, preserve groundwater recharge areas, and support long-term conservation objectives associated with Camp Edwards and surrounding conservation lands. Because the parcel is adjacent to existing protected land, its preservation will contribute to maintaining a large contiguous block of protected open space within the Upper Cape region.

Following enactment of Article 97 legislation by the General Court, Algonquin will also transfer approximately 2.8 acres of replacement conservation land to the Town of Bourne. Algonquin has acquired this parcel and intends to subdivide a portion for conveyance to the Town as replacement conservation land. The parcel consists of wooded, undeveloped land located in a predominantly rural setting and will provide long-term open space, habitat protection, groundwater recharge, and conservation benefits consistent with the purposes of the affected Article 97 lands.

Together, the approximately 60-acre conservation parcel adjacent to JBCC and the 2.8-acre Article 97 replacement parcel provide approximately 62.8 acres of permanently protected open space, which closely corresponds to the 62.5-acre mitigation target identified through the ADI analysis.

Collectively, transfer of 2.8 acres of replacement land to the Town of Bourne, and protection of approximately 60 acres adjacent to JBCC will provide more than 62 acres of permanently protected open space. These measures offset unavoidable Project impacts while advancing regional conservation, habitat connectivity, groundwater protection, recreation, and open space preservation objectives.

The Project is consistent with Objective OS3 because it incorporates a comprehensive open space mitigation strategy that includes the proposed transfer of 2.8 acres of Article 97 replacement land to the Town of Bourne and protection of approximately 60 acres adjacent to JBCC. Together, these permanently protected lands offset unavoidable impacts to open space resources, enhance regional habitat connectivity, and are consistent with the mitigation framework established in the Open Space Technical Bulletin.

5.4 Built Systems

The goals within the RPP associated with built systems are identified below, along with a brief description of the Project’s consistency with those goals.

5.4.1 COMMUNITY DESIGN

5.4.1.1 Existing Conditions

The Project area encompasses a range of community settings within the Town of Bourne and JBCC, including transportation corridors, utility ROWs, residential neighborhoods, commercial areas, military facilities, conservation lands, and public open space. Community character within the Project area is shaped by the presence of longstanding infrastructure, including highways, utility corridors, electrical transmission facilities, and existing natural gas pipeline systems, many of which have been present in the landscape for decades.

Much of the Project area follows existing utility and transportation corridors, including areas characterized by maintained ROWs, roadway infrastructure, and associated utility facilities. These developed corridors are interspersed with forested lands, conservation areas, water supply protection lands, and recreational resources, creating a landscape that reflects both developed and natural character.

Residential neighborhoods near the Project area are generally concentrated along local roads and developed portions of Bourne, while commercial development occurs primarily along major transportation routes and village centers. Community character in these developed areas is influenced by a mix of residential uses, commercial establishments, transportation infrastructure, and public facilities.

Within JBCC, community character differs substantially and is defined primarily by military operations, extensive forested landscapes, utility infrastructure, and restricted-access lands. The military reservation contains large tracts of undeveloped land that contribute to the region's open space network and provide a visual buffer from surrounding development.

The Project area also includes visually significant resources associated with the Cape Cod Canal, conservation lands, and public recreation areas. Existing vegetation, forest cover, and landscape buffers contribute to the visual character of these areas by screening infrastructure and maintaining the natural appearance of the surrounding landscape.

Community character within the Project area reflects a combination of transportation infrastructure, military facilities, utility corridors, residential neighborhoods, commercial development, and conservation lands. Existing natural gas infrastructure has been present within many portions of the Project area for decades and is generally collocated with existing infrastructure corridors.

5.4.1.2 Impact Summary

Construction activities will result in temporary visual impacts associated with construction equipment, materials staging, soil disturbance, vegetation clearing, and temporary workspaces. These effects will be most noticeable within active construction areas and along portions of the pipeline corridor where vegetation clearing is required. Because these activities are temporary and construction will progress through the corridor, visual impacts are expected to be short-term in nature.

Following construction, visual changes will primarily be limited to areas of maintained utility ROW and aboveground facilities. Most pipeline segments will remain underground and will not be visible once construction is complete. Potential long-term visual impacts are most relevant at the proposed Sagamore M&R Station on Canal Street. This facility will introduce aboveground utility infrastructure into an area that may be visible from nearby roadways, residences, or adjacent land uses.

5.4.1.3 Avoidance, Minimization, and Mitigation Summary

To protect and enhance the unique character of the region's built environment based on the local context. The Project has been designed to minimize effects on community character by utilizing existing utility and transportation corridors wherever practicable and by collocating new facilities with existing infrastructure. Approximately 90 percent of the proposed G-31 and G-32 pipelines will be located within or immediately adjacent to existing utility easements, thereby reducing the introduction of new visual elements into previously undeveloped areas.

5.4.1.4 Consistency with RPP Goals and Objectives

Objective CD1 – Promote context-sensitive building and site design.

New buildings are limited to the four new M&R stations. Three of the stations are located in areas that are anticipated to be largely visually shielded from nearby residences and public areas. The Sagamore M&R Station is the most visible station, and therefore Algonquin has developed a landscape screening plan for the station (see Attachment 11).

Through limited visual impacts and implementation of screening, the Project aligns with the methods outlined in the Community Design Technical Bulletin. Therefore, the Project is consistent with Objective CD1.

Objective CD2 – Minimize the amount of newly disturbed land and impervious surfaces.

The Project has been designed to minimize land alteration and limit the conversion of pervious surfaces to impervious materials to the maximum extent practicable. Permanent Project features, including pipelines, M&R stations, and access roads, have been sited primarily within existing utility corridors, roadways, or previously disturbed areas to avoid creating new developed footprints. Temporary construction workspaces, including ATWS, will be fully restored following construction and will not result in permanent land conversion. Where permanent access is required, Algonquin will use existing roads where practicable or design access roads with gravel or other pervious surfaces to maintain infiltration and minimize stormwater runoff. The Project proposes 7.2 acres of new impervious surface.

For areas where permanent impacts remain, Algonquin will implement mitigation measures to offset those impacts. These measures include minimizing the size of permanent easements and operational areas, stabilizing disturbed soils, restoring vegetation using native or appropriate seed mixes, and implementing long-term erosion and sedimentation controls consistent with Algonquin's E&SCP and applicable federal and state requirements. Stormwater management features will be incorporated where necessary to maintain existing drainage patterns and protect downgradient resources. Through these design and mitigation measures, permanent land alteration and impervious surface impacts are minimized and appropriately mitigated, consistent with MEPA and Association to Preserve Cape Cod guidance.

Through design review and siting, as well as adherence to Massachusetts stormwater standards, the Project aligns with the methods outlined in the Community Design Technical Bulletin. Therefore, the Project is consistent with Objective CD2.

Objective CD3 – Avoid adverse visual impacts from infrastructure to scenic resources.

Visual impacts from scenic resources were reviewed and it was determined that Project facilities will not be visible, or visually striking, from any scenic resources. Further, with implementation of the Project's avoidance, minimization, restoration, and visual screening measures, long-term impacts to community character are expected to be limited. The Project is expected to remain consistent with the existing character of the surrounding community while minimizing effects on scenic, residential, recreational, and commercial resources.

Because the Project is largely collocated within existing utility and transportation corridors, restores disturbed areas following construction, and incorporates visual screening for the Sagamore M&R Station, the Project aligns with the methods outlined in the Community Design Technical Bulletin. Therefore, the Project is consistent with Objective CD3.

5.4.2 COASTAL RESILIENCY

5.4.2.1 Existing Conditions

The Project area includes coastal, floodplain, wetland, and shoreline resources that contribute to the resilience of the Cape Cod Canal corridor and surrounding environment. Together, these features provide important flood storage, storm damage prevention, erosion control, groundwater recharge, and water quality functions. Portions of the Project area occur within FEMA-mapped 100-year flood hazard areas (Zones AE and A) and within coastal resource areas associated with the Cape Cod Canal.

Climate change is expected to increase stress on these resources through rising sea levels, more frequent coastal storm events, greater precipitation intensity, and changing groundwater conditions. Increased storm intensity may result in more frequent flooding, higher stormwater runoff volumes, increased erosion potential, and greater pressure on infrastructure located within coastal and flood-prone environments. Floodplain and wetland resources within the Project area provide additional climate resilience benefits by storing floodwaters, supporting groundwater recharge, maintaining hydrologic connectivity, and reducing downstream flooding.

Consistent with these projected climate conditions, the Project evaluated future precipitation scenarios as part of the stormwater design for permanent aboveground facilities. Hydrologic analyses incorporated climate-adjusted rainfall conditions, including a projected 2070 storm event, to evaluate future performance of stormwater management systems and support the long-term resilience of Project infrastructure. Proposed stormwater systems incorporate infiltration practices, controlled overflow structures, groundwater recharge, and erosion protection measures designed to manage runoff and maintain functionality under future climate conditions.

5.4.2.2 Impact Summary

The Project area includes coastal and flood-prone resources associated with the Cape Cod Canal, adjacent shoreline areas, coastal wetland resource areas, and mapped floodplain areas. These resources are vulnerable to climate-related hazards, including sea level rise, coastal storm surge, increased precipitation, localized flooding, erosion, and changing groundwater conditions. Climate projections indicate that more frequent and intense storm events may increase flooding risks, particularly within existing floodplain areas.

Temporary construction activities within coastal resources are primarily associated with the temporary workspace at the Sagamore Bridge needed to remove the existing G-24 and G-11 pipelines and existing

cathodic protection as well as the removal of the G-11 pipelines adjacent to Nightingale Pond. These activities may require vegetation removal, equipment access, grading, excavation, and installation of erosion and sediment controls. These activities have the potential to temporarily affect drainage patterns or increase erosion and sedimentation if not properly managed. However, impacts will be short-term, confined to the construction period and defined workspace, and controlled through implementation of approved erosion and sediment control measures, restoration of disturbed areas, and adherence to Project-specific construction BMPs.

The Project will not result in permanent impacts to flood storage, flood conveyance, or coastal resiliency resources. The G-31 pipeline will be installed beneath the Cape Cod Canal via HDD, avoiding direct impacts to the Canal, associated coastal flood zones, and shoreline resources. Similarly, removal of existing pipelines within the 100-year floodplain associated with Nightingale Pond will not alter flood storage capacity, change drainage patterns, or increase the frequency or extent of flooding. Although temporary workspace is required within portions of the Coastal Bank and buffer near the Sagamore Bridge, no permanent impacts to the Coastal Bank resource area are proposed, and the Coastal Bank's form, stability, and storm damage prevention functions will be maintained. The Project is not expected to increase vulnerability to coastal storm damage, flooding, erosion, or other climate-related hazards, and will maintain the long-term resiliency and function of coastal and flood-prone resources within the Project area.

5.4.2.3 Avoidance, Minimization, and Mitigation Summary

The Project has been designed and will be constructed to avoid, minimize, and mitigate potential impacts to coastal resiliency resources, including coastal flood zones, floodplain areas, coastal wetland resources, and shoreline features associated with the Cape Cod Canal. Through route selection, engineering design, and construction planning, Algonquin prioritized techniques that avoid permanent impacts to coastal and flood-prone areas while maintaining existing flood storage, drainage patterns, and shoreline stability.

The most significant coastal resiliency avoidance measure is the use of HDD beneath the Cape Cod Canal, which eliminates direct impacts to the Canal, associated coastal flood zones, shoreline resources, and coastal wetland areas. The Project also avoids permanent fill within floodplains and flood-prone areas and does not alter existing coastal landforms, flood conveyance pathways, or flood storage capacity. In addition, removal of existing pipeline facilities within the floodplain associated with Nightingale Pond will not result in changes to flood elevations, flood storage, or the extent and frequency of flooding.

Construction activities within flood-prone areas will be limited to the minimum area necessary to safely complete the work. Temporary disturbances associated with vegetation clearing, equipment access, grading, dewatering, and workspace establishment will be controlled through implementation of erosion and sedimentation controls, stormwater management BMPs, and construction sequencing measures designed to maintain existing drainage patterns and prevent sediment transport to adjacent wetlands and coastal resources. Work areas will be stabilized during construction and restored promptly following completion of activities.

Following construction, all temporarily disturbed areas will be restored to preconstruction grades and contours to maintain existing drainage characteristics and floodplain functions. Disturbed vegetation will be reestablished in accordance with approved restoration plans, and temporary erosion and sediment controls will remain in place until vegetation is successfully established. Because the Project does not introduce permanent fill, reduce flood storage capacity, alter flood conveyance, or permanently impact Coastal Bank or other coastal landforms, no compensatory mitigation is required. As a result, the Project will not increase vulnerability to flooding, erosion, storm damage, or other climate-related hazards and will maintain the long-term resiliency and function of coastal resources within the Project area.

5.4.2.4 Consistency with RPP Goals and Objectives

Objective CR1 – Minimize development and risk within areas vulnerable to flooding.

The Project has been designed to minimize development within areas vulnerable to flooding and avoid increases in flood risk through careful siting, engineering design, and construction methods. Although limited portions of the Project are located within FEMA-mapped 100-year flood hazard areas (Zones AE and A), the Project will not introduce substantial new aboveground development within these flood-prone areas, reduce flood storage capacity, impede flood flows, or alter existing drainage patterns.

The G-31 pipeline will be installed beneath the Cape Cod Canal using HDD, avoiding direct impacts to coastal flood zones, coastal banks, and associated floodplain resources. Similarly, removal of existing pipeline facilities within the floodplain associated with Nightingale Pond will not alter flood elevations, flood storage, flood conveyance, or the frequency and extent of flooding.

All new and relocated M&R stations are located outside mapped floodplain areas and have been designed to withstand extreme weather conditions, including flooding events. Temporary construction within flood-prone areas will be managed through implementation of erosion and sediment controls, stormwater management measures, and restoration of disturbed areas in accordance with the Project's E&SCP. Disturbed vegetation within temporary workspaces will be revegetated following construction to restore infiltration capacity, stabilize soils, and maintain natural floodplain functions.

As a result, the Project will not increase exposure to flood hazards or exacerbate flooding conditions and will improve the long-term resiliency and reliability of regional energy infrastructure. Therefore, the Project is consistent with Objective CR1 because it minimizes development and risk within areas vulnerable to flooding while maintaining existing floodplain functions and supporting climate resilience.

Objective CR2 – Plan for erosion.

The Project has been designed to avoid and minimize erosion risks associated with Coastal Banks and other coastal resiliency resources through careful siting, use of trenchless construction methods, temporary construction controls, and restoration of disturbed areas. Coastal Banks within the Project area are significant for storm damage prevention because they buffer adjacent upland areas from coastal storm flows and flooding.

The Project intersects Coastal Bank in two locations along the Cape Cod Canal: 1) where the G-31 pipeline will be installed beneath the Canal via HDD, and 2) near the Sagamore Bridge where temporary access is required to remove an existing cathodic protection anode bed at the direction of the USACE. The G-31 pipeline HDD crossing avoids direct disturbance to the Canal shoreline and Coastal Bank, thereby minimizing the potential for erosion, instability, and impacts to storm damage prevention functions.

Consistent with the DRI objective to limit development within 150 feet of a Coastal Bank, the Project proposes no new permanent aboveground development on the coastal bank and within the 150-foot Coastal Bank buffer. See Table 5-15 for the impacts within the 150-foot buffer to Coastal Bank. No work will alter the Coastal Bank's form, stability, or storm damage prevention function, and no permanent impacts to Coastal Bank are proposed. Figure 5.3-4, Sheets 1, 3, and 4 in Attachment 1 show the Coastal Bank within the Project area.

Construction work within the Coastal Bank buffer has been minimized through workspace limitations, erosion and sediment controls, construction BMPs, and prompt restoration and revegetation of disturbed

areas. Environmental inspectors will monitor construction activities to ensure implementation of BMPs and protection of adjacent coastal resources. Temporary work areas will be stabilized and revegetated to maintain shoreline stability, infiltration capacity, and resistance to erosion. Following construction, all temporary work areas will be restored to preconstruction conditions to maintain shoreline stability, infiltration capacity, and the Coastal Bank's ability to buffer adjacent uplands from storm events and erosion.

Because the Project avoids permanent aboveground development within the Coastal Bank buffer, minimizes temporary disturbance, and restores affected areas following construction, it will not increase erosion hazards or diminish the storm damage prevention functions of Coastal Bank. Therefore, the Project is consistent with Objective CR2.

Table 5-15. Total Acreage of Impacts to 150-foot Buffer to Coastal Bank

Location	Status	Impact	Natural Areas (acres)	Non–Natural Areas (acres)
Non-JBCC	Redevelopment	Permanent	<0.1	<0.1
Non-JBCC	Redevelopment	Temporary	2.9	0.7
Non-JBCC	New development	Permanent	<0.1	0.0
Non-JBCC	New development	Temporary	0.6	<0.1
Total			**3.6**	**0.7**

Objective CR3 – Restore coastal resource areas to promote their natural beneficial functions.

The Project will restore all temporarily disturbed areas within the Coastal Bank and its 150-foot Buffer Zone following construction. Temporary disturbance associated with removal of the existing cathodic protection anode bed near the Sagamore Bridge will be restored to preconstruction contours and revegetated, preserving the Coastal Bank's storm damage prevention function and ability to buffer adjacent upland areas from coastal flooding. Although limited temporary work will occur within the Coastal Bank buffer, no permanent development is proposed and no long-term impacts to coastal resource area functions are anticipated

The Project avoids impacts to Coastal Bank through the use of HDD beneath the Cape Cod Canal and does not alter coastal landforms, shoreline processes, or sediment transport functions.

Because the Project restores all temporary disturbances, preserves the function of coastal resource areas, and incorporates design features into the M&R stations that enhance long-term resilience to climate-related hazards, it is consistent with Objective CR3.

5.4.3 CAPITAL FACILITIES AND INFRASTRUCTURE

The Project is fundamentally an infrastructure resiliency and reliability project designed to maintain uninterrupted natural gas service to Cape Cod while accommodating implementation of the CCBP.

5.4.3.1 Existing Conditions

The Project area contains substantial existing utility infrastructure including interstate natural gas transmission pipelines, electric transmission and distribution systems, public water systems,

telecommunications facilities, transportation corridors, and municipal infrastructure. Existing Algonquin facilities include the G-8C, G-8L, G-11, and G-24 pipelines, and the Bourne and Sagamore M&R stations.

5.4.3.2 Impact Summary

The Project will result in both temporary construction-period impacts and limited permanent infrastructure changes associated with relocating existing natural gas facilities out of conflict with the CCBP. Construction impacts will include temporary land disturbance, vegetation clearing, equipment activity, traffic management, noise, air emissions, stormwater runoff potential, and work within or near wetlands, flood-prone areas, open space, and utility corridors. These impacts will be localized and managed through construction sequencing, erosion and sediment controls, stormwater controls, dewatering practices, traffic management, construction noise controls, waste management procedures, and restoration of temporarily disturbed areas.

Permanent impacts will be limited primarily to buried replacement pipelines, relocated and new M&R stations, access roads, maintained ROWs, and stormwater management features. Aboveground facilities will introduce discrete permanent infrastructure, but these facilities were sited to support system reliability, avoid conflicts with future bridge construction, reduce proximity to residences where practicable, use previously disturbed or infrastructure-adjacent locations, and minimize environmental impacts.

5.4.3.3 Avoidance, Minimization, and Mitigation Summary

The Project minimizes impacts to capital facilities and infrastructure by relocating existing natural gas facilities to avoid conflicts with the CCBP while maintaining reliable uninterrupted gas service. Use of HDD beneath the Cape Cod Canal avoids in-water and open-cut construction, protecting canal operations, navigation, and existing infrastructure. The preferred alternative also maximizes collocation with existing pipeline, electric transmission, and transportation corridors, reducing the need for new utility corridors and limiting disturbance to developed areas.

Additional minimization measures include limiting the size of aboveground facilities, workspaces, and access roads; avoiding bridge construction work zones; and restoring temporarily disturbed areas following construction. Construction will be conducted within defined limits of work and supported by erosion and sediment controls, dewatering management, spill prevention measures, traffic controls, and environmental compliance monitoring.

Although the Project will result in temporary construction impacts and limited permanent land use changes, those impacts have been minimized through use of existing utility corridors, trenchless construction methods, and restoration commitments. Overall, the Project enhances the reliability and resiliency of critical regional energy infrastructure while limiting new disturbance and supporting the long-term reliable natural gas service.

5.4.3.4 Consistency with RPP Goals and Objectives

Objective CAP1 – Ensure capital facilities and infrastructure promote efficiency, sustainability, and resiliency.

A principal objective throughout Project development was to maximize use of existing infrastructure corridors and avoid creation of new utility corridors wherever practicable. To achieve this objective, Algonquin undertook extensive coordination with Eversource to locate substantial portions of the Project within or adjacent to existing electric transmission line ROWs. Use of these existing utility corridors significantly reduces impacts to undeveloped lands, minimizes fragmentation of natural resources, and

avoids the need to establish new linear infrastructure corridors through protected open space, forested habitat, and conservation lands.

The collocation strategy required substantial engineering and operational coordination due to the presence of existing high-voltage electric transmission infrastructure, transmission support structures, maintenance access requirements, utility separation standards, electromagnetic compatibility considerations, safety clearances, construction access constraints, and long-term operational requirements of both utility systems. Project design was refined through ongoing coordination with Eversource to ensure that natural gas facilities could be safely installed, operated, maintained, and accessed without adversely affecting electric transmission system reliability or future maintenance requirements.

As a result of this coordination, the Project is able to utilize existing utility corridors for approximately 90 percent of the G-31 and G-32 pipeline alignments, substantially reducing the extent of new disturbance that would otherwise be required to construct replacement energy infrastructure. This approach also minimizes impacts to residential neighborhoods, transportation infrastructure, open space resources, wildlife habitat, and conservation lands compared to development of a new independent corridor.

Permanent Project features, including pipelines, M&R stations, and access roads, have been sited primarily within existing utility corridors, roadways, or previously disturbed areas to avoid creating new developed footprints.

The entire G-31 pipeline has been designed to be located within or immediately adjacent to Eversource's overhead transmission line easement to minimize impacts (2.17 miles; 100 percent collocation)The G-32 pipeline originates at the proposed Pave Paws Road M&R Station and proceeds west approximately 0.30 mile within and adjacent to the Eversource easement until turning south and proceeding approximately 2.15 miles within and immediately adjacent to the Eversource overhead transmission line easement. From there, the G-32 pipeline pivots west, departing from the Eversource easement until terminating at the proposed Bourne Rotary M&R Station. A total of approximately 2.45 miles of the G-32 pipeline (approximately 80 percent) is located within or immediately adjacent to the Eversource overhead transmission line easement.

Algonquin's existing G-24 and G-11 pipelines at the Sagamore Bridge crossing cannot remain operational within Algonquin's existing pipeline ROW due to interference with the CCBP. The removal of these pipelines will occur within Algonquin's existing easement and partially on lands of the USACE, with the construction workspace and ATWS adjacent to the existing pipeline easements. Algonquin has proposed to relocate the G-24 and G-11 pipelines as close to the Algonquin existing easement as practicable while accommodating the CCBP.

Construction activities will result in temporary interactions with existing infrastructure systems, including electric transmission facilities, water supply infrastructure, transportation facilities, and other aboveground and underground utilities. Potential impacts are primarily temporary and consist of utility crossings, construction access, temporary disruptions associated with construction activities, and short-term modifications required to safely work around existing infrastructure.

The greatest concentration of utility coordination occurs within existing Eversource transmission corridors, where construction activities must be sequenced and managed to maintain continuous operation of the electric transmission network while allowing installation of the relocated natural gas facilities. Similar coordination has been undertaken with water districts, transportation agencies, JBCC, the USACE, and other utility owners to avoid service interruptions and maintain infrastructure functionality throughout construction.

Infrastructure impact avoidance and minimization were key considerations throughout route selection and facility design. Measures incorporated into the Project include:

- Extensive collocation of facilities within existing Eversource transmission corridors and other utility ROWs.
- Use of existing access roads and previously disturbed areas wherever practicable.
- Coordination with utility owners to identify and avoid conflicts with existing infrastructure.
- Development of utility crossing plans and construction sequencing requirements.
- Use of trenchless construction methods, including HDD beneath the Cape Cod Canal and other constrained locations.
- Design refinements that reduced overall land alteration and utility conflicts compared to earlier Project configurations.

Temporary disturbances associated with utility crossings, access roads, staging areas, and construction workspaces will be restored following construction. Areas not required for long-term operation will be stabilized, revegetated, and restored to preconstruction conditions to the maximum extent practicable. Coordination with Eversource and other utility owners will continue throughout construction and restoration to ensure protection of utility infrastructure and maintenance of existing operational requirements.

The Project is consistent with CAP1 because it will provide a resilient natural gas delivery system capable of supporting Cape Cod's energy needs while maintaining compatibility with the CCBP.

Objective CAP2 – Enhance the coordinated provision of services and facilities that respond to the needs of the region.

The Project does not create new utility service or expand existing service capacity. Instead, it relocates existing natural gas infrastructure to maintain reliable service and avoid future conflicts with planned bridge replacement projects. While the Project supports the continued provision of critical regional energy infrastructure, it does not represent a new or expanded service as contemplated under this objective.

5.4.4 TRANSPORTATION

5.4.4.1 Existing Conditions

Major transportation infrastructure includes the Bourne Bridge, Sagamore Bridge, U.S. Route 6, Massachusetts Route 3, Route 25, Route 28, local roadways, military access routes, and the Cape Cod Canal navigation corridor. Transportation infrastructure associated with the CCBP is a defining feature of the regional setting and drives the need for utility relocations throughout the Project area.

5.4.4.2 Impact Summary

The Project will not result in permanent adverse impacts to transportation facilities, roadway operations, parking resources, bicycle accommodations, pedestrian access, or transit services. The Project is a utility relocation project designed to support the CCBP and does not create new traffic demand, increase parking requirements, generate new vehicle trips, or alter long-term travel patterns. Following construction, transportation facilities will continue to operate under existing conditions and no reductions in roadway capacity or access are anticipated.

Temporary transportation impacts may occur during construction and will be limited to active work areas. Potential construction-related impacts include short-term lane or shoulder closures, temporary traffic control measures, construction vehicle movements, equipment and material deliveries, and localized access

restrictions near work zones. Transportation impacts may occur during pipeline installation, HDD operations, aboveground facility construction, access road improvements, and associated support activities. These impacts will be temporary in nature and managed through implementation of the Project Traffic Management Plan (see Attachment 6), coordination with applicable agencies, and deployment of appropriate traffic control measures to maintain public safety and transportation system functionality during construction.

Project design incorporates several measures to avoid or minimize disruptions to transportation facilities. Many crossings of transportation infrastructure have been specifically designed to avoid surface disturbance and maintain existing operations. For example, the G-31 pipeline will be installed beneath the Cape Cod Canal using HDD, avoiding impacts to roadway networks, canal-related transportation facilities, and navigation infrastructure. Similarly, HDD will be used to install the relocated G-11/G-24 pipelines beneath Route 3/Route 6 approaching the Sagamore Bridge, avoiding disruptions to roadways and a park and ride lot. These trenchless construction methods eliminate the need for surface excavation at key transportation crossings and substantially reduce potential construction-related transportation impacts.

The Project has been coordinated with MassDOT, the CCBP, the USACE, and the Town of Bourne to ensure compatibility with planned transportation improvements and minimize potential conflicts with future bridge replacement activities. Through ongoing coordination, facility siting and construction methods were selected to maintain transportation access and support implementation of the CCBP.

For consistency with the RPP Transportation Technical Bulletin, Table 5-16 summarizes transportation-related impacts by placetype. The majority of impacts occur within existing transportation and utility corridors and reflect temporary or permanent utility-related work associated with the Project rather than the creation of new transportation facilities or transportation demand.

Table 5-16. Transportation-Related Impacts by Placetype

Land	Development	Temporary or Permanent	Natural Areas (acres)	Non–Natural Areas (acres)
JBCC	Redevelopment	Permanent	10.7	0.0
JBCC	New development	Permanent	0.2	0.0
JBCC	Redevelopment	Temporary	0.7	0.0
JBCC	New development	Temporary	0.3	0.0
JBCC Subtotal			*11.9*	*0.0*
Non-JBCC	Redevelopment	Permanent	5.5	3.0
Non-JBCC	New development	Permanent	0.4	0.6
Non-JBCC	Redevelopment	Temporary	3.5	0.6
Non-JBCC	New development	Temporary	2.7	0.3
Non-JBCC Subtotal			*12.1*	*4.5*
Total			**24.0**	**4.5**

Note: Totals may not sum exactly due to rounding.

5.4.4.3 Avoidance, Minimization, and Mitigation Summary

The Project avoids long-term transportation impacts by relocating existing bridge-mounted natural gas facilities to a buried pipeline system located outside future bridge construction areas. The Project also minimizes transportation impacts through the use of HDD beneath the Cape Cod Canal, major

transportation facilities, and other sensitive locations, thereby avoiding roadway closures and surface disturbances where practicable.

Transportation impacts during construction will be minimized through implementation of the Traffic Management Plan (see Attachment 6), construction sequencing, designated haul routes, and ongoing coordination with MassDOT, the CCBP, the Town of Bourne, USACE, emergency responders, railroad operators, and other affected stakeholders. Construction activities will maintain emergency access and local access to the extent practicable and will minimize the duration and extent of lane or shoulder closures.

Mitigation measures include temporary traffic controls, signage, flaggers or police details where required, coordination with affected property owners and agencies, and restoration of disturbed pavement, shoulders, and access routes following construction. Because the Project does not permanently alter transportation facilities or generate new traffic demand, no long-term transportation impacts are anticipated.

The Project has been coordinated with MassDOT, the CCBP, and the Town of Bourne throughout project development to reduce transportation impacts and avoid conflicts with other planned transportation improvements, including bridge replacement activities.

5.4.4.4 Consistency with RPP Goals and Objectives

Objective TR1 – Improve safety and eliminate hazards for all users of Cape Cod's transportation system

The Project has been designed to maintain safe transportation operations during both construction and long-term operation. The Project does not introduce new transportation facilities, increase traffic volumes, or alter roadway configurations that could create new safety hazards for motorists, pedestrians, bicyclists, or transit users. Because the Project is primarily a utility relocation project, transportation-related impacts are limited to temporary construction activities and are not expected to affect long-term transportation safety. Project planning and design have been coordinated with MassDOT, the USACE, the Town of Bourne, and to ensure compatibility with planned transportation improvements and maintain safe transportation operations throughout Project implementation.

Temporary construction activities may require short-term lane or shoulder closures, traffic control measures, construction vehicle movements, and localized access restrictions near active work areas. These activities will be managed in accordance with the Project Traffic Management Plan and applicable agency requirements to maintain safe travel conditions and minimize disruptions to the transportation network. Construction work zones will be clearly delineated, and appropriate traffic control measures will be implemented to protect roadway users and construction personnel.

The Project also incorporates construction methods specifically intended to avoid transportation hazards and disruptions. HDD will be used beneath the Cape Cod Canal and the MassDOT Park-and-Ride facility, eliminating the need for roadway excavation and avoiding impacts to roadway operations, parking facilities, and associated transportation infrastructure. By maintaining existing transportation operations and implementing appropriate traffic management measures during construction, the Project is consistent with Objective TR1.

Objective TR2 – Provide and promote healthy transportation options and appropriate connections for all users

The Project maintains existing transportation connections and does not permanently affect existing pedestrian, bicycle, transit, or vehicular transportation facilities and will maintain connectivity among

transportation networks serving the Project area. Existing transportation connections will remain available during Project operation, and any temporary disruptions during construction will be managed through traffic control measures and maintenance of safe access routes where practicable.

Several Project elements have been specifically designed to avoid impacts to transportation facilities and user access. HDD installation beneath the Cape Cod Canal and the Sagamore Bridge approach area avoids surface disruption of transportation infrastructure and allows existing transportation facilities and services to continue operating without long-term interruption. The Project's utility relocation activities support implementation of the CCBP, an important regional transportation improvement initiative intended to enhance long-term mobility and connectivity across the Cape Cod Canal corridor. Through preservation of existing transportation facilities and coordination with planned transportation improvements, the Project is consistent with Objective TR2

Objective TR3 – Implement and promote vehicle trip reduction strategies

The Project will not generate new permanent vehicle trips, increase parking demand, induce new development, or create new long-term transportation demand. As a utility relocation project, the Project does not include residential, commercial, retail, office, or institutional uses that would generate recurring employee, customer, or visitor trips. Consequently, the Project will not contribute to increased traffic volumes or demand for transportation infrastructure following construction.

Construction activities will generate temporary vehicle trips associated with construction personnel, equipment, and material deliveries; however, these trips are temporary, limited to the construction period, and managed through construction planning and traffic management measures. Because the Project does not create ongoing transportation demand and facilitates implementation of a major regional transportation improvement project, it is consistent with Objective TR3.

Objective TR4 – Provide and promote an efficient and reliable transportation system by reducing congestion

The Project will not result in long-term increases in traffic volumes, roadway congestion, or travel delays. Because the Project does not create new trip-generating land uses or increase transportation demand during operations, it will not affect the operating capacity or efficiency of the regional transportation network following construction. Existing roadway, transit, bicycle, and pedestrian facilities will continue to operate under existing conditions once construction is complete.

Temporary traffic impacts may occur during construction due to lane or shoulder closures, traffic control measures, and construction vehicle movements. These impacts will be temporary and managed through implementation of Traffic Management Plans, coordination with transportation agencies, and construction sequencing designed to minimize disruptions to roadway operations. In addition, the use of HDD at key transportation crossings avoids roadway excavation and substantially reduces the potential for traffic disruption and congestion relative to conventional open-cut construction methods.

The Project also supports regional transportation efficiency by facilitating implementation of the CCBP. Relocation of existing utility infrastructure is necessary to avoid conflicts with future bridge replacement activities. Accordingly, the Project is consistent with Objective TR4.

5.4.5 ENERGY

5.4.5.1 Existing Conditions

Existing energy infrastructure within the Project area includes interstate natural gas transmission facilities owned and operated by Algonquin and associated National Grid delivery facilities serving Cape Cod. These facilities currently provide natural gas service to residential, commercial, institutional, and industrial customers throughout Cape Cod. Electrical transmission and distribution in the Project area is provided by Eversource Energy.

5.4.5.2 Impact Summary

The Project will maintain regional energy reliability by continuing to provide reliable and uninterrupted service to National Grid's Cape Cod distribution system. Importantly, the Project does not expand capacity.

Although the Project does not include renewable energy production, its construction directly addresses the needs of the CCBP. The Project will improve long-term operational reliability and system resilience for Cape Cod's energy infrastructure through 2029 and beyond.

5.4.5.3 Avoidance, Minimization, and Mitigation Summary

To minimize regional disruption, the Project is strictly designed as a replacement and reconfiguration of existing infrastructure rather than a system expansion. Because the existing pipelines cannot be installed on the new bridge structures, the Project reestablishes delivery functionality through alternative, location-specific configurations and replacement delivery points. These updates are scoped to maintain existing transportation capacity.

Mitigation efforts are further integrated through a highly coordinated construction schedule. The Project schedule ensures continuous, uninterrupted gas service to National Grid's customers throughout Cape Cod while existing pipelines are decommissioned. This relocation preserves operational reliability and long-term resilience of the region's energy delivery system.

5.4.5.4 Consistency with RPP Goals and Objectives

Objective EN1 – Support renewable energy development that is context-sensitive.

The Project does not propose renewable energy generation or associated infrastructure and therefore does not directly advance renewable energy development. However, the Project supports regional energy reliability by relocating existing natural gas facilities necessary to maintain uninterrupted service to Cape Cod. The Project does not increase system capacity or expand service, but rather preserves existing energy infrastructure while accommodating the CCBP.

Objective EN2 – Increase resiliency of energy generation and delivery.

The Project is consistent with Objective EN2 because it enhances the reliability and resiliency of Cape Cod's existing energy delivery system. Natural gas service to Cape Cod currently relies on facilities attached to the Bourne and Sagamore Bridges. Because these bridges will be replaced as part of the CCBP,

relocation of the existing infrastructure is necessary to maintain uninterrupted service to homes, businesses, institutions, and public facilities throughout the region.

The Project replaces existing natural gas transmission infrastructure with a more resilient configuration that avoids future conflicts with bridge replacement and long-term bridge operations. The Project does not increase natural gas transportation capacity, expand service territory, or induce additional demand. Rather, it preserves existing service by replacing infrastructure that will be displaced by the bridge replacement program.

Construction has been planned to maintain continuous natural gas service . In addition, the Project includes reconfiguration of pipeline and delivery facilities, including new delivery points where necessary to replace existing infrastructure and maintain system operability. These changes are solely intended to preserve existing service and improve system reliability; they do not represent a system expansion.

Overall, the Project strengthens the long-term resiliency of Cape Cod's energy delivery network by maintaining critical energy infrastructure and ensuring continued reliable natural gas service to the region.

Objective EN3 – Promote energy efficiency and conservation measures by minimizing energy consumption through planning and design.

This objective does not apply to the Project as there are no buildings proposed with the scope of work.

5.4.6 WASTE MANAGEMENT

The goal of this section is to promote a sustainable solid waste management system for the region that prioritizes reuse and diversion and protects public health, safety, and the environment.

5.4.6.1 Existing Conditions

Existing waste management infrastructure in the Project area consists primarily of regional municipal solid waste, construction and demolition debris, recycling, transfer, and disposal facilities that serve Bourne, Barnstable County, and the broader southeastern Massachusetts/Cape Cod region. The Project area itself is not characterized by major solid waste disposal infrastructure, but construction activities will rely on existing permitted off-site facilities and licensed haulers for the management of construction debris, excess materials, recyclable materials, and any regulated waste streams generated during construction.

5.4.6.2 Impact Summary

Construction of the Project will generate temporary construction and demolition waste, including removed pipeline materials, M&R station components, vegetation debris, asphalt, brick, concrete rubble, drilling materials, packaging materials, and general construction waste. Existing pipeline segments and M&R facilities scheduled for removal will be dismantled and managed in accordance with applicable federal, state, and local regulations.

Waste generated during construction will be segregated, recycled, reused, or disposed of at approved facilities, as appropriate. The Project will not require expansion of local waste management infrastructure and will not result in substantial long-term waste generation following construction. Restoration of temporary work areas will further minimize long-term waste-related impacts.

5.4.6.3 Avoidance, Minimization, and Mitigation Summary

Waste management activities will be implemented in accordance with the Project Waste Management Plan (see Attachment 8) and applicable Massachusetts solid waste regulations. The Project will minimize waste generation through material reuse, recycling, and beneficial reuse whenever practicable.

Construction contractors will be required to:

- Segregate recyclable and non-recyclable waste streams.
- Recycle or reuse suitable construction and demolition materials to the maximum extent practicable.
- Transport wastes in accordance with applicable regulations to approved recycling, treatment, or disposal facilities.
- Maintain documentation of waste generation, recycling, reuse, and disposal activities.
- Manage waste materials to prevent releases to the environment and protect public health and safety.

Materials that cannot be reused or recycled will be disposed of at appropriately permitted facilities in accordance with state and federal requirements. Waste handling, storage, transportation, and disposal activities will comply with Massachusetts waste ban regulations and applicable requirements of 310 CMR 19.000 and 310 CMR 30.000.

Demolition and Material Management

Following commissioning of the replacement facilities, existing M&R stations and associated infrastructure will be decommissioned and removed. Demolition activities will be sequenced to ensure facilities are safely isolated prior to removal. The process will generally include: 1) confirmation that the station has been taken out of service and depressurized; 2) removal of aboveground piping, buildings, regulators, electrical equipment, fencing, and other appurtenances; 3) removal of belowground infrastructure, including piping, conduits, concrete foundations, grounding systems, and associated facilities; 4) backfilling and regrading of excavated areas as necessary; and 5) restoration of the site to existing grade in accordance with Project restoration requirements.

Construction and demolition waste generated during facility removal may include metals, concrete, asphalt, brick, uncontaminated soil and rock, wood, electrical equipment, piping, vegetation debris, drilling materials, and general construction debris. Algonquin will prioritize reuse, recycling, beneficial reuse, sale, or donation of materials whenever practicable before disposal is considered.

To ensure compliance with applicable waste management requirements, contractors will be required to implement the following measures:

- Properly store waste materials on-site in accordance with federal, state, and local regulations and Algonquin policies.
- Identify and utilize approved recycling, treatment, and disposal facilities.
- Segregate waste streams from the point of generation through handling, storage, and transport.
- Characterize and profile waste materials, as necessary, to ensure acceptance at appropriate permitted facilities.
- Transport waste materials to approved recycling, treatment, or disposal facilities.
- Maintain records documenting waste generation, recycling, reuse, and disposal activities.
- Utilize clean imported fill, where necessary, for site restoration and grading.

- Ensure waste storage areas and containers are properly maintained and cleaned.

Algonquin will review and approve all receiving facilities to confirm compliance with applicable federal and state requirements, including Massachusetts solid and hazardous waste regulations (310 CMR 19.000 and 310 CMR 30.000). Non-hazardous waste that cannot be recycled or reused will be disposed of at approved Subtitle D landfills, while hazardous waste will be managed at appropriately licensed treatment, storage, and disposal facilities. Additional information is provided in the Waste Management Plan (see Attachment 8) and summarized in Table 5-17.

Asphalt, Brick, and Concrete (ABC) Rubble

ABC rubble generated during demolition activities will be segregated from other waste streams and managed in accordance with applicable MassDEP regulations. Materials will be evaluated for recycling and beneficial reuse opportunities to maximize diversion from disposal facilities. Where on-site processing is proposed, required notifications will be provided to MassDEP and the local board of health, and processing activities will be conducted using appropriate BMPs to control dust, runoff, and other potential environmental impacts.

ABC rubble suitable for recycling will be transported to approved recycling facilities. Any contaminated, painted, coated, or otherwise non-conforming materials will be managed in accordance with applicable regulatory requirements. Documentation of recycling, reuse, transport, and disposal activities will be maintained as part of the Project record.

Asbestos-Containing Material

Prior to demolition or pipeline removal activities, Algonquin will retain a certified asbestos inspector to conduct surveys for ACM, as required. If ACM is identified, removal and disposal will be performed by licensed asbestos abatement contractors in accordance with Massachusetts asbestos regulations, including applicable MassDEP notification requirements.

Any ACM encountered during construction will be properly characterized, removed, transported, and disposed of at approved facilities to protect workers, the public, and the environment. Required notifications, survey reports, disposal documentation, and regulatory approvals will be maintained as part of the Project record.

Table 5-17. Construction and Demolition Material Plan

Material Type	Estimated Quantity (if available)	Reuse/Recycling Method	Disposal Facility Type
Metal	TBD	Recycle	Scrap metal recycler
Concrete/ABC Rubble	TBD	Recycle/Beneficial Reuse	Approved recycling facility
Wood	TBD	Reuse/Recycle where practicable	Recycling or disposal facility
ACM (if encountered)	Unknown	Not applicable	Licensed ACM disposal facility

5.4.6.4 Consistency with RPP Goals and Objectives

Objective WM1 – To Reduce waste and waste disposal by promoting waste diversion, reuse, beneficial reuse, deconstruction and other Zero Waste initiatives.

The Project is consistent with Objective WM1 because it incorporates waste reduction, reuse, recycling, and beneficial reuse measures into construction and demolition activities. In accordance with the Project Waste Management Plan (see Attachment 8) and Section 5.4.6.3, construction and demolition materials will be evaluated for reuse or recycling before disposal. Materials such as metal, asphalt, concrete, brick, uncontaminated soil, and other recyclable materials will be segregated and directed to approved recycling or beneficial reuse facilities where practicable.

The Project will implement a comprehensive construction and demolition waste management program that includes waste segregation, documentation of recycling and disposal activities, use of approved facilities, and compliance with Massachusetts waste ban regulations. Existing facilities scheduled for removal will be deconstructed in a manner that maximizes material recovery and minimizes disposal volumes.

Because the Project involves relocation of existing infrastructure rather than construction of new development intended to generate ongoing waste streams, long-term solid waste generation will be negligible. Through implementation of the Waste Management Plan and material recovery practices, the Project supports the intent of Objective WM1 by minimizing waste disposal and promoting sustainable management of construction and demolition materials.

Objective WM2 – Support an integrated solid waste management system.

The Project is not a waste management, recycling, transfer, treatment, or disposal facility. However, all construction and demolition waste generated by the Project will be managed through existing licensed waste management, recycling, and disposal facilities in accordance with applicable regulatory requirements.

5.4.7 CLIMATE CHANGE

5.4.7.1 Existing Conditions

Existing climate conditions affecting the Project area include projected increases in precipitation intensity, flooding frequency, heat events, and sea level rise. These regional climate considerations influence resource management, infrastructure planning, and resiliency evaluations throughout Cape Cod and are reflected in regional planning initiatives and environmental review programs.

5.4.7.2 Impact Summary

The Project will result in temporary climate-related impacts associated with construction activities, including greenhouse gas emissions from construction equipment, vehicles, HDD operations, and material transport, as well as carbon impacts associated with vegetation clearing and soil disturbance. Algonquin evaluated these impacts through a quantitative carbon analysis of forest clearing and disturbed soils and identified measures to reduce and mitigate carbon losses.

The Project does not increase natural gas transportation capacity, expand service territory, or induce additional energy demand. Operational emissions will be limited to routine operation and maintenance of

replacement facilities. As a result, the Project is best characterized as a utility relocation and resiliency project rather than a capacity-expansion project.

The Project also evaluated potential climate-related risks, including increased precipitation, flooding, sea level rise, coastal storms, and localized heat effects. Permanent aboveground facilities have been designed with stormwater management measures capable of accommodating future precipitation conditions, while facility siting and design have considered long-term climate resilience.

A primary long-term benefit of the Project is the relocation of existing bridge-mounted natural gas infrastructure to an underground configuration, including installation beneath the Cape Cod Canal using HDD. This approach improves the resilience of Cape Cod's energy delivery system to future flooding, sea level rise, and coastal storm events.

5.4.7.3 Avoidance, Minimization, and Mitigation Summary

The Project incorporates measures to avoid, minimize, and mitigate both carbon impacts and climate-related risks. Avoidance is achieved through the relocation of bridge-mounted infrastructure to buried facilities and the use of HDD beneath the Cape Cod Canal, eliminating the need for open-cut construction and reducing exposure to coastal hazards.

Construction-related emissions will be minimized through equipment maintenance, anti-idling practices, efficient construction sequencing, and management of vehicle and material transport. The Project also minimizes climate impacts by collocating facilities within existing utility and transportation corridors where practicable, reducing the need for new disturbance and limiting tree clearing.

Consistent with recommendations identified during environmental review, Algonquin has sought to minimize forest clearing through route selection and design refinements and will restore temporary work areas following construction. Disturbed areas will be revegetated in accordance with the E&SCP, and forest mitigation measures, including permanent protection of privately owned forestland, will help offset the loss of forest resources and support long-term carbon sequestration.

Permanent stormwater management infrastructure has been designed to accommodate future precipitation conditions while maintaining groundwater recharge and protecting water quality within the Cape Cod Sole Source Aquifer. Collectively, these measures reduce temporary construction-related climate impacts while improving the long-term resiliency of critical regional energy infrastructure.

5.4.7.4 Consistency with RPP Goals and Objectives

Objective CC1 – Promote low- or no-carbon transportation alternatives.

The Project will not generate long-term commuter traffic, parking demand, or transportation-related emissions. Transportation impacts will be limited primarily to temporary construction-related vehicle and equipment activity. To reduce emissions during construction, contractors will implement anti-idling measures consistent with 310 CMR 7.11(1), maintain equipment in proper operating condition, and minimize unnecessary vehicle trips and equipment operation where practicable.

Objective CC2 – Promote low or no-carbon technologies for building energy use, including appliances, lighting, and heating, ventilation, and cooling (HVAC) systems.

Not Applicable. The Project does not include habitable buildings or structures requiring building heating, cooling, lighting, or other energy-consuming building systems.

Objective CC3 – Promote carbon sequestration and other emissions removal practices as appropriate to context.

The Project is consistent with Objective CC3 through measures that avoid unnecessary forest clearing, restore disturbed areas, and support long-term carbon sequestration. Project siting and design prioritized use of existing utility corridors and previously disturbed areas, reducing the amount of new clearing required for construction.

Approximately 44.8 acres of forestland will be temporarily or permanently disturbed during construction. Following construction, approximately temporary impacted areas acres will be restored and allowed to revert to forest conditions, permanent easements will remain as maintained scrub-shrub utility corridor and approximately 7.2 acres will be converted to paved or gravel surfaces. See Figure 5.4-1 in Attachment 1. Disturbed work areas will be regraded, stabilized, and revegetated in accordance with the E&SCP (see Attachment 3).

In addition to restoration, Algonquin proposes to offset permanent forest loss through the acquisition and permanent protection of privately owned forestland. As documented in the Quantitative Carbon Analysis (Attachment 12), younger regenerating forests generally exhibit higher carbon sequestration rates than mature forests. Over a 50-year analysis period, the Project is expected to result in a net positive change in long-term carbon sequestration due to forest regeneration within restored areas.

The Project also supports embodied carbon reduction through reuse and recycling of construction materials and, where practicable, reuse of equipment and facilities from the existing Bourne and Sagamore M&R Stations. Additional information is provided in Section 5.4.6 and Attachment 8 (Waste Management Plan).

Objective CC4 – Promote low- or no-carbon energy generation as appropriate to context.

Not Applicable. The Project does not include renewable or low-carbon energy generation facilities. The Project's purpose is to relocate existing natural gas infrastructure to accommodate the CCBP while maintaining safe and reliable energy service to Cape Cod.

Objective CC5 – Promote strategies to address climate change induced impacts such as wildfire and extreme temperatures and changes in precipitation.

The Project incorporates measures to increase resilience to climate-related hazards, including changing precipitation patterns, flooding, coastal storms, and wildfire risk. Permanent access roads associated with the Project will be maintained to support operation and maintenance activities and may also function as localized firebreaks within utility corridors.

Stormwater management systems at aboveground facilities have been designed to accommodate both current and projected future precipitation conditions. Drainage analyses (see Attachment 5) evaluated stormwater controls using National Oceanic and Atmospheric Administration (NOAA) Atlas 14 precipitation data (NOAA 2025) and incorporated consideration of projected future rainfall intensities. Stormwater infrastructure is being refined to accommodate projected 2070 storm conditions (EEA 2023) while maintaining compliance with the Massachusetts Stormwater Management Standards, including requirements for groundwater recharge, water quality treatment, and peak flow attenuation.

By relocating existing bridge-mounted infrastructure, incorporating climate-resilient stormwater design, minimizing unnecessary disturbance, and maintaining reliable energy service during future climate conditions, the Project advances the intent of Objective CC5 and improves the long-term resilience of critical regional infrastructure.

5.5 Community Systems

5.5.1 CULTURAL HERITAGE

5.5.1.1 Existing Conditions

Existing cultural resources in the Project area include aboveground historical structures and belowground archaeological resources (Table 5-18). The historic architectural survey included an overview and identification survey to identify properties listed in or eligible for listing in the National Register of Historic Places (NRHP). The Public Archaeology Laboratory, Inc., reviewed existing cultural resource information, including NRHP listings, MHC inventory records, prior survey reports, local histories, and historic maps, and conducted fieldwork under Massachusetts State Archaeologist's Permit #4307.

Table 5-18. Existing Cultural Resources

Resource Area	Existing Conditions Findings	Status / Context
Historic architectural resources	Twenty-seven historic architectural properties were recorded within the Project study area, including 23 individual properties and four historic districts.	Twenty-one properties were recommended not eligible for NRHP listing; one JBCC property required no further evaluation because no contributing aboveground resources were identified in the study area.
Preliminarily eligible historic properties	Grazing Fields Farm, Bourne Scenic Park, North Sagamore Area, Cape Cod Canal, and Bourne Fire Tower.	Preliminarily evaluated as eligible for the NRHP.
Archaeological resources	The Public Archaeology Laboratory, Inc., surveyed high- and moderate-sensitivity areas and excavated 3,107 test pits during the intensive archaeological survey.	Sixteen pre-Contact archaeological sites were identified; no site was considered eligible for the NRHP.

5.5.1.2 Impact Summary

The Project occurs within a region that contains significant historic, cultural, and archaeological resources associated with the Cape Cod Canal, the Bourne and Sagamore Bridges, and the broader cultural landscape of Bourne. Algonquin completed consultation under Section 106 of the National Historic Preservation Act with MHC, the Massachusetts Board of Underwater Archaeological Resources, the Barnstable Historical Commission, and affiliated Tribal Historic Preservation Offices, including the Mashpee Wampanoag Tribe, the Wampanoag Tribe of Gay Head (Aquinnah), and the Narragansett Indian Tribe. To evaluate impacts to cultural and historical resources under Section 106, Algonquin conducted surveys within the area of

potential affect (APE). The APE was supplied to both FERC and the SHPO and includes the Project area in addition to areas beyond the Project footprint to evaluate both direct impacts and indirect impacts.

For the proposed aboveground facilities, the APE established for the historic architectural properties survey extends 0.25 mile from the Project construction limits. It extends beyond the 0.25-mile area in some locations to include the boundaries of known or potential historic districts and the full extent of properties for which only a portion are within the 0.25-mile area. For the proposed pipeline, the APE defined for the historic architectural properties survey is a linear area encompassing a minimum of 150 feet from either side of the pipeline centerline (300 feet total) and the property limits of associated existing M&R stations. It extends beyond a 300-foot corridor in some locations to include the boundaries of known or potential historic districts and the full extent of properties for which only a portion are within 150 feet of the Project. This APE encompasses the Project construction limits and was deemed sufficient by FERC and SHPO to address any potential effects from takings, vibration, noise, and tree clearing.

Algonquin conducted the intensive archaeological survey within the Project APE for the pipeline (300 foot corridor). Nine archaeological resources were identified in the G-31 pipeline study area: one pre-contact site and eight pre-contact find spots. Four archaeological resources were identified in the G-32 pipeline study area: one pre-contact site and three pre-contact find spots. One archaeological resource, a find spot, was identified in the G-24/G-11 pipelines study area. Three archaeological resources were identified in the G-8L/G-8C pipelines study area: one pre-contact find spot and one site with pre- and post-contact components. None of the identified archaeological sites were recommended as eligible for listing on the NRHP. One previously identified NRHP-eligible site was avoided as the proposed workspace was removed from Project plans.

A total of 27 historic architectural properties, consisting of 23 individual properties and four historic districts, were recorded within the APE. Of these, 21 properties were recommended as not eligible for NRHP listing due to a lack of integrity, significance, or architectural merit. One property, JBCC (MHC No. BOU.B), requires no further evaluation because no contributing aboveground resources were identified within the Project study area. The remaining five properties (Grazing Fields Farm, Bourne Scenic Park (MHC No. BOU.AQ), North Sagamore Area (MHC No. BOU.O), the Cape Cod Canal (MHC No. BOU.AF), and the Bourne Fire Tower) were preliminarily evaluated as eligible for the NRHP.

5.5.1.3 Avoidance, Minimization, and Mitigation Summary

Project impacts to archeological resources and historic architectural properties have been minimized through extensive field surveys, use of existing utility and transportation corridors, use of trenchless construction techniques, and design refinements. All identified and known archeological sites identified during the survey were avoided through design refinements. Four of the five properties identified, and all known historic architectural properties, are beyond the impact area for the Project. Impacts to the remaining one historic property within the Project area, the Cape Cod Canal, are avoided through use of trenchless construction. The HDD crossing beneath the Cape Cod Canal avoids direct disturbance to the Canal bed and associated archaeological resources while eliminating the need for dredging or in-water excavation. The Project also incorporates procedures governing the post-review discovery of historic properties and human remains during construction.

5.5.1.4 Consistency with RPP Goals and Objectives

Objective CH1 – Protect and preserve forms, layouts, scale, massing, and key character defining features of historic resources, including traditional development patterns of villages and neighborhoods.

Historic resources and cultural landscapes were identified within the Project area in accordance with Section 106 regulations, as overseen by the MHC. Through the avoidance strategies listed in Section 5.5.1.3, the Project aligns with the Cultural Heritage Technical Bulletin and will avoid direct impacts to historic resources and cultural landscapes. Therefore, the Project is consistent with Objective CH1 because it is sited to avoid cultural resources, and avoids impacts to the Cape Cod Canal through the implementation of the HDD.

Objective CH2 – Protect and preserve archaeological resources and assets from alteration or relocation.

Based on completed consultation and the selected construction methods, no significant long-term adverse impacts to historic or cultural resources are anticipated. Avoidance and minimization measures for archaeological resources include:

- Completion of Section 106 consultation and coordination with state and Tribal historic preservation authorities.
- Extensive archaeological field surveys with the Project's APE effects.
- Use of HDD beneath the Cape Cod Canal to avoid direct disturbance of sensitive cultural resources.
- Collocation within existing disturbed corridors to reduce the potential for effects on previously undisturbed archaeological resources.
- Implementation of inadvertent discovery procedures for archaeological resources and human remains.

Through the avoidance strategies listed here and in Section 5.5.1.3, the Project aligns with the Cultural Heritage Technical Bulletin and will avoid direct impacts to historic resources and cultural landscapes. Therefore, the Project is consistent with Objective CH2.

Objective CH3 – Preserve and enhance public access and rights to and along the shore.

The Project has limited impacts to coastal and shoreline resources to the crossing of the Cape Cod Canal. The only recreational trails and access to the Canal within the Project area are the USACE service roads on both sides of the Canal, which are utilized for walking, bicycling, fishing, sightseeing, and access to Canal recreation areas. These facilities provide an important public recreational resource and access to the Canal for non-motorized users. Impacts to these roads and trails and to public access to the shore will be avoided through the implementation of the HDD; therefore, the Project aligns with the Cultural Heritage Technical Bulletin and is consistent with Objective CH3.

Objective CH4 – Protect and preserve traditional agricultural and maritime development and uses.

The Project will have no impact on agricultural or maritime development and, through the cultural and historic review, Algonquin confirmed that no traditional agricultural or maritime uses of the Canal will be impacted. The Project overall will have limited impacts to coastal and shoreline resources, and is consistent with Object CH4 because implementation of the HDD avoids any potential impacts to traditional development and uses of the Canal.

5.5.2 ECONOMY

5.5.2.1 Existing Conditions

The Project area supports a mix of residential, commercial, industrial, military, tourism, transportation, and utility-related economic activities. The Cape Cod Canal and bridge transportation network represent regionally important infrastructure supporting both the local and regional economy.

5.5.2.2 Impact Summary

The Project replaces existing infrastructure that would otherwise conflict with bridge replacement activities and ensures continued operation of energy infrastructure necessary to support the regional economy. The Project will provide important economic benefits by supporting the CCBP and maintaining uninterrupted natural gas service to Cape Cod residents, businesses, institutions, and public facilities.

In addition to providing reliable natural gas supply, the Project will create temporary construction jobs throughout its development period. Many of these positions may be filled by local workers, resulting in direct economic benefits for individuals and the communities in which they live. Non-local laborers may also contribute to a modest increase in the overall population within the Project area; however, existing infrastructure and housing availability are expected to adequately support these workers.

The Project is anticipated to generate both short-term and long-term positive cumulative economic impacts locally and statewide. Temporary influx of laborers during construction will provide short-term economic value by their reliance on local stores and businesses regardless of season. Long-term, annual tax revenues will increase as a result of Project operations.

The workforce required to construct the Project will be temporary; no workers will be needed during the daily operations of the Project facilities after construction is complete. Although the number of employees required to operate this development is less than 10, making Objective EC2 not applicable overall, Algonquin provides a response to Objective EC2 in terms of consistency within the construction phase.

5.5.2.3 Avoidance, Minimization, and Mitigation Summary

The Project is anticipated to generate both short-term and long-term positive cumulative economic impacts locally and statewide. Revenues from construction employment, as well as local expenditures by both the construction companies (for construction materials) and non-local construction workers (for temporary housing, food, and entertainment), will benefit the local economy. The increased property tax base during Project operation will be beneficial in the long term. Construction of the Project will result in increased state and local sales tax revenues associated with the purchase of construction materials, as well as goods and services by the construction workforce. Local communities will benefit from ad valorem taxes paid annually by Algonquin over the life of the Project. Algonquin estimates that the total Project construction (and inspection) cost will be approximately $135 million and the total cost of construction materials will

be approximately $27.5 million. During construction of the Project facilities, Algonquin estimates the average peak workforce will generate and support an estimated 130 total (direct, indirect, and induced) jobs in Massachusetts during 2027 and 2028.

5.5.2.4 Consistency with RPP Goals and Objectives

Objective EC1 – Support traditional and emerging businesses and industries.

This Project is a replacement of natural gas utility infrastructure to accommodate the CCBP. No expansion or increased capacity is proposed. The existing facilities do not require any staff to be assigned to operate the facilities on a daily basis. This remains true after the completion of the Project. Therefore, operation of the Project will not result in a change of development type or impact other business types and Objective EC1 is not applicable.

Objective EC2 – Support local workforce, economic activity, and entrepreneurship.

The Project is anticipated to generate both short-term and long-term positive cumulative economic impacts locally and statewide. Construction of the Project will result in increased state and local sales tax revenues associated with the purchase of construction materials for the Project and with goods and services by the construction workforce. Local communities will benefit from ad valorem taxes paid annually by Algonquin over the life of the Project. Algonquin estimates that the total Project construction (and inspection) cost will be approximately $135 million and the total cost of construction materials will be approximately $27.5 million.

During construction of the Project facilities, the average peak workforce is estimated to be approximately 190 workers between 2027 and 2029. Algonquin estimates that local workers will account for approximately 30 percent of construction jobs for each phase, and the remaining 70 percent of the construction workforce will consist of non-local workers. Workers are defined here as surveyors, welders, equipment operators, and general laborers, and local workers are defined here as those who normally reside within daily commuting distance of the work sites. Algonquin does not anticipate the need to hire additional permanent operations staff to be assigned specifically to the Project.

5.5.3 HOUSING

5.5.3.1 Existing Conditions

Residential development occurs throughout portions of Bourne adjacent to the Project area, particularly near transportation corridors and established neighborhoods. Housing resources within Bourne contribute to the broader residential character of communities located near portions of the proposed facility relocations.

5.5.3.2 Impact Summary

The Project does not create, remove, or alter housing units within Barnstable County or the Town of Bourne. No residential properties are displaced, and no permanent conversion of residential land uses is proposed.

5.5.3.3 Avoidance, Minimization and Mitigation Summary

During construction, non-local workers are most likely to use available temporary housing such as area campgrounds and recreational vehicle (RV) parks or hotels/motels in Barnstable County and possibly adjacent towns or counties that are within a reasonable daily commuting distance of the Project area. Non-local workers are also likely to use Airbnb services for short-term housing rentals, or they may provide their own housing units (e.g., travel trailers or RV campers). The anticipated migration of non-local workers to Barnstable County represents less than 0.5 percent of the total temporary housing in Barnstable County, and therefore the temporary demand for these housing facilities is unlikely to displace permanent residents or adversely affect housing prices.

5.5.3.4 Consistency with RPP Goals and Objectives

The RPP Housing goal is to promote an adequate supply of ownership and rental housing that is safe, healthy, and attainable for people with different income levels and diverse needs. The Housing objectives are to promote increased housing diversity and choice, increase year-round housing supply, protect and improve existing housing stock, and increase affordable and attainable housing.

Because the Project is a natural gas pipeline relocation and replacement project, the Housing goal and objectives are not directly applicable. The Project will not create new housing demand, remove existing housing, displace residents, or affect the availability or affordability of ownership or rental housing. However, by maintaining reliable natural gas service to Cape Cod while accommodating replacement of the Bourne and Sagamore Bridges, the Project will continue to support existing residential communities and public services.

Accordingly, the HOU objectives are not applicable to the Project, and no adverse housing-related impacts are anticipated.

6 CONCLUSIONS

6.1 Project Benefits

The Project is a critical infrastructure project that will enable implementation of the CCBP while maintaining uninterrupted natural gas service to Cape Cod residents, businesses, institutions, public facilities, and critical infrastructure. The Project relocates existing bridge-mounted natural gas facilities that conflict with planned bridge replacement activities and replaces them with a more resilient underground system designed to maintain the reliability and long-term operation of the region's energy delivery network.

While the Project will result in temporary construction-related impacts to natural resources, transportation facilities, open space, and community resources, these impacts have been avoided and minimized to the maximum extent practicable through route selection, extensive use of existing utility corridors, HDD, restoration of temporary work areas, and implementation of comprehensive environmental protection measures.

The Project provides substantial long-term public benefits by supporting a major regional transportation improvement initiative, improving the resiliency of critical energy infrastructure, reducing reliance on aging bridge-dependent utility facilities, and maintaining reliable energy service for Cape Cod. The Project also incorporates climate adaptation, stormwater management, habitat restoration, forestland protection, and other mitigation measures that help maintain the long-term environmental, community, and infrastructure functions of the Project area.

Overall, the Project represents a significant regional benefit by balancing critical infrastructure needs with environmental stewardship, climate resilience, and protection of Cape Cod's natural and community resources.

6.2 Summary of Mitigation Commitments

The Project applies a mitigation hierarchy of avoidance, minimization, restoration, and compensation. Avoidance is achieved through route selection, use of existing utility corridors, HDD beneath the Cape Cod Canal, avoidance of extensive roadway-based construction, reduced contractor workspace, and facility siting refinements. Minimization is achieved through erosion and sedimentation controls, spill prevention, environmental inspection, reduced wetland workspace, temporary construction matting, traffic management, public outreach, utility coordination, and construction sequencing. Restoration will be implemented for temporary disturbances to wetlands, floodplains, open space, residential areas, road shoulders, access routes, habitat, and construction workspaces. Compensatory mitigation will be provided where required through NHESP, Article 97, wetlands, and Cape Cod Commission review processes. Table 6-1 provides a summary of key mitigation commitments.

Table 6-1. Summary of Mitigation Commitments

Resource Area	Primary Commitments
Water Resources and Stormwater	HDD beneath the Canal; WHPA-aware routing and siting; erosion and sediment controls; SPCC procedures; controlled dewatering; phased water withdrawals; hydrostatic test water reuse where practicable; stormwater controls at M&R stations; restoration of drainage and recharge functions.
Wetlands, Coastal Resources, and Floodplains	Avoid in-water Canal work; reduce wetland workspace; use timber mats; maintain flood storage; restore contours, hydrology, and vegetation; comply with wetlands, Water Quality Certification, and utility Limited Project requirements; monitor restoration as required.

Resource Area	Primary Commitments
Wildlife, Habitat, and Rare Species	Reduce tree clearing and habitat impacts; use existing corridors; implement NHESP-approved protection plans; manage invasive plants; restore temporary habitat disturbance; protect approximately 60 acres near JBCC; contribute to Eastern Box Turtle mitigation.
Open Space and Article 97 Lands	Use existing corridors and access routes; restore temporary disturbances; coordinate with EEA and landowners; provide Article 97 mitigation and compensation for permanent encumbrances where required.
Cultural Resources	Continue MHC and Tribal consultation; use HDD and existing corridors to avoid resources; implement inadvertent discovery procedures; restore temporary disturbances affecting historic settings.
Transportation and Community	Implement Traffic Management Plans; maintain residential, business, public facility, and emergency access; provide notifications; restore road shoulders, lawns, landscaping, and access routes.
Energy Infrastructure and Climate Resilience	Relocate existing bridge-mounted natural gas infrastructure to a resilient underground system; protect existing utility services through coordination and construction planning; incorporate climate-resilient stormwater management measures; facilitate implementation of the CCBP; restore temporary disturbances; and provide forestland protection measures that support long-term carbon sequestration and climate resilience.

6.3 Summary of RPP Consistency

The Project is consistent with the goals, objectives, and performance standards of the Cape Cod Regional Policy Plan and associated Technical Bulletins (Cape Cod Commission 2025a, 2025b). By supporting implementation of the CCBP, the Project enables a critical regional transportation initiative while maintaining reliable natural gas service to Cape Cod and enhancing the resiliency of essential energy infrastructure.

The Project incorporates extensive avoidance and minimization measures, including use of existing utility corridors, horizontal directional drilling beneath the Cape Cod Canal and other sensitive resources, reduced in-street construction, and comprehensive environmental protection controls. Temporary construction impacts will be restored following completion of the work, and compensatory mitigation will be provided where required.

Overall, the Project provides substantial regional benefits by improving the long-term reliability and resilience of critical infrastructure; supporting regional transportation objectives; and protecting the environmental, natural resource, and community values that are central to the character and sustainability of Cape Cod.

7 REFERENCES

Cape Cod Commission. 2023. Drinking Water and Groundwater. Available at: https://www.capecodcommission.org/our-work/drinkingwater/#:~:text=Since%202000%2C%20public%20community%20drinking,Cape%20Cod's%20Sole%20Source%20Aquifer. Accessed July 30, 2025.

Cape Cod Commission. 2025a. *Cape Cod Regional Policy Plan 2025*. Available at: https://www.capecodcommission.org/regional-policy-plan. Accessed July 2026.

Cape Cod Commission. 2025b. Cape Cod Regional Policy Plan 2025 Technical Bulletins. Available at: https://resources.capecodcommission.org/resource-library/08429d4a5e6e/cape-cod-regional-policy-plan-2025-technical-bulletins/. Accessed July 2026.

Cape Cod Commission. 2025c. Regional Policy Plan All Data Viewer. Available at: https://experience.arcgis.com/experience/b1b1ed9eaf2b4101824567a3c77e07b7/page/HOME

Cape Cod Commission. 2026. Cape Cod's Sole Source Aquifer. Available at: https://www.capecodcommission.org/our-work/sole-source-aquifer/. Accessed July 2026.

Environmental Management Commission. 2026. *Environmental Performance Standards for Massachusetts National Guard Properties at the Joint Base Cape Cod*. March 19, 2026. Executive Office of Energy and Environmental Affairs. Available at: https://www.mass.gov/info-details/environmental-management-commission-emc#the-environmental-performance-standards. Accessed July 2026.

Federal Emergency Management Agency (FEMA). 2024. Flood Insurance Rate Map (FIRM), Plymouth County, Massachusetts, Map No. 25001C0314K. Dated June 2024. Available at: https://hazards-fema.maps.arcgis.com/apps/webappviewer/index.html?id=8b0adb51996444d4879338b5529aa9cd&extent=-70.84070915810544,42.039472434093796,-70.79912418953855,42.05540669842036. Accessed July 30, 2025.

Federal Energy Regulatory Commission (FERC). 2013a. *Upland Erosion Control, Revegetation, and Maintenance Plan*. Available at: https://www.ferc.gov/industries/gas/enviro/plan.pdf. Accessed August 19, 2025.

Federal Energy Regulatory Commission (FERC). 2013b. *Wetland and Waterbody Construction and Mitigation Procedures*. Available at: https://www.ferc.gov/industries/gas/enviro/procedures.pdf. Accessed August 19, 2025.

GeoEngineers. 2024a. Prepared for [Algonquin] Geotechnical Data Report. Cape Canal Bridge Relocation Project. Cape Cod Canal HDD, Barnstable County, Massachusetts. November 8, 2024.

GeoEngineers. 2024b. Prepared for [Algonquin] Geotechnical Data Report. Cape Canal Bridge Relocation Project. Cape Cod Canal HDD, Barnstable County, Massachusetts. December 6, 2024.

Joint Base Cape Cod (JBCC). 2025. Joint Base Cape Cod Overview. Available at: https://www.massnationalguard.org/JBCC/jbcc-overview.html. Accessed July 2025.

Massachusetts Bureau of Geographic Information (MassGIS). 2011. Shellfish Suitability Areas. Available at: https://www.mass.gov/info-details/massgis-data-shellfish-suitability-areas. Accessed September 2, 2025.

Massachusetts Bureau of Geographic Information (MassGIS). 2013. MassGIS Data: NHESP Potential Vernal Pools. Available at: https://www.mass.gov/info-details/massgis-data-nhesp-potential-vernal-pools. Accessed August 2025.

Massachusetts Bureau of Geographic Information (MassGIS). 2017. MassGIS Data: MassDEP Wetlands (2005). Available at: https://www.mass.gov/info-details/massgis-data-massdep-wetlands-2005. Accessed January 2026.

Massachusetts Bureau of Geographic Information (MassGIS). 2020. MassGIS Data: EPA Designated Sole Source Aquifers. Available at: https://www.mass.gov/info-details/massgis-data-epa-designated-sole-source-aquifers. Accessed August 2025.

Massachusetts Bureau of Geographic Information (MassGIS).2021a. NHESP Priority Habitats of Rare Species. Available at: https://www.mass.gov/infodetails/massgis-data-nhesp-priority-habitats-of-rare-species. Accessed July 2026.

Massachusetts Bureau of Geographic Information (MassGIS).2021b. NHESP Estimated Habitats of Rare Wildlife. Available at: https://www.mass.gov/infodetails/massgis-data-nhesp-estimated-habitats-of-rare-wildlife. Accessed July 2026.

Massachusetts Bureau of Geographic Information (MassGIS). 2024. MassGIS Well Location Viewer. Available at: https://www.arcgis.com/home/item.html?id=660e5b4cb7af4f4e932c9d5a7b7e82f2. Accessed July 30, 2025.

Massachusetts Bureau of Geographic Information (MassGIS). 2025a. MassGIS Data: MassDEP Wellhead Protection Areas (Zone II, Zone I, IWPA). Available at: https://www.mass.gov/info-details/massgis-data-massdep-wellhead-protection-areas-zone-ii-zone-i-iwpa. Accessed July 30, 2025.

Massachusetts Bureau of Geographic Information (MassGIS). 2025b. NHESP Certified Vernal Pools. Available at: https://www.mass.gov/info-details/massgis-data-nhesp-certified-vernal-pools. Accessed August 2025.

Massachusetts Bureau of Geographic Information (MassGIS). 2025c. MassMapper. Available at: https://maps.massgis.digital.mass.gov/MassMapper/MassMapper.html. Accessed August 2025.

Massachusetts Executive Office of Energy and Environmental Affairs (EEA). 2023. 2070 Coastal Flood Exceedance Probabilities (MC-FRM). Dataset. Originally published November 15, 2022. Available at: https://czm-moris-mass-eoeea.hub.arcgis.com/datasets/Mass-EOEEA::2070-coastal-flood-exceedance-probabilities-mc-frm/about. Accessed September 2025.

National Oceanic and Atmospheric Administration (NOAA). 2025. Precipitation Frequency Data Server (PFDS) Atlas 14. Available at: https://hdsc.nws.noaa.gov/pfds/. Accessed July 2025.

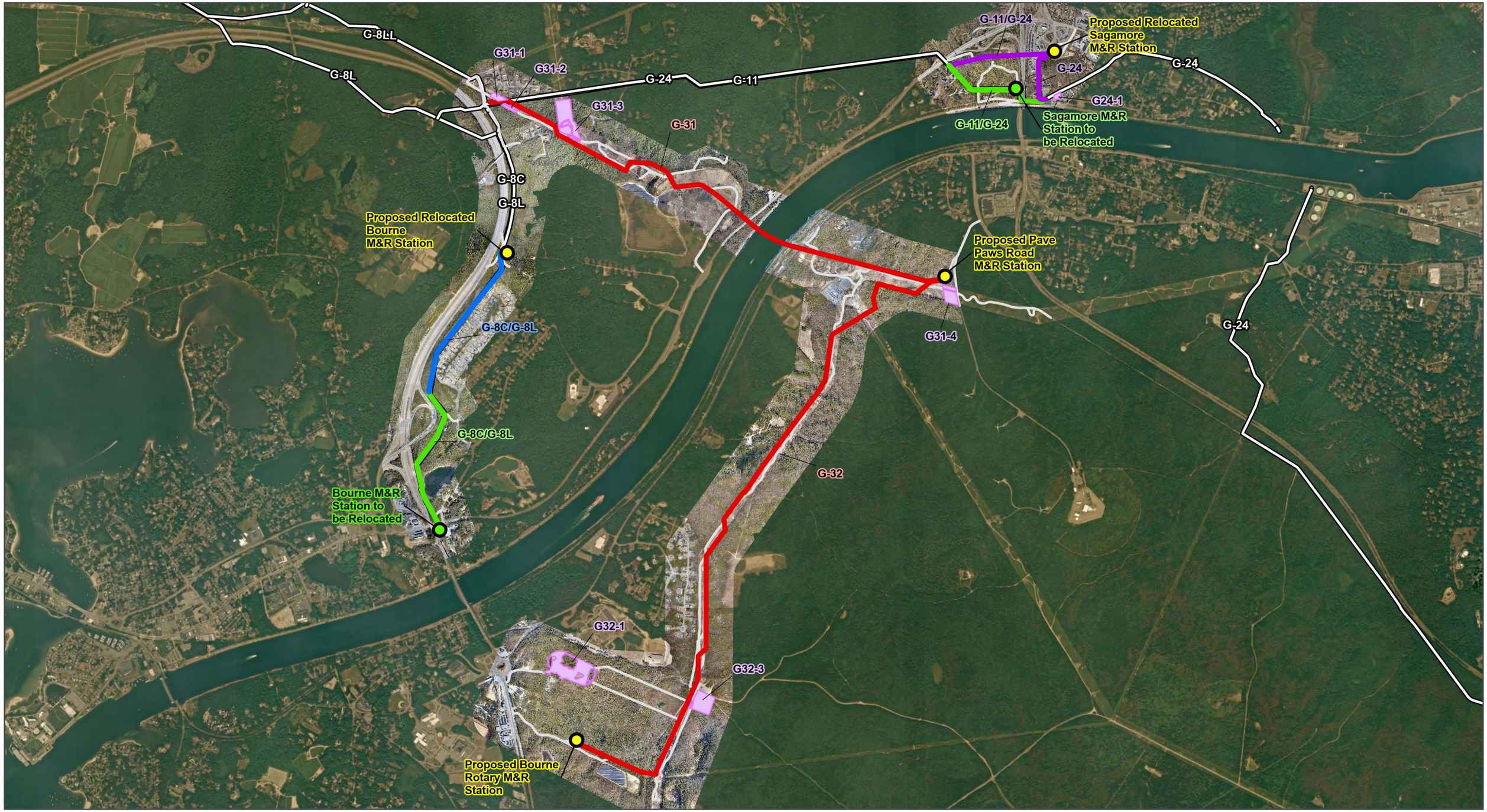
Natural Resources Conservation Service. 2025. Soil Survey Geographic Database (SSURGO). U.S. Department of Agriculture, Natural Resources Conservation Service Soil Survey Staff. Available at: https://www.nrcs.usda.gov/resources/data-and-reports/soil-survey-geographic-database-ssurgo. Accessed August 19, 2025.

U.S. Army Corps of Engineers (USACE). 2025. Cape Cod Canal. Available at: https://www.nae.usace.army.mil/Missions/Recreation/Cape-Cod-Canal. Accessed July 2025.

U.S. Geological Survey (USGS). 1980. Cape Cod Aquifer, Cape Cod, Massachusetts. Available at: https://www.usgs.gov/publications/cape-cod-aquifer-cape-cod-massachusetts. Accessed July 29, 2025.

ATTACHMENT 1

Figures



ALGONQUIN GAS TRANSMISSION LLC
CAPE COD CANAL PIPELINE RELOCATION PROJECT

Figure 3.2-1
Aerial Overview

- M&R Station to be Relocated
- Proposed M&R Station
- Existing Algonquin Gas Transmission Pipeline
- Pipeline Abandonment
- Pipeline Relocation
- Pipeline Removal
- Pipeline Replacement
- Proposed Access Road
- Proposed Ware Yard

Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 StatePlane
Massachusetts Mainland FIPS
2001 Feet
41.759°N 70.565°W

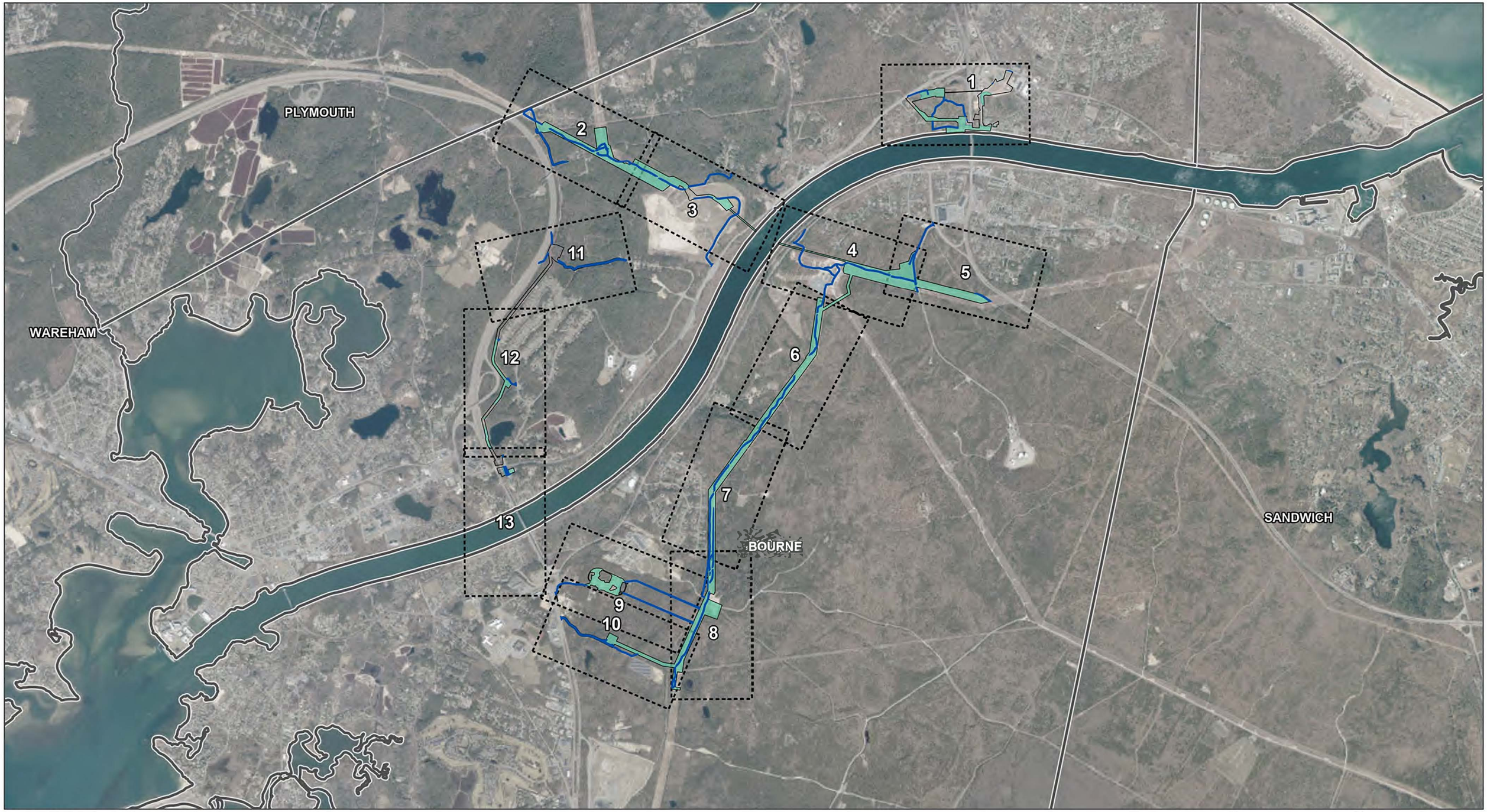
0 1,000 2,000 Feet
0 250 500 Meters

N

1:24,000

Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65956
Layout: Aerial
Aprx: 65956_CCRP_CCC_DRI

SWCA ENVIRONMENTAL CONSULTANTS



ALGONQUIN GAS TRANSMISSION LLC
CAPE COD CANAL PIPELINE
RELOCATION PROJECT

Figure 3.2-2
Transportation
Overview

- Municipal Boundary
- Limits of Disturbance
- Sheet Index
- Access Road
- Areas Mapped for Natural Resources

Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 2011 StatePlane
Massachusetts Mnid FIPS 2001
FtUS
41.7564°N 70.5667°W

0 1,000 2,000 Feet
0 250 500 Meters

N

1:30,000

Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65956
Layout: ROADS INDEX
Aprx: 65956_CCRP_CCC_DRI

SWCA ENVIRONMENTAL CONSULTANTS

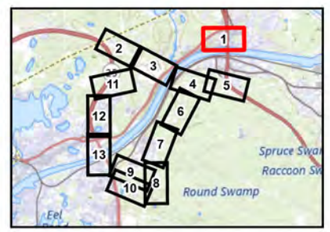
ALGONQUIN GAS TRANSMISSION LLC
CAPE COD RELOCATION PROJECT

Transportation

SHEET 1 OF 13

- Municipal Boundary
- Road
- Limits of Disturbance
- Areas Mapped for Natural Resources

Access Road
- Permanent - Existing
- Permanent - New
- Temporary - Existing
- Temporary - New



Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 2011 StatePlane
Massachusetts Mnld FIPS 2001
FtUS
41.7793°N 70.5447°W

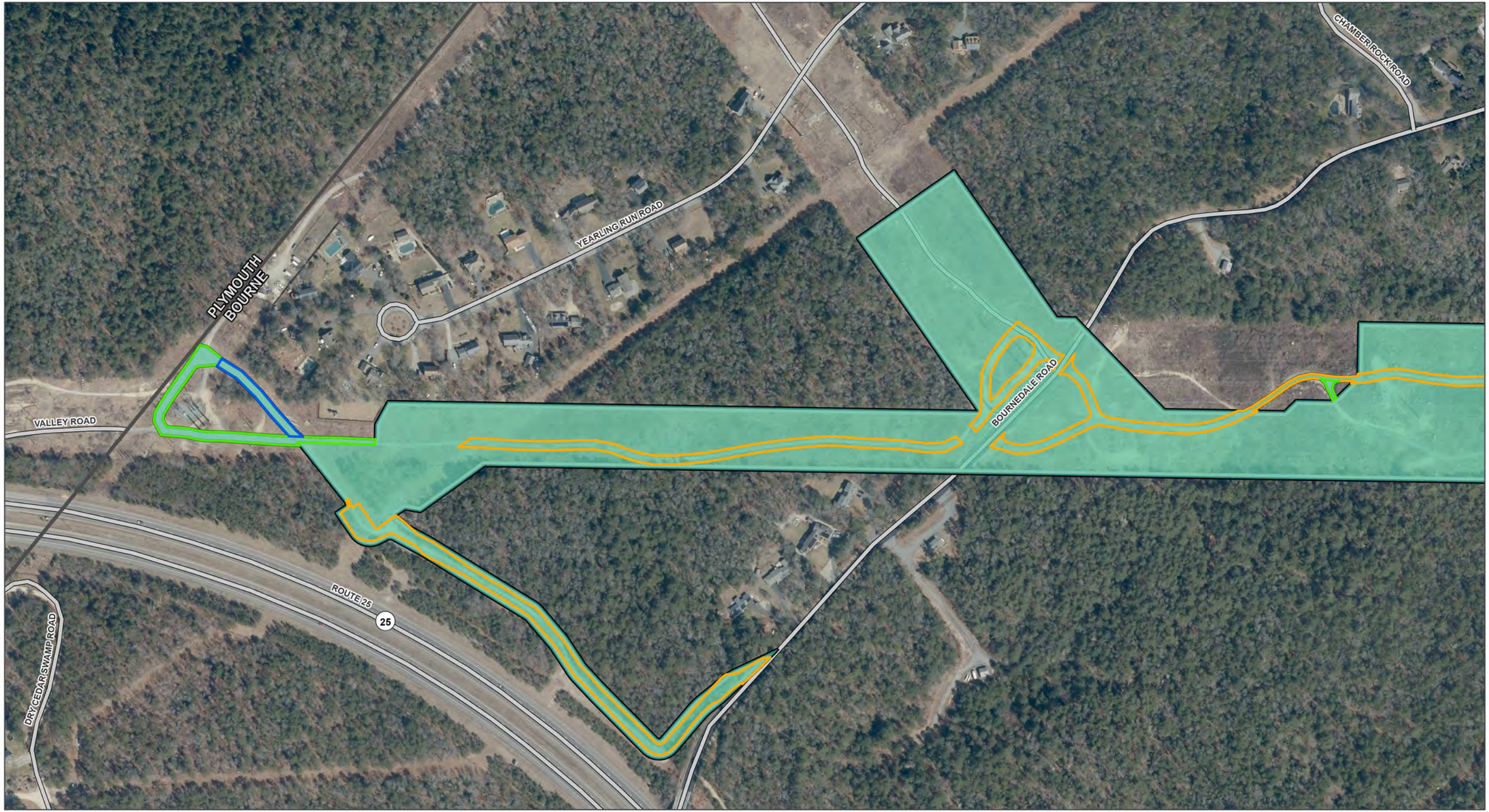
0 100 200 Feet
0 25 50 Meters

N

1:3,000

Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65956
Layout: ROADS SHEETS
Aprx: 65956_CCRP_CCC_DRI

SWCA ENVIRONMENTAL CONSULTANTS



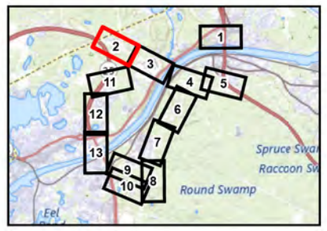
ALGONQUIN GAS TRANSMISSION LLC
CAPE COD RELOCATION PROJECT

Transportation

SHEET 2 OF 13

- Municipal Boundary
- Road
- Limits of Disturbance
- Areas Mapped for Natural Resources

Access Road
- Permanent - Existing
- Temporary - Existing
- Temporary - New



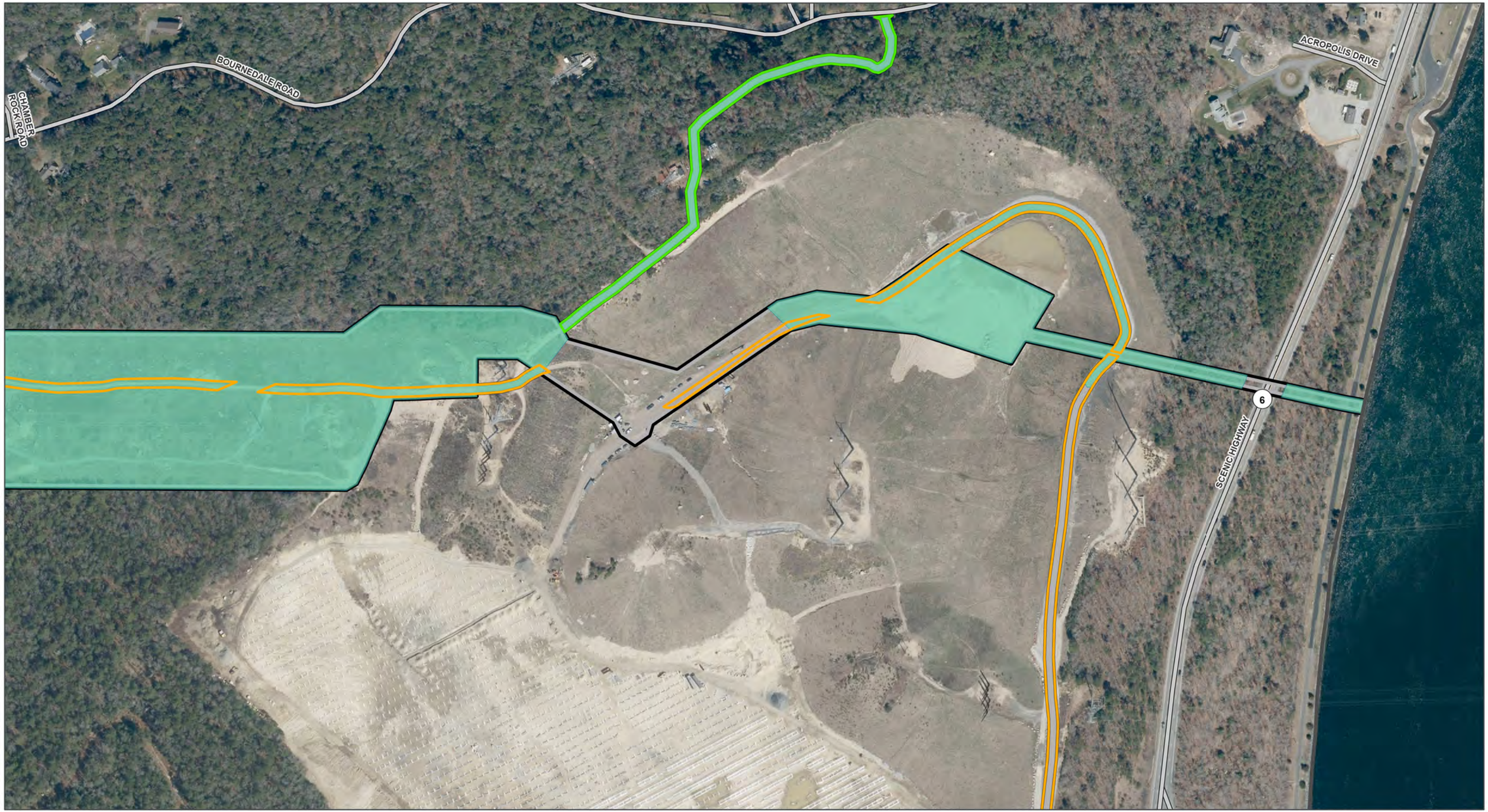
Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 2011 StatePlane
Massachusetts Mnld FIPS 2001
FtUS
41.777°N 70.5835°W

0 100 200 Feet
0 25 50 Meters

1:3,000

Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65956
Layout: ROADS SHEETS
Aprx: 65956_CCRP_CCC_DRI

SWCA ENVIRONMENTAL CONSULTANTS



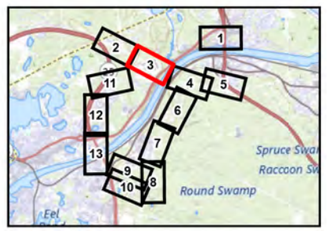
ALGONQUIN GAS TRANSMISSION LLC
CAPE COD RELOCATION PROJECT

Transportation

SHEET 3 OF 13

- Municipal Boundary
- Road
- Limits of Disturbance
- Areas Mapped for Natural Resources

Access Road
- Permanent - Existing
- Temporary - Existing



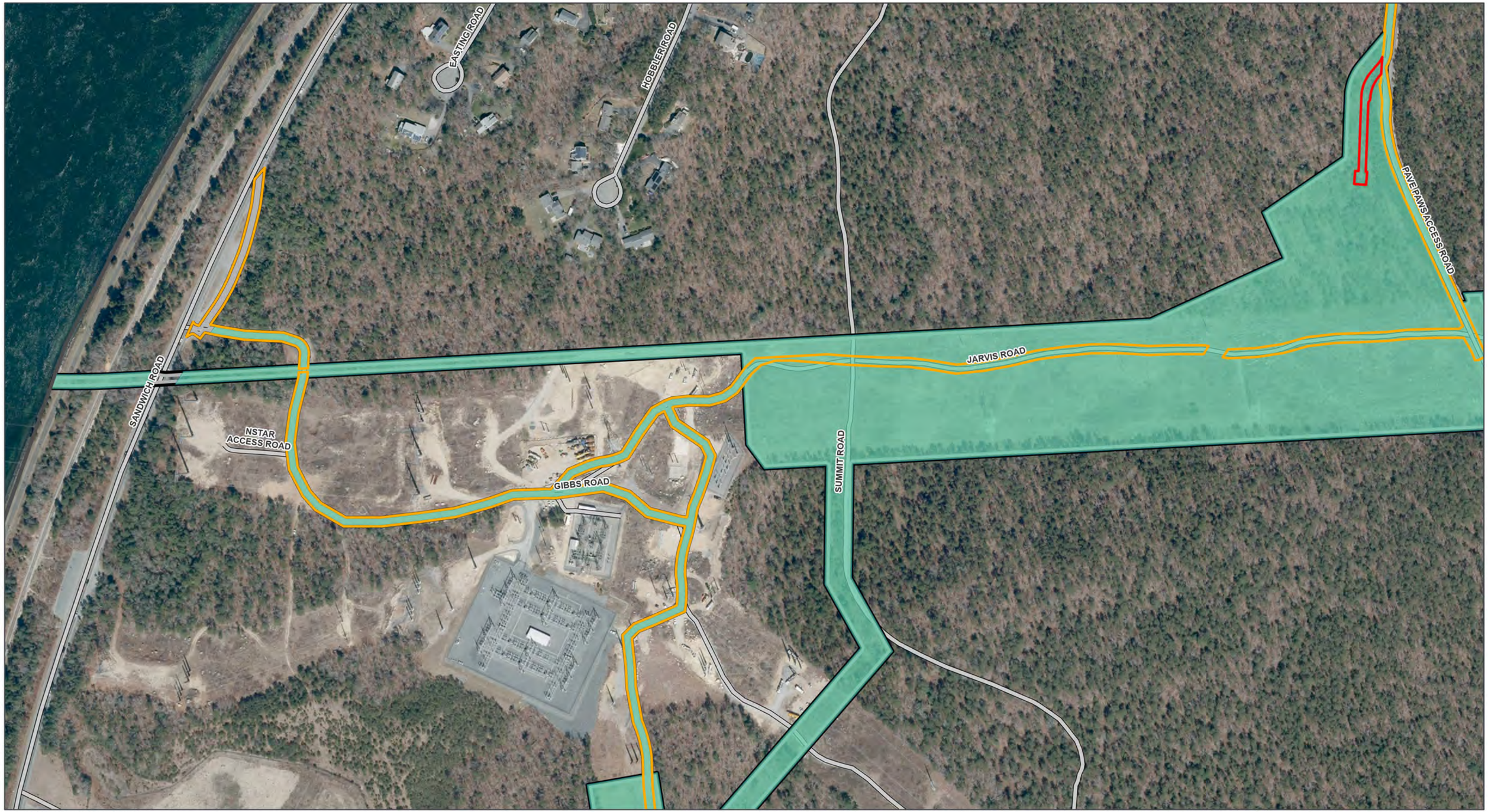
Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 2011 StatePlane
Massachusetts Mnld FIPS 2001
FtUS
41.7721°N 70.5708°W

Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65956
Layout: ROADS SHEETS
Aprx: 65956_CCRP_CCC_DRI

0 100 200 Feet
0 25 50 Meters

1:3,000

SWCA ENVIRONMENTAL CONSULTANTS



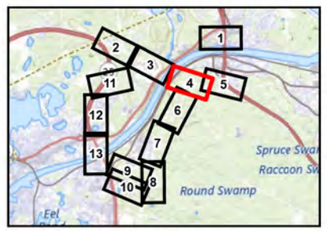
ALGONQUIN GAS TRANSMISSION LLC
CAPE COD RELOCATION PROJECT

Transportation

SHEET 4 OF 13

- Municipal Boundary
- Road
- Limits of Disturbance
- Areas Mapped for Natural Resources

Access Road
- Permanent - Existing
- Permanent - New



Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 2011 StatePlane
Massachusetts Mnld FIPS 2001
FtUS
41.767°N 70.5563°W

0 100 200 Feet
0 25 50 Meters

1:3,000

Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65956
Layout: ROADS SHEETS
Aprx: 65956_CCRP_CCC_DRI

SWCA ENVIRONMENTAL CONSULTANTS

SUMMIT ROAD
FACTORY OUTLET ROAD
RAMP-RT 6 TO RT 6A CONN
RAMP-RT 6 EB TO MID CAPE CONN (RT 6A)
ADAMS STREET
WOODLAND ROAD
HILLTOP DRIVE
COUNTRY WAY
CRESTVIEW ROAD
CRESTVIEW LANE
HILL CREST DRIVE
RAMP-MID CAPE CONN (RT 6A) TO RT 6 EB
MID-CAPE HIGHWAY
6
PAVED RAWS ACCESS ROAD
JARVIS ROAD
SAGAMORE ROAD

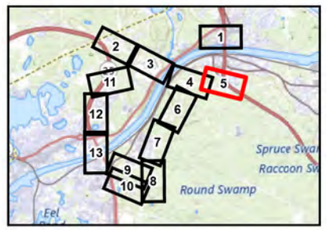
ALGONQUIN GAS TRANSMISSION LLC
CAPE COD RELOCATION PROJECT

Transportation

SHEET 5 OF 13

Road
Limits of Disturbance
Areas Mapped for Natural Resources

Access Road
Permanent - Existing
Permanent - New
Temporary - Existing



Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 2011 StatePlane
Massachusetts Mnld FIPS 2001
FtUS
41.7665°N 70.5439°W

Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65956
Layout: ROADS SHEETS
Aprx: 65956_CCRP_CCC_DRI

0 100 200 Feet
0 25 50 Meters

N

1:3,000

SWCA ENVIRONMENTAL CONSULTANTS

SUMMIT ROAD

GIBBS ROAD

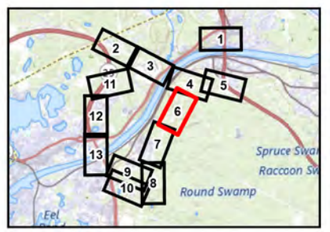
ALGONQUIN GAS TRANSMISSION LLC
CAPE COD RELOCATION PROJECT

Transportation

SHEET 6 OF 13

Road
Limits of Disturbance
Areas Mapped for Natural Resources

Access Road
Permanent - Existing



Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 2011 StatePlane
Massachusetts Mnld FIPS 2001
FtUS
41.7594°N 70.561°W

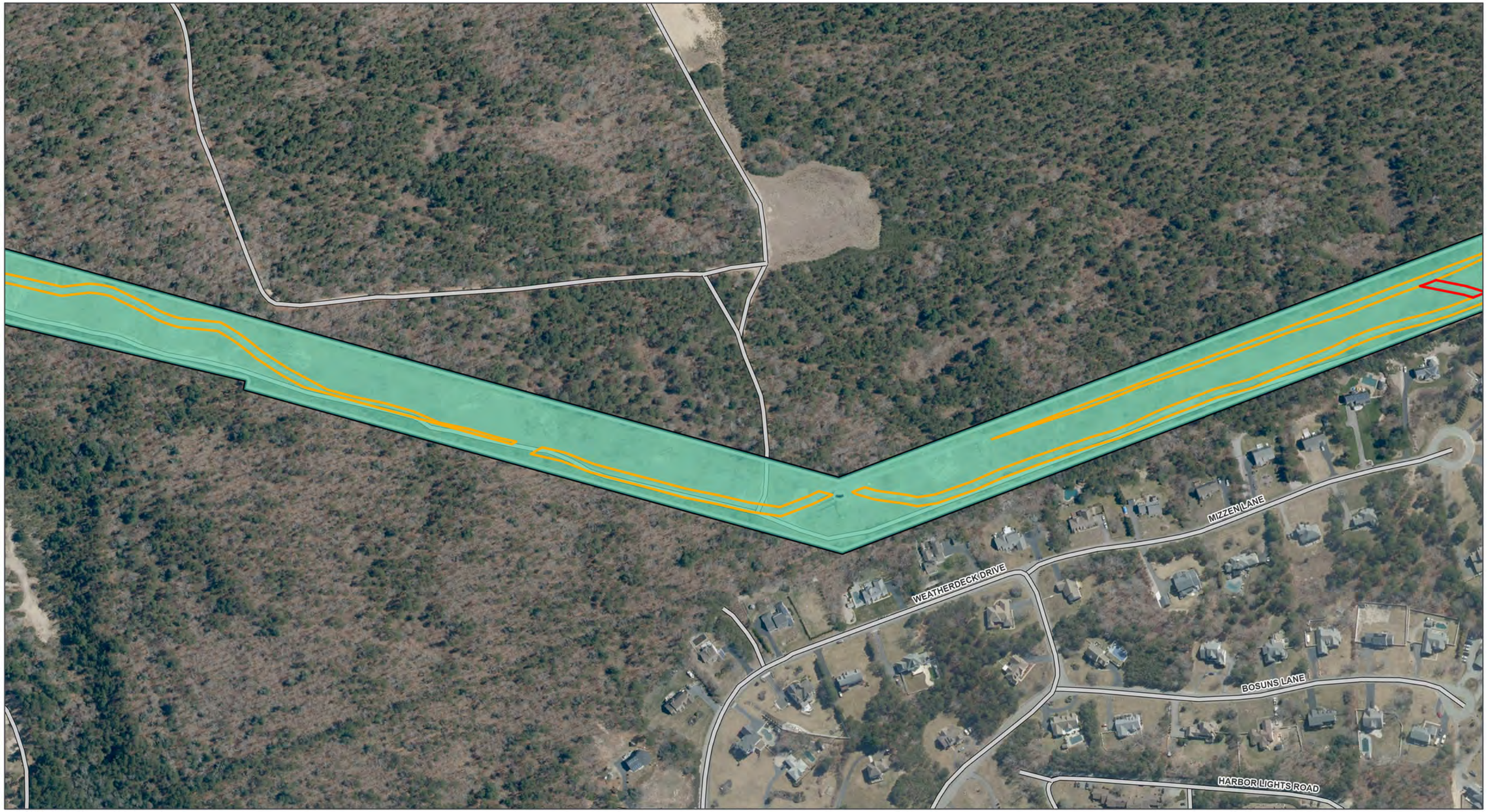
0 100 200
Feet
0 25 50
Meters

1:3,000



Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65956
Layout: ROADS SHEETS
Aprx: 65956_CCRP_CCC_DRI

SWCA
ENVIRONMENTAL CONSULTANTS



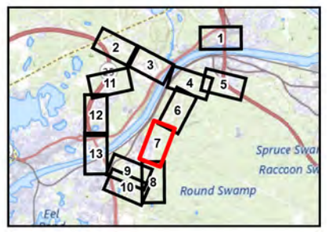
ALGONQUIN GAS TRANSMISSION LLC
CAPE COD RELOCATION PROJECT

Transportation

SHEET 7 OF 13

Road
Limits of Disturbance
Areas Mapped for Natural Resources

Access Road
Permanent - Existing
Permanent - New



Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 2011 StatePlane
Massachusetts Mnld FIPS 2001
FtUS
41.7503°N 70.5687°W

0 100 200 Feet
0 25 50 Meters

1:3,000

Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65956
Layout: ROADS SHEETS
Aprx: 65956_CCRP_CCC_DRI

SWCA ENVIRONMENTAL CONSULTANTS

KENDRICK ROAD

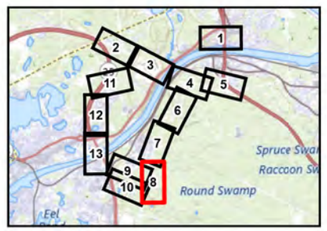
ALGONQUIN GAS TRANSMISSION LLC
CAPE COD RELOCATION PROJECT

Transportation

SHEET 8 OF 13

Road
Limits of Disturbance
Areas Mapped for Natural Resources

Access Road
Permanent - Existing
Permanent - New
Temporary - Existing
Temporary - New



Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 2011 StatePlane
Massachusetts Mnld FIPS 2001
FtUS
41.7396°N 70.5703°W

0 100 200 Feet
0 25 50 Meters

1:3,000

Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65956
Layout: ROADS SHEETS
Aprx: 65956_CCRP_CCC_DRI

SWCA ENVIRONMENTAL CONSULTANTS

SANDWICH ROAD

SANDWICH ROAD CONNECTOR

BOURNE ROTARY

28

MACARTHUR BOULEVARD

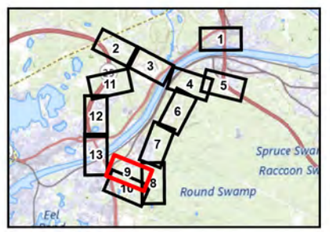
ALGONQUIN GAS TRANSMISSION LLC
CAPE COD RELOCATION PROJECT

Transportation

SHEET 9 OF 13

Road
Limits of Disturbance
Areas Mapped for Natural Resources

Access Road
Temporary - Existing
Temporary - New



Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 2011 StatePlane
Massachusetts Mnld FIPS 2001
FtUS
41.7425°N 70.5791°W

0 100 200
Feet
Meters
0 25 50

1:3,000

Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65956
Layout: ROADS SHEETS
Aprx: 65956_CCRP_CCC_DRI

SWCA
ENVIRONMENTAL CONSULTANTS

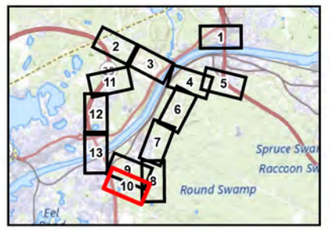
ALGONQUIN GAS TRANSMISSION LLC
CAPE COD RELOCATION PROJECT

Transportation

SHEET 10 OF 13

Road
Limits of Disturbance
Areas Mapped for Natural Resources

Access Road
Permanent - Existing
Permanent - New
Temporary - Existing



Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 2011 StatePlane
Massachusetts Mnld FIPS 2001
FtUS
41.7383°N 70.58°W

0 100 200 Feet
0 25 50 Meters

1:3,000

Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65956
Layout: ROADS SHEETS
Aprx: 65956_CCRP_CCC_DRI

SWCA ENVIRONMENTAL CONSULTANTS

ROUTE 25

TANAGER LANE

HEATHER HILL ROAD

SEAN CIRCLE

FAWN HOLLOW WAY

MIRASOL DRIVE

DESERET DRIVE

SETTLERS WAY

CORDWOOD CIRCLE

25

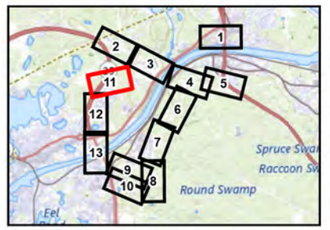
ALGONQUIN GAS TRANSMISSION LLC
CAPE COD RELOCATION PROJECT

Transportation

SHEET 11 OF 13

Road
Limits of Disturbance
Areas Mapped for Natural Resources

Access Road
Permanent - Existing
Permanent - New
Temporary - New



Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 2011 StatePlane
Massachusetts Mnld FIPS 2001
FtUS
41.7672°N 70.5858°W

0 100 200 Feet
0 25 50 Meters

N

1:3,000

Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65956
Layout: ROADS SHEETS
Aprx: 65956_CCRP_CCC_DRI

SWCA ENVIRONMENTAL CONSULTANTS

WHITE CLIFF ROAD
HIGH RIDGE DRIVE
SETTLERS WAY
DESERET DRIVE
NIGHTINGALE POND ROAD
MIRASOL DRIVE
RAMP-RTS 6/28 SB TO RT 25 WB
28
RAMP-RT 25 WB TO RTS 6/28 NB
RAMP-RTS 6/28 SB TO RT 25 EB
BOURNE BRIDGE APPROACH
25
ROUTE 25
RAMP-RT 25 EB TO RTS 6/28

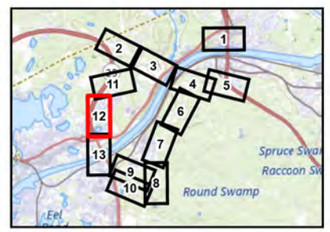
ALGONQUIN GAS TRANSMISSION LLC
CAPE COD RELOCATION PROJECT

Transportation

SHEET 12 OF 13

Road
Limits of Disturbance
Areas Mapped for Natural Resources

Access Road
Temporary - Existing
Temporary - New



Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 2011 StatePlane
Massachusetts Mnld FIPS 2001
FtUS
41.7584°N 70.5911°W

0 100 200 Feet
0 25 50 Meters

1:3,000

Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65956
Layout: ROADS SHEETS
Aprx: 65956_CCRP_CCC_DRI

SWCA ENVIRONMENTAL CONSULTANTS



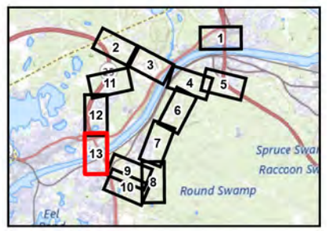
ALGONQUIN GAS TRANSMISSION LLC
CAPE COD RELOCATION PROJECT

Transportation

SHEET 13 OF 13

- Municipal Boundary
- Road
- Limits of Disturbance
- Areas Mapped for Natural Resources

Access Road
- Temporary - Existing



Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 2011 StatePlane
Massachusetts Mnld FIPS 2001
FtUS
41.7477°N 70.5913°W

0 100 200 Feet
0 25 50 Meters

N

1:3,000

Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65956
Layout: ROADS SHEETS
Aprx: 65956_CCRP_CCC_DRI

SWCA ENVIRONMENTAL CONSULTANTS

PLYMOUTH
WAREHAM
BOURNE
SANDWICH
1
2
3
4
5
6
7
8
9
10
11
12
13

ALGONQUIN GAS TRANSMISSION LLC
CAPE COD CANAL PIPELINE
RELOCATION PROJECT

Figure 5.2-1
Project Area and Area of Development Impact
Overview

- Municipal Boundary
- Limits of Disturbance
- Sheet Index

Land Disturbance Type
- New Development in Areas Mapped for Natural Resources
- Redevelopment in Areas Mapped for Natural Resources
- New Development in Areas Not Mapped for Natural Resources
- Redevelopment in Areas Not Mapped for Natural Resources

Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 2011 StatePlane
Massachusetts Mnld FIPS 2001
FtUS
41.7564°N 70.5667°W

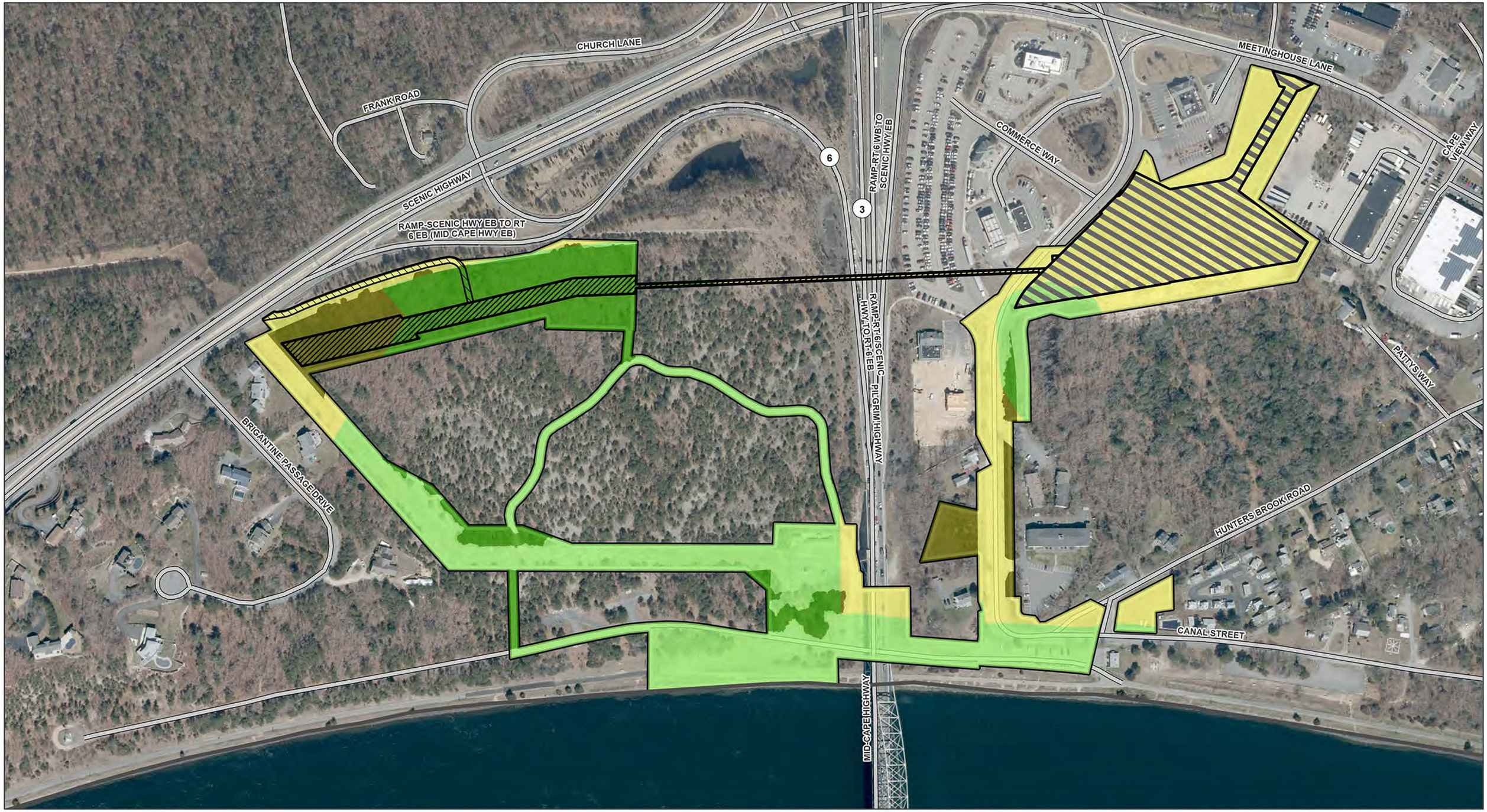
0 1,000 2,000 Feet
0 250 500 Meters

N

1:30,000

Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65856
Layout: Natural Areas Index
Aprx: 65856_CCRP_CCC_DRI

SWCA
ENVIRONMENTAL CONSULTANTS



ALGONQUIN GAS TRANSMISSION LLC
CAPE COD RELOCATION PROJECT

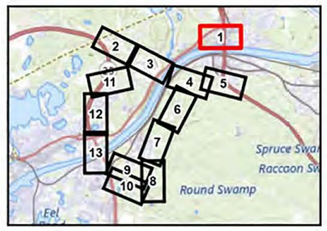
Project Area and Area of Development Impact

SHEET 1 OF 13

- Municipal Boundary
- Road
- Limits of Disturbance
- Permanent Easement
- Permanent Access Road
- Proposed M&R Station

Land Disturbance Type

- New Development in Areas Mapped for Natural Resources
- Redevelopment in Areas Mapped for Natural Resources
- New Development in Areas Not Mapped for Natural Resources
- Redevelopment in Areas Not Mapped for Natural Resources



Bourne, MA
USGS 7.5' Quadrangles: Sagamore and Pocasset
NAD 1983 2011 StatePlane Massachusetts Mnld FIPS 2001 FtUS
41.7793°N 70.5447°W

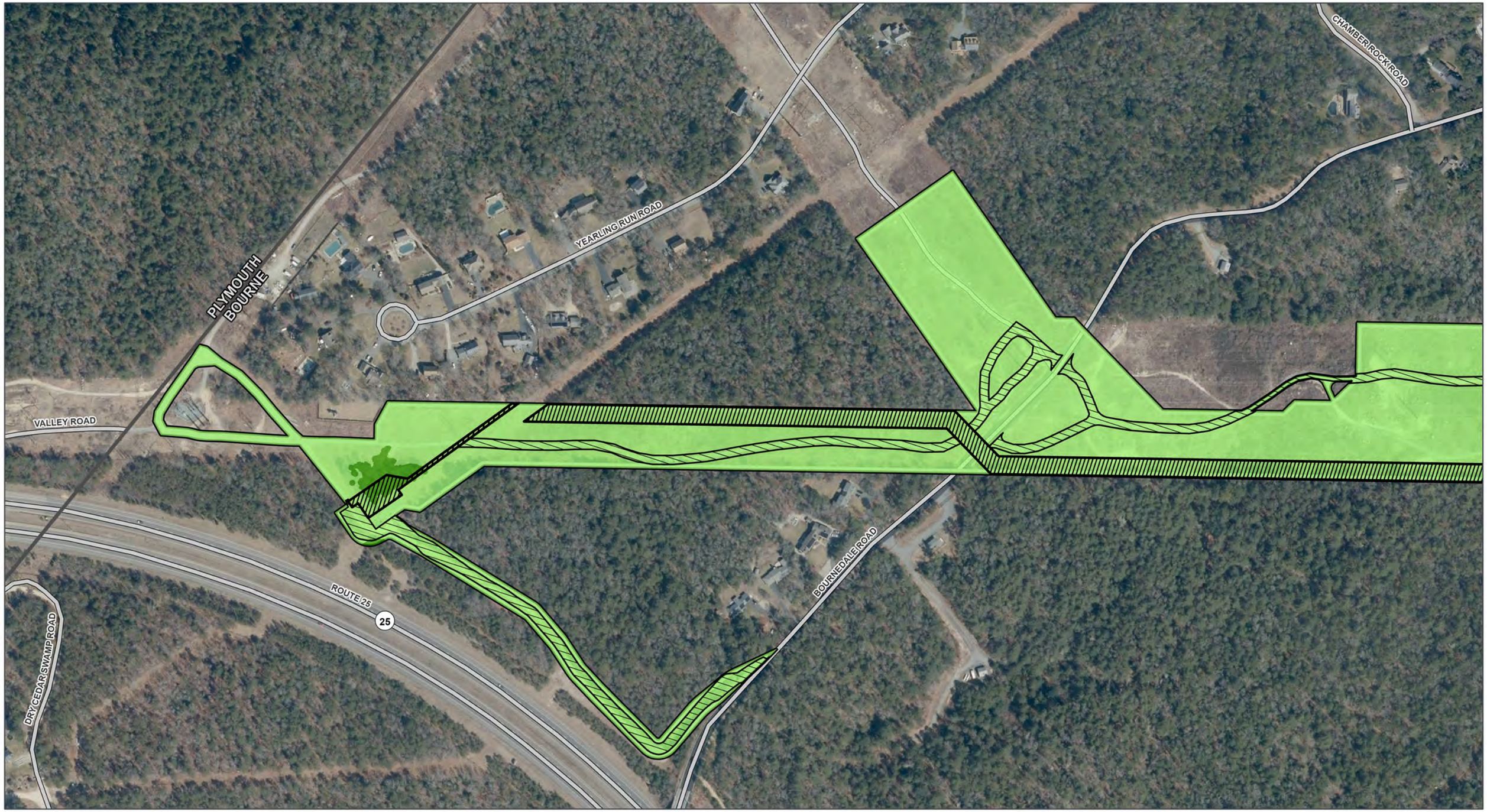
Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65956
Layout: Natural Areas Sheets Aprx: 65956_CCRP_CCC_DRI

0 100 200 Feet
0 25 50 Meters

N

1:3,000

SWCA ENVIRONMENTAL CONSULTANTS



ALGONQUIN GAS TRANSMISSION LLC
CAPE COD RELOCATION PROJECT

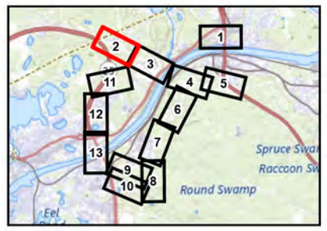
Project Area and Area of Development Impact

SHEET 2 OF 13

- Municipal Boundary
- Road
- Limits of Disturbance
- Permanent Easement
- Permanent Access Road

Land Disturbance Type

- New Development in Areas Mapped for Natural Resources
- Redevelopment in Areas Mapped for Natural Resources
- New Development in Areas Not Mapped for Natural Resources
- Redevelopment in Areas Not Mapped for Natural Resources



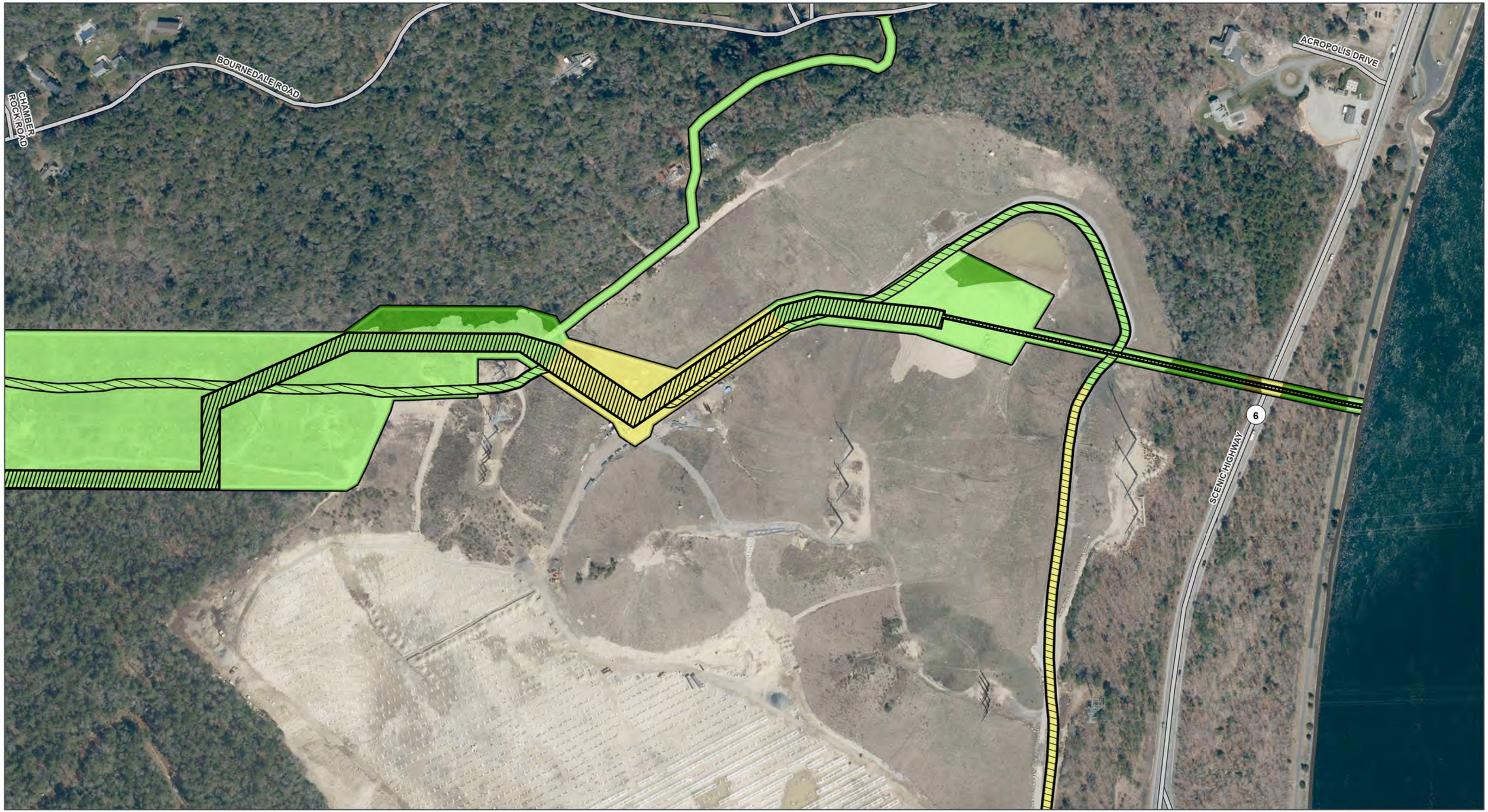
Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 2011 StatePlane
Massachusetts Mnld FIPS 2001
FtUS
41.777°N 70.5835°W

Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65956
Layout: Natural Areas Sheets
Aprx: 65956_CCRP_CCC_DRI

0 100 200 Feet
0 25 50 Meters

1:3,000

SWCA ENVIRONMENTAL CONSULTANTS



ALGONQUIN GAS TRANSMISSION LLC
CAPE COD RELOCATION PROJECT

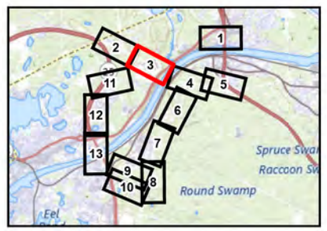
Project Area and Area of Development Impact

SHEET 3 OF 13

- Municipal Boundary
- Road
- Limits of Disturbance
- Permanent Easement
- Permanent Access Road

Land Disturbance Type

- New Development in Areas Mapped for Natural Resources
- Redevelopment in Areas Mapped for Natural Resources
- New Development in Areas Not Mapped for Natural Resources
- Redevelopment in Areas Not Mapped for Natural Resources



Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 2011 StatePlane
Massachusetts Mnld FIPS 2001
FtUS
41.7721°N 70.5708°W

Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65956
Layout: Natural Areas Sheets
Aprx: 65956_CCRP_CCC_DRI

0 100 200 Feet
0 25 50 Meters

1:3,000

SWCA ENVIRONMENTAL CONSULTANTS



ALGONQUIN GAS TRANSMISSION LLC
CAPE COD RELOCATION PROJECT

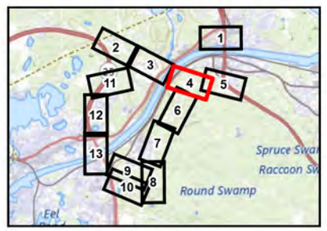
Project Area and Area of Development Impact

SHEET 4 OF 13

- Municipal Boundary
- Road
- Limits of Disturbance
- Permanent Easement
- Permanent Access Road
- Proposed M&R Station

Land Disturbance Type

- New Development in Areas Mapped for Natural Resources
- Redevelopment in Areas Mapped for Natural Resources
- New Development in Areas Not Mapped for Natural Resources
- Redevelopment in Areas Not Mapped for Natural Resources



Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 2011 StatePlane
Massachusetts Mnld FIPS 2001
FtUS
41.767°N 70.5563°W

0 100 200 Feet
0 25 50 Meters

1:3,000

Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65956
Layout: Natural Areas Sheets
Aprx: 65956_CCRP_CCC_DRI

SWCA ENVIRONMENTAL CONSULTANTS

SUMMIT ROAD
FACTORY OUTLET ROAD
RAMP-RT 6 TO RT 6A CONN
RAMP-RT 6 EB TO MID CAPE CONN (RT 6A)
ADAMS STREET
WOODLAND ROAD
HILLTOP DRIVE
COUNTRY WAY
CRESTVIEW ROAD
CRESTVIEW LANE
HILL CREST DRIVE
RAMP-MID CAPE CONN (RT 6A) TO RT 6 EB
MID-CAPE HIGHWAY
6
JARVIS ROAD
SAGAMORE ROAD
PAVE PAWS ACCESS ROAD

ALGONQUIN GAS TRANSMISSION LLC
CAPE COD RELOCATION PROJECT

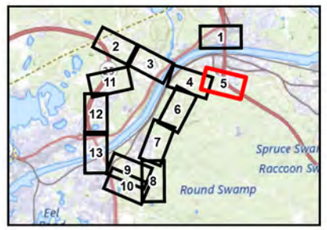
Project Area and Area of Development Impact

SHEET 5 OF 13

- Road
- Limits of Disturbance
- Permanent Easement
- Permanent Access Road
- Proposed M&R Station

Land Disturbance Type

- New Development in Areas Mapped for Natural Resources
- Redevelopment in Areas Mapped for Natural Resources
- New Development in Areas Not Mapped for Natural Resources
- Redevelopment in Areas Not Mapped for Natural Resources



Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 2011 StatePlane
Massachusetts Mnld FIPS 2001
FtUS
41.7665°N 70.5439°W

Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65956
Layout: Natural Areas Sheets
Aprx: 65956_CCRP_CCC_DRI

0 100 200 Feet
0 25 50 Meters

N

1:3,000

SWCA ENVIRONMENTAL CONSULTANTS

SUMMIT ROAD

GIBBS ROAD

ALGONQUIN GAS TRANSMISSION LLC
CAPE COD RELOCATION PROJECT

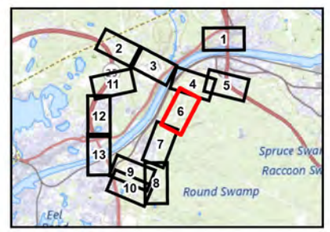
Project Area and Area of Development Impact

SHEET 6 OF 13

- Road
- Limits of Disturbance
- Permanent Easement
- Permanent Access Road

Land Disturbance Type

- New Development in Areas Mapped for Natural Resources
- Redevelopment in Areas Mapped for Natural Resources
- New Development in Areas Not Mapped for Natural Resources
- Redevelopment in Areas Not Mapped for Natural Resources



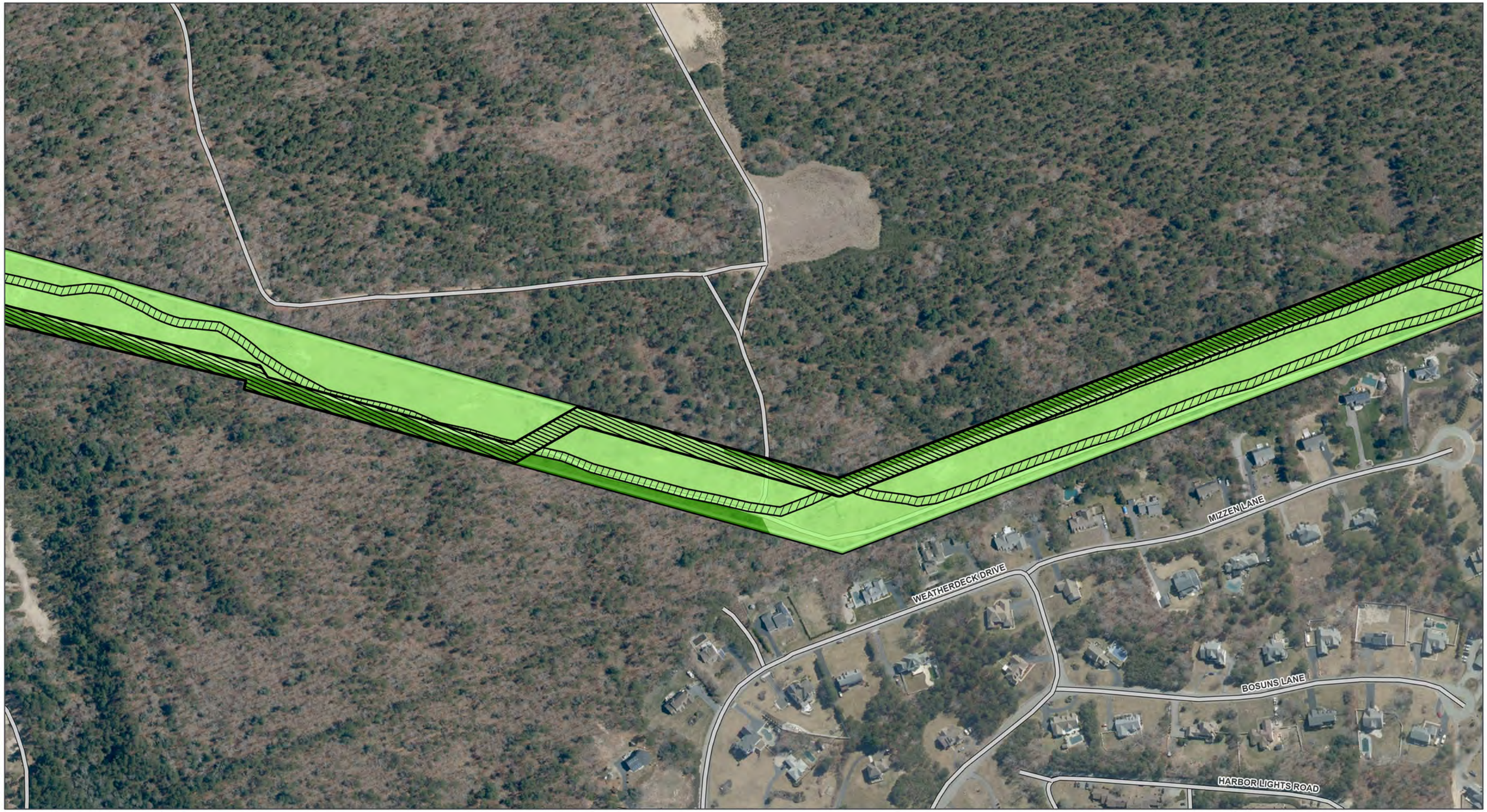
Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 2011 StatePlane
Massachusetts Mnld FIPS 2001
FtUS
41.7594°N 70.561°W

0 100 200 Feet
0 25 50 Meters

1:3,000

Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65956
Layout: Natural Areas Sheets
Aprx: 65956_CCRP_CCC_DRI

SWCA ENVIRONMENTAL CONSULTANTS



ALGONQUIN GAS TRANSMISSION LLC
CAPE COD RELOCATION PROJECT

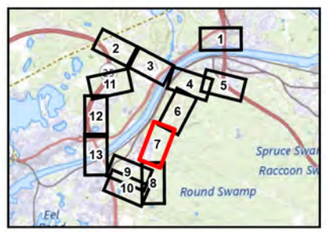
Project Area and Area of Development Impact

SHEET 7 OF 13

- Road
- Limits of Disturbance
- Permanent Easement
- Permanent Access Road

Land Disturbance Type

- New Development in Areas Mapped for Natural Resources
- Redevelopment in Areas Mapped for Natural Resources
- New Development in Areas Not Mapped for Natural Resources
- Redevelopment in Areas Not Mapped for Natural Resources



Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 2011 StatePlane
Massachusetts Mnld FIPS 2001
FtUS
41.7503°N 70.5687°W

0 100 200 Feet
0 25 50 Meters

1:3,000

Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65956
Layout: Natural Areas Sheets
Aprx: 65956_CCRP_CCC_DRI

SWCA ENVIRONMENTAL CONSULTANTS



ALGONQUIN GAS TRANSMISSION LLC
CAPE COD RELOCATION PROJECT

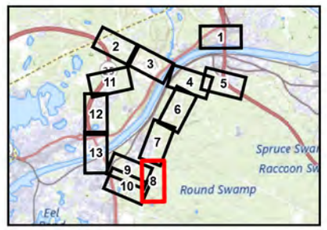
Project Area and Area of Development Impact

SHEET 8 OF 13

- Road
- Limits of Disturbance
- Permanent Easement
- Permanent Access Road

Land Disturbance Type

- New Development in Areas Mapped for Natural Resources
- Redevelopment in Areas Mapped for Natural Resources
- New Development in Areas Not Mapped for Natural Resources
- Redevelopment in Areas Not Mapped for Natural Resources



Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 2011 StatePlane
Massachusetts Mnld FIPS 2001
FtUS
41.7396°N 70.5703°W

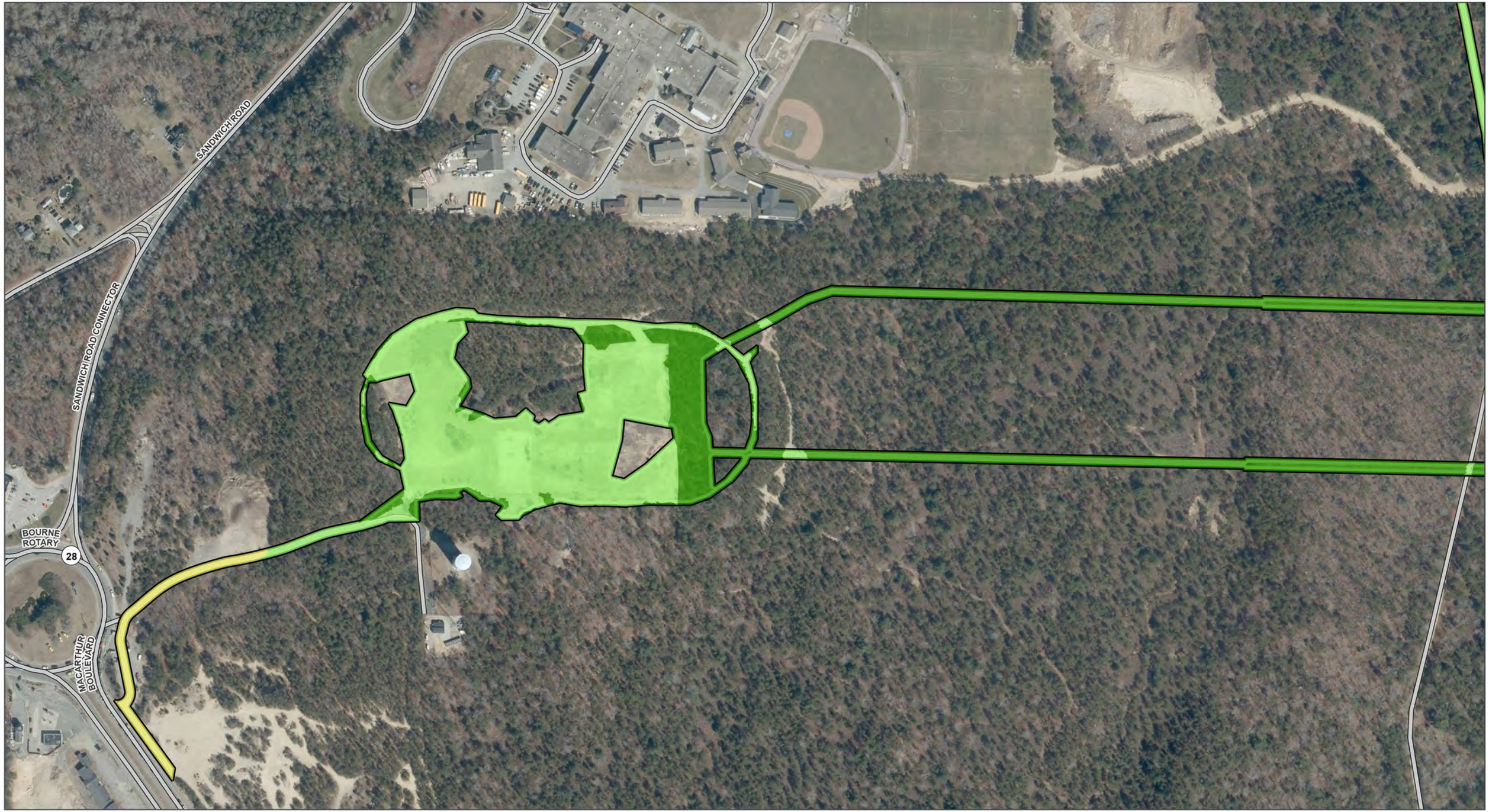
0 100 200 Feet
0 25 50 Meters

N

1:3,000

Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65956
Layout: Natural Areas Sheets
Aprx: 65956_CCRP_CCC_DRI

SWCA ENVIRONMENTAL CONSULTANTS



ALGONQUIN GAS TRANSMISSION LLC
CAPE COD RELOCATION PROJECT

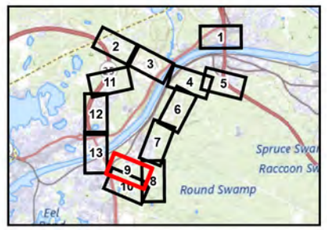
Project Area and Area of Development Impact

SHEET 9 OF 13

- Road
- Limits of Disturbance
- Permanent Easement

Land Disturbance Type

- New Development in Areas Mapped for Natural Resources
- Redevelopment in Areas Mapped for Natural Resources
- New Development in Areas Not Mapped for Natural Resources
- Redevelopment in Areas Not Mapped for Natural Resources



Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 2011 StatePlane
Massachusetts Mnld FIPS 2001
FtUS
41.7425°N 70.5791°W

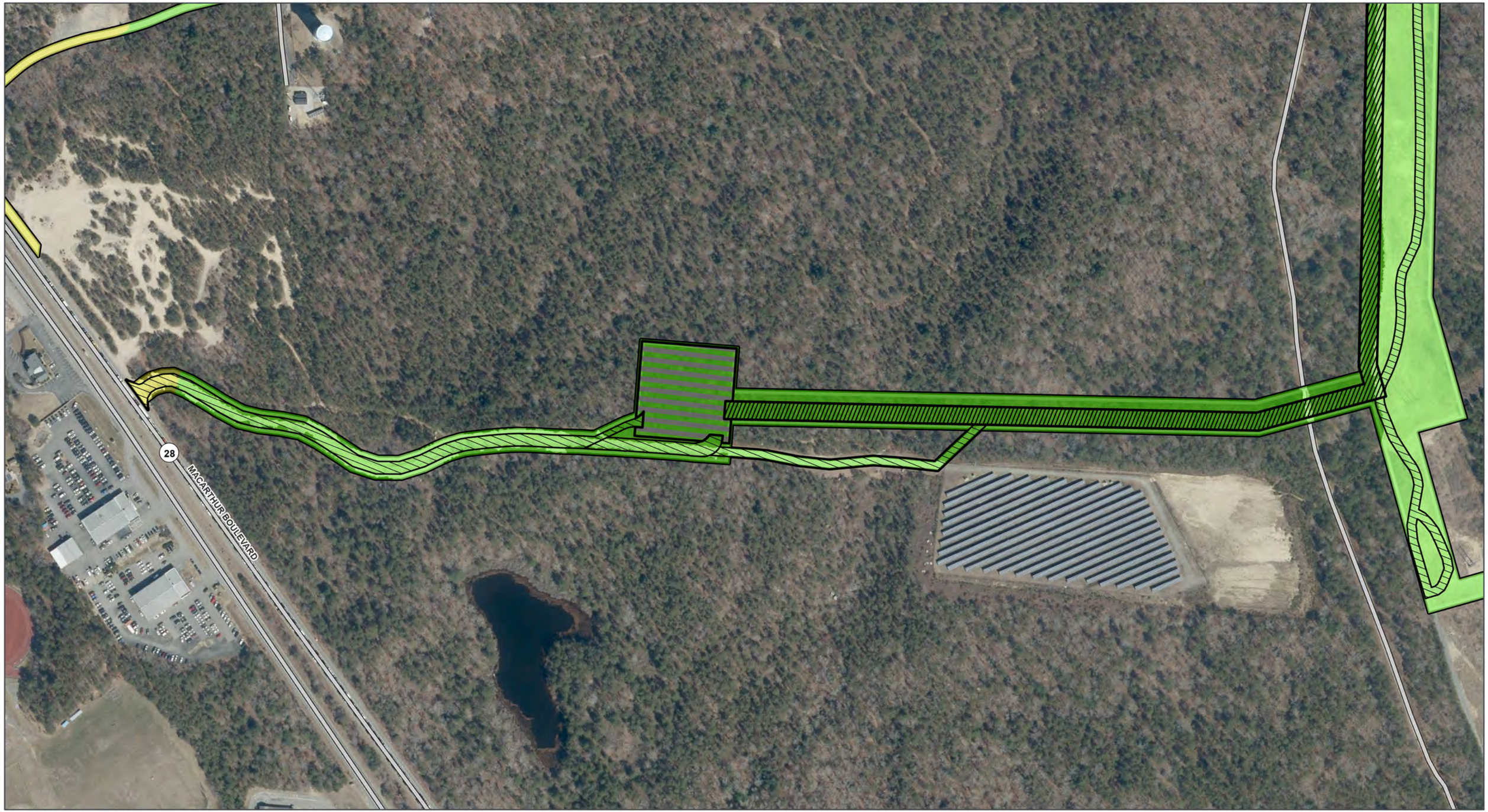
0 100 200 Feet
0 25 50 Meters

N

1:3,000

Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65956
Layout: Natural Areas Sheets
Aprx: 65956_CCRP_CCC_DRI

SWCA ENVIRONMENTAL CONSULTANTS



ALGONQUIN GAS TRANSMISSION LLC
CAPE COD RELOCATION PROJECT

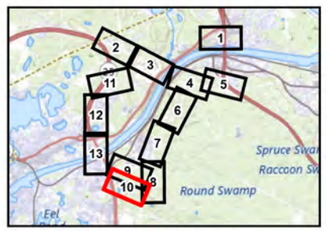
Project Area and Area of Development Impact

SHEET 10 OF 13

- Road
- Limits of Disturbance
- Permanent Easement
- Permanent Access Road
- Proposed M&R Station

Land Disturbance Type

- New Development in Areas Mapped for Natural Resources
- Redevelopment in Areas Mapped for Natural Resources
- New Development in Areas Not Mapped for Natural Resources
- Redevelopment in Areas Not Mapped for Natural Resources



Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 2011 StatePlane
Massachusetts Mnld FIPS 2001
FtUS
41.7383°N 70.58°W

0 100 200 Feet
0 25 50 Meters

N

1:3,000

Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65956
Layout: Natural Areas Sheets
Aprx: 65956_CCRP_CCC_DRI

SWCA ENVIRONMENTAL CONSULTANTS

ROUTE 25

TANAGER LANE

SEAN CIRCLE

FAWN HOLLOW WAY

MIRASOL DRIVE

DESERET DRIVE

SETTLERS WAY

CORDWOOD CIRCLE

25

ALGONQUIN GAS TRANSMISSION LLC
CAPE COD RELOCATION PROJECT

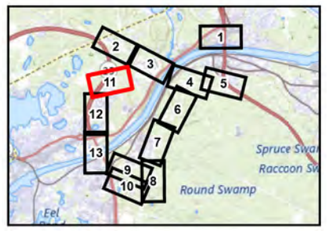
Project Area and Area of Development Impact

SHEET 11 OF 13

- Road
- Limits of Disturbance
- Permanent Access Road
- Proposed M&R Station

Land Disturbance Type

- New Development in Areas Mapped for Natural Resources
- Redevelopment in Areas Mapped for Natural Resources
- New Development in Areas Not Mapped for Natural Resources
- Redevelopment in Areas Not Mapped for Natural Resources



Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 2011 StatePlane
Massachusetts Mnld FIPS 2001
FtUS
41.7672°N 70.5858°W

0 100 200 Feet
0 25 50 Meters

N

1:3,000

Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65956
Layout: Natural Areas Sheets
Aprx: 65956_CCRP_CCC_DRI

SWCA ENVIRONMENTAL CONSULTANTS

WHITE CLIFF ROAD
HIGH RIDGE DRIVE
SETTLERS WAY
DESERET DRIVE
NIGHTINGALE POND ROAD
MIRASOL DRIVE
28
RAMP-RTS 6/28 SB TO RT 25 WB / RAMP-RT 25 WB TO RTS 6/28 NB
RAMP-RTS 6/28 SB TO RT 25 EB
25
ROUTE 25
RAMP-RT-25 EB TO RTS 6/28
BOURNE BRIDGE APPROACH

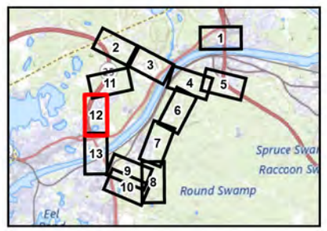
ALGONQUIN GAS TRANSMISSION LLC
CAPE COD RELOCATION PROJECT

Project Area and Area of Development Impact

SHEET 12 OF 13

Road
Limits of Disturbance

Land Disturbance Type
- New Development in Areas Mapped for Natural Resources
- Redevelopment in Areas Mapped for Natural Resources
- New Development in Areas Not Mapped for Natural Resources
- Redevelopment in Areas Not Mapped for Natural Resources



Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 2011 StatePlane
Massachusetts Mnld FIPS 2001
FtUS
41.7584°N 70.5911°W

0 100 200 Feet
0 25 50 Meters

N

1:3,000

Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65956
Layout: Natural Areas Sheets
Aprx: 65956_CCRP_CCC_DRI

SWCA ENVIRONMENTAL CONSULTANTS

ALGONQUIN GAS TRANSMISSION LLC
CAPE COD RELOCATION PROJECT

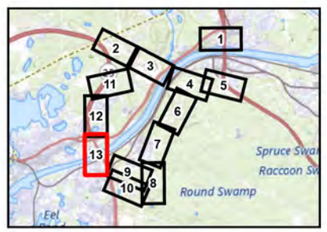
Project Area and Area of Development Impact

SHEET 13 OF 13

- Municipal Boundary
- Road
- Limits of Disturbance

Land Disturbance Type

- New Development in Areas Mapped for Natural Resources
- Redevelopment in Areas Mapped for Natural Resources
- New Development in Areas Not Mapped for Natural Resources
- Redevelopment in Areas Not Mapped for Natural Resources



Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 2011 StatePlane
Massachusetts Mnld FIPS 2001
FtUS
41.7477°N 70.5913°W

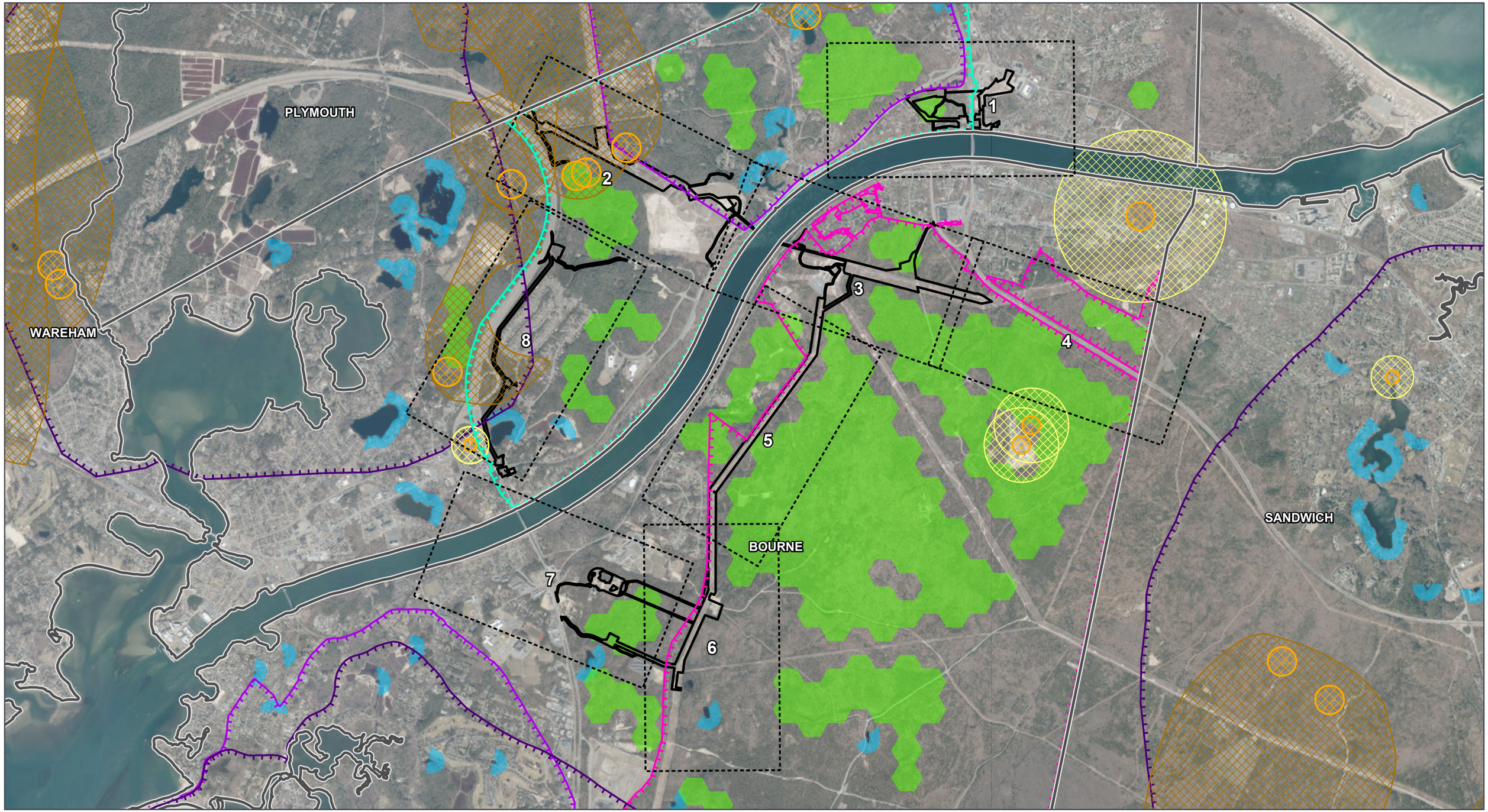
0 100 200 Feet
0 25 50 Meters

N

1:3,000

Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65956
Layout: Natural Areas Sheets
Aprx: 65956_CCRP_CCC_DRI

SWCA ENVIRONMENTAL CONSULTANTS



ALGONQUIN GAS TRANSMISSION LLC
CAPE COD CANAL PIPELINE
RELOCATION PROJECT

Figure 5.3-1
Critical Water Resources
Overview

- Municipal Boundary
- Limits of Disturbance
- Sheet Index
- Bournedale District of Critical Planning Concerns
- Buttermilk Bay Marine Water Recharge Area
- Contributing Areas to Ponds
- Herring Cove Watershed ACEC
- Interim Wellhead Protection Area
- Potential Plume Area (Joint Base Cape Cod)
- Potential Public Water Supply Area
- Zone I Wellhead Protection Area
- Zone 2 Wellhead Protection Area

Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 2011 StatePlane
Massachusetts Mnld FIPS 2001
FtUS
41.7564°N 70.5667°W

0 1,000 2,000 Feet
0 250 500 Meters

N

1:30,000

Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65956
Layout: WR Index
Aprx: 65956_CCRP_CCC_DRI

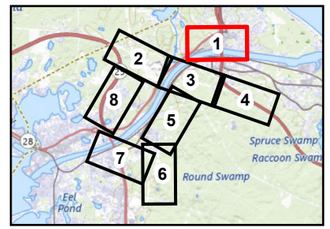
SWCA ENVIRONMENTAL CONSULTANTS

ALGONQUIN GAS TRANSMISSION LLC
CAPE COD RELOCATION PROJECT

Critical Water Resources

SHEET 1 OF 8

- Municipal Boundary
- Road
- Limits of Disturbance
- Permanent Access Road
- Permanent Easement
- Proposed M&R Station
- Bournedale District of Critical Planning Concerns
- Herring Cove Watershed ACEC
- Interim Wellhead Protection Area
- Potential Public Water Supply Area



Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 2011 StatePlane
Massachusetts Mnld FIPS 2001
FtUS
41.7789°N 70.5453°W

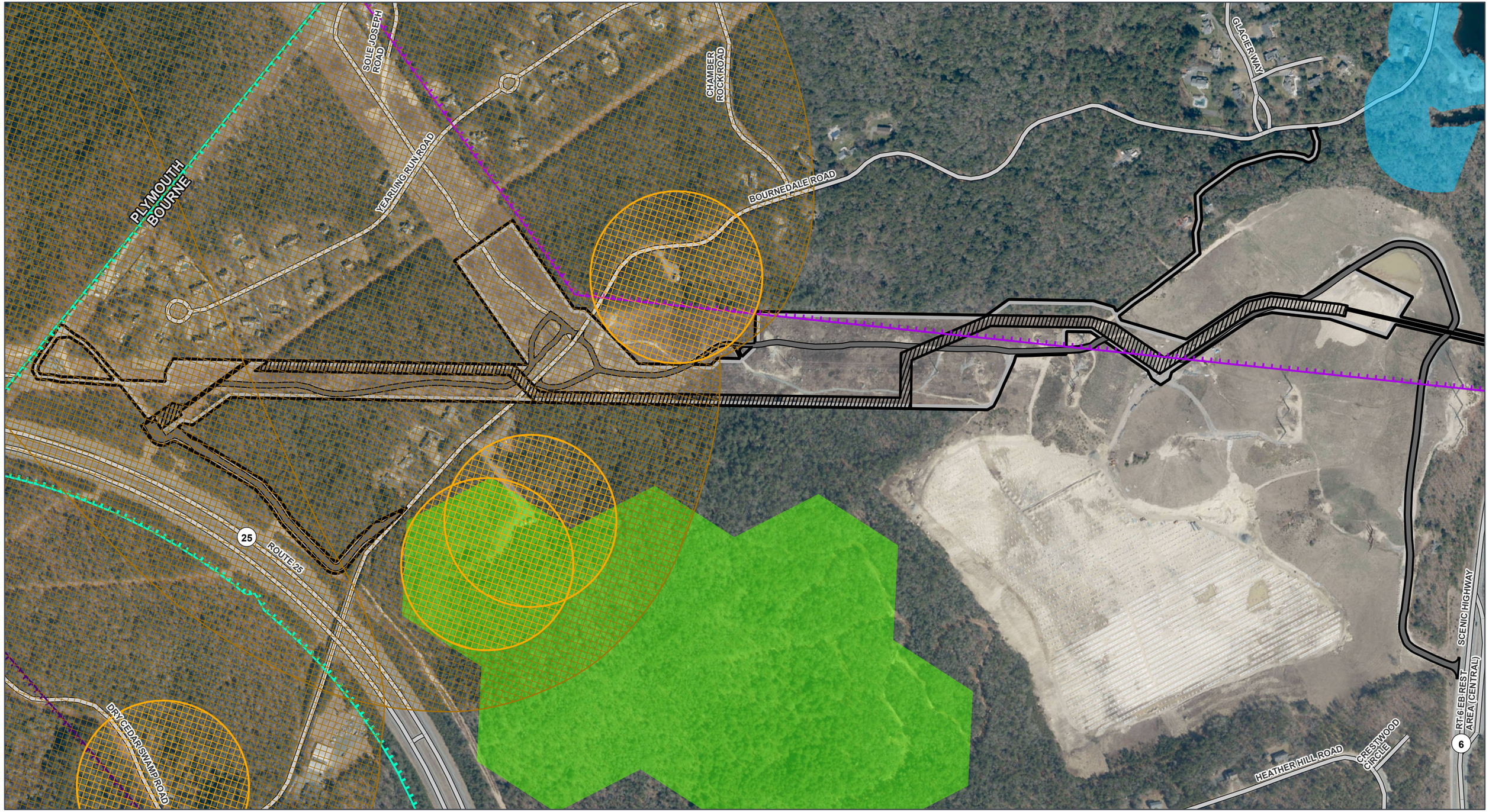
0 250 500 Feet
0 50 100 Meters

N

1:5,000

Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65956
Layout: WR Sheets
Aprx: 65956_CCRP_CCC_DRI

SWCA ENVIRONMENTAL CONSULTANTS

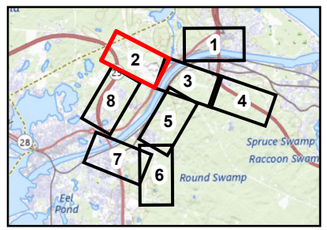


ALGONQUIN GAS TRANSMISSION LLC
CAPE COD RELOCATION PROJECT

Critical Water Resources

SHEET 2 OF 8

- Municipal Boundary
- Road
- Limits of Disturbance
- Permanent Access Road
- Permanent Easement
- Buttermilk Bay Marine Water Recharge Area
- Bournedale District of Critical Planning Concerns
- Contributing Areas to Ponds
- Herring Cove Watershed ACEC
- Zone I Wellhead Protection Area
- Zone 2 Wellhead Protection Area
- Potential Public Water Supply Area



Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 2011 StatePlane
Massachusetts Mnld FIPS 2001
FtUS
41.7744°N 70.5785°W

Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65956
Layout: WR Sheets
Aprx: 65956_CCRP_CCC_DRI

0 250 500 Feet
0 50 100 Meters

1:5,000

SWCA ENVIRONMENTAL CONSULTANTS

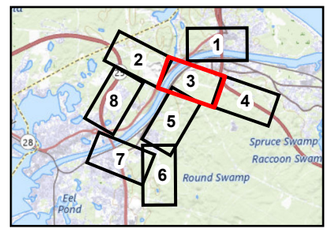


ALGONQUIN GAS TRANSMISSION LLC
CAPE COD RELOCATION PROJECT

Critical Water Resources

SHEET 3 OF 8

- Municipal Boundary
- Road
- Limits of Disturbance
- Permanent Access Road
- Permanent Easement
- Proposed M&R Station
- Bournedale District of Critical Planning Concerns
- Contributing Areas to Ponds
- Herring Cove Watershed ACEC
- Potential Plume Area (Joint Base Cape Cod)
- Potential Public Water Supply Area



Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 2011 StatePlane
Massachusetts Mnld FIPS 2001
FtUS
41.7671°N 70.5562°W

0 250 500 Feet
0 50 100 Meters

N

1:5,000

Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65956
Layout: WR Sheets
Aprx: 65956_CCRP_CCC_DRI

SWCA ENVIRONMENTAL CONSULTANTS

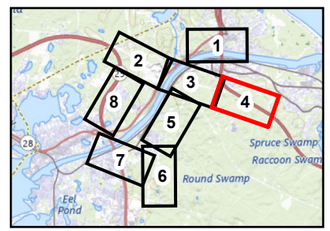
ADAMS STREET
WOODLAND ROAD
COUNTRY WAY
HILLTOP DRIVE
CRESTVIEW ROAD
CRESTVIEW LANE
HILL CREST DRIVE
RAMP MID CAPE CONN (RT 6A) TO RT 6 EB
6
MID-CAPE HIGHWAY
JARVIS ROAD
SANDWICH
BOURNE
SAGAMORE ROAD
FLAT ROCK ROAD
PAVE PAWS ACCESS ROAD

ALGONQUIN GAS TRANSMISSION LLC
CAPE COD RELOCATION PROJECT

Critical Water Resources

SHEET 4 OF 8

- Municipal Boundary
- Road
- Limits of Disturbance
- Interim Wellhead Protection Area
- Potential Plume Area (Joint Base Cape Cod)
- Potential Public Water Supply Area



Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 2011 StatePlane
Massachusetts Mnld FIPS 2001
FtUS
41.7611°N 70.5337°W

0 250 500 Feet
0 50 100 Meters

1:5,000

Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65956
Layout: WR Sheets
Aprx: 65956_CCRP_CCC_DRI

SWCA ENVIRONMENTAL CONSULTANTS

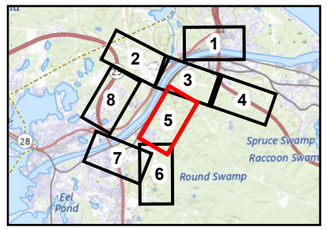
GIBBS ROAD
SUMMIT ROAD
MIZZEN LANE
WEATHERDECK DRIVE
BOSUNS LANE
HARBOR LIGHTS ROAD
ADMIRALTY COURT
SKIPPERS WATCH
CONSTITUTION LANE
MAINSTAY LANE
FORETOP ROAD
SANDWICH ROAD

ALGONQUIN GAS TRANSMISSION LLC
CAPE COD RELOCATION PROJECT

Critical Water Resources

SHEET 5 OF 8

- Road
- Limits of Disturbance
- Permanent Access Road
- Permanent Easement
- Potential Plume Area (Joint Base Cape Cod)
- Potential Public Water Supply Area



Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 2011 StatePlane
Massachusetts Mnld FIPS 2001
FtUS
41.7549°N 70.5649°W

0 250 500 Feet
0 50 100 Meters

1:5,000

Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65956
Layout: WR Sheets
Aprx: 65956_CCRP_CCC_DRI

SWCA ENVIRONMENTAL CONSULTANTS

CATROAD

KENDRICK ROAD

LZDB ACCESS ROAD

MIZZEN LANE

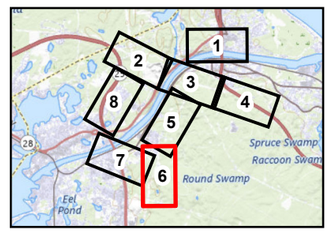
BOSUNS LANE

ALGONQUIN GAS TRANSMISSION LLC
CAPE COD RELOCATION PROJECT

Critical Water Resources

SHEET 6 OF 8

- Road
- Limits of Disturbance
- Permanent Access Road
- Permanent Easement
- Contributing Areas to Ponds
- Potential Plume Area (Joint Base Cape Cod)
- Potential Public Water Supply Area



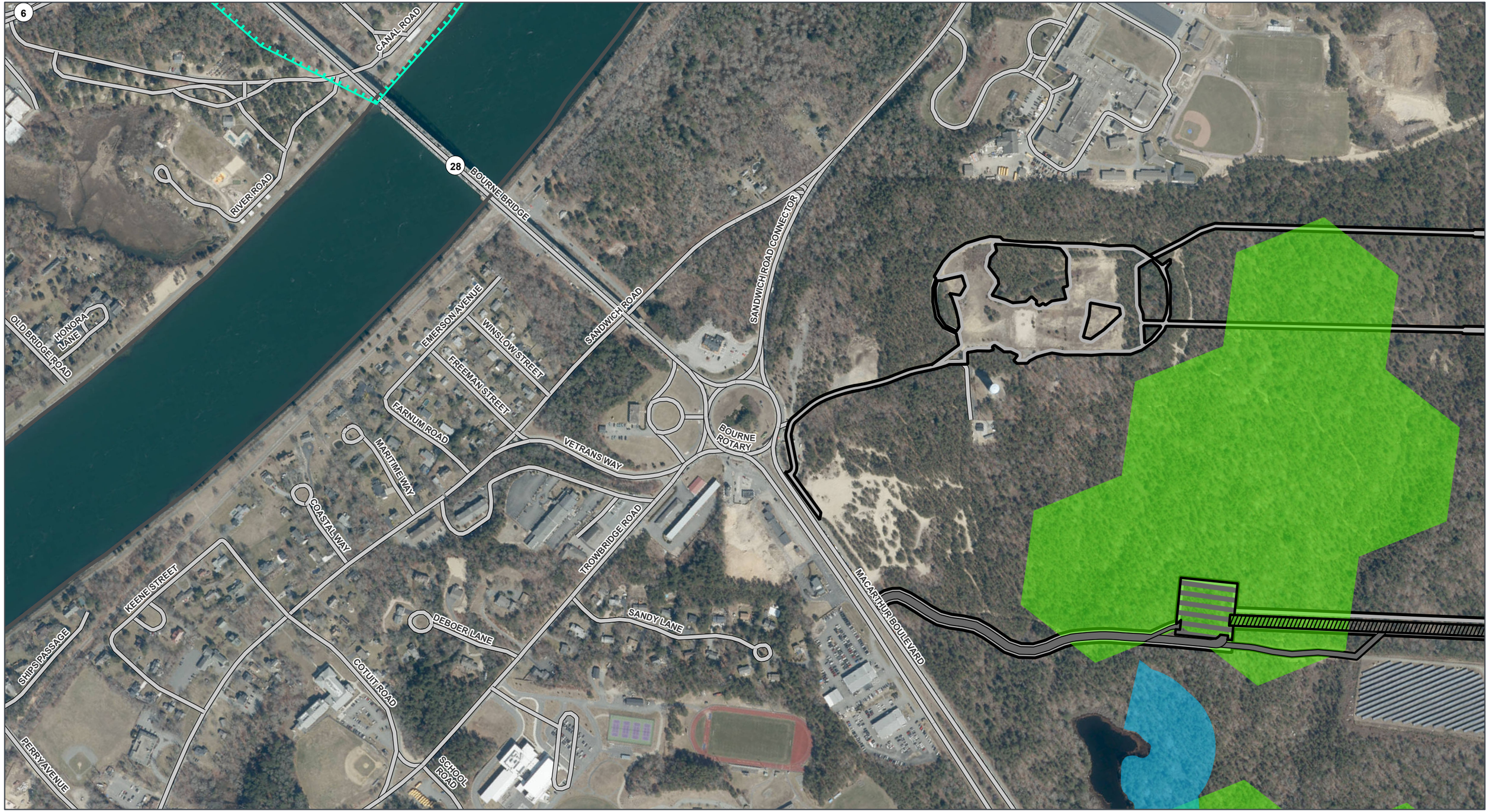
Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 2011 StatePlane
Massachusetts Mnld FIPS 2001
FtUS
41.7379°N 70.5703°W

0 250 500 Feet
0 50 100 Meters

1:5,000

Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65956
Layout: WR Sheets
Aprx: 65956_CCRP_CCC_DRI

SWCA ENVIRONMENTAL CONSULTANTS

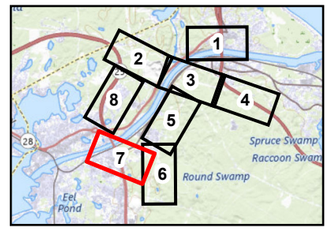


ALGONQUIN GAS TRANSMISSION LLC
CAPE COD RELOCATION PROJECT

Critical Water Resources

SHEET 7 OF 8

- Municipal Boundary
- Road
- Limits of Disturbance
- Permanent Access Road
- Permanent Easement
- Proposed M&R Station
- Bournedale District of Critical Planning Concerns
- Contributing Areas to Ponds
- Potential Public Water Supply Area



Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 2011 StatePlane
Massachusetts Mnld FIPS 2001
FtUS
41.7433°N 70.5864°W

0 250 500 Feet
0 50 100 Meters

1:5,000

Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65956
Layout: WR Sheets
Aprx: 65956_CCRP_CCC_DRI

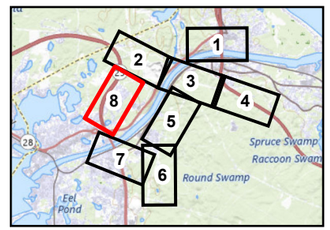
SWCA ENVIRONMENTAL CONSULTANTS

ALGONQUIN GAS TRANSMISSION LLC
CAPE COD RELOCATION PROJECT

Critical Water Resources

SHEET 8 OF 8

- Road
- Limits of Disturbance
- Permanent Access Road
- Proposed M&R Station
- Buttermilk Bay Marine Water Recharge Area
- Bournedale District of Critical Planning Concerns
- Contributing Areas to Ponds
- Interim Wellhead Protection Area
- Zone I Wellhead Protection Area
- Zone 2 Wellhead Protection Area
- Potential Public Water Supply Area



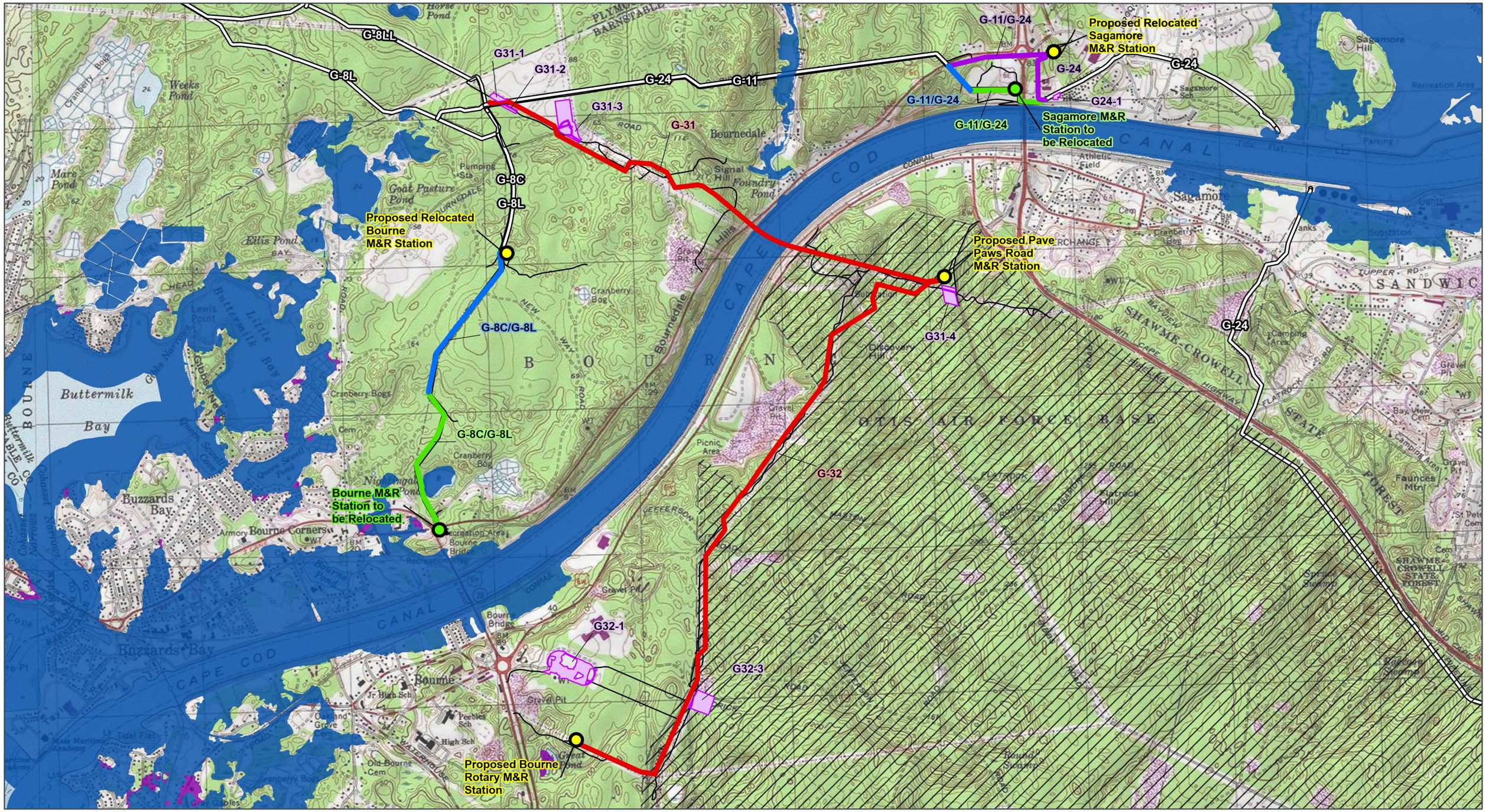
Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 2011 StatePlane
Massachusetts Mnld FIPS 2001
FtUS
41.7616°N 70.5889°W

0 250 500 Feet
0 50 100 Meters

1:5,000

Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65956
Layout: WR Sheets
Aprx: 65956_CCRP_CCC_DRI

SWCA ENVIRONMENTAL CONSULTANTS



ALGONQUIN GAS TRANSMISSION LLC
CAPE COD CANAL PIPELINE
RELOCATION PROJECT

Figure 5.3-2
FEMA Flood Zones Affected by the Project

- M&R Station to be Relocated
- Proposed M&R Station
- Existing Algonquin Gas Transmission Pipeline
- Pipeline Abandonment
- Pipeline Relocation
- Pipeline Removal
- Pipeline Replacement
- Proposed Access Road
- Proposed Ware Yard
- FEMA 100-year Flood Zone
- FEMA 500-year Flood Zone
- Area Not Included

Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 StatePlane
Massachusetts Mainland FIPS
2001 Feet
41.759°N 70.565°W

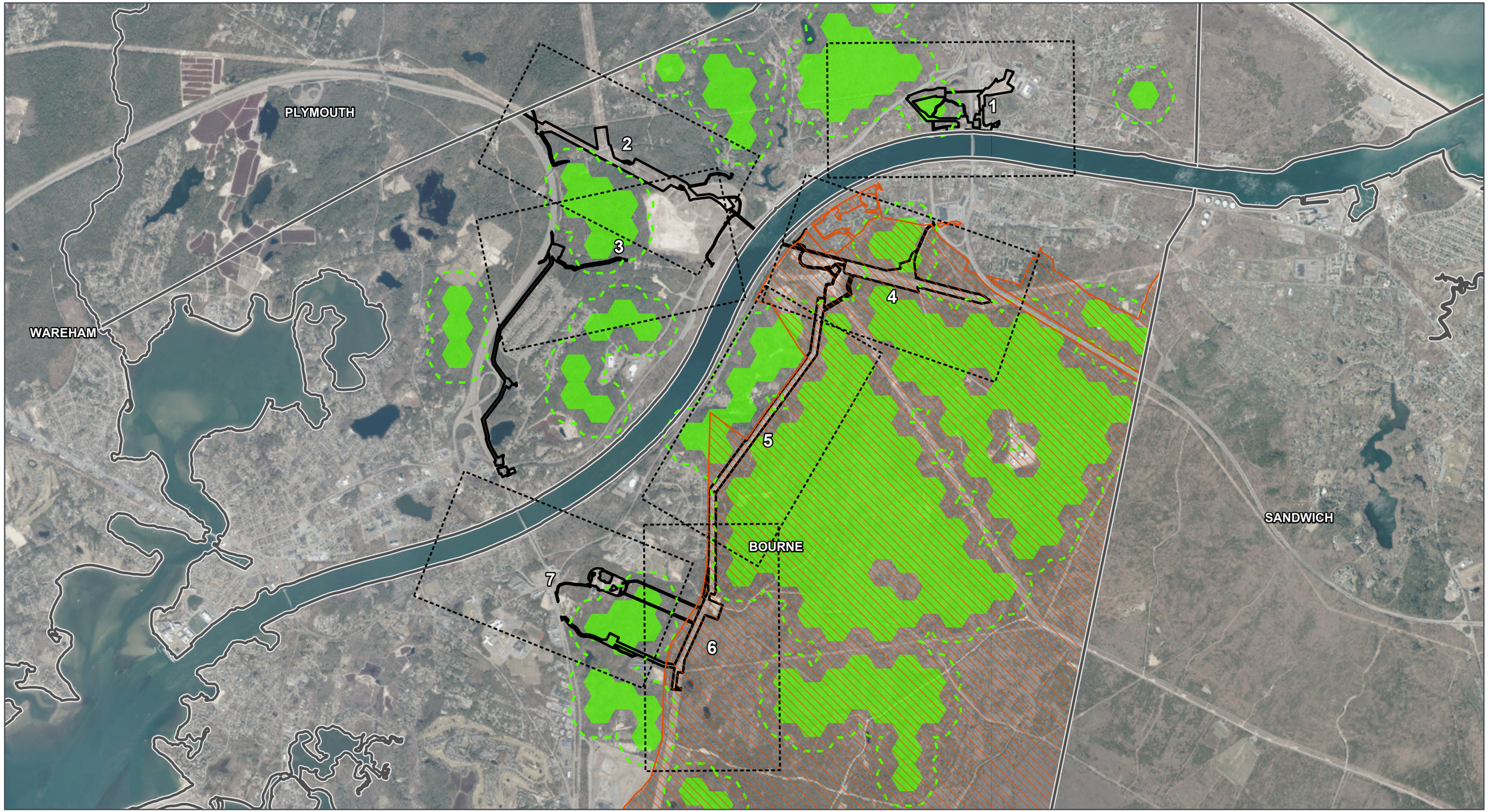
0 1,000 2,000 Feet
0 250 500 Meters

N

1:24,000

Base Map: Esri ArcGIS Online, accessed March 2026
Updated: 65956
Layout: Figure 3 FEMA
Aprx: 65956_CCRP_WPA_NOI

SWCA ENVIRONMENTAL CONSULTANTS



ALGONQUIN GAS TRANSMISSION LLC
CAPE COD CANAL PIPELINE
RELOCATION PROJECT

Figure 5.3-3
Potential Public Water Supply Areas
Overview

- Municipal Boundary
- 400-ft PPWSA Buffer
- Joint Base Cape Cod
- Limits of Disturbance
- Potential Public Water Supply Area (PPWSA)
- Sheet Index

Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 2011 StatePlane
Massachusetts Mnld FIPS 2001
FtUS
41.7564°N 70.5667°W

0 1,000 2,000 Feet
0 250 500 Meters

N

1:30,000

Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65956
Layout: PPWSA Index
Aprx: 65956_CCRP_CCC_DRI

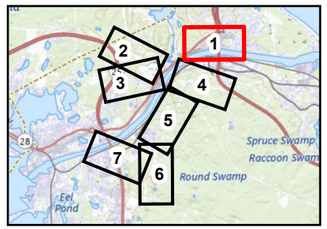
SWCA ENVIRONMENTAL CONSULTANTS

ALGONQUIN GAS TRANSMISSION LLC
CAPE COD RELOCATION PROJECT

Potential Public Water Supply Areas

SHEET 1 OF 7

- Municipal Boundary
- Road
- 400-ft PPWSA Buffer
- Potential Public Water Supply Area (PPWSA)
- Limits of Disturbance
- Permanent Access Road
- Permanent Easement
- Proposed M&R Station



Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 2011 StatePlane
Massachusetts Mnld FIPS 2001
FtUS
41.7789°N 70.5453°W

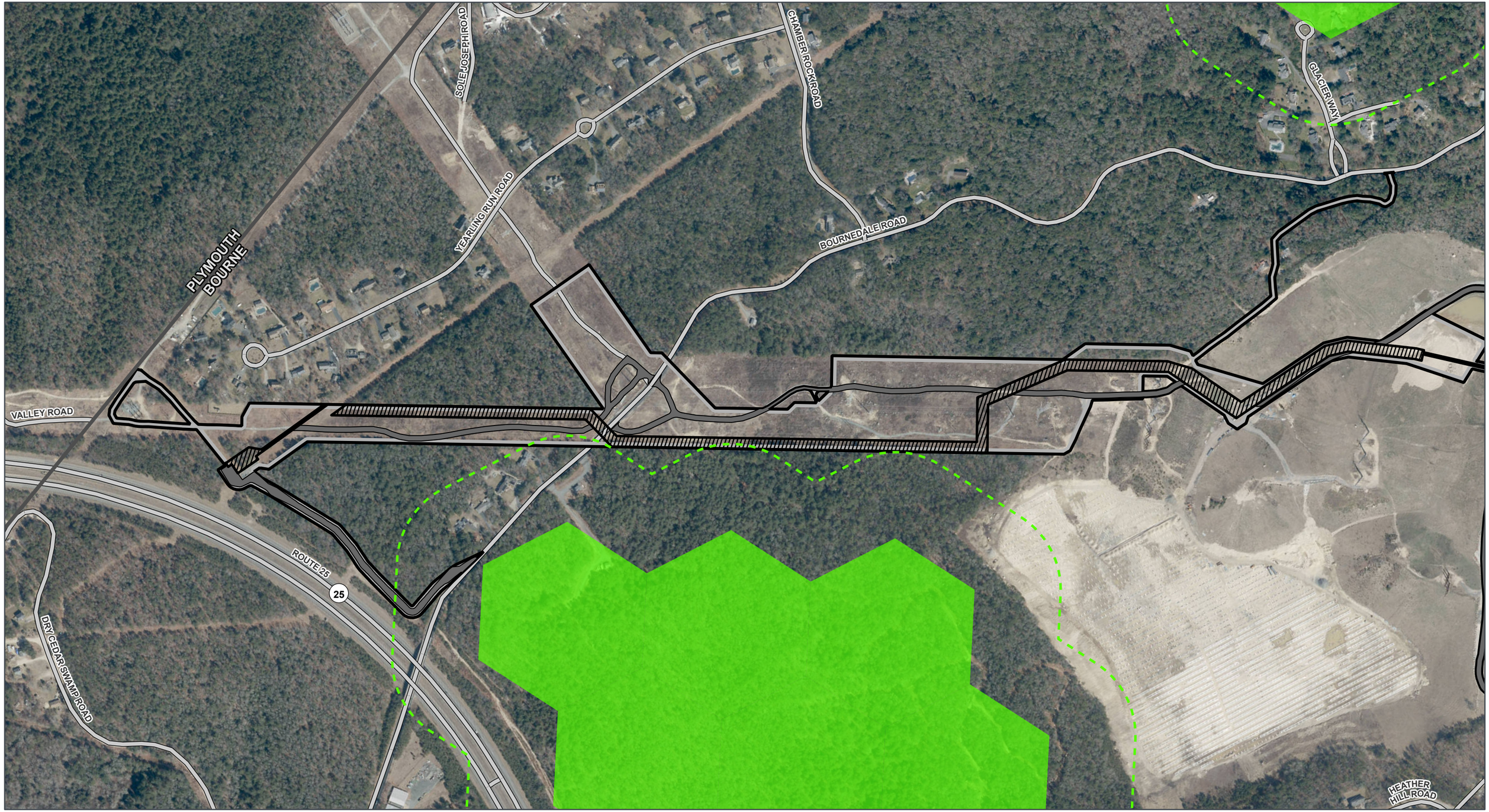
0 250 500 Feet
0 50 100 Meters

N

1:5,000

Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65956
Layout: PPWSA Sheets
Aprx: 65956_CCRP_CCC_DRI

SWCA ENVIRONMENTAL CONSULTANTS

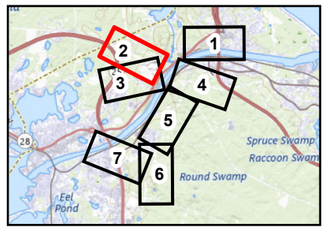


ALGONQUIN GAS TRANSMISSION LLC
CAPE COD RELOCATION PROJECT

Potential Public Water Supply Areas

SHEET 2 OF 7

- Municipal Boundary
- Road
- 400-ft PPWSA Buffer
- Potential Public Water Supply Area (PPWSA)
- Limits of Disturbance
- Permanent Access Road
- Permanent Easement



Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 2011 StatePlane
Massachusetts Mnld FIPS 2001
FtUS
41.7754°N 70.5793°W

0 250 500 Feet
0 50 100 Meters

1:5,000

Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65956
Layout: PPWSA Sheets
Aprx: 65956_CCRP_CCC_DRI

SWCA ENVIRONMENTAL CONSULTANTS

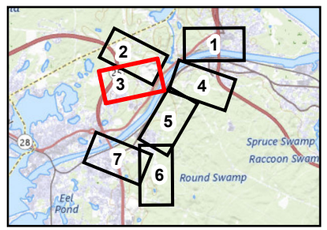


ALGONQUIN GAS TRANSMISSION LLC
CAPE COD RELOCATION PROJECT

Potential Public Water Supply Areas

SHEET 3 OF 7

- Municipal Boundary
- Road
- 400-ft PPWSA Buffer
- Potential Public Water Supply Area (PPWSA)
- Limits of Disturbance
- Permanent Access Road
- Permanent Easement
- Proposed M&R Station



Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 2011 StatePlane
Massachusetts Mnld FIPS 2001
FtUS
41.7677°N 70.5802°W

0 250 500 Feet
0 50 100 Meters

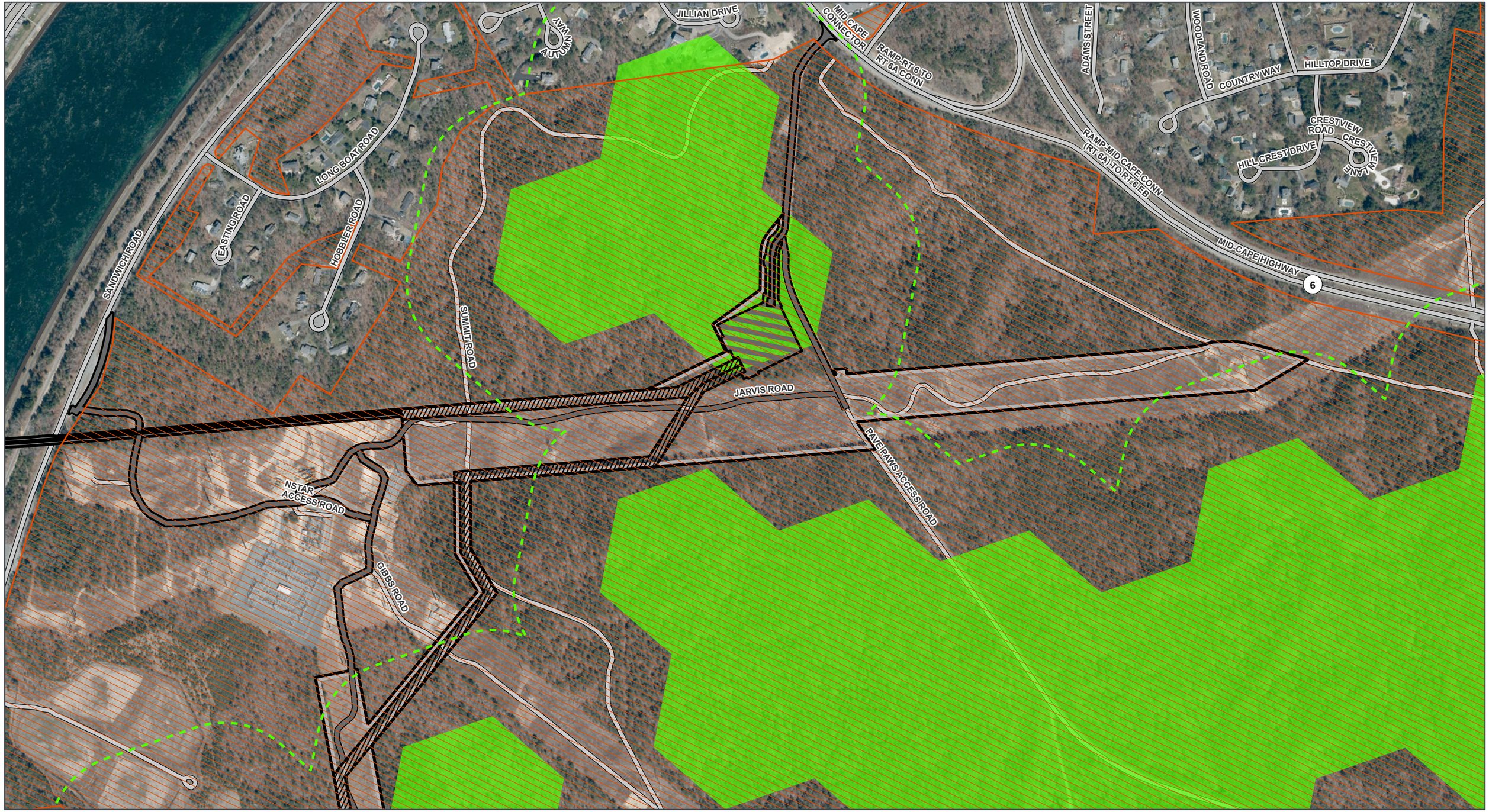
N



1:5,000

Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65956
Layout: PPWSA Sheets
Aprx: 65956_CCRP_CCC_DRI

SWCA ENVIRONMENTAL CONSULTANTS

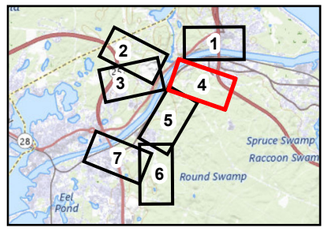


ALGONQUIN GAS TRANSMISSION LLC
CAPE COD RELOCATION PROJECT

Potential Public Water Supply Areas

SHEET 4 OF 7

- Municipal Boundary
- Road
- 400-ft PPWSA Buffer
- Potential Public Water Supply Area (PPWSA)
- Joint Base Cape Cod
- Limits of Disturbance
- Permanent Access Road
- Permanent Easement
- Proposed M&R Station



Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 2011 StatePlane
Massachusetts Mnld FIPS 2001
FtUS
41.766°N 70.5506°W

0 250 500 Feet
0 50 100 Meters

N

1:5,000

Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65956
Layout: PPWSA Sheets
Aprx: 65956_CCRP_CCC_DRI

SWCA ENVIRONMENTAL CONSULTANTS

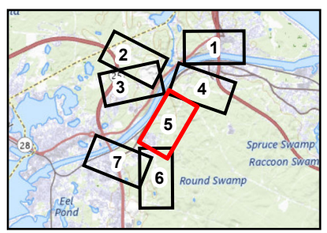
GIBBS ROAD
SUMMIT ROAD
MIZZEN LANE
WEATHERDECK DRIVE
BOSUNS LANE
HARBOR LIGHTS ROAD
ADMIRALTY COURT
SKIPPERS WATCH
CONSTITUTION LANE
MAINSTAY LANE
FORETOP ROAD
SANDWICH ROAD

ALGONQUIN GAS TRANSMISSION LLC
CAPE COD RELOCATION PROJECT

Potential Public Water Supply Areas

SHEET 5 OF 7

- Road
- 400-ft PPWSA Buffer
- Potential Public Water Supply Area (PPWSA)
- Joint Base Cape Cod
- Limits of Disturbance
- Permanent Access Road
- Permanent Easement



Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 2011 StatePlane
Massachusetts Mnld FIPS 2001
FtUS
41.7549°N 70.5649°W

0 250 500 Feet
0 50 100 Meters

1:5,000

Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65956
Layout: PPWSA Sheets
Aprx: 65956_CCRP_CCC_DRI

SWCA ENVIRONMENTAL CONSULTANTS

CAT ROAD

KENDRICK ROAD

LZDB ACCESS ROAD

MIZZEN LANE

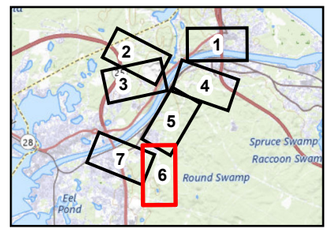
BOSUNS LANE

ALGONQUIN GAS TRANSMISSION LLC
CAPE COD RELOCATION PROJECT

Potential Public Water Supply Areas

SHEET 6 OF 7

- Road
- 400-ft PPWSA Buffer
- Potential Public Water Supply Area (PPWSA)
- Joint Base Cape Cod
- Limits of Disturbance
- Permanent Access Road
- Permanent Easement



Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 2011 StatePlane
Massachusetts Mnld FIPS 2001
FtUS
41.7379°N 70.5703°W

0 250 500 Feet
0 50 100 Meters

N

1:5,000



Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65956
Layout: PPWSA Sheets
Aprx: 65956_CCRP_CCC_DRI

SWCA ENVIRONMENTAL CONSULTANTS

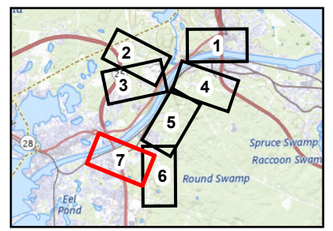
6
28
CANAL ROAD
RIVER ROAD
BOURNE BRIDGE
SANDWICH ROAD CONNECTOR
SANDWICH ROAD
OLD BRIDGE ROAD
HONORA LANE
EMERSON AVENUE
WINSLOW STREET
FREEMAN STREET
FARNUM ROAD
MARITIME WAY
VETRANS WAY
BOURNE ROTARY
COASTAL WAY
TROWBRIDGE ROAD
KEENE STREET
DEBOER LANE
SANDY LANE
MACARTHUR BOULEVARD
SHIPS PASSAGE
COTUIT ROAD
PERRY AVENUE
SCHOOL ROAD

ALGONQUIN GAS TRANSMISSION LLC
CAPE COD RELOCATION PROJECT

Potential Public Water Supply Areas

SHEET 7 OF 7

- Municipal Boundary
- Road
- 400-ft PPWSA Buffer
- Potential Public Water Supply Area (PPWSA)
- Limits of Disturbance
- Permanent Access Road
- Permanent Easement
- Proposed M&R Station



Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 2011 StatePlane
Massachusetts Mnld FIPS 2001
FtUS
41.7433°N 70.5864°W

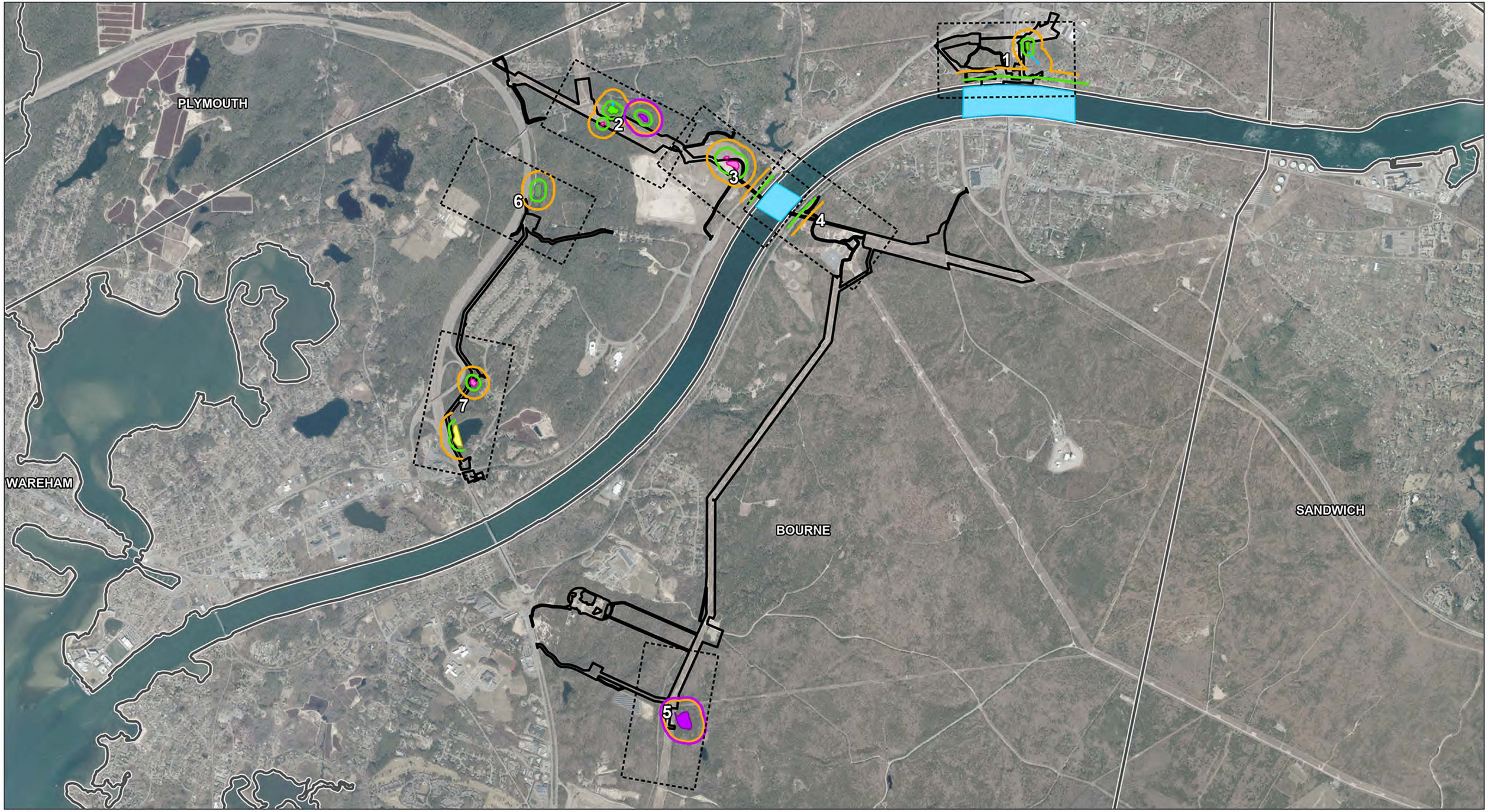
0 250 500 Feet
0 50 100 Meters

N

1:5,000

Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65956
Layout: PPWSA Sheets
Aprx: 65956_CCRP_CCC_DRI

SWCA ENVIRONMENTAL CONSULTANTS



ALGONQUIN GAS TRANSMISSION LLC
CAP ECOD RELOCATION PROJECT

Figure 5.3-4

Aquatic Resources

Overview

- 100-foot Buffer Zone
- 300-foot Buffer Zone
- 350-foot Vernal Pool Buffer
- MassDEP Hydrological Connection
- Municipal Boundary
- Limits of Disturbance
- Delineated Bordering Vegetated Wetland
- Delineated Intermittent Stream
- Delineated Isolated Land Subject to Flooding
- Delineated Isolated Land Subject to Flooding / Vernal Pool
- Delineated Isolated Vegetated Wetland
- Delineated Pond
- Land Under Ocean
- MassDEP Wetland
- Sheet Index

Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 2011 StatePlane
Massachusetts Mnld FIPS 2001
FtUS
41.7561°N 70.567°W

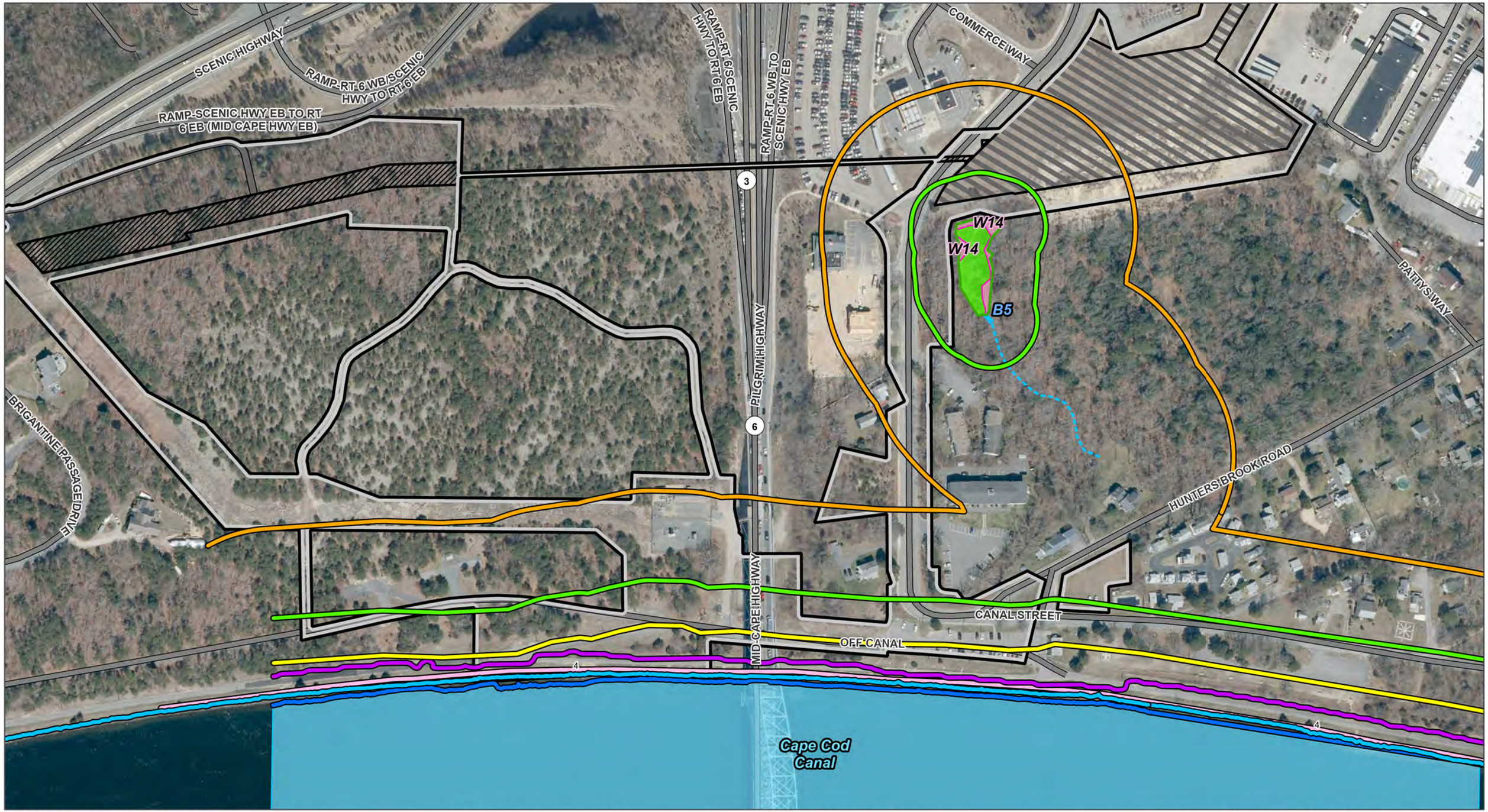
0 1,000 2,000 Feet
0 250 500 Meters

N

1:26,000

Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65956
Layout: Aquatic Resources Index
Aprx: 65956_CCRP_CCC_DRI

SWCA ENVIRONMENTAL CONSULTANTS



ALGONQUIN GAS TRANSMISSION LLC
CAPE COD RELOCATION PROJECT

Aquatic Resources

SHEET 1 OF 7

- 100-foot Buffer Zone
- 300-foot Buffer Zone
- 350-foot Vernal Pool Buffer
- Coastal Bank
- Delineated Inland Bank
- Delineated Wetland Line
- Land Subject to Coastal Storm Flowage
- Land Subject to Tidal Action
- MassDEP Hydrological Connection
- Mean High Water
- Mean Low Water
- Municipal Boundary
- Delineated Bordering Vegetated Wetland
- Delineated Intermittent Stream
- Delineated Isolated Vegetated Wetland
- Land Under Ocean
- Limits of Disturbance
- Permanent Access Road
- Permanent Easement
- Proposed M&R Station



Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 2011 StatePlane
Massachusetts Mnld FIPS 2001
FtUS
41.7788°N 70.5435°W

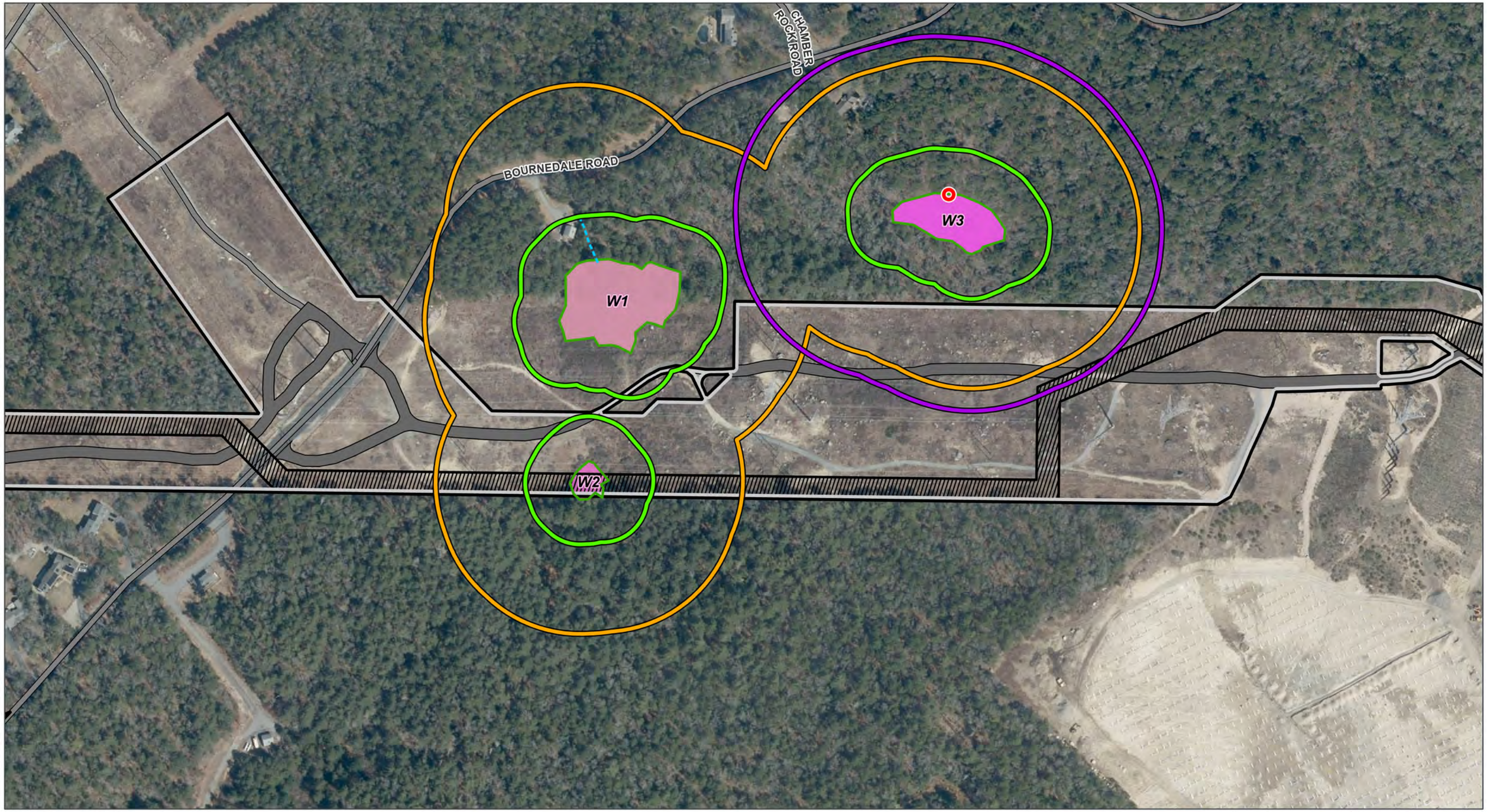
Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65956
Layout: Aquatic Resources Sheets
Aprx: 65956_CCRP_CCC_DRI

0 50 100 Feet
0 25 50 Meters

N

1:2,400

SWCA ENVIRONMENTAL CONSULTANTS

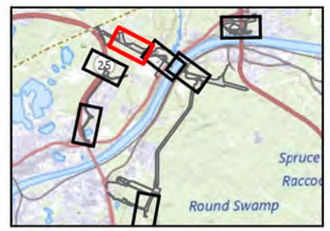


ALGONQUIN GAS TRANSMISSION LLC
CAPE COD RELOCATION PROJECT

Aquatic Resources

SHEET 2 OF 7

- Certified Vernal Pool
- 100-foot Buffer Zone
- 300-foot Buffer Zone
- 350-foot Vernal Pool Buffer
- Delineated Wetland Line
- MassDEP Hydrological Connection
- Delineated Bordering Vegetated Wetland
- Delineated Isolated Land Subject to Flooding/Vernal Pool
- Delineated Isolated Vegetated Wetland
- Limits of Disturbance
- Permanent Access Road
- Permanent Easement



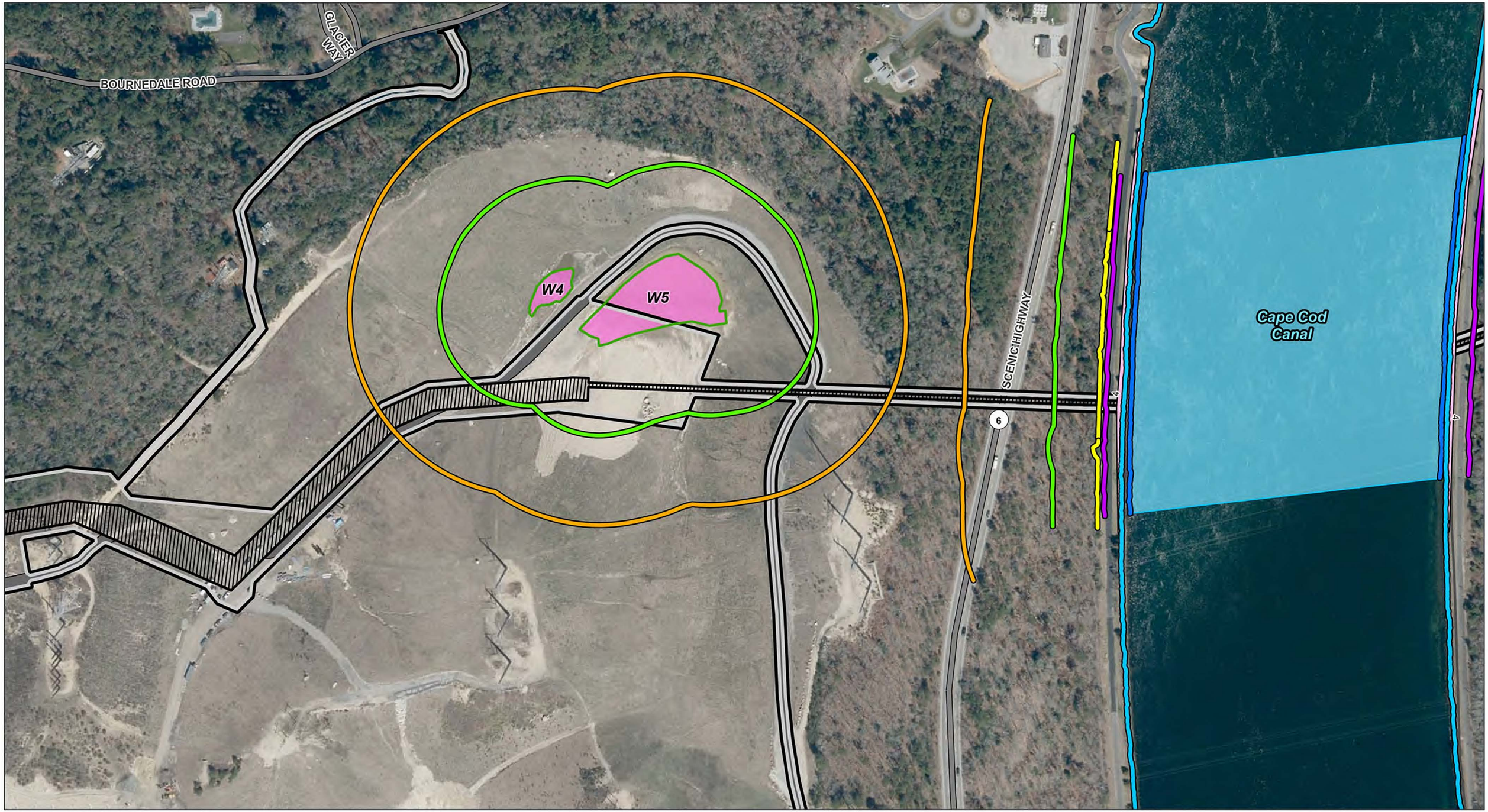
Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 2011 StatePlane
Massachusetts Mnld FIPS 2001
FtUS
41.7748°N 70.5779°W

0 50 100 Feet
0 25 50 Meters

1:2,400

Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65956
Layout: Aquatic Resources Sheets
Aprx: 65956_CCRP_CCC_DRI

SWCA ENVIRONMENTAL CONSULTANTS



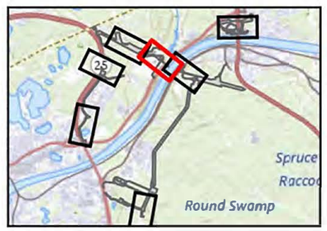
ALGONQUIN GAS TRANSMISSION LLC
CAPE COD RELOCATION PROJECT

Aquatic Resources

SHEET 3 OF 7

- 100-foot Buffer Zone
- 300-foot Buffer Zone
- 350-foot Vernal Pool Buffer
- Coastal Bank
- Delineated Wetland Line
- Land Subject to Coastal Storm Flowage
- Land Subject to Tidal Action
- Mean High Water
- Mean Low Water
- Municipal Boundary
- Delineated IVW / ILSF
- Land Under Ocean
- Limits of Disturbance
- Permanent Access Road
- Permanent Easement

IVW = Isolated Vegetated Wetland, ILSF = Isolated Land Subject to Flooding. W4 is an IVW, W5 is both an IVW and ILSF



Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 2011 StatePlane
Massachusetts Mnid FIPS 2001
FtUS
41.7712°N 70.5677°W

0 50 100 Feet
0 25 50 Meters

1:2,400

Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65956
Layout: Aquatic Resources Sheets
Aprx: 65956_CCRP_CCC_DRI

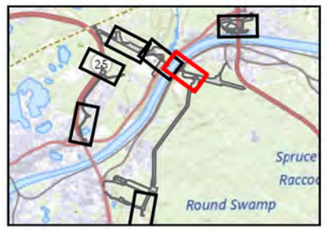
SWCA ENVIRONMENTAL CONSULTANTS

ALGONQUIN GAS TRANSMISSION LLC
CAPE COD RELOCATION PROJECT

Aquatic Resources

SHEET 4 OF 7

- 100-foot Buffer Zone
- 300-foot Buffer Zone
- 350-foot Vernal Pool Buffer
- Coastal Bank
- Land Subject to Coastal Storm Flowage
- Land Subject to Tidal Action
- Mean High Water
- Mean Low Water
- Municipal Boundary
- Land Under Ocean
- Limits of Disturbance
- Permanent Access Road
- Permanent Easement



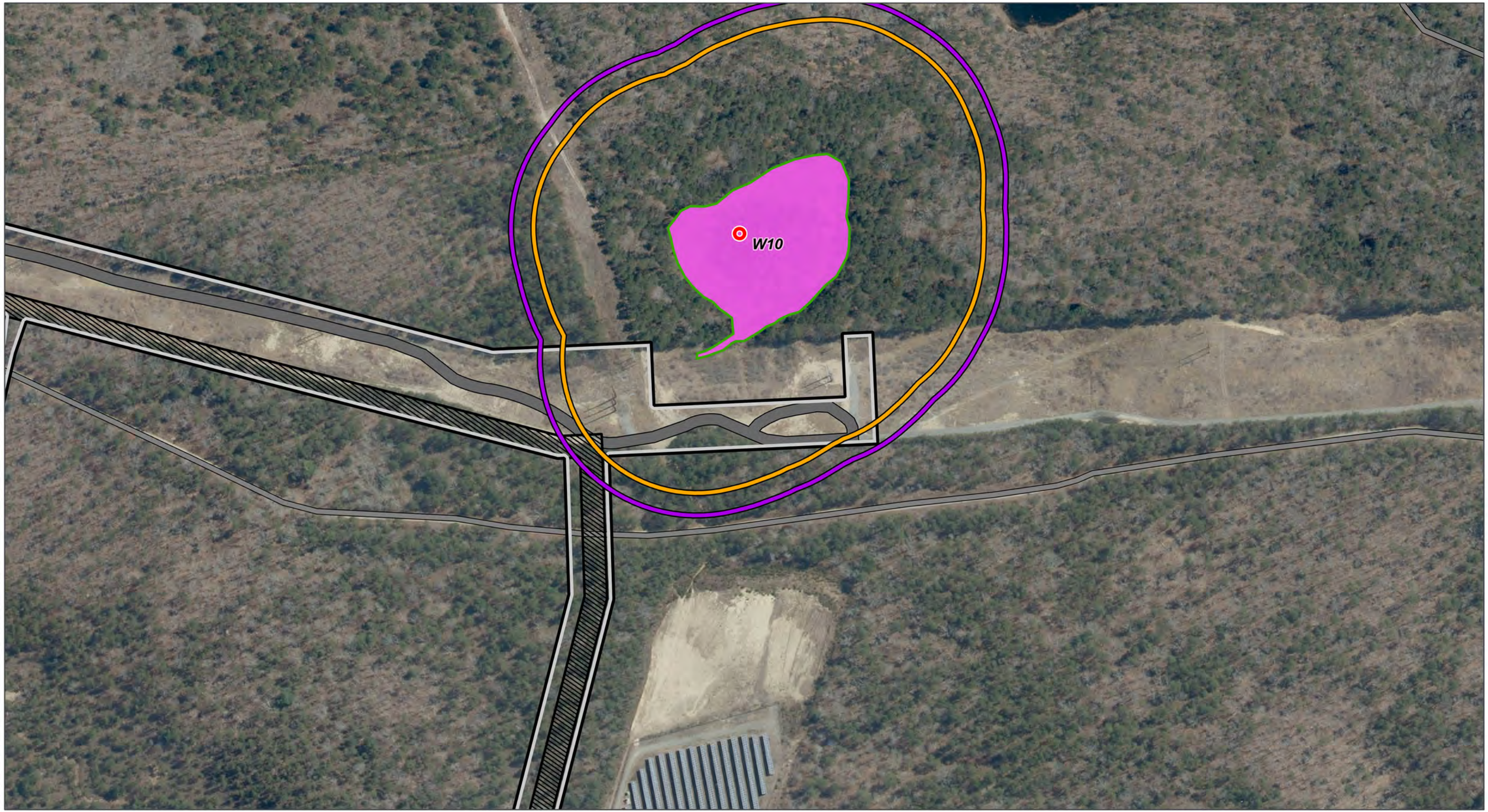
Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 2011 StatePlane
Massachusetts Mnld FIPS 2001
FtUS
41.7683°N 70.5601°W

0 50 100 Feet
0 25 50 Meters

1:2,400

Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65956
Layout: Aquatic Resources Sheets
Aprx: 65956_CCRP_CCC_DRI

SWCA ENVIRONMENTAL CONSULTANTS

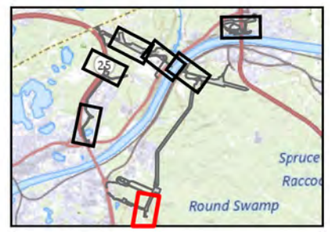


ALGONQUIN GAS TRANSMISSION LLC
CAPE COD RELOCATION PROJECT

Aquatic Resources

SHEET 5 OF 7

- Certified Vernal Pool
- 300-foot Buffer Zone
- 350-foot Vernal Pool Buffer
- Delineated Wetland Line
- Delineated Isolated Land Subject to Flooding/Vernal Pool
- Delineated Isolated Vegetated Wetland
- Limits of Disturbance
- Permanent Access Road
- Permanent Easement



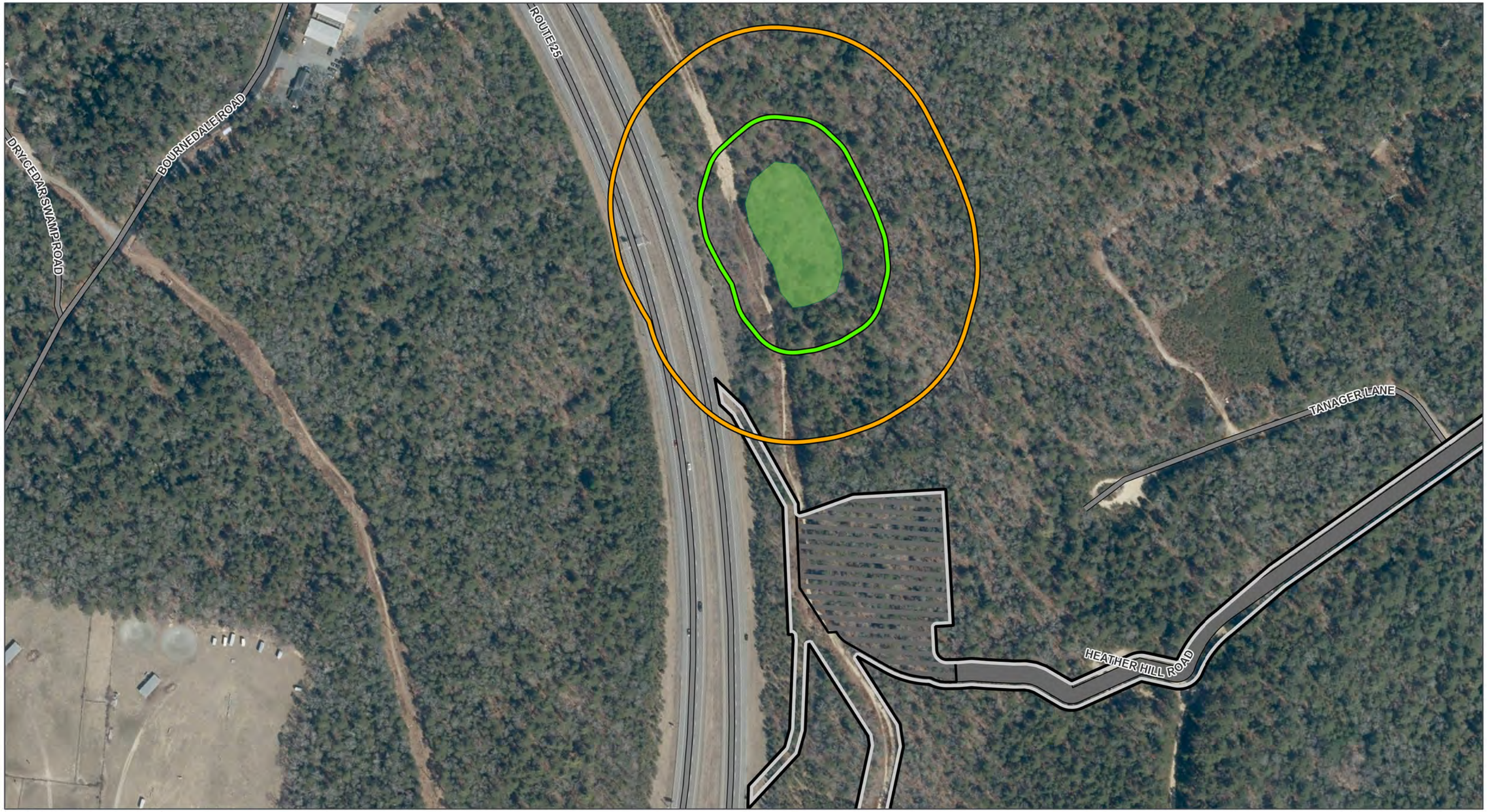
Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 2011 StatePlane
Massachusetts Mnld FIPS 2001
FtUS
41.7355°N 70.5739°W

0 50 100 Feet
0 25 50 Meters

1:2,400

Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65956
Layout: Aquatic Resources Sheets
Aprx: 65956_CCRP_CCC_DRI

SWCA ENVIRONMENTAL CONSULTANTS

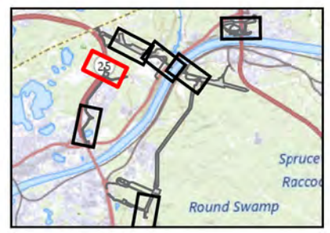


ALGONQUIN GAS TRANSMISSION LLC
CAPE COD RELOCATION PROJECT

Aquatic Resources

SHEET 6 OF 7

- 100-foot Buffer Zone
- 300-foot Buffer Zone
- 350-foot Vernal Pool Buffer
- Limits of Disturbance
- MassDEP Wetland
- Permanent Access Road
- Proposed M&R Station



Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 2011 StatePlane
Massachusetts Mnld FIPS 2001
FtUS
41.7697°N 70.5861°W

0 50 100 Feet
0 25 50 Meters

1:2,400

Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65956
Layout: Aquatic Resources Sheets
Aprx: 65956_CCRP_CCC_DRI

SWCA ENVIRONMENTAL CONSULTANTS

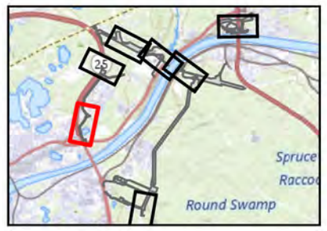


ALGONQUIN GAS TRANSMISSION LLC
CAPE COD RELOCATION PROJECT

Aquatic Resources

SHEET 7 OF 7

- 100-foot Buffer Zone
- 300-foot Buffer Zone
- 350-foot Vernal Pool Buffer
- Delineated Inland Bank
- Delineated Wetland Line
- Bordering Land Subject to Flooding
- Delineated Isolated Vegetated Wetland
- Delineated Pond
- Limits of Disturbance



Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 2011 StatePlane
Massachusetts Mnld FIPS 2001
FtUS
41.7563°N 70.5919°W

0 50 100 Feet
0 25 50 Meters

1:2,400

Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65956
Layout: Aquatic Resources Sheets
Aprx: 65956_CCRP_CCC_DRI

SWCA ENVIRONMENTAL CONSULTANTS

ALGONQUIN GAS TRANSMISSION LLC
CAPE COD CANAL PIPELINE
RELOCATION PROJECT

Figure 5.3-5
OMP Exclusionary Areas

Limits of Disturbance

OMP Exclusionary Area

Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 2011 StatePlane
Massachusetts Mnld FIPS 2001
FtUS
41.7564°N 70.5667°W

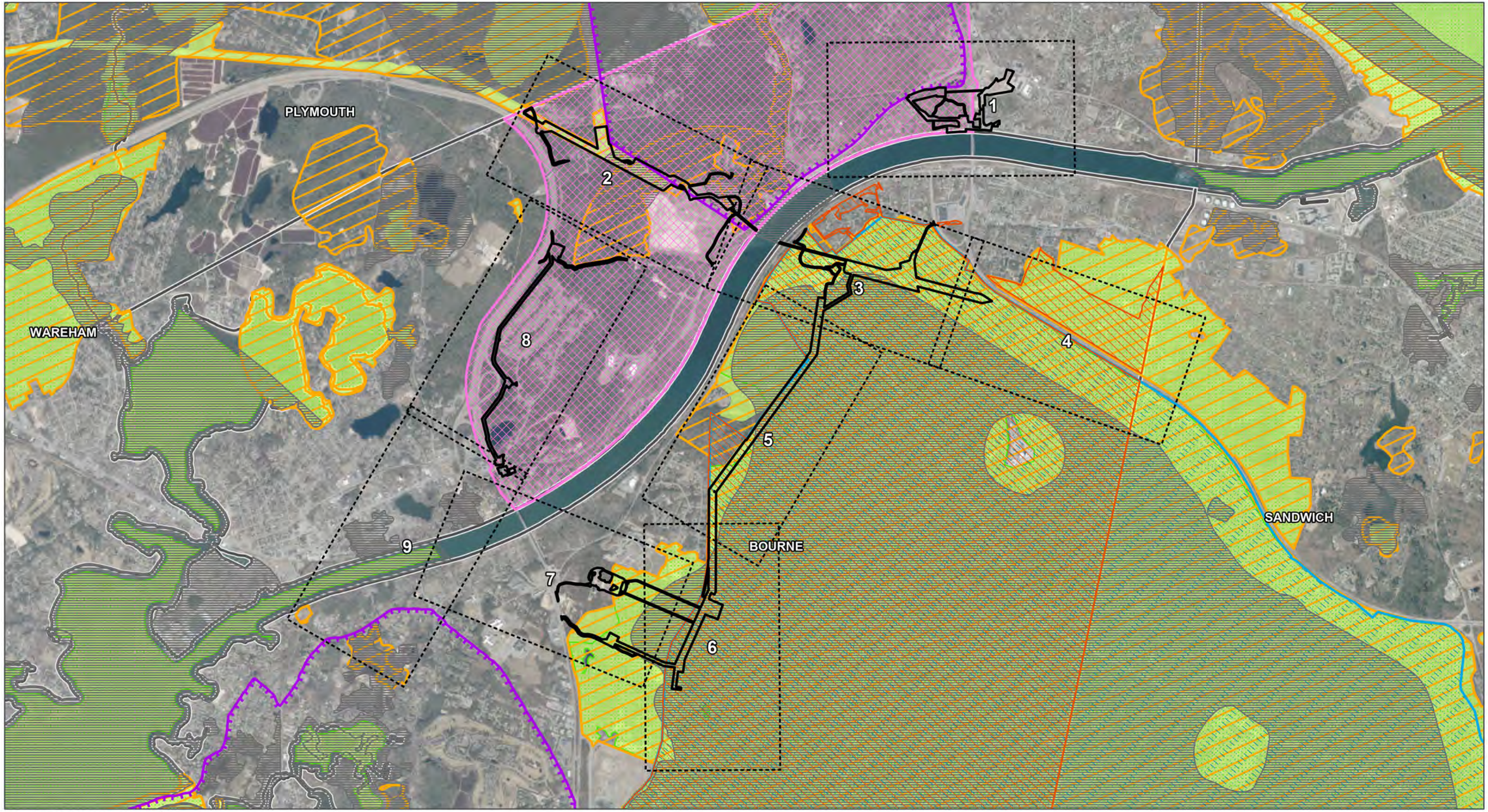
0 1,000 2,000
Feet
Meters
0 250 500

N

1:100,000

Base Map: Esri ArcGIS Online, accessed April 2026
Updated: 65956
Layout: Exclusionary Areas
Aprx: 65956_CCRP_CCC_DRI

SWCA
ENVIRONMENTAL CONSULTANTS



ALGONQUIN GAS TRANSMISSION LLC
CAPE COD CANAL PIPELINE
RELOCATION PROJECT

Significant Habitat Areas

Overview

Figure 5.3-6

- Municipal Boundary
- Areas of Critical Environmental Concern
- BioMap Core Habitat
- BioMap Critical Natural Landscapes
- Bournedale District of Critical Planning Concerns
- Estimated Habitats of Rare Wildlife
- Joint Base Cape Cod
- Important Bird Areas
- Limits of Disturbance
- Priority Habitats of Rare Species
- Sheet Index

Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 2011 StatePlane
Massachusetts Mnld FIPS 2001
FtUS
41.7564°N 70.5667°W

0 1,000 2,000 Feet
0 250 500 Meters

N

1:30,000

Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65956
Layout: SHA Index
Aprx: 65956_CCRP_CCC_DRI

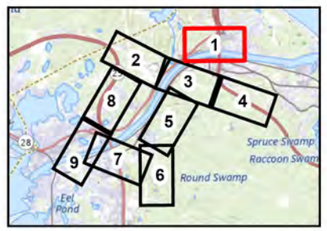
SWCA ENVIRONMENTAL CONSULTANTS

ALGONQUIN GAS TRANSMISSION LLC
CAPE COD RELOCATION PROJECT

Significant Habitat Areas

SHEET 1 OF 9

- Municipal Boundary
- Limits of Disturbance
- Permanent Access Road
- Permanent Easement
- Proposed M&R Station
- Areas of Critical Environmental Concern
- BioMap Critical Natural Landscapes
- Bournedale District of Critical Planning Concerns



Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 2011 StatePlane
Massachusetts Mnld FIPS 2001
FtUS
41.7789°N 70.5453°W

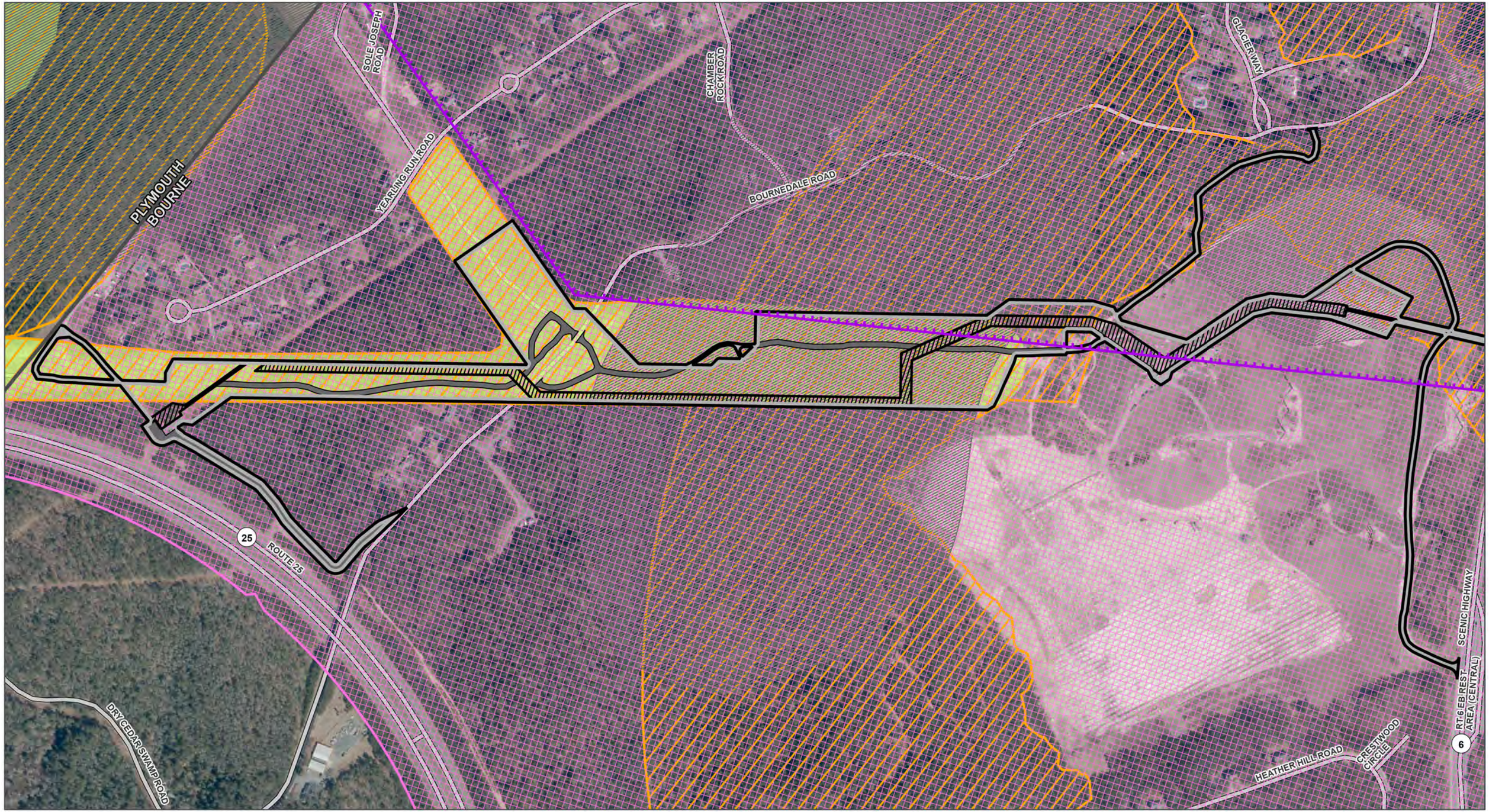
Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65956
Layout: SHA Sheets
Aprx: 65956_CCRP_CCC_DRI

0 250 500 Feet
0 50 100 Meters

N

1:5,000

SWCA ENVIRONMENTAL CONSULTANTS

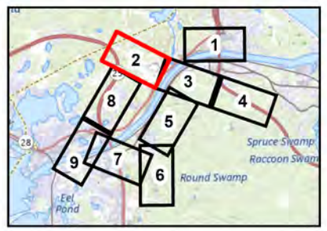


ALGONQUIN GAS TRANSMISSION LLC
CAPE COD RELOCATION PROJECT

Significant Habitat Areas

SHEET 2 OF 9

- Municipal Boundary
- Limits of Disturbance
- Permanent Access Road
- Permanent Easement
- Areas of Critical Environmental Concern
- BioMap Core Habitat
- BioMap Critical Natural Landscapes
- Bournedale District of Critical Planning Concerns
- Priority Habitats of Rare Species



Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 2011 StatePlane
Massachusetts Mnld FIPS 2001
FtUS
41.7744°N 70.5785°W

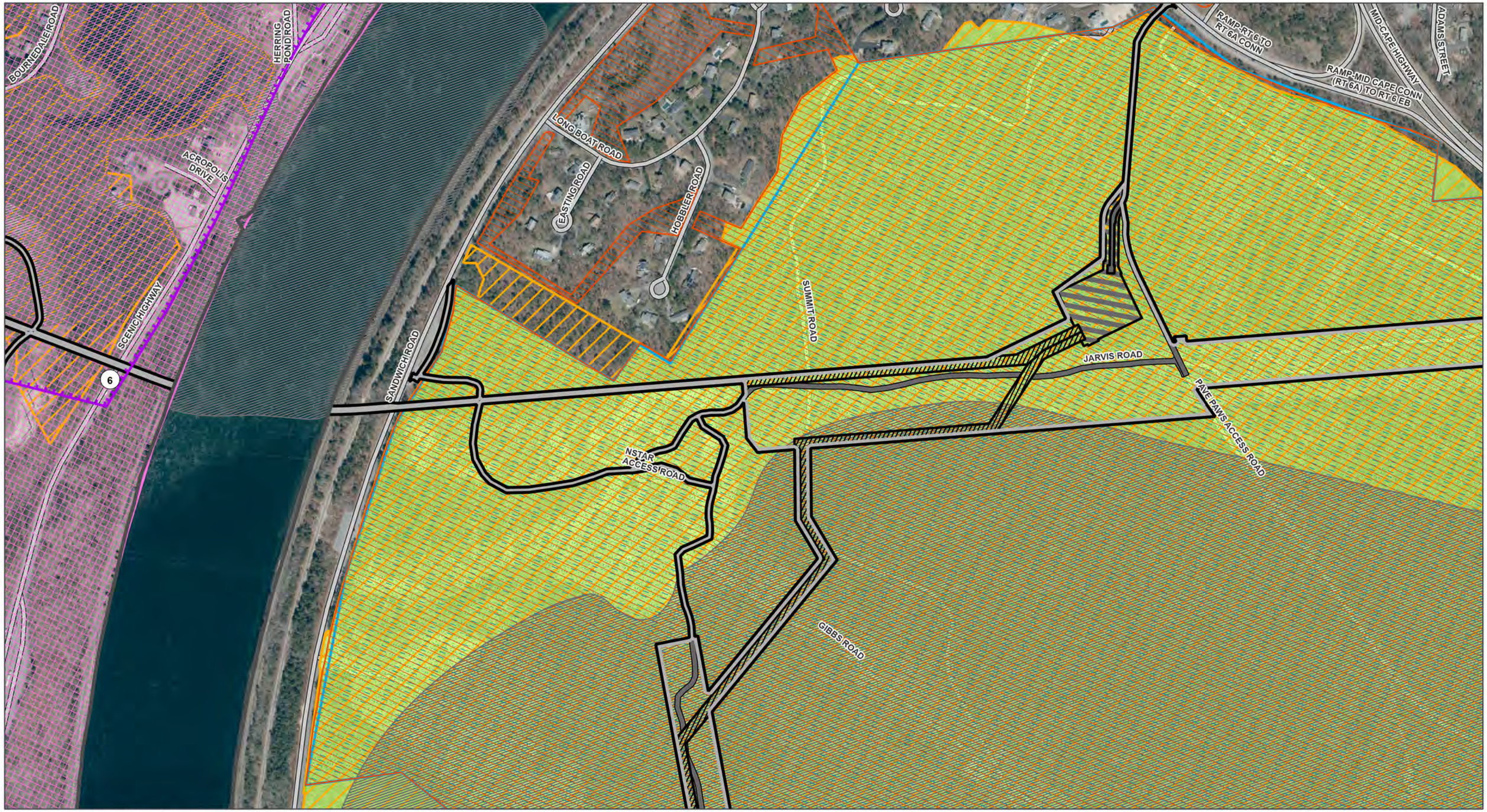
0 250 500 Feet
0 50 100 Meters

N

1:5,000

Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65956
Layout: SHA Sheets
Aprx: 65956_CCRP_CCC_DRI

SWCA ENVIRONMENTAL CONSULTANTS

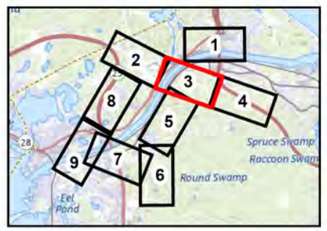


ALGONQUIN GAS TRANSMISSION LLC
CAPE COD RELOCATION PROJECT

Significant Habitat Areas

SHEET 3 OF 9

- Municipal Boundary
- Limits of Disturbance
- Permanent Access Road
- Permanent Easement
- Proposed M&R Station
- Areas of Critical Environmental Concern
- BioMap Core Habitat
- BioMap Critical Natural Landscapes
- Bournedale District of Critical Planning Concerns
- Estimated Habitats of Rare Wildlife
- Important Bird Areas
- Joint Base Cape Cod
- Priority Habitats of Rare Species



Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 2011 StatePlane
Massachusetts Mnld FIPS 2001
FtUS
41.7671°N 70.5562°W

0 250 500 Feet
0 50 100 Meters

1:5,000

Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65956
Layout: SHA Sheets
Aprx: 65956_CCRP_CCC_DRI

SWCA ENVIRONMENTAL CONSULTANTS

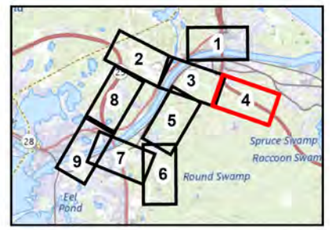
ADAMS STREET
WOODLAND ROAD
COUNTRY WAY
HILLTOP DRIVE
CRESTVIEW ROAD
CRESTVIEW LANE
HILL CREST DRIVE
RAMP MID CAPE CONN (Rt-6A) TO RT 6 EB
6
MID-CAPE HIGHWAY
JARVIS ROAD
SANDWICH
BOURNE
SAGAMORE ROAD
FLAT ROCK ROAD
PAVE PAWS ACCESS ROAD

ALGONQUIN GAS TRANSMISSION LLC
CAPE COD RELOCATION PROJECT

Significant Habitat Areas

SHEET 4 OF 9

- Municipal Boundary
- Limits of Disturbance
- BioMap Core Habitat
- BioMap Critical Natural Landscapes
- Estimated Habitats of Rare Wildlife
- Important Bird Areas
- Joint Base Cape Cod
- Priority Habitats of Rare Species



Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 2011 StatePlane
Massachusetts Mnld FIPS 2001
FtUS
41.7611°N 70.5337°W

0 250 500 Feet
0 50 100 Meters

1:5,000

Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65956
Layout: SHA Sheets
Aprx: 65956_CCRP_CCC_DRI

SWCA ENVIRONMENTAL CONSULTANTS

GIBBS ROAD

SUMMIT ROAD

MIZZEN LANE

WEATHERDECK DRIVE

BOSUNS LANE

HARBOR LIGHTS ROAD

ADMIRALTY COURT

SKIPPERS WATCH

CONSTITUTION LANE

MAINSTAY LANE

FORETOP ROAD

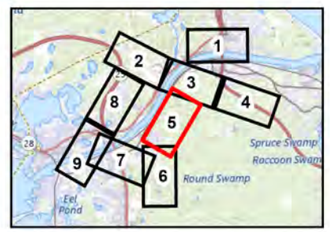
SANDWICH ROAD

ALGONQUIN GAS TRANSMISSION LLC
CAPE COD RELOCATION PROJECT

Significant Habitat Areas

SHEET 5 OF 9

- Limits of Disturbance
- Permanent Access Road
- Permanent Easement
- BioMap Core Habitat
- BioMap Critical Natural Landscapes
- Estimated Habitats of Rare Wildlife
- Important Bird Areas
- Joint Base Cape Cod
- Priority Habitats of Rare Species



Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 2011 StatePlane
Massachusetts Mnld FIPS 2001
FtUS
41.7549°N 70.5649°W

0 250 500 Feet
0 50 100 Meters

1:5,000

Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65956
Layout: SHA Sheets
Aprx: 65956_CCRP_CCC_DRI

SWCA ENVIRONMENTAL CONSULTANTS

CAT ROAD

KENDRICK ROAD

LZDB ACCESS ROAD

MIZZEN LANE

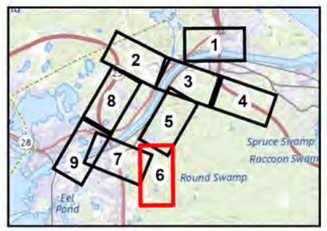
BOSUNS LANE

ALGONQUIN GAS TRANSMISSION LLC
CAPE COD RELOCATION PROJECT

Significant Habitat Areas

SHEET 6 OF 9

- Limits of Disturbance
- Permanent Access Road
- Permanent Easement
- BioMap Core Habitat
- BioMap Critical Natural Landscapes
- Estimated Habitats of Rare Wildlife
- Important Bird Areas
- Joint Base Cape Cod
- Priority Habitats of Rare Species



Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 2011 StatePlane
Massachusetts Mnld FIPS 2001
FtUS
41.7379°N 70.5703°W

0 250 500 Feet
0 50 100 Meters

N

1:5,000



Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65956
Layout: SHA Sheets
Aprx: 65956_CCRP_CCC_DRI

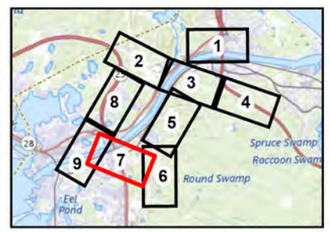
SWCA ENVIRONMENTAL CONSULTANTS

ALGONQUIN GAS TRANSMISSION LLC
CAPE COD RELOCATION PROJECT

Significant Habitat Areas

SHEET 7 OF 9

- Municipal Boundary
- Limits of Disturbance
- Permanent Access Road
- Permanent Easement
- Proposed M&R Station
- BioMap Core Habitat
- BioMap Critical Natural Landscapes
- Bournedale District of Critical Planning Concerns
- Estimated Habitats of Rare Wildlife
- Priority Habitats of Rare Species



Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 2011 StatePlane
Massachusetts Mnld FIPS 2001
FtUS
41.7433°N 70.5864°W

Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65956
Layout: SHA Sheets
Aprx: 65956_CCRP_CCC_DRI

0 250 500 Feet
0 50 100 Meters

1:5,000

SWCA ENVIRONMENTAL CONSULTANTS

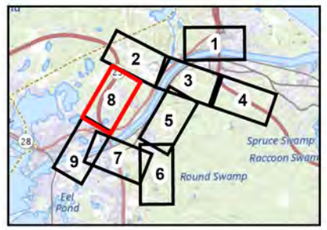


ALGONQUIN GAS TRANSMISSION LLC
CAPE COD RELOCATION PROJECT

Significant Habitat Areas

SHEET 8 OF 9

- Limits of Disturbance
- Permanent Access Road
- Proposed M&R Station
- BioMap Core Habitat
- Bournedale District of Critical Planning Concerns
- Priority Habitats of Rare Species



Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 2011 StatePlane
Massachusetts Mnld FIPS 2001
FtUS
41.7616°N 70.5889°W

0 250 500 Feet
0 50 100 Meters

1:5,000



Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65956
Layout: SHA Sheets
Aprx: 65956_CCRP_CCC_DRI

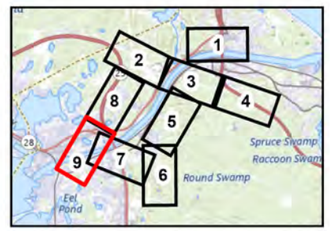
SWCA ENVIRONMENTAL CONSULTANTS

ALGONQUIN GAS TRANSMISSION LLC
CAPE COD RELOCATION PROJECT

Significant Habitat Areas

SHEET 9 OF 9

- Municipal Boundary
- Limits of Disturbance
- Areas of Critical Environmental Concern
- BioMap Core Habitat
- BioMap Critical Natural Landscapes
- Bournedale District of Critical Planning Concerns
- Estimated Habitats of Rare Wildlife
- Priority Habitats of Rare Species



Bourne, MA
USGS 7.5' Quadrangles:
Sagamore and Pocasset
NAD 1983 2011 StatePlane
Massachusetts Mnld FIPS 2001
FtUS
41.7459°N 70.6013°W

0 250 500 Feet
0 50 100 Meters

1:5,000

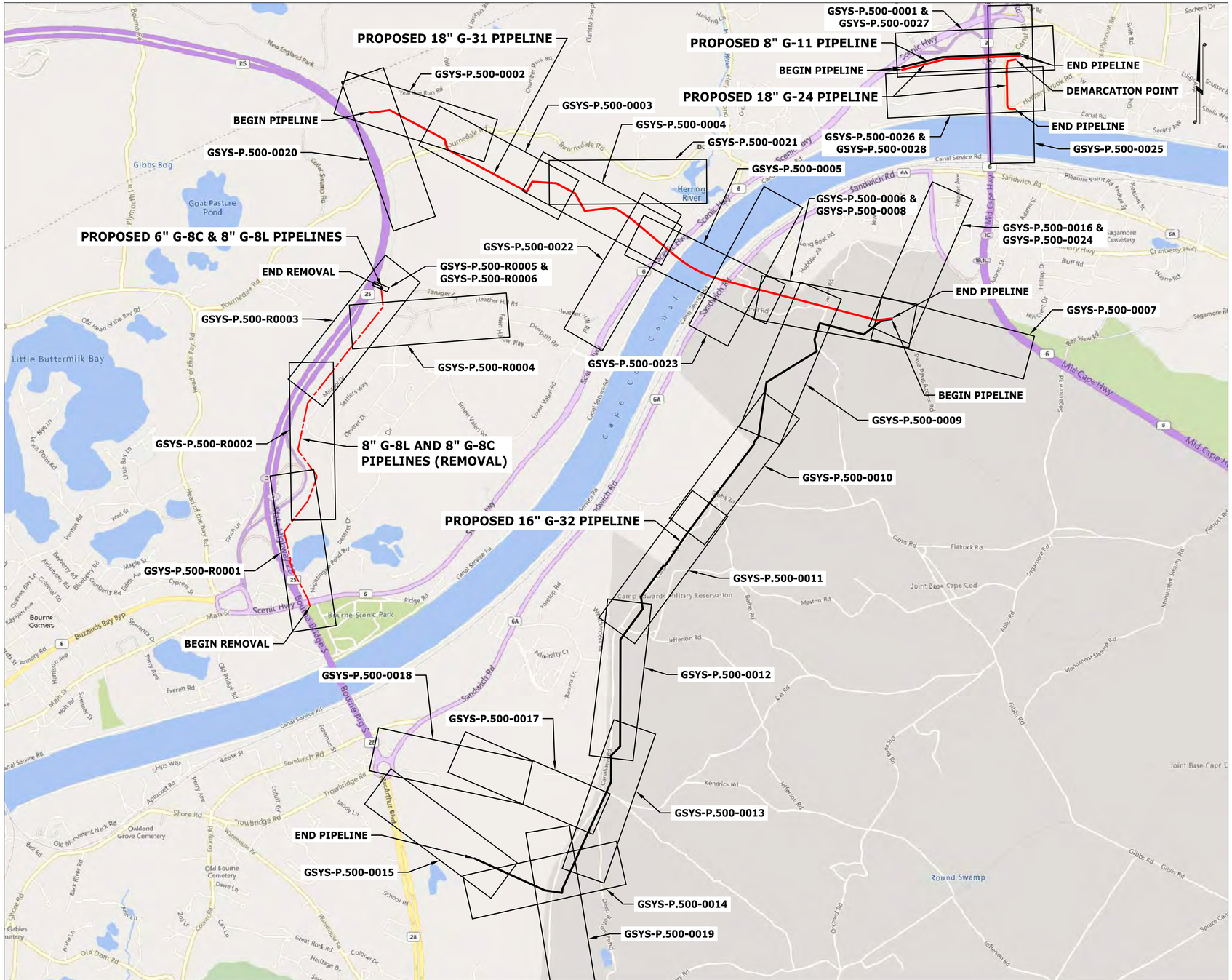
Base Map: Esri ArcGIS Online, accessed July 2026
Updated: 65956
Layout: SHA Sheets
Aprx: 65956_CCRP_CCC_DRI

SWCA ENVIRONMENTAL CONSULTANTS

ATTACHMENT 2

Alignment Sheets, Typical Construction Examples, and HDD Profile

ENBRIDGE
CAPE COD CANAL PIPELINE RELOCATION PROJECT
PROPOSED 8" G-11, 18" G-24, 18" G-31, 16" G-32 PIPELINES, AND REMOVAL OF 8" G-8C & 8" G-8L PIPELINES



COVER SHEET / INDEX SHEET DRAWING		
DRAWING NUMBER	**DRAWING TITLE**	**REVISION**
GSYS-P.500-0029	COVER & INDEX SHEET	G
ALIGNMENT SHEET DRAWINGS - PROPOSED 18" G-24 PIPELINE		
DRAWING NUMBER	**DRAWING TITLE**	**REVISION**
GSYS-P.500-0001	ALIGNMENT SHEET - PROPOSED 18" G-24 PIPELINE	F
GSYS-P.500-0025	ALIGNMENT SHEET - PROPOSED 18" G-24 PIPELINE	D
GSYS-P.500-0026	ALIGNMENT SHEET - PROPOSED 18" G-24 PIPELINE	D
ALIGNMENT SHEET DRAWINGS - PROPOSED 18" G-31 PIPELINE		
DRAWING NUMBER	**DRAWING TITLE**	**REVISION**
GSYS-P.500-0002	ALIGNMENT SHEET - PROPOSED 18" G-31 PIPELINE	F
GSYS-P.500-0003	ALIGNMENT SHEET - PROPOSED 18" G-31 PIPELINE	F
GSYS-P.500-0004	ALIGNMENT SHEET - PROPOSED 18" G-31 PIPELINE	F
GSYS-P.500-0005	ALIGNMENT SHEET - PROPOSED 18" G-31 PIPELINE	F
GSYS-P.500-0006	ALIGNMENT SHEET - PROPOSED 18" G-31 PIPELINE	F
GSYS-P.500-0007	ALIGNMENT SHEET - PROPOSED 18" G-31 PIPELINE	F
GSYS-P.500-0020	ALIGNMENT SHEET - PROPOSED 18" G-31 PIPELINE	D
GSYS-P.500-0021	ALIGNMENT SHEET - PROPOSED 18" G-31 PIPELINE	D
GSYS-P.500-0022	ALIGNMENT SHEET - PROPOSED 18" G-31 PIPELINE	D
GSYS-P.500-0023	ALIGNMENT SHEET - PROPOSED 18" G-31 PIPELINE	D
GSYS-P.500-0024	ALIGNMENT SHEET - PROPOSED 18" G-31 PIPELINE	D
ALIGNMENT SHEET DRAWINGS - PROPOSED 16" G-32 PIPELINE		
DRAWING NUMBER	**DRAWING TITLE**	**REVISION**
GSYS-P.500-0008	ALIGNMENT SHEET - PROPOSED 16" G-32 PIPELINE	F
GSYS-P.500-0009	ALIGNMENT SHEET - PROPOSED 16" G-32 PIPELINE	F
GSYS-P.500-0010	ALIGNMENT SHEET - PROPOSED 16" G-32 PIPELINE	F
GSYS-P.500-0011	ALIGNMENT SHEET - PROPOSED 16" G-32 PIPELINE	E
GSYS-P.500-0012	ALIGNMENT SHEET - PROPOSED 16" G-32 PIPELINE	E
GSYS-P.500-0013	ALIGNMENT SHEET - PROPOSED 16" G-32 PIPELINE	F
GSYS-P.500-0014	ALIGNMENT SHEET - PROPOSED 16" G-32 PIPELINE	E
GSYS-P.500-0015	ALIGNMENT SHEET - PROPOSED 16" G-32 PIPELINE	F
GSYS-P.500-0016	ALIGNMENT SHEET - PROPOSED 16" G-32 PIPELINE	E
GSYS-P.500-0017	ALIGNMENT SHEET - PROPOSED 16" G-32 PIPELINE	G
GSYS-P.500-0018	ALIGNMENT SHEET - PROPOSED 16" G-32 PIPELINE	G
GSYS-P.500-0019	ALIGNMENT SHEET - PROPOSED 16" G-32 PIPELINE	E
ALIGNMENT SHEET DRAWINGS - PROPOSED 8" G-11 PIPELINE		
DRAWING NUMBER	**DRAWING TITLE**	**REVISION**
GSYS-P.500-0027	ALIGNMENT SHEET - PROPOSED 8" G-11 PIPELINE	D
GSYS-P.500-0028	ALIGNMENT SHEET - PROPOSED 8" G-11 PIPELINE	D
ALIGNMENT SHEET DRAWINGS - REMOVAL OF 8" G-8C AND 8" G-8L PIPELINES		
DRAWING NUMBER	**DRAWING TITLE**	**REVISION**
GSYS-P.500-R0001	ALIGNMENT SHEET - REMOVAL OF 8" G-8C AND 8" G-8L PIPELINES	G
GSYS-P.500-R0002	ALIGNMENT SHEET - REMOVAL OF 8" G-8C AND 8" G-8L PIPELINES	F
GSYS-P.500-R0003	ALIGNMENT SHEET - REMOVAL OF 8" G-8C AND 8" G-8L PIPELINES	D
GSYS-P.500-R0004	ALIGNMENT SHEET - REMOVAL OF 8" G-8C AND 8" G-8L PIPELINES	D
GSYS-P.500-R0005	ALIGNMENT SHEET - PROPOSED 6" G-8C PIPELINE	C
GSYS-P.500-R0006	ALIGNMENT SHEET - PROPOSED 8" G-8L PIPELINE	C
CONSTRUCTION TYPICAL DRAWINGS		
DRAWING NUMBER	**DRAWING TITLE**	**REVISION**
GSYS-M.223-0001	CONSTRUCTION TYPICAL	D
GSYS-M.223-0002	CONSTRUCTION TYPICAL	D
GSYS-M.223-0003	CONSTRUCTION TYPICAL	C
GSYS-M.223-0004	CONSTRUCTION TYPICAL	C
GSYS-M.223-0005	CONSTRUCTION TYPICAL	C
GSYS-M.223-0006	CONSTRUCTION TYPICAL	C
GSYS-M.223-0007	CONSTRUCTION TYPICAL	C
GSYS-M.223-0008	CONSTRUCTION TYPICAL	C
GSYS-M.223-0009	CONSTRUCTION TYPICAL	C

COMMONWEALTH OF MASSACHUSETTS
CLAY H. WILLIS
STRUCTURAL
NO. 49138
PROFESSIONAL ENGINEER
06/23/26

REV	DATE	DSN	CK	DESCRIPTION
G	03/25/26	TL	JL	RE-ISSUED FOR BID
F	03/20/26	TL	JL	RE-ISSUED FOR BID
E	01/29/26	TL	JL	RE-ISSUED FOR BID
D	08/21/25	TL	JL	ISSUED FOR BID
C	07/07/25	TL	JL	ISSUED FOR REVIEW (90% DESIGN)
B	05/06/25	LBJ	JL	RE-ISSUED FOR REVIEW (60% DESIGN)

wood.
WOOD GROUP USA, INC.

DRAWN BY:	TL	04/04/25
DESIGN CHECKER:	JL	04/04/25
DESIGN ENGINEER:	PA	04/08/25
PROJECT MANAGER:	EL	04/08/25
TITLE	INITIALS	DATE

ENBRIDGE - CAPE COD CANAL PIPELINE RELOCATION PROJECT
PROPOSED 8" G-11, 18" G-24, 18" G-31, 16" G-32 PIPELINES
AND REMOVAL OF 8" G-8C & 8" G-8L PIPELINES
TITLE: COVER & INDEX SHEET

LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

YEAR: 2026 | W.O.: AFE 30002835 | SCALE: N/A | DWG.: GSYS-P.500-0029 | REV.: G

ENBRIDGE
Algonquin Gas Transmission
915 N. Eldridge Parkway, Houston, TX 77079-2703 (713) 627-5400

M:\259271\MAPPING\DRAWINGS\91-ALIGNMENT\RE-ISSUED FOR BID 2\GSYS-P.500-0029

RIGHT-OF-WAY

TRACT NUMBERS

0+00									22+85
G-11-MA-BA-010	G-11-MA-BA-010A	G-11-MA-BA-011	G-11-MA-BA-012	G-11-MA-BA-013.RD HWY 6 (SAGAMORE BRIDGE S)	G-11-MA-BA-014	G-24-MA-BA-001.5.RD CANAL ST	G-11-MA-BA-015.MS		
26 FT.	352 FT.	857 FT.	240FT.	522 FT.	80 FT.	74 FT.	134 FT.		
0+26	3+78	12+35	14+75		19+97	20+77	21+51		

SURVEY DATA

SURVEY COMPANY:
FIELD BOOK:
PAGES:

0+00 BEGIN PIPELINE									22+85
0+42 TREE LINE 0+46 TREE LINE 0+63 TREE LINE	8+51 P.I. <11°02'05" RT. 8+51 HDD EXIT	13+66 WATERLINE	14+76 FENCE	15+22 TELEPHONE LINE 16+16 GUARDRAIL 16+17 EDGE OF PAVEMENT	19+35 DRAINAGE LINE 19+61 DRAINAGE LINE 19+68 EDGE OF PAVEMENT 19+76 EDGE OF PAVEMENT	20+84 TELEPHONE LINE 20+98 WATERLINE	21+39 EDGE OF PAVEMENT	22+85 HDD ENTRY	

CLASS LOCATION

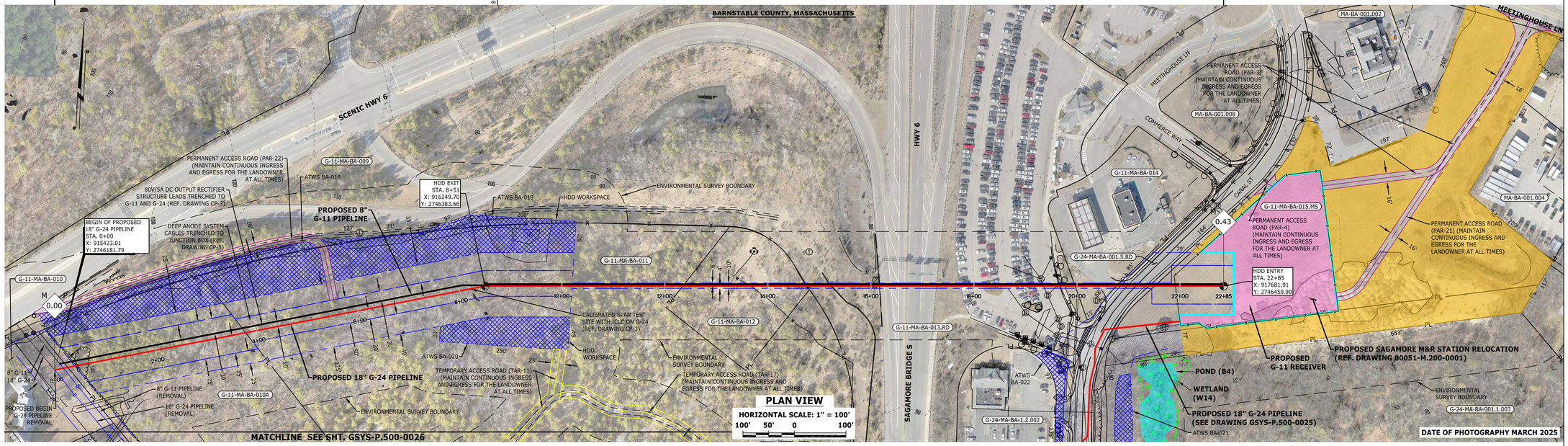
0+00	CLASS 2	15+00	CLASS 3	22+85

PIPE MATERIAL

0+00	18" O.D. X 0.375" W.T., API 5L, X-52, 16-20 MILS FBE 851 FT.	8+51	18" O.D. X 0.500" W.T., API-5L, X-52, 16-20 MILS FBE + 24 MILS ARO 1434 FT. (HDD)	22+85

ALIGNMENT LEGEND

- PIPELINE MILEPOST
- PROPOSED G-24 PIPELINE
- PROPOSED G-11 PIPELINE
- 18" G-24 & 8" G-11 PIPELINES (TO BE REMOVED)
- CONSTRUCTION LIMIT
- WAREYARD / STAGING AREA
- EXISTING PERMANENT ROW
- PROPOSED PERMANENT ROW
- ADDITIONAL TEMPORARY WORKSPACE
- PROPOSED METERING & REGULATING STATION (M&R) SITE / PIG TRAP SITE
- FACILITIES TEMPORARY WORKSPACE
- FACILITIES PERMANENT WORKSPACE
- PROPOSED GRAVEL AREA
- DELINEATED WETLAND BOUNDARY
- DELINEATED WATERBODY BANK
- DELINEATED WATERBODY CENTERLINE
- PERMANENT ACCESS ROAD
- TEMPORARY ACCESS ROAD
- PROPERTY LINE
- MAJOR CONTOUR
- MUNICIPALITY LINE
- ENVIRONMENTAL SURVEY BOUNDARY
- FENCE
- EXISTING AGT PIPELINE
- FOREIGN PIPELINE
- POWERLINE
- WATER PIPELINE
- RAILROAD TRACK
- OVERHEAD WIRE
- TELEPHONE LINE
- UTILITY LINES
- SANITARY SEWER
- TEE TAP
- BLOW OFF VALVE
- MAINLINE VALVE (MLV)
- POINT OF INTERSECTION
- BORE ENTRY/EXIT
- TRANSMISSION TOWER
- LIGHT POLE
- UTILITY POLE
- FIRE HYDRANT
- WELL (GAS)
- WELL (WATER)
- WELL (OIL)
- WELL (UNKNOWN)



ENVIRONMENTAL DATA

E & S TYPICALS

E&S TYPICALS WILL BE USED AS A PLAN AND WILL HAVE FURTHER INPUT FROM ENVIRONMENTAL INSPECTOR.

PROFILE

HORIZONTAL SCALE: 1" = 100'
100' 50' 0 100'

VERTICAL SCALE: 1" = 100'
100' 50' 0 100'

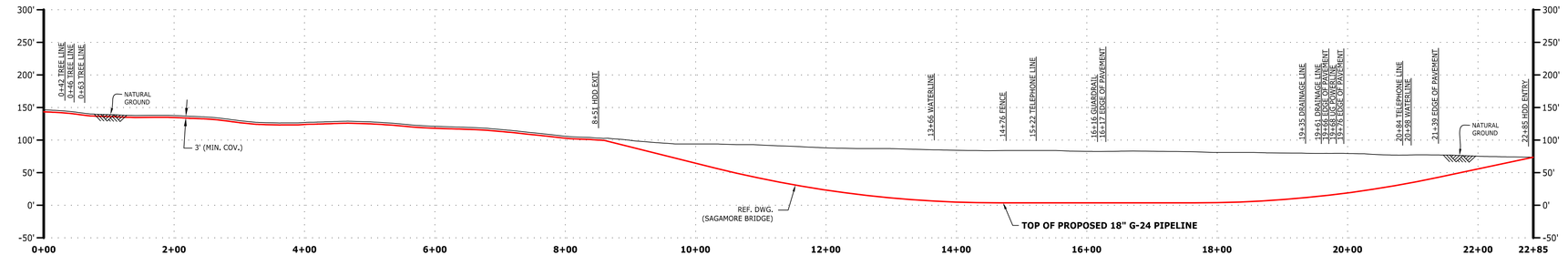
THE LOCATION OF TRENCH PLUGS AND SLOPE BREAKERS ARE INTENDED TO BE USED AS A GUIDELINE ONLY. EXACT LOCATION TO BE DETERMINED IN THE FIELD.

SLOPE BREAKERS
TRENCH PLUG

PERMANENT SLOPE BREAKER & TRENCH PLUG SPACING

% SLOPE	SLOPE BREAKER SPACING (FT)	% SLOPE	TRENCH PLUG SPACING (FT)
5-15%	300 FT	<5%	NO STRUCTURE
15-30%	200 FT	5-15%	300 FT
>30%	100 FT	15-30%	200 FT
		>30%	100 FT

IN AG FIELDS AND RESIDENTIAL AREAS WHERE SLOPE BREAKERS ARE NOT TYPICALLY REQUIRED, INSTALL PERMANENT TRENCH PLUGS AT THE SAME SPACING AS IF PERMANENT SLOPE BREAKERS WERE REQUIRED. (FERC PLAN)



LAND USE CLASSIFICATION

CC CULTIVATED CROPS	DF DECIDUOUS FOREST	D/OS DEVELOPED OPEN SPACE	
EF EVERGREEN FOREST	S/SSHRUB SCRUB	D/LI DEVELOPED LOW INTENSITY	
H/P HAY PASTURE	MF MIXED FOREST	D/MI DEVELOPED MEDIUM INTENSITY	

SEGMENTABLE ELBOW	QTY
90 DEG, 5D, 18" OD, 0.375" WT, CS, x52, FBE COATING SYSTEM 2B	1
45 DEG, 5D, 18" OD, 0.375" WT, CS, x52, FBE COATING SYSTEM 2B	2

STAMP/SEAL

COMMONWEALTH OF MASSACHUSETTS CLAY H. WILLIS STRUCTURAL NO. 49136 REGISTERED PROFESSIONAL ENGINEER
10/23/26

THIS DOCUMENT IS RELEASED FOR THE PURPOSE OF:
BID REVIEW
IT IS NOT TO BE USED FOR: CONSTRUCTION, RECORDATION, CONVEYANCE, SALES, OR AS THE BASIS FOR THE ISSUANCE OF A PERMIT

UNDER THE AUTHORITY OF:
PE NAME: CLAY WILLIS
PE STATE: MASSACHUSETTS
PE NUMBER 49136

SOILS

LAND USE

% SLOPE	5-15%	<5%	5-15%	<5%	5-15%	<5%	5-15%	<5%	5-15%	<5%	5-15%	<5%	5-15%	<5%	5-15%	<5%	5-15%	<5%

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		F	01/29/26	TL	JL	RE-ISSUED FOR BID
		E	08/21/25	TL	JL	ISSUED FOR BID
SAGAMORE BRIDGE OVERBEND	OVERBEND PLAN AND PROFILE - SAGAMORE BRIDGE HDD	D	07/07/25	TL	JL	ISSUED FOR REVIEW (90% DESIGN)
CP-3	CATHODIC PROTECTION DESIGN	C	04/08/25	TL	RAL	ISSUED FOR REVIEW (60% DESIGN)
00051-M.200-0001	SAGAMORE M&R STATION - LOCATION MAP AND PLOT PLAN	B	02/26/24	LBJ	JL	ISSUED FOR REVIEW
SAGAMORE BRIDGE	SAGAMORE BRIDGE HORIZONTAL DIRECTIONAL DRILL	A	11/16/23	LBJ	JL	ISSUED FOR REVIEW

wood. WOOD GROUP USA, INC.

TITLE	INITIALS	DATE
DRAWN BY:	LBJ	02/19/24
DESIGN CHECKER:	TS	02/20/24
DESIGN ENGINEER:	PA	02/20/24
PROJECT MANAGER:	EL	02/20/24

ENBRIDGE
CAPE COD CANAL PIPELINE RELOCATION PROJECT
PROPOSED 18" G-24 PIPELINE
TITLE: ALIGNMENT SHEET

LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

YEAR: 2026 | W.O.: AFE 30002835 | SCALE: 1" = 100' | DWG.: GSYS-P.500-0001 | REV.: F

Algonquin Gas Transmission
915 N. Eldridge Parkway, Houston, TX 77079-2703 (713) 627-5400

M:\259271\MAPPING\DRAWINGS\91-ALIGNMENT\RE-ISSUED FOR BID\259271-G_24

RIGHT-OF-WAY

TRACT NUMBERS

22+85			34+84
G-11-MA-BA-015.MS	G-24-MA-BA-001.5.RD CANAL ST	G-24-MA-BA-001.5.RD CANAL ST	
123 FT. 24+08	1000 FT.	34+08 76 FT.	

SURVEY DATA

SURVEY COMPANY:
FIELD BOOK:
PAGES:

22+85		34+84
24+15 GUARDRAIL 24+16 EDGE OF PAVEMENT 24+33 P.I. <58°04'07" LT. 24+69 DRAINAGE LINE 25+07 P.I. <37°25'07" LT. 25+04 P.I. <11°55'08" RT. 25+33 P.I. <05°55'43" LT. 25+49 P.I. <05°16'35" LT. 25+98 UTILITY LINE 26+44 P.I. <44°48'14" RT. 26+48 DRAINAGE LINE 26+58 P.I. <45°00'00" LT. 26+78 P.I. <45°00'00" LT. 26+83 P.I. <45°06'58" RT. 27+46 OH POWERLINE 27+81 DRAINAGE LINE 27+83 DRAINAGE LINE 27+92 P.I. <90°00'00" RT. 28+08 DRAINAGE LINE 28+35 UTILITY LINE 29+07 UTILITY LINE 29+15 UTILITY LINE 29+48 UTILITY LINE 30+49 DRAINAGE LINE 30+80 UTILITY LINE 32+33 OH POWERLINE 33+00 UTILITY LINE 33+14 P.I. <26°38' LT. 33+41 P.I. <26°14'24" LT. 33+51 OH POWERLINE 33+72 TELEPHONE LINE 33+79 DRAINAGE LINE 33+91 P.I. <44°45'29" LT. 34+30 TELEPHONE LINE 34+72 WATERLINE	34+84 END PIPELINE

CLASS LOCATION

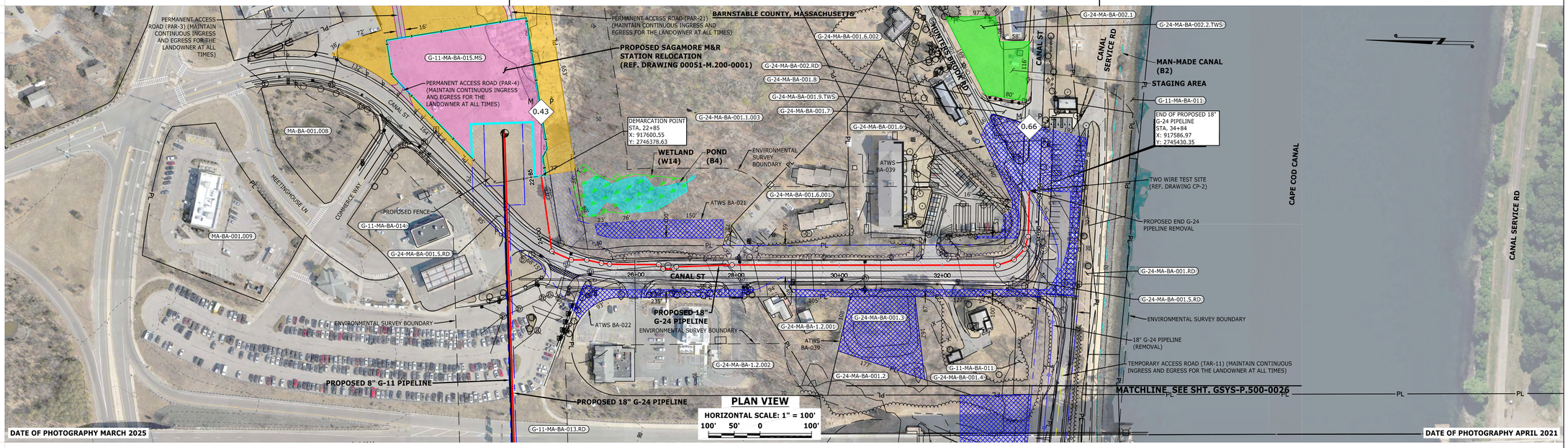
22+85		34+84
	CLASS 3	

PIPE MATERIAL

22+85		34+84
	18" O.D. X 0.375" W.T., API 5L, X-52, 16-20 MILS FBE 1199 FT.	

ALIGNMENT LEGEND

- PIPELINE MILEPOST
- PROPOSED G-24 PIPELINE
- PROPOSED G-11 PIPELINE
- 18" G-24 & 8" G-11 PIPELINES (TO BE REMOVED)
- CONSTRUCTION LIMIT
- WAREYARD / STAGING AREA
- EXISTING PERMANENT ROW
- PROPOSED PERMANENT ROW
- ADDITIONAL TEMPORARY WORKSPACE
- PROPOSED METERING & REGULATING STATION (M&R) SITE / PIG TRAP SITE
- FACILITIES TEMPORARY WORKSPACE
- FACILITIES PERMANENT WORKSPACE
- PROPOSED GRAVEL AREA
- DELINEATED WETLAND BOUNDARY
- DELINEATED WATERBODY BANK
- DELINEATED WATERBODY CENTERLINE
- PERMANENT ACCESS ROAD
- TEMPORARY ACCESS ROAD
- PROPERTY LINE
- MAJOR CONTOUR
- MUNICIPALITY LINE
- ENVIRONMENTAL SURVEY BOUNDARY
- FENCE
- EXISTING AGT PIPELINE
- FOREIGN PIPELINE
- POWERLINE
- WATER PIPELINE
- RAILROAD TRACK
- OVERHEAD WIRE
- TELEPHONE LINE
- UTILITY LINES
- SANITARY SEWER
- TEE TAP
- BLOW OFF VALVE
- MAINLINE VALVE (MLV)
- POINT OF INTERSECTION
- BORE ENTRY/EXIT
- TRANSMISSION TOWER
- LIGHT POLE
- UTILITY POLE
- FIRE HYDRANT
- WELL (GAS)
- WELL (WATER)
- WELL (OIL)
- WELL (UNKNOWN)



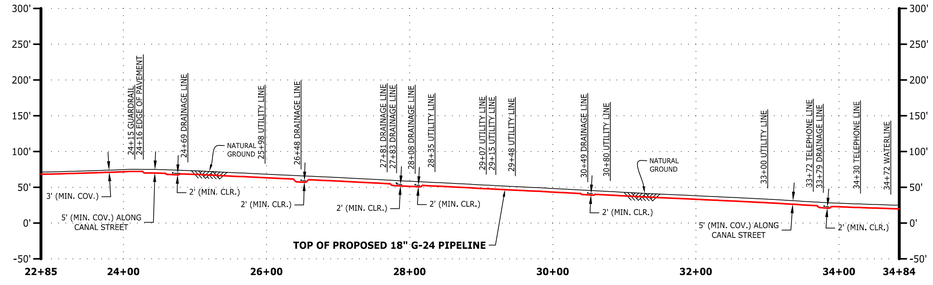
ENVIRONMENTAL DATA

E & S TYPICALS

E&S TYPICALS WILL BE USED AS A PLAN AND WILL HAVE FURTHER INPUT FROM ENVIRONMENTAL INSPECTOR.

PROFILE

HORIZONTAL SCALE: 1" = 100'
100' 50' 0 100'
VERTICAL SCALE: 1" = 100'
100' 50' 0 100'



THE LOCATION OF TRENCH PLUGS AND SLOPE BREAKERS ARE INTENDED TO BE USED AS A GUIDELINE ONLY. EXACT LOCATION TO BE DETERMINED IN THE FIELD.

SLOPE BREAKERS
TRENCH PLUG

PERMANENT SLOPE BREAKER & TRENCH PLUG SPACING

% SLOPE	SLOPE BREAKER SPACING (FT)	% SLOPE	TRENCH PLUG SPACING (FT)
5-15%	300 FT	<5%	NO STRUCTURE
15-30%	200 FT	5-15%	300 FT
>30%	100 FT	15-30%	200 FT
		>30%	100 FT

IN AG FIELDS AND RESIDENTIAL AREAS WHERE SLOPE BREAKERS ARE NOT TYPICALLY REQUIRED, INSTALL PERMANENT TRENCH PLUGS AT THE SAME SPACING AS IF PERMANENT SLOPE BREAKERS WERE REQUIRED. (FERC PLAN)

LAND USE CLASSIFICATION

CC CULTIVATED CROPS	DF DECIDUOUS FOREST	D/OS DEVELOPED OPEN SPACE	
EF EVERGREEN FOREST	S/S SHRUB SCRUB	D/LI DEVELOPED LOW INTENSITY	
H/P HAY PASTURE	MF MIXED FOREST	D/MI DEVELOPED MEDIUM INTENSITY	

SEGMENTABLE ELBOW	QTY
90 DEG, SD, 18" OD, 0.375" WT, CS, x52, FBE COATING SYSTEM 2B	1
45 DEG, SD, 18" OD, 0.375" WT, CS, x52, FBE COATING SYSTEM 2B	6

STAMP/SEAL

COMMONWEALTH OF MASSACHUSETTS CLAY H. WILLIS STRUCTURAL NO. 49136 REGISTERED PROFESSIONAL ENGINEER
5/6/25

THIS DOCUMENT IS RELEASED FOR THE PURPOSE OF:
BID REVIEW
IT IS NOT TO BE USED FOR: CONSTRUCTION, RECORDATION, CONVEYANCE, SALES, OR AS THE BASIS FOR THE ISSUANCE OF A PERMIT

UNDER THE AUTHORITY OF:
PE NAME: CLAY WILLIS
PE STATE: MASSACHUSETTS
PE NUMBER 49136

SOILS																
LAND USE																
% SLOPE			5-15%		<5%		5-15%	<5%	5-15%	<5%	5-15%		<5%	5-15%		<5%

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		D	01/29/26	TL	JL	RE-ISSUED FOR BID
		C	08/21/25	TL	JL	ISSUED FOR BID
CP-2	CATHODIC PROTECTION DESIGN	B	07/07/25	TL	JL	ISSUED FOR REVIEW (90% DESIGN)
00051-M.200-0001	SAGAMORE M&R STATION - LOCATION MAP AND PLOT PLAN	A	04/08/25	TL	RAL	ISSUED FOR REVIEW (60% DESIGN)

wood. WOOD GROUP USA, INC.

TITLE	INITIALS	DATE
DRAWN BY:	TL	03/31/25
DESIGN CHECKER:	JL	04/01/25
DESIGN ENGINEER:	PA	04/08/25
PROJECT MANAGER:	EL	04/08/25

ENBRIDGE
CAPE COD CANAL PIPELINE RELOCATION PROJECT
PROPOSED 18" G-24 PIPELINE
TITLE: ALIGNMENT SHEET

ENBRIDGE

Algonquin Gas Transmission
915 N. Eldridge Parkway, Houston, TX 77079-2703 (713) 627-5400

YEAR: 2026 | W.O.: AFE 30002835 | SCALE: 1" = 100' | DWG.: GSYS-P.500-0025 | REV.: D

M:\259271\MAPPING\DRAWINGS\91-ALIGNMENT\RE-ISSUED FOR BID\259271-G_24

RIGHT-OF-WAY

TRACT NUMBERS

SURVEY DATA

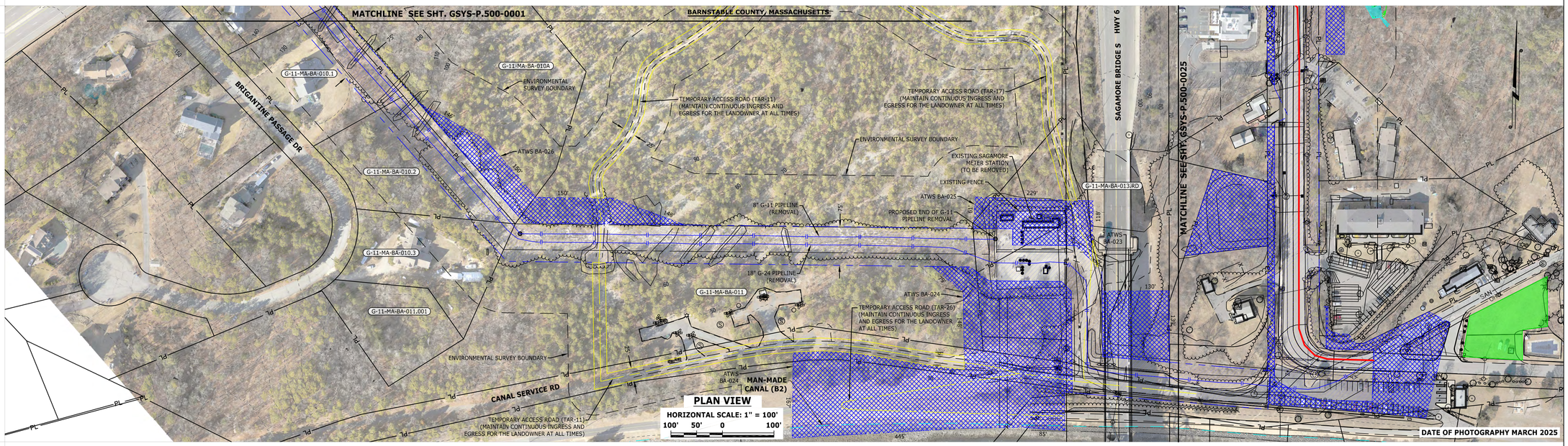
SURVEY COMPANY:
FIELD BOOK:
PAGES:

CLASS LOCATION

PIPE MATERIAL

ALIGNMENT LEGEND

- PIPELINE MILEPOST
- PROPOSED G-24 PIPELINE
- PROPOSED G-11 PIPELINE
- 18" G-24 & 8" G-11 PIPELINES (TO BE REMOVED)
- CONSTRUCTION LIMIT
- WAREYARD / STAGING AREA
- EXISTING PERMANENT ROW
- PROPOSED PERMANENT ROW
- ADDITIONAL TEMPORARY WORKSPACE
- PROPOSED METERING & REGULATING STATION (M&R) SITE / PIG TRAP SITE
- FACILITIES TEMPORARY WORKSPACE
- FACILITIES PERMANENT WORKSPACE
- PROPOSED GRAVEL AREA
- DELINEATED WETLAND BOUNDARY
- DELINEATED WATERBODY BANK
- DELINEATED WATERBODY CENTERLINE
- PERMANENT ACCESS ROAD
- TEMPORARY ACCESS ROAD
- PROPERTY LINE
- MAJOR CONTOUR
- MUNICIPALITY LINE
- ENVIRONMENTAL SURVEY BOUNDARY
- FENCE
- EXISTING AGT PIPELINE
- FOREIGN PIPELINE
- POWERLINE
- WATER PIPELINE
- RAILROAD TRACK
- OVERHEAD WIRE
- TELEPHONE LINE
- UTILITY LINES
- SANITARY SEWER
- TEE TAP
- BLOW OFF VALVE
- MAINLINE VALVE (MLV)
- POINT OF INTERSECTION
- BORE ENTRY/EXIT
- TRANSMISSION TOWER
- LIGHT POLE
- UTILITY POLE
- FIRE HYDRANT
- WELL (GAS)
- WELL (WATER)
- WELL (OIL)
- WELL (UNKNOWN)



ENVIRONMENTAL DATA

E & S TYPICALS

E&S TYPICALS WILL BE USED AS A PLAN AND WILL HAVE FURTHER INPUT FROM ENVIRONMENTAL INSPECTOR.

PROFILE

HORIZONTAL SCALE: 1" = 100'
100' 50' 0 100'
VERTICAL SCALE: 1" = 100'
100' 50' 0 100'

THE LOCATION OF TRENCH PLUGS AND SLOPE BREAKERS ARE INTENDED TO BE USED AS A GUIDELINE ONLY. EXACT LOCATION TO BE DETERMINED IN THE FIELD.

SLOPE BREAKERS
TRENCH PLUG

PERMANENT SLOPE BREAKER & TRENCH PLUG SPACING

% SLOPE	SLOPE BREAKER SPACING (FT)	% SLOPE	TRENCH PLUG SPACING (FT)
5-15%	300 FT	<5%	NO STRUCTURE
15-30%	200 FT	5-15%	300 FT
>30%	100 FT	15-30%	200 FT
		>30%	100 FT

IN AG FIELDS AND RESIDENTIAL AREAS WHERE SLOPE BREAKERS ARE NOT TYPICALLY REQUIRED, INSTALL PERMANENT TRENCH PLUGS AT THE SAME SPACING AS IF PERMANENT SLOPE BREAKERS WERE REQUIRED. (FERC PLAN)

LAND USE CLASSIFICATION

CC CULTIVATED CROPS DF DECIDUOUS FOREST D/OS DEVELOPED OPEN SPACE
EF EVERGREEN FOREST S/S SHRUB SCRUB D/LI DEVELOPED LOW INTENSITY
H/P HAY PASTURE MF MIXED FOREST D/MI DEVELOPED MEDIUM INTENSITY

SOILS

LAND USE

% SLOPE

STAMP/SEAL

COMMONWEALTH OF MASSACHUSETTS
CLAY H. WILLIS
STRUCTURAL
NO. 49136
REGISTERED PROFESSIONAL ENGINEER
01/23/26

THIS DOCUMENT IS RELEASED FOR THE PURPOSE OF:
BID REVIEW
IT IS NOT TO BE USED FOR:
CONSTRUCTION, RECORDATION, CONVEYANCE, SALES, OR AS THE BASIS FOR THE ISSUANCE OF A PERMIT

UNDER THE AUTHORITY OF:
PE NAME: CLAY WILLIS
PE STATE: MASSACHUSETTS
PE NUMBER 49136

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		D	01/29/26	TL	JL	RE-ISSUED FOR BID
		C	08/21/25	TL	JL	ISSUED FOR BID
		B	07/07/25	TL	JL	ISSUED FOR REVIEW (90% DESIGN)
		A	04/08/25	TL	RAL	ISSUED FOR REVIEW (60% DESIGN)

wood.
WOOD GROUP USA, INC.

TITLE	INITIALS	DATE
DRAWN BY:	TL	03/31/25
DESIGN CHECKER:	JL	04/01/25
DESIGN ENGINEER:	PA	04/08/25
PROJECT MANAGER:	EL	04/08/25

ENBRIDGE
CAPE COD CANAL PIPELINE RELOCATION PROJECT
PROPOSED 18" G-24 PIPELINE
TITLE: ALIGNMENT SHEET
LOC.: BARNSTABLE COUNTY, MASSACHUSETTS
YEAR: 2026 | W.O.: AFE 30002835 | SCALE: 1" = 100' | DWG.: GSYS-P.500-0026 | REV.: D

ENBRIDGE
Algonquin Gas Transmission
915 N. Eldridge Parkway, Houston, TX 77079-2703 (713) 627-5400

M:\259271\MAPPING\DRAWINGS\91-ALIGNMENT\RE-ISSUED FOR BID\259271-G_24

RIGHT-OF-WAY

TRACT NUMBERS

0+00		17+00
G-31-MA-BA-001.004	G-31-MA-BA-001	
36 FT.	1664 FT.	
0+36		

SURVEY DATA

SURVEY COMPANY:
FIELD BOOK:
PAGES:

0+00 BEGIN PIPELINE		17+00
0+11 P.I. <44°59'57" RT.	15+98 P.I. <45°00'00" RT.	
0+39 TREE LINE 0+44 P.I. <45°01'28" LT.	16+62 OH POWERLINE 16+72 EDGE OF GRAVEL 16+76 PERMANENT ACCESS ROAD (PAR-12)	
1+31 WALL	16+81 OH POWERLINE 16+91 EDGE OF GRAVEL	
1+92 OH POWERLINE 2+05 OH POWERLINE 2+34 OH POWERLINE 2+34 EDGE OF GRAVEL 2+41 PERMANENT ACCESS ROAD (PAR-12) 2+51 EDGE OF GRAVEL 2+79 OH POWERLINE 3+02 OH POWERLINE	16+92 ROSE ENTRY	
3+24 OH POWERLINE		
4+03 P.I. <28°41'33" RT. 4+28 8" AGT PIPELINE (UNKNOWN COVER, FIELD VERIFY) 4+55 18" AGT PIPELINE (UNKNOWN COVER, FIELD VERIFY)		

CLASS LOCATION

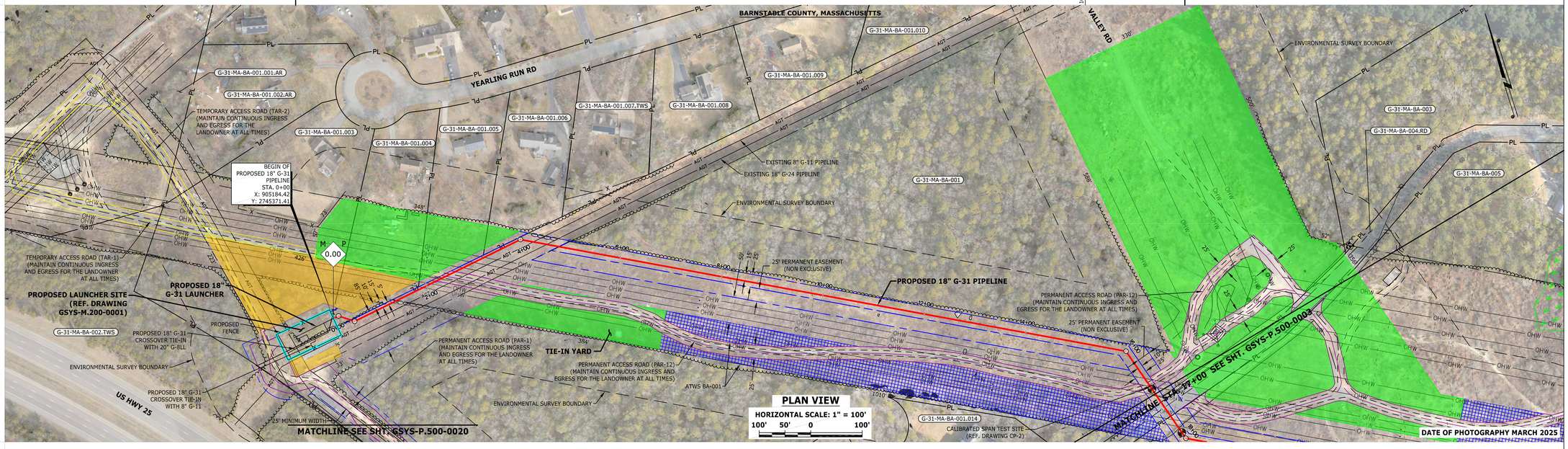
0+00	CLASS 2	17+00

PIPE MATERIAL

0+00		16+87		17+00
18" O.D. X 0.375" W.T., API 5L, X-52, 16-20 MILS FBE			18" O.D. X 0.500" W.T., API 5L, X-52, 16-20 MILS FBE + 24 MILS ARO	
1687 FT.			13 FT. (BORE)	

ALIGNMENT LEGEND

- PIPELINE MILEPOST
- PROPOSED G-31 PIPELINE
- PROPOSED G-32 PIPELINE
- CONSTRUCTION LIMIT
- WAREYARD / STAGING AREA
- EXISTING PERMANENT ROW
- PROPOSED PERMANENT ROW
- ADDITIONAL TEMPORARY WORKSPACE
- PROPOSED METERING & REGULATING STATION (M&R) SITE / PIG TRAP SITE
- FACILITIES TEMPORARY WORKSPACE
- FACILITIES PERMANENT WORKSPACE
- PROPOSED GRAVEL AREA
- DELINEATED WETLAND BOUNDARY
- DELINEATED WATERBODY BANK
- DELINEATED WATERBODY CENTERLINE
- PERMANENT ACCESS ROAD
- TEMPORARY ACCESS ROAD
- PROPERTY LINE
- MAJOR CONTOUR
- MUNICIPALITY LINE
- ENVIRONMENTAL SURVEY BOUNDARY
- FENCE
- EXISTING AGT PIPELINE
- FOREIGN PIPELINE
- POWERLINE
- WATER PIPELINE
- RAILROAD TRACK
- OVERHEAD WIRE
- TELEPHONE LINE
- UTILITY LINES
- SANITARY SEWER
- TEE TAP
- BLOW OFF VALVE
- MAINLINE VALVE (MLV)
- POINT OF INTERSECTION
- BORE ENTRY/EXIT
- TRANSMISSION TOWER
- LIGHT POLE
- UTILITY POLE
- FIRE HYDRANT
- WELL (GAS)
- WELL (WATER)
- WELL (OIL)
- WELL (UNKNOWN)



PLAN VIEW

HORIZONTAL SCALE: 1" = 100'

100' 50' 0 100'

ENVIRONMENTAL DATA

E & S TYPICALS

E&S TYPICALS WILL BE USED AS A PLAN AND WILL HAVE FURTHER INPUT FROM ENVIRONMENTAL INSPECTOR.

PROFILE

HORIZONTAL SCALE: 1" = 100'

100' 50' 0 100'

VERTICAL SCALE: 1" = 100'

100' 50' 0 100'

THE LOCATION OF TRENCH PLUGS AND SLOPE BREAKERS ARE INTENDED TO BE USED AS A GUIDELINE ONLY. EXACT LOCATION TO BE DETERMINED IN THE FIELD.

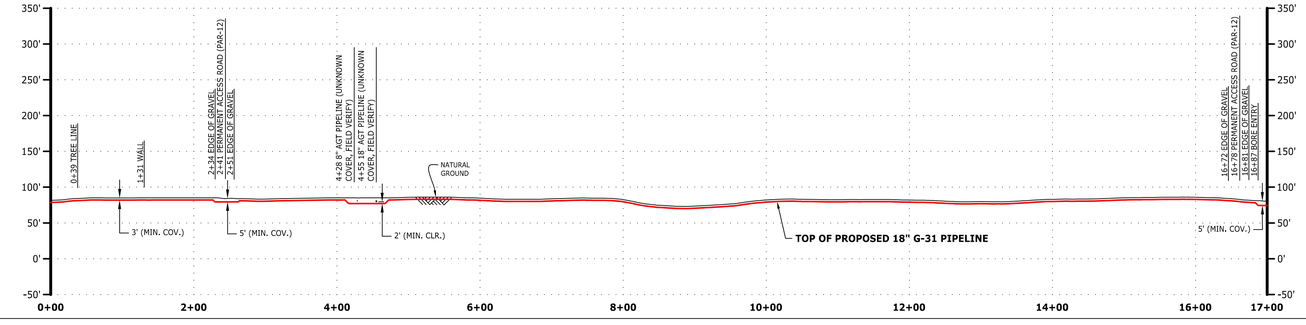
SLOPE BREAKERS ○

TRENCH PLUG ▲

PERMANENT SLOPE BREAKER & TRENCH PLUG SPACING

% SLOPE	SLOPE BREAKER SPACING (FT)	% SLOPE	TRENCH PLUG SPACING (FT)
5-15%	300 FT	<5%	NO STRUCTURE
15-30%	200 FT	5-15%	300 FT
>30%	100 FT	15-30%	200 FT
		>30%	100 FT

IN AG FIELDS AND RESIDENTIAL AREAS WHERE SLOPE BREAKERS ARE NOT TYPICALLY REQUIRED, INSTALL PERMANENT TRENCH PLUGS AT THE SAME SPACING AS IF PERMANENT SLOPE BREAKERS WERE REQUIRED. (FERC PLAN)



LAND USE CLASSIFICATION

CC CULTIVATED CROPS	DF DECIDUOUS FOREST	D/OS DEVELOPED OPEN SPACE	**SOILS**																	
EF EVERGREEN FOREST	S/SSHRUB SCRUB	D/LI DEVELOPED LOW INTENSITY	**LAND USE**																	
H/P HAY PASTURE	MF MIXED FOREST	D/MI DEVELOPED MEDIUM INTENSITY	**% SLOPE**	5-15%		<5%			5-15%	<5%	5-15%	<5%	5-15%	15-30%	5-15%	<5%	5-15%		<5%	5-15%	<5%

SEGMENTABLE ELBOW	QTY
90 DEG, SD, 18" OD, 0.375" WT, CS, x52, FBE COATING SYSTEM 2B	0
45 DEG, SD, 18" OD, 0.375" WT, CS, x52, FBE COATING SYSTEM 2B	8

STAMP/SEAL

CLAY H. WILLIS STRUCTURAL NO. 49136 REGISTERED PROFESSIONAL ENGINEER 04/23/26

THIS DOCUMENT IS RELEASED FOR THE PURPOSE OF:
BID REVIEW
IT IS NOT TO BE USED FOR:
CONSTRUCTION, RECORDATION, CONVEYANCE, SALES, OR AS THE BASIS FOR THE ISSUANCE OF A PERMIT

UNDER THE AUTHORITY OF:
PE NAME: CLAY WILLIS
PE STATE: MASSACHUSETTS
PE NUMBER 49136

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		F	01/29/26	TL	JL	RE-ISSUED FOR BID
		E	08/21/25	TL	JL	ISSUED FOR BID
		D	07/07/25	TL	JL	ISSUED FOR REVIEW (90% DESIGN)
GSYS-C.300-0002	ACCESS ROAD PLAN AND PROFILE	C	04/08/25	TL	RAL	ISSUED FOR REVIEW (60% DESIGN)
CP-2	CATHODIC PROTECTION DESIGN	B	02/26/24	LBJ	JL	ISSUED FOR REVIEW
GSYS-M.200-0001	SITE PLAN - G-31 LAUNCHER TRAP	A	11/16/23	LBJ	JL	ISSUED FOR REVIEW

wood.
WOOD GROUP USA, INC.

TITLE	INITIALS	DATE
DRAWN BY:	LBJ	02/26/24
DESIGN CHECKER:	JL	02/26/24
DESIGN ENGINEER:	PA	02/26/24
PROJECT MANAGER:	EL	02/26/24

ENBRIDGE

CAPE COD CANAL PIPELINE RELOCATION PROJECT
PROPOSED 18" G-31 PIPELINE
TITLE: ALIGNMENT SHEET

LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

YEAR: 2026 | W.O.: AFE 30002835 | SCALE: 1" = 100'

Algonquin Gas Transmission
915 N. Eldridge Parkway, Houston, TX 77079-2703 (713) 627-5400

DWG.: GSYS-P.500-0002 | REV.: F

M:\259271\MAPPING\DRAWINGS\ALIGNMENT\RE-ISSUED FOR BID\259271-G_01

RIGHT-OF-WAY

TRACT NUMBERS

17+00	G-31-MA-BA-001	17+18	G-31-MA-BA-004.RD BOURNEDALE RD	17+51	G-31-MA-BA-005	29+56	G-31-MA-BA-007	34+05	G-31-MA-BA-008	35+13	G-31-MA-BA-007	41+00
	18 FT.		33 FT.		1205 FT.		449 FT.		208 FT.		487 FT.	

SURVEY DATA

SURVEY COMPANY:
FIELD BOOK:
PAGES:

17+00
17+10 OH POWERLINE
17+18 CHAINLINK WOOD
17+18 EDGE OF GRAVEL
17+21 CL BOURNEDALE RD
17+43 OH POWERLINE
17+43 OH POWERLINE
17+79 GUARDRAIL - WOOD
17+79 GUARDRAIL
17+89 BORE EXIT
18+11 P.I. <45°00'00" LT.

35+26 P.I. <90°00'00" LT.
35+43 OH POWERLINE
35+60 OH POWERLINE
35+60 OH POWERLINE
35+88 TEMPORARY ACCESS ROAD (TAR-4)
35+88 EDGE OF GRAVEL
36+01 OH POWERLINE
36+11 OH POWERLINE
36+71 OH POWERLINE
36+94 OH POWERLINE
37+45 P.I. <65°38'53" RT.
37+74 OH POWERLINE
38+13 OH POWERLINE
38+56 EDGE OF GRAVEL
38+69 PERMANENT ACCESS ROAD (PAR-20)
38+82 EDGE OF GRAVEL
39+39 OH POWERLINE
40+10 OH POWERLINE
40+63 OH POWERLINE

41+00

CLASS LOCATION

17+00 — CLASS 2 — 20+80 — CLASS 1 — 41+00

PIPE MATERIAL

17+00 — 18" O.D. X 0.500" W.T., API 5L, X-52, 16-20 MILS FBE + 24 MILS ARO — 17+89

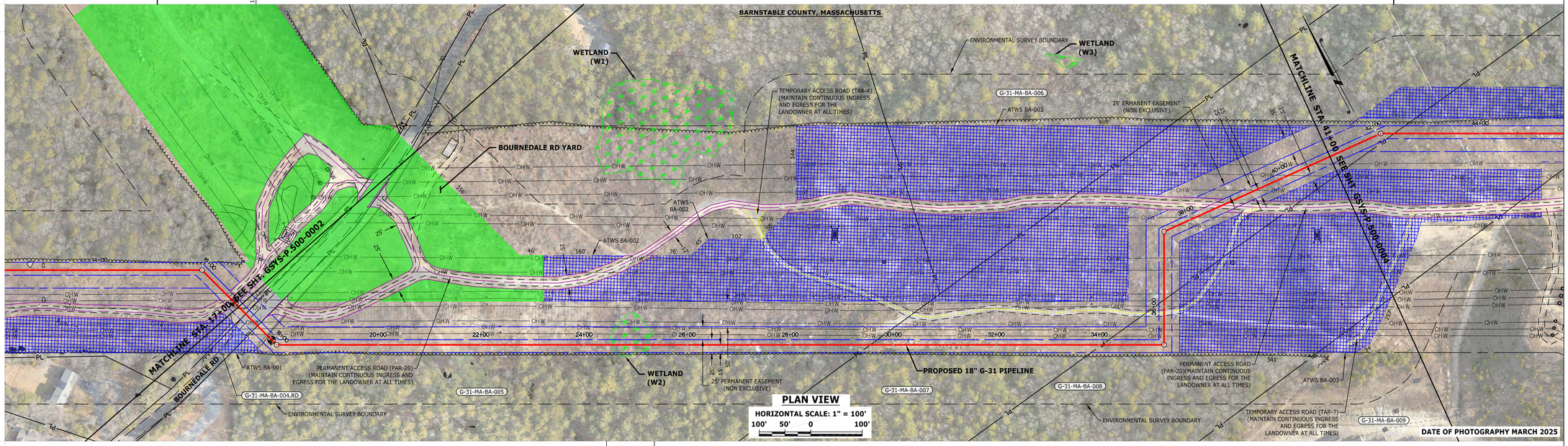
89 FT. (BORE)

18" O.D. X 0.375" W.T., API 5L, X-52, 16-20 MILS FBE — 41+00

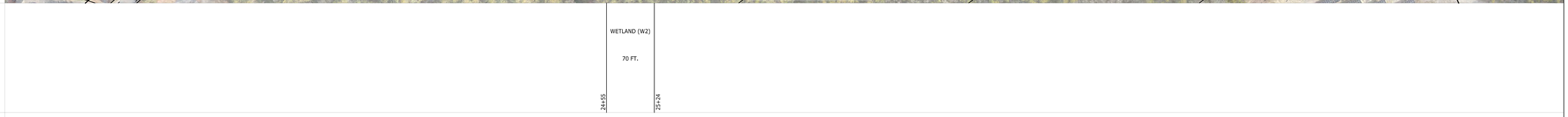
2311 FT.

ALIGNMENT LEGEND

- PIPELINE MILEPOST
- PROPOSED G-31 PIPELINE
- PROPOSED G-32 PIPELINE
- CONSTRUCTION LIMIT
- WAREYARD / STAGING AREA
- EXISTING PERMANENT ROW
- PROPOSED PERMANENT ROW
- ADDITIONAL TEMPORARY WORKSPACE
- PROPOSED METERING & REGULATING STATION (M&R) SITE / PIG TRAP SITE
- FACILITIES TEMPORARY WORKSPACE
- FACILITIES PERMANENT WORKSPACE
- PROPOSED GRAVEL AREA
- DELINEATED WETLAND BOUNDARY
- DELINEATED WATERBODY BANK
- DELINEATED WATERBODY CENTERLINE
- PERMANENT ACCESS ROAD
- TEMPORARY ACCESS ROAD
- PROPERTY LINE — PL
- MAJOR CONTOUR — -100'-
- MUNICIPALITY LINE
- ENVIRONMENTAL SURVEY BOUNDARY
- FENCE — X —
- EXISTING AGT PIPELINE — AGT —
- FOREIGN PIPELINE — F —
- POWERLINE — P —
- WATER PIPELINE — W —
- RAILROAD TRACK — T —
- OVERHEAD WIRE — OHW —
- TELEPHONE LINE — C —
- UTILITY LINES
- SANITARY SEWER — SAN —
- TEE TAP
- BLOW OFF VALVE
- MAINLINE VALVE (MLV)
- POINT OF INTERSECTION
- BORE ENTRY/EXIT
- TRANSMISSION TOWER
- LIGHT POLE
- UTILITY POLE
- FIRE HYDRANT
- WELL (GAS)
- WELL (WATER)
- WELL (OIL)
- WELL (UNKNOWN)



ENVIRONMENTAL DATA



E & S TYPICALS

E&S TYPICALS WILL BE USED AS A PLAN AND WILL HAVE FURTHER INPUT FROM ENVIRONMENTAL INSPECTOR.

PROFILE

HORIZONTAL SCALE: 1" = 100'
100' 50' 0 100'
VERTICAL SCALE: 1" = 100'
100' 50' 0 100'

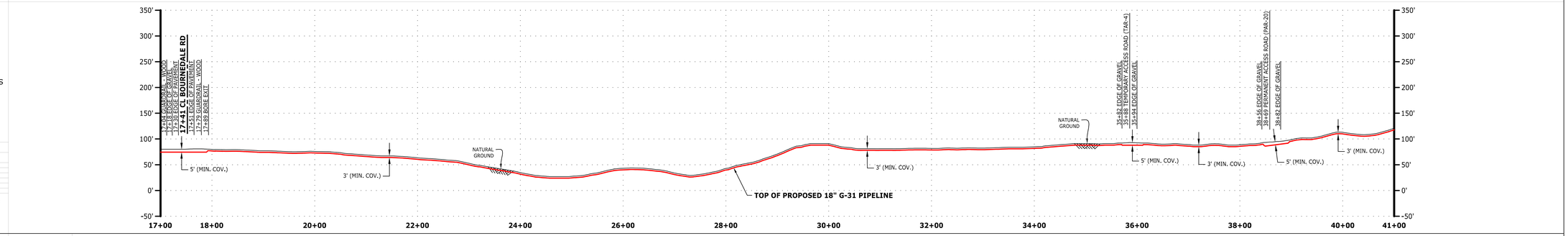
THE LOCATION OF TRENCH PLUGS AND SLOPE BREAKERS ARE INTENDED TO BE USED AS A GUIDELINE ONLY. EXACT LOCATION TO BE DETERMINED IN THE FIELD.

SLOPE BREAKERS ○
TRENCH PLUG ▲

PERMANENT SLOPE BREAKER & TRENCH PLUG SPACING

% SLOPE	SLOPE BREAKER SPACING (FT)	% SLOPE	TRENCH PLUG SPACING (FT)
5-15%	300 FT	<5%	NO STRUCTURE
15-30%	200 FT	5-15%	300 FT
>30%	100 FT	15-30%	200 FT
		>30%	100 FT

IN AG FIELDS AND RESIDENTIAL AREAS WHERE SLOPE BREAKERS ARE NOT TYPICALLY REQUIRED, INSTALL PERMANENT TRENCH PLUGS AT THE SAME SPACING AS IF PERMANENT SLOPE BREAKERS WERE REQUIRED. (FERC PLAN)



LAND USE CLASSIFICATION

CC CULTIVATED CROPS DF DECIDUOUS FOREST D/OS DEVELOPED OPEN SPACE
EF EVERGREEN FOREST S/SSHRUB SCRUB D/LI DEVELOPED LOW INTENSITY
H/P HAY PASTURE MF MIXED FOREST D/MI DEVELOPED MEDIUM INTENSITY

SEGMENTABLE ELBOW	QTY
90 DEG, SD, 18" OD, 0.375" WT, CS, x52, FBE COATING SYSTEM 2B	2
45 DEG, SD, 18" OD, 0.375" WT, CS, x52, FBE COATING SYSTEM 2B	3

SOILS																											
LAND USE																											
% SLOPE	<5%	5-15%	<5%	5-15%	15-30%	5-15%	<5%	5-15%	15-30%	<5%	5-15%	15-30%	>30%	<5%	15-30%	5-15%	15-30%	5-15%	<5%	5-15%	15-30%	5-15%	15-30%				

STAMP/SEAL

THIS DOCUMENT IS RELEASED FOR THE PURPOSE OF:
BID REVIEW
IT IS NOT TO BE USED FOR:
CONSTRUCTION, RECORDATION, CONVEYANCE, SALES, OR AS THE BASIS FOR THE ISSUANCE OF A PERMIT

UNDER THE AUTHORITY OF:
PE NAME: CLAY WILLIS
PE STATE: MASSACHUSETTS
PE NUMBER: 49136

COMMONWEALTH OF MASSACHUSETTS — CLAY H. WILLIS — NO. 49136 — REGISTERED PROFESSIONAL ENGINEER — 04/23/26

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		F	01/29/26	TL	JL	RE-ISSUED FOR BID
		E	08/21/25	TL	JL	ISSUED FOR BID
		D	07/07/25	TL	JL	ISSUED FOR REVIEW (90% DESIGN)
		C	04/08/25	TL	RAL	ISSUED FOR REVIEW (60% DESIGN)
		B	02/26/24	LBJ	JL	ISSUED FOR REVIEW
		A	11/16/23	LBJ	JL	ISSUED FOR REVIEW

wood. WOOD GROUP USA, INC.

	INITIALS	DATE
DRAWN BY:	LBJ	02/26/24
DESIGN CHECKER:	JL	02/26/24
DESIGN ENGINEER:	PA	02/26/24
PROJECT MANAGER:	EL	02/26/24

ENBRIDGE
CAPE COD CANAL PIPELINE RELOCATION PROJECT
PROPOSED 18" G-31 PIPELINE
TITLE: ALIGNMENT SHEET
LOC.: BARNSTABLE COUNTY, MASSACHUSETTS
YEAR: 2026 | W.O.: AFE 30002835 | SCALE: 1" = 100'
DWG.: GSYS-P.500-0003 | REV.: F

ENBRIDGE
Algonquin Gas Transmission
915 N. Eldridge Parkway, Houston, TX 77079-2703 (713) 627-5400

M:\29271\MAPPING\DRAWINGS\P1-ALIGNMENT\RE-ISSUED FOR BID\29271-G_01

| | 41+00 | | |

| | | |

RIGHT-OF-WAY

TRACT NUMBERS

89+00: G-31-MA-BA-023 — 817 FT. | 97+17 | G-31-MA-BA-025 — 1728 FT. | 114+45

SURVEY DATA

SURVEY COMPANY:
FIELD BOOK:
PAGES:

89+00 | 98+17 OH POWERLINE | 98+70 HDD EXIT | 98+84 TOE OF SLOPE | 99+04 TOP OF SLOPE | 101+19 TOP OF SLOPE | 101+38 TOE OF SLOPE | 103+53 TOE OF SLOPE | 111+60 P.I. <31°19'06" LT. | 112+12 TREE LINE | 114+45 END PIPELINE

CLASS LOCATION

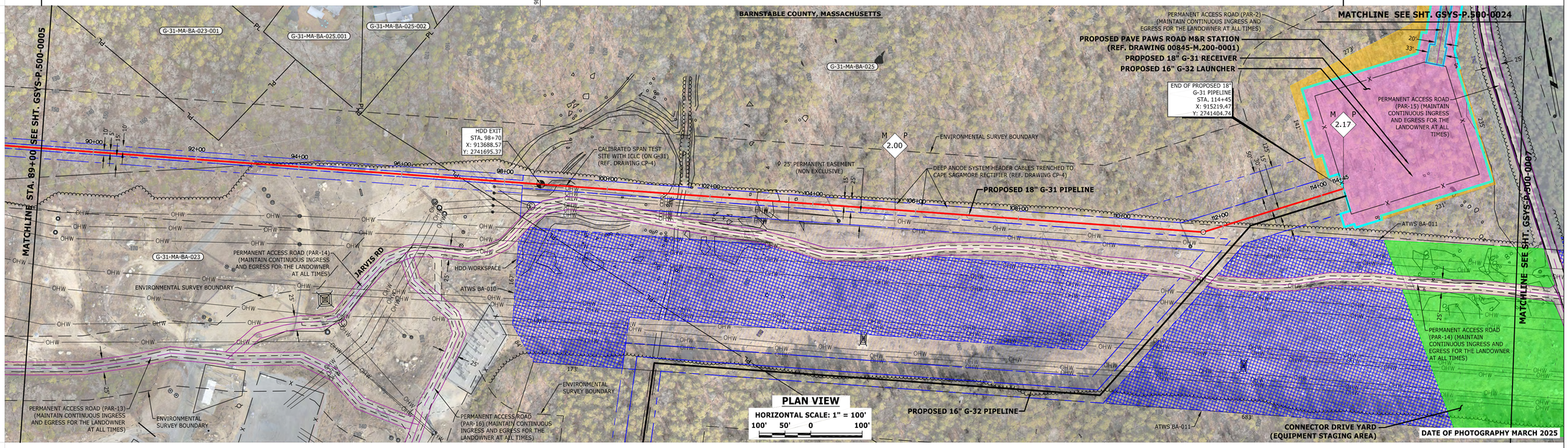
89+00 — CLASS 1 — 114+45

PIPE MATERIAL

89+00: 18" O.D. X 0.500" W.T., API-5L, X-52, 16-20 MILS FBE + 24 MILS ARO — 970 FT. (HDD) | 98+70 | 18" O.D. X 0.375" W.T., API 5L, X-52, 16-20 MILS FBE — 1575 FT. | 114+45

ALIGNMENT LEGEND

- PIPELINE MILEPOST
- PROPOSED G-31 PIPELINE
- PROPOSED G-32 PIPELINE
- CONSTRUCTION LIMIT
- WAREYARD / STAGING AREA
- EXISTING PERMANENT ROW
- PROPOSED PERMANENT ROW
- ADDITIONAL TEMPORARY WORKSPACE
- PROPOSED METERING & REGULATING STATION (M&R) SITE / PIG TRAP SITE
- FACILITIES TEMPORARY WORKSPACE
- FACILITIES PERMANENT WORKSPACE
- PROPOSED GRAVEL AREA
- DELINEATED WETLAND BOUNDARY
- DELINEATED WATERBODY BANK
- DELINEATED WATERBODY CENTERLINE
- PERMANENT ACCESS ROAD
- TEMPORARY ACCESS ROAD
- PROPERTY LINE — PL —
- MAJOR CONTOUR — -100'- —
- MUNICIPALITY LINE
- ENVIRONMENTAL SURVEY BOUNDARY
- FENCE — X —
- EXISTING AGT PIPELINE — AGT —
- FOREIGN PIPELINE — F —
- POWERLINE — P —
- WATER PIPELINE — W —
- RAILROAD TRACK — | —
- OVERHEAD WIRE — OHW —
- TELEPHONE LINE — C —
- UTILITY LINES
- SANITARY SEWER — SAN —
- TEE TAP
- BLOW OFF VALVE
- MAINLINE VALVE (MLV)
- POINT OF INTERSECTION
- BORE ENTRY/EXIT
- TRANSMISSION TOWER
- LIGHT POLE
- UTILITY POLE
- FIRE HYDRANT
- WELL (GAS)
- WELL (WATER)
- WELL (OIL)
- WELL (UNKNOWN)



PLAN VIEW
HORIZONTAL SCALE: 1" = 100'
100' 50' 0 100'

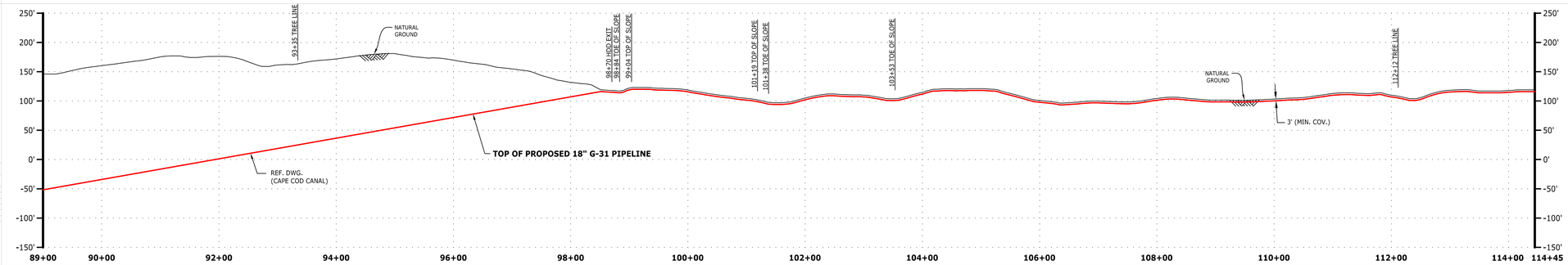
ENVIRONMENTAL DATA

E & S TYPICALS

E&S TYPICALS WILL BE USED AS A PLAN AND WILL HAVE FURTHER INPUT FROM ENVIRONMENTAL INSPECTOR.

PROFILE

HORIZONTAL SCALE: 1" = 100'
100' 50' 0 100'
VERTICAL SCALE: 1" = 100'
100' 50' 0 100'



THE LOCATION OF TRENCH PLUGS AND SLOPE BREAKERS ARE INTENDED TO BE USED AS A GUIDELINE ONLY. EXACT LOCATION TO BE DETERMINED IN THE FIELD.

SLOPE BREAKERS ○
TRENCH PLUG ▲

PERMANENT SLOPE BREAKER & TRENCH PLUG SPACING

% SLOPE	SLOPE BREAKER SPACING (FT)	% SLOPE	TRENCH PLUG SPACING (FT)
5-15%	300 FT	<5%	NO STRUCTURE
15-30%	200 FT	5-15%	300 FT
>30%	100 FT	15-30%	200 FT
		>30%	100 FT

IN AG FIELDS AND RESIDENTIAL AREAS WHERE SLOPE BREAKERS ARE NOT TYPICALLY REQUIRED, INSTALL PERMANENT TRENCH PLUGS AT THE SAME SPACING AS IF PERMANENT SLOPE BREAKERS WERE REQUIRED. (FERC PLAN)

LAND USE CLASSIFICATION

CC CULTIVATED CROPS DF DECIDUOUS FOREST D/OS DEVELOPED OPEN SPACE
EF EVERGREEN FOREST S/S SHRUB SCRUB D/LI DEVELOPED LOW INTENSITY
H/P HAY PASTURE MF MIXED FOREST D/MI DEVELOPED MEDIUM INTENSITY

SEGMENTABLE ELBOW	QTY
90 DEG, SD, 18" OD, 0.375" WT, CS, x52, FBE COATING SYSTEM 2B	0
45 DEG, SD, 18" OD, 0.375" WT, CS, x52, FBE COATING SYSTEM 2B	1

STAMP/SEAL

CLAY H. WILLIS — STRUCTURAL — NO. 49136 — COMMONWEALTH OF MASSACHUSETTS — REGISTERED PROFESSIONAL ENGINEER — 02/23/26

THIS DOCUMENT IS RELEASED FOR THE PURPOSE OF: BID REVIEW
IT IS NOT TO BE USED FOR: CONSTRUCTION, RECORDATION, CONVEYANCE, SALES, OR AS THE BASIS FOR THE ISSUANCE OF A PERMIT
UNDER THE AUTHORITY OF:
PE NAME: CLAY WILLIS
PE STATE: MASSACHUSETTS
PE NUMBER 49136

| SOILS / LAND USE / % SLOPE | | |

RIGHT-OF-WAY

TRACT NUMBERS

SURVEY DATA

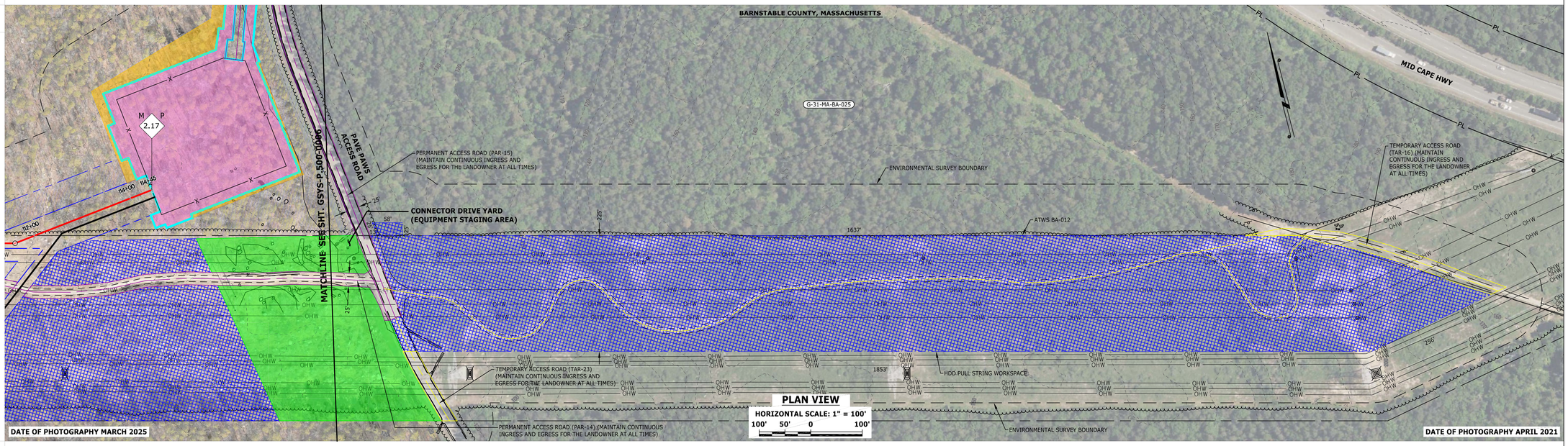
SURVEY COMPANY:
FIELD BOOK:
PAGES:

CLASS LOCATION

PIPE MATERIAL

ALIGNMENT LEGEND

- PIPELINE MILEPOST
- PROPOSED G-31 PIPELINE
- PROPOSED G-32 PIPELINE
- CONSTRUCTION LIMIT
- WAREYARD / STAGING AREA
- EXISTING PERMANENT ROW
- PROPOSED PERMANENT ROW
- ADDITIONAL TEMPORARY WORKSPACE
- PROPOSED METERING & REGULATING STATION (M&R) SITE / PIG TRAP SITE
- FACILITIES TEMPORARY WORKSPACE
- FACILITIES PERMANENT WORKSPACE
- PROPOSED GRAVEL AREA
- DELINEATED WETLAND BOUNDARY
- DELINEATED WATERBODY BANK
- DELINEATED WATERBODY CENTERLINE
- PERMANENT ACCESS ROAD
- TEMPORARY ACCESS ROAD
- PROPERTY LINE — PL —
- MAJOR CONTOUR — -100'- —
- MUNICIPALITY LINE
- ENVIRONMENTAL SURVEY BOUNDARY
- FENCE — X —
- EXISTING AGT PIPELINE — AGT —
- FOREIGN PIPELINE — F —
- POWERLINE — P —
- WATER PIPELINE — W —
- RAILROAD TRACK
- OVERHEAD WIRE — OHW —
- TELEPHONE LINE — C —
- UTILITY LINES
- SANITARY SEWER — SAN —
- TEE TAP
- BLOW OFF VALVE
- MAINLINE VALVE (MLV)
- POINT OF INTERSECTION
- BORE ENTRY/EXIT
- TRANSMISSION TOWER
- LIGHT POLE
- UTILITY POLE
- FIRE HYDRANT
- WELL (GAS)
- WELL (WATER)
- WELL (OIL)
- WELL (UNKNOWN)



ENVIRONMENTAL DATA

E & S TYPICALS

E&S TYPICALS WILL BE USED AS A PLAN AND WILL HAVE FURTHER INPUT FROM ENVIRONMENTAL INSPECTOR.

PROFILE

HORIZONTAL SCALE: 1" = 100'
100' 50' 0 100'
VERTICAL SCALE: 1" = 100'
100' 50' 0 100'

THE LOCATION OF TRENCH PLUGS AND SLOPE BREAKERS ARE INTENDED TO BE USED AS A GUIDELINE ONLY. EXACT LOCATION TO BE DETERMINED IN THE FIELD.

SLOPE BREAKERS ○
TRENCH PLUG ▲

PERMANENT SLOPE BREAKER & TRENCH PLUG SPACING

% SLOPE	SLOPE BREAKER SPACING (FT)	% SLOPE	TRENCH PLUG SPACING (FT)
5-15%	300 FT	<5%	NO STRUCTURE
15-30%	200 FT	5-15%	300 FT
>30%	100 FT	15-30%	200 FT
		>30%	100 FT

IN AG FIELDS AND RESIDENTIAL AREAS WHERE SLOPE BREAKERS ARE NOT TYPICALLY REQUIRED, INSTALL PERMANENT TRENCH PLUGS AT THE SAME SPACING AS IF PERMANENT SLOPE BREAKERS WERE REQUIRED. (FERC PLAN)

LAND USE CLASSIFICATION

CC CULTIVATED CROPS | DF DECIDUOUS FOREST | D/OS DEVELOPED OPEN SPACE
EF EVERGREEN FOREST | S/S SHRUB SCRUB | D/LI DEVELOPED LOW INTENSITY
H/P HAY PASTURE | MF MIXED FOREST | D/MI DEVELOPED MEDIUM INTENSITY

SOILS

LAND USE

% SLOPE

STAMP/SEAL

CLAY T. WILLIS — STRUCTURAL — NO. 49136 — COMMONWEALTH OF MASSACHUSETTS — REGISTERED PROFESSIONAL ENGINEER
10/23/26

THIS DOCUMENT IS RELEASED FOR THE PURPOSE OF:
BID REVIEW
IT IS NOT TO BE USED FOR:
CONSTRUCTION, RECORDATION, CONVEYANCE, SALES, OR AS THE BASIS FOR THE ISSUANCE OF A PERMIT
UNDER THE AUTHORITY OF:
PE NAME: CLAY WILLIS
PE STATE: MASSACHUSETTS
PE NUMBER: 49136

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		F	01/29/26	TL	JL	RE-ISSUED FOR BID
		E	08/21/25	TL	JL	ISSUED FOR BID
		D	07/07/25	TL	JL	ISSUED FOR REVIEW (90% DESIGN)
		C	04/08/25	TL	RAL	ISSUED FOR REVIEW (60% DESIGN)
		B	02/26/24	LBJ	JL	ISSUED FOR REVIEW
		A	11/16/23	LBJ	JL	ISSUED FOR REVIEW

wood. WOOD GROUP USA, INC.

DRAWN BY:	LBJ	02/26/24
DESIGN CHECKER:	JL	02/26/24
DESIGN ENGINEER:	PA	02/26/24
PROJECT MANAGER:	EL	02/26/24

ENBRIDGE
CAPE COD CANAL PIPELINE RELOCATION PROJECT
PROPOSED 18" G-31 PIPELINE
TITLE: ALIGNMENT SHEET

ENBRIDGE

LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

Algonquin Gas Transmission
915 N. Eldridge Parkway, Houston, TX 77079-2703 (713) 627-5400

TITLE	INITIALS	DATE	YEAR:	W.O.:	SCALE:	DWG.:	REV.:
			2026	AFE 30002835	1" = 100'	GSYS-P.500-0007	F

M:\25927\MAPPING\DRAWINGS\M-ALIGNMENT\RE-ISSUED FOR BID\25927-G_31

RIGHT-OF-WAY

TRACT NUMBERS

SURVEY DATA

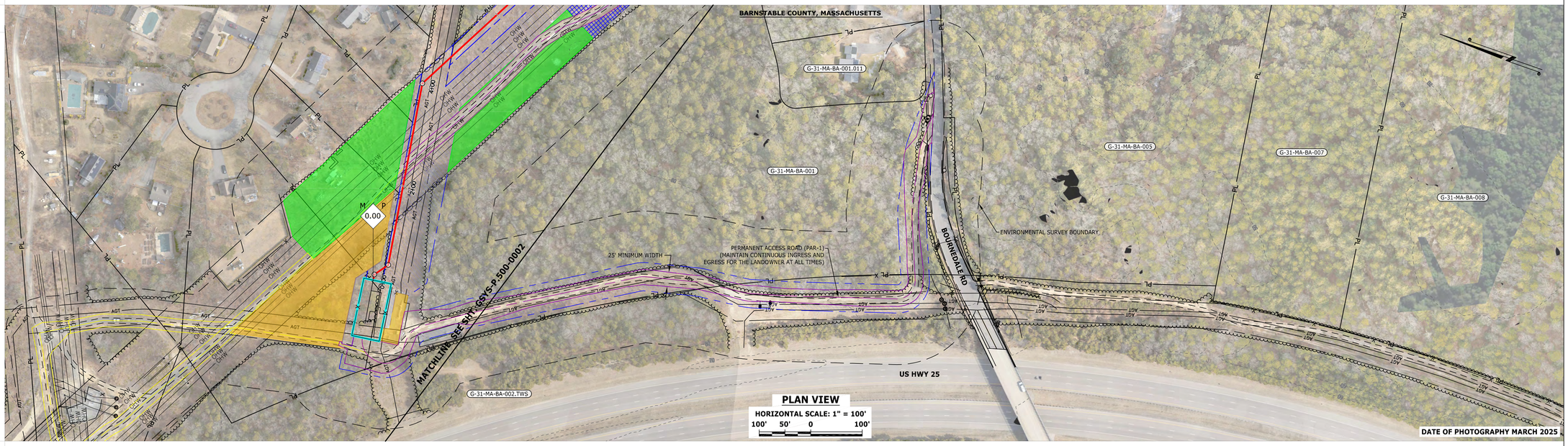
SURVEY COMPANY:
FIELD BOOK:
PAGES:

CLASS LOCATION

PIPE MATERIAL

ALIGNMENT LEGEND

- PIPELINE MILEPOST
- PROPOSED G-31 PIPELINE
- PROPOSED G-32 PIPELINE
- CONSTRUCTION LIMIT
- WAREYARD / STAGING AREA
- EXISTING PERMANENT ROW
- PROPOSED PERMANENT ROW
- ADDITIONAL TEMPORARY WORKSPACE
- PROPOSED METERING & REGULATING STATION (M&R) SITE / PIG TRAP SITE
- FACILITIES TEMPORARY WORKSPACE
- FACILITIES PERMANENT WORKSPACE
- PROPOSED GRAVEL AREA
- DELINEATED WETLAND BOUNDARY
- DELINEATED WATERBODY BANK
- DELINEATED WATERBODY CENTERLINE
- PERMANENT ACCESS ROAD
- TEMPORARY ACCESS ROAD
- PROPERTY LINE
- MAJOR CONTOUR
- MUNICIPALITY LINE
- ENVIRONMENTAL SURVEY BOUNDARY
- FENCE
- EXISTING AGT PIPELINE
- FOREIGN PIPELINE
- POWERLINE
- WATER PIPELINE
- RAILROAD TRACK
- OVERHEAD WIRE
- TELEPHONE LINE
- UTILITY LINES
- SANITARY SEWER
- TEE TAP
- BLOW OFF VALVE
- MAINLINE VALVE (MLV)
- POINT OF INTERSECTION
- BORE ENTRY/EXIT
- TRANSMISSION TOWER
- LIGHT POLE
- UTILITY POLE
- FIRE HYDRANT
- WELL (GAS)
- WELL (WATER)
- WELL (OIL)
- WELL (UNKNOWN)



ENVIRONMENTAL DATA

E & S TYPICALS

E&S TYPICALS WILL BE USED AS A PLAN AND WILL HAVE FURTHER INPUT FROM ENVIRONMENTAL INSPECTOR.

PROFILE

HORIZONTAL SCALE: 1" = 100'
100' 50' 0 100'

VERTICAL SCALE: 1" = 100'
100' 50' 0 100'

THE LOCATION OF TRENCH PLUGS AND SLOPE BREAKERS ARE INTENDED TO BE USED AS A GUIDELINE ONLY. EXACT LOCATION TO BE DETERMINED IN THE FIELD.

SLOPE BREAKERS ○
TRENCH PLUG ▲

PERMANENT SLOPE BREAKER & TRENCH PLUG SPACING

% SLOPE	SLOPE BREAKER SPACING (FT)	% SLOPE	TRENCH PLUG SPACING (FT)
5-15%	300 FT	<5%	NO STRUCTURE
15-30%	200 FT	5-15%	300 FT
>30%	100 FT	15-30%	200 FT
		>30%	100 FT

IN AG FIELDS AND RESIDENTIAL AREAS WHERE SLOPE BREAKERS ARE NOT TYPICALLY REQUIRED, INSTALL PERMANENT TRENCH PLUGS AT THE SAME SPACING AS IF PERMANENT SLOPE BREAKERS WERE REQUIRED. (FERC PLAN)

LAND USE CLASSIFICATION

CC CULTIVATED CROPS DF DECIDUOUS FOREST D/OS DEVELOPED OPEN SPACE
EF EVERGREEN FOREST S/S SHRUB SCRUB D/LI DEVELOPED LOW INTENSITY
H/P HAY PASTURE MF MIXED FOREST D/MI DEVELOPED MEDIUM INTENSITY

SOILS

LAND USE

% SLOPE

STAMP/SEAL

CLAY H. WILLIS STRUCTURAL No. 49136 REGISTERED PROFESSIONAL ENGINEER
5/23/26

THIS DOCUMENT IS RELEASED FOR THE PURPOSE OF:
BID REVIEW
IT IS NOT TO BE USED FOR:
CONSTRUCTION, RECORDATION, CONVEYANCE, SALES, OR AS THE BASIS FOR THE ISSUANCE OF A PERMIT
UNDER THE AUTHORITY OF:
PE NAME: CLAY WILLIS
PE STATE: MASSACHUSETTS
PE NUMBER: 49136

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		D	01/29/26	TL	JL	RE-ISSUED FOR BID
		C	08/21/25	TL	JL	ISSUED FOR BID
		B	07/07/25	TL	JL	ISSUED FOR REVIEW (90% DESIGN)
GSYS-C.300-0002	ACCESS ROAD PLAN AND PROFILE	A	04/08/25	TL	RAL	ISSUED FOR REVIEW (60% DESIGN)

wood. WOOD GROUP USA, INC.

TITLE	INITIALS	DATE
DRAWN BY:	TL	04/01/25
DESIGN CHECKER:	JL	04/02/25
DESIGN ENGINEER:	PA	04/08/25
PROJECT MANAGER:	EL	04/08/25

ENBRIDGE
CAPE COD CANAL PIPELINE RELOCATION PROJECT
PROPOSED 18" G-31 PIPELINE
TITLE: ALIGNMENT SHEET

LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

YEAR: 2026 | W.O.: AFE 30002835 | SCALE: 1" = 100'

DWG.: GSYS-P.500-0020 | REV.: D

ENBRIDGE
Algonquin Gas Transmission
915 N. Eldridge Parkway, Houston, TX 77079-2703 (713) 627-5400

M:\259271\MAPPING\DRAWINGS\P-ALIGNMENT\RE-ISSUED FOR BID\259271-G-31

RIGHT-OF-WAY

TRACT NUMBERS

SURVEY DATA

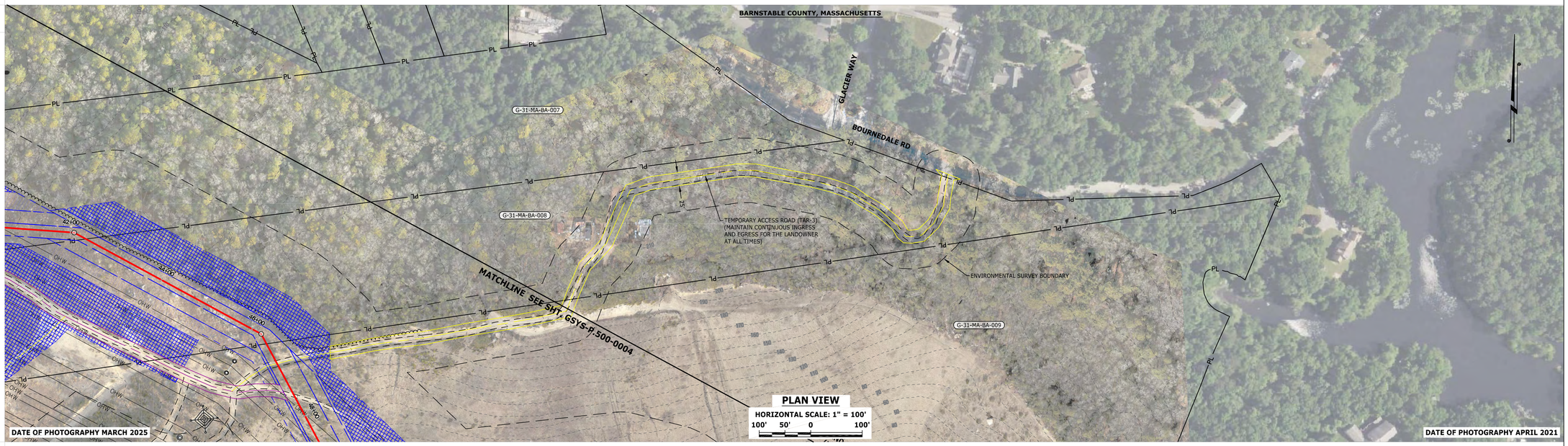
SURVEY COMPANY:
FIELD BOOK:
PAGES:

CLASS LOCATION

PIPE MATERIAL

ALIGNMENT LEGEND

- PIPELINE MILEPOST
- PROPOSED G-31 PIPELINE
- PROPOSED G-32 PIPELINE
- CONSTRUCTION LIMIT
- WAREYARD / STAGING AREA
- EXISTING PERMANENT ROW
- PROPOSED PERMANENT ROW
- ADDITIONAL TEMPORARY WORKSPACE
- PROPOSED METERING & REGULATING STATION (M&R) SITE / PIG TRAP SITE
- FACILITIES TEMPORARY WORKSPACE
- FACILITIES PERMANENT WORKSPACE
- PROPOSED GRAVEL AREA
- DELINEATED WETLAND BOUNDARY
- DELINEATED WATERBODY BANK
- DELINEATED WATERBODY CENTERLINE
- PERMANENT ACCESS ROAD
- TEMPORARY ACCESS ROAD
- PROPERTY LINE — PL —
- MAJOR CONTOUR — -100'- —
- MUNICIPALITY LINE
- ENVIRONMENTAL SURVEY BOUNDARY
- FENCE — X —
- EXISTING AGT PIPELINE — AGT —
- FOREIGN PIPELINE — II —
- POWERLINE — P —
- WATER PIPELINE — W —
- RAILROAD TRACK — T —
- OVERHEAD WIRE — OHW —
- TELEPHONE LINE — C —
- UTILITY LINES
- SANITARY SEWER — SAN —
- TEE TAP
- BLOW OFF VALVE
- MAINLINE VALVE (MLV)
- POINT OF INTERSECTION
- BORE ENTRY/EXIT
- TRANSMISSION TOWER
- LIGHT POLE
- UTILITY POLE
- FIRE HYDRANT
- WELL (GAS)
- WELL (WATER)
- WELL (OIL)
- WELL (UNKNOWN)



PLAN VIEW
HORIZONTAL SCALE: 1" = 100'
100' 50' 0 100'

ENVIRONMENTAL DATA

E & S TYPICALS

E&S TYPICALS WILL BE USED AS A PLAN AND WILL HAVE FURTHER INPUT FROM ENVIRONMENTAL INSPECTOR.

PROFILE

HORIZONTAL SCALE: 1" = 100'
100' 50' 0 100'
VERTICAL SCALE: 1" = 100'
100' 50' 0 100'

THE LOCATION OF TRENCH PLUGS AND SLOPE BREAKERS ARE INTENDED TO BE USED AS A GUIDELINE ONLY. EXACT LOCATION TO BE DETERMINED IN THE FIELD.

SLOPE BREAKERS ○
TRENCH PLUG ▲

PERMANENT SLOPE BREAKER & TRENCH PLUG SPACING

% SLOPE	SLOPE BREAKER SPACING (FT)	% SLOPE	TRENCH PLUG SPACING (FT)
5-15%	300 FT	<5%	NO STRUCTURE
15-30%	200 FT	5-15%	300 FT
>30%	100 FT	15-30%	200 FT
		>30%	100 FT

IN AG FIELDS AND RESIDENTIAL AREAS WHERE SLOPE BREAKERS ARE NOT TYPICALLY REQUIRED, INSTALL PERMANENT TRENCH PLUGS AT THE SAME SPACING AS IF PERMANENT SLOPE BREAKERS WERE REQUIRED. (FERC PLAN)

LAND USE CLASSIFICATION

CC	CULTIVATED CROPS	DF	DECIDUOUS FOREST
D/OS	DEVELOPED OPEN SPACE		
EF	EVERGREEN FOREST	S/S	SHRUB SCRUB
D/LI	DEVELOPED LOW INTENSITY		
H/P	HAY PASTURE	MF	MIXED FOREST
D/MI	DEVELOPED MEDIUM INTENSITY		

SOILS
LAND USE
% SLOPE

STAMP/SEAL

COMMONWEALTH OF MASSACHUSETTS — CLAY C. WILLIS — 52,671 — PROFESSIONAL ENGINEER — 05/22/26

THIS DOCUMENT IS RELEASED FOR THE PURPOSE OF:
BID REVIEW
IT IS NOT TO BE USED FOR:
CONSTRUCTION, RECORDATION, CONVEYANCE, SALES, OR AS THE BASIS FOR THE ISSUANCE OF A PERMIT

UNDER THE AUTHORITY OF:
PE NAME: CLAY WILLIS
PE STATE: MASSACHUSETTS
PE NUMBER 49136

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		D	01/29/26	TL	JL	RE-ISSUED FOR BID
		C	08/21/25	TL	JL	ISSUED FOR BID
		B	07/07/25	TL	JL	ISSUED FOR REVIEW (90% DESIGN)
		A	04/08/25	TL	RAL	ISSUED FOR REVIEW (60% DESIGN)

wood. WOOD GROUP USA, INC.

TITLE	INITIALS	DATE
DRAWN BY:	TL	04/01/25
DESIGN CHECKER:	JL	04/02/25
DESIGN ENGINEER:	PA	04/08/25
PROJECT MANAGER:	EL	04/08/25

ENBRIDGE
CAPE COD CANAL PIPELINE RELOCATION PROJECT
PROPOSED 18" G-31 PIPELINE
TITLE: ALIGNMENT SHEET
LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

YEAR: 2026 | W.O.: AFE 30002835 | SCALE: 1" = 100' | DWG.: GSYS-P.500-0021 | REV.: D

ENBRIDGE
Algonquin Gas Transmission
915 N. Eldridge Parkway, Houston, TX 77079-2703 (713) 627-5400

M:\25\27\1\MAPPING\DRAWINGS\01-ALIGNMENT\RE-ISSUED FOR BID\25271-G_31

RIGHT-OF-WAY

TRACT NUMBERS

SURVEY DATA

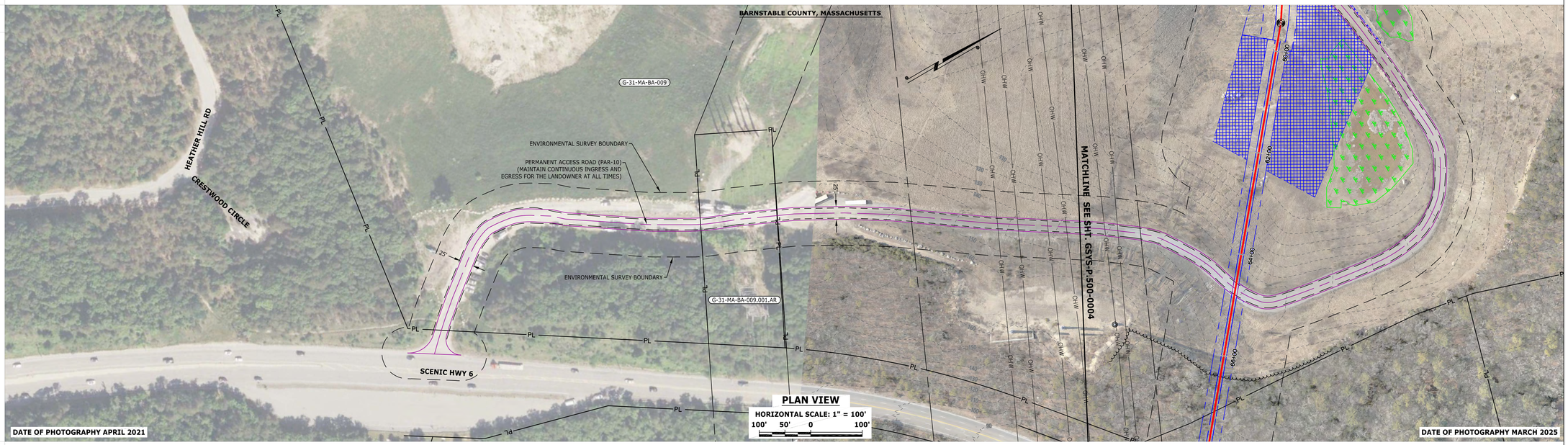
SURVEY COMPANY:
FIELD BOOK:
PAGES:

CLASS LOCATION

PIPE MATERIAL

ALIGNMENT LEGEND

- PIPELINE MILEPOST
- PROPOSED G-31 PIPELINE
- PROPOSED G-32 PIPELINE
- CONSTRUCTION LIMIT
- WAREYARD / STAGING AREA
- EXISTING PERMANENT ROW
- PROPOSED PERMANENT ROW
- ADDITIONAL TEMPORARY WORKSPACE
- PROPOSED METERING & REGULATING STATION (M&R) SITE / PIG TRAP SITE
- FACILITIES TEMPORARY WORKSPACE
- FACILITIES PERMANENT WORKSPACE
- PROPOSED GRAVEL AREA
- DELINEATED WETLAND BOUNDARY
- DELINEATED WATERBODY BANK
- DELINEATED WATERBODY CENTERLINE
- PERMANENT ACCESS ROAD
- TEMPORARY ACCESS ROAD
- PROPERTY LINE — PL —
- MAJOR CONTOUR - -100'- -
- MUNICIPALITY LINE
- ENVIRONMENTAL SURVEY BOUNDARY
- FENCE — X —
- EXISTING AGT PIPELINE — AGT —
- FOREIGN PIPELINE — || —
- POWERLINE — P —
- WATER PIPELINE — W —
- RAILROAD TRACK — | —
- OVERHEAD WIRE — OHW —
- TELEPHONE LINE — C —
- UTILITY LINES
- SANITARY SEWER — SAN —
- TEE TAP
- BLOW OFF VALVE
- MAINLINE VALVE (MLV)
- POINT OF INTERSECTION
- BORE ENTRY/EXIT
- TRANSMISSION TOWER
- LIGHT POLE
- UTILITY POLE
- FIRE HYDRANT
- WELL (GAS)
- WELL (WATER)
- WELL (OIL)
- WELL (UNKNOWN)



PLAN VIEW

HORIZONTAL SCALE: 1" = 100'

100' 50' 0 100'

ENVIRONMENTAL DATA

E & S TYPICALS

E&S TYPICALS WILL BE USED AS A PLAN AND WILL HAVE FURTHER INPUT FROM ENVIRONMENTAL INSPECTOR.

PROFILE

HORIZONTAL SCALE: 1" = 100'

100' 50' 0 100'

VERTICAL SCALE: 1" = 100'

100' 50' 0 100'

THE LOCATION OF TRENCH PLUGS AND SLOPE BREAKERS ARE INTENDED TO BE USED AS A GUIDELINE ONLY. EXACT LOCATION TO BE DETERMINED IN THE FIELD.

SLOPE BREAKERS
TRENCH PLUG

PERMANENT SLOPE BREAKER & TRENCH PLUG SPACING

% SLOPE	SLOPE BREAKER SPACING (FT)	% SLOPE	TRENCH PLUG SPACING (FT)
5-15%	300 FT	<5%	NO STRUCTURE
15-30%	200 FT	5-15%	300 FT
>30%	100 FT	15-30%	200 FT
		>30%	100 FT

IN AG FIELDS AND RESIDENTIAL AREAS WHERE SLOPE BREAKERS ARE NOT TYPICALLY REQUIRED, INSTALL PERMANENT TRENCH PLUGS AT THE SAME SPACING AS IF PERMANENT SLOPE BREAKERS WERE REQUIRED. (FERC PLAN)

LAND USE CLASSIFICATION

CC CULTIVATED CROPS	DF DECIDUOUS FOREST	D/OS DEVELOPED OPEN SPACE	
EF EVERGREEN FOREST	S/S SHRUB SCRUB	D/LI DEVELOPED LOW INTENSITY	
H/P HAY PASTURE	MF MIXED FOREST	D/MI DEVELOPED MEDIUM INTENSITY	

SOILS

LAND USE

% SLOPE

STAMP/SEAL

COMMONWEALTH OF MASSACHUSETTS — CLAY H. WILLIS — NO. 49136 — REGISTERED PROFESSIONAL ENGINEER — STRUCTURAL
10/23/26

THIS DOCUMENT IS RELEASED FOR THE PURPOSE OF:
BID REVIEW
IT IS NOT TO BE USED FOR:
CONSTRUCTION, RECORDATION, CONVEYANCE, SALES, OR AS THE BASIS FOR THE ISSUANCE OF A PERMIT

UNDER THE AUTHORITY OF:
PE NAME: CLAY WILLIS
PE STATE: MASSACHUSETTS
PE NUMBER: 49136

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		D	01/29/26	TL	JL	RE-ISSUED FOR BID
		C	08/21/25	TL	JL	ISSUED FOR BID
		B	07/07/25	TL	JL	ISSUED FOR REVIEW (90% DESIGN)
		A	04/08/25	TL	RAL	ISSUED FOR REVIEW (60% DESIGN)

wood. WOOD GROUP USA, INC.

TITLE	INITIALS	DATE
DRAWN BY:	TL	04/01/25
DESIGN CHECKER:	JL	04/02/25
DESIGN ENGINEER:	PA	04/08/25
PROJECT MANAGER:	EL	04/08/25

ENBRIDGE
CAPE COD CANAL PIPELINE RELOCATION PROJECT
PROPOSED 18" G-31 PIPELINE
TITLE: ALIGNMENT SHEET

LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

YEAR: 2026 | W.O.: AFE 30002835 | SCALE: 1" = 100' | DWG.: GSYS-P.500-0022 | REV.: D

ENBRIDGE

Algonquin Gas Transmission
915 N. Eldridge Parkway, Houston, TX 77079-2703 (713) 627-5400

M:\25927\TWAPPING\DRAWINGS\P-ALIGNMENT\ISSUED FOR BID\25927-P_S1

RIGHT-OF-WAY

TRACT NUMBERS

SURVEY DATA

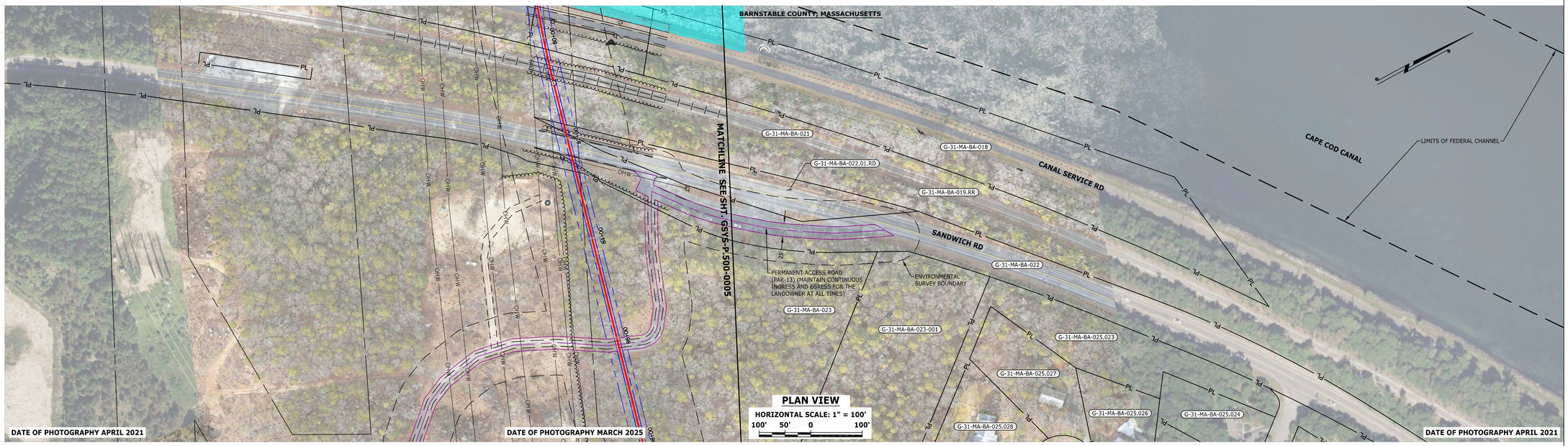
SURVEY COMPANY:
FIELD BOOK:
PAGES:

CLASS LOCATION

PIPE MATERIAL

ALIGNMENT LEGEND

- PIPELINE MILEPOST
- PROPOSED G-31 PIPELINE
- PROPOSED G-32 PIPELINE
- CONSTRUCTION LIMIT
- WAREYARD / STAGING AREA
- EXISTING PERMANENT ROW
- PROPOSED PERMANENT ROW
- ADDITIONAL TEMPORARY WORKSPACE
- PROPOSED METERING & REGULATING STATION (M&R) SITE / PIG TRAP SITE
- FACILITIES TEMPORARY WORKSPACE
- FACILITIES PERMANENT WORKSPACE
- PROPOSED GRAVEL AREA
- DELINEATED WETLAND BOUNDARY
- DELINEATED WATERBODY BANK
- DELINEATED WATERBODY CENTERLINE
- PERMANENT ACCESS ROAD
- TEMPORARY ACCESS ROAD
- PROPERTY LINE — PL —
- MAJOR CONTOUR - -100'- -
- MUNICIPALITY LINE
- ENVIRONMENTAL SURVEY BOUNDARY
- FENCE — X —
- EXISTING AGT PIPELINE — AGT —
- FOREIGN PIPELINE — || —
- POWERLINE — P —
- WATER PIPELINE — W —
- RAILROAD TRACK — | —
- OVERHEAD WIRE — OHW —
- TELEPHONE LINE — C —
- UTILITY LINES
- SANITARY SEWER — SAN —
- TEE TAP
- BLOW OFF VALVE
- MAINLINE VALVE (MLV)
- POINT OF INTERSECTION
- BORE ENTRY/EXIT
- TRANSMISSION TOWER
- LIGHT POLE
- UTILITY POLE
- FIRE HYDRANT
- WELL (GAS)
- WELL (WATER)
- WELL (OIL)
- WELL (UNKNOWN)



PLAN VIEW
HORIZONTAL SCALE: 1" = 100'
100' 50' 0 100'

ENVIRONMENTAL DATA

E & S TYPICALS

E&S TYPICALS WILL BE USED AS A PLAN AND WILL HAVE FURTHER INPUT FROM ENVIRONMENTAL INSPECTOR.

PROFILE

HORIZONTAL SCALE: 1" = 100'
100' 50' 0 100'
VERTICAL SCALE: 1" = 100'
100' 50' 0 100'

THE LOCATION OF TRENCH PLUGS AND SLOPE BREAKERS ARE INTENDED TO BE USED AS A GUIDELINE ONLY. EXACT LOCATION TO BE DETERMINED IN THE FIELD.

SLOPE BREAKERS ○
TRENCH PLUG ▲

PERMANENT SLOPE BREAKER & TRENCH PLUG SPACING

% SLOPE	SLOPE BREAKER SPACING (FT)	% SLOPE	TRENCH PLUG SPACING (FT)
5-15%	300 FT	<5%	NO STRUCTURE
15-30%	200 FT	5-15%	300 FT
>30%	100 FT	15-30%	200 FT
		>30%	100 FT

IN AG FIELDS AND RESIDENTIAL AREAS WHERE SLOPE BREAKERS ARE NOT TYPICALLY REQUIRED, INSTALL PERMANENT TRENCH PLUGS AT THE SAME SPACING AS IF PERMANENT SLOPE BREAKERS WERE REQUIRED. (FERC PLAN)

LAND USE CLASSIFICATION

CC CULTIVATED CROPS DF DECIDUOUS FOREST D/OS DEVELOPED OPEN SPACE
EF EVERGREEN FOREST S/S SHRUB SCRUB D/LI DEVELOPED LOW INTENSITY
H/P HAY PASTURE MF MIXED FOREST D/MI DEVELOPED MEDIUM INTENSITY

SOILS

LAND USE

% SLOPE

STAMP/SEAL

COMMONWEALTH OF MASSACHUSETTS — CLAY H. WILLIS — STRUCTURAL — NO. 49136 — REGISTERED PROFESSIONAL ENGINEER — 04/23/26

THIS DOCUMENT IS RELEASED FOR THE PURPOSE OF:
BID REVIEW
IT IS NOT TO BE USED FOR:
CONSTRUCTION, RECORDATION, CONVEYANCE, SALES, OR AS THE BASIS FOR THE ISSUANCE OF A PERMIT

UNDER THE AUTHORITY OF:
PE NAME: CLAY WILLIS
PE STATE: MASSACHUSETTS
PE NUMBER 49136

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		D	01/29/26	TL	JL	RE-ISSUED FOR BID
		C	08/21/25	TL	JL	ISSUED FOR BID
		B	07/07/25	TL	JL	ISSUED FOR REVIEW (90% DESIGN)
		A	04/08/25	TL	RAL	ISSUED FOR REVIEW (60% DESIGN)

wood. WOOD GROUP USA, INC.

	INITIALS	DATE
DRAWN BY:	TL	04/01/25
DESIGN CHECKER:	JL	04/02/25
DESIGN ENGINEER:	PA	04/08/25
PROJECT MANAGER:	EL	04/08/25

ENBRIDGE
CAPE COD CANAL PIPELINE RELOCATION PROJECT
PROPOSED 18" G-31 PIPELINE
TITLE: ALIGNMENT SHEET
LOC.: BARNSTABLE COUNTY, MASSACHUSETTS
YEAR: 2026 W.O.: AFE 30002835 SCALE: 1" = 100'
DWG.: GSYS-P.500-0023 REV.: D

ENBRIDGE
Algonquin Gas Transmission
915 N. Eldridge Parkway, Houston, TX 77079-2703 (713) 627-5400

M:\259271\MAPPING\DRAWINGS\P-ALIGNMENT\RE-ISSUED FOR BID\259271-G_31

RIGHT-OF-WAY

TRACT NUMBERS

SURVEY DATA

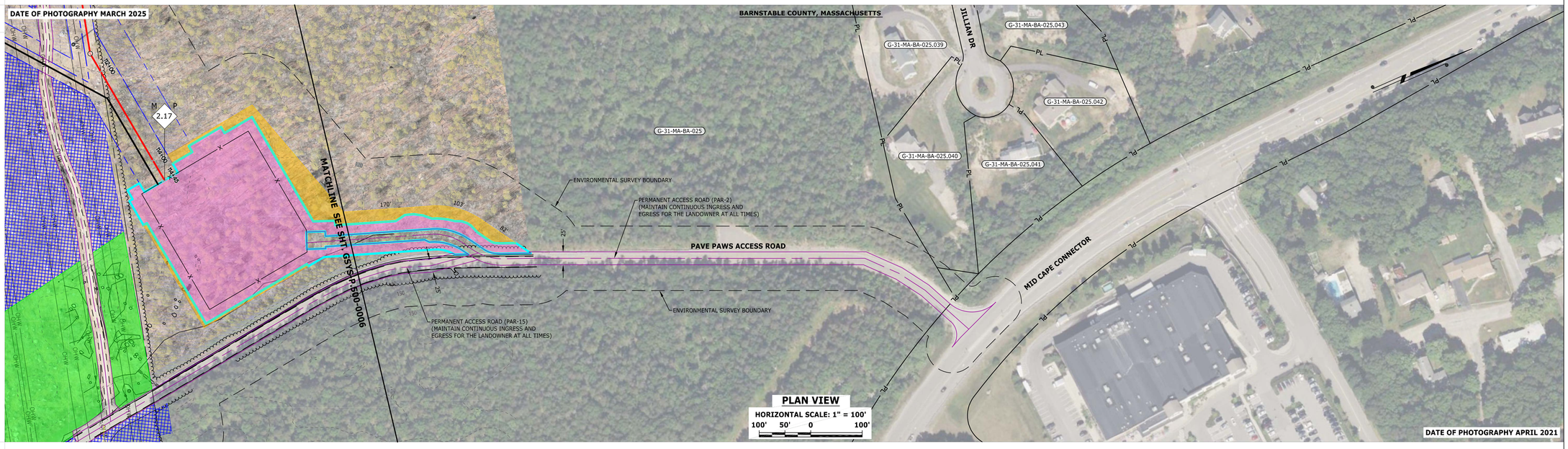
SURVEY COMPANY:
FIELD BOOK:
PAGES:

CLASS LOCATION

PIPE MATERIAL

ALIGNMENT LEGEND

- PIPELINE MILEPOST
- PROPOSED G-31 PIPELINE
- PROPOSED G-32 PIPELINE
- CONSTRUCTION LIMIT
- WAREYARD / STAGING AREA
- EXISTING PERMANENT ROW
- PROPOSED PERMANENT ROW
- ADDITIONAL TEMPORARY WORKSPACE
- PROPOSED METERING & REGULATING STATION (M&R) SITE / PIG TRAP SITE
- FACILITIES TEMPORARY WORKSPACE
- FACILITIES PERMANENT WORKSPACE
- PROPOSED GRAVEL AREA
- DELINEATED WETLAND BOUNDARY
- DELINEATED WATERBODY BANK
- DELINEATED WATERBODY CENTERLINE
- PERMANENT ACCESS ROAD
- TEMPORARY ACCESS ROAD
- PROPERTY LINE
- MAJOR CONTOUR
- MUNICIPALITY LINE
- ENVIRONMENTAL SURVEY BOUNDARY
- FENCE
- EXISTING AGT PIPELINE
- FOREIGN PIPELINE
- POWERLINE
- WATER PIPELINE
- RAILROAD TRACK
- OVERHEAD WIRE
- TELEPHONE LINE
- UTILITY LINES
- SANITARY SEWER
- TEE TAP
- BLOW OFF VALVE
- MAINLINE VALVE (MLV)
- POINT OF INTERSECTION
- BORE ENTRY/EXIT
- TRANSMISSION TOWER
- LIGHT POLE
- UTILITY POLE
- FIRE HYDRANT
- WELL (GAS)
- WELL (WATER)
- WELL (OIL)
- WELL (UNKNOWN)



ENVIRONMENTAL DATA

E & S TYPICALS

E&S TYPICALS WILL BE USED AS A PLAN AND WILL HAVE FURTHER INPUT FROM ENVIRONMENTAL INSPECTOR.

PROFILE

HORIZONTAL SCALE: 1" = 100'
100' 50' 0 100'

VERTICAL SCALE: 1" = 100'
100' 50' 0 100'

THE LOCATION OF TRENCH PLUGS AND SLOPE BREAKERS ARE INTENDED TO BE USED AS A GUIDELINE ONLY. EXACT LOCATION TO BE DETERMINED IN THE FIELD.

SLOPE BREAKERS ○
TRENCH PLUG ▲

PERMANENT SLOPE BREAKER & TRENCH PLUG SPACING

% SLOPE	SLOPE BREAKER SPACING (FT)	% SLOPE	TRENCH PLUG SPACING (FT)
5-15%	300 FT	<5%	NO STRUCTURE
15-30%	200 FT	5-15%	300 FT
>30%	100 FT	15-30%	200 FT
		>30%	100 FT

IN AG FIELDS AND RESIDENTIAL AREAS WHERE SLOPE BREAKERS ARE NOT TYPICALLY REQUIRED, INSTALL PERMANENT TRENCH PLUGS AT THE SAME SPACING AS IF PERMANENT SLOPE BREAKERS WERE REQUIRED. (FERC PLAN)

LAND USE CLASSIFICATION

CC CULTIVATED CROPS DF DECIDUOUS FOREST D/OS DEVELOPED OPEN SPACE
EF EVERGREEN FOREST S/S SHRUB SCRUB D/LI DEVELOPED LOW INTENSITY
H/P HAY PASTURE MF MIXED FOREST D/MI DEVELOPED MEDIUM INTENSITY

SOILS

LAND USE

% SLOPE

STAMP/SEAL

COMMONWEALTH OF MASSACHUSETTS — CLAY H. WILLIS — STRUCTURAL — NO. 49136 — REGISTERED PROFESSIONAL ENGINEER — 04/23/26

THIS DOCUMENT IS RELEASED FOR THE PURPOSE OF:
BID REVIEW
IT IS NOT TO BE USED FOR:
CONSTRUCTION, RECORDATION, CONVEYANCE, SALES, OR AS THE BASIS FOR THE ISSUANCE OF A PERMIT
UNDER THE AUTHORITY OF:
PE NAME: CLAY WILLIS
PE STATE: MASSACHUSETTS
PE NUMBER 49136

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		D	01/29/26	TL	JL	RE-ISSUED FOR BID
		C	08/21/25	TL	JL	ISSUED FOR BID
		B	07/07/25	TL	JL	ISSUED FOR REVIEW (90% DESIGN)
		A	04/08/25	TL	RAL	ISSUED FOR REVIEW (60% DESIGN)

WOOD GROUP USA, INC.

	INITIALS	DATE
DRAWN BY:	TL	04/01/25
DESIGN CHECKER:	JL	04/02/25
DESIGN ENGINEER:	PA	04/08/25
PROJECT MANAGER:	EL	04/08/25

ENBRIDGE
CAPE COD CANAL PIPELINE RELOCATION PROJECT
PROPOSED 18" G-31 PIPELINE
TITLE: ALIGNMENT SHEET
LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

YEAR: 2026 | W.O.: AFE 30002835 | SCALE: 1" = 100'

ENBRIDGE
Algonquin Gas Transmission
915 N. Eldridge Parkway, Houston, TX 77079-2703 (713) 627-5400

DWG.: GSYS-P.500-0024 | REV.: D

M:\239271\MAPPING\DRAWINGS\P1-ALIGNMENT\RE-ISSUED FOR BID\239271-G_01

RIGHT-OF-WAY

TRACT NUMBERS

G-32-MA-BA-001 — 113 FT. — 12+87 — G-32-MA-BA-001.001 — 1287 FT.

SURVEY DATA

SURVEY COMPANY:
FIELD BOOK:
PAGES:

14+00: 11+96 TREE LINE; 11+27 TREE LINE

7+91 TREE LINE; 7+15 TREE LINE; 6+33 P.I. <52°30'00" RT.; 6+19 TREE LINE; 5+83 OH POWERLINE; 5+26 OH POWERLINE; 5+05 OH POWERLINE; 5+14 OH POWERLINE; 5+04 OH POWERLINE; 4+90 OH POWERLINE; 3+95 OH POWERLINE; 3+68 OH POWERLINE; 3+36 EDGE OF GRAVEL; 3+30 OH POWERLINE; 3+30 PERMANENT ACCESS ROAD (PAR-14); 3+23 EDGE OF GRAVEL; 2+64 OH POWERLINE; 2+45 OH POWERLINE; 1+93 P.I. <31°10'54" LT.; 1+92 TREE LINE

0+00 BEGIN PIPELINE

CLASS LOCATION

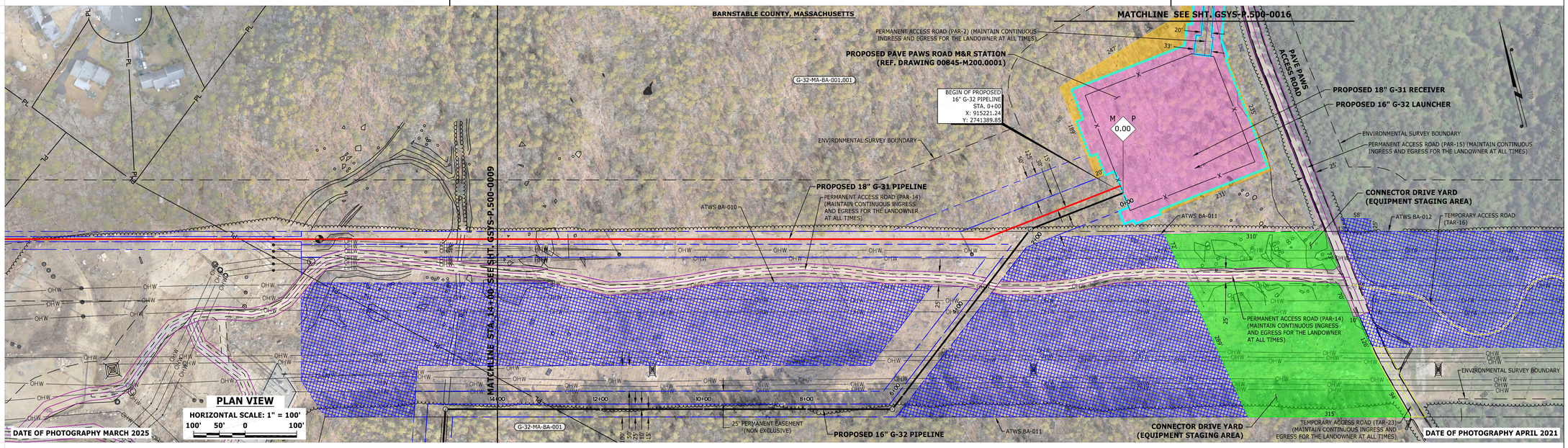
14+00 — CLASS 1 — 0+00

PIPE MATERIAL

14+00 — 16" O.D. X 0.375" W.T., API 5L, X-52, 16-20 MILS FBE — 1400 FT. — 0+00

ALIGNMENT LEGEND

- PIPELINE MILEPOST
- PROPOSED G-31 PIPELINE
- PROPOSED G-32 PIPELINE
- CONSTRUCTION LIMIT
- WAREYARD / STAGING AREA
- EXISTING PERMANENT ROW
- PROPOSED PERMANENT ROW
- ADDITIONAL TEMPORARY WORKSPACE
- PROPOSED METERING & REGULATING STATION (M&R) SITE / PIG TRAP SITE
- FACILITIES TEMPORARY WORKSPACE
- FACILITIES PERMANENT WORKSPACE
- PROPOSED GRAVEL AREA
- DELINEATED WETLAND BOUNDAY
- DELINEATED WATERBODY BANK
- DELINEATED WATERBODY CENTERLINE
- PERMANENT ACCESS ROAD
- TEMPORARY ACCESS ROAD
- PROPERTY LINE (PL)
- MAJOR CONTOUR (-100'-)
- MUNICIPALITY LINE
- ENVIRONMENTAL SURVEY BOUNDARY
- FENCE (X)
- EXISTING AGT PIPELINE (AGT)
- FOREIGN PIPELINE (F)
- POWERLINE (P)
- WATER PIPELINE (W)
- RAILROAD TRACK (T)
- OVERHEAD WIRE (OHW)
- TELEPHONE LINE (C)
- UTILITY LINES
- SANITARY SEWER (SAN)
- TEE TAP
- BLOW OFF VALVE
- MAINLINE VALVE (MLV)
- POINT OF INTERSECTION
- BORE ENTRY/EXIT
- TRANSMISSION TOWER
- LIGHT POLE
- UTILITY POLE
- FIRE HYDRANT
- WELL (GAS)
- WELL (WATER)
- WELL (OIL)
- WELL (UNKNOWN)



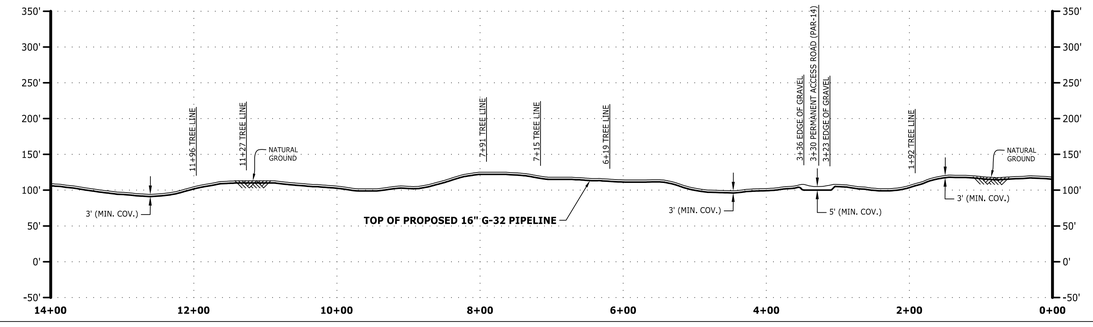
ENVIRONMENTAL DATA

E & S TYPICALS

E&S TYPICALS WILL BE USED AS A PLAN AND WILL HAVE FURTHER INPUT FROM ENVIRONMENTAL INSPECTOR.

PROFILE

HORIZONTAL SCALE: 1" = 100'
100' 50' 0 100'
VERTICAL SCALE: 1" = 100'
100' 50' 0 100'



THE LOCATION OF TRENCH PLUGS AND SLOPE BREAKERS ARE INTENDED TO BE USED AS A GUIDELINE ONLY. EXACT LOCATION TO BE DETERMINED IN THE FIELD.

SLOPE BREAKERS
TRENCH PLUG

PERMANENT SLOPE BREAKER & TRENCH PLUG SPACING

% SLOPE	SLOPE BREAKER SPACING (FT)	% SLOPE	TRENCH PLUG SPACING (FT)
5-15%	300 FT	<5%	NO STRUCTURE
15-30%	200 FT	5-15%	300 FT
>30%	100 FT	15-30%	200 FT
		>30%	100 FT

IN AG FIELDS AND RESIDENTIAL AREAS WHERE SLOPE BREAKERS ARE NOT TYPICALLY REQUIRED, INSTALL PERMANENT TRENCH PLUGS AT THE SAME SPACING AS IF PERMANENT SLOPE BREAKERS WERE REQUIRED. (FERC PLAN)

LAND USE CLASSIFICATION

CC CULTIVATED CROPS · DF DECIDUOUS FOREST D/OS DEVELOPED OPEN SPACE
EF EVERGREEN FOREST S/S SHRUB SCRUB · D/LI DEVELOPED LOW INTENSITY
H/P HAY PASTURE · MF MIXED FOREST D/MI DEVELOPED MEDIUM INTENSITY

SEGMENTABLE ELBOW	QTY
90 DEG, SD, 16" OD, 0.375" WT, CS, x52, FBE COATING SYSTEM 2B	1
45 DEG, SD, 16" OD, 0.375" WT, CS, x52, FBE COATING SYSTEM 2B	0

SOILS																					
LAND USE																					
% SLOPE	15-30%	>30%	15-30%	5-15%	15-30%	5-15%	<5%	5-15%	<5%	15-30%	>30%	<5%	15-30%	<5%	5-15%	15-30%	5-15%	15-30%		5-15%	

STAMP/SEAL

COMMONWEALTH OF MASSACHUSETTS — CLAY H. WILLIS — STRUCTURAL — NO. 49136 — REGISTERED PROFESSIONAL ENGINEER — 02/26/26

THIS DOCUMENT IS RELEASED FOR THE PURPOSE OF:
BID REVIEW
IT IS NOT TO BE USED FOR: CONSTRUCTION, RECORDATION, CONVEYANCE, SALES, OR AS THE BASIS FOR THE ISSUANCE OF A PERMIT

UNDER THE AUTHORITY OF:
PE NAME: CLAY WILLIS
PE STATE: MASSACHUSETTS
PE NUMBER 49136

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		F	01/29/26	TL	JL	RE-ISSUED FOR BID
		E	08/21/25	TL	JL	ISSUED FOR BID
		D	07/07/25	TL	RAL	ISSUED FOR REVIEW (90% DESIGN)
		C	04/08/25	TL	RAL	ISSUED FOR REVIEW (60% DESIGN)
		B	02/26/24	LBJ	JL	ISSUED FOR REVIEW
00845-M.200-0001	PAVE PAWS ROAD M&R STATION - LOCATION MAP AND PLOT PLAN	A	11/16/23	LBJ	JL	ISSUED FOR REVIEW

wood. WOOD GROUP USA, INC.

TITLE	INITIALS	DATE
DRAWN BY:	LBJ	02/26/24
DESIGN CHECKER:	JL	02/26/24
DESIGN ENGINEER:	PA	02/26/24
PROJECT MANAGER:	EL	02/26/24

ENBRIDGE
CAPE COD CANAL PIPELINE RELOCATION PROJECT
PROPOSED 16" G-32 PIPELINE
TITLE: ALIGNMENT SHEET
LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

YEAR: 2026 | W.O.: AFE 30002835 | SCALE: 1" = 100' | DWG.: GSYS-P.500-0008 | REV.: F

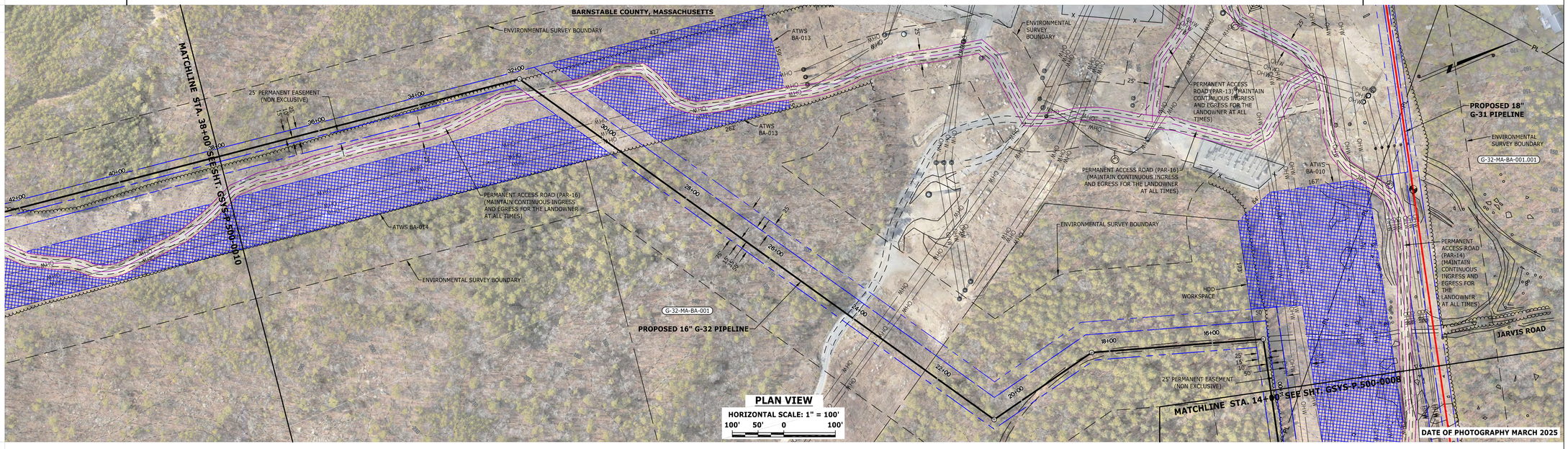
ENBRIDGE
Algonquin Gas Transmission
915 N. Eldridge Parkway, Houston, TX 77079-2703 (713) 627-5400

M:\259271\MAPPING\DRAWINGS\ALIGNMENT\ALIGNMENT.dwg - ISSUED FOR BID\259271-G_32

RIGHT-OF-WAY TRACT NUMBERS	38+00	G-32-MA-BA-001 2400 FT.	14+00
SURVEY DATA SURVEY COMPANY: FIELD BOOK: PAGES:	38+00	31+88 P.I. <50°04'10" LT. 31+92 TREE LINE 31+62 EDGE OF GRAVEL 31+52 PERMANENT ACCESS ROAD (PAR-16) 31+44 EDGE OF GRAVEL 30+44 OH POWERLINE 30+11 OH POWERLINE 29+91 OH POWERLINE 29+60 TREE LINE 24+15 EDGE OF GRAVEL 24+03 EDGE OF GRAVEL 23+56 OH POWERLINE 23+39 OH POWERLINE 23+30 OH POWERLINE 20+65 P.I. <70°05'39" RT. 18+35 P.I. <30°00'00" LT. 15+01 P.I. <86°07'27" LT.	14+00
CLASS LOCATION	38+00	CLASS 1	14+00
PIPE MATERIAL	38+00	16" O.D. X 0.375" W.T., API 5L, X-52, 16-20 MILS FBE 2400 FT.	14+00

ALIGNMENT LEGEND

- PIPELINE MILEPOST
- PROPOSED G-31 PIPELINE
- PROPOSED G-32 PIPELINE
- CONSTRUCTION LIMIT
- WAREYARD / STAGING AREA
- EXISTING PERMANENT ROW
- PROPOSED PERMANENT ROW
- ADDITIONAL TEMPORARY WORKSPACE
- PROPOSED METERING & REGULATING STATION (M&R) SITE / PIG TRAP SITE
- FACILITIES TEMPORARY WORKSPACE
- FACILITIES PERMANENT WORKSPACE
- PROPOSED GRAVEL AREA
- DELINEATED WETLAND BOUNDARY
- DELINEATED WATERBODY BANK
- DELINEATED WATERBODY CENTERLINE
- PERMANENT ACCESS ROAD
- TEMPORARY ACCESS ROAD
- PROPERTY LINE — PL —
- MAJOR CONTOUR - -100'- -
- MUNICIPALITY LINE
- ENVIRONMENTAL SURVEY BOUNDARY
- FENCE — X —
- EXISTING AGT PIPELINE — AGT —
- FOREIGN PIPELINE — F —
- POWERLINE — P —
- WATER PIPELINE — W —
- RAILROAD TRACK
- OVERHEAD WIRE — OHW —
- TELEPHONE LINE — C —
- UTILITY LINES
- SANITARY SEWER — SAN —
- TEE TAP
- BLOW OFF VALVE
- MAINLINE VALVE (MLV)
- POINT OF INTERSECTION
- BORE ENTRY/EXIT
- TRANSMISSION TOWER
- LIGHT POLE
- UTILITY POLE
- FIRE HYDRANT
- WELL (GAS)
- WELL (WATER)
- WELL (OIL)
- WELL (UNKNOWN)



ENVIRONMENTAL DATA

E & S TYPICALS

E&S TYPICALS WILL BE USED AS A PLAN AND WILL HAVE FURTHER INPUT FROM ENVIRONMENTAL INSPECTOR.

PROFILE

HORIZONTAL SCALE: 1" = 100'
100' 50' 0 100'

VERTICAL SCALE: 1" = 100'
100' 50' 0 100'

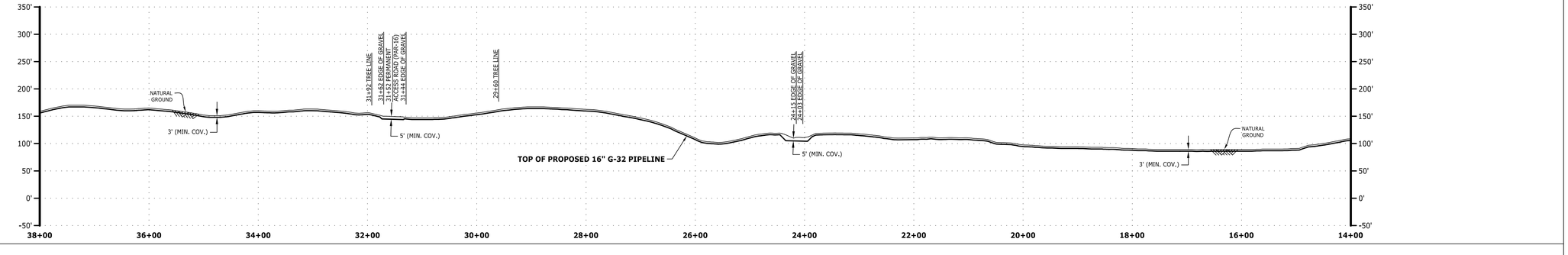
THE LOCATION OF TRENCH PLUGS AND SLOPE BREAKERS ARE INTENDED TO BE USED AS A GUIDELINE ONLY. EXACT LOCATION TO BE DETERMINED IN THE FIELD.

SLOPE BREAKERS ○
TRENCH PLUG ▲

PERMANENT SLOPE BREAKER & TRENCH PLUG SPACING

% SLOPE	SLOPE BREAKER SPACING (FT)	% SLOPE	TRENCH PLUG SPACING (FT)
5-15%	300 FT	<5%	NO STRUCTURE
15-30%	200 FT	5-15%	300 FT
>30%	100 FT	15-30%	200 FT
		>30%	100 FT

IN AG FIELDS AND RESIDENTIAL AREAS WHERE SLOPE BREAKERS ARE NOT TYPICALLY REQUIRED, INSTALL PERMANENT TRENCH PLUGS AT THE SAME SPACING AS IF PERMANENT SLOPE BREAKERS WERE REQUIRED. (FERC PLAN)



LAND USE CLASSIFICATION

CC CULTIVATED CROPS	DF DECIDUOUS FOREST	D/OS DEVELOPED OPEN SPACE	**SOILS**																								
EF EVERGREEN FOREST	S/S SHRUB SCRUB	D/LI DEVELOPED LOW INTENSITY	**LAND USE**																								
H/P HAY PASTURE	MF MIXED FOREST	D/MI DEVELOPED MEDIUM INTENSITY	**% SLOPE**	15-30%	<5%	5-15%	15-30%	5-15%	15-30%	5-15%	15-30%	>30%	<5%	15-30%	5-15%	<5%	5-15%	15-30%	>30%	15-30%	>30%	15-30%	>30%	<5%	15-30%		

SEGMENTABLE ELBOW	QTY
90 DEG, SD, 16" OD, 0.375" WT, CS, x52, FBE COATING SYSTEM 2B	3
45 DEG, SD, 16" OD, 0.375" WT, CS, x52, FBE COATING SYSTEM 2B	0

STAMP/SEAL

CLAY H. WILLIS — COMMONWEALTH OF MASSACHUSETTS — NO. 49138 — REGISTERED PROFESSIONAL ENGINEER — 04/23/26

THIS DOCUMENT IS RELEASED FOR THE PURPOSE OF:
BID REVIEW
IT IS NOT TO BE USED FOR:
CONSTRUCTION, RECORDATION, CONVEYANCE, SALES, OR AS THE BASIS FOR THE ISSUANCE OF A PERMIT

UNDER THE AUTHORITY OF:
PE NAME: CLAY WILLIS
PE STATE: MASSACHUSETTS
PE NUMBER: 49138

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		F	01/29/26	TL	JL	RE-ISSUED FOR BID
		E	08/21/25	TL	JL	ISSUED FOR BID
		D	07/07/25	TL	RAL	ISSUED FOR REVIEW (90% DESIGN)
		C	04/08/25	TL	RAL	ISSUED FOR REVIEW (60% DESIGN)
		B	02/26/24	LBJ	JL	ISSUED FOR REVIEW
		A	11/16/23	LBJ	JL	ISSUED FOR REVIEW

WOOD GROUP USA, INC.

DRAWN BY:	LBJ	02/26/24
DESIGN CHECKER:	JL	02/26/24
DESIGN ENGINEER:	PA	02/26/24
PROJECT MANAGER:	EL	02/26/24
TITLE	INITIALS	DATE

ENBRIDGE
CAPE COD CANAL PIPELINE RELOCATION PROJECT
PROPOSED 16" G-32 PIPELINE
TITLE: ALIGNMENT SHEET
LOC.: BARNSTABLE COUNTY, MASSACHUSETTS
YEAR: 2026 | W.O.: AFE 30002835 | SCALE: 1" = 100'
DWG.: GSYS-P.500-0009 | REV.: F

ENBRIDGE
Algonquin Gas Transmission
915 N. Eldridge Parkway, Houston, TX 77079-2703 (713) 627-5400

M:\239271\MAPPING\DRAWINGS\PI-ALIGNMENTS\RELEASED FOR BID\239271-G-32

| | | |

RIGHT-OF-WAY

TRACT NUMBERS

G-32-MA-BA-001

2400 FT.

SURVEY DATA

SURVEY COMPANY:
FIELD BOOK:
PAGES:

83+24 P.I. <45°00'00" RT.
83+14 OH POWERLINE
82+93 OH POWERLINE
82+57 OH POWERLINE
81+41 EDGE OF GRAVEL
81+32 PERMANENT ACCESS ROAD (PAR-16)
81+13 EDGE OF GRAVEL
81+13 TREE LINE
80+83 P.I. <45°00'00" LT.
73+58 P.I. <41°29'39" LT.
73+11 P.I. <43°36'18" RT.

CLASS LOCATION

86+00 CLASS 2 83+50 CLASS 1 62+00

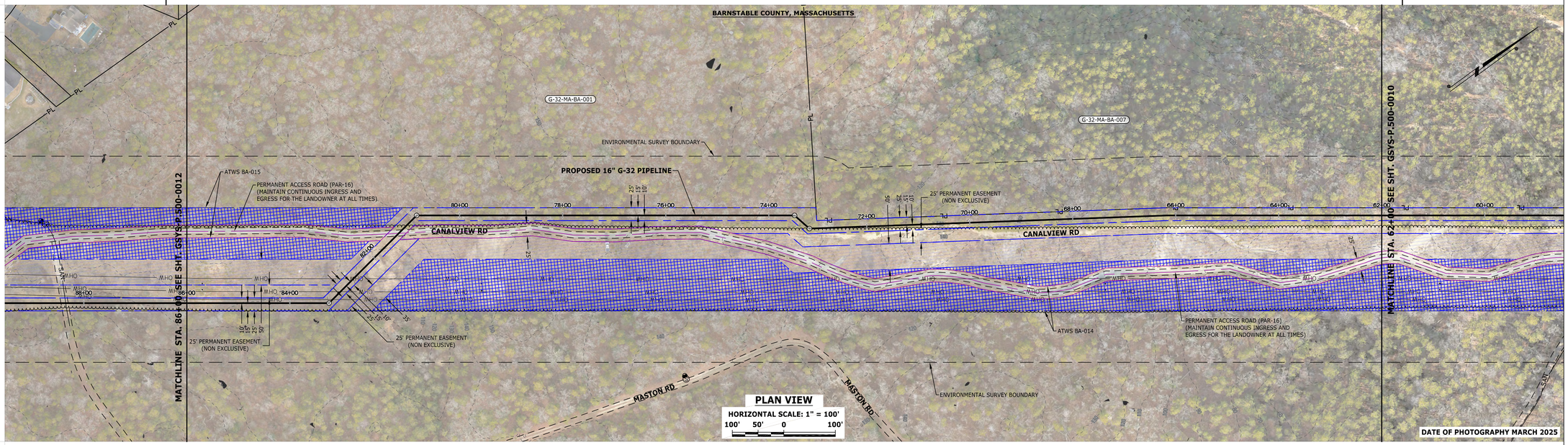
PIPE MATERIAL

16" O.D. X 0.375" W.T., API 5L, X-52, 16-20 MILS FBE

2400 FT.

ALIGNMENT LEGEND

- PIPELINE MILEPOST
- PROPOSED G-31 PIPELINE
- PROPOSED G-32 PIPELINE
- CONSTRUCTION LIMIT
- WAREYARD / STAGING AREA
- EXISTING PERMANENT ROW
- PROPOSED PERMANENT ROW
- ADDITIONAL TEMPORARY WORKSPACE
- PROPOSED METERING & REGULATING STATION (M&R) SITE / PIG TRAP SITE
- FACILITIES TEMPORARY WORKSPACE
- FACILITIES PERMANENT WORKSPACE
- PROPOSED GRAVEL AREA
- DELINEATED WETLAND BOUNDARY
- DELINEATED WATERBODY BANK
- DELINEATED WATERBODY CENTERLINE
- PERMANENT ACCESS ROAD
- TEMPORARY ACCESS ROAD
- PROPERTY LINE — PL —
- MAJOR CONTOUR — -100'-
- MUNICIPALITY LINE
- ENVIRONMENTAL SURVEY BOUNDARY
- FENCE — X —
- EXISTING AGT PIPELINE — AGT —
- FOREIGN PIPELINE — F —
- POWERLINE — P —
- WATER PIPELINE — W —
- RAILROAD TRACK — T —
- OVERHEAD WIRE — OHW —
- TELEPHONE LINE — C —
- UTILITY LINES
- SANITARY SEWER — SAN —
- TEE TAP
- BLOW OFF VALVE
- MAINLINE VALVE (MLV)
- POINT OF INTERSECTION
- BORE ENTRY/EXIT
- TRANSMISSION TOWER
- LIGHT POLE
- UTILITY POLE
- FIRE HYDRANT
- WELL (GAS)
- WELL (WATER)
- WELL (OIL)
- WELL (UNKNOWN)



ENVIRONMENTAL DATA

E & S TYPICALS

E&S TYPICALS WILL BE USED AS A PLAN AND WILL HAVE FURTHER INPUT FROM ENVIRONMENTAL INSPECTOR.

PROFILE

HORIZONTAL SCALE: 1" = 100'
100' 50' 0 100'

VERTICAL SCALE: 1" = 100'
100' 50' 0 100'

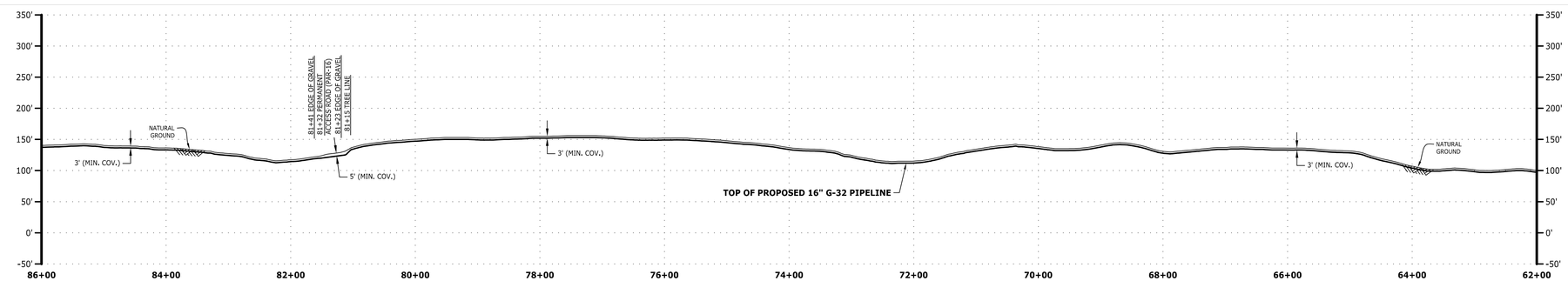
THE LOCATION OF TRENCH PLUGS AND SLOPE BREAKERS ARE INTENDED TO BE USED AS A GUIDELINE ONLY. EXACT LOCATION TO BE DETERMINED IN THE FIELD.

SLOPE BREAKERS ○
TRENCH PLUG ▲

PERMANENT SLOPE BREAKER & TRENCH PLUG SPACING

% SLOPE	SLOPE BREAKER SPACING (FT)	% SLOPE	TRENCH PLUG SPACING (FT)
5-15%	300 FT	<5%	NO STRUCTURE
15-30%	200 FT	5-15%	300 FT
>30%	100 FT	15-30%	200 FT
		>30%	100 FT

IN AG FIELDS AND RESIDENTIAL AREAS WHERE SLOPE BREAKERS ARE NOT TYPICALLY REQUIRED, INSTALL PERMANENT TRENCH PLUGS AT THE SAME SPACING AS IF PERMANENT SLOPE BREAKERS WERE REQUIRED. (FERC PLAN)



LAND USE CLASSIFICATION

CC CULTIVATED CROPS DF DECIDUOUS FOREST D/OS DEVELOPED OPEN SPACE
EF EVERGREEN FOREST S/S SHRUB SCRUB D/LI DEVELOPED LOW INTENSITY
H/P HAY PASTURE MF MIXED FOREST D/MI DEVELOPED MEDIUM INTENSITY

SEGMENTABLE ELBOW	QTY
90 DEG, SD, 16" OD, 0.375" WT, CS, x52, FBE COATING SYSTEM 2B	0
45 DEG, SD, 16" OD, 0.375" WT, CS, x52, FBE COATING SYSTEM 2B	4

SOILS																										
LAND USE																										
% SLOPE	5-15%	15-30%	5-15%	15-30%	5-15%		<5%		5-15%	15-30%	5-15%	>30%	5-15%	>30%	15-30%	>30%	5-15%	15-30%	>30%	15-30%	5-15%	15-30%	>30%	15-30%	5-15%	

STAMP/SEAL

CLAY H. WILLIS STRUCTURAL — COMMONWEALTH OF MASSACHUSETTS — NO. 49136 — REGISTERED PROFESSIONAL ENGINEER — 02/23/26

THIS DOCUMENT IS RELEASED FOR THE PURPOSE OF:
BID REVIEW
IT IS NOT TO BE USED FOR: CONSTRUCTION, RECORDATION, CONVEYANCE, SALES, OR AS THE BASIS FOR THE ISSUANCE OF A PERMIT

UNDER THE AUTHORITY OF:
PE NAME: CLAY WILLIS
PE STATE: MASSACHUSETTS
PE NUMBER: 49136

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		E	01/29/26	TL	JL	RE-ISSUED FOR BID
		D	08/21/25	TL	JL	ISSUED FOR BID
		C	07/07/25	TL	RAL	ISSUED FOR REVIEW (90% DESIGN)
		B	04/08/25	TL	RAL	ISSUED FOR REVIEW (60% DESIGN)
		A	02/26/24	LBJ	JL	ISSUED FOR REVIEW

wood. WOOD GROUP USA, INC.

TITLE	INITIALS	DATE
DRAWN BY:	LBJ	02/26/24
DESIGN CHECKER:	JL	02/26/24
DESIGN ENGINEER:	PA	02/26/24
PROJECT MANAGER:	EL	02/26/24

ENBRIDGE
CAPE COD CANAL PIPELINE RELOCATION PROJECT
PROPOSED 16" G-32 PIPELINE
TITLE: ALIGNMENT SHEET

LOC.: BARNSTABLE COUNTY, MASSACHUSETTS
YEAR: 2026 | W.O.: AFE 30002835 | SCALE: 1" = 100' | DWG.: GSYS-P.500-0011 | REV.: E

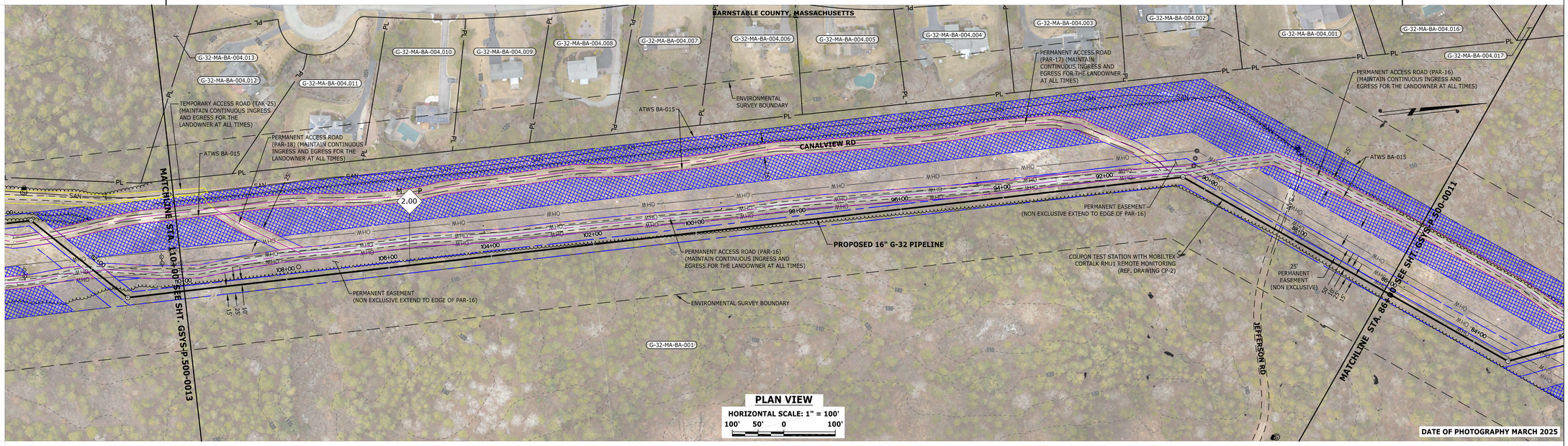
Algonquin Gas Transmission
915 N. Eldridge Parkway, Houston, TX 77079-2703 (713) 627-5400

M:\2392\1\MAPPING\DRAWINGS\P-ALIGNMENT\RE-ISSUED FOR BID\2392_1_22

RIGHT-OF-WAY TRACT NUMBERS	110+00	G-32-MA-BA-001 2400 FT.		86+00
SURVEY DATA SURVEY COMPANY: FIELD BOOK: PAGES:	110+00	99+88 TREE LINE	90+49 P.I. = 26°04'26" LT.	88+44 EDGE OF GRAVEL 88+37 CL JEFFERSON RD 88+35 SANITARY SEWER (UNKNOWN DEPTH - FIELD VERIFY) 88+30 EDGE OF GRAVEL	86+00
CLASS LOCATION	110+00	CLASS 2			86+00
PIPE MATERIAL	110+00	16" O.D. X 0.375" W.T., API 5L, X-52, 16-20 MILS FBE 2400 FT.			86+00

ALIGNMENT LEGEND

- PIPELINE MILEPOST
- PROPOSED G-31 PIPELINE
- PROPOSED G-32 PIPELINE
- CONSTRUCTION LIMIT
- WAREYARD / STAGING AREA
- EXISTING PERMANENT ROW
- PROPOSED PERMANENT ROW
- ADDITIONAL TEMPORARY WORKSPACE
- PROPOSED METERING & REGULATING STATION (M&R) SITE / PIG TRAP SITE
- FACILITIES TEMPORARY WORKSPACE
- FACILITIES PERMANENT WORKSPACE
- PROPOSED GRAVEL AREA
- DELINEATED WETLAND BOUNDARY
- DELINEATED WATERBODY BANK
- DELINEATED WATERBODY CENTERLINE
- PERMANENT ACCESS ROAD
- TEMPORARY ACCESS ROAD
- PROPERTY LINE — PL —
- MAJOR CONTOUR - -100'- -
- MUNICIPALITY LINE
- ENVIRONMENTAL SURVEY BOUNDARY
- FENCE — X —
- EXISTING AGT PIPELINE — AGT —
- FOREIGN PIPELINE — F —
- POWERLINE — P —
- WATER PIPELINE — W —
- RAILROAD TRACK — T —
- OVERHEAD WIRE — OHW —
- TELEPHONE LINE — C —
- UTILITY LINES
- SANITARY SEWER — SAN —
- TEE TAP
- BLOW OFF VALVE
- MAINLINE VALVE (MLV)
- POINT OF INTERSECTION
- BORE ENTRY/EXIT
- TRANSMISSION TOWER
- LIGHT POLE
- UTILITY POLE
- FIRE HYDRANT
- WELL (GAS)
- WELL (WATER)
- WELL (OIL)
- WELL (UNKNOWN)



PLAN VIEW
HORIZONTAL SCALE: 1" = 100'
100' 50' 0 100'

ENVIRONMENTAL DATA

E & S TYPICALS

E&S TYPICALS WILL BE USED AS A PLAN AND WILL HAVE FURTHER INPUT FROM ENVIRONMENTAL INSPECTOR.

PROFILE

HORIZONTAL SCALE: 1" = 100'
100' 50' 0 100'
VERTICAL SCALE: 1" = 100'
100' 50' 0 100'

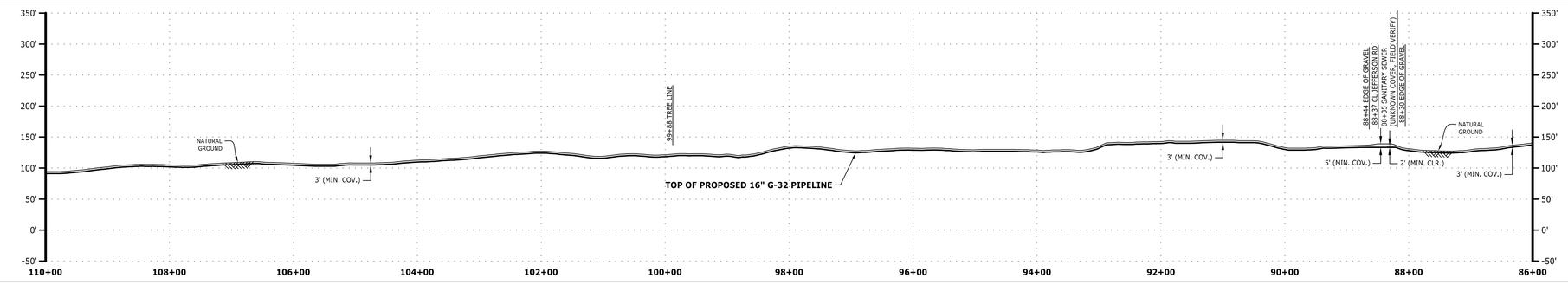
THE LOCATION OF TRENCH PLUGS AND SLOPE BREAKERS ARE INTENDED TO BE USED AS A GUIDELINE ONLY. EXACT LOCATION TO BE DETERMINED IN THE FIELD.

SLOPE BREAKERS ○
TRENCH PLUG ▲

PERMANENT SLOPE BREAKER & TRENCH PLUG SPACING

% SLOPE	SLOPE BREAKER SPACING (FT)	% SLOPE	TRENCH PLUG SPACING (FT)
5-15%	300 FT	<5%	NO STRUCTURE
15-30%	200 FT	5-15%	300 FT
>30%	100 FT	15-30%	200 FT
		>30%	100 FT

IN AG FIELDS AND RESIDENTIAL AREAS WHERE SLOPE BREAKERS ARE NOT TYPICALLY REQUIRED, INSTALL PERMANENT TRENCH PLUGS AT THE SAME SPACING AS IF PERMANENT SLOPE BREAKERS WERE REQUIRED. (FERC PLAN)



LAND USE CLASSIFICATION

CC CULTIVATED CROPS | DF DECIDUOUS FOREST | D/OS DEVELOPED OPEN SPACE
EF EVERGREEN FOREST | S/S SHRUB SCRUB | D/LI DEVELOPED LOW INTENSITY
H/P HAY PASTURE | MF MIXED FOREST | D/MI DEVELOPED MEDIUM INTENSITY

SEGMENTABLE ELBOW	QTY
90 DEG, SD, 16" OD, 0.375" WT, CS, x52, FBE COATING SYSTEM 2B	0
45 DEG, SD, 16" OD, 0.375" WT, CS, x52, FBE COATING SYSTEM 2B	0

SOILS																															
LAND USE																															
% SLOPE	<5%	5-15%	15-30%		5-15%		<5%		5-15%			<5%		5-15%	15-30%		5-15%		15-30%	>30%		15-30%	5-15%	<5%	5-15%	>30%	15-30%	<5%	5-15%	<5%	>30%		<5%	5-15%	>30%	15-30%	5-15%

STAMP/SEAL

COMMONWEALTH OF MASSACHUSETTS
CLAY C. WILLIS
STRUCTURAL
NO. 49136
REGISTERED PROFESSIONAL ENGINEER
02/23/26

THIS DOCUMENT IS RELEASED FOR THE PURPOSE OF:
BID REVIEW
IT IS NOT TO BE USED FOR: CONSTRUCTION, RECORDATION, CONVEYANCE, SALES, OR AS THE BASIS FOR THE ISSUANCE OF A PERMIT

UNDER THE AUTHORITY OF:
PE NAME: CLAY WILLIS
PE STATE: MASSACHUSETTS
PE NUMBER 49136

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		E	01/29/26	TL	JL	RE-ISSUED FOR BID
		D	08/21/25	TL	JL	ISSUED FOR BID
		C	07/07/25	TL	RAL	ISSUED FOR REVIEW (90% DESIGN)
		B	04/08/25	TL	RAL	ISSUED FOR REVIEW (60% DESIGN)
CP-2	CATHODIC PROTECTION DESIGN	A	02/26/24	LBJ	JL	ISSUED FOR REVIEW

wood.
WOOD GROUP USA, INC.

DRAWN BY:	LBJ	02/26/24
DESIGN CHECKER:	JL	02/26/24
DESIGN ENGINEER:	PA	02/26/24
PROJECT MANAGER:	EL	02/26/24
TITLE	INITIALS	DATE

ENBRIDGE
CAPE COD CANAL PIPELINE RELOCATION PROJECT
PROPOSED 16" G-32 PIPELINE
TITLE: ALIGNMENT SHEET

ENBRIDGE

Algonquin Gas Transmission
915 N. Eldridge Parkway, Houston, TX 77079-2703 (713) 627-5400

YEAR: 2026 | W.O.: AFE 30002835 | SCALE: 1" = 100' | DWG.: GSYS-P.500-0012 | REV.: E

M:\25\25271\MAPPING\DRAWINGS\ALIGNMENT\ALIGNMENT_ISSUED FOR BID\25271-G-32

RIGHT-OF-WAY

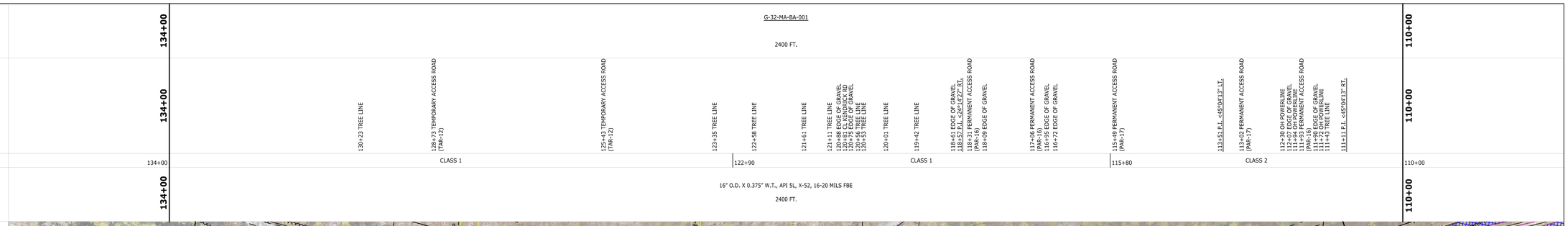
TRACT NUMBERS

SURVEY DATA

SURVEY COMPANY:
FIELD BOOK:
PAGES:

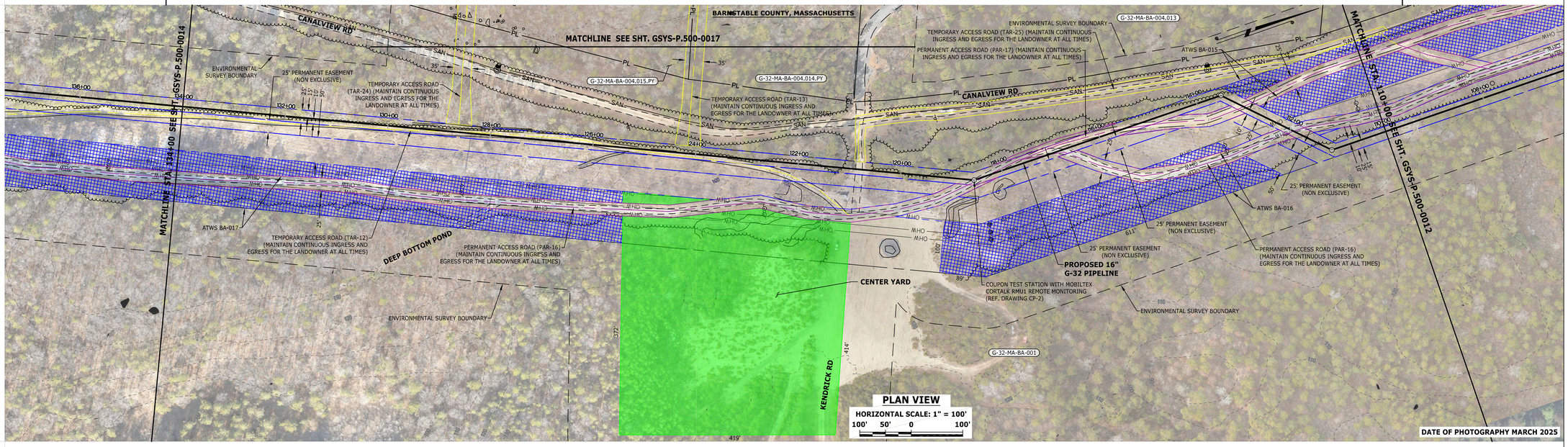
CLASS LOCATION

PIPE MATERIAL



ALIGNMENT LEGEND

- PIPELINE MILEPOST
- PROPOSED G-31 PIPELINE
- PROPOSED G-32 PIPELINE
- CONSTRUCTION LIMIT
- WAREYARD / STAGING AREA
- EXISTING PERMANENT ROW
- PROPOSED PERMANENT ROW
- ADDITIONAL TEMPORARY WORKSPACE
- PROPOSED METERING & REGULATING STATION (M&R) SITE / PIG TRAP SITE
- FACILITIES TEMPORARY WORKSPACE
- FACILITIES PERMANENT WORKSPACE
- PROPOSED GRAVEL AREA
- DELINEATED WETLAND BOUNDARY
- DELINEATED WATERBODY BANK
- DELINEATED WATERBODY CENTERLINE
- PERMANENT ACCESS ROAD
- TEMPORARY ACCESS ROAD
- PROPERTY LINE — PL —
- MAJOR CONTOUR - -100'- -
- MUNICIPALITY LINE
- ENVIRONMENTAL SURVEY BOUNDARY
- FENCE — X —
- EXISTING AGT PIPELINE — AGT —
- FOREIGN PIPELINE — F —
- POWERLINE — P —
- WATER PIPELINE — W —
- RAILROAD TRACK — | —
- OVERHEAD WIRE — OHW —
- TELEPHONE LINE — C —
- UTILITY LINES
- SANITARY SEWER — SAN —
- TEE TAP
- BLOW OFF VALVE
- MAINLINE VALVE (MLV)
- POINT OF INTERSECTION
- BORE ENTRY/EXIT
- TRANSMISSION TOWER
- LIGHT POLE
- UTILITY POLE
- FIRE HYDRANT
- WELL (GAS)
- WELL (WATER)
- WELL (OIL)
- WELL (UNKNOWN)



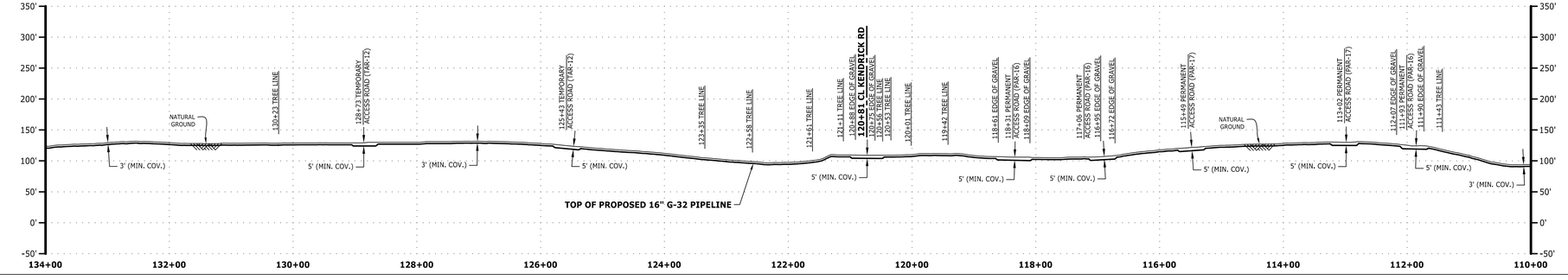
ENVIRONMENTAL DATA

E & S TYPICALS

E&S TYPICALS WILL BE USED AS A PLAN AND WILL HAVE FURTHER INPUT FROM ENVIRONMENTAL INSPECTOR.

PROFILE

HORIZONTAL SCALE: 1" = 100'
100' 50' 0 100'
VERTICAL SCALE: 1" = 100'
100' 50' 0 100'



THE LOCATION OF TRENCH PLUGS AND SLOPE BREAKERS ARE INTENDED TO BE USED AS A GUIDELINE ONLY. EXACT LOCATION TO BE DETERMINED IN THE FIELD.

SLOPE BREAKERS ○
TRENCH PLUG ▲

PERMANENT SLOPE BREAKER & TRENCH PLUG SPACING

% SLOPE	SLOPE BREAKER SPACING (FT)	% SLOPE	TRENCH PLUG SPACING (FT)
5-15%	300 FT	<5%	NO STRUCTURE
15-30%	200 FT	5-15%	300 FT
>30%	100 FT	15-30%	200 FT
		>30%	100 FT

IN AG FIELDS AND RESIDENTIAL AREAS WHERE SLOPE BREAKERS ARE NOT TYPICALLY REQUIRED, INSTALL PERMANENT TRENCH PLUGS AT THE SAME SPACING AS IF PERMANENT SLOPE BREAKERS WERE REQUIRED. (FERC PLAN)

LAND USE CLASSIFICATION

CC CULTIVATED CROPS DF DECIDUOUS FOREST D/OS DEVELOPED OPEN SPACE
EF EVERGREEN FOREST S/S SHRUB SCRUB D/LI DEVELOPED LOW INTENSITY
H/P HAY PASTURE MF MIXED FOREST D/MI DEVELOPED MEDIUM INTENSITY

SEGMENTABLE ELBOW	QTY
90 DEG, SD, 16" OD, 0.375" WT, CS, x52, FBE COATING SYSTEM 2B	0
45 DEG, SD, 16" OD, 0.375" WT, CS, x52, FBE COATING SYSTEM 2B	2

	>30%	15-30%	>30%	15-30%	5-15%	<5%	5-15%	15-30%	<5%	15-30%	5-15%	15-30%	5-15%	<5%	15-30%	<5%	5-15%	15-30%	5-15%	15-30%	>30%	15-30%	<5%
SOILS																							
LAND USE																							
% SLOPE																							

STAMP/SEAL

THIS DOCUMENT IS RELEASED FOR THE PURPOSE OF:
BID REVIEW
IT IS NOT TO BE USED FOR:
CONSTRUCTION, RECORDATION, CONVEYANCE, SALES, OR AS THE BASIS FOR THE ISSUANCE OF A PERMIT

UNDER THE AUTHORITY OF:
PE NAME: CLAY WILLIS
PE STATE: MASSACHUSETTS
PE NUMBER 49136

CLAY H. WILLIS — COMMONWEALTH OF MASSACHUSETTS — NO. 49136 — REGISTERED PROFESSIONAL ENGINEER — 02/23/26

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		F	03/20/26	TL	JL	RE-ISSUED FOR BID
		E	01/29/26	TL	JL	RE-ISSUED FOR BID
		D	08/21/25	TL	JL	ISSUED FOR BID
		C	07/07/25	TL	RAL	ISSUED FOR REVIEW (90% DESIGN)
		B	04/08/25	TL	RAL	ISSUED FOR REVIEW (60% DESIGN)
		A	02/26/24	LBJ	JL	ISSUED FOR REVIEW

wood. WOOD GROUP USA, INC.

TITLE	INITIALS	DATE
DRAWN BY:	LBJ	02/26/24
DESIGN CHECKER:	JL	02/26/24
DESIGN ENGINEER:	PA	02/26/24
PROJECT MANAGER:	EL	02/26/24

ENBRIDGE
CAPE COD CANAL PIPELINE RELOCATION PROJECT
PROPOSED 16" G-32 PIPELINE
TITLE: ALIGNMENT SHEET
LOC.: BARNSTABLE COUNTY, MASSACHUSETTS
YEAR: 2026 W.O.: AFE 30002835 SCALE: 1" = 100'
DWG.: GSYS-P.500-0013 REV.: F

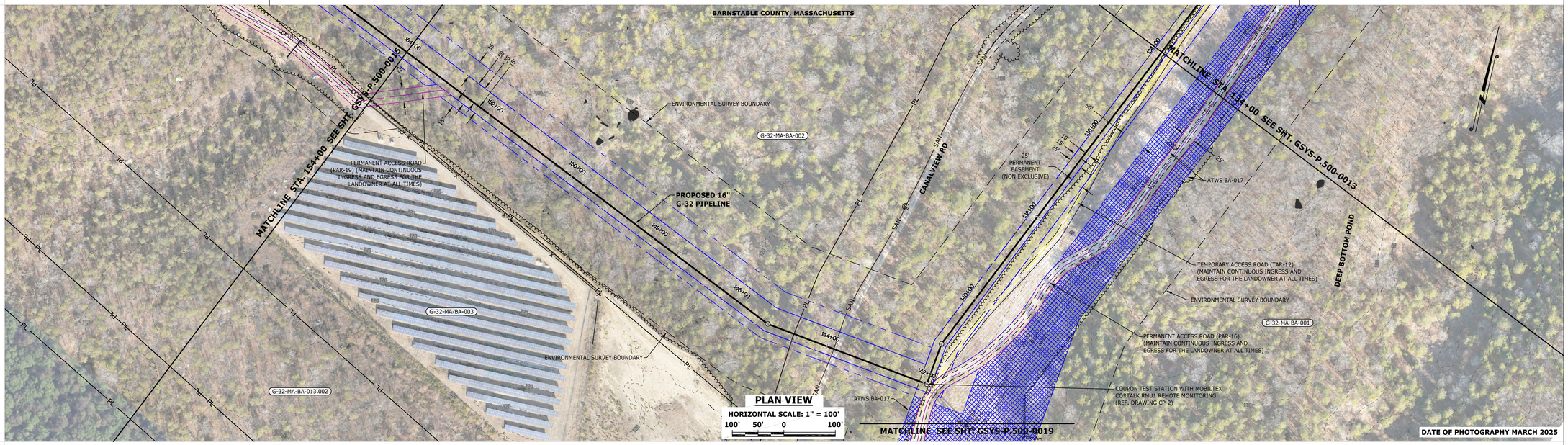
ENBRIDGE
Algonquin Gas Transmission
915 N. Eldridge Parkway, Houston, TX 77079-2703 (713) 627-5400

M:\259271\MAPPING\DRAWINGS\ALIGNMENT\RE-ISSUED FOR BID\V2\0073-G_S2

RIGHT-OF-WAY	154+00	G-32-MA-BA-002		144+68	G-32-MA-BA-001	134+00
TRACT NUMBERS		932 FT.			1068 FT.	
SURVEY DATA	154+00	145+23 P.I. <168°14'57" RT.	143+86 SANITARY SEWER (UNKNOWN COVER, FIELD VERIFY) 143+81 CL CANAL VIEW RD	141+93 P.I. <90°42'03" RT.	141+10 P.I. <17°02'35" LT.	134+00
SURVEY COMPANY:						
FIELD BOOK:						
PAGES:						
CLASS LOCATION	154+00	CLASS 1				134+00
PIPE MATERIAL	154+00	16" O.D. X 0.375" W.T., API 5L, X-52, 16-20 MILS FBE				134+00
		2000 FT.				

ALIGNMENT LEGEND

- PIPELINE MILEPOST
- PROPOSED G-31 PIPELINE
- PROPOSED G-32 PIPELINE
- CONSTRUCTION LIMIT
- WAREYARD / STAGING AREA
- EXISTING PERMANENT ROW
- PROPOSED PERMANENT ROW
- ADDITIONAL TEMPORARY WORKSPACE
- PROPOSED METERING & REGULATING STATION (M&R) SITE / PIG TRAP SITE
- FACILITIES TEMPORARY WORKSPACE
- FACILITIES PERMANENT WORKSPACE
- PROPOSED GRAVEL AREA
- DELINEATED WETLAND BOUNDARY
- DELINEATED WATERBODY BANK
- DELINEATED WATERBODY CENTERLINE
- PERMANENT ACCESS ROAD
- TEMPORARY ACCESS ROAD
- PROPERTY LINE — PL —
- MAJOR CONTOUR - -100'- -
- MUNICIPALITY LINE
- ENVIRONMENTAL SURVEY BOUNDARY
- FENCE — X —
- EXISTING AGT PIPELINE — AGT —
- FOREIGN PIPELINE — II —
- POWERLINE — P —
- WATER PIPELINE — W —
- RAILROAD TRACK — | —
- OVERHEAD WIRE — OHW —
- TELEPHONE LINE — C — —
- UTILITY LINES
- SANITARY SEWER — SAN —
- TEE TAP
- BLOW OFF VALVE
- MAINLINE VALVE (MLV)
- POINT OF INTERSECTION
- BORE ENTRY/EXIT
- TRANSMISSION TOWER
- LIGHT POLE
- UTILITY POLE
- FIRE HYDRANT
- WELL (GAS)
- WELL (WATER)
- WELL (OIL)
- WELL (UNKNOWN)



ENVIRONMENTAL DATA

E & S TYPICALS

E&S TYPICALS WILL BE USED AS A PLAN AND WILL HAVE FURTHER INPUT FROM ENVIRONMENTAL INSPECTOR.

PROFILE

HORIZONTAL SCALE: 1" = 100'
100' 50' 0 100'
VERTICAL SCALE: 1" = 100'
100' 50' 0 100'

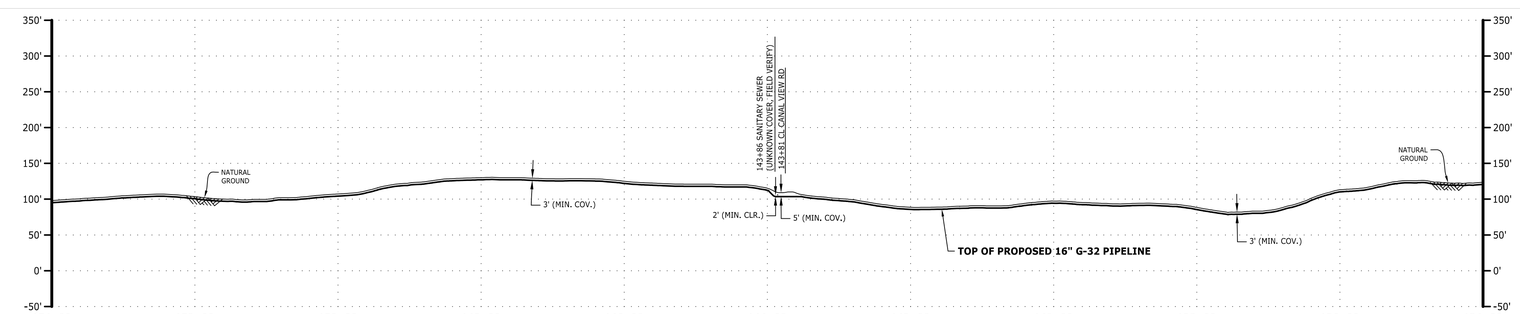
THE LOCATION OF TRENCH PLUGS AND SLOPE BREAKERS ARE INTENDED TO BE USED AS A GUIDELINE ONLY. EXACT LOCATION TO BE DETERMINED IN THE FIELD.

SLOPE BREAKERS
TRENCH PLUG

PERMANENT SLOPE BREAKER & TRENCH PLUG SPACING

% SLOPE	SLOPE BREAKER SPACING (FT)	% SLOPE	TRENCH PLUG SPACING (FT)
5-15%	300 FT	<5%	NO STRUCTURE
15-30%	200 FT	5-15%	300 FT
>30%	100 FT	15-30%	200 FT
		>30%	100 FT

IN AG FIELDS AND RESIDENTIAL AREAS WHERE SLOPE BREAKERS ARE NOT TYPICALLY REQUIRED, INSTALL PERMANENT TRENCH PLUGS AT THE SAME SPACING AS IF PERMANENT SLOPE BREAKERS WERE REQUIRED. (FERC PLAN)



LAND USE CLASSIFICATION

CC CULTIVATED CROPS DF DECIDUOUS FOREST D/OS DEVELOPED OPEN SPACE
EF EVERGREEN FOREST S/S SHRUB SCRUB D/LI DEVELOPED LOW INTENSITY
H/P HAY PASTURE MF MIXED FOREST D/MI DEVELOPED MEDIUM INTENSITY

SEGMENTABLE ELBOW	QTY
90 DEG, 5D, 16" OD, 0.375" WT, CS, x52, FBE COATING SYSTEM 2B	1
45 DEG, 5D, 16" OD, 0.375" WT, CS, x52, FBE COATING SYSTEM 2B	0

SOILS																								
LAND USE																								
% SLOPE	15-30%	<5%	5-15%	15-30%	5-15%	<5%	5-15%	<5%	5-15%	<5%	5-15%	15-30%	5-15%	15-30%	>30%	5-15%	15-30%	>30%						

STAMP/SEAL

COMMONWEALTH OF MASSACHUSETTS — CLAY H. WILLIS — STRUCTURAL — NO. 49136 — REGISTERED PROFESSIONAL ENGINEER
05/23/26

THIS DOCUMENT IS RELEASED FOR THE PURPOSE OF:
BID REVIEW
IT IS NOT TO BE USED FOR: CONSTRUCTION, RECORDATION, CONVEYANCE, SALES, OR AS THE BASIS FOR THE ISSUANCE OF A PERMIT
UNDER THE AUTHORITY OF:
PE NAME: CLAY WILLIS
PE STATE: MASSACHUSETTS
PE NUMBER: 49136

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		E	01/29/26	TL	JL	RE-ISSUED FOR BID
		D	08/21/25	TL	JL	ISSUED FOR BID
		C	07/07/25	TL	RAL	ISSUED FOR REVIEW (90% DESIGN)
		B	04/08/25	TL	RAL	ISSUED FOR REVIEW (60% DESIGN)
CP-2	CATHODIC PROTECTION DESIGN	A	02/26/24	LBJ	JL	ISSUED FOR REVIEW

wood. WOOD GROUP USA, INC.

TITLE	INITIALS	DATE
DRAWN BY:	LBJ	02/26/24
DESIGN CHECKER:	JL	02/26/24
DESIGN ENGINEER:	PA	02/26/24
PROJECT MANAGER:	EL	02/26/24

ENBRIDGE
CAPE COD CANAL PIPELINE RELOCATION PROJECT
PROPOSED 16" G-32 PIPELINE
TITLE: ALIGNMENT SHEET
LOC.: BARNSTABLE COUNTY, MASSACHUSETTS
YEAR: 2026 | W.O.: AFE 30002835 | SCALE: 1" = 100'

ENBRIDGE
Algonquin Gas Transmission
915 N. Eldridge Parkway, Houston, TX 77079-2703 (713) 627-5400

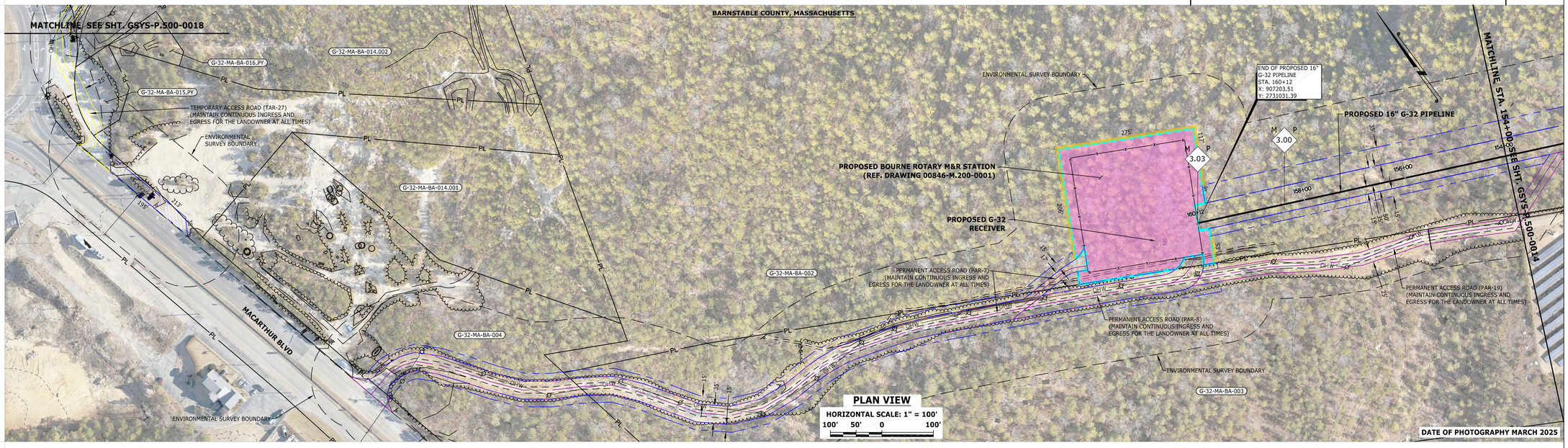
DWG.: GSYS-P.500-0014 | REV.: E

M:\2792\TYMAPPING\DRAWINGS\ALIGNMENT\RE-ISSUED FOR BID\2792TYM_G-32

RIGHT-OF-WAY		160+12	154+00
TRACT NUMBERS	G-32-MA-BA-002 612 FT.		
SURVEY DATA		160+12 END PIPELINE	154+00
SURVEY COMPANY: FIELD BOOK: PAGES:			
CLASS LOCATION	CLASS 1	160+12	154+00
PIPE MATERIAL	16" O.D. X 0.375" W.T., API 5L, X-52, 16-20 MILS FBE 612 FT.	160+12	154+00

ALIGNMENT LEGEND

- PIPELINE MILEPOST
- PROPOSED G-31 PIPELINE
- PROPOSED G-32 PIPELINE
- CONSTRUCTION LIMIT
- WAREYARD / STAGING AREA
- EXISTING PERMANENT ROW
- PROPOSED PERMANENT ROW
- ADDITIONAL TEMPORARY WORKSPACE
- PROPOSED METERING & REGULATING STATION (M&R) SITE / PIG TRAP SITE
- FACILITIES TEMPORARY WORKSPACE
- FACILITIES PERMANENT WORKSPACE
- PROPOSED GRAVEL AREA
- DELINEATED WETLAND BOUNDARY
- DELINEATED WATERBODY BANK
- DELINEATED WATERBODY CENTERLINE
- PERMANENT ACCESS ROAD
- TEMPORARY ACCESS ROAD
- PROPERTY LINE
- MAJOR CONTOUR
- MUNICIPALITY LINE
- ENVIRONMENTAL SURVEY BOUNDARY
- FENCE
- EXISTING AGT PIPELINE
- FOREIGN PIPELINE
- POWERLINE
- WATER PIPELINE
- RAILROAD TRACK
- OVERHEAD WIRE
- TELEPHONE LINE
- UTILITY LINES
- SANITARY SEWER
- TEE TAP
- BLOW OFF VALVE
- MAINLINE VALVE (MLV)
- POINT OF INTERSECTION
- BORE ENTRY/EXIT
- TRANSMISSION TOWER
- LIGHT POLE
- UTILITY POLE
- FIRE HYDRANT
- WELL (GAS)
- WELL (WATER)
- WELL (OIL)
- WELL (UNKNOWN)



ENVIRONMENTAL DATA

E & S TYPICALS

E&S TYPICALS WILL BE USED AS A PLAN AND WILL HAVE FURTHER INPUT FROM ENVIRONMENTAL INSPECTOR.

PROFILE

HORIZONTAL SCALE: 1" = 100'
100' 50' 0 100'

VERTICAL SCALE: 1" = 100'
100' 50' 0 100'

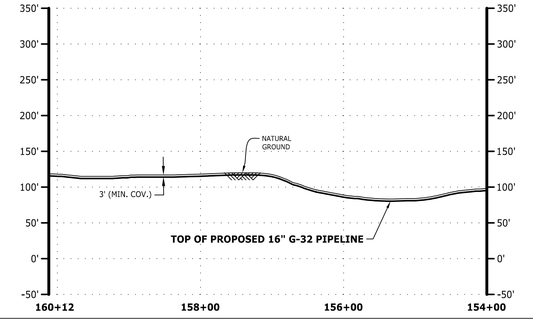
THE LOCATION OF TRENCH PLUGS AND SLOPE BREAKERS ARE INTENDED TO BE USED AS A GUIDELINE ONLY. EXACT LOCATION TO BE DETERMINED IN THE FIELD.

SLOPE BREAKERS
TRENCH PLUG

PERMANENT SLOPE BREAKER & TRENCH PLUG SPACING

% SLOPE	SLOPE BREAKER SPACING (FT)	% SLOPE	TRENCH PLUG SPACING (FT)
5-15%	300 FT	<5%	NO STRUCTURE
15-30%	200 FT	5-15%	300 FT
>30%	100 FT	15-30%	200 FT
		>30%	100 FT

IN AG FIELDS AND RESIDENTIAL AREAS WHERE SLOPE BREAKERS ARE NOT TYPICALLY REQUIRED, INSTALL PERMANENT TRENCH PLUGS AT THE SAME SPACING AS IF PERMANENT SLOPE BREAKERS WERE REQUIRED. (FERC PLAN)



LAND USE CLASSIFICATION

SOILS	
LAND USE	
% SLOPE	

CC CULTIVATED CROPS DF DECIDUOUS FOREST D/OS DEVELOPED OPEN SPACE
EF EVERGREEN FOREST S/S SHRUB SCRUB D/LI DEVELOPED LOW INTENSITY
H/P HAY PASTURE MF MIXED FOREST D/MI DEVELOPED MEDIUM INTENSITY

SEGMENTABLE ELBOW	QTY
90 DEG, SD, 16" OD, 0.375" WT, CS, x52, FBE COATING SYSTEM 2B	0
45 DEG, SD, 16" OD, 0.375" WT, CS, x52, FBE COATING SYSTEM 2B	0

% SLOPE	5-15%	<5%	5-15%	<5%	>30%	15-30%	<5%	15-30%

STAMP/SEAL

COMMONWEALTH OF MASSACHUSETTS
CLAY H. WILLIS
STRUCTURAL
NO. 49136
REGISTERED PROFESSIONAL ENGINEER
02/23/26

THIS DOCUMENT IS RELEASED FOR THE PURPOSE OF:
BID REVIEW
IT IS NOT TO BE USED FOR:
CONSTRUCTION, RECORDATION, CONVEYANCE, SALES, OR AS THE BASIS FOR THE ISSUANCE OF A PERMIT

UNDER THE AUTHORITY OF:
PE NAME: CLAY WILLIS
PE STATE: MASSACHUSETTS
PE NUMBER 49136

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		F	03/20/26	TL	JL	RE-ISSUED FOR BID
		E	01/29/26	TL	JL	RE-ISSUED FOR BID
		D	08/21/25	TL	JL	ISSUED FOR BID
		C	07/07/25	TL	RAL	ISSUED FOR REVIEW (90% DESIGN)
		B	04/08/25	TL	RAL	ISSUED FOR REVIEW (60% DESIGN)
00846-M.200-0001	BOURNE ROTARY M&R STATION - LOCATION MAP AND PLOT PLAN	A	02/26/24	LBJ	JL	ISSUED FOR REVIEW

wood.
WOOD GROUP USA, INC.

TITLE	INITIALS	DATE
DRAWN BY:	LBJ	02/26/24
DESIGN CHECKER:	JL	02/26/24
DESIGN ENGINEER:	PA	02/26/24
PROJECT MANAGER:	EL	02/26/24

ENBRIDGE
CAPE COD CANAL PIPELINE RELOCATION PROJECT
PROPOSED 16" G-32 PIPELINE
TITLE: ALIGNMENT SHEET
LOC.: BARNSTABLE COUNTY, MASSACHUSETTS
YEAR: 2026 W.O.: AFE 30002835 SCALE: 1" = 100'

ENBRIDGE
Algonquin Gas Transmission
915 N. Eldridge Parkway, Houston, TX 77079-2703 (713) 627-5400

DWG.: GSYS-P.500-0015 REV.: F

M:\259271\MAPPING\DRAWINGS\01-ALIGNMENT\RE-ISSUED FOR BID\259271-G-32

RIGHT-OF-WAY

TRACT NUMBERS

SURVEY DATA

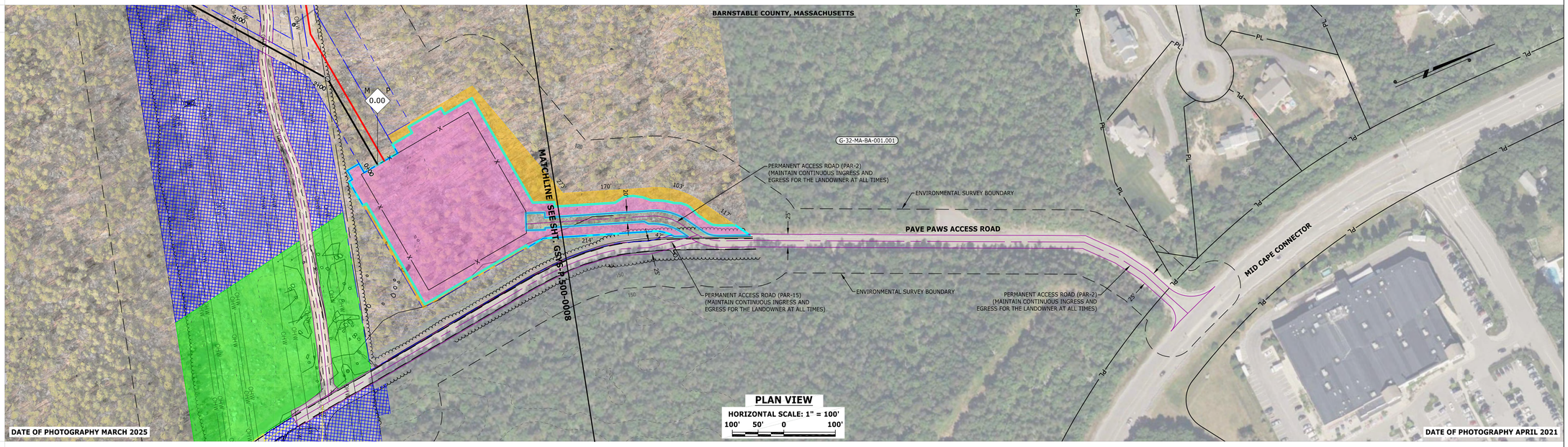
SURVEY COMPANY:
FIELD BOOK:
PAGES:

CLASS LOCATION

PIPE MATERIAL

ALIGNMENT LEGEND

- PIPELINE MILEPOST
- PROPOSED G-31 PIPELINE
- PROPOSED G-32 PIPELINE
- CONSTRUCTION LIMIT
- WAREYARD / STAGING AREA
- EXISTING PERMANENT ROW
- PROPOSED PERMANENT ROW
- ADDITIONAL TEMPORARY WORKSPACE
- PROPOSED METERING & REGULATING STATION (M&R) SITE / PIG TRAP SITE
- FACILITIES TEMPORARY WORKSPACE
- FACILITIES PERMANENT WORKSPACE
- PROPOSED GRAVEL AREA
- DELINEATED WETLAND BOUNDARY
- DELINEATED WATERBODY BANK
- DELINEATED WATERBODY CENTERLINE
- PERMANENT ACCESS ROAD
- TEMPORARY ACCESS ROAD
- PROPERTY LINE — PL —
- MAJOR CONTOUR — -100'-
- MUNICIPALITY LINE
- ENVIRONMENTAL SURVEY BOUNDARY
- FENCE — X —
- EXISTING AGT PIPELINE — AGT —
- FOREIGN PIPELINE — II —
- POWERLINE — P —
- WATER PIPELINE — W —
- RAILROAD TRACK — I —
- OVERHEAD WIRE — OHW —
- TELEPHONE LINE — C —
- UTILITY LINES
- SANITARY SEWER — SAN —
- TEE TAP
- BLOW OFF VALVE
- MAINLINE VALVE (MLV)
- POINT OF INTERSECTION
- BORE ENTRY/EXIT
- TRANSMISSION TOWER
- LIGHT POLE
- UTILITY POLE
- FIRE HYDRANT
- WELL (GAS)
- WELL (WATER)
- WELL (OIL)
- WELL (UNKNOWN)



PLAN VIEW

HORIZONTAL SCALE: 1" = 100'

100' 50' 0 100'

ENVIRONMENTAL DATA

E & S TYPICALS

E&S TYPICALS WILL BE USED AS A PLAN AND WILL HAVE FURTHER INPUT FROM ENVIRONMENTAL INSPECTOR.

PROFILE

HORIZONTAL SCALE: 1" = 100'

100' 50' 0 100'

VERTICAL SCALE: 1" = 100'

100' 50' 0 100'

THE LOCATION OF TRENCH PLUGS AND SLOPE BREAKERS ARE INTENDED TO BE USED AS A GUIDELINE ONLY. EXACT LOCATION TO BE DETERMINED IN THE FIELD.

SLOPE BREAKERS
TRENCH PLUG

PERMANENT SLOPE BREAKER & TRENCH PLUG SPACING

% SLOPE	SLOPE BREAKER SPACING (FT)	% SLOPE	TRENCH PLUG SPACING (FT)
5-15%	300 FT	<5%	NO STRUCTURE
15-30%	200 FT	5-15%	300 FT
>30%	100 FT	15-30%	200 FT
		>30%	100 FT

IN AG FIELDS AND RESIDENTIAL AREAS WHERE SLOPE BREAKERS ARE NOT TYPICALLY REQUIRED, INSTALL PERMANENT TRENCH PLUGS AT THE SAME SPACING AS IF PERMANENT SLOPE BREAKERS WERE REQUIRED. (FERC PLAN)

LAND USE CLASSIFICATION

CC	CULTIVATED CROPS	DF	DECIDUOUS FOREST
EF	EVERGREEN FOREST	S/S	SHRUB SCRUB
H/P	HAY PASTURE	MF	MIXED FOREST
D/OS	DEVELOPED OPEN SPACE		
D/LI	DEVELOPED LOW INTENSITY		
D/MI	DEVELOPED MEDIUM INTENSITY		

SOILS

LAND USE

% SLOPE

STAMP/SEAL

CLAY H. WILLIS STRUCTURAL NO. 49136 REGISTERED PROFESSIONAL ENGINEER STATE OF MASSACHUSETTS

10/23/26

THIS DOCUMENT IS RELEASED FOR THE PURPOSE OF:
BID REVIEW

IT IS NOT TO BE USED FOR:
CONSTRUCTION, RECREATION, CONVEYANCE, SALES, OR AS THE BASIS FOR THE ISSUANCE OF A PERMIT

UNDER THE AUTHORITY OF:
PE NAME: CLAY WILLIS
PE STATE: MASSACHUSETTS
PE NUMBER 49136

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		E	01/29/26	TL	JL	RE-ISSUED FOR BID
		D	08/21/25	TL	JL	ISSUED FOR BID
		C	07/07/25	TL	RAL	ISSUED FOR REVIEW (90% DESIGN)
		B	04/08/25	TL	RAL	ISSUED FOR REVIEW (60% DESIGN)
		A	02/26/24	LBJ	JL	ISSUED FOR REVIEW

WOOD GROUP USA, INC.

DRAWN BY:	LBJ	02/26/24
DESIGN CHECKER:	JL	02/26/24
DESIGN ENGINEER:	PA	02/26/24
PROJECT MANAGER:	EL	02/26/24
TITLE	INITIALS	DATE

ENBRIDGE
CAPE COD CANAL PIPELINE RELOCATION PROJECT
PROPOSED 16" G-32 PIPELINE
TITLE: ALIGNMENT SHEET

LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

YEAR: 2026 | W.O.: AFE 30002835 | SCALE: 1" = 100'

Algonquin Gas Transmission
915 N. Eldridge Parkway, Houston, TX 77079-2703 (713) 627-5400

DWG.: GSYS-P.500-0016 | REV.: E

M:\25927\MAPPING\DRAWINGS\ALIGNMENT\RE-ISSUED FOR BID\25927-G_32

RIGHT-OF-WAY

TRACT NUMBERS

SURVEY DATA

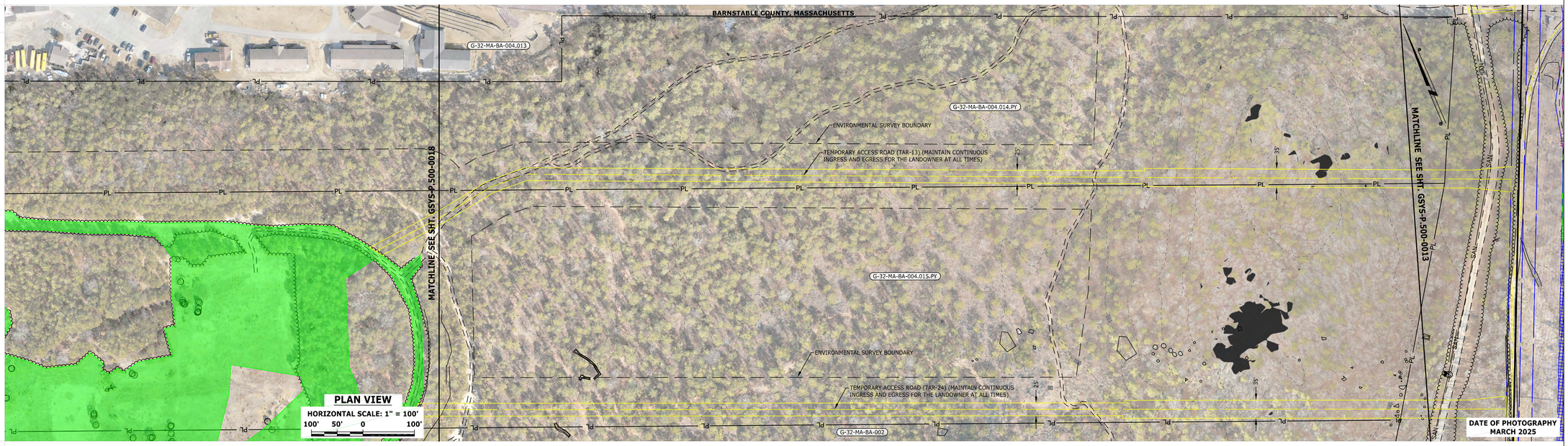
SURVEY COMPANY:
FIELD BOOK:
PAGES:

CLASS LOCATION

PIPE MATERIAL

ALIGNMENT LEGEND

- PIPELINE MILEPOST
- PROPOSED G-31 PIPELINE
- PROPOSED G-32 PIPELINE
- CONSTRUCTION LIMIT
- WAREYARD / STAGING AREA
- EXISTING PERMANENT ROW
- PROPOSED PERMANENT ROW
- ADDITIONAL TEMPORARY WORKSPACE
- PROPOSED METERING & REGULATING STATION (M&R) SITE / PIG TRAP SITE
- FACILITIES TEMPORARY WORKSPACE
- FACILITIES PERMANENT WORKSPACE
- PROPOSED GRAVEL AREA
- DELINEATED WETLAND BOUNDARY
- DELINEATED WATERBODY BANK
- DELINEATED WATERBODY CENTERLINE
- PERMANENT ACCESS ROAD
- TEMPORARY ACCESS ROAD
- PROPERTY LINE — PL —
- MAJOR CONTOUR - -100'- -
- MUNICIPALITY LINE
- ENVIRONMENTAL SURVEY BOUNDARY
- FENCE — X —
- EXISTING AGT PIPELINE — AGT —
- FOREIGN PIPELINE — || —
- POWERLINE — P —
- WATER PIPELINE — W —
- RAILROAD TRACK — | —
- OVERHEAD WIRE — OHW —
- TELEPHONE LINE — C —
- UTILITY LINES
- SANITARY SEWER — SAN —
- TEE TAP
- BLOW OFF VALVE
- MAINLINE VALVE (MLV)
- POINT OF INTERSECTION
- BORE ENTRY/EXIT
- TRANSMISSION TOWER
- LIGHT POLE
- UTILITY POLE
- FIRE HYDRANT
- WELL (GAS)
- WELL (WATER)
- WELL (OIL)
- WELL (UNKNOWN)



ENVIRONMENTAL DATA

E & S TYPICALS

E&S TYPICALS WILL BE USED AS A PLAN AND WILL HAVE FURTHER INPUT FROM ENVIRONMENTAL INSPECTOR.

PROFILE

HORIZONTAL SCALE: 1" = 100'

100' 50' 0 100'

VERTICAL SCALE: 1" = 100'

100' 50' 0 100'

THE LOCATION OF TRENCH PLUGS AND SLOPE BREAKERS ARE INTENDED TO BE USED AS A GUIDELINE ONLY. EXACT LOCATION TO BE DETERMINED IN THE FIELD.

SLOPE BREAKERS ○
TRENCH PLUG ▲

PERMANENT SLOPE BREAKER & TRENCH PLUG SPACING

% SLOPE	SLOPE BREAKER SPACING (FT)	% SLOPE	TRENCH PLUG SPACING (FT)
5-15%	300 FT	<5%	NO STRUCTURE
15-30%	200 FT	5-15%	300 FT
>30%	100 FT	15-30%	200 FT
		>30%	100 FT

IN AG FIELDS AND RESIDENTIAL AREAS WHERE SLOPE BREAKERS ARE NOT TYPICALLY REQUIRED, INSTALL PERMANENT TRENCH PLUGS AT THE SAME SPACING AS IF PERMANENT SLOPE BREAKERS WERE REQUIRED. (FERC PLAN)

LAND USE CLASSIFICATION

CC	CULTIVATED CROPS	DF	DECIDUOUS FOREST
D/OS	DEVELOPED OPEN SPACE	EF	EVERGREEN FOREST
S/S	SHRUB SCRUB	D/LI	DEVELOPED LOW INTENSITY
H/P	HAY PASTURE	MF	MIXED FOREST
D/MI	DEVELOPED MEDIUM INTENSITY		

SOILS

LAND USE

% SLOPE

STAMP/SEAL

COMMONWEALTH OF MASSACHUSETTS — CLAY E. WILLIS — NO. 49136 — REGISTERED PROFESSIONAL ENGINEER — 02/23/26

THIS DOCUMENT IS RELEASED FOR THE PURPOSE OF:
BID REVIEW
IT IS NOT TO BE USED FOR:
CONSTRUCTION, RECORDATION, CONVEYANCE, SALES, OR AS THE BASIS FOR THE ISSUANCE OF A PERMIT

UNDER THE AUTHORITY OF:
PE NAME: CLAY WILLIS
PE STATE: MASSACHUSETTS
PE NUMBER 49136

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		G	03/25/26	TL	JL	RE-ISSUED FOR BID
		F	03/20/26	TL	JL	RE-ISSUED FOR BID
		E	01/29/26	TL	JL	RE-ISSUED FOR BID
		D	08/21/25	TL	JL	ISSUED FOR BID
		C	07/07/25	TL	RAL	ISSUED FOR REVIEW (90% DESIGN)
		B	04/08/25	TL	RAL	ISSUED FOR REVIEW (60% DESIGN)

wood. WOOD GROUP USA, INC.

TITLE	INITIALS	DATE
DRAWN BY:	LBJ	02/26/24
DESIGN CHECKER:	JL	02/26/24
DESIGN ENGINEER:	PA	02/26/24
PROJECT MANAGER:	EL	02/26/24

ENBRIDGE
CAPE COD CANAL PIPELINE RELOCATION PROJECT
PROPOSED 16" G-32 PIPELINE
TITLE: ALIGNMENT SHEET
LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

ENBRIDGE
Algonquin Gas Transmission
915 N. Eldridge Parkway, Houston, TX 77079-2703 (713) 627-5400

YEAR: 2026 | W.O.: AFE 30002835 | SCALE: 1" = 100' | DWG.: GSYS-P.500-0017 | REV.: G

w_259271\MAPPING\DRAWINGS\P-ALIGNMENT\RE-ISSUED FOR BID_2\259271-G_32

RIGHT-OF-WAY

TRACT NUMBERS

SURVEY DATA

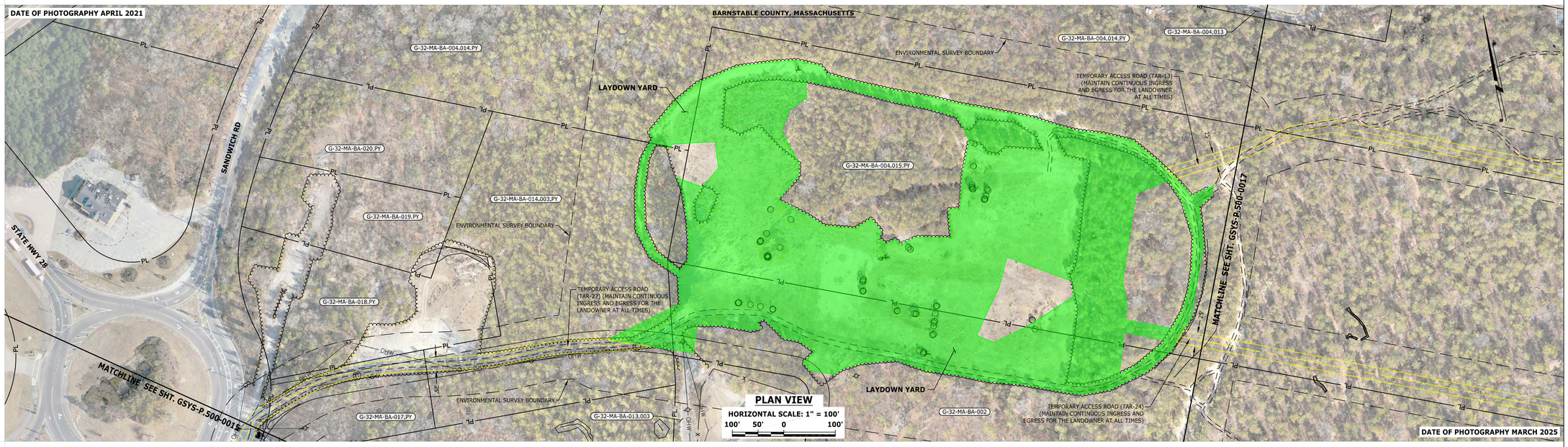
SURVEY COMPANY:
FIELD BOOK:
PAGES:

CLASS LOCATION

PIPE MATERIAL

ALIGNMENT LEGEND

- PIPELINE MILEPOST
- PROPOSED G-31 PIPELINE
- PROPOSED G-32 PIPELINE
- CONSTRUCTION LIMIT
- WAREYARD / STAGING AREA
- EXISTING PERMANENT ROW
- PROPOSED PERMANENT ROW
- ADDITIONAL TEMPORARY WORKSPACE
- PROPOSED METERING & REGULATING STATION (M&R) SITE / PIG TRAP SITE
- FACILITIES TEMPORARY WORKSPACE
- FACILITIES PERMANENT WORKSPACE
- PROPOSED GRAVEL AREA
- DELINEATED WETLAND BOUNDARY
- DELINEATED WATERBODY BANK
- DELINEATED WATERBODY CENTERLINE
- PERMANENT ACCESS ROAD
- TEMPORARY ACCESS ROAD
- PROPERTY LINE — PL —
- MAJOR CONTOUR — -100'- —
- MUNICIPALITY LINE
- ENVIRONMENTAL SURVEY BOUNDARY
- FENCE — X —
- EXISTING AGT PIPELINE — AGT —
- FOREIGN PIPELINE
- POWERLINE — P —
- WATER PIPELINE — W —
- RAILROAD TRACK
- OVERHEAD WIRE — OHW —
- TELEPHONE LINE — C —
- UTILITY LINES
- SANITARY SEWER — SAN —
- TEE TAP
- BLOW OFF VALVE
- MAINLINE VALVE (MLV)
- POINT OF INTERSECTION
- BORE ENTRY/EXIT
- TRANSMISSION TOWER
- LIGHT POLE
- UTILITY POLE
- FIRE HYDRANT
- WELL (GAS)
- WELL (WATER)
- WELL (OIL)
- WELL (UNKNOWN)



ENVIRONMENTAL DATA

E & S TYPICALS

E&S TYPICALS WILL BE USED AS A PLAN AND WILL HAVE FURTHER INPUT FROM ENVIRONMENTAL INSPECTOR.

PROFILE

HORIZONTAL SCALE: 1" = 100'
100' 50' 0 100'
VERTICAL SCALE: 1" = 100'
100' 50' 0 100'

THE LOCATION OF TRENCH PLUGS AND SLOPE BREAKERS ARE INTENDED TO BE USED AS A GUIDELINE ONLY. EXACT LOCATION TO BE DETERMINED IN THE FIELD.

SLOPE BREAKERS
TRENCH PLUG

PERMANENT SLOPE BREAKER & TRENCH PLUG SPACING

% SLOPE	SLOPE BREAKER SPACING (FT)	% SLOPE	TRENCH PLUG SPACING (FT)
5-15%	300 FT	<5%	NO STRUCTURE
15-30%	200 FT	5-15%	300 FT
>30%	100 FT	15-30%	200 FT
		>30%	100 FT

IN AG FIELDS AND RESIDENTIAL AREAS WHERE SLOPE BREAKERS ARE NOT TYPICALLY REQUIRED, INSTALL PERMANENT TRENCH PLUGS AT THE SAME SPACING AS IF PERMANENT SLOPE BREAKERS WERE REQUIRED. (FERC PLAN)

LAND USE CLASSIFICATION

CC CULTIVATED CROPS	DF DECIDUOUS FOREST	D/OS DEVELOPED OPEN SPACE
EF EVERGREEN FOREST	S/S SHRUB SCRUB	D/LI DEVELOPED LOW INTENSITY
H/P HAY PASTURE	MF MIXED FOREST	D/MI DEVELOPED MEDIUM INTENSITY

SOILS

LAND USE

% SLOPE

STAMP/SEAL

COMMONWEALTH OF MASSACHUSETTS — CLAY H. WILLIS — STRUCTURAL — No. 49136 — REGISTERED PROFESSIONAL ENGINEER — 02/23/26

THIS DOCUMENT IS RELEASED FOR THE PURPOSE OF:
BID REVIEW
IT IS NOT TO BE USED FOR: CONSTRUCTION, RECORDATION, CONVEYANCE, SALES, OR AS THE BASIS FOR THE ISSUANCE OF A PERMIT

UNDER THE AUTHORITY OF:
PE NAME: CLAY WILLIS
PE STATE: MASSACHUSETTS
PE NUMBER 49136

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		G	03/25/26	TL	JL	RE-ISSUED FOR BID
		F	03/20/26	TL	JL	RE-ISSUED FOR BID
		E	01/29/26	TL	JL	RE-ISSUED FOR BID
		D	08/21/25	TL	JL	ISSUED FOR BID
		C	07/07/25	TL	RAL	ISSUED FOR REVIEW (90% DESIGN)
		B	04/08/25	TL	RAL	ISSUED FOR REVIEW (60% DESIGN)

wood. WOOD GROUP USA, INC.

TITLE	INITIALS	DATE
DRAWN BY:	LBJ	02/26/24
DESIGN CHECKER:	JL	02/26/24
DESIGN ENGINEER:	PA	02/26/24
PROJECT MANAGER:	EL	02/26/24

ENBRIDGE
CAPE COD CANAL PIPELINE RELOCATION PROJECT
PROPOSED 16" G-32 PIPELINE
TITLE: ALIGNMENT SHEET
LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

YEAR: 2026 | W.O.: AFE 30002835 | SCALE: 1" = 100'

ENBRIDGE
Algonquin Gas Transmission
915 N. Eldridge Parkway, Houston, TX 77079-2703 (713) 627-5400

DWG.: GSYS-P.500-0018 | REV.: G

M:\259271\MAPPING\DRAWINGS\ALIGNMENT\RE-ISSUED FOR BID 2\259271-sc_32

RIGHT-OF-WAY

TRACT NUMBERS

SURVEY DATA

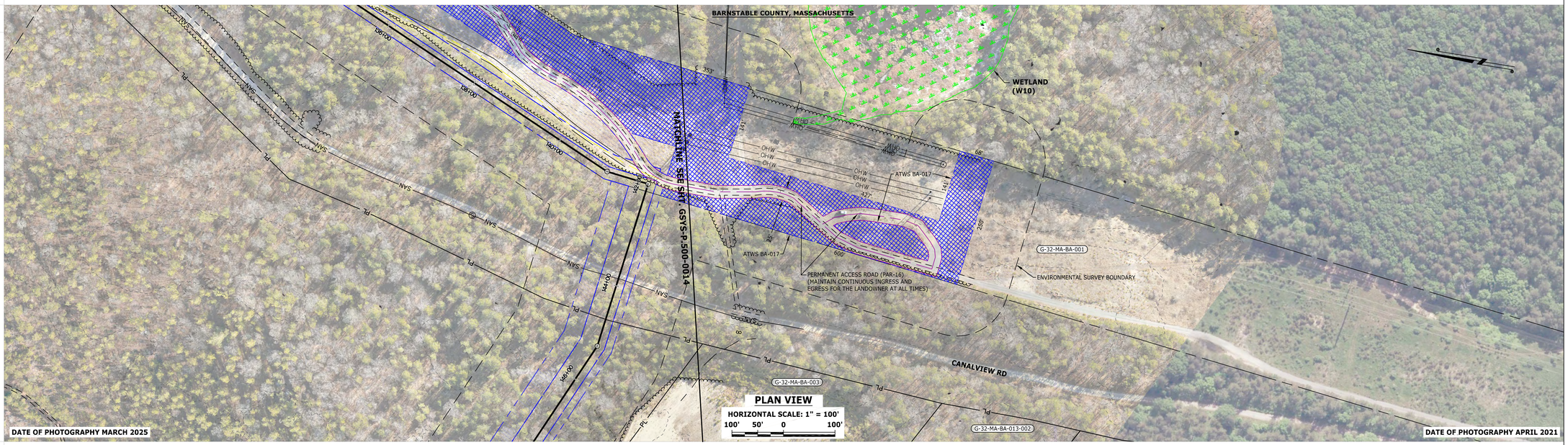
SURVEY COMPANY:
FIELD BOOK:
PAGES:

CLASS LOCATION

PIPE MATERIAL

ALIGNMENT LEGEND

- PIPELINE MILEPOST
- PROPOSED G-31 PIPELINE
- PROPOSED G-32 PIPELINE
- CONSTRUCTION LIMIT
- WAREYARD / STAGING AREA
- EXISTING PERMANENT ROW
- PROPOSED PERMANENT ROW
- ADDITIONAL TEMPORARY WORKSPACE
- PROPOSED METERING & REGULATING STATION (M&R) SITE / PIG TRAP SITE
- FACILITIES TEMPORARY WORKSPACE
- FACILITIES PERMANENT WORKSPACE
- PROPOSED GRAVEL AREA
- DELINEATED WETLAND BOUNDARY
- DELINEATED WATERBODY BANK
- DELINEATED WATERBODY CENTERLINE
- PERMANENT ACCESS ROAD
- TEMPORARY ACCESS ROAD
- PROPERTY LINE — PL —
- MAJOR CONTOUR - -100'- -
- MUNICIPALITY LINE
- ENVIRONMENTAL SURVEY BOUNDARY
- FENCE — X —
- EXISTING AGT PIPELINE — AGT —
- FOREIGN PIPELINE — || —
- POWERLINE — P —
- WATER PIPELINE — W —
- RAILROAD TRACK — | —
- OVERHEAD WIRE — OHW —
- TELEPHONE LINE — C —
- UTILITY LINES
- SANITARY SEWER — SAN —
- TEE TAP
- BLOW OFF VALVE
- MAINLINE VALVE (MLV)
- POINT OF INTERSECTION
- BORE ENTRY/EXIT
- TRANSMISSION TOWER
- LIGHT POLE
- UTILITY POLE
- FIRE HYDRANT
- WELL (GAS)
- WELL (WATER)
- WELL (OIL)
- WELL (UNKNOWN)



ENVIRONMENTAL DATA

E & S TYPICALS

E&S TYPICALS WILL BE USED AS A PLAN AND WILL HAVE FURTHER INPUT FROM ENVIRONMENTAL INSPECTOR.

PROFILE

HORIZONTAL SCALE: 1" = 100'

100' 50' 0 100'

VERTICAL SCALE: 1" = 100'

100' 50' 0 100'

THE LOCATION OF TRENCH PLUGS AND SLOPE BREAKERS ARE INTENDED TO BE USED AS A GUIDELINE ONLY. EXACT LOCATION TO BE DETERMINED IN THE FIELD.

SLOPE BREAKERS
TRENCH PLUG

PERMANENT SLOPE BREAKER & TRENCH PLUG SPACING

% SLOPE	SLOPE BREAKER SPACING (FT)	% SLOPE	TRENCH PLUG SPACING (FT)
5-15%	300 FT	<5%	NO STRUCTURE
15-30%	200 FT	5-15%	300 FT
>30%	100 FT	15-30%	200 FT
		>30%	100 FT

IN AG FIELDS AND RESIDENTIAL AREAS WHERE SLOPE BREAKERS ARE NOT TYPICALLY REQUIRED, INSTALL PERMANENT TRENCH PLUGS AT THE SAME SPACING AS IF PERMANENT SLOPE BREAKERS WERE REQUIRED. (FERC PLAN)

LAND USE CLASSIFICATION

CC CULTIVATED CROPS	DF DECIDUOUS FOREST	D/OS DEVELOPED OPEN SPACE	
EF EVERGREEN FOREST	S/S SHRUB SCRUB	D/LI DEVELOPED LOW INTENSITY	
H/P HAY PASTURE	MF MIXED FOREST	D/MI DEVELOPED MEDIUM INTENSITY	

SOILS

LAND USE

% SLOPE

STAMP/SEAL

CLAY H. WILLIS STRUCTURAL NO. 49136 COMMONWEALTH OF MASSACHUSETTS PROFESSIONAL ENGINEER
06/23/26

THIS DOCUMENT IS RELEASED FOR THE PURPOSE OF:
BID REVIEW
IT IS NOT TO BE USED FOR:
CONSTRUCTION, RECORDATION, CONVEYANCE, SALES, OR AS THE BASIS FOR THE ISSUANCE OF A PERMIT

UNDER THE AUTHORITY OF:
PE NAME: CLAY WILLIS
PE STATE: MASSACHUSETTS
PE NUMBER: 49136

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		E	01/29/26	TL	JL	RE-ISSUED FOR BID
		D	08/21/25	TL	JL	ISSUED FOR BID
		C	07/07/25	TL	RAL	ISSUED FOR REVIEW (90% DESIGN)
		B	04/08/25	TL	RAL	ISSUED FOR REVIEW (60% DESIGN)
		A	02/26/24	LBJ	JL	ISSUED FOR REVIEW

wood.
WOOD GROUP USA, INC.

TITLE	INITIALS	DATE
DRAWN BY:	LBJ	02/26/24
DESIGN CHECKER:	JL	02/26/24
DESIGN ENGINEER:	PA	02/26/24
PROJECT MANAGER:	EL	02/26/24

ENBRIDGE
CAPE COD CANAL PIPELINE RELOCATION PROJECT
PROPOSED 16" G-32 PIPELINE
TITLE: ALIGNMENT SHEET

LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

YEAR: 2026 | W.O.: AFE 30002835 | SCALE: 1" = 100' | DWG.: GSYS-P.500-0019 | REV.: E

ENBRIDGE

Algonquin Gas Transmission
915 N. Eldridge Parkway, Houston, TX 77079-2703 (713) 627-5400

M:\2292\1\MAPPING\DRAWINGS\P-ALIGNMENT\RE-ISSUED FOR BID\2292P-G_32

RIGHT-OF-WAY

TRACT NUMBERS

0+00	G-11-MA-BA-010		G-11-MA-BA-010A		G-11-MA-BA-011		G-11-MA-BA-012		G-11-MA-BA-013.RD HWY 6 (SAGAMORE BRIDGE S)		G-11-MA-BA-014	G-24-MA-BA-001.5.RD CANAL ST		G-11-MA-BA-015.MS	22+74
	9 FT.	0+09	352 FT.	2+61	864 FT.	12+25	238 FT.	14+63	522 FT.	19+85	83 FT.	20+68	74 FT.	21+42	132 FT.

SURVEY DATA

SURVEY COMPANY:
FIELD BOOK:
PAGES:

0+00 BEGIN PIPELINE														22+74 END PIPELINE
0+27 TREE LINE 0+32 TREE LINE 0+54 TREE LINE		7+90 P.I. <11°02'03" RT.	8+40 HDD EXIT		13+53 WATERLINE	14+64 FENCE	15+12 TELEPHONE LINE	16+05 GUARDRAIL 16+06 EDGE OF PAVEMENT		19+24 DRAINAGE LINE	19+55 EDGE OF PAVEMENT 19+56 UG POWERLINE 19+65 EDGE OF PAVEMENT	20+75 TELEPHONE LINE 20+88 WATERLINE	21+30 EDGE OF PAVEMENT	22+74 HDD ENTRY	

CLASS LOCATION

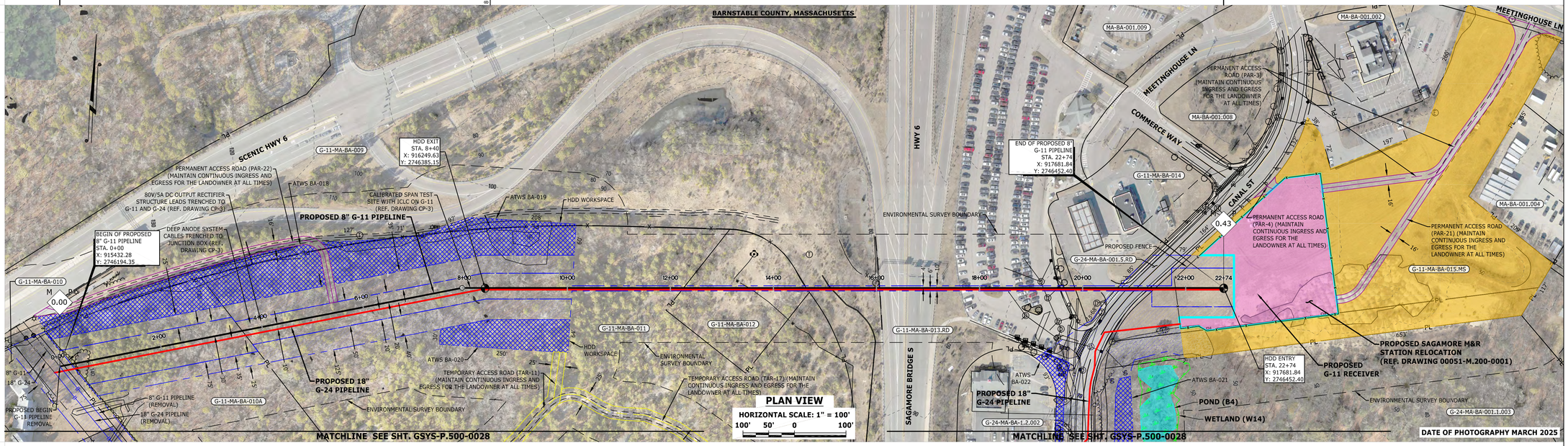
0+00	CLASS 2	14+90	CLASS 3	22+74

PIPE MATERIAL

0+00	8.625" O.D. X 0.322" W.T., API 5L, Gr. B, 16-20 MILS FBE 840 FT.	8+40	8.625" O.D. X 0.500" W.T., API 5L, Gr. B, 16-20 MILS FBE + 24 MILS ARO 1434 FT. (HDD)	22+74

ALIGNMENT LEGEND

- PIPELINE MILEPOST
- PROPOSED G-24 PIPELINE
- PROPOSED G-11 PIPELINE
- 18" G-24 & 8" G-11 PIPELINES (TO BE REMOVED)
- CONSTRUCTION LIMIT
- WAREYARD / STAGING AREA
- EXISTING PERMANENT ROW
- PROPOSED PERMANENT ROW
- ADDITIONAL TEMPORARY WORKSPACE
- PROPOSED METERING & REGULATING STATION (M&R) SITE / PIG TRAP SITE
- FACILITIES TEMPORARY WORKSPACE
- FACILITIES PERMANENT WORKSPACE
- PROPOSED GRAVEL AREA
- DELINEATED WETLAND BOUNDARY
- DELINEATED WATERBODY BANK
- DELINEATED WATERBODY CENTERLINE
- PERMANENT ACCESS ROAD
- TEMPORARY ACCESS ROAD
- PROPERTY LINE
- MAJOR CONTOUR
- MUNICIPALITY LINE
- ENVIRONMENTAL SURVEY BOUNDARY
- FENCE
- EXISTING AGT PIPELINE
- FOREIGN PIPELINE
- POWERLINE
- WATER PIPELINE
- RAILROAD TRACK
- OVERHEAD WIRE
- TELEPHONE LINE
- UTILITY LINES
- SANITARY SEWER
- TEE TAP
- BLOW OFF VALVE
- MAINLINE VALVE (MLV)
- POINT OF INTERSECTION
- BORE ENTRY/EXIT
- TRANSMISSION TOWER
- LIGHT POLE
- UTILITY POLE
- FIRE HYDRANT
- WELL (GAS)
- WELL (WATER)
- WELL (OIL)
- WELL (UNKNOWN)



PLAN VIEW
HORIZONTAL SCALE: 1" = 100'
100' 50' 0 100'

ENVIRONMENTAL DATA

E & S TYPICALS

E&S TYPICALS WILL BE USED AS A PLAN AND WILL HAVE FURTHER INPUT FROM ENVIRONMENTAL INSPECTOR.

PROFILE

HORIZONTAL SCALE: 1" = 100'
100' 50' 0 100'

VERTICAL SCALE: 1" = 100'
100' 50' 0 100'

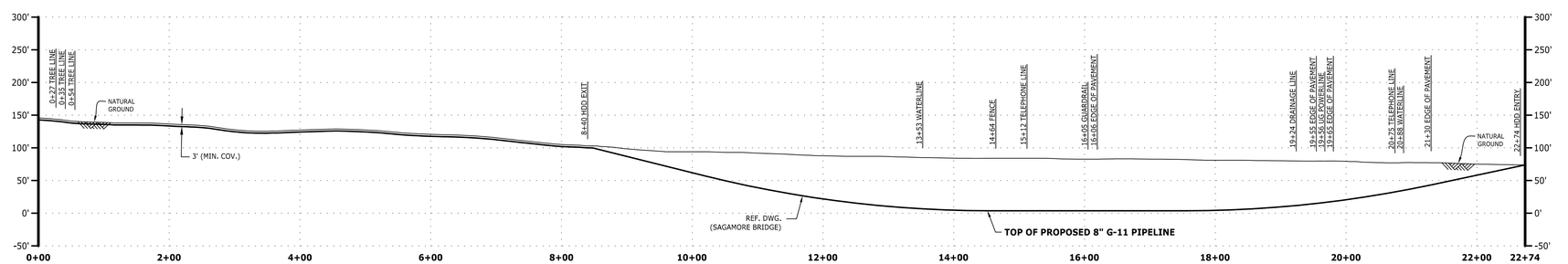
THE LOCATION OF TRENCH PLUGS AND SLOPE BREAKERS ARE INTENDED TO BE USED AS A GUIDELINE ONLY. EXACT LOCATION TO BE DETERMINED IN THE FIELD.

SLOPE BREAKERS
TRENCH PLUG

PERMANENT SLOPE BREAKER & TRENCH PLUG SPACING

% SLOPE	SLOPE BREAKER SPACING (FT)	% SLOPE	TRENCH PLUG SPACING (FT)
5-15%	300 FT	<5%	NO STRUCTURE
15-30%	200 FT	5-15%	300 FT
>30%	100 FT	15-30%	200 FT
		>30%	100 FT

IN AG FIELDS AND RESIDENTIAL AREAS WHERE SLOPE BREAKERS ARE NOT TYPICALLY REQUIRED, INSTALL PERMANENT TRENCH PLUGS AT THE SAME SPACING AS IF PERMANENT SLOPE BREAKERS WERE REQUIRED. (FERC PLAN)



LAND USE CLASSIFICATION

CC CULTIVATED CROPS DF DECIDUOUS FOREST D/OS DEVELOPED OPEN SPACE
EF EVERGREEN FOREST S/S SHRUB SCRUB D/LI DEVELOPED LOW INTENSITY
H/P HAY PASTURE MF MIXED FOREST D/MI DEVELOPED MEDIUM INTENSITY

SEGMENTABLE ELBOW	QTY
90 DEG, SD, 8.625" OD, 0.322" WT, CS, x52, FBE COATING SYSTEM 2B	1
45 DEG, SD, 8.625" OD, 0.322" WT, CS, x52, FBE COATING SYSTEM 2B	2

SOILS															
LAND USE															
% SLOPE	5-15%	<5%	5-15%	15-30%	5-15%	<5%	5-15%	<5%	5-15%		<5%	5-15%	<5%	5-15%	<5%	5-15%	<5%

STAMP/SEAL

CLAY H. WILLIS — STRUCTURAL — NO. 49136 — COMMONWEALTH OF MASSACHUSETTS — REGISTERED PROFESSIONAL ENGINEER
5/23/26

THIS DOCUMENT IS RELEASED FOR THE PURPOSE OF:
BID REVIEW
IT IS NOT TO BE USED FOR: CONSTRUCTION, RECORDATION, CONVEYANCE, SALES, OR AS THE BASIS FOR THE ISSUANCE OF A PERMIT
UNDER THE AUTHORITY OF:
PE NAME: CLAY WILLIS
PE STATE: MASSACHUSETTS
PE NUMBER 49136

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
SAGAMORE BRIDGE OVERBEND	OVERBEND PLAN AND PROFILE - SAGAMORE BRIDGE HDD	D	01/29/26	TL	JL	RE-ISSUED FOR BID
CP-3	CATHODIC PROTECTION DESIGN	C	08/21/25	TL	JL	ISSUED FOR BID
00051-M.200-0001	SAGAMORE M&R STATION - LOCATION MAP AND PLOT PLAN	B	07/07/25	TL	JL	ISSUED FOR REVIEW (90% DESIGN)
SAGAMORE BRIDGE (REV. P9)	SAGAMORE BRIDGE HORIZONTAL DIRECTIONAL DRILL	A	04/08/25	TL	RAL	ISSUED FOR REVIEW (60% DESIGN)

wood. WOOD GROUP USA, INC.

DRAWN BY:	TL	03/31/25	ENBRIDGE CAPE COD CANAL PIPELINE RELOCATION PROJECT PROPOSED 8" G-11 PIPELINE
DESIGN CHECKER:	JL	04/01/25	
DESIGN ENGINEER:	PA	04/08/25	TITLE: ALIGNMENT SHEET
PROJECT MANAGER:	EL	04/08/25	LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

ENBRIDGE
Algonquin Gas Transmission
915 N. Eldridge Parkway, Houston, TX 77079-2703 (713) 627-5400

TITLE	INITIALS	DATE	YEAR:	W.O.:	SCALE:	DWG.:	REV.:
			2026	AFE 30002835	1" = 100'	GSYS-P.500-0027	D

M:\259271\MAPPING\DRAWINGS\91-ALIGNMENT\RE-ISSUED FOR BID\259271-G_11

RIGHT-OF-WAY

TRACT NUMBERS

SURVEY DATA

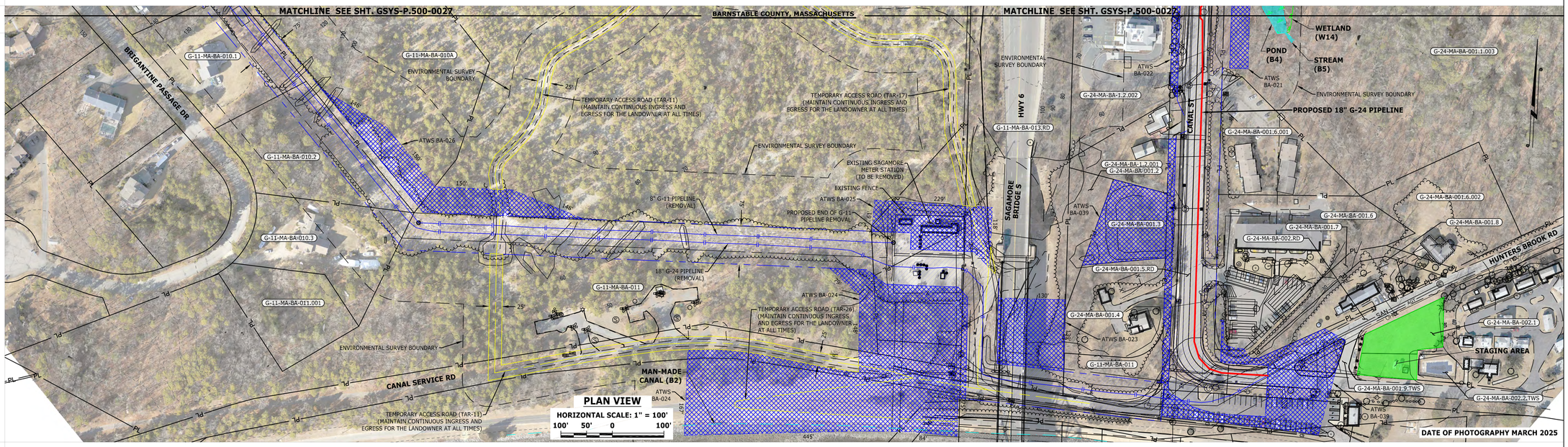
SURVEY COMPANY:
FIELD BOOK:
PAGES:

CLASS LOCATION

PIPE MATERIAL

ALIGNMENT LEGEND

- PIPELINE MILEPOST
- PROPOSED G-24 PIPELINE
- PROPOSED G-11 PIPELINE
- 18" G-24 & 8" G-11 PIPELINES (TO BE REMOVED)
- CONSTRUCTION LIMIT
- WAREYARD / STAGING AREA
- EXISTING PERMANENT ROW
- PROPOSED PERMANENT ROW
- ADDITIONAL TEMPORARY WORKSPACE
- PROPOSED METERING & REGULATING STATION (M&R) SITE / PIG TRAP SITE
- FACILITIES TEMPORARY WORKSPACE
- FACILITIES PERMANENT WORKSPACE
- PROPOSED GRAVEL AREA
- DELINEATED WETLAND BOUNDARY
- DELINEATED WATERBODY BANK
- DELINEATED WATERBODY CENTERLINE
- PERMANENT ACCESS ROAD
- TEMPORARY ACCESS ROAD
- PROPERTY LINE
- MAJOR CONTOUR
- MUNICIPALITY LINE
- ENVIRONMENTAL SURVEY BOUNDARY
- FENCE
- EXISTING AGT PIPELINE
- FOREIGN PIPELINE
- POWERLINE
- WATER PIPELINE
- RAILROAD TRACK
- OVERHEAD WIRE
- TELEPHONE LINE
- UTILITY LINES
- SANITARY SEWER
- TEE TAP
- BLOW OFF VALVE
- MAINLINE VALVE (MLV)
- POINT OF INTERSECTION
- BORE ENTRY/EXIT
- TRANSMISSION TOWER
- LIGHT POLE
- UTILITY POLE
- FIRE HYDRANT
- WELL (GAS)
- WELL (WATER)
- WELL (OIL)
- WELL (UNKNOWN)



ENVIRONMENTAL DATA

E & S TYPICALS

E&S TYPICALS WILL BE USED AS A PLAN AND WILL HAVE FURTHER INPUT FROM ENVIRONMENTAL INSPECTOR.

PROFILE

HORIZONTAL SCALE: 1" = 100'
100' 50' 0 100'

VERTICAL SCALE: 1" = 100'
100' 50' 0 100'

THE LOCATION OF TRENCH PLUGS AND SLOPE BREAKERS ARE INTENDED TO BE USED AS A GUIDELINE ONLY. EXACT LOCATION TO BE DETERMINED IN THE FIELD.

SLOPE BREAKERS ○
TRENCH PLUG ▲

PERMANENT SLOPE BREAKER & TRENCH PLUG SPACING

% SLOPE	SLOPE BREAKER SPACING (FT)	% SLOPE	TRENCH PLUG SPACING (FT)
5-15%	300 FT	<5%	NO STRUCTURE
15-30%	200 FT	5-15%	300 FT
>30%	100 FT	15-30%	200 FT
		>30%	100 FT

IN AG FIELDS AND RESIDENTIAL AREAS WHERE SLOPE BREAKERS ARE NOT TYPICALLY REQUIRED, INSTALL PERMANENT TRENCH PLUGS AT THE SAME SPACING AS IF PERMANENT SLOPE BREAKERS WERE REQUIRED. (FERC PLAN)

LAND USE CLASSIFICATION

CC CULTIVATED CROPS DF DECIDUOUS FOREST D/OS DEVELOPED OPEN SPACE
EF EVERGREEN FOREST S/S SHRUB SCRUB D/LI DEVELOPED LOW INTENSITY
H/P HAY PASTURE MF MIXED FOREST D/MI DEVELOPED MEDIUM INTENSITY

SOILS

LAND USE

% SLOPE

STAMP/SEAL

COMMONWEALTH OF MASSACHUSETTS
CLAY H. WILLIS
STRUCTURAL
NO. 49136
REGISTERED PROFESSIONAL ENGINEER
5/23/26

THIS DOCUMENT IS RELEASED FOR THE PURPOSE OF:
BID REVIEW
IT IS NOT TO BE USED FOR:
CONSTRUCTION, RECORDATION, CONVEYANCE, SALES, OR AS THE BASIS FOR THE ISSUANCE OF A PERMIT

UNDER THE AUTHORITY OF:
PE NAME: CLAY WILLIS
PE STATE: MASSACHUSETTS
PE NUMBER 49136

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		D	01/29/26	TL	JL	RE-ISSUED FOR BID
		C	08/21/25	TL	JL	ISSUED FOR BID
		B	07/07/25	TL	JL	ISSUED FOR REVIEW (90% DESIGN)
		A	04/08/25	TL	RAL	ISSUED FOR REVIEW (60% DESIGN)

wood.
WOOD GROUP USA, INC.

TITLE	INITIALS	DATE
DRAWN BY:	TL	03/31/25
DESIGN CHECKER:	JL	04/01/25
DESIGN ENGINEER:	PA	04/08/25
PROJECT MANAGER:	EL	04/08/25

ENBRIDGE
CAPE COD CANAL PIPELINE RELOCATION PROJECT
PROPOSED 8" G-11 PIPELINE
TITLE: ALIGNMENT SHEET
LOC.: BARNSTABLE COUNTY, MASSACHUSETTS
YEAR: 2026 | W.O.: AFE 30002835 | SCALE: 1" = 100' | DWG.: GSYS-P.500-0028 | REV.: D

ENBRIDGE
Algonquin Gas Transmission
915 N. Eldridge Parkway, Houston, TX 77079-2703 (713) 627-5400

M:\259271\MAPPING\DRAWINGS\91-ALIGNMENT\RE-ISSUED FOR BID\259271-G_11

RIGHT-OF-WAY

TRACT NUMBERS

1360+76	G-8-MA-BA-135.MS	1360+31	G-8-MA-BA-134.RD	1359+42	G-8-MA-BA-130	1337+00
	45 FT.		89 FT.		2242 FT.	

SURVEY DATA

SURVEY COMPANY:
FIELD BOOK:
PAGES:

1360+76 BEGINNING OF REMOVAL	1360+08 SCENIC HWY 6 (NE BOUND)	1359+76 SCENIC HWY 6 (SW BOUND)	1359+44 FENCE LINE	1358+93 P.I. <086°51'04" RT.	1353+26 P.I. <110°21'45" LT.	1351+36 P.I. <30°39'34" LT.	1350+85 P.I. <26°45'09" RT.	1346+17 OH POWERLINE	1346+11 OH POWERLINE	1346+05 OH POWERLINE	1345+54 P.I. <29°10'22" LT.	1345+24 P.I. <20°20'46" LT.	1338+04 P.I. <165°10'16" RT.	1337+00

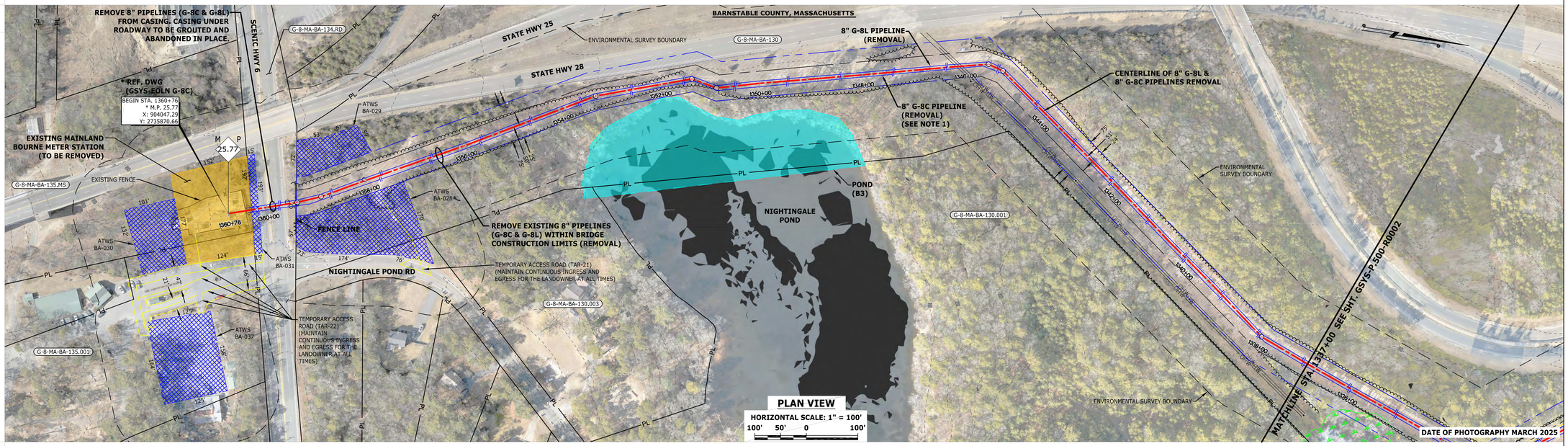
CLASS LOCATION

1360+76	CLASS 3	1347+33	CLASS 2	1337+00

PIPE MATERIAL

ALIGNMENT LEGEND

- PIPELINE MILEPOST (M / P)
- CENTERLINE OF G-8C & G-8L REMOVAL
- 8" G-8C & 8" G-8L PIPELINES (TO BE REMOVED)
- PROPOSED G-8C PIPELINE
- PROPOSED G-8L PIPELINE
- CONSTRUCTION LIMIT
- WAREYARD / STAGING AREA
- EXISTING PERMANENT ROW
- PROPOSED PERMANENT ROW
- ADDITIONAL TEMPORARY WORKSPACE
- PROPOSED METERING & REGULATING STATION (M&R) SITE
- FACILITIES TEMPORARY WORKSPACE
- FACILITIES PERMANENT WORKSPACE
- PROPOSED GRAVEL AREA
- DELINEATED WETLAND BOUNDARY
- DELINEATED WATERBODY BANK
- DELINEATED WATERBODY CENTERLINE
- PERMANENT ACCESS ROAD
- TEMPORARY ACCESS ROAD
- PROPERTY LINE (PL)
- MAJOR CONTOUR (-100-)
- MUNICIPALITY LINE
- ENVIRONMENTAL SURVEY BOUNDARY
- FENCE (X)
- EXISTING AGT PIPELINE (AGT)
- FOREIGN PIPELINE (I)
- POWERLINE (P)
- WATER PIPELINE (W)
- RAILROAD TRACK (I)
- OVERHEAD WIRE (OHW)
- TELEPHONE LINE (C)
- UTILITY LINES
- SANITARY SEWER (SAN)
- TEE TAP
- BLOW OFF VALVE
- MAINLINE VALVE (MLV)
- POINT OF INTERSECTION
- BORE ENTRY/EXIT
- TRANSMISSION TOWER
- LIGHT POLE
- UTILITY POLE
- FIRE HYDRANT
- WELL (GAS)
- WELL (WATER)
- WELL (OIL)
- WELL (UNKNOWN)



ENVIRONMENTAL DATA

E & S TYPICALS

E&S TYPICALS WILL BE USED AS A PLAN AND WILL HAVE FURTHER INPUT FROM ENVIRONMENTAL INSPECTOR.

PROFILE

HORIZONTAL SCALE: 1" = 100'
100' 50' 0 100'
VERTICAL SCALE: 1" = 100'
100' 50' 0 100'

THE LOCATION OF TRENCH PLUGS AND SLOPE BREAKERS ARE INTENDED TO BE USED AS A GUIDELINE ONLY. EXACT LOCATION TO BE DETERMINED IN THE FIELD.

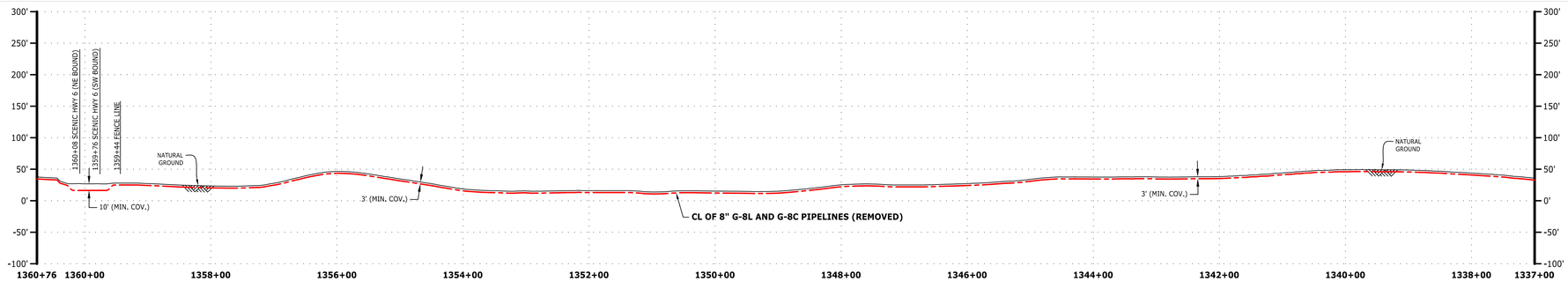
SLOPE BREAKERS ○
TRENCH PLUG ▲

PERMANENT SLOPE BREAKER & TRENCH PLUG SPACING

% SLOPE	SLOPE BREAKER SPACING (FT)	% SLOPE	TRENCH PLUG SPACING (FT)
5-15%	300 FT	<5%	NO STRUCTURE
15-30%	200 FT	5-15%	300 FT
>30%	100 FT	15-30%	200 FT
		>30%	100 FT

IN AG FIELDS AND RESIDENTIAL AREAS WHERE SLOPE BREAKERS ARE NOT TYPICALLY REQUIRED, INSTALL PERMANENT TRENCH PLUGS AT THE SAME SPACING AS IF PERMANENT SLOPE BREAKERS WERE REQUIRED. (FERC PLAN)

NOTE:
1. G-8C REMOVAL INCLUDES VARIOUS PIPE SIZES BETWEEN 8.625" O.D. AND 6.625" O.D.



LAND USE CLASSIFICATION

CC CULTIVATED CROPS DF DECIDUOUS FOREST D/OS DEVELOPED OPEN SPACE
EF EVERGREEN FOREST S/S SHRUB SCRUB D/LI DEVELOPED LOW INTENSITY
H/P HAY PASTURE MF MIXED FOREST D/MI DEVELOPED MEDIUM INTENSITY

SOILS
LAND USE
% SLOPE

THIS DOCUMENT IS RELEASED FOR THE PURPOSE OF: BID REVIEW

IT IS NOT TO BE USED FOR: CONSTRUCTION, RECORDATION, CONVEYANCE, SALES, OR AS THE BASIS FOR THE ISSUANCE OF A PERMIT

UNDER THE AUTHORITY OF:
PE NAME: CLAY WILLIS
PE STATE: MASSACHUSETTS
PE NUMBER: 49136

CLAY H. WILLIS — COMMONWEALTH OF MASSACHUSETTS — NO. 49136 — REGISTERED PROFESSIONAL ENGINEER — STRUCTURAL — 01/23/26

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		G	01/29/26	TL	JL	RE-ISSUED FOR BID
		F	08/21/25	TL	JL	ISSUED FOR BID
		E	07/07/25	TL	JL	ISSUED FOR REVIEW (90% DESIGN)
		D	05/06/25	LBJ	JL	RE-ISSUED FOR REVIEW (60% DESIGN)
		C	04/08/25	TL	RAL	ISSUED FOR REVIEW (60% DESIGN)
GSYS-EOLN G-8C	OPERATIONS ALIGNMENT SHEET	B	02/26/24	TCS	JL	ISSUED FOR REVIEW

WOOD GROUP USA, INC.

TITLE	INITIALS	DATE
DRAWN BY:	LBJ	02/08/24
DESIGN CHECKER:	JL	02/09/24
DESIGN ENGINEER:	PA	02/09/24
PROJECT MANAGER:	EL	02/09/24

ENBRIDGE
CAPE COD CANAL PIPELINE RELOCATION PROJECT
REMOVAL OF 8" G-8C & 8" G-8L PIPELINES
TITLE: ALIGNMENT SHEET

LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

YEAR: 2026 | W.O.: AFE 30002835 | SCALE: 1" = 100' | DWG.: GSYS-P.500-R0001 | REV.: G

Algonquin Gas Transmission
915 N. Eldridge Parkway, Houston, TX 77079-2703 (713) 627-5400

M:\259271\MAPPING\DRAWINGS\01-ALIGNMENT\RE-ISSUED FOR BID\GSYS-P.500-R0001

RIGHT-OF-WAY

TRACT NUMBERS

1337+00	G-8-MA-BA-130	1325+75	G-8-MA-BA-129	1320+38	G-8-MA-BA-129.20	1317+51	UNKNOWN	1315+68	G-8-MA-BA-129.18	1314+64	G-8-MA-BA-129.17	1313+37	G-8-MA-BA-129.16	1313+00
	1125 FT.		537 FT.		287 FT.		183 FT.		104 FT.		127 FT.		37 FT.	

SURVEY DATA

SURVEY COMPANY:
FIELD BOOK:
PAGES:

1337+00	1333+21 P.I. <19°27'46" RT. 1333+01 TEMPORARY ACCESS ROAD (TAR-20)	1332+78 P.I. <32°02'49" RT. 1332+45 P.I. <05°22'14" RT.	1330+13 TEMPORARY ACCESS ROAD (TAR-20) 1330+02 TEMPORARY ACCESS ROAD (TAR-20)	1327+78 TEMPORARY ACCESS ROAD (TAR-20)	1326+94 P.I. <22°03'57" LT. 1326+53 P.I. <26°24'01" LT. 1326+31 TEMPORARY ACCESS ROAD (TAR-20)	1320+56 TEMPORARY ACCESS ROAD (TAR-20)	1317+49 P.I. <26°17'28" LT. 1317+07 OH POWERLINE	1313+00

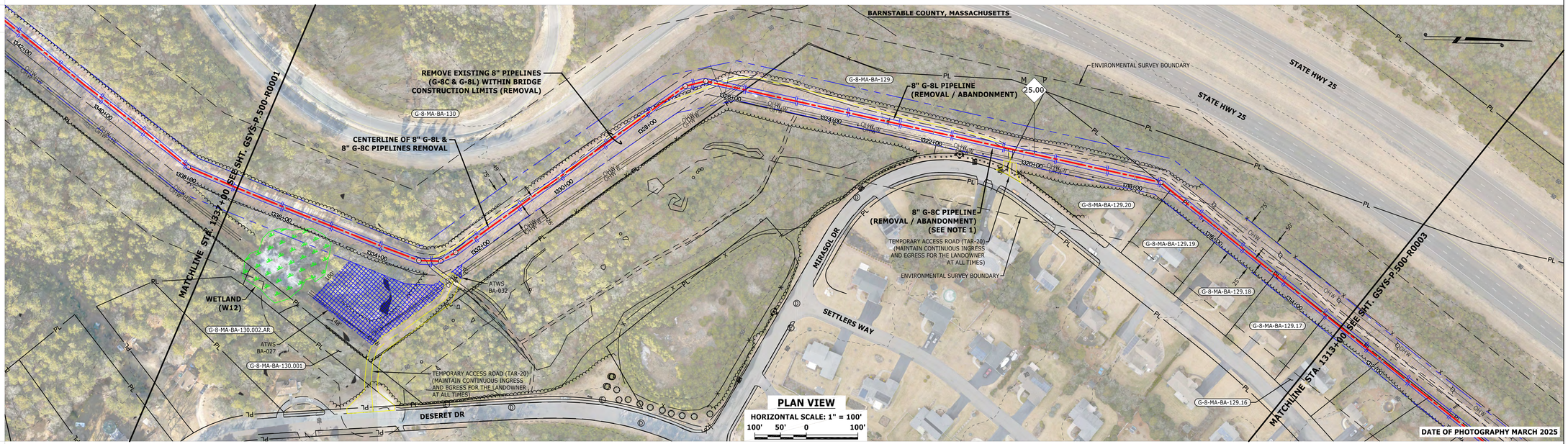
CLASS LOCATION

1337+00	CLASS 2	1334+66	CLASS 3	1313+00

PIPE MATERIAL

ALIGNMENT LEGEND

- PIPELINE MILEPOST
- CENTERLINE OF G-8C & G-8L REMOVAL
- 8" G-8C & 8" G-8L PIPELINES (TO BE REMOVED)
- PROPOSED G-8C PIPELINE
- PROPOSED G-8L PIPELINE
- CONSTRUCTION LIMIT
- WAREYARD / STAGING AREA
- EXISTING PERMANENT ROW
- PROPOSED PERMANENT ROW
- ADDITIONAL TEMPORARY WORKSPACE
- PROPOSED METERING & REGULATING STATION (M&R) SITE
- FACILITIES TEMPORARY WORKSPACE
- FACILITIES PERMANENT WORKSPACE
- PROPOSED GRAVEL AREA
- DELINEATED WETLAND BOUNDARY
- DELINEATED WATERBODY BANK
- DELINEATED WATERBODY CENTERLINE
- PERMANENT ACCESS ROAD
- TEMPORARY ACCESS ROAD
- PROPERTY LINE
- MAJOR CONTOUR
- MUNICIPALITY LINE
- ENVIRONMENTAL SURVEY BOUNDARY
- FENCE
- EXISTING AGT PIPELINE
- FOREIGN PIPELINE
- POWERLINE
- WATER PIPELINE
- RAILROAD TRACK
- OVERHEAD WIRE
- TELEPHONE LINE
- UTILITY LINES
- SANITARY SEWER
- TEE TAP
- BLOW OFF VALVE
- MAINLINE VALVE (MLV)
- POINT OF INTERSECTION
- BORE ENTRY/EXIT
- TRANSMISSION TOWER
- LIGHT POLE
- UTILITY POLE
- FIRE HYDRANT
- WELL (GAS)
- WELL (WATER)
- WELL (OIL)
- WELL (UNKNOWN)



ENVIRONMENTAL DATA

E & S TYPICALS

E&S TYPICALS WILL BE USED AS A PLAN AND WILL HAVE FURTHER INPUT FROM ENVIRONMENTAL INSPECTOR.

PROFILE

HORIZONTAL SCALE: 1" = 100'
100' 50' 0 100'

VERTICAL SCALE: 1" = 100'
100' 50' 0 100'

THE LOCATION OF TRENCH PLUGS AND SLOPE BREAKERS ARE INTENDED TO BE USED AS A GUIDELINE ONLY. EXACT LOCATION TO BE DETERMINED IN THE FIELD.

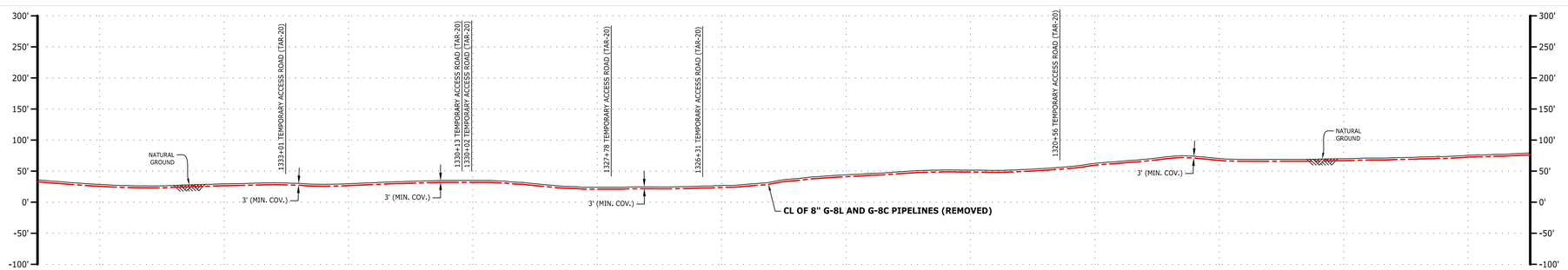
SLOPE BREAKERS
TRENCH PLUG

PERMANENT SLOPE BREAKER & TRENCH PLUG SPACING

% SLOPE	SLOPE BREAKER SPACING (FT)	% SLOPE	TRENCH PLUG SPACING (FT) NO STRUCTURE
5-15%	300 FT	<5%	300 FT
15-30%	200 FT	5-15%	200 FT
>30%	100 FT	15-30%	100 FT
		>30%	100 FT

IN AG FIELDS AND RESIDENTIAL AREAS WHERE SLOPE BREAKERS ARE NOT TYPICALLY REQUIRED, INSTALL PERMANENT TRENCH PLUGS AT THE SAME SPACING AS IF PERMANENT SLOPE BREAKERS WERE REQUIRED. (FERC PLAN)

NOTE:
1. G-8C REMOVAL INCLUDES VARIOUS PIPE SIZES BETWEEN 8.625" O.D. AND 6.625" O.D.



LAND USE CLASSIFICATION

CC CULTIVATED CROPS	DF DECIDUOUS FOREST	D/OS DEVELOPED OPEN SPACE	
EF EVERGREEN FOREST	S/S SHRUB SCRUB	D/LI DEVELOPED LOW INTENSITY	
H/P HAY PASTURE	MF MIXED FOREST	D/MI DEVELOPED MEDIUM INTENSITY	

SOILS
LAND USE
% SLOPE



THIS DOCUMENT IS RELEASED FOR THE PURPOSE OF:
BID REVIEW

IT IS NOT TO BE USED FOR:
CONSTRUCTION, RECORDATION, CONVEYANCE, SALES, OR AS THE BASIS FOR THE ISSUANCE OF A PERMIT

UNDER THE AUTHORITY OF:
PE NAME: CLAY WILLIS
PE STATE: MASSACHUSETTS
PE NUMBER: 49136

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		F	01/29/26	TL	JL	RE-ISSUED FOR BID
		E	08/21/25	TL	JL	ISSUED FOR BID
		D	07/07/25	TL	JL	ISSUED FOR REVIEW (90% DESIGN)
		C	05/06/25	LBJ	JL	RE-ISSUED FOR REVIEW (60% DESIGN)
		B	04/08/25	TL	RAL	ISSUED FOR REVIEW (60% DESIGN)
		A	02/26/24	TCS	JL	ISSUED FOR REVIEW

wood.
WOOD GROUP USA, INC.

TITLE	INITIALS	DATE
DRAWN BY:	LBJ	02/08/24
DESIGN CHECKER:	JL	02/09/24
DESIGN ENGINEER:	PA	02/09/24
PROJECT MANAGER:	EL	02/09/24

ENBRIDGE
CAPE COD CANAL PIPELINE RELOCATION PROJECT
REMOVAL OF 8" G-8C & 8" G-8L PIPELINES
TITLE: ALIGNMENT SHEET

LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

YEAR: 2026 | W.O.: AFE 30002835 | SCALE: 1" = 100' | DWG.: GSYS-P.500-R0002 | REV.: F

Algonquin Gas Transmission
915 N. Eldridge Parkway, Houston, TX 77079-2703 (713) 627-5400

M:\259271\MAPPING\DRAWINGS\91-ALIGNMENT\RE-ISSUED FOR BID\GSYS-P.500-R0001

RIGHT-OF-WAY

TRACT NUMBERS

1313+00	G-8-MA-BA-129.16	G-8-MA-BA-129.15	G-8-MA-BA-129.14	G-8-MA-BA-129.13	G-8-MA-BA-129.12	G-8-MA-BA-129.11	G-8-MA-BA-129.10	G-8-MA-BA-129.09	G-8-MA-BA-129.08	G-8-MA-BA-129.07	G-8-MA-BA-129.06	G-8-MA-BA-129.05	G-8-MA-BA-129.04	G-8-MA-BA-129.03	G-8-MA-BA-129.02	G-8-MA-BA-129.01	G-8-MA-BA-128.MS	UNKNOWN	1290+08
	101 FT.	117 FT.	98 FT.	86 FT.	82 FT.	89 FT.	86 FT.	99 FT.	99 FT.	110 FT.	124 FT.	125 FT.	125 FT.	144 FT.	224 FT.	51 FT.	470 FT.	62 FT.	
	1311+99	1310+82	1309+84	1308+98	1308+16	1307+27	1306+41	1305+42	1304+43	1303+33	1302+09	1300+84	1299+59	1298+15	1295+91	1295+40		1290+70	

SURVEY DATA

SURVEY COMPANY:
FIELD BOOK:
PAGES:

1313+00																	1293+99 P.I. <44°41'01" RT.		1290+23 P.I. <29°17'49" LT.	1290+08 END OF REMOVAL

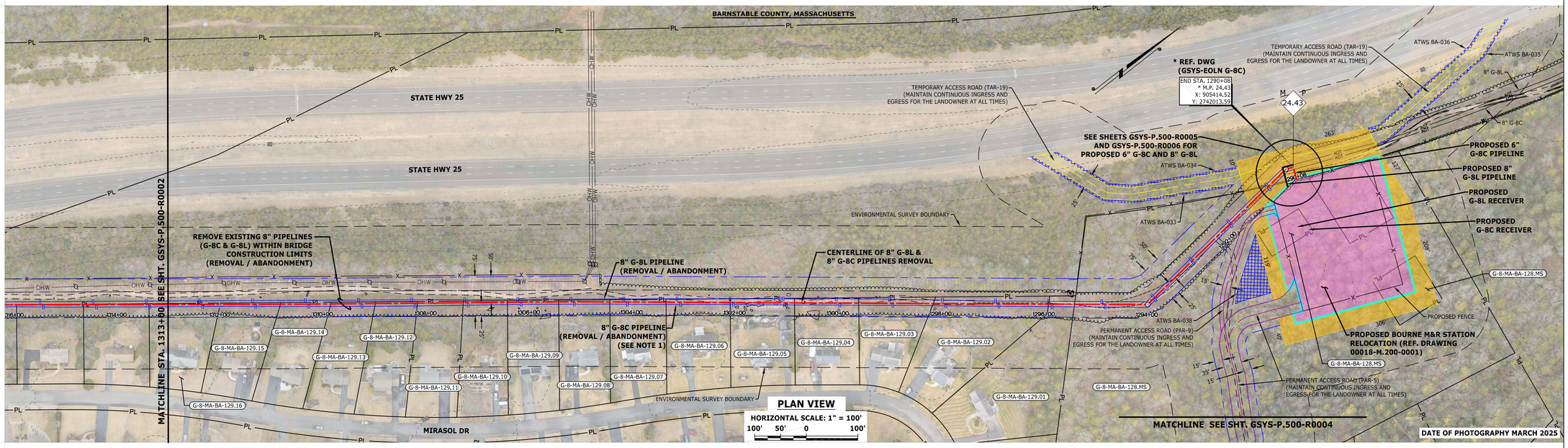
CLASS LOCATION

1313+00	CLASS 3	1292+93	CLASS 1	1290+08

PIPE MATERIAL

ALIGNMENT LEGEND

- PIPELINE MILEPOST
- CENTERLINE OF G-8C & G-8L REMOVAL
- 8" G-8C & 8" G-8L PIPELINES (TO BE REMOVED)
- PROPOSED G-8C PIPELINE
- PROPOSED G-8L PIPELINE
- CONSTRUCTION LIMIT
- WAREYARD / STAGING AREA
- EXISTING PERMANENT ROW
- PROPOSED PERMANENT ROW
- ADDITIONAL TEMPORARY WORKSPACE
- PROPOSED METERING & REGULATING STATION (M&R) SITE
- FACILITIES TEMPORARY WORKSPACE
- FACILITIES PERMANENT WORKSPACE
- PROPOSED GRAVEL AREA
- DELINEATED WETLAND BOUNDARY
- DELINEATED WATERBODY BANK
- DELINEATED WATERBODY CENTERLINE
- PERMANENT ACCESS ROAD
- TEMPORARY ACCESS ROAD
- PROPERTY LINE
- MAJOR CONTOUR
- MUNICIPALITY LINE
- ENVIRONMENTAL SURVEY BOUNDARY
- FENCE
- EXISTING AGT PIPELINE
- FOREIGN PIPELINE
- POWERLINE
- WATER PIPELINE
- RAILROAD TRACK
- OVERHEAD WIRE
- TELEPHONE LINE
- UTILITY LINES
- SANITARY SEWER
- TEE TAP
- BLOW OFF VALVE
- MAINLINE VALVE (MLV)
- POINT OF INTERSECTION
- BORE ENTRY/EXIT
- TRANSMISSION TOWER
- LIGHT POLE
- UTILITY POLE
- FIRE HYDRANT
- WELL (GAS)
- WELL (WATER)
- WELL (OIL)
- WELL (UNKNOWN)



ENVIRONMENTAL DATA

E & S TYPICALS

E&S TYPICALS WILL BE USED AS A PLAN AND WILL HAVE FURTHER INPUT FROM ENVIRONMENTAL INSPECTOR.

PROFILE

HORIZONTAL SCALE: 1" = 100'
100' 50' 0 100'
VERTICAL SCALE: 1" = 100'
100' 50' 0 100'

THE LOCATION OF TRENCH PLUGS AND SLOPE BREAKERS ARE INTENDED TO BE USED AS A GUIDELINE ONLY. EXACT LOCATION TO BE DETERMINED IN THE FIELD.

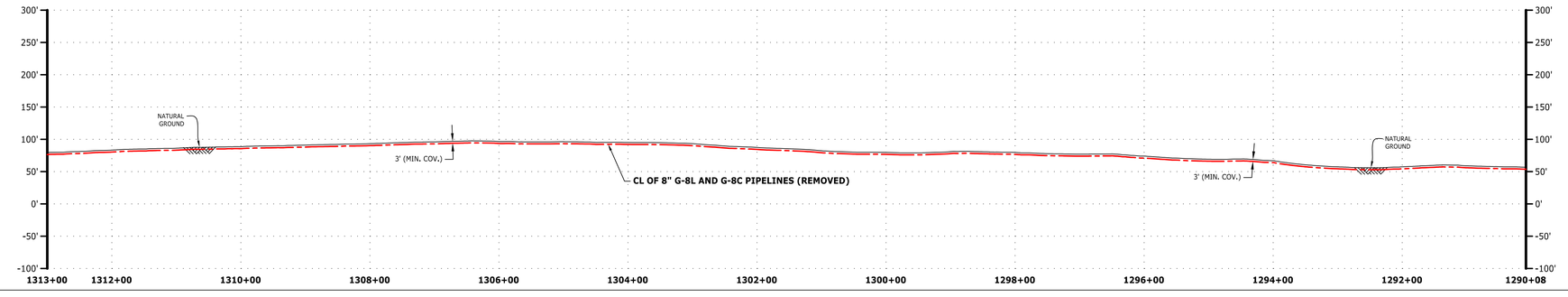
SLOPE BREAKERS ○
TRENCH PLUG ▲

PERMANENT SLOPE BREAKER & TRENCH PLUG SPACING

% SLOPE	SLOPE BREAKER SPACING (FT)	% SLOPE	TRENCH PLUG SPACING (FT)
5-15%	300 FT	<5%	NO STRUCTURE
15-30%	200 FT	5-15%	300 FT
>30%	100 FT	15-30%	200 FT
		>30%	100 FT

IN AG FIELDS AND RESIDENTIAL AREAS WHERE SLOPE BREAKERS ARE NOT TYPICALLY REQUIRED, INSTALL PERMANENT TRENCH PLUGS AT THE SAME SPACING AS IF PERMANENT SLOPE BREAKERS WERE REQUIRED. (FERC PLAN)

NOTE:
1. G-8C REMOVAL INCLUDES VARIOUS PIPE SIZES BETWEEN 8.625" O.D. AND 6.625" O.D.



LAND USE CLASSIFICATION

CC CULTIVATED CROPS	DF DECIDUOUS FOREST	D/OS DEVELOPED OPEN SPACE	
EF EVERGREEN FOREST	S/S SHRUB SCRUB	D/LI DEVELOPED LOW INTENSITY	
H/P HAY PASTURE	MF MIXED FOREST	D/MI DEVELOPED MEDIUM INTENSITY	

SOILS
LAND USE
% SLOPE

M:\259271\MAPPING\DRAWINGS\91-ALIGNMENT\RE-ISSUED FOR BID\GSYS-P.500-R0001

CLAY H. WILLIS — COMMONWEALTH OF MASSACHUSETTS — NO. 49136 — REGISTERED PROFESSIONAL ENGINEER — STRUCTURAL — 04/23/26

THIS DOCUMENT IS RELEASED FOR THE PURPOSE OF:
BID REVIEW
IT IS NOT TO BE USED FOR:
CONSTRUCTION, RECORDATION, CONVEYANCE, SALES, OR AS THE BASIS FOR THE ISSUANCE OF A PERMIT

UNDER THE AUTHORITY OF:
PE NAME: CLAY WILLIS
PE STATE: MASSACHUSETTS
PE NUMBER 49136

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		D	01/29/26	TL	JL	RE-ISSUED FOR BID
		C	08/21/25	TL	JL	ISSUED FOR BID
00018-M.200-0001	BOURNE M&R STATION - LOCATION MAP AND PLOT PLAN	B	07/07/25	TL	JL	ISSUED FOR REVIEW (90% DESIGN)
GSYS-EOLN G-8C	OPERATIONS ALIGNMENT SHEET	A	04/08/25	TL	RAL	ISSUED FOR REVIEW (60% DESIGN)

wood. WOOD GROUP USA, INC.

DRAWN BY:	TL	04/02/25
DESIGN CHECKER:	JL	04/03/25
DESIGN ENGINEER:	PA	04/08/25
PROJECT MANAGER:	EL	04/08/25
TITLE	INITIALS	DATE

ENBRIDGE
CAPE COD CANAL PIPELINE RELOCATION PROJECT
REMOVAL OF 8" G-8C & 8" G-8L PIPELINES
TITLE: ALIGNMENT SHEET
LOC.: BARNSTABLE COUNTY, MASSACHUSETTS
YEAR: 2026 | W.O.: AFE 30002835 | SCALE: 1" = 100'

ENBRIDGE
Algonquin Gas Transmission
915 N. Eldridge Parkway, Houston, TX 77079-2703 (713) 627-5400

DWG.: GSYS-P.500-R0003 | REV.: D

RIGHT-OF-WAY

TRACT NUMBERS

SURVEY DATA

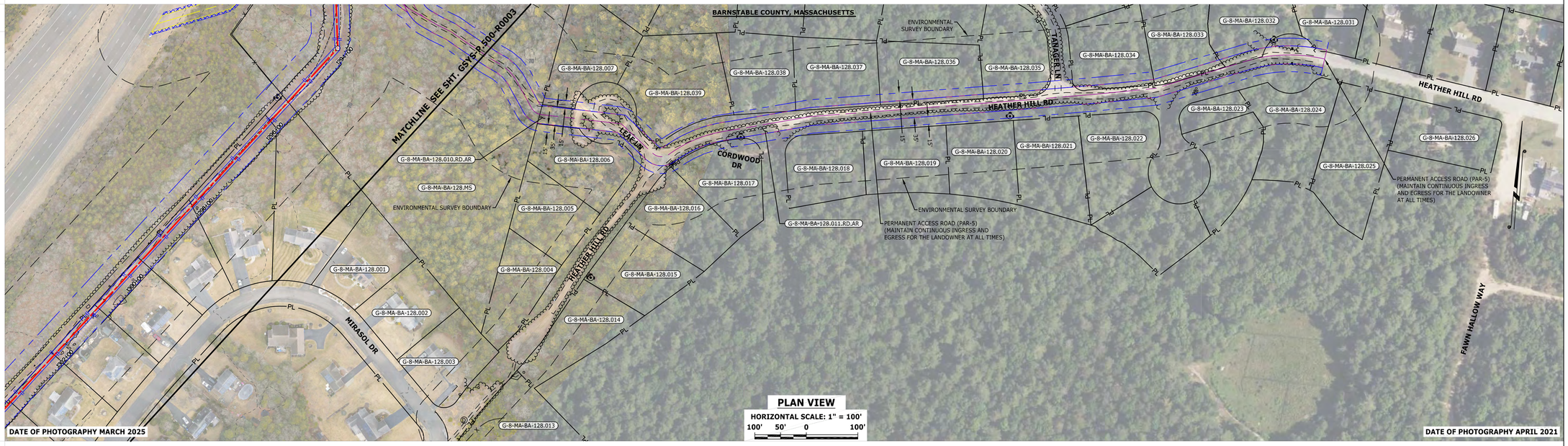
SURVEY COMPANY:
FIELD BOOK:
PAGES:

CLASS LOCATION

PIPE MATERIAL

ALIGNMENT LEGEND

- PIPELINE MILEPOST
- CENTERLINE OF G-8C & G-8L REMOVAL
- 8" G-8C & 8" G-8L PIPELINES (TO BE REMOVED)
- PROPOSED G-8C PIPELINE
- PROPOSED G-8L PIPELINE
- CONSTRUCTION LIMIT
- WAREYARD / STAGING AREA
- EXISTING PERMANENT ROW
- PROPOSED PERMANENT ROW
- ADDITIONAL TEMPORARY WORKSPACE
- PROPOSED METERING & REGULATING STATION (M&R) SITE
- FACILITIES TEMPORARY WORKSPACE
- FACILITIES PERMANENT WORKSPACE
- PROPOSED GRAVEL AREA
- DELINEATED WETLAND BOUNDARY
- DELINEATED WATERBODY BANK
- DELINEATED WATERBODY CENTERLINE
- PERMANENT ACCESS ROAD
- TEMPORARY ACCESS ROAD
- PROPERTY LINE — PL
- MAJOR CONTOUR — -100'-
- MUNICIPALITY LINE
- ENVIRONMENTAL SURVEY BOUNDARY
- FENCE — X
- EXISTING AGT PIPELINE — AGT
- FOREIGN PIPELINE — I
- POWERLINE — P
- WATER PIPELINE — W
- RAILROAD TRACK — I
- OVERHEAD WIRE — OHW
- TELEPHONE LINE — C
- UTILITY LINES
- SANITARY SEWER — SAN
- TEE TAP
- BLOW OFF VALVE
- MAINLINE VALVE (MLV)
- POINT OF INTERSECTION
- BORE ENTRY/EXIT
- TRANSMISSION TOWER
- LIGHT POLE
- UTILITY POLE
- FIRE HYDRANT
- WELL (GAS)
- WELL (WATER)
- WELL (OIL)
- WELL (UNKNOWN)



PLAN VIEW

HORIZONTAL SCALE: 1" = 100'

100' 50' 0 100'

ENVIRONMENTAL DATA

E & S TYPICALS

E&S TYPICALS WILL BE USED AS A PLAN AND WILL HAVE FURTHER INPUT FROM ENVIRONMENTAL INSPECTOR.

PROFILE

HORIZONTAL SCALE: 1" = 100'

100' 50' 0 100'

VERTICAL SCALE: 1" = 100'

100' 50' 0 100'

THE LOCATION OF TRENCH PLUGS AND SLOPE BREAKERS ARE INTENDED TO BE USED AS A GUIDELINE ONLY. EXACT LOCATION TO BE DETERMINED IN THE FIELD.

SLOPE BREAKERS ○
TRENCH PLUG ▲

PERMANENT SLOPE BREAKER & TRENCH PLUG SPACING

% SLOPE	SLOPE BREAKER SPACING (FT)	% SLOPE	TRENCH PLUG SPACING (FT)
5-15%	300 FT	<5%	NO STRUCTURE
15-30%	200 FT	5-15%	300 FT
>30%	100 FT	15-30%	200 FT
		>30%	100 FT

IN AG FIELDS AND RESIDENTIAL AREAS WHERE SLOPE BREAKERS ARE NOT TYPICALLY REQUIRED, INSTALL PERMANENT TRENCH PLUGS AT THE SAME SPACING AS IF PERMANENT SLOPE BREAKERS WERE REQUIRED. (FERC PLAN)

LAND USE CLASSIFICATION

CC CULTIVATED CROPS	DF DECIDUOUS FOREST	D/OS DEVELOPED OPEN SPACE	
EF EVERGREEN FOREST	S/S SHRUB SCRUB	D/LI DEVELOPED LOW INTENSITY	
H/P HAY PASTURE	MF MIXED FOREST	D/MI DEVELOPED MEDIUM INTENSITY	

SOILS

LAND USE

% SLOPE

M:\259271\MAPPING\DRAWINGS\01-ALIGNMENT\RE-ISSUED FOR BID\GSYS-P.500-R0001

COMMONWEALTH OF MASSACHUSETTS — CLAY H. WILLIS — STRUCTURAL — NO. 49136 — REGISTERED PROFESSIONAL ENGINEER — 01/23/26

THIS DOCUMENT IS RELEASED FOR THE PURPOSE OF:
BID REVIEW
IT IS NOT TO BE USED FOR: CONSTRUCTION, RECORDATION, CONVEYANCE, SALES, OR AS THE BASIS FOR THE ISSUANCE OF A PERMIT

UNDER THE AUTHORITY OF:
PE NAME: CLAY WILLIS
PE STATE: MASSACHUSETTS
PE NUMBER: 49136

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		D	01/29/26	TL	JL	RE-ISSUED FOR BID
		C	08/21/25	TL	JL	ISSUED FOR BID
		B	07/07/25	TL	JL	ISSUED FOR REVIEW (90% DESIGN)
		A	04/08/25	TL	RAL	ISSUED FOR REVIEW (60% DESIGN)

wood. WOOD GROUP USA, INC.

TITLE	INITIALS	DATE
DRAWN BY:	TL	04/02/25
DESIGN CHECKER:	JL	04/03/25
DESIGN ENGINEER:	PA	04/08/25
PROJECT MANAGER:	EL	04/08/25

ENBRIDGE
CAPE COD CANAL PIPELINE RELOCATION PROJECT
REMOVAL OF 8" G-8C & 8" G-8L PIPELINES
TITLE: ALIGNMENT SHEET

LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

YEAR: 2026 | W.O.: AFE 30002835 | SCALE: 1" = 100'

ENBRIDGE

Algonquin Gas Transmission
915 N. Eldridge Parkway, Houston, TX 77079-2703 (713) 627-5400

DWG.: GSYS-P.500-R0004 | REV.: D

RIGHT-OF-WAY

TRACT NUMBERS

SURVEY DATA

SURVEY COMPANY:
FIELD BOOK:
PAGES:

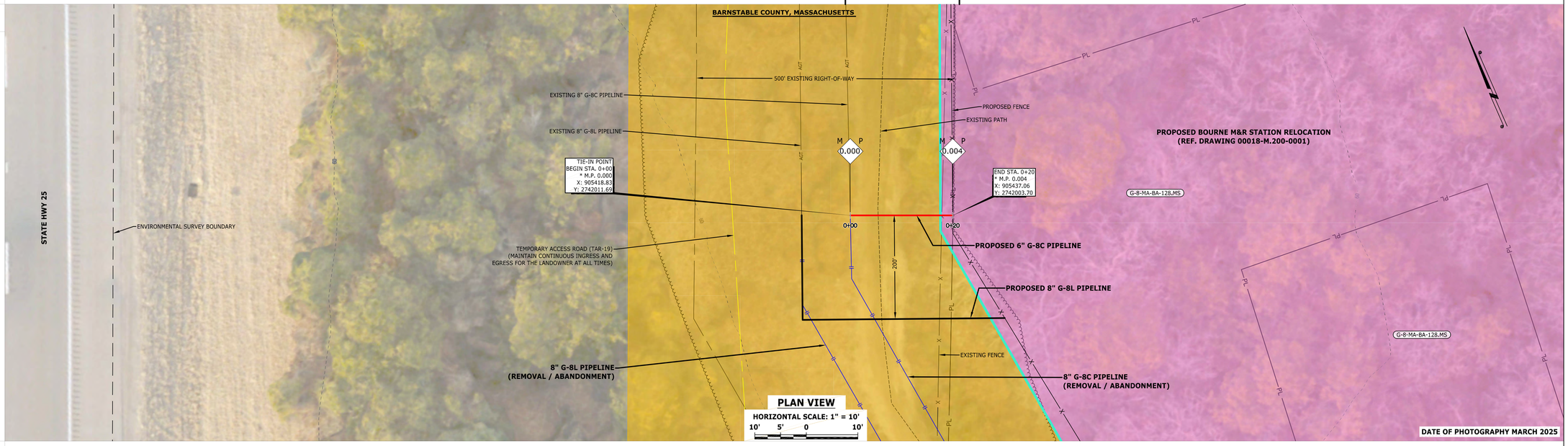
CLASS LOCATION

PIPE MATERIAL

	0+00		0+20
RIGHT-OF-WAY		UNKNOWN 20 FT.	
SURVEY DATA	0+00 BEGIN PIPELINE 0+00 PIPELINE TIE-IN	0+18 EXISTING FENCE 0+20 FACILITY FENCE	0+20 END PIPELINE
CLASS LOCATION	0+00	CLASS 1	0+20
PIPE MATERIAL	0+00	6.625" O.D. X 0.277" W.T., API 5L, Gr. B, 16-20 MILS FBE 20 FT.	0+20

ALIGNMENT LEGEND

- PIPELINE MILEPOST
- CENTERLINE OF G-8C & G-8L REMOVAL
- 8" G-8C & 8" G-8L PIPELINES (TO BE REMOVED)
- PROPOSED G-8C PIPELINE
- PROPOSED G-8L PIPELINE
- CONSTRUCTION LIMIT
- WAREYARD / STAGING AREA
- EXISTING PERMANENT ROW
- PROPOSED PERMANENT ROW
- ADDITIONAL TEMPORARY WORKSPACE
- PROPOSED METERING & REGULATING STATION (M&R) SITE
- FACILITIES TEMPORARY WORKSPACE
- FACILITIES PERMANENT WORKSPACE
- PROPOSED GRAVEL AREA
- DELINEATED WETLAND BOUNDARY
- DELINEATED WATERBODY BANK
- DELINEATED WATERBODY CENTERLINE
- PERMANENT ACCESS ROAD
- TEMPORARY ACCESS ROAD
- PROPERTY LINE — PL —
- MAJOR CONTOUR — 100' —
- MUNICIPALITY LINE
- ENVIRONMENTAL SURVEY BOUNDARY
- FENCE — X —
- EXISTING AGT PIPELINE — AGT —
- FOREIGN PIPELINE
- POWERLINE — P —
- WATER PIPELINE — W —
- RAILROAD TRACK
- OVERHEAD WIRE — OHW —
- TELEPHONE LINE — C —
- UTILITY LINES
- SANITARY SEWER — SAN —
- TEE TAP
- BLOW OFF VALVE
- MAINLINE VALVE (MLV)
- POINT OF INTERSECTION
- BORE ENTRY/EXIT
- TRANSMISSION TOWER
- LIGHT POLE
- UTILITY POLE
- FIRE HYDRANT
- WELL (GAS)
- WELL (WATER)
- WELL (OIL)
- WELL (UNKNOWN)



ENVIRONMENTAL DATA

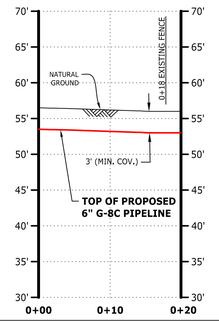
E & S TYPICALS

E&S TYPICALS WILL BE USED AS A PLAN AND WILL HAVE FURTHER INPUT FROM ENVIRONMENTAL INSPECTOR.

PROFILE

HORIZONTAL SCALE: 1" = 10'
10' 5' 0 10'

VERTICAL SCALE: 1" = 10'
10' 5' 0 10'



THE LOCATION OF TRENCH PLUGS AND SLOPE BREAKERS ARE INTENDED TO BE USED AS A GUIDELINE ONLY. EXACT LOCATION TO BE DETERMINED IN THE FIELD.

SLOPE BREAKERS ○
TRENCH PLUG ▲

PERMANENT SLOPE BREAKER & TRENCH PLUG SPACING

% SLOPE	SLOPE BREAKER SPACING (FT)	% SLOPE	TRENCH PLUG SPACING (FT)
5-15%	300 FT	<5%	NO STRUCTURE
15-30%	200 FT	5-15%	300 FT
>30%	100 FT	15-30%	200 FT
		>30%	100 FT

IN AG FIELDS AND RESIDENTIAL AREAS WHERE SLOPE BREAKERS ARE NOT TYPICALLY REQUIRED, INSTALL PERMANENT TRENCH PLUGS AT THE SAME SPACING AS IF PERMANENT SLOPE BREAKERS WERE REQUIRED. (FERC PLAN)

LAND USE CLASSIFICATION

CC CULTIVATED CROPS DF DECIDUOUS FOREST D/OS DEVELOPED OPEN SPACE
EF EVERGREEN FOREST S/S SHRUB SCRUB D/LI DEVELOPED LOW INTENSITY
H/P HAY PASTURE MF MIXED FOREST D/MI DEVELOPED MEDIUM INTENSITY

SEGMENTABLE ELBOW	QTY
90 DEG, SD, 6.625" OD, 0.277" WT, CS, x52, FBE COATING SYSTEM 2B	1

SOILS		
LAND USE		
% SLOPE	5-15%	<5%

CLAY H. WILLIS — STRUCTURAL — NO. 49136 — COMMONWEALTH OF MASSACHUSETTS — PROFESSIONAL ENGINEER — 05/23/26

THIS DOCUMENT IS RELEASED FOR THE PURPOSE OF:
BID REVIEW
IT IS NOT TO BE USED FOR: CONSTRUCTION, RECORDATION, CONVEYANCE, SALES, OR AS THE BASIS FOR THE ISSUANCE OF A PERMIT
UNDER THE AUTHORITY OF:
PE NAME: CLAY WILLIS
PE STATE: MASSACHUSETTS
PE NUMBER: 49136

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		C	01/29/26	TL	JL	RE-ISSUED FOR BID
		B	08/21/25	TL	JL	ISSUED FOR BID
00018-M.200-0001	BOURNE M&R STATION - LOCATION MAP AND PLOT PLAN	A	07/07/25	TL	JL	ISSUED FOR REVIEW (90% DESIGN)

wood. WOOD GROUP USA, INC.

TITLE	INITIALS	DATE
DRAWN BY:	TL	06/04/25
DESIGN CHECKER:	JL	06/05/25
DESIGN ENGINEER:	PA	07/07/25
PROJECT MANAGER:	EL	07/07/25

ENBRIDGE
CAPE COD CANAL PIPELINE RELOCATION PROJECT
PROPOSED 6" G-8C PIPELINE
TITLE: ALIGNMENT SHEET

LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

YEAR: 2026 | W.O.: AFE 30002835 | SCALE: 1" = 10'

Algonquin Gas Transmission
915 N. Eldridge Parkway, Houston, TX 77079-2703 (713) 627-5400

DWG.: GSYS-P.500-R0005 | REV.: C

M:\259271\MAPPING\DRAWINGS\91-ALIGNMENT\RE-ISSUED FOR BID\GSYS-P.500-R0001

RIGHT-OF-WAY

TRACT NUMBERS

SURVEY DATA

SURVEY COMPANY:
FIELD BOOK:
PAGES:

CLASS LOCATION

CLASS 1

PIPE MATERIAL

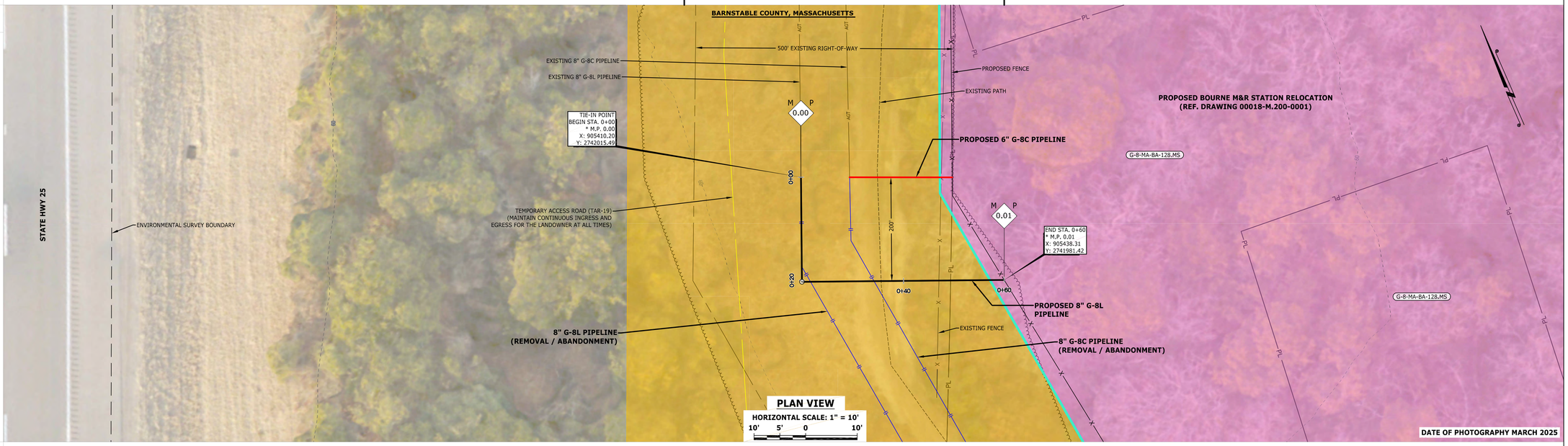
8.625" O.D. X 0.322" W.T., API 5L, Gr. B, 16-20 MILS FBE

60 FT.

0+00		0+49	0+60
	UNKNOWN	G-8-MA-BA-128.MS	
	49 FT.	11 FT.	
0+00 BEGIN PIPELINE 0+00 PIPELINE TIE-IN	0+20 P.I. <90°00'00" LT.	0+47 EXISTING FENCE	0+60 FACILITY FENCE 0+60 END PIPELINE
0+00			0+60
0+00			0+60

ALIGNMENT LEGEND

- PIPELINE MILEPOST
- CENTERLINE OF G-8C & G-8L REMOVAL
- 8" G-8C & 8" G-8L PIPELINES (TO BE REMOVED)
- PROPOSED G-8C PIPELINE
- PROPOSED G-8L PIPELINE
- CONSTRUCTION LIMIT
- WAREYARD / STAGING AREA
- EXISTING PERMANENT ROW
- PROPOSED PERMANENT ROW
- ADDITIONAL TEMPORARY WORKSPACE
- PROPOSED METERING & REGULATING STATION (M&R) SITE
- FACILITIES TEMPORARY WORKSPACE
- FACILITIES PERMANENT WORKSPACE
- PROPOSED GRAVEL AREA
- DELINEATED WETLAND BOUNDARY
- DELINEATED WATERBODY BANK
- DELINEATED WATERBODY CENTERLINE
- PERMANENT ACCESS ROAD
- TEMPORARY ACCESS ROAD
- PROPERTY LINE — PL —
- MAJOR CONTOUR — -100'- —
- MUNICIPALITY LINE
- ENVIRONMENTAL SURVEY BOUNDARY
- FENCE — X —
- EXISTING AGT PIPELINE — AGT —
- FOREIGN PIPELINE — I —
- POWERLINE — P —
- WATER PIPELINE — W —
- RAILROAD TRACK
- OVERHEAD WIRE — OHW —
- TELEPHONE LINE — C —
- UTILITY LINES
- SANITARY SEWER — SAN —
- TEE TAP
- BLOW OFF VALVE
- MAINLINE VALVE (MLV)
- POINT OF INTERSECTION
- BORE ENTRY/EXIT
- TRANSMISSION TOWER
- LIGHT POLE
- UTILITY POLE
- FIRE HYDRANT
- WELL (GAS)
- WELL (WATER)
- WELL (OIL)
- WELL (UNKNOWN)



PLAN VIEW

HORIZONTAL SCALE: 1" = 10'

10' 5' 0 10'

ENVIRONMENTAL DATA

E & S TYPICALS

E&S TYPICALS WILL BE USED AS A PLAN AND WILL HAVE FURTHER INPUT FROM ENVIRONMENTAL INSPECTOR.

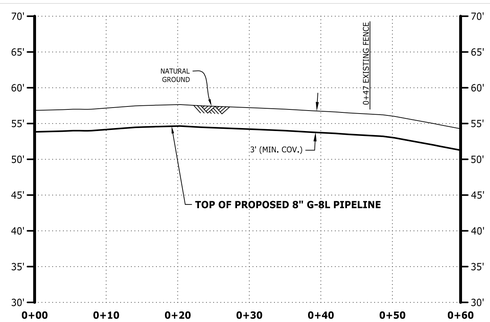
PROFILE

HORIZONTAL SCALE: 1" = 10'

10' 5' 0 10'

VERTICAL SCALE: 1" = 10'

10' 5' 0 10'



THE LOCATION OF TRENCH PLUGS AND SLOPE BREAKERS ARE INTENDED TO BE USED AS A GUIDELINE ONLY. EXACT LOCATION TO BE DETERMINED IN THE FIELD.

SLOPE BREAKERS ○

TRENCH PLUG ▲

PERMANENT SLOPE BREAKER & TRENCH PLUG SPACING

% SLOPE	SLOPE BREAKER SPACING (FT)	% SLOPE	TRENCH PLUG SPACING (FT)
5-15%	300 FT	<5%	NO STRUCTURE
15-30%	200 FT	5-15%	300 FT
>30%	100 FT	15-30%	200 FT
		>30%	100 FT

IN AG FIELDS AND RESIDENTIAL AREAS WHERE SLOPE BREAKERS ARE NOT TYPICALLY REQUIRED, INSTALL PERMANENT TRENCH PLUGS AT THE SAME SPACING AS IF PERMANENT SLOPE BREAKERS WERE REQUIRED. (FERC PLAN)

LAND USE CLASSIFICATION

CC	CULTIVATED CROPS	DF	DECIDUOUS FOREST
D/OS	DEVELOPED OPEN SPACE		
EF	EVERGREEN FOREST	S/S	SHRUB SCRUB
D/LI	DEVELOPED LOW INTENSITY		
H/P	HAY PASTURE	MF	MIXED FOREST
D/MI	DEVELOPED MEDIUM INTENSITY		

SEGMENTABLE ELBOW	QTY
90 DEG, SD, 8.625" OD, 0.322" WT, CS, x52, FBE COATING SYSTEM 2B	1
45 DEG, SD, 8.625" OD, 0.322" WT, CS, x52, FBE COATING SYSTEM 2B	0

SOILS	
LAND USE	
% SLOPE	5-15%

THIS DOCUMENT IS RELEASED FOR THE PURPOSE OF:
BID REVIEW
IT IS NOT TO BE USED FOR:
CONSTRUCTION, RECORDATION, CONVEYANCE, SALES, OR AS THE BASIS FOR THE ISSUANCE OF A PERMIT

UNDER THE AUTHORITY OF:
PE NAME: CLAY WILLIS
PE STATE: MASSACHUSETTS
PE NUMBER 49136

COMMONWEALTH OF MASSACHUSETTS — CLAY H. WILLIS — No. 49136 — REGISTERED PROFESSIONAL ENGINEER — 06/23/26

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		C	01/29/26	TL	JL	RE-ISSUED FOR BID
		B	08/21/25	TL	JL	ISSUED FOR BID
00018-M.200-0001	BOURNE M&R STATION - LOCATION MAP AND PLOT PLAN	A	07/07/25	TL	JL	ISSUED FOR REVIEW (90% DESIGN)

wood.
WOOD GROUP USA, INC.

TITLE	INITIALS	DATE
DRAWN BY:	TL	06/04/25
DESIGN CHECKER:	JL	06/05/25
DESIGN ENGINEER:	PA	07/07/25
PROJECT MANAGER:	EL	07/07/25

ENBRIDGE
CAPE COD CANAL PIPELINE RELOCATION PROJECT
PROPOSED 8" G-8L PIPELINE
TITLE: ALIGNMENT SHEET
LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

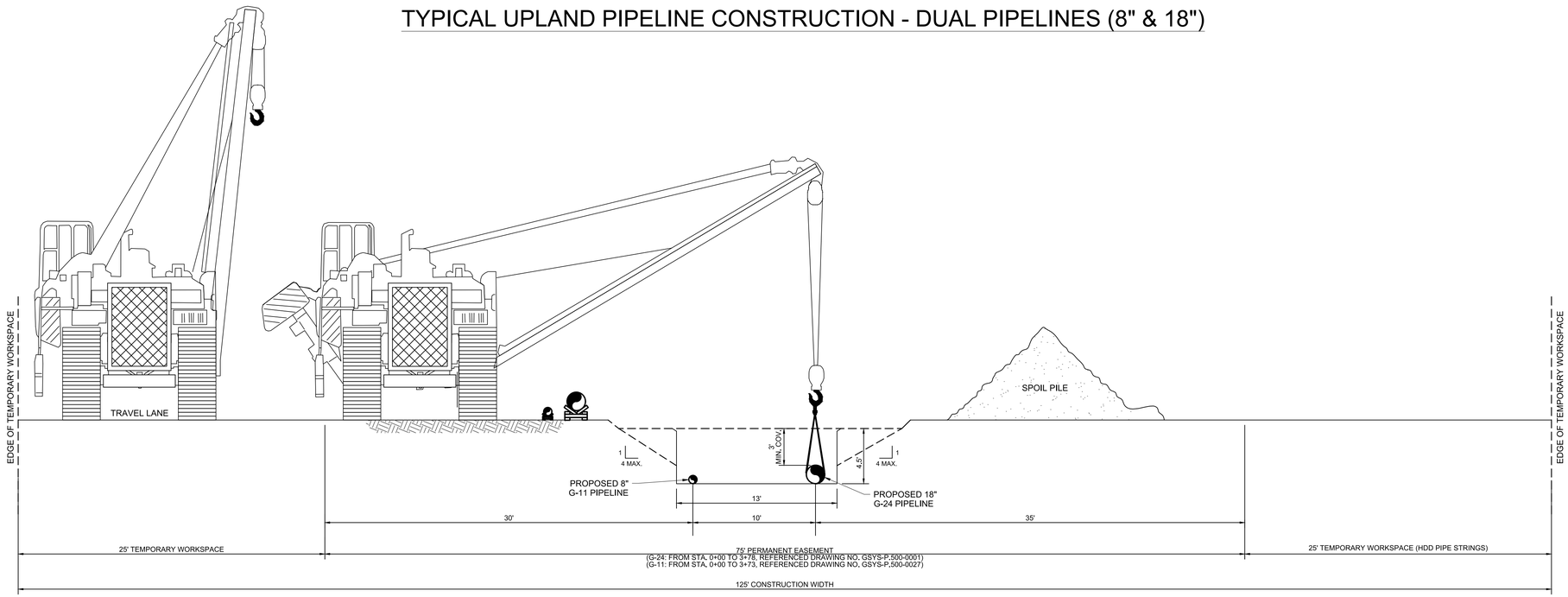
YEAR: 2026 | W.O.: AFE 30002835 | SCALE: 1" = 10' | DWG.: GSYS-P.500-R0006 | REV.: C

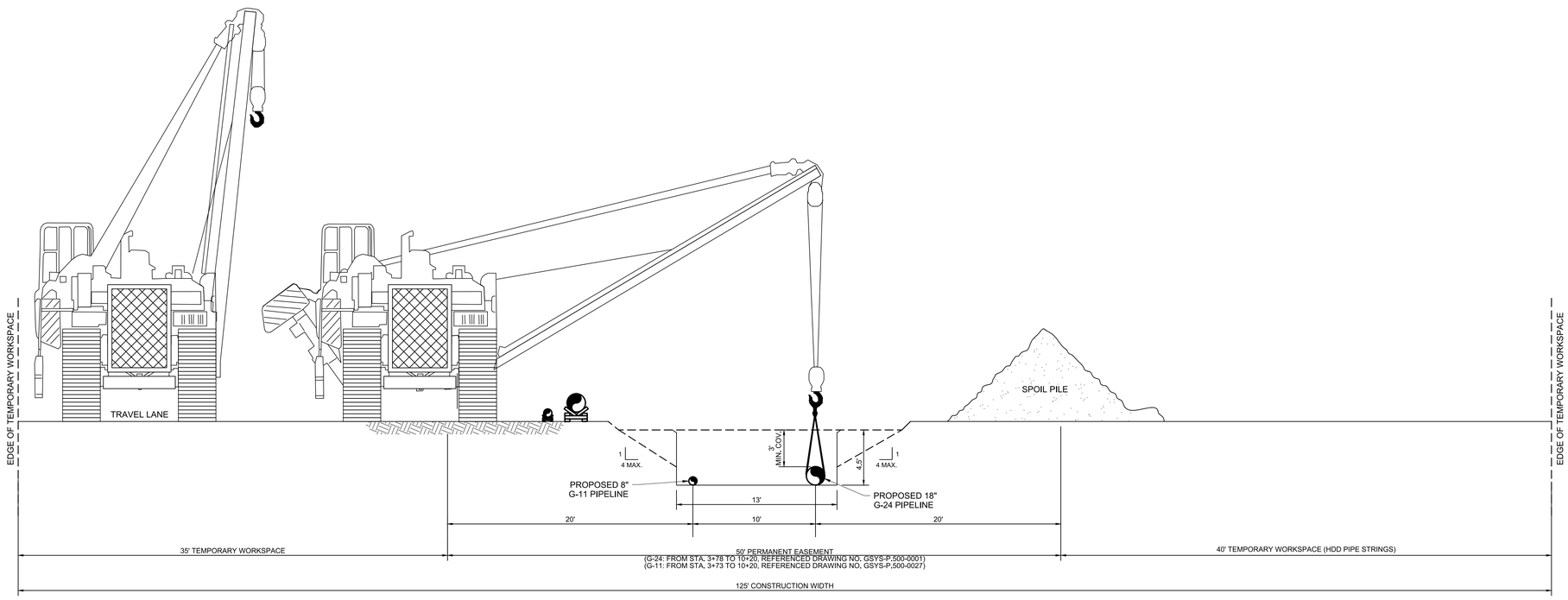
ENBRIDGE
Algonquin Gas Transmission
915 N. Eldridge Parkway, Houston, TX 77079-2703 (713) 627-5400

M:\253271\MAPPING\DRAWINGS\01-ALIGNMENT\RE-ISSUED FOR BID\GSYS-P.500-R0001

Typical Pipeline Construction Methods and HDD Plan & Profile

TYPICAL UPLAND PIPELINE CONSTRUCTION - DUAL PIPELINES (8" & 18")





NOTES:

1. ADDITIONAL TEMPORARY WORKSPACE AND TEMPORARY WORKSPACE COULD BE MODIFIED DEPENDING ON SITE SPECIFIC CONDITIONS INCLUDING DEEPER DEPTH OF COVER, TOP SOIL SEGREGATION (NOT INCLUDED WITHIN CONSTRUCTION PROFILE), MODIFICATION IN SIDE SLOPE OF DITCH, PRESENCE OF PROTECTED RESOURCES.

REV	DATE	DSN	CK	DESCRIPTION
D	01/29/26	TL	JL	RE-ISSUED FOR BID
C	08/21/25	TL	JL	ISSUED FOR BID
B	07/07/25	RAL	LR	ISSUED FOR REVIEW (90% DESIGN)
A	04/08/25	RAL	LR	ISSUED FOR REVIEW (60% DESIGN)

WOOD GROUP USA, INC.

TITLE	INITIALS	DATE
DRAWN BY:	RAL	04/02/25
DESIGN CHECKER:	JL	04/02/25
DESIGN ENGINEER:	PA	04/08/25
PROJECT MANAGER:	EL	04/08/25

ENBRIDGE
CAPE COD CANAL PIPELINE RELOCATION PROJECT
CONSTRUCTION TYPICAL

TITLE:

LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

YEAR: 2026 | W.O.: AFE 30002835 | SCALE: N.T.S.

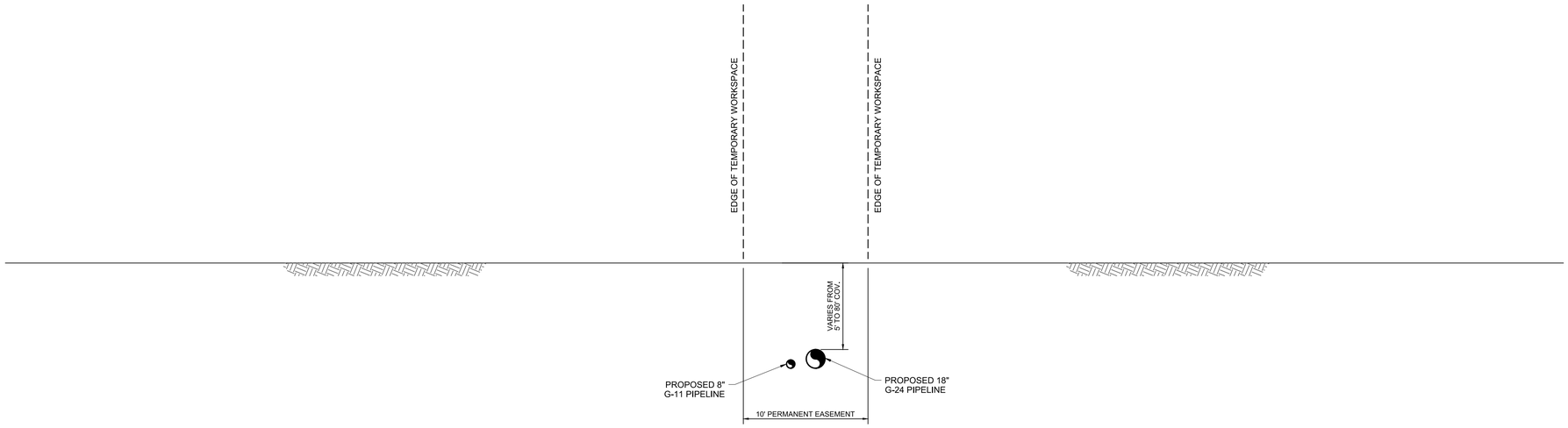
ENBRIDGE

Algonquin Gas Transmission
915 N. Eldridge Parkway, Houston, TX 77079-2703 (713) 627-5400

DWG.: GSYS-M.223-0001 | REV.: D

M:\259271MAPPING\DRAWINGS\99-TYPICAL\Construction\GSYS-M.223-0001

TYPICAL CONSTRUCTION - DUAL PIPELINES (8" & 18") HDD



DUAL PIPELINES (8" & 18") - HDD CROSSING

NOTES:

1. CURRENT CONFIGURATION ASSUMES THE DUAL PIPELINES HAVE A MINIMUM OF 6" WALL TO WALL SEPARATION.
2. ADDITIONAL TEMPORARY WORKSPACE AND TEMPORARY WORKSPACE COULD BE MODIFIED DEPENDING ON SITE SPECIFIC CONDITIONS INCLUDING DEEPER DEPTH OF COVER, TOP SOIL SEGREGATION (NOT INCLUDED WITHIN CONSTRUCTION PROFILE), MODIFICATION IN SIDE SLOPE OF DITCH, PRESENCE OF PROTECTED RESOURCES.

REV	DATE	DSN	CK	DESCRIPTION
D	01/29/26	TL	JL	RE-ISSUED FOR BID
C	08/21/25	TL	JL	ISSUED FOR BID
B	07/07/25	RAL	LR	ISSUED FOR REVIEW (90% DESIGN)
A	04/08/25	RAL	LR	ISSUED FOR REVIEW (60% DESIGN)

WOOD GROUP USA, INC.

TITLE	INITIALS	DATE
DRAWN BY:	RAL	04/02/25
DESIGN CHECKER:	JL	04/02/25
DESIGN ENGINEER:	PA	04/08/25
PROJECT MANAGER:	EL	04/08/25

ENBRIDGE
CAPE COD CANAL PIPELINE RELOCATION PROJECT
CONSTRUCTION TYPICAL

TITLE:

LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

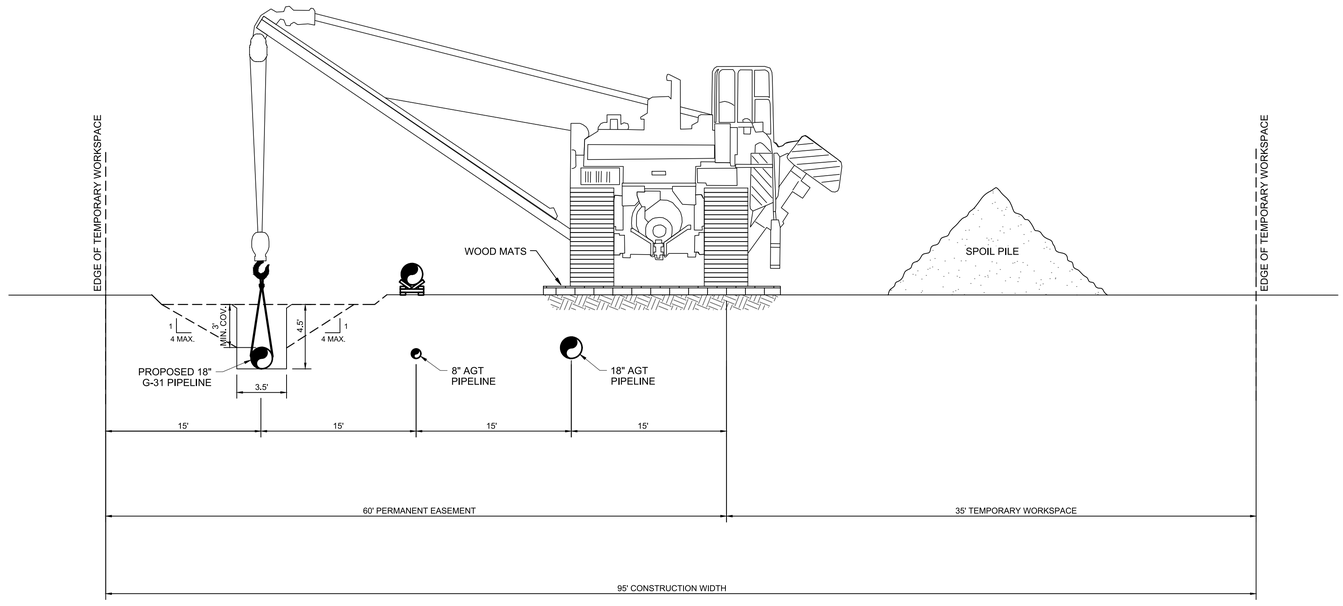
YEAR: 2026 | W.O.: AFE 30002835 | SCALE: N.T.S.

DWG.: GSYS-M.223-0002 | REV.: D

Algonquin Gas Transmission
915 N. Eldridge Parkway, Houston, TX 77079-2703 (713) 627-5400

M:\26927\1MAPPING\DRAWINGS\99-TYPICALS\construction\GSYS-M.223-0002

TYPICAL UPLAND PIPELINE CONSTRUCTION - SINGLE PIPELINE (18")



NOTES:

1. ADDITIONAL TEMPORARY WORKSPACE AND TEMPORARY WORKSPACE COULD BE MODIFIED DEPENDING ON SITE SPECIFIC CONDITIONS INCLUDING DEEPER DEPTH OF COVER, TOP SOIL SEGREGATION (NOT INCLUDED WITHIN CONSTRUCTION PROFILE), MODIFICATION IN SIDE SLOPE OF DITCH, PRESENCE OF PROTECTED RESOURCES.

REV	DATE	DSN	CK	DESCRIPTION
C	08/21/25	TL	JL	ISSUED FOR BID
B	07/07/25	RAL	LR	ISSUED FOR REVIEW (90% DESIGN)
A	04/08/25	RAL	LR	ISSUED FOR REVIEW (60% DESIGN)

wood.
WOOD GROUP USA, INC.

TITLE	INITIALS	DATE
DRAWN BY:	RAL	04/02/25
DESIGN CHECKER:	JL	04/02/25
DESIGN ENGINEER:	PA	04/08/25
PROJECT MANAGER:	EL	04/08/25

ENBRIDGE
CAPE COD CANAL PIPELINE RELOCATION PROJECT
CONSTRUCTION TYPICAL

TITLE:

LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

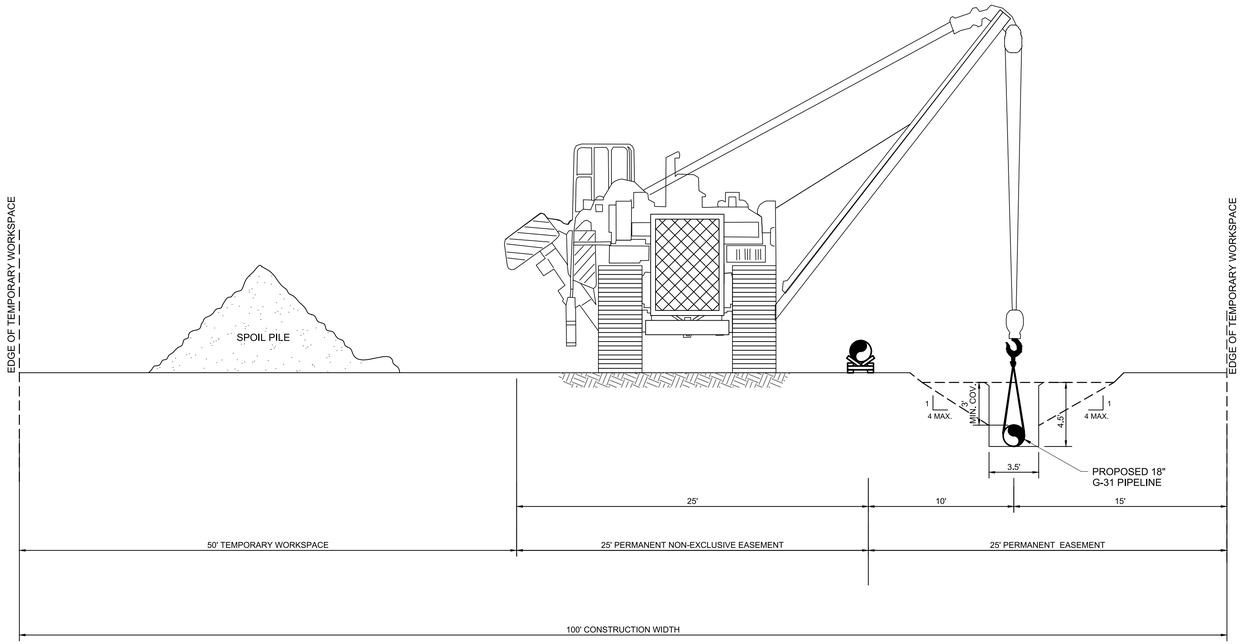
YEAR: 2025 | W.O.: AFE 30002835 | SCALE: N.T.S. | DWG.: GSYS-M.223-0003 | REV.: C

ENBRIDGE

Algonquin Gas Transmission
915 N. Eldridge Parkway, Houston, TX 77079-2703 (713) 627-5400

M:\295271\MAPPING\DRAWINGS\99-TYPICALS\Construction\GSYS-M.223-0003

TYPICAL UPLAND PIPELINE CONSTRUCTION - SINGLE PIPELINE (18")



NOTES:.

1. ADDITIONAL TEMPORARY WORKSPACE AND TEMPORARY WORKSPACE COULD BE MODIFIED DEPENDING ON SITE SPECIFIC CONDITIONS INCLUDING DEEPER DEPTH OF COVER, TOP SOIL SEGREGATION (NOT INCLUDED WITHIN CONSTRUCTION PROFILE), MODIFICATION IN SIDE SLOPE OF DITCH, PRESENCE OF PROTECTED RESOURCES.

REV	DATE	DSN	CK	DESCRIPTION
C	08/21/25	TL	JL	ISSUED FOR BID
B	07/07/25	RAL	LR	ISSUED FOR REVIEW (90% DESIGN)
A	04/08/25	RAL	LR	ISSUED FOR REVIEW (60% DESIGN)

WOOD GROUP USA, INC.

TITLE	INITIALS	DATE
DRAWN BY:	RAL	04/02/25
DESIGN CHECKER:	JL	04/02/25
DESIGN ENGINEER:	PA	04/08/25
PROJECT MANAGER:	EL	04/08/25

ENBRIDGE
CAPE COD CANAL PIPELINE RELOCATION PROJECT
CONSTRUCTION TYPICAL

TITLE:

LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

YEAR: 2025 | W.O.: AFE 30002835 | SCALE: N.T.S.

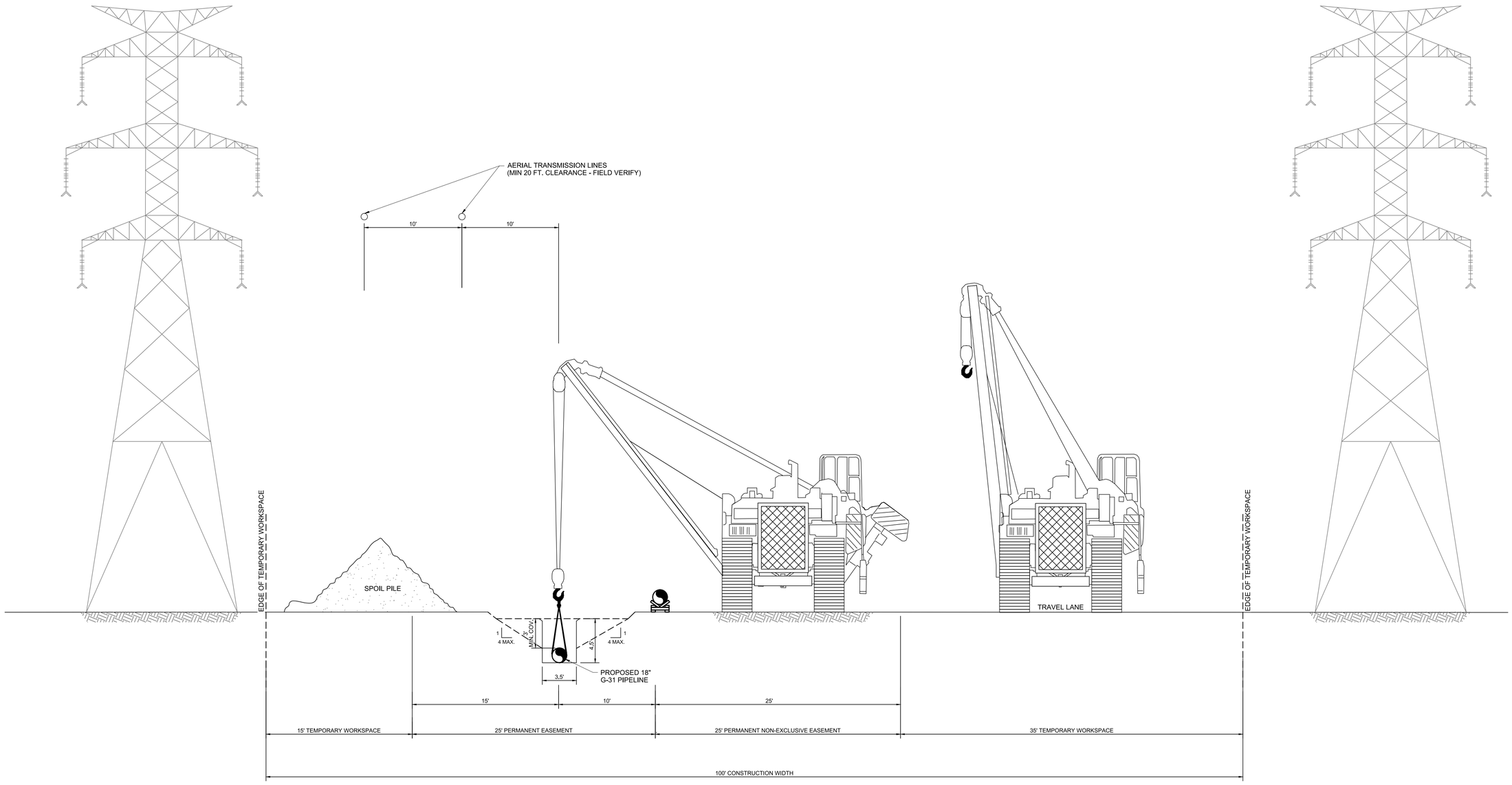
ENBRIDGE

Algonquin Gas Transmission
915 N. Eldridge Parkway, Houston, TX 77079-2703 (713) 627-5400

DWG.: GSYS-M.223-0004 | REV.: C

M:\295271\MAPPING\DRAWINGS\90-TYPICAL\Construction\GSYS-M.223-0004

TYPICAL UPLAND (PARALLELING POWER LINES) PIPELINE CONSTRUCTION - SINGLE PIPELINE (18")



NOTES:

1. ADDITIONAL TEMPORARY WORKSPACE AND TEMPORARY WORKSPACE COULD BE MODIFIED DEPENDING ON SITE SPECIFIC CONDITIONS INCLUDING DEEPER DEPTH OF COVER, TOP SOIL SEGREGATION (NOT INCLUDED WITHIN CONSTRUCTION PROFILE), MODIFICATION IN SIDE SLOPE OF DITCH, PRESENCE OF PROTECTED RESOURCES.

REV	DATE	DSN	CK	DESCRIPTION
C	08/21/25	TL	JL	ISSUED FOR BID
B	07/07/25	RAL	LR	ISSUED FOR REVIEW (90% DESIGN)
A	04/08/25	RAL	LR	ISSUED FOR REVIEW (60% DESIGN)

wood.
WOOD GROUP USA, INC.

TITLE	INITIALS	DATE
DRAWN BY:	RAL	04/02/25
DESIGN CHECKER:	JL	04/02/25
DESIGN ENGINEER:	PA	04/08/25
PROJECT MANAGER:	EL	04/08/25

ENBRIDGE
CAPE COD CANAL PIPELINE RELOCATION PROJECT
CONSTRUCTION TYPICAL

TITLE:

LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

YEAR: 2025 | W.O.: AFE 30002835 | SCALE: N.T.S.

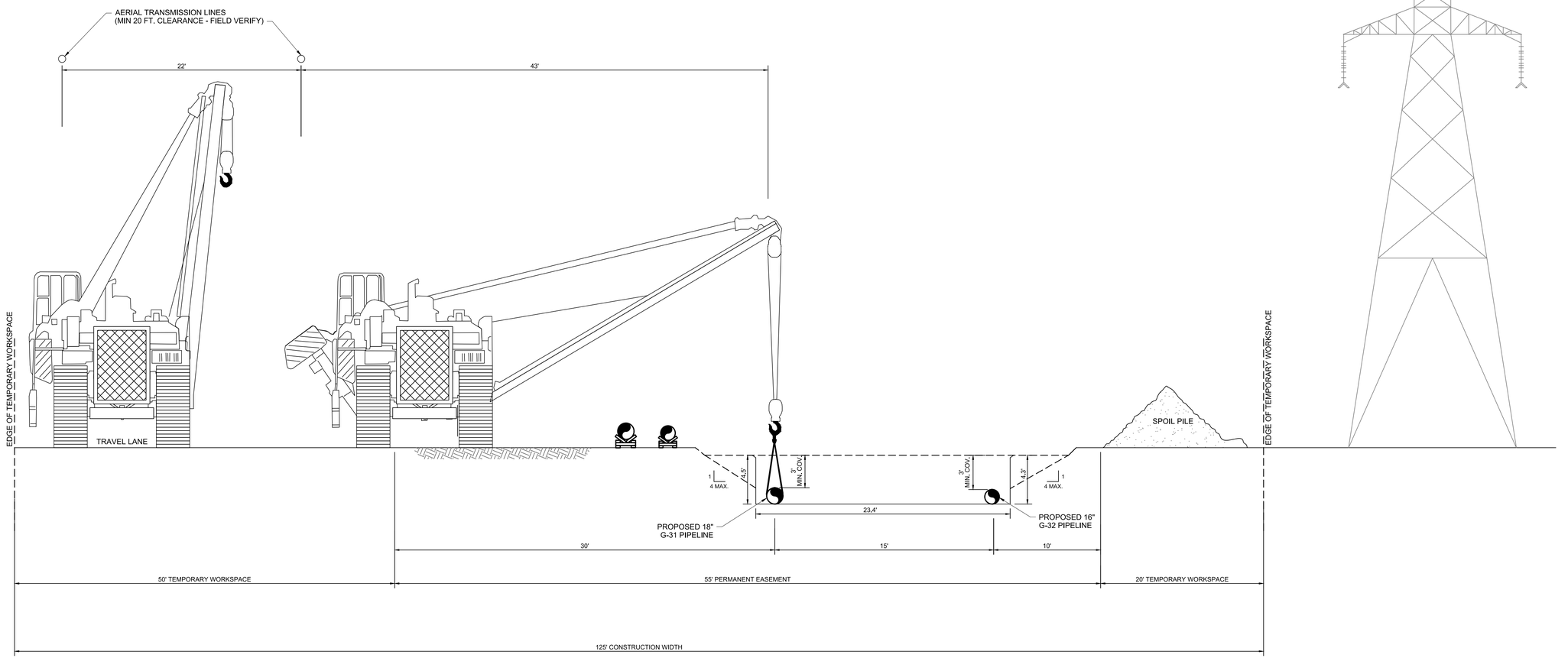
ENBRIDGE

Algonquin Gas Transmission
915 N. Eldridge Parkway, Houston, TX 77079-2703 (713) 627-5400

DWG.: GSYS-M.223-0005 | REV.: C

M:\295271\MAPPING\DRAWINGS\99-TYPICAL\Construction\GSYS-M.223-0005

TYPICAL UPLAND (PARALLELING POWER LINES) PIPELINE CONSTRUCTION - DUAL PIPELINES (16" & 18")



NOTES:

1. ADDITIONAL TEMPORARY WORKSPACE AND TEMPORARY WORKSPACE COULD BE MODIFIED DEPENDING ON SITE SPECIFIC CONDITIONS INCLUDING DEEPER DEPTH OF COVER, TOP SOIL SEGREGATION (NOT INCLUDED WITHIN CONSTRUCTION PROFILE). MODIFICATION IN SIDE SLOPE OF DITCH, PRESENCE OF PROTECTED RESOURCES.

REV	DATE	DSN	CK	DESCRIPTION
C	08/21/25	TL	JL	ISSUED FOR BID
B	07/07/25	RAL	LR	ISSUED FOR REVIEW (90% DESIGN)
A	04/08/25	RAL	LR	ISSUED FOR REVIEW (60% DESIGN)

WOOD GROUP USA, INC.

TITLE	INITIALS	DATE
DRAWN BY:	RAL	04/02/25
DESIGN CHECKER:	JL	04/02/25
DESIGN ENGINEER:	PA	04/08/25
PROJECT MANAGER:	EL	04/08/25

ENBRIDGE
CAPE COD CANAL PIPELINE RELOCATION PROJECT
CONSTRUCTION TYPICAL

TITLE:

LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

YEAR: 2025 | W.O.: AFE 30002835 | SCALE: N.T.S.

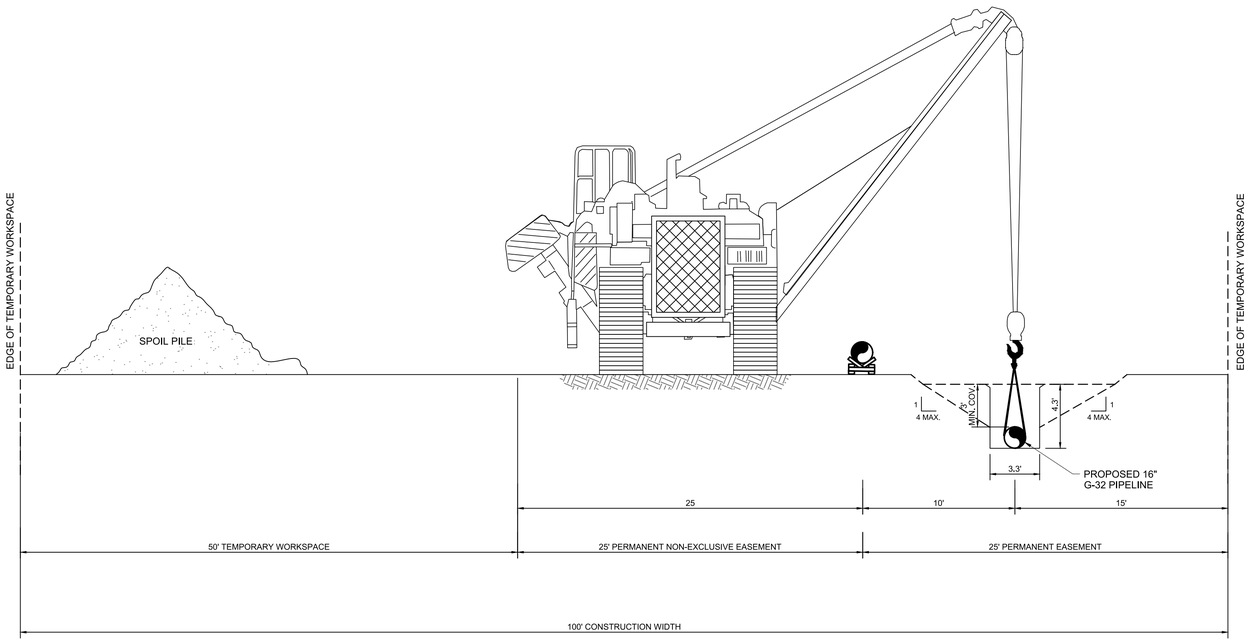
ENBRIDGE

Algonquin Gas Transmission
915 N. Eldridge Parkway, Houston, TX 77079-2703 (713) 627-5400

DWG.: GSYS-M.223-0006 | REV.: C

M:\250271\MAPPING\DRAWINGS\99-TYPICAL\Construction\GSYS-M.223-0006

TYPICAL UPLAND PIPELINE CONSTRUCTION - SINGLE PIPELINE (16")



NOTES:

1. ADDITIONAL TEMPORARY WORKSPACE AND TEMPORARY WORKSPACE COULD BE MODIFIED DEPENDING ON SITE SPECIFIC CONDITIONS INCLUDING DEEPER DEPTH OF COVER, TOP SOIL SEGREGATION (NOT INCLUDED WITHIN CONSTRUCTION PROFILE), MODIFICATION IN SIDE SLOPE OF DITCH, PRESENCE OF PROTECTED RESOURCES.

REV	DATE	DSN	CK	DESCRIPTION
C	08/21/25	TL	JL	ISSUED FOR BID
B	07/07/25	RAL	LR	ISSUED FOR REVIEW (90% DESIGN)
A	04/08/25	RAL	LR	ISSUED FOR REVIEW (60% DESIGN)

WOOD GROUP USA, INC.

TITLE	INITIALS	DATE
DRAWN BY:	RAL	04/02/25
DESIGN CHECKER:	JL	04/02/25
DESIGN ENGINEER:	PA	04/08/25
PROJECT MANAGER:	EL	04/08/25

ENBRIDGE
CAPE COD CANAL PIPELINE RELOCATION PROJECT
CONSTRUCTION TYPICAL

TITLE:

LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

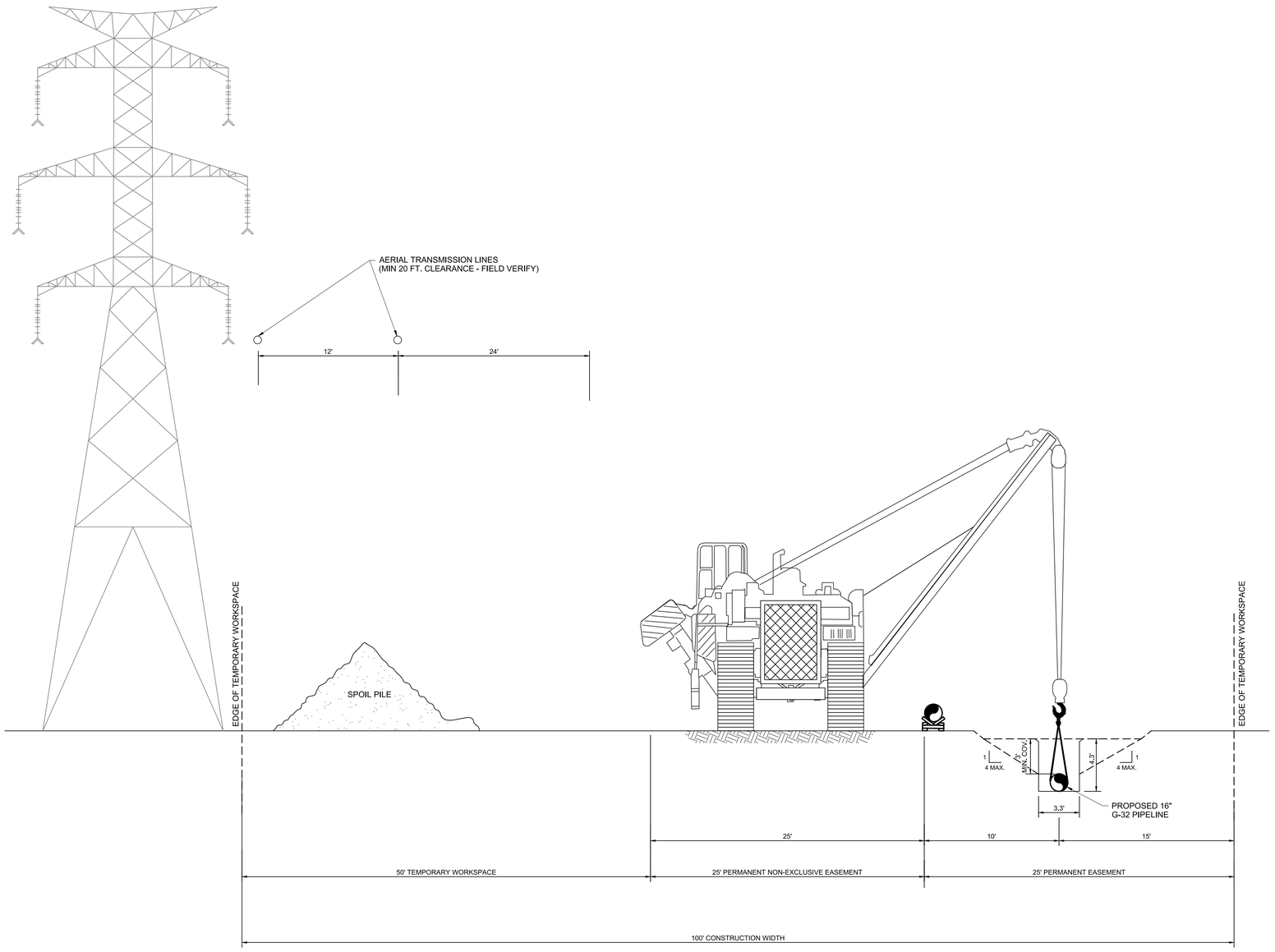
YEAR: 2025 | W.O.: AFE 30002835 | SCALE: N.T.S. | DWG.: GSYS-M.223-0007 | REV.: C

ENBRIDGE

Algonquin Gas Transmission
915 N. Eldridge Parkway, Houston, TX 77079-2703 (713) 627-5400

M:\25927\1MAPPING\DRAWINGS\99-TYPICAL\Construction\GSYS-M.223-0007

TYPICAL UPLAND (PARALLELING POWER LINES) PIPELINE CONSTRUCTION WORKSPACE - 16"



NOTES:

1. ADDITIONAL TEMPORARY WORKSPACE AND TEMPORARY WORKSPACE COULD BE MODIFIED DEPENDING ON SITE SPECIFIC CONDITIONS INCLUDING DEEPER DEPTH OF COVER, TOP SOIL SEGREGATION (NOT INCLUDED WITHIN CONSTRUCTION PROFILE), MODIFICATION IN SIDE SLOPE OF DITCH, PRESENCE OF PROTECTED RESOURCES.

REV	DATE	DSN	CK	DESCRIPTION
C	08/21/25	TL	JL	ISSUED FOR BID
B	07/07/25	RAL	LR	ISSUED FOR REVIEW (90% DESIGN)
A	04/08/25	RAL	LR	ISSUED FOR REVIEW (60% DESIGN)

wood.
WOOD GROUP USA, INC.

TITLE	INITIALS	DATE
DRAWN BY:	RAL	04/02/25
DESIGN CHECKER:	JL	04/02/25
DESIGN ENGINEER:	PA	04/08/25
PROJECT MANAGER:	EL	04/08/25

ENBRIDGE
CAPE COD CANAL PIPELINE RELOCATION PROJECT
CONSTRUCTION TYPICAL

TITLE:

LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

YEAR: 2025 | W.O.: AFE 30002835 | SCALE: N.T.S.

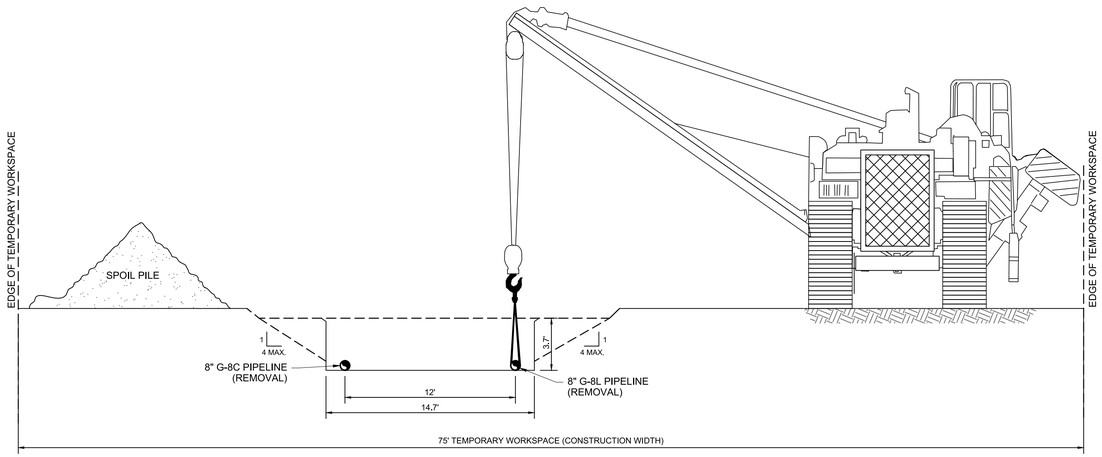
ENBRIDGE

Algonquin Gas Transmission
915 N. Eldridge Parkway, Houston, TX 77079-2703 (713) 627-5400

DWG.: GSYS-M.223-0008 | REV.: C

M:\26927\1MAP\PNG\DRAWINGS\96-TYPICAL\Construction\GSYS-M.223-0008

TYPICAL UPLAND PIPELINE CONSTRUCTION - DUAL PIPELINES REMOVAL (8")



NOTES:

1. ADDITIONAL TEMPORARY WORKSPACE AND TEMPORARY WORKSPACE COULD BE MODIFIED DEPENDING ON SITE SPECIFIC CONDITIONS INCLUDING DEEPER DEPTH OF COVER, TOP SOIL SEGREGATION (NOT INCLUDED WITHIN CONSTRUCTION PROFILE), MODIFICATION IN SIDE SLOPE OF DITCH, PRESENCE OF PROTECTED RESOURCES.

REV	DATE	DSN	CK	DESCRIPTION
C	08/21/25	TL	JL	ISSUED FOR BID
B	07/07/25	RAL	LR	ISSUED FOR REVIEW (90% DESIGN)
A	04/08/25	RAL	LR	ISSUED FOR REVIEW (60% DESIGN)

wood.
WOOD GROUP USA, INC.

TITLE	INITIALS	DATE
DRAWN BY:	RAL	04/02/25
DESIGN CHECKER:	JL	04/02/25
DESIGN ENGINEER:	PA	04/08/25
PROJECT MANAGER:	EL	04/08/25

ENBRIDGE
CAPE COD CANAL PIPELINE RELOCATION PROJECT
CONSTRUCTION TYPICAL

TITLE:

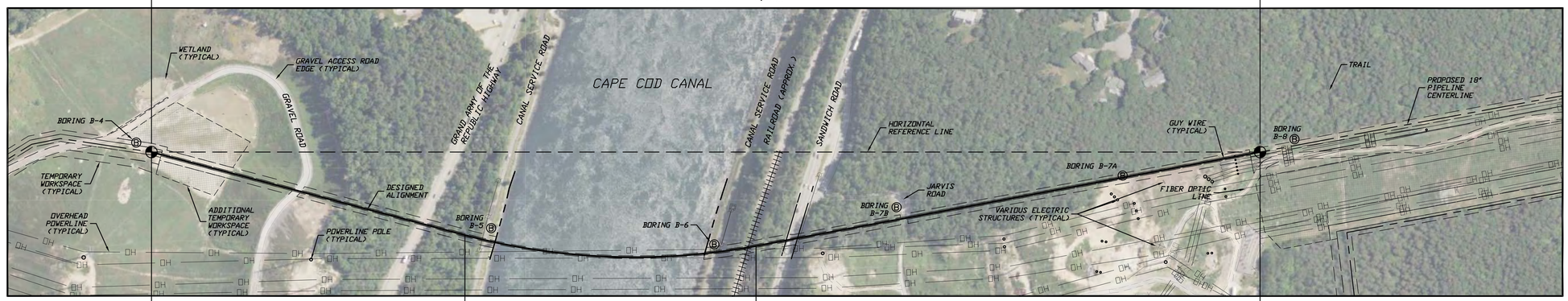
LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

YEAR: 2025 | W.O.: AFE 30002835 | SCALE: N.T.S. | DWG.: GSYS-M.223-0009 | REV.: C

ENBRIDGE

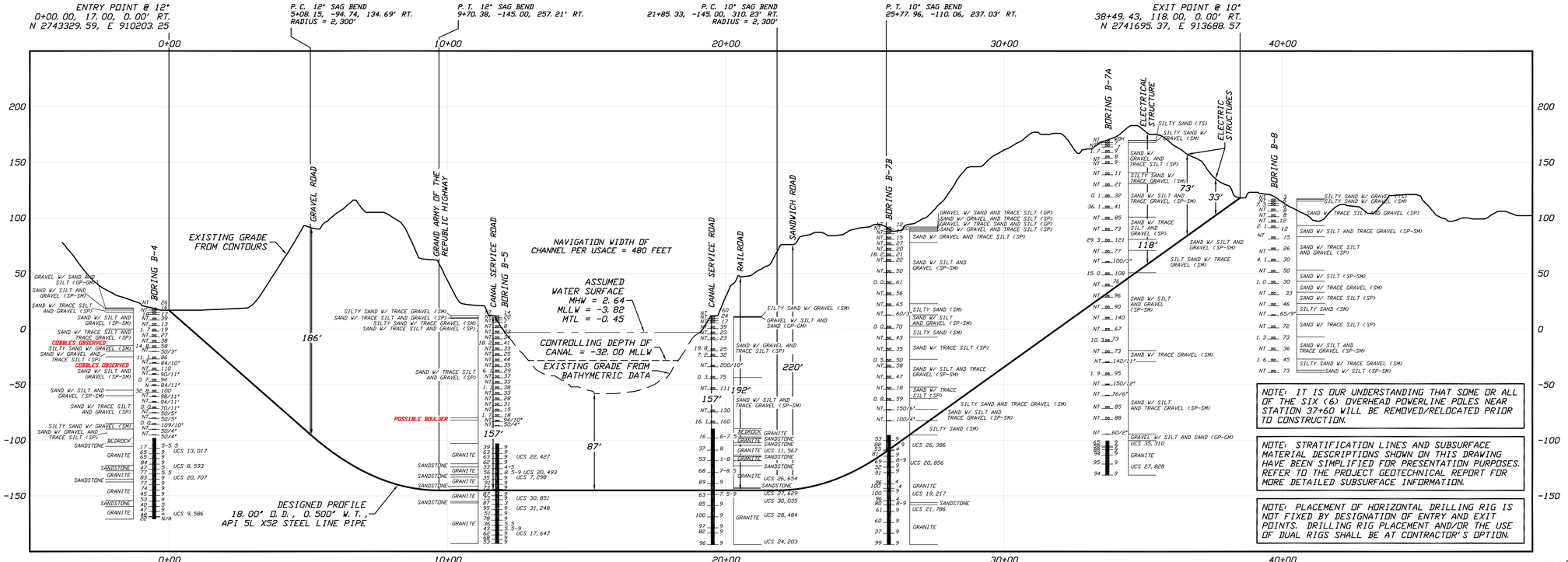
Algonquin Gas Transmission
915 N. Eldridge Parkway, Houston, TX 77079-2703 (713) 627-5400

M:\295271\MAPPING\DRAWINGS\99-TYPICAL\Construction\GSYS-M.223-0009



PLAN

SCALE: 1"=200'



PROFILE

SCALE: 1"=200' HORIZONTAL
1"= 50' VERTICAL

NOTE: IT IS OUR UNDERSTANDING THAT SOME OR ALL OF THE SIX (6) OVERHEAD POWERLINE POLES NEAR STATION 37+60 WILL BE REMOVED/RELOCATED PRIOR TO CONSTRUCTION.

NOTE: STRATIFICATION LINES AND SUBSURFACE MATERIAL DESCRIPTIONS SHOWN ON THIS DRAWING HAVE BEEN SIMPLIFIED FOR PRESENTATION PURPOSES. REFER TO THE PROJECT GEOTECHNICAL REPORT FOR MORE DETAILED SUBSURFACE INFORMATION.

NOTE: PLACEMENT OF HORIZONTAL DRILLING RIG IS NOT FIXED BY DESIGNATION OF ENTRY AND EXIT POINTS. DRILLING RIG PLACEMENT AND/OR THE USE OF DUAL RIGS SHALL BE AT CONTRACTOR'S OPTION.

GENERAL LEGEND

DRILLED PATH ENTRY/EXIT POINT

GEOTECHNICAL LEGEND

(B) BORING LOCATION

SPLIT SPOON SAMPLE

53 X 23 — PENETRATION RESISTANCE IN BLOWS PER FOOT FOR A 140 POUND HAMMER FALLING 30 INCHES
└ PERCENTAGE OF GRAVEL BY WEIGHT FOR SAMPLES CONTAINING GRAVEL

CORE BARREL SAMPLE

UCS 6,250 — UNCONFINED COMPRESSIVE STRENGTH (PSI)
53 6 — MOHS HARDNESS
└ ROCK QUALITY DESIGNATION (PERCENT)

GEOTECHNICAL NOTES

1. GEOTECHNICAL DATA PROVIDED BY GEOENGINEERS USA, P.C., BOSTON, MA. REFER TO THE GEOTECHNICAL DATA REPORT DATED NOVEMBER, 2024 FOR MORE DETAILED SUBSURFACE INFORMATION.
2. THE LETTER "N" TO THE LEFT OF A SAMPLE INDICATES THAT NO GRAVEL WAS OBSERVED IN THE SAMPLE. THE LETTERS "NT" INDICATE THAT GRAVEL WAS OBSERVED BUT NO GRADATION TEST WAS PERFORMED.
3. THE GEOTECHNICAL DATA IS ONLY DESCRIPTIVE OF THE LOCATIONS ACTUALLY SAMPLED. EXTENSION OF THIS DATA OUTSIDE OF THE ORIGINAL BORINGS MAY BE DONE TO CHARACTERIZE THE SOIL CONDITIONS, HOWEVER, COMPANY DOES NOT GUARANTEE THESE CHARACTERIZATIONS TO BE ACCURATE. CONTRACTOR MUST USE HIS OWN EXPERIENCE AND JUDGMENT IN INTERPRETING THIS DATA.

TOPOGRAPHIC SURVEY NOTES

1. TOPOGRAPHIC SURVEY DATA PROVIDED BY ENBRIDGE, CALGARY, CANADA.
2. NORTHINGS AND EASTINGS ARE IN U.S. SURVEY FEET REFERENCED TO MASSACHUSETTS STATE PLANE COORDINATES, MAINLAND ZONE, NAD 83.
3. ELEVATIONS ARE IN FEET REFERENCED TO NAVD 88.

DESIGNED PATH NOTES

1. DESIGNED PATH STATIONING IS IN FEET BY HORIZONTAL MEASUREMENT AND IS REFERENCED TO CONTROL ESTABLISHED FOR THE DRILLED SEGMENT.
2. DESIGNED PATH COORDINATES REFER TO CENTERLINE OF PILOT HOLE AS OPPOSED TO TOP OF INSTALLED PIPE.

PILOT HOLE TOLERANCES

THE PILOT HOLE SHALL BE DRILLED TO THE TOLERANCES LISTED BELOW. HOWEVER, IN ALL CASES, RIGHT-OF-WAY RESTRICTIONS AND CONCERN FOR ADJACENT FACILITIES SHALL TAKE PRECEDENCE OVER THESE TOLERANCES.

1. ENTRY POINT: UP TO 5 FEET FORWARD OR BACK FROM THE DESIGNED ENTRY POINT; UP TO 5 FEET RIGHT OR LEFT OF THE DESIGNED ALIGNMENT
2. EXIT POINT: UP TO 10 FEET SHORT OR 30 FEET LONG RELATIVE TO THE DESIGNED EXIT POINT; UP TO 5 FEET RIGHT OR LEFT OF THE DESIGNED ALIGNMENT
3. ELEVATION: UP TO 2 FEET ABOVE AND 20 FEET BELOW THE DESIGNED PROFILE
4. ALIGNMENT: UP TO 10 FEET RIGHT OR LEFT OF THE DESIGNED ALIGNMENT
5. CURVE RADIUS: NO LESS THAN 1,200 FEET BASED ON A 3-JOINT AVERAGE (ASSUMING RANGE 2 DRILL PIPE)

PROTECTION OF EXISTING FACILITIES

CONTRACTOR SHALL UNDERTAKE THE FOLLOWING STEPS PRIOR TO COMMENCING DRILLING OPERATIONS.

1. CONTACT THE UTILITY LOCATION/NOTIFICATION SERVICE FOR THE CONSTRUCTION AREA.
2. POSITIVELY LOCATE AND STAKE ALL EXISTING UNDERGROUND FACILITIES. ANY FACILITIES LOCATED WITHIN 10 FEET OF THE DESIGNED DRILLED PATH SHALL BE EXPOSED.
3. MODIFY DRILLING PRACTICES AND DOWNHOLE ASSEMBLIES AS NECESSARY TO PREVENT DAMAGE TO EXISTING FACILITIES.

CAPE COD CANAL PIPELINE RELOCATION PROJECT

PLAN AND PROFILE
18-INCH PIPELINE CROSSING OF CAPE COD CANAL BY HORIZONTAL DIRECTIONAL DRILLING

LOCATION: BARNSTABLE COUNTY, MASSACHUSETTS

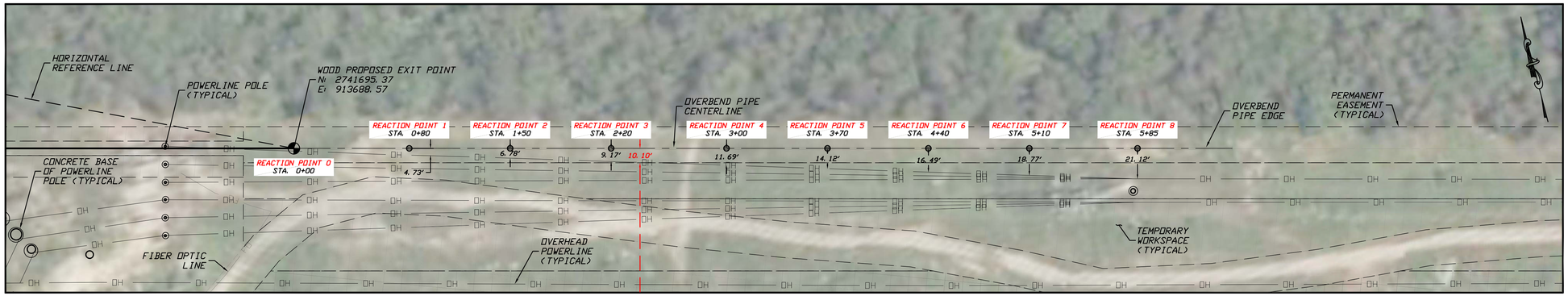
DRAWN	DATE	CHECKED	APPROVED	SCALE	DRAWING LABEL	REVISION
JDH&A	08/01/25	ACM	JMS	SHOWN FOR D-SIZED PLOT	CAPE COD CANAL	1

NO.	DATE	REVISION DESCRIPTION	BY	CHKD	APP.
1	08/20/25	ISSUE FOR BID	RCL	DLB	JMS

J.D. Hair & Associates, Inc.
Consulting Engineers
6100 South Yale Avenue
Suite 1610
Tulsa, Oklahoma 74136

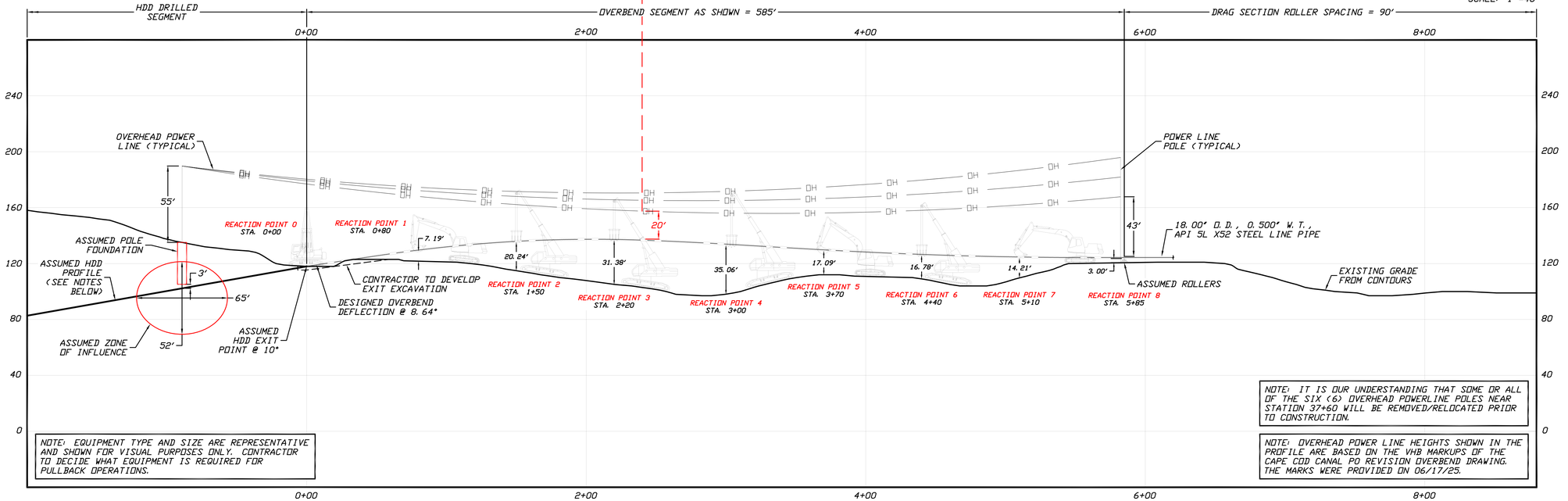
PROJECT NO.
WOOD\2336

SHEET NO.
1



PLAN

SCALE: 1"=40'



GENERAL LEGEND

DESIGNED PATH EXIT POINT

TOPOGRAPHIC SURVEY NOTES

1. TOPOGRAPHIC SURVEY DATA PROVIDED BY ENBRIDGE, CALGARY, CANADA.
2. NORTHINGS AND EASTINGS ARE IN U.S. SURVEY FEET REFERENCED TO MASSACHUSETTS STATE PLANE COORDINATES, MAINLAND ZONE, NAD 83.
3. ELEVATIONS ARE IN FEET REFERENCED TO NAVD 88.

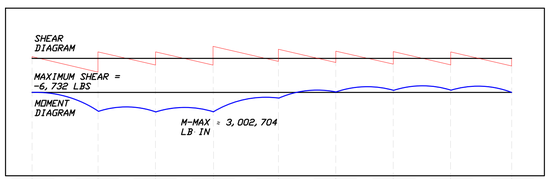
18-INCH STEEL LINE PIPE PROPERTIES

- OUTSIDE DIAMETER = 18.00 INCHES
- NOMINAL WALL THICKNESS = 0.500 INCHES
- UNIT WEIGHT = 93.45 POUNDS/FOOT
- SPECIFIED MINIMUM YIELD STRENGTH (SMYS) = 52,000 PSI

OVERBEND AND PULLBACK CRITERIA

- LENGTH OF SUSPENDED PIPE SEGMENT = ~585 FEET
- WEIGHT OF SUSPENDED PIPE SEGMENT = 54,668 POUNDS
- MAXIMUM LIFT POINT LOAD = 9,933 POUNDS
- FINITE ELEMENT ANALYSIS PEAK STRESS = ~49.3% OF SMYS
- DRAG SECTION ROLLER SPACING AS SHOWN = 90 FEET (BASED ON L/240 DEFLECTION LIMIT)

SUPPORT POINT LOADING ANALYSIS



REACTION POINT 0 | REACTION POINT 1 | REACTION POINT 2 | REACTION POINT 3 | REACTION POINT 4 | REACTION POINT 5 | REACTION POINT 6 | REACTION POINT 7 | REACTION POINT 8

REACTION POINT	STA.	HEIGHT* (FT) RELATIVE TO GRADE	HEIGHT* (FT) RELATIVE TO EXIT	VERT. REACTION FORCE (LBS)***	BENDING** STRESS (PSI)
0 (EXIT)	0+00	0.00	0.00	697	-0
1	0+80	7.19	10.91	9,933	24,756
2	1+50	20.24	17.17	6,669	25,659
3	2+20	31.38	18.52	9,204	25,660
4	3+00	35.06	15.18	5,969	7,635
5	3+70	17.09	11.09	5,679	637
6	4+40	16.79	7.82	6,874	2,698
7	5+10	14.21	5.98	6,393	2,823
8	5+85	3.00**	5.63	3,872	-0

* HEIGHTS ARE REFERENCED TO BOTTOM OF PIPE ** PIPE ON ROLLERS AT GROUND SURFACE *** BASED ON FEA ANALYSIS

OVERBEND NOTES

1. THE OVERBEND GEOMETRY INDICATED ON THIS DRAWING DEMONSTRATES ONE OF MANY POSSIBLE CONFIGURATIONS THAT WOULD BE CONSIDERED ACCEPTABLE WITH REGARD TO ALLOWABLE STRESSES. ON THE BASIS OF MOMENT-CURVATURE AND PURE BENDING, CALCULATED BENDING STRESSES IN THIS CONFIGURATION FALL BELOW 50% OF THE SPECIFIED MINIMUM YIELD STRENGTH OF THE 18-INCH STEEL PIPE. DYNAMIC LOADS INVOLVED WITH POSITIONING, LIFTING, OR HANDLING THE STEEL PIPE DURING PULLBACK HAVE NOT BEEN CONSIDERED IN THIS ANALYSIS. CONTRACTOR RETAINS ULTIMATE RESPONSIBILITY FOR HANDLING THE PULL SECTION SO THAT THE PIPE AND THE CORROSION COATING ARE NOT DAMAGED.
2. CONTRACTOR IS RESPONSIBLE FOR DETERMINING ACTUAL LIFT POINT LOCATIONS, LIFT HEIGHTS, AND LIFTING EQUIPMENT NECESSARY TO ENSURE THAT OPERATIONS ARE CONDUCTED SAFELY AND THE PIPE IS NOT DAMAGED OR OVERSTRESSED.
3. THE OVERBEND GEOMETRY SHOWN IS BASED ON THE PULL SECTION ENTERING THE REAMED HOLE AT THE EXIT POINT LOCATION AND EXIT ANGLE BASED ON AN ASSUMED HDD DESIGN EXIT POINT. NOTE THAT MODIFICATIONS MAY BE REQUIRED BASED ON THE ACTUAL LOCATION AND ANGLE OF THE EXIT POINT AT THE COMPLETION OF REAMING OPERATIONS.
4. THE OVERBEND GEOMETRY TABLE INCLUDED ON THIS DRAWING IS INTENDED TO PROVIDE GUIDANCE WITH REGARD TO POTENTIAL LIFTING HEIGHTS ALONG THE LENGTH OF THE OVERBEND. THE HEIGHTS THAT HAVE BEEN PROVIDED REPRESENT VERTICAL DISTANCES FROM THE GRADE TO THE BOTTOM OF THE PIPE. NOTE THAT LIFT HEIGHTS MAY NEED TO BE MODIFIED BASED ON ACTUAL GRADE ELEVATIONS AT THE TIME OF CONSTRUCTION.

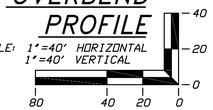
OVERBEND GEOMETRY TABLE

OFFSET (X)	HEIGHT* (Y)	OFFSET (X)	HEIGHT* (Y)
0+00	0.0	4+20	16.28
0+20	2.31**	4+40	16.79
0+40	2.76**	4+60	20.00
0+60	3.24	4+80	20.56
0+80	7.19	5+00	17.31
1+00	9.98	5+20	11.42
1+20	13.35	5+40	5.41
1+40	18.02	5+60	3.32
1+60	22.33	5+80	3.06
1+80	26.16	5+85	3.00***
2+00	28.76	–	–
2+20	31.38	–	–
2+40	33.09	–	–
2+60	35.97	–	–
2+80	37.11	–	–
3+00	35.06	–	–
3+20	29.00	–	–
3+40	22.84	–	–
3+60	18.39	–	–
3+80	16.54	–	–
4+00	16.69	–	–

* HEIGHTS NOTED ARE FROM EXISTING GRADE TO BOTTOM OF PIPE
** HEIGHTS NOTED ARE FROM EXCAVATION TO BOTTOM OF PIPE
*** PIPE ON ROLLERS AT GROUND SURFACE

OVERBEND PROFILE

SCALE: 1"=40' HORIZONTAL
1"=40' VERTICAL



CAPE COD CANAL PIPELINE RELOCATION PROJECT

OVERBEND PLAN AND PROFILE
18-INCH PIPELINE CROSSING OF CAPE COD CANAL
BY HORIZONTAL DIRECTIONAL DRILLING

LOCATION: BARNSTABLE COUNTY, MASSACHUSETTS

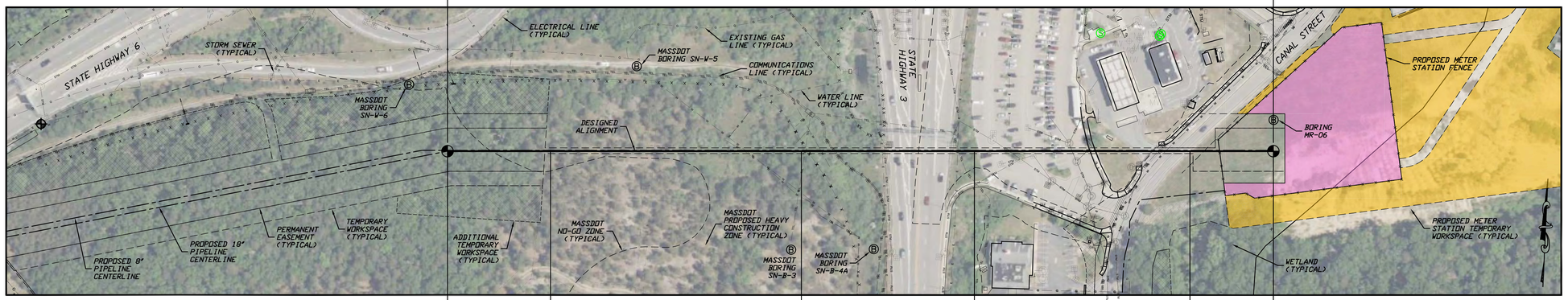
DRAWN	DATE	CHECKED	APPROVED	SCALE	DRAWING LABEL	REVISION
JDH&A	08/01/25	ACM	JMS	SHOWN FOR D-SIZED PLOT	CANAL OVERBEND	0

NO.	DATE	REVISION DESCRIPTION	BY	CHKD	APP.

J.D. Hair & Associates, Inc.
Consulting Engineers
6100 South Yale Avenue
Suite 1610
Tulsa, Oklahoma 74136

PROJECT NO.
WOOD\2336

SHEET NO.
2



PLAN

SCALE: 1"=100'

EXIT POINT @ 14°
14+33.79, 101.47
N 2746383.66, E 916249.70

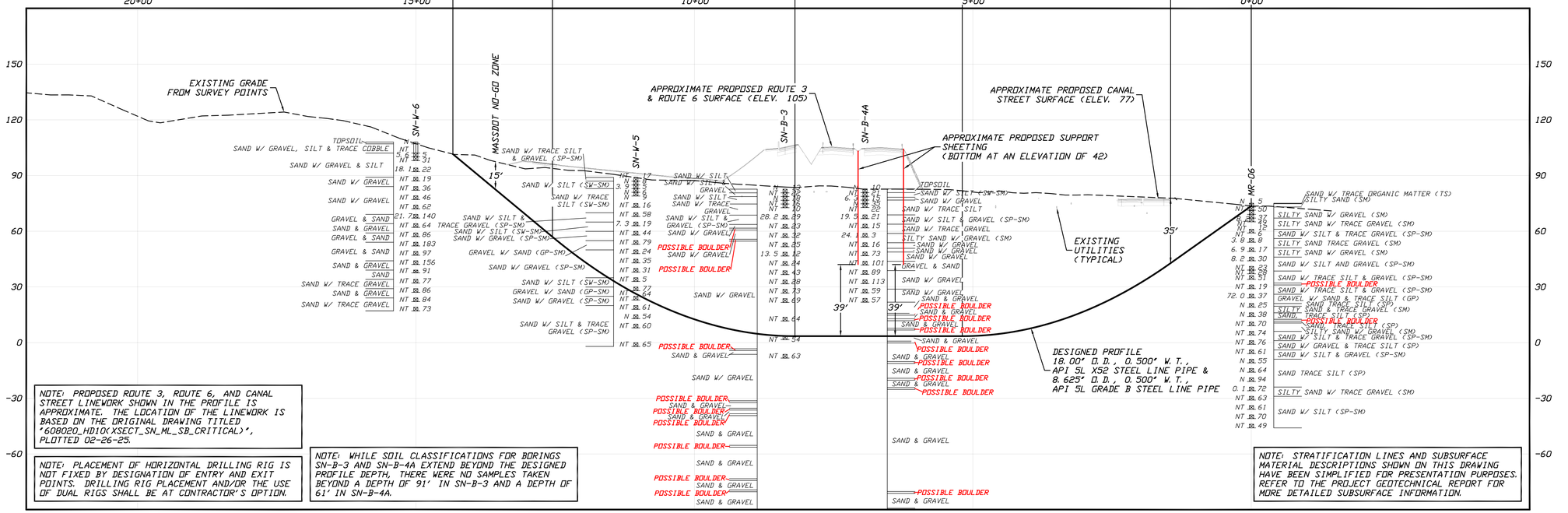
P. T. 14° SAG BEND
12+54.95, 56.88

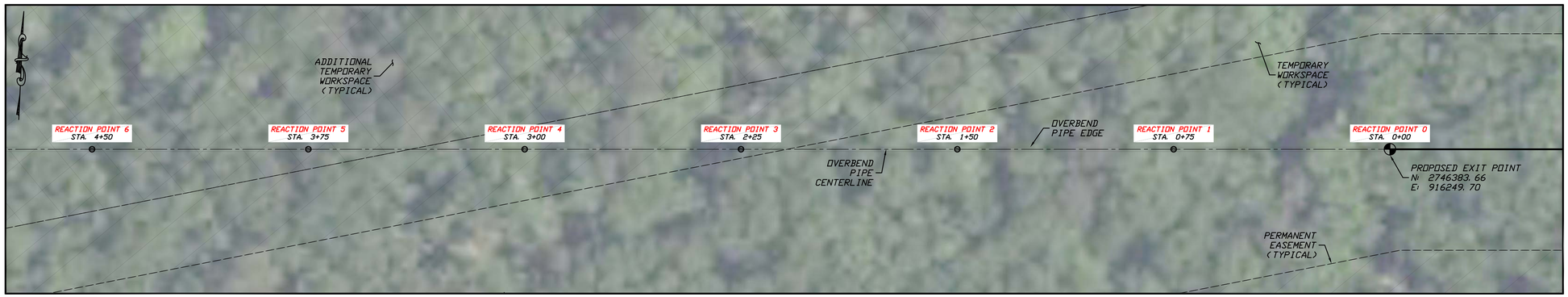
P. C. 14° SAG BEND
8+19.49, 3.42
RADIUS = 1,800'

P. T. 12° SAG BEND
5+19.04, 3.42

P. C. 12° SAG BEND
1+44.80, 42.75
RADIUS = 1,800'

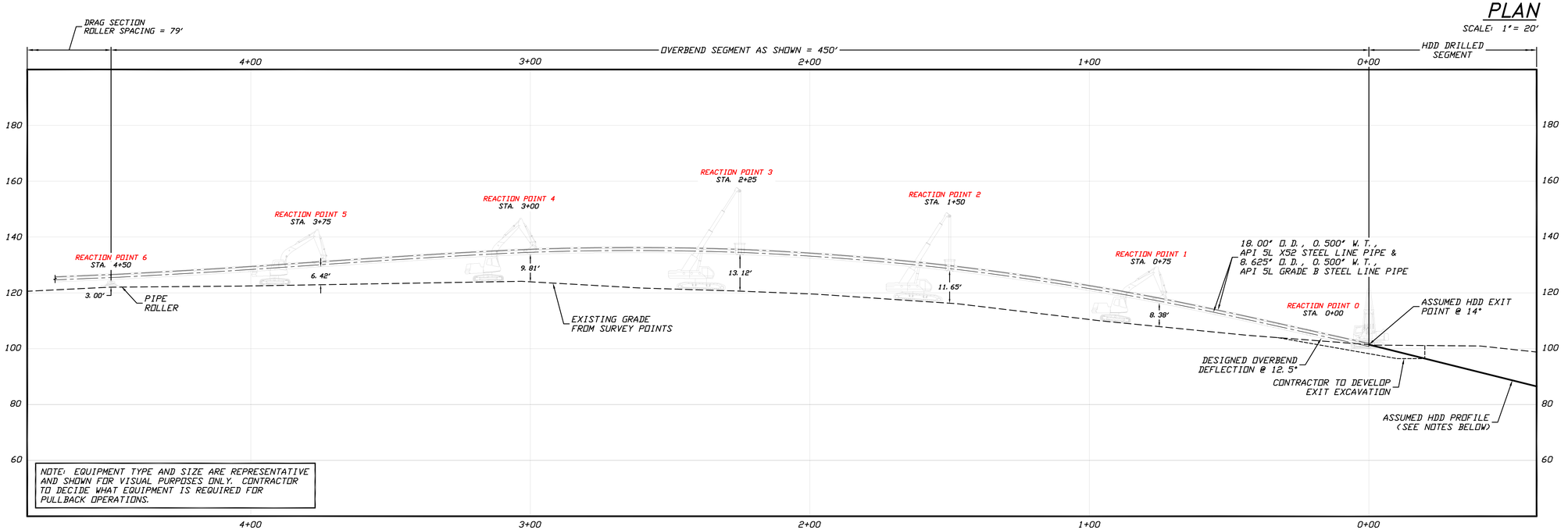
ENTRY POINT @ 12°
0+00.00, 73.53
N 2746450.90, E 917681.91


20+00
15+00
10+00
5+00
0+00
150
120
90
60
30
0
-30
-60
EXISTING GRADE FROM SURVEY POINTS
MASSDOT NO-GO ZONE
SN-W-6
SN-W-5
SN-B-3
SN-B-4A
MR-06
APPROXIMATE PROPOSED ROUTE 3 & ROUTE 6 SURFACE (ELEV. 105)
APPROXIMATE PROPOSED CANAL STREET SURFACE (ELEV. 77)
APPROXIMATE PROPOSED SUPPORT SHEETING (BOTTOM AT AN ELEVATION OF 42)
EXISTING UTILITIES (TYPICAL)
15'
35'
39'
39'
TOPSOIL
SAND W/ GRAVEL, SILT & TRACE COBBLE
SAND W/ GRAVEL & SILT
SAND W/ GRAVEL
SAND W/ GRAVEL
GRAVEL & SAND
SAND & GRAVEL
GRAVEL & SAND
GRAVEL & SAND
SAND & GRAVEL
SAND
SAND W/ TRACE GRAVEL
SAND & GRAVEL
SAND W/ TRACE GRAVEL
SAND W/ SILT & GRAVEL (SP-SM)
SAND W/ SILT (SW-SM)
SAND W/ TRACE SILT & GRAVEL (SW-SM)
SAND W/ SILT & GRAVEL (SP-SM)
SAND W/ SILT (SW-SM)
SAND W/ GRAVEL (SP-SM)
SAND W/ SILT & GRAVEL (SP-SM)
SAND W/ SILT (SW-SM)
SAND W/ GRAVEL (GP-SM)
SAND W/ GRAVEL (SP-SM)
SAND W/ SILT (SW-SM)
GRAVEL W/ SAND (GP-SM)
SAND W/ GRAVEL (SP-SM)
SAND W/ SILT & TRACE GRAVEL (SP-SM)
SAND W/ GRAVEL
POSSIBLE BOULDER
SAND & GRAVEL
SAND W/ GRAVEL
SAND & GRAVEL
SAND W/ GRAVEL
SAND & GRAVEL
SAND W/ GRAVEL



PLAN

SCALE: 1" = 20'



NOTE: EQUIPMENT TYPE AND SIZE ARE REPRESENTATIVE AND SHOWN FOR VISUAL PURPOSES ONLY. CONTRACTOR TO DECIDE WHAT EQUIPMENT IS REQUIRED FOR PULLBACK OPERATIONS.

GENERAL LEGEND

DESIGNED PATH EXIT POINT

TOPOGRAPHIC SURVEY NOTES

1. TOPOGRAPHIC SURVEY DATA PROVIDED BY ENBRIDGE, CALGARY, CANADA.
2. NORTHINGS AND EASTINGS ARE IN U.S. SURVEY FEET REFERENCED TO MASSACHUSETTS STATE PLANE COORDINATES, MAINLAND ZONE, NAD 83.
3. ELEVATIONS ARE IN FEET REFERENCED TO NAVD 88.

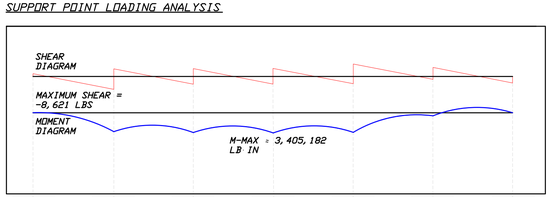
18-INCH AND 8-INCH STEEL LINE PIPE PROPERTIES

- OUTSIDE DIAMETER = 18.00 INCHES AND 8.625 INCHES
- NOMINAL WALL THICKNESS = 0.500 INCHES
- UNIT WEIGHT = 93.45 POUNDS/FOOT (18-INCH) AND 43.39 POUNDS/FOOT (8-INCH)
- SPECIFIED MINIMUM YIELD STRENGTH (SMYS) = 52,000 PSI (18-INCH) AND 35,000 PSI (8-INCH)

OVERBEND AND PULLBACK CRITERIA

- LENGTH OF SUSPENDED PIPE SEGMENT = ~453 FEET
- WEIGHT OF SUSPENDED COMBINED PIPE SEGMENT = 61,989 POUNDS
- MAXIMUM LIFT POINT LOAD = 13,138 POUNDS
- FINITE ELEMENT ANALYSIS PEAK STRESS OF 18-INCH PIPE = 38% OF SMYS
- FINITE ELEMENT ANALYSIS PEAK STRESS OF 8-INCH PIPE = 40% OF SMYS
- DRAG SECTION ROLLER SPACING AS SHOWN = 79 FEET (BASED ON L/240 DEFLECTION LIMIT)

SUPPORT POINT LOADING ANALYSIS



REACTION POINT	STA.	HEIGHT* (FT) RELATIVE TO GRADE	HEIGHT* (FT) RELATIVE TO EXIT	VERT. REACTION FORCE (LBS)***	18-INCH BENDING** STRESS (PSI)	8-INCH BENDING** STRESS (PSI)
0 (EXIT)	0+00	-0.60	-0.60	1,471	0	0
1	0+75	8.38	14.83	13,783	27,614	13,116
2	1+50	11.65	26.48	10,371	28,761	13,864
3	2+25	13.12	38.28	10,442	29,082	13,892
4	3+00	9.81	38.31	13,138	28,007	13,316
5	3+75	6.42	27.88	7,879	4,819	1,978
6	4+50	3.00**	23.89	4,506	0	0

* HEIGHTS ARE REFERENCED TO BOTTOM OF PIPE ** PIPE ON ROLLERS AT GROUND SURFACE *** BASED ON FEA ANALYSIS

OVERBEND NOTES

1. THE OVERBEND GEOMETRY INDICATED ON THIS DRAWING DEMONSTRATES ONE OF MANY POSSIBLE CONFIGURATIONS THAT WOULD BE CONSIDERED ACCEPTABLE WITH REGARD TO ALLOWABLE STRESSES. ON THE BASIS OF MOMENT-CURVATURE AND PURE BENDING, CALCULATED BENDING STRESSES IN THIS CONFIGURATION FALL BELOW 60% OF THE SPECIFIED MINIMUM YIELD STRENGTH (SMYS) OF THE 18-INCH STEEL PIPE AND BELOW 40% OF THE SMYS OF THE 8-INCH STEEL PIPE. DYNAMIC LOADS INVOLVED WITH POSITIONING, LIFTING, OR HANDLING THE STEEL PIPES DURING PULLBACK HAVE NOT BEEN CONSIDERED IN THIS ANALYSIS. CONTRACTOR RETAINS ULTIMATE RESPONSIBILITY FOR HANDLING THE PULL SECTION SO THAT THE PIPES AND THE CORROSION COATING ARE NOT DAMAGED.
2. REACTIONS MUST BE MAINTAINED AT ALL DESIGNATED LIFT POINTS AND CARE MUST BE TAKEN TO MINIMIZE LOAD SHEDDING. MANIPULATION OF THE FRONT AND REAR OF THE STEEL PIPE SHALL BE CONDUCTED IN A MANNER THAT PRESERVES LOAD EQUILIBRIUM AND PREVENTS UNDUE STRESS. EFFORTS SHALL BE TAKEN TO ENSURE THE PIPE IS NOT SUDDENLY UNSUPPORTED UPON ADVANCING BEYOND ANY ONE LIFT POINT/ROLLER/CRADLE.
3. THE OVERBEND GEOMETRY SHOWN IS BASED ON THE BUNDLED PULL SECTION ENTERING THE REAMED HOLE AT APPROXIMATELY THE DESIGNED EXIT POINT LOCATION WITH AN OVERBEND EXIT ANGLE OF 12.5°. NOTE THAT MODIFICATIONS MAY BE REQUIRED BASED ON THE ACTUAL LOCATION AND ANGLE OF THE EXIT POINT AT THE COMPLETION OF REAMING OPERATIONS.
4. THE OVERBEND GEOMETRY TABLE INCLUDED ON THIS DRAWING IS INTENDED TO PROVIDE GUIDANCE WITH REGARD TO POTENTIAL LIFTING HEIGHTS ALONG THE LENGTH OF THE OVERBEND. THE HEIGHTS THAT HAVE BEEN PROVIDED REPRESENT VERTICAL DISTANCES FROM THE GRADE TO THE BOTTOM OF THE 18-INCH PIPE. NOTE THAT LIFT HEIGHTS MAY NEED TO BE MODIFIED BASED ON ACTUAL GRADE ELEVATIONS AT THE TIME OF CONSTRUCTION.

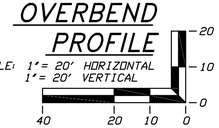
OVERBEND GEOMETRY TABLE

OFFSET (X)	HEIGHT* (Y)	OFFSET (X)	HEIGHT* (Y)
0+00	-0.67	4+20	4.09
0+20	2.74	4+40	3.12
0+40	4.40	4+50	3.00**
0+60	6.83	–	–
0+80	8.84	–	–
1+00	10.31	–	–
1+20	11.08	–	–
1+40	11.48	–	–
1+60	12.07	–	–
1+80	12.58	–	–
2+00	12.79	–	–
2+20	13.11	–	–
2+40	13.08	–	–
2+60	12.69	–	–
2+80	11.46	–	–
3+00	9.81	–	–
3+20	8.98	–	–
3+40	8.13	–	–
3+60	7.18	–	–
3+80	6.16	–	–
4+00	5.14	–	–

* HEIGHTS NOTED ARE FROM EXISTING GRADE TO BOTTOM OF 18" PIPE
** PIPE ON ROLLERS AT GROUND SURFACE

OVERBEND PROFILE

SCALE: 1" = 20' HORIZONTAL
1" = 20' VERTICAL



CAPE COD CANAL PIPELINE RELOCATION PROJECT

OVERBEND PLAN AND PROFILE
18-INCH AND 8-INCH BUNDLED PIPELINE CROSSING OF THE SAGAMORE BRIDGE BY HORIZONTAL DIRECTIONAL DRILLING

LOCATION: BARNSTABLE COUNTY, MASSACHUSETTS

DRAWN	DATE	CHECKED	APPROVED	SCALE	DRAWING LABEL	REVISION
RCL	08/01/25	ACM	JMS	SHOWN FOR D-SIZED PLOT	BRIDGE OVERBEND	0

NO.	DATE	BY	CHKD	APP.

REVISION DESCRIPTION

J.D. Hair & Associates, Inc.
Consulting Engineers
6100 South Yale Avenue
Suite 1610
Tulsa, Oklahoma 74136

PROJECT NO.
WOOD\2336

SHEET NO.
2

ATTACHMENT 3

Algonquin Erosion and Sedimentation Control Plan and Spill Protection, Control, and Countermeasure Plan

Erosion and Sedimentation Control Plan

Effective June 6, 2014

Revised: December 2024

Table of Contents

1. INTRODUCTION 1
- 1.1 PURPOSE OF THIS PLAN 1
- 1.2 GUIDELINES AND REQUIREMENTS 2
- 1.3 SURVEYS, PERMITS & NOTIFICATIONS 2
- 1.4 INQUIRIES 2

2. SUPERVISION AND INSPECTION 3
- 2.1 ROLE & RESPONSIBILITIES OF THE ENVIRONMENTAL INSPECTOR 3
- 2.2 ENVIRONMENTAL TRAINING FOR CONSTRUCTION 5

3. CONSTRUCTION TECHNIQUES FOR NATURAL GAS FACILTIES 6
- 3.1 TYPICAL ROW REQUIREMENTS 6
- 3.2 ACCESS ROADS & ACCESS POINTS 6
- 3.3 PIPE AND CONTRACTOR WAREYARDS 8
- 3.4 OFF-ROW DISTURBANCE 8
- 3.5 CONSTRUCTION SEQUENCE FOR PIPELINE INSTALLATION 9
  - 3.5.1 Clearing & Flagging 10
  - 3.5.2 Temporary Sediment Barriers 11
  - 3.5.3 Grading 11
  - 3.5.4 Temporary Slope Breakers 13
  - 3.5.5 Trenching 14
  - 3.5.6 Trench & Site Dewatering 15
  - 3.5.7 Pipe Installation 15
  - 3.5.8 Backfilling 16
    - 3.5.8.1 Permanent Trench Breakers 17
  - 3.5.9 Hydrostatic Testing 17
  - 3.5.10 Pipeline Abandonment and Removal 19
- 3.6 ROW RESTORATION & FINAL CLEANUP 19
  - 3.6.1 Permanent Erosion Control 20
  - 3.6.2 Revegetation and Seeding 22
  - 3.6.3 Mulch 23
  - 3.6.4 Frozen Conditions & Winter Construction 24
  - 3.6.5 Unauthorized Vehicle Access to ROW 24
- 3.7 ABOVEGROUND FACILITY CONSTRUCTION 24

4. SPECIAL CONSTRUCTION METHODS 27
- 4.1 AGRICULTURAL AREAS 27
  - 4.1.1 Drain Tiles 27
  - 4.1.2 Irrigation 27
  - 4.1.3 Soil Compaction Mitigation & Restoration 27
- 4.2 ROAD CROSSINGS 28
- 4.3 RESIDENTIAL AREAS 28
  - 4.3.1 Stove Pipe Technique 29
  - 4.3.2 Drag Section Technique 29
  - 4.3.3 Residential Area Cleanup and Restoration 29

4.4 HORIZONTAL DIRECTIONAL DRILL METHOD 30

5. WATERBODY CROSSINGS 32
5.1 GENERAL WATERBODY PROCEDURES 32
5.1.1 Time Windows for Instream Work 33
5.1.2 Equipment Bridges 33
5.1.3 Clearing and Grading near Waterbodies 34
5.1.4 Temporary Erosion and Sediment Controls at Waterbodies 34
5.2 TYPES OF WATERBODY CROSSING METHODS 35
5.2.1 Flume Crossing 35
5.2.2 Dam-and-Pump Crossing 36
5.2.3 Wet Crossing 37
5.3 FERC WATERBODY CLASSIFICATIONS 37
5.3.1 Minor Waterbodies 37
5.3.2 Intermediate Waterbodies 38
5.3.3 Major Waterbodies 38
5.4 Restoration 39

6. WETLAND CROSSINGS 40
6.1 General Wetland Procedures 40
6.2 Clearing and Grading at Wetlands 41
6.3 Temporary Erosion & Sediment Control at Wetlands 42
6.4 Wetland Crossing Procedure 42
6.4.1 Push-pull Technique 43
6.5 Wetland Cleanup and Restoration 43

7. SPILL PREVENTION & RESPONSE 45
7.1 SPCC / PPC Plan 45
7.2 Spill Prevention Measures 45
7.3 Spill Cleanup & Response 46

8. POST-CONSTRUCTION ACTIVITIES 47
8.1 POST-CONSTRUCTION MONITORING 47
8.2 POST-CONSTRUCTION MAINTENANCE 48
8.2.1 Uplands 48
8.2.2 Waterbodies and Wetlands 48
8.3 REPORTING 49

APPENDIX A – E&SCP FIGURES
APPENDIX B – WATERBODY REFERENCE CITING FERC REQUIREMENTS
APPENDIX C – SEED MIX RECOMMENDATIONS

LIST OF FIGURES

APPENDIX A

Figure Number	CATEGORY ABBREVIATION / Figure Name
CONSTRUCTION WORK AREAS (CW)	
CW-1	Typical Trench Detail
CW-2	Right-of-Way Topsoil Segregation Techniques
CW-3	Typical Construction Widths Acquiring New Permanent Right-of-Way
CW-4	Typical Construction Widths Not Acquiring New Permanent Right-of-Way (Single Line System)
CW-5	Typical Construction Widths Not Acquiring New Permanent Right-of-Way (Multiple Line System)
ACCESS ROADS & ROAD CROSSINGS (RD)	
RD-1	Access Road Cross Section
RD-2	Rock Access Pad
RD-3	Typical Temporary Access Road Through Wetlands
RD-4	Typical Paved Road Crossing Control Measures (Open Cut)
RD-5	Typical Paved Road Crossing Control Measures (Bored)
EROSION CONTROLS (EC)	
EC-1	Silt Fence Detail
EC-2	Straw Bale Detail
EC-3	Straw Bale Check Dam in a Drainageway
EC-4	Rock-lined Drainage Swale
EC-5	Storm Drain Inlet Protection
EC-6	Temporary Trench Plug Options
EC-7	Temporary Slope Breaker
EC-8	Permanent Slope Breaker
EC-9	Chevron Slope Breaker
EC-10	Trench Breaker Detail (Sack)
EC-11	Trench Breaker Detail (Foam)
EC-12	Permanent Trench Breaker Options
EC-13	Erosion Control Fabric/Blanket Installation
EC-14	Typical Erosion Control Blankets on Slopes

LIST OF FIGURES, continued

Figure Number	CATEGORY ABBREVIATION / Figure Name
WATER DISCHARGES (WD)	
WD-1	Filter Bag
WD-2	Discharge Structure for Hydrostatic Test Water
WD-2	Options for Small Water Discharges
WD-3	Discharge of Hydrostatic Test Water to a Surface Water
BRIDGES (BR)	
BR-1	Temporary Equipment Bridge (Equipment Pads with or without Culverts)
BR-2	Temporary Equipment Bridge (Crushed Stone with Culverts)
BR-3	Temporary Equipment Bridge (Flexi-float or Portable Bridge)
WATERBODY & WETLAND CROSSINGS (WC)	
WC-1	Typical Standard Wetland Crossing
WC-2	Typical Wet Waterbody Crossing
WC-3	Typical Flume Waterbody Crossing
WC-4	Typical Dam-and-Pump Waterbody Crossing
WC-5	Typical Erosion Control Blankets on Streambanks
WC-6	Typical Rip-Rap Placement
SPECIAL USE / AGRICULTURAL & RESIDENTIAL AREAS (SU)	
SU-1	Drain Tile Repair Procedure

DEFINITIONS

7(c) – Activities authorized under a project-specific Certificate of Public Convenience and Necessity from the Federal Energy Regulatory Commission (FERC), pursuant to Section 7(c) of the Natural Gas Act, to transport or sell natural gas, as well as construct, acquire, extend, alter or operate specific natural gas facilities that provide natural gas service.

Abandonment – Permanent reduction in the availability for service of a FERC jurisdictional facility, including facility modifications which would result in changes to certificated parameters (e.g., permanently operating compressors at lower than certificated horsepower or pipelines at lower than certificated design pressures) as well as changes in operating status (e.g., abandoned-in-place, idled and not maintained, decommissioned or removed facilities). Abandonment of pipe or facilities may be authorized under the blanket certificate or a project-specific Order of Abandonment by FERC, in accordance with Section 7(b) of the Natural Gas Act.

Agricultural Land – Actively cultivated and rotated land used for the production of crops including but not limited to corn, grains, orchards, vineyards and hayfields.

Blanket Certificate Project – Blanket certificate authorization is obtained from FERC by the Company and allows the Company to construct, modify, acquire, operate, and abandon a limited set of natural gas facilities, and offer a set of services without the need for further activity-specific certificate authorizations. Regulations for FERC's Blanket Certificate program are provided under Title 18 CFR Part 157, Subpart F. Examples of these projects include, but is not limited to, pipe replacements requiring new permanent right-of-way (ROW) or temporary workspace outside of the original construction footprint, miscellaneous pipe rearrangements, new receipt and delivery points, abandonments, temporary compression facilities, underground storage field remediation and maintenance activities, and underground storage testing and development activities.

Chief Inspector – Person, designated by the Company, responsible for the quality assurance of construction activities on a project by managing on-site project inspection staff and ensuring the construction contractor meets the requirements of the Company's construction specifications, permits, and any plans and drawings related to specific construction activities. All inspectors on the project report to the Chief Inspector and the Chief Inspector reports to the Company's Construction Superintendent.

Project Clearance Package – The project clearance package is issued through the Encompass Pacman module. It contains all the necessary permits, clearances, plans and other requirements specific to a project.

Deviation – A change to the placement of work limits, structures specified in the construction drawings, or changes in the design of control measures as set forth in the E&SCP, with the exception of minor variations from specifications in the typical E&SCP figures (refer to Appendix A) that are required due to site-specific conditions and which are designed to achieve an equivalent or greater degree of environmental protection.

Environmental Inspector (EI) – On-site Company representative responsible for inspecting and verifying site compliance with environmental conditions identified in the E&SCP as well as project-specific terms and conditions contained within the Project Clearance Package. The environmental inspector will perform the duties that are outlined in Section 2.1 of this plan.

Ephemeral stream – Waterbody which flows water only during precipitation events in a typical year and for a short duration after the events. Runoff from rainfall is the primary source of water for stream flow. Ephemeral stream beds are located above the water table year-round. Groundwater is not a source of water for the stream.

Intermediate waterbody – Defined by FERC as a waterbody greater than 10 feet wide but less than or equal to 100 feet wide, measured from water's edge to water's edge at the time of construction.

Intermittent stream – Waterbody which flows during certain times of the year when groundwater provides water for stream flow. During dry periods, intermittent streams may not have flowing water. Runoff from rainfall is a supplemental source of water for stream flow.

Line List – A list prepared by the Company of project-specific instructions for all properties affected by the project, specifying each property owner, the length of crossing, and any special instructions or restrictions for construction crew(s).

Major waterbody – Defined by FERC as a waterbody greater than 100 feet wide, measured at the water's edge at the time of construction.

Minor waterbody – Defined by FERC as a waterbody less than or equal to 10 feet wide, measured at the water's edge at the time of construction.

Pasture – Non-forested land used for grazing of domesticated livestock (horses, cattle, sheep, etc.). Pasture receives periodic renovation and treatments such as tillage, fertilization, mowing, weed control, and may be irrigated. Typical vegetation consists primarily of grasses, herbaceous plants, legumes, and forbs.

Perennial stream – Waterbody which flows water year-round during a typical year. The water table is located above the stream bed for most of the year. Groundwater is the primary source of water for stream flow and runoff from rainfall is a supplemental source of water for stream flow.

Riparian area – Ecosystems that occupy the transitional zone between terrestrial and aquatic ecosystems. Typical examples of riparian areas include floodplains, streambanks, and lakeshores.

Spill Prevention, Control and Countermeasure Plan /
Preparedness, Prevention and Contingency Plan for Construction Projects (SPCC / PPC Plan) – Company document that contains measures to prevent or reduce the risk of spills or accidental exposure of oil or hazardous materials associated with construction activities, as well as procedures to be employed in the event of a spill, including measures that provide for prompt and effective cleanup of spills, notifications and proper disposal of waste generated during cleanup.

State-designated waterbody – Waterbodies specifically identified or recognized by the States or authorized Indian Tribe for water use, value or quality. Designations take into consideration the protection and propagation fish, shellfish and wildlife, as well as use and value for public water supplies, agricultural, industrial, recreational and other purposes, such as navigation. FERC's Procedures contain specific requirements with regards to state-designated fisheries.

Sensitive resource area – Areas (defined by FERC) that include wetlands, waterbodies, cultural resource sites, or sensitive species habitats.

Take up-and-Relay Pipeline Construction – Also called “lift and relay”, Company construction terminology for the removal of existing pipe and installation of new pipe at the same alignment within the existing permanent easement.

Wetland – Areas that are inundated or saturated by surface or groundwater at a frequency or duration sufficient to support and, under normal circumstances, do support a prevalence of vegetation typically adapted for life in saturated soil conditions. Types of wetlands include swamps, marshes, bogs, sloughs, wet meadows, mudflats and natural ponds.

Waterbody – Any natural or artificial stream, river, or drainage with perceptible flow at the time of crossing during construction, as well as other permanent waterbodies such as ponds and lakes.

1. INTRODUCTION

1.1 PURPOSE OF THIS PLAN

This Erosion and Sedimentation Control Plan (E&SCP) has been prepared for use by the Company and its contractors as a guidance manual for minimizing erosion of disturbed soils and transportation of sediments off the construction ROW and into sensitive resource and residential areas during natural gas construction projects. The procedures developed in this plan, which represent the Company's best management practices, are designed to accommodate varying field conditions while achieving compliance with regulatory requirements and protecting environmentally sensitive areas.

This E&SCP is designed to provide guidelines, best management practices and typical techniques for the installation and implementation of soil erosion and sediment control measures while permitting adequate flexibility to use the most appropriate best management practice measures based on site-specific conditions. The intent of the E&SCP is to provide general information on the pipeline construction process and sequence, and to describe specific measures that will be employed during and following construction to minimize impacts to the environment.

Figures provided in Appendix A of this plan illustrate typical and minimum requirements of best management practices for design and utilization of construction workspace areas, access roads and erosion controls, as well as construction methods for special use areas (e.g., agricultural and residential land) and crossing of features during pipeline construction, including wetlands, waterbodies and roads. References to specific figure numbers provided in Appendix A are indicated throughout the E&SCP.

The goal of the E&SCP is to preserve the integrity of environmentally sensitive areas and to maintain existing water quality by:

- Minimizing the extent and duration of disturbance;
- Diverting runoff to stabilized areas;
- Installing temporary and permanent erosion control measures; and
- Establishing an effective inspection and maintenance program.

The E&SCP is intended to be used on Company projects that have been authorized by Federal Energy Regulatory Commission (FERC) pursuant to Section 7(b) and/or 7(c) of the Natural Gas Act to construct, acquire, alter, abandon or operate gas facilities or to provide gas services. This plan is also intended to be used for projects that are conducted under Company's blanket certificate which are regulated under 18 CFR Part 157, Subpart F. All blanket certificate projects that involve ground disturbance or changes to operational air and noise emissions are subject to the FERC's standard environmental conditions, including adherence to FERC's *Upland Erosion Control, Revegetation and Maintenance Plan* (Plan) and *Wetland and Waterbody Construction and Mitigation Procedures* (Procedures), May 2013 Version.

1.2 GUIDELINES AND REQUIREMENTS

The measures described in this E&SCP have been developed based on guidelines from the FERC, United States Army Corps of Engineers (COE), the United States Fish and Wildlife Service, the United States Department of Agriculture, the Natural Resource Conservation Service, and various state agencies as well as from the Company's significant experience and practical knowledge of pipeline construction and effective environmental protection measures. Lessons and insights gained during pipeline construction projects and comments from agency representatives are also incorporated into this E&SCP.

In accordance with FERC regulations, projects under the jurisdiction of Section 7 or the Company's blanket certificate are required to comply with the FERC's Plan and Procedures unless written approval to deviate from the Plan or Procedures is received from the Director of the Office of Energy Projects and the appropriate state agency. This revised version of the E&SCP is consistent with the requirements of FERC's Plan and Procedures (May 2013 version).

If conflicts or differences occur between project-specific conditions of appropriate federal and state agencies and the best management practices described in this E&SCP, consult with the Project Environment Lead (PEL). The more stringent or site-specific requirement is typically applicable unless otherwise approved by PEL. With the exception of minor variations from the typical figures that may be required due to site-specific conditions and are designed to achieve an equivalent or greater degree of environmental protection, any deviations from the construction drawings or changes in the design of control measures as set forth in this E&SCP must be approved by the Company's PEL Lead and the appropriate permitting agency prior to implementation. Measures and practices identified within this plan are to be implemented during construction unless otherwise specified by project-specific permit conditions.

1.3 SURVEYS, PERMITS & NOTIFICATIONS

The Company shall perform the required environmental field surveys and acquire the necessary environmental permits, clearances and authorizations prior to start of construction of the project. The Company shall notify the appropriate federal, state, and local agencies prior to, during, and/or subsequent to the construction of the project, as identified in the Project Clearance Package.

1.4 INQUIRIES

Reach out to the PEL for any inquiries regarding this E&SCP. For field conditions requiring an immediate response, contact the on-site construction lead, Environmental Inspector or PEL.

2. SUPERVISION AND INSPECTION

To effectively mitigate project-related impacts, the E&SCP must be properly implemented in the field. Quick and appropriate decisions in the field regarding critical issues such as stream and wetland crossings, placement of erosion controls, trench dewatering, spoil containment, and other construction-related items are essential.

To ensure that the E&SCP is properly implemented, Environmental Inspector(s) (EI) will be assigned by the Company for active construction or restoration activities. Enbridge will typically employ an Environmental Inspector for large work activities which could affect environmental resources, such as wetlands and waterbodies. For small work activities with no resource impacts (i.e., integrity dig with no waterbody crossings, etc.) the Construction Site Inspector may take on the Environmental Inspector role. They are a resource to provide environmental compliance assurance, assist with planning and execution, respond to workers who may have questions and perform the duties that are outlined in Section 2.1 below.

2.1 ROLE & RESPONSIBILITIES OF THE ENVIRONMENTAL INSPECTOR

Designated EIs, in addition to the on-site construction lead, have the authority to stop any activities that could violate the environmental conditions of the FERC's Orders (if applicable), stipulations of other environmental permits or approvals, or landowner easement agreements, as well as order appropriate corrective action.

The EI will have peer status with all other activity inspectors and will report directly to the Chief Inspector who has overall authority on the construction spread or project.

The number and experience of EIs assigned to each construction spread shall be appropriate for the length of the construction spread and the number/significance of resources affected. On 7(c) and other large construction projects, the person designated as the EI will typically be a dedicated role for each construction spread. On blanket certificate projects and any other small construction activities carried out under this E&SCP, the EI role may be carried out by the Chief Inspector or another designated and properly trained Company Inspector on site, at the discretion of the Company. In such instances, the Company may employ additional periodic oversight of the EI by an environmental specialist.

At a minimum, the EI shall be responsible for:

1. Inspecting construction activities for compliance with the requirements of this E&SCP, the construction drawings, the environmental conditions of the FERC's Orders (if applicable), proposed mitigation measures, other federal or state and local (if applicable) environmental permits and approvals, and environmental requirements in landowner easement agreements;

2. Identifying, documenting, and overseeing corrective actions, as necessary to bring an activity back into compliance;

3. Verifying that the limits of authorized construction work areas and locations of access roads are visibly marked before clearing, and maintained throughout construction;

4. Verifying the location of signs and/or highly visible flagging marking the boundaries of sensitive resource areas, including waterbodies and wetlands, or areas with special requirements along the construction work area;

5. Identifying erosion/sediment control and soil stabilization needs in all areas;

6. Ensuring that the design of slope breakers will not cause erosion or direct water into sensitive resource areas, including cultural resource sites, wetlands, waterbodies and sensitive species habitats;

7. Verifying that dewatering activities are properly monitored and do not result in the deposition of sand, silt, and/or sediment into sensitive resource areas, including wetlands, waterbodies, cultural resource sites, and sensitive species habitat; stopping dewatering activities if such deposition is occurring and ensuring the design of the discharge is changed to prevent reoccurrence; and verifying that dewatering structures are removed after completion of dewatering activities;

8. Ensuring that subsoil and topsoil are tested in agricultural and residential areas to measure compaction and determine the need for corrective action;

9. Advising the Chief Inspector when environmental conditions (such as wet weather, severe storm events or frozen soils) make it advisable to restrict or delay construction activities to avoid topsoil mixing excessive compaction;

10. Ensuring restoration of contours and topsoil;

11. Verifying that the soils imported for agricultural or residential use have been certified as free of noxious weeds and soil pests, unless otherwise approved by the landowner, and is considered clean and free of hazardous materials;

12. Ensuring that the appropriate erosion/sediment control and stabilization needs are implemented in all areas, including ensuring that erosion and sediment controls are properly installed and maintained daily to prevent sediment flow into sensitive resource areas (e.g., wetlands, waterbodies, cultural resource sites, and sensitive species habitats) and onto roads, and determining the need for additional erosion control devices;

13. Inspecting and ensuring the maintenance of temporary erosion and sediment control measures at least:
    a. On a daily basis in areas of active construction or equipment operation;
    b. On a weekly basis in areas with no construction or equipment operation; and
    c. Within 24 hours of each 0.5 inch of rainfall.

14. Ensuring the repair of all ineffective temporary erosion and sediment control measures within 24 hours of identification, or as soon as conditions allow if compliance with this time frame would result in greater environmental impacts;

15. Identifying areas that should be given special attention to ensure stabilization and restoration after the construction phase;

16. Ensuring proper seed mixes, rates and restoration methods are used, and obtaining documentation;

17. Ensuring that the Contractor implements and complies with the Company's *Spill Prevention, Control and Countermeasure Plan & Preparedness, Prevention and Contingency Plan for Construction Projects* (SPCC/PPC Plan), the Company's *Waste Management Plan*, and other Company environmental documents and standard operating procedures;

18. Verifying that locations for any disposal of excess construction materials for beneficial reuse comply with this E&SCP and any applicable permits / clearances; and,

19. Keeping records of compliance with the environmental conditions of the FERC's Orders and the mitigation measures proposed by the Company in the application submitted to the FERC (if applicable), and other federal or state environmental permits during active construction and restoration. Records should include photo documentation.

2.2 ENVIRONMENTAL TRAINING FOR CONSTRUCTION

Environmental training will be given to both the Company personnel and contractor personnel whose activities have the potential to impact the environment during construction. All construction personnel from the Chief Inspector, EI, craft inspectors, contractor job superintendent to loggers, welders, equipment operators, and laborers will be given some form of environmental training. The level of training will be commensurate with the type of duties of the personnel. At the discretion of the Company, environmental training for personnel may also be required on projects where it is not required by FERC.

Training will be given prior to the start of construction and throughout the construction process, as needed, and will cover the following issues:

- Specifics of this E&SCP and other Company plans;
- Job or activity specific permit requirements;
- Company policies and commitments;
- Cultural resource procedures and restrictions;
- Threatened and endangered species procedures and restrictions; and
- Any other pertinent information related to the job.

In addition to the EI, all other construction personnel are expected to play an important role in maintaining strict compliance with all permit conditions, and to promptly report any conditions that are perceived as having the potential to threaten environmental protection to the appropriate inspector during construction.

3. CONSTRUCTION TECHNIQUES FOR NATURAL GAS FACILTIES

3.1 TYPICAL ROW REQUIREMENTS

Pipeline construction workspace requirements are a function of pipe diameter, equipment size, topography, geological rock formations, location of construction such as at road crossings or river crossings, pipeline crossovers, methods of construction such as boring or open-cut construction, or existing soil conditions encountered during construction. As the diameter of the pipeline being installed increases, so does the depth of trench, excavated spoil material, equipment size, and ultimately the amount of construction work space that will be required to construct a project. See Figure CW-1 for a detail of a typical trench and Figures CW-3, CW-4 and CW-5 for typical construction ROW widths. All workspace locations for a given project will be shown on the construction drawings.

Additional construction ROW may be required at specific locations including, but not limited to, steep side or vertical slopes, road crossings, pipeline crossovers, areas requiring supplemental topsoil segregation, and staging areas associated with wetland and waterbody crossings. In particular, as shown on the construction drawings, the construction ROW width may be expanded up to 25 feet for the following situations / areas without approval from the FERC, however, prior approval is required from the EI or PEL:

- Accommodate full construction ROW topsoil segregation;
- Ensure safe construction where topographic conditions, such as side-slopes, or soil limitations exist; and
- Facilitate truck turn-arounds where no reasonable alternative access exists in limited, upland, non-riparian or non-forested areas.

All construction activities, including staging areas and additional spoil storage areas, are restricted to the construction ROW limits identified on the construction drawings, except for specific activities in limited, non-wetland and non-riparian areas that are allowed by the FERC Plan and Procedures (i.e. slope breakers, energy-dissipating devices, dewatering structures, and drain tile system repairs). Use of these limited areas is subject to landowner or land management agency approval and compliance with all applicable survey, permit, and reporting requirements; therefore, prior Company approval is required to use these areas. In some cases, federal, state and local permits and authorizations may require additional approvals.

Minor field realignments and workspace shifts per landowner needs and requirements are only allowed if construction activities remain within the environmental field survey area, comply with project-specific environmental permits and landowner easements, and do not affect new landowners or sensitive resource areas.

3.2 ACCESS ROADS & ACCESS POINTS

To the extent practical, all access to the construction ROW will be limited to existing roads and will be minimized in wetlands. However, additional access roads to the construction ROW may be required at various points along the project where other road crossings (paved or gravel state/local roads) do not exist. Examples of types of access used include pipeline ROWs, abandoned town roads, railroad ROWs, power line service

roads, logging roads and farm roads. Improvements to access roads (i.e., grading, placing gravel, replacing/installing culverts, and trimming overhanging vegetation) may be required due to the size and nature of the equipment that would utilize the road (Figure RD-1). The following conditions apply to the use of all access roads:

1. During construction and restoration activities, access to the ROW is limited to the use of new or existing access roads identified in the Project Clerance Package.

2. The only access roads that can be used in wetlands, other than the construction ROW, are those existing roads requiring no modification or improvements, other than routine repair, and posing no impact on the wetland.

3. The construction ROW may be used for access across wetlands when the wetland soil is firm enough to avoid rutting or the construction ROW has been appropriately stabilized to avoid rutting (e.g., with timber riprap, prefabricated equipment mats, or terra mats). However, access is not allowed through wetlands that are specifically being avoided by HDD or would not otherwise be impacted by the project.

4. In wetlands that cannot be appropriately stabilized, all construction equipment other than that needed to install the wetland crossing shall use access roads located in upland areas. Where access roads in upland areas do not provide reasonable access, limit all other construction equipment to one pass through the wetland using the construction ROW.

5. Blanket certificate projects may not have construction drawings available in which case access to the ROW will be identified in the Project Clearance Package.

6. Maintain safe and accessible conditions at all road crossings and access points during construction and restoration. Access road maintenance through the construction sequence may include grading and the addition of gravel or stone when necessary.

7. Maintain access roads in a stable manner to prevent off-ROW impacts, including impacts to adjacent and/or nearby sensitive resource areas, and implement all appropriate erosion and sediment control measures for construction/improvement of access roads.

8. Minimize the use of tracked equipment on public roadways.

9. Remove any soil or gravel spilled or tracked onto roadways daily or more frequent as necessary to maintain safe road conditions.

10. Repair any damages to roadway surfaces, shoulders, and bar ditches.

11. If crushed stone/rock access pads are used in residential or agricultural areas, stone shall be placed on synthetic, nonwoven geotextile fabric to facilitate removal after construction (Figure RD-2).

12. All access roads across a waterbody must use an equipment bridge in accordance with Section 5.1.2.

13. For access through a saturated wetland, use timber mats or an equivalent, unless otherwise authorized by agency permits (Figure RD-3).

14. Limit construction equipment operating in wetland areas to that needed to clear the ROW, dig the trench, fabricate and install the pipeline, backfill the trench, and restore the construction ROW. All other construction equipment shall use access roads located in upland areas to the maximum extent practical.

3.3 PIPE AND CONTRACTOR WAREYARDS

Pipe and contractor wareyards are required for storing and staging equipment, pipe, fuel, oil, pipe fabrication, and other construction-related materials and preparations. The Contractor shall perform the following measures at pipe and contractor wareyards:

1. Strip and segregate topsoil in agricultural lands;
2. Install erosion and sediment control structures as directed by the EI or identified in the Project Clearance Package construction drawings, and as outlined in this E&SCP and the SPCC/PPC Plan. Maintain controls throughout construction and restoration activities;
3. Implement and comply with the SPCC/PPC Plan and the Waste Management Plan, including the completion of any required site-specific forms and attachments; and,
4. Restore and revegetate all disturbed areas in accordance with the measures outlined in this E&SCP, landowner agreements and/or as directed by the EI. At a minimum, the area must be returned to preconstruction contours and stabilized prior to contractor demobilization.

3.4 OFF-ROW DISTURBANCE

All construction activities are restricted to the construction ROW limits identified in the Project Clearance Package construction drawings, except for specific activities in limited, non-wetland and non-riparian areas that are allowed by the FERC Plan and Procedures. Activities allowed to occur off-ROW are limited to the installation of slope breakers, energy- dissipating devices and dewatering structures, as well as repairs to drain tile. Minor field realignment and workspace shifts per landowner needs and requirements are only allowed if construction activities remain within the environmental field survey area, maintain compliance with project-specific environmental permits and landowner easements, do not affect new landowners or environmental resources, and do not require the operation of heavy equipment off ROW. In the event that inadvertent off-ROW disturbance occurs, the following measures will be implemented:

1. The EI will immediately report the occurrence to the Chief Inspector and ROW Agent;

2. The conditions that caused the disturbance will be evaluated by the Chief Inspector and the EI, and they will determine whether work at the location can proceed under those conditions; and

3. If determined to be necessary by the Chief Inspector and EI, one or more of the following corrective actions will be taken: immediate restoration of the preconstruction contours, seeding and mulching of the disturbed area, and/or installation of erosion or sediment control devices, conduct additional tailgate or employee/contractor training, and investigation of the issue to develop lessons learned for

future issue prevention.

4. The Company's Project Environment Lead will be notified.

3.5 CONSTRUCTION SEQUENCE FOR PIPELINE INSTALLATION

Natural gas pipelines are installed using conventional overland buried pipeline construction techniques. These activities are necessary for the installation of a stable, safe, and reliable transmission facility consistent with U.S. Department of Transportation (U.S.DOT) requirements and regulations. This section provides an overview of the equipment and operations necessary for the installation of a natural gas pipeline, describes potential impacts that may occur from each operation, and identifies the measures that will be implemented to control these potential impacts. This section also discusses in detail the erosion and sediment control techniques that typically apply to each construction activity including clearing, grading, trenching, lowering-in of pipe, backfilling, and hydrostatic testing. Pipe abandonment in-place or removal, which may be associated with a pipeline replacement activity or occur as an independent activity on an existing pipeline, are also covered at the end of this section. ROW restoration is the final step in the typical construction sequence and will be addressed in Section 3.6.

Installation of the pipeline typically proceeds in a linear manner from one end of the construction spread to the other in an assembly line or "mainline" fashion. However, different stages may be running in parallel on different physical segments of the project. In some cases, this means that full completion of one of the construction sequence stages described below may not occur before the next construction sequence stage is initiated. Construction sequencing should be planned to limit the amount and duration of open trench sections, as necessary, to prevent excessive erosion or sediment flow into sensitive environmental resource areas. This is due to the Company's effort to adhere to strict construction schedules in order to minimize safety concerns, landowner effects, and environmental disturbance. The spacing between the individual crews responsible for each interdependent activity is based on anticipated rate of linear progress. The activities listed below are typically performed in the following sequence:

- Surveying and flagging the ROW;
- Clearing the ROW;
- Installing temporary sediment barriers;
- Grading the ROW;
- Installing temporary slope breakers;
- Trenching/excavating the trench;
- Pipe stringing and bending;
- Welding and weld inspection;
- Lowering the pipe into the trench;
- Backfilling the trench;
- Hydrostatic testing of pipe; and
- ROW restoration and clean-up.

Obstacles to the mainline technique are often encountered and are not considered to be out of the ordinary. These obstacles, which include side hill crossings, rock, wetlands, streams, roads and residential areas, do not normally interrupt the assembly line flow.

3.5.1 Clearing & Flagging

Clearing operations include the removal of vegetation within the construction ROW. Various clearing methods are employed depending on tree size, contour of the land, and the ability of the ground to support clearing equipment. Vegetative clearing can be accomplished either by hand or by cutting equipment. The following procedures will be standard practice during clearing:

1. Prior to beginning the removal of vegetation,
    a. The limits of clearing will be established and visibly marked before clearing;
    b. Signs and/or highly visible flagging will also be used to mark the boundaries of sensitive resource areas, including waterbodies and wetlands, and/or areas with special requirements along the construction work area, in accordance with the construction drawings;
    c. Flagging or marking shall be maintained throughout construction;
    d. Trees to be protected per landowner requests or as otherwise directed will be clearly marked;

2. All construction activities and ground disturbance will be confined to within the construction ROW shown in the Project Clearance Package construction drawings (with the limited exception of compliance activities described above in Section 3.4);

3. All brush and trees will be felled into the construction ROW to minimize damage to trees and structures adjacent to the ROW. Trees that inadvertently fall beyond the edge of the ROW will be immediately moved onto the ROW and disturbed areas will be immediately stabilized, per landowner approval;

4. Trees will be chipped and removed or cut into lengths identified by the landowner and then stacked at the edge of the ROW or removed. Trees may be burned depending on local and state restrictions, applicable permits, construction Line List stipulations, and landowner agreements;

5. Brush and limbs may be disposed of in one or more of the following ways depending on local restrictions, applicable permits, construction Line List stipulations, and landowner agreements:
    a. Stockpiled along the edge of the ROW;
    b. Burned;
    c. Chipped, spread across the ROW in upland areas, and plowed in at the discretion of the Chief Inspector or EI (excess material must be removed);
    d. Used as part of erosion control mix material; or
    e. Hauled off site to a Company-approved location.

6. Existing surface drainage patterns shall not be altered by the placement of timber or brush piles at the edge of the construction ROW.

3.5.2 Temporary Sediment Barriers

Sediment barriers, which are temporary sediment controls intended to minimize the flow and deposition of sediment beyond approved workspaces or into sensitive resource areas, shall be installed following vegetative clearing operations. They may be constructed of materials such as silt fence, staked straw bales, compacted earth (e.g., drivable berms across travel lanes), sand bags, or other appropriate materials (Figures EC-1, EC-2, EC-3 and EC-5). Where allowed by regulatory agencies, hay bales may be used in lieu of straw bales with the following restrictions**:** hay bales shall not be used for mulching and the Contractor is responsible for their removal and disposal.

1. Install temporary sediment barriers at the base of slopes greater than 5% where the base of the slope is less than 50 feet from a road crossing, waterbody and/or wetland in accordance with Sections 5.1.4 and 6.3 respectively.
2. Do not stake or trench in place straw bales used on equipment bridges or on mats across the travel lane.
3. Inspect temporary sediment barriers daily in areas of active construction to ensure proper functioning and maintenance. In other areas with no construction or equipment operation, sediment barriers will be inspected and maintained on a weekly basis throughout construction, and within 24 hours of each 0.5 inch of rainfall. Conduct an inspection within 24 hours once a storm event has produced 0.5 inch of rainfall, even if the storm event is still continuing.
4. Maintain all temporary sediment barriers in place until permanent revegetation measures are successful or the upland areas adjacent to wetlands, waterbodies, or roads are stabilized.
5. Remove temporary sediment barriers from an area when replaced by permanent erosion or sediment control measures or when the area has been successfully restored as specified in Section 8.1.

3.5.3 Grading

The construction ROW will be graded as needed to provide a level workspace for safe operation of heavy equipment used in pipeline construction. The following procedures will be standard practice during grading:

3.5.3.1 Topsoil Segregation

During construction, topsoil and subsoil will be disturbed by grading of the right-of-way, trench excavation, and by heavy equipment moving along the right-of-way. Implementation of proper topsoil segregation is intended to mitigate these construction impacts and promote or facilitate post-construction revegetation success.

Topsoil segregation methods will be used in all residential areas (except where the topsoil is being replaced), wetlands (except areas where standing water is present or soils are saturated), cultivated or rotated croplands, managed pastures, hayfields, and other areas at the landowner's or land managing agency's request. Either the "ditch plus spoil side" or the "full right-of-way" segregation method will be used, as illustrated in Figure CW-2.

a. Prevent the mixing of topsoil with subsoil by stripping topsoil from either the full work area or from the trench and subsoil storage area ("ditch plus spoil side" method) as stipulated in the Construction Contract or Line List.

b. Segregate at least 12 inches of topsoil in deep soils with more than 12 inches of topsoil. In soils with less than 12 inches of topsoil, make every effort to segregate the entire topsoil layer.

c. Within wetlands, segregate the top 12 inches of topsoil within the trenchline, except in areas where standing water is present or soils are saturated.

d. In residential areas, importation of topsoil (i.e. topsoil replacement) is an acceptable alternative to topsoil segregation, if approved by the landowner and Chief Inspector.

e. Maintain separation of salvaged topsoil and subsoil throughout all construction activities.

f. Leave gaps in the topsoil piles and spoil piles for the installation of temporary slope breakers to allow water to be diverted off the construction ROW.

g. Never use topsoil for padding the pipe, constructing temporary slope breakers, trench breakers or trench plugs, improving or maintaining roads, or as a fill material.

h. Stabilize topsoil piles and minimize loss due to wind and water erosion with use of sediment barriers, mulch, temporary seeding, tackifiers, or functional equivalents, where necessary and per the FERC Plan and Procedures or permit conditions.

3.5.3.2 Tree Stump Removal and Disposal

a. Remove tree stumps in upland areas along the entire width of the permanent ROW to allow adequate clearance for the safe operation of vehicles and equipment. Stumps within the temporary ROW will be removed or ground below the surface in accordance with Company construction specifications to allow the safe passage of equipment, as determined by the Chief Inspector or EI.

b. In wetlands, limit pulling of tree stumps and grading activities to directly over the trenchline.

c. Dispose of stumps by one of the following methods with the approval of the Chief Inspector and the landowner and in accordance with regulatory requirements:

- Buried at a Company-approved off-site location (except in wetlands and agricultural areas);
- Burned on construction ROW;
- Chipped, spread across the construction ROW in upland areas, and plowed in;
- Used as erosion control mix material;
- Ground to grade in wetlands, excess chips will be removed for proper disposal; or

- Hauled off-site.

d. Grading operations and tree stump removal in wetland areas will be conducted in accordance with Section 6.2.

3.5.3.3 Rock Management

Rock, including blast rock, will be used, removed or disposed of in one of the following ways:

a. Rock excavated from the trench may be used to backfill the trench only to the top of the existing bedrock profile. (Rock that is not returned to the trench shall be considered construction material or waste, unless approved for use as mulch or for some other use on the construction work areas by the land owner or land managing agency.);

b. Windrowed per written landowner agreement with the Company;

c. Removed and disposed of at a Company-approved landfill; or

d. Used as riprap for streambank stabilization as allowed by applicable regulatory agency(ies) and provided the rock is uncontaminated and free of soil and other debris (Figure WC-6).

3.5.4 Temporary Slope Breakers

Temporary slope breakers, also called interceptor dikes, are temporary erosion control measures intended to reduce runoff velocity and divert water off the construction ROW. Temporary slope breakers may be constructed of materials such as compacted soil, silt fence, staked straw bales, or sand bags. Segregated topsoil may not be used for constructing temporary slope breakers. If permitted by regulatory agency(ies), hay bales may be used in lieu of straw bales except for mulching. If hay bales are used, the Contractor is responsible for their removal and Company-approved disposal.

1. Install temporary slope breakers on all disturbed areas as necessary following grading operations (Figure EC-7) to avoid excessive erosion. Unless otherwise specified by permit conditions, temporary slope breakers must be installed on slopes greater than 5% at the recommended spacing interval indicated below (Closer spacing should be used if necessary):

Slope (%)	**Spacing (feet)**
< 5	No structure
5 – 15	300
> 15 – 30	200
> 30	100

2. Direct the outfall of each slope breaker to a stable, well vegetated area or construct an energy-dissipating device (silt fence, staked straw bales, erosion control fabric) at the end of the slope breaker.

3. Position the outfall of each temporary slope breaker to prevent sediment discharge into wetlands, waterbodies, or other sensitive resource areas.

4. Install temporary slope breakers across the entire construction ROW along slopes greater than 5 % where the base of the slope is less than 50 feet from waterbody, wetland, and road crossings.

5. Inspect temporary slope breakers daily in areas of active construction to insure proper functioning and maintenance. In other areas, the slope breakers will be inspected and maintained on a weekly basis throughout construction, and within 24 hours of each 0.5 inch of rainfall. Repairs should be made within 24 hours of identification, if possible.

Drivable berms, which are smaller versions of slope breakers constructed of compacted soil or sand bags, may be used in place of staked straw bales at the entrances and exits of travel lanes at road crossings, waterbodies, and wetlands. They are installed across the width of the travel lane at the start of the equipment crossing and made low enough to allow equipment and other vehicles to pass. Yet, they should function to reduce and divert water runoff from sensitive resource areas.

3.5.5 Trenching

The trench centerline will be staked after the construction ROW has been prepared. In general, a trench will be excavated to a depth that will permit burial of the pipe with a minimum of 3 feet of cover (Figure CW-1). Overland trenching may be accomplished using a conventional backhoe or a rotary wheel-ditching machine. In shale or rocky areas where the use of the conventional excavation equipment is limited, a tractor-drawn ripper or rock hammer may be employed to break and loosen hard substratum material. In areas where rock cannot be ripped or hammered, drilling and blasting may be required. A backhoe may then be used to remove rock and soil from the ditch.

The following procedures will be standard practice during ditching:

- Flag drainage tiles damaged during ditching activities for repair;
- Place spoil in additional extra work areas or at least 10 feet away from the waterbody's edge in the construction ROW. Spoil will be contained with erosion and sediment control devices to prevent spoil materials or sediment-laden water from transferring into waterbodies and wetlands or off of the ROW; and,
- If temporary erosion or sediment controls are damaged or removed during trenching, they shall be repaired and/or replaced before the end of the work day.

3.5.5.1 Temporary Trench Plugs

Temporary trench plugs are barriers within the ditch that are intended to segment the continuous open trench prior to backfill. They typically consist of unexcavated portions of the ditch (hard plug), compacted subsoil or sandbags (soft plug) placed across the ditch, or some functional equivalent. Along steep slopes, they serve to reduce erosion and sedimentation in the trench and minimize dewatering problems at the base of slopes where sensitive environments such as waterbodies and wetlands are frequently located. In addition, they provide access across the trench for wildlife and livestock.

a. Do not use topsoil for constructing trench plugs.

b. Coordinate with the landowner to identify optimal locations for the placement of temporary hard plugs designed to provide access for livestock.

c. Temporary trench plugs may be used in conjunction with slope breakers to prevent water in the trench from overflowing into sensitive resource areas (Figure EC-6). Attempt to divert trench overflow to a well-vegetated off-ROW location or construct an energy-dissipating device.

d. Position temporary trench plugs, as necessary, to reduce trenchline erosion and minimize the volume and velocity of trench water flow at the base of slopes.

3.5.6 Trench & Site Dewatering

Dewatering may be periodically conducted to remove accumulated groundwater or precipitation from the construction ROW, including from within the trenchline. The need for erosion controls as well as the type of control used will vary depending on the type and amount of sediment within the water, and volume and rate of discharge.

1. Conduct dewatering (on or off the construction ROW) in such a manner that does not cause erosion and does not result in silt-laden water flowing into any waterbody or wetland.
2. Elevate and screen the intake of each hose used to withdraw the water from the trench to minimize pumping of deposited sediments.
3. Water may be discharged into areas where adequate vegetation is present adjacent to the construction ROW to function as a filter medium.
4. Where vegetation is absent or in the vicinity of waterbody / wetland areas, water will be pumped into a discharge structure that accommodates the anticipated discharge volumes as well as type and amount of sediment within the water being discharged, including
    a. a filter bag, as illustrated in Figure WD-1, or
    b. a structure composed of sediment barriers (Options for these types of controls are illustrated in Figure WD-2 and WD-3.).

    A structure that is more typically used for discharges of hydrostatic test water, as illustrated in Figure WD-2, may be necessary for large volumes of water.
5. When using filter bags, secure the discharge hose to the bag with a clamp.
6. Remove dewatering structures as soon as practicable after the completion of dewatering activities.

3.5.7 Pipe Installation

During all phases of the pipe installation process, ensure that all roadway crossings and access points are safe and accessible conditions. Repair damaged temporary erosion controls by the end of the work day. If portions of slope breakers are removed from the travel lane to facilitate safe work conditions, they shall be restored prior to the end of the work day.

3.5.7.1 Stringing and Bending

Following trench excavation, pipe sections will be delivered to the construction site by truck or tracked vehicle, and strung out along the trench. Individual pipe sections will be placed on temporary supports or wooden skids and staggered to allow room for work on the exposed ends. Certain pipe sections will be bent, as necessary, to conform to changes in slope and direction of the trench.

All rope bands should be collected and disposed of properly.

3.5.7.2 Welding

Once the bending operation is complete, the pipe sections will be welded together on supports using approved welding procedures that comply with Company welding specifications. After welding, the welds will be inspected radiographically or ultrasonically to ensure their structural integrity.

3.5.7.3 Lowering-in and Tie-ins

Lowering-in consists of placing the completed pipeline sections into the trench typically using two or more sideboom tractors acting in unison and spaced so as not to buckle or otherwise damage the pipe. The pipeline will be lifted from the supports, swung out over the trench, and lowered directly into the trench. The equipment uses a “leap frogging” technique requiring sufficient area to safely move around other tractors within the construction ROW to gain an advanced position on the pipe. The unwelded ends of the completed pipeline segments (typically present at road crossings, stream crossings, etc.) are then welded together or “tied-in” by specialized tie-in crews.

3.5.8 Backfilling

Backfilling consists of covering the pipe with the earth removed from the trench or with other fill material hauled to the site when the existing trench spoil is not adequate for backfill. Backfilling will follow lowering-in of the pipeline as close as is practical.

In areas where the trench bottom is irregularly shaped due to consolidated rock or where the excavated spoil materials are unacceptable for backfilling around the pipe, padding material may be required to prevent damage to the pipe. This padding material will generally consist of sand or screened spoil materials from trench excavation.

1. Under no circumstances shall topsoil be used as padding material.

2. Excess rock, including blast rock, may be used to backfill the trench only to the top of the existing bedrock profile in accordance with Company specifications. Rock that is not used to backfill the trench will be managed as described in Section 3.5.3.3.

3. Any excess material will be spread within the ROW in upland areas and land contours will be roughed-in to match adjacent topography.

4. The trench may be backfilled with a crown over the pipe to compensate for compaction and settling. Openings will be left in the completed trench crown to restore pre-construction drainage patterns. Crowning shall not be used in wetland areas.

3.5.8.1 Permanent Trench Breakers

Permanent trench breakers are intended to slow subsurface water flow and erosion along the trench and around the pipe in sloping terrain. An engineer or similarly qualified professional shall determine the need for and spacing of permanent trench breakers. However, trench breakers will not be installed within a wetland.

Permanent trench breakers will be constructed with sand bags, polyurethane foam, or an equivalent as identified in the permit requirements (Figure EC-10 and EC-11). Topsoil shall not be used to construct trench breakers. Sakrete may be used at the discretion of the Chief Inspector on severe slopes greater than 30 percent.

Permanent trench breakers, which are used in conjunction with slope breakers, shall be installed at the locations shown on the construction drawings, at the same spacing interval as and upslope of permanent slope breakers, or as otherwise determined by an engineer or similarly qualified professional, such as the EI (Figure EC-12). At a minimum, install trench breakers:

a. At the base of slopes greater than 5% where the base of the slope is less than 50 feet from a waterbody or wetland;

b. Where needed to avoid draining of a resource, including at wetland boundaries where the pipeline trench may drain a wetland, and/or seal the trench bottom as necessary to maintain the original wetland hydrology; and,

c. In agricultural fields and residential areas where slope breakers are not typically required, install trench breakers at the same spacing as if permanent slope breakers were required.

3.5.9 Hydrostatic Testing

Once the pipeline is completed and before it is placed into service, it will be hydrostatically tested for structural integrity. Hydrostatic testing involves filling the pipeline with clean water and maintaining a test pressure in excess of normal operating pressures for a specified period of time (typically 8 hours). The testing procedure involves filling the pipeline with water, performing the pressure test, and discharging the test water.

The following general hydrostatic testing procedures shall be adhered to for all projects. Environmental conditions for hydrostatic testing activities are also addressed in the project-specific Hydrostatic Test Clearance Package that is issued by the PEL if permits are required for water appropriation and/or discharge. During planning and permitting of test events:

1. Identify the location of all waterbodies proposed for use as a hydrostatic test water source or discharge location. Use only the water sources identified in the Project Clearance Package.

a. Do not use water from or discharge into state-designated exceptional value waters, waterbodies that provide habitat for federally listed threatened or endangered species, or waterbodies designated as public water supplies, unless appropriate federal, state, and/or local permitting agencies grant written permission.

2. Locate hydrostatic test manifolds outside wetlands and riparian areas to the maximum extent practicable.
3. Attempt to locate discharge sites in a well-vegetated and stabilized area, if practical, at least 50-feet from adjacent waterbody/wetland areas.
4. Apply for and obtain state-issued water withdrawal permits and National Pollutant Discharge Elimination System (NPDES) or state-issued discharge permits, as required.

During preparation for testing, including appropriation of source water and preparing discharge/outfall site:

1. At least 48 hours before testing activities, the EI shall notify appropriate state agencies (as identified in the relevant permit for hydrostatic test discharges) of the intent to use specific test water sources (unless waived in writing).
2. If pumps used for hydrostatic testing are within 100 feet of any waterbody or wetland, the use of secondary containment, operation and refueling of those pumps will be addressed and conducted in accordance with the SPCC/PPC Plan.
3. Screen the intake hose to minimize the potential for entrainment of fish and other aquatic life.
4. Maintain adequate flow rates to protect aquatic life, provide for all waterbody uses, and provide for downstream withdrawals of water by existing users.
5. Install all discharge structures in a well-vegetated and stabilized area, if practical, and attempt to maintain at least a 50-foot vegetated buffer from adjacent waterbody/wetland areas. If an adequate buffer is not available, sediment barriers or similar sediment control measure must be installed.

During the discharge of hydrostatic test water on-site:

1. Discharge water only at the locations shown on the construction drawings or locations identified in the Project Clearance Package or Environment's Hydrostatic Test Clearance Package.
2. Regulate rate of discharge water and use energy dissipation device(s) and sediment barriers, as necessary, to prevent erosion, streambed scour to aquatic resources, sedimentation, flooding or excessive stream flow (Figures WD-2 and WD-3).
3. Use absorbent booms as necessary during discharge from existing pipe or as stipulated by the applicable NPDES permit.
4. The test water may be discharged through an appropriate filtration system including holding tanks or frac tanks and/or carbon filters if needed to meet effluent limitations or conditions stipulated in the NPDES permit.

5. Do not discharge into state-designated exceptional value waters, waterbodies which provide habitat for federally listed threatened or endangered species, or waterbodies designated as public water supplies, unless appropriate federal, state, and local permitting agencies grant written permission.
6. The EI or appropriate designee shall sample and test the source water and discharge water in accordance with the permit requirements.

3.5.10 Pipeline Abandonment and Removal

Pipeline abandonment and removal activities may occur when gas service is no longer needed, such as the abandonment of a lateral to a customer receipt or delivery point. Removal or in-place abandonment of pipe can also be conducted as part of an expansion or maintenance project, such as the lift-and-relay of existing pipe, the replacement or relocation of an existing pipeline due to road or highway modifications, or activities required to maintain compliance with U.S.DOT requirements.

Abandonment approval from FERC, such as project-specific Section 7(b) Order or blanket certificate authorization, is required prior to abandoning facilities or services. Abandonment of FERC-regulated natural gas pipelines or storage facilities, either in place or by removal, must follow FERC's regulations.

Where removal of a section of existing pipeline is required, construction activities typically proceed in a construction sequence similar to what has been described above in Section 3.5, except that instead of the pipeline installation step, the existing pipeline would be cut and removed from the trench. If the pipeline removal is associated with a lift-and-relay project or a replacement, then the new pipeline installation would follow the removal of the old pipe. Pipe that is abandoned by removal will be handled, taken off-site and properly disposed of or recycled in accordance with Company procedures.

When a pipeline is abandoned in place, typically work involves only relatively small excavations to remove above-ground appurtenances and meters, as well as expose the pipe in certain locations, cut it, fill with grout or blanket gas and cap the ends of the pipe, in accordance with agency and Company requirements.

Mitigation measures for pipeline abandonment and removal activities, such as erosion control measures, will follow the same requirements outlined within the E&SCP for pipeline installation in order to minimize erosion and enhance revegetation, as well as mitigate the extent and duration of project-related disturbance to wetlands and waterbodies.

3.6 ROW RESTORATION & FINAL CLEANUP

Restoration of the ROW will begin after pipeline construction activities have been completed. Restoration measures include the re-establishment of final grades and drainage patterns as well as the installation of permanent erosion and sediment control devices to minimize post-construction erosion. Residential areas will be restored in accordance with Section 4.3.3. Property shall be restored as close to its preconstruction condition as practical unless otherwise specified by the landowner.

1. The Contractor shall make every reasonable effort to complete final cleanup of an area (including final grading, topsoil replacement and installation of permanent erosion control structures) within 20 days after backfilling the trench in that area (within 10 days in residential areas). If seasonal or other weather conditions prevent compliance with these timeframes, continue to inspect and maintain temporary erosion and sediment controls (i.e. temporary slope breakers, sediment barriers, and mulch) until conditions allow completion of cleanup. If construction or restoration unexpectedly continues into the winter season, follow the requirements of Frozen Conditions & Winter Construction, Section 3.6.4.

2. Seed all disturbed soils within 6 working days of final grading, weather and soil conditions permitting.

3. If construction or restoration unexpectedly cannot be completed and is delayed until the next recommended growing season, the winter stabilization measures shall be followed.

4. Grade the ROW to pre-construction contours, with the exception of the installation of any permanent measures required herein.

5. Spread segregated topsoil back across the graded ROW to its original profile.

6. Remove excess rock from at least the top 12 inches of soil in all cultivated or rotated cropland, managed pastures, hayfields, residential areas, as well as other areas at the landowner's request. The size, density, and distribution of rock on the construction ROW shall be similar to adjacent areas not disturbed by construction. The landowner or land managing agency may approve other provisions in writing.

7. A travel lane may be left open temporarily to allow access by construction traffic if the temporary erosion and sediment control structures are installed, regularly inspected and maintained. When access is no longer required, the travel lane must be removed and the ROW restored.

8. Remove all construction debris (used filter bags, skids, trash, etc.) from all construction work areas unless the landowner or land managing agency approves leaving material onsite for beneficial reuse, stabilization, or habitat restoration. Grade or till the ROW to leave the soil in the proper condition for planting.

3.6.1 Permanent Erosion Control

3.6.1.1 Permanent Slope Breakers

Permanent slope breakers are intended to reduce runoff velocity, divert water off the construction ROW, and prevent sediment deposition into sensitive resources. Permanent slope breakers will be constructed of compacted soil (Figure EC-8). Stone or some functional equivalent may be used when approved by the Company.

a. Construct and maintain permanent slope breakers in all areas, except cultivated areas and lawns, unless requested by the landowner, at the locations shown on the construction drawings.

b. Use spacing recommendations obtained from the local soil conservation authority or land managing agency. If not shown on the construction drawings or in the absence of written recommendations, use the following spacing (same as temporary slope breaker spacing) unless closer spacing is necessary to avoid excessive erosion on the construction ROW:

Slope (%)	Spacing (feet)
< 5	No structure
5 – 15	300
> 15 – 30	200
> 30	100

c. A permanent trench breaker will be located immediately upslope of the slope breaker.

d. Install permanent slope breakers across the construction ROW at the base of slopes adjacent to roads. When the ROW parallels an existing utility ROW, permanent slope breakers may be installed to match existing slope breakers on the adjacent undisturbed utility ROW.

e. Install permanent slope breakers across the construction ROW at the base of slopes greater than 5% that are less than 50 feet from a wetland or waterbody, or as needed to prevent sediment transport into a wetland or waterbody.

f. Construct slope breakers with a 2 to 8 percent outslope to divert surface flow to a stable vegetative area without causing water to pool or erode behind the slope breaker. In the absence of a stable vegetative area, install an energy-dissipating device at the end of the slope breaker.

g. Slope breakers may extend slightly (about 4 feet) beyond the edge of the construction ROW to effectively drain water off the disturbed area. Where slope breakers extend beyond the edge of the construction ROW, they are subject to compliance with all applicable survey and permit requirements.

h. Install chevron-style slope breakers on slopes as appropriate (Figure EC-9).

i. Where drainage is insufficient in upland areas, install a rock-lined drainage swale as approved by the EI. The drainage swale is generally 8 feet wide and a maximum of 18-24 inches deep (Figure EC-4).

3.6.1.2 Erosion Control Fabric / Blankets

Erosion control fabric or blankets are used during restoration, including as mulch, to slow down stormwater and stabilize soil until vegetation becomes established. Examples of these erosion controls include jute thatching or bonded fiber blankets. Do not use synthetic monofilament mesh/netted erosion control materials in areas designated as sensitive wildlife habitat, unless the product is specifically designed to minimize harm to wildlife.

Install erosion control fabric or blankets where necessary or as recommended by the EI

a. at slope breaker outlets and drainage swales (Figure EC-7, EC-8 and EC-4);

b. on slopes adjacent to roads or waterbodies (Figure EC-14); and

c. on waterbody banks at the time of final bank recontouring (Figure WC-5).

Anchor the erosion control fabric or blanket with staples or other appropriate devices in accordance with the manufacturers' recommendations (Figure EC-13). Evaluate flow conditions to determine if erosion control fabric is suitable as an effective vegetation stabilization technique on waterbody banks. High-velocity erosion control fabric should be used on the swale side of permanent slope breakers.

3.6.2 Revegetation and Seeding

Successful revegetation of soils disturbed by project-related activities is essential. Seeding will be conducted using the following requirements:

1. Fertilize and add soil pH modifiers in accordance with the recommendations in Appendix C. Incorporate recommended soil pH modifier and fertilizer into the top 2 inches of soil as soon as practicable after application;

2. Seed all disturbed areas within 6 working days of final grading, weather and soil conditions permitting;

3. Prepare seedbed in disturbed areas to a depth of 3 to 4 inches to provide a firm seedbed. When hydroseeding, scarify the seedbed to facilitate lodging and germination of seed;

4. Seed disturbed areas in accordance with the seed mixes, rates, and dates in Appendix C, except in upland areas where landowners or a land management agency may request alternative seed mixes, however, seeding is not required in cultivated croplands unless requested by the landowner;

5. Perform seeding of permanent vegetation within the recommended seeding dates as outlined in Appendix C. If seeding cannot be done within those dates, use appropriate temporary erosion control measures discussed in Section 3.5.2 and perform seeding of permanent vegetation at the beginning of the next recommended seeding season. Dormant seeding or temporary seeding of annual species may also be used, if necessary, to establish cover, as approved by the EI. Mulch in accordance with Section 3.6.3. Lawns may be seeded on a schedule established with the landowner;

6. Base seeding rates on Pure Live Seed (PLS);

7. Use seed within 12 months of seed testing;

8. Treat legume seed with an inoculant specific to the species using the manufacturer's recommended rate of inoculant appropriate for the seeding method (broadcast, drill, or hydroseeding); and,

9. Uniformly apply and cover seed in accordance with the appropriate seed mix from Appendix C, in the absence of any recommendations from the local soil conservation authorities, landowner, or land managing agency to the contrary.

    a. A seed drill equipped with a cultipacker is preferred for application but, where permitted by regulatory agencies, broadcast or hydroseeding can be used at double the recommended seeding rates.

    b. Where seed is broadcast, firm the seedbed with a cultipacker or roller after seeding.

    c. In rocky soils, or where site conditions may limit the effectiveness of this equipment, other alternatives may be appropriate (e.g., use of a chain drag) to lightly cover seed after application, as approved by the EI.

3.6.3 Mulch

Mulch is intended to stabilize the soil surface and shall consist of weed-free straw, wood fiber hydromulch, erosion control fabric or some functional equivalent as approved by the EI and Chief Inspector.

1. Mulch all disturbed upland areas (except cultivated cropland) **before** seeding if:

    a. Final cleanup, including final grading and installation of permanent erosion control measures, is not completed in an area within 20 days after the trench in that area is backfilled (10 days in residential areas); or

    b. Construction or restoration activity is interrupted for extended periods, such as when seeding cannot be completed due to seeding period restrictions.

    NOTE: When mulching before seeding, increase mulch application on all slopes within 100 feet of waterbodies and wetlands to a rate of 3 tons/acre of straw or equivalent.

2. Apply mulch on all slopes (except in cultivated cropland) concurrent with or immediately after seeding, where necessary, to stabilize the soil surface and to reduce wind and water erosion. Spread mulch uniformly over the ROW at a rate of 2 tons/acre of straw or equivalent.

3. Mulch with woodchips only under the following conditions with prior approval from the Chief Inspector or the EI:

    a. Do not use more than 1 ton/acre; and

    b. Add the equivalent of 11 lbs/acre available nitrogen (at least 50% of which is slow release).

4. Ensure that mulch is anchored to minimize loss by wind and water. Anchoring may be achieved by wet soil conditions, when approved by the EI, mechanical means, or use of liquid mulch binders.

5. When anchoring with liquid mulch binders, use rates recommended by the manufacturer. Do not use liquid mulch binders within 100 feet of wetlands and waterbodies, except where the product is certified environmentally non-toxic by the appropriate state or federal agency or independent standards-setting organization.

6. If used, install erosion control fabric or blankets in accordance with Section 3.6.1.2.

3.6.4 Frozen Conditions & Winter Construction

Winter weather may not provide suitable conditions for soil handling or restoration of disturbed areas. In the event that the construction occurs too late in the year for cleanup activities to adequately proceed or if construction is planned to occur during winter weather conditions, the Company will develop a project-specific Winter Construction Plan that addresses:

- Winter construction procedures (e.g., snow handling and removal, access road construction and maintenance, soil handling under saturated or frozen conditions, topsoil stripping);
- Stabilization and monitoring procedures if ground conditions will delay restoration until the following spring (e.g., mulching and erosion controls, inspection and reporting, stormwater control during spring thaw conditions); and,
- Final restoration procedures (e.g., subsidence and compaction repair, topsoil replacement, seeding).

The Winter Construction Plan will be provided within the Project Clearance Package. Section 7(c) and prior notice projects are required to file the Winter Construction Plan for the review and written approval by the FERC. (The requirement to file a plan does not apply to projects constructed under the automatic authorization provisions in the FERC's regulations.)

3.6.5 Unauthorized Vehicle Access to ROW

The Company will offer to install and maintain measures to control unauthorized vehicle access to the ROW based on requests by the manager or owner of forested lands. These measures may include:

- Signs;
- Fences with locking gates;
- Permanent access roads;
- Slash and timber barriers, pipe barriers, or a line of boulders across the ROW; or
- Conifers or other appropriate shrubs with a mature height of 4 feet or less across the ROW.

3.7 ABOVEGROUND FACILITY CONSTRUCTION

Construction at aboveground facilities, including compressor stations, meter stations, valve sites, and other facilities, will follow the same best management practices identified for pipeline installation and removal on the ROW. Work activities in this category can include installation of new aboveground facilities, modification

or relocation of facilities at existing compressor station sites, upgrades or installations at existing meter station sites, construction of new receipt or delivery points, and a variety of other activities. Certain project types covered in this section may trigger additional stormwater permitting. Check with the PEL Lead to ensure that all stormwater requirements are met prior to construction.

1. Aboveground facilities shall not be located in any wetland, except as permitted or where the location of such facilities outside of wetlands would prohibit compliance with U.S.DOT regulations.

2. Install temporary sediment barriers at the base of slopes adjacent to roads and at waterbodies and wetlands in accordance with Sections 5.1.4 and 6.3 respectively.

3. Inspect temporary sediment barriers daily in areas of active construction to ensure proper functioning and maintenance. In other areas with no construction or equipment operation, sediment barriers will be inspected and maintained on a weekly basis throughout construction, and within 24 hours of each 0.5 inch of rainfall. Conduct an inspection within 24 hours once a storm event has produced 0.5 inch of rainfall, even if the storm event is still continuing.

4. If a waterbody is present on or immediately adjacent to an existing facility property where work is being conducted, install sediment barriers as necessary along the edge of the construction area to contain spoil and sediment within the work area.

5. All extra work areas should be located at least 50 feet away from the water's edge of a waterbody or a wetland, except where the adjacent upland consists of cultivated or rotated cropland or other disturbed land. FERC approval is necessary for the use of work areas if these setback conditions cannot be met.

6. Wetland boundaries and buffers (e.g., extra work area setbacks, refueling restrictions) must be clearly marked in the field with signs and /or highly visible flagging until construction-related ground disturbing activities are complete.

7. When work is required within a wetland at an existing facility, and standing water or saturated soils are present, or if construction equipment causes ruts or mixing of the topsoil and subsoil in wetlands, use low-ground-weight construction equipment or operate normal equipment on timber riprap, prefabricated equipment mats or terra mats. Do not use more than two layers of timber riprap to stabilize the work area.

8. Maintain all temporary sediment barriers in place until permanent revegetation measures are successful or the upland areas adjacent to wetlands, waterbodies and roads are stabilized.

9. Remove temporary sediment barriers from an area when replaced by permanent erosion or sediment control measures or when the area has been successfully restored as specified in Section 8.1.

10. Temporary slope breakers are to be installed on all disturbed areas as necessary to avoid excessive erosion as described in Section 3.5.4.

11. Where required for work in wetlands (except areas where standing water is present or soils are saturated) segregate topsoil as described in Section 3.5.3.1.

12. Place spoil at least 10 feet upgradient from the edge of waterbodies or as indicated on construction drawings. Spoil will be contained with erosion and sediment control devices to prevent spoil materials or silt-laden water from transferring into waterbodies and wetlands or off of the facility property.

13. If required, dewatering should be conducted as described in Section 3.5.6.

14. The Contractor shall make every reasonable effort to complete final cleanup of an area (including final grading and installation of permanent erosion control structures) within 20 days after ground disturbing activities are completed. If seasonal or other weather conditions prevent compliance with these time frames, continue to inspect and maintain temporary erosion and sediment controls (temporary slope breakers and sediment barriers) until conditions allow completion of cleanup. Cleanup shall be conducted in accordance with Section 3.6 of this document.

15. Grade to contours shown on construction drawings or site plans or return grade to pre-construction contours.

16. New gravel, stone and paving at the site shall be placed in accordance with construction drawings. No additional gravel, stone, or paving shall be added without prior approval by PEL.

17. Install permanent erosion controls and post-construction stormwater measures at the locations shown on the construction drawings.

18. Disturbed soils will be seeded within 6 working days of final grading, weather and soil conditions permitting, unless permit conditions indicate otherwise.

19. Remove all timber riprap and prefabricated equipment mats in any wetlands upon completion of construction.

4. SPECIAL CONSTRUCTION METHODS

The Company will utilize the following specialized construction procedures for agricultural areas, road crossings, and residential areas along the pipeline project, when applicable. The project construction drawings, Line Lists, and Construction Contract will indicate the locations where specialized construction methods will be used.

4.1 AGRICULTURAL AREAS

The following sections identify construction procedures and best practices for activities within actively cultivated or rotated land used for the production of crops including but not limited to corn, grains, orchards, vineyards and hayfields.

4.1.1 Drain Tiles

Develop procedures for constructing through drain-tiled areas and repairing drain tiles after construction. Engage qualified drain tile specialists, as needed, to conduct or monitor repairs to drain tile systems affected by construction. Use drain tile specialist from the project area, if available.

1. Attempt to locate existing drain tiles.
2. Probe all drainage tile systems within the area of disturbance to check for damage.
3. Ensure that the depth of cover over the new pipeline is sufficient to avoid interference with drain tile systems (existing or proposed). For adjacent pipeline loops in agricultural areas, install the new pipeline with at least the same depth of cover as the existing pipeline(s).
4. Repair damaged drain tiles to their original or better condition (Figure SU-1). Filter-covered drain tiles may not be used unless the local soil conservation authorities and the landowner agree in writing prior to construction.

4.1.2 Irrigation

Maintain water flow in crop irrigation systems, unless shutoff is coordinated with affected parties. Repair any damage to irrigation systems as soon as practical.

4.1.3 Soil Compaction Mitigation & Restoration

The following measures are to be employed during decompaction and restoration of soil within agricultural areas disturbed by construction activities:

1. In agricultural areas, test topsoil and subsoil disturbed by construction activities for compaction at regular intervals. Use penetrometers or other appropriate devices to conduct tests. In order to approximate preconstruction conditions, conduct tests on the same soil type under similar moisture conditions in undisturbed areas.
2. Plow severely compacted soils with a paraplow or other deep tillage implement;
    a. In areas where topsoil has been segregated, plow the subsoil before replacing the segregated topsoil.
    b. If subsequent construction and cleanup activities result in further compaction, conduct additional tilling.

3. Soils imported for use within agricultural areas are to be certified as free of noxious weeds and soil pests, unless otherwise approved by the landowner.

4. Remove excess rock from at least the top 12 inches of soil in all cultivated or rotated cropland, managed pastures, hayfields. The size, density, and distribution of rock on the construction work area shall be similar to adjacent areas not disturbed by construction. The landowner or land management agency may approve other provisions in writing.

4.2 ROAD CROSSINGS

The "open cut" method is typically used when installing the pipeline across small roads (Figure RD-4). Traffic is diverted while the trench is excavated across the road and the pipeline is installed. An open cut crossing may involve closing the road to all traffic and constructing an adequate detour around the crossing area, or excavating one-half of the road at a time allowing through traffic to be maintained. Any detour constructed around the crossing area must remain within the approved construction workspace. After completing the crossing, all backfill is compacted, the road bed is repaired and the road surface is replaced.

Bores are often used to install the pipeline across highways, major roads with heavy traffic, and railroads (Figure RD-5), unless the crossing permit allows an open cut crossing. Similar to a directional drill, as discussed in Section 4.4, the road bore is accomplished with a horizontal drill rig or boring machine. The boring machine drills a hole under the road to allow insertion of the pipe. Typically, a dummy pipe section is pulled through which is welded to the line pipe. The dummy pipe is pulled back through placing the line pipe in the crossing. In some instances, a casing (another larger pipe) is installed in the hole and the pipeline is inserted inside the casing. Casings typically are not installed today, although some states require casings on rail crossings. Casings also may be used in soils where it is difficult to pull pipe. The benefit of the road bore is that it allows installation of the pipeline without disrupting traffic.

Access roads shall be used and maintained in accordance with Section 3.2.

4.3 RESIDENTIAL AREAS

Specialized construction procedures will be utilized in areas of heavy residential or commercial/ industrial congestion where residences or business establishments lie within 50 feet from the edge of the construction ROW.

1. Install safety fence at the edge of the construction ROW for a distance of 100 feet on either side of the residence or business establishment.

2. For a distance of 100 feet on either side any residence or business establishment, maintain a minimum distance of 25 feet between any structure and the edge of the construction work area. If a distance of 25 feet cannot be maintained, refer to Section 4.3.2.

3. If crushed stone/rock access pads are used in residential areas, rock shall be placed on nonwoven synthetic geotextile fabric to facilitate rock removal after construction.

4. Attempt to leave mature trees and landscaping intact within the construction work area unless the trees and landscaping interfere with the installation techniques or present unsafe working conditions, or as specified in landowner agreements.

5. Prevent the mixing of subsoil and topsoil by implementing segregation methods in all residential areas, except where the topsoil is being replaced, as stipulated in Section 3.5.3.1, unless the landowner or land managing agency specifically approves otherwise.

In addition to the aforementioned specialized procedures, smaller "spreads" of labor and equipment, operating independent of the mainline work force, will utilize either the stove pipe or drag section pipeline construction techniques in those areas of congestion where a minimum distance of 25 feet cannot be maintained between the residence (or business establishment) and the edge of the construction work area. In no case shall the temporary work area be located within 10 feet of a residence unless the landowner agrees in writing, or the area is within the existing maintained ROW.

The following techniques shall be utilized for a distance of 100 feet on either side of the residence or business establishment at the locations identified in the Company Construction Contract and/or Line List. Refer to site-specific residential construction plans, as applicable.

4.3.1 Stove Pipe Technique

The stove pipe construction technique is a less efficient alternative to the mainline method of construction, typically used when the pipeline is to be installed in very close proximity to an existing structure or when an open trench would adversely impact a commercial/industrial establishment. The technique involves installing one joint of pipe at a time whereby the welding, weld inspection, and coating activities are all performed in the open trench. At the end of each day after the pipe is lowered-in, the trench is backfilled and/or covered with steel plates or timber mats. The length of excavation performed each day cannot exceed the amount of pipe installed.

4.3.2 Drag Section Technique

The drag section construction technique, while less efficient than the mainline method, is normally preferred over the stove pipe alternative. This technique involves the trenching, installation, and backfill of a prefabricated length of pipe containing several segments all in one day. At the end of each day after the pipe is lowered-in, the trench is backfilled and/or covered with steel plates or timber mats. Use of the drag section technique will typically require adequate staging areas outside of the residential and/or commercial/industrial congestion for assembly of the prefabricated sections.

4.3.3 Residential Area Cleanup and Restoration

Restore all lawn areas and landscaping immediately following cleanup operations, or as specified in landowner agreements, including

1. Perform appropriate soil compaction mitigation in severely compacted residential areas.
2. Remove excess rock from at least the top 12 inches of soil in all cultivated or rotated cropland, managed pastures, hayfields. The size, density, and distribution of rock on the construction work area shall be similar to adjacent areas not disturbed by construction. The landowner or land management agency may approve other provisions in writing.

3. Importation of topsoil is an acceptable alternative to topsoil segregation. Soils imported for use within residential areas are to be certified as free of noxious weeds and soil pests, unless otherwise approved by the landowner.
4. Reseed all disturbed lawns with a seed mixture acceptable to landowner or comparable to the adjoining lawn.

In residential areas, complete final grading, topsoil replacement, and installation of permanent erosion control structures within 10 days after backfilling the trench. Mulch all disturbed areas before seeding if final grading and installation of permanent erosion control measures will not be completed within 10 days after the trench in that area is backfilled in residential areas. If seasonal or other weather conditions prevent compliance with these time frames, maintain temporary erosion controls (i.e., temporary slope breakers, sediment barriers, and mulch) until conditions allow completion of cleanup.

Landowners shall be compensated for damages in a fair and reasonable manner, and as specified in the damage provision within the controlling easement on each property.

4.4 HORIZONTAL DIRECTIONAL DRILL METHOD

Horizontal Directional Drilling (HDD) is a trenchless crossing method that can help avoid direct impacts to sensitive resources (e.g., waterbodies and wetlands) or infrastructure (e.g., roads and railways) by directionally drilling beneath them. HDD installation typically is carried out in three stages:

1. Directional drilling of a small diameter pilot hole;
2. Enlarging the pilot hole to a sufficient diameter to accommodate the pipeline; and,
3. Pulling the prefabricated pipeline, or pull string, into the enlarged bore hole.

For each waterbody or wetland that would be crossed using the HDD method, the Company will prepare a project-specific HDD Plan that includes:

- Site-specific construction diagrams that show the location of mud pits, pipe assembly areas, and all areas to be disturbed or cleared for construction;
- Justification that disturbed areas are limited to the minimum needed to construct the crossing;
- Identification of any aboveground disturbance or clearing between the HDD entry and exit workspaces during construction;
- A description of how an inadvertent release of drilling mud would be contained and cleaned up; and
- A contingency plan for crossing the waterbody or wetland in the event the HDD is unsuccessful and how the abandoned drill hole would be sealed, if necessary.

The HDD Plan will be provided within the Project Clearance Package.

Section 7(c) and prior notice projects are required to file HDD plans for the review and written approval by the FERC. (This requirement to file a plan does not apply to projects constructed under the automatic

authorization provisions in the FERC's regulations.)

During post-construction maintenance activities, do not conduct any routine vegetation mowing or clearing in riparian areas or wetlands that are between HDD entry and exit points.

5. WATERBODY CROSSINGS

The intent of these procedures is to minimize the extent and duration of project related disturbances within waterbodies. The following section describes the construction procedures and mitigation measures that will be used for pipeline installations at waterbodies. The length of the crossing, the sensitivity of the area, existing conditions at the time of the crossing, and permit requirements will determine the most appropriate measures to be used.

The *Waterbody Reference Citing FERC Requirements* in Appendix B summarizes general waterbody crossing methods and requirements identified in the FERC Procedures. These tables provide a brief reference of the restrictions on construction techniques for waterbody crossings; equipment bridges; construction time windows. However, as more stringent agency specific requirements may exist, refer to the Project Clearance Package for project-specific requirements.

5.1 GENERAL WATERBODY PROCEDURES

Pipeline construction across waterbody channels may result in short term water quality impacts. The following general procedures are to be followed to minimize or avoid impacts at waterbody crossings:

1. Crossings of waterbodies may proceed using standard upland construction techniques when they are dry or frozen and not flowing provided that the EI verifies that water is unlikely to flow between initial disturbance and final stabilization of the feature. In the event of perceptible flow, all applicable requirements of Section 5 must be followed.
2. Construct crossings as close to perpendicular to the axis of the waterbody channel as engineering and routing conditions permit.
3. Where waterbodies meander or have multiple channels, route the pipeline to minimize the number of waterbody crossings.
4. Perform mobilization of construction equipment, trench excavation, and backfilling in a manner that will minimize the potential for erosion and sedimentation within the waterbody channel.
5. Locate all extra work areas, such as staging and additional spoil storage areas, at least 50 feet away from water's edge, except where the adjacent upland consists of cultivated or rotated cropland or other disturbed land. Site-specific written approval by FERC is required for all extra work areas with a less than 50-foot setback and associated measures to be used to ensure the waterbody is adequately protected.
6. Implement erosion control measures to confine water quality impacts within the immediate construction area and to minimize impacts to downstream areas.
7. Place all spoil from the waterbody within the construction ROW at least 10 feet from the water's edge or in the extra work areas shown on the construction drawings.
8. Maintain adequate flow rates to protect aquatic life and prevent the interruption of existing downstream uses.
9. Dewater trench in accordance with the procedures described in Section 3.5.6.

5.1.1 Time Windows for Instream Work

Unless expressly permitted or further restricted by the appropriate federal or state agency in writing on a site-specific basis, instream work must occur during the following time windows:

- Coldwater fisheries – June 1 through September 30; and
- Coolwater and warmwater fisheries – June 1 through November 30.

Installation or removal of equipment bridges above the top of bank is not subject to the aforementioned time windows.

5.1.2 Equipment Bridges

Equipment bridges may be installed and used where needed to allow equipment access across waterbodies.

1. Until the equipment bridge is installed, only clearing equipment and equipment necessary for installation of equipment bridges may cross the waterbody, and the number of crossings shall be limited to one crossing per piece of equipment, unless otherwise authorized by the appropriate permitting agency. EI approval is required prior to equipment crossing a waterbody without an equipment bridge.

2. Construct and maintain equipment bridges that allow unrestricted flow and prevent sediment from entering the waterbody. The Construction Contract agreement and/or permit conditions may specify the type of bridge to be used. Examples of bridges are provided below:
    a. Equipment pads with or without culvert(s), as illustrated in Figure BR-1;
    b. Clean crushed stone and culvert(s), as illustrated in Figure BR-2;
    c. Flexi-float or portable bridges, as illustrated in Figure BR-3;
    d. Double equipment pads, geotextile fabric and sideboards with or without culvert(s); or
    e. Railroad car bridges without culverts.

3. Design and maintain each equipment bridge to withstand the highest flows that would occur. Align culverts/flumes to prevent bank erosion or streambed scour. If necessary, install energy dissipating devices downstream of culverts.

4. Do not use soil to construct or stabilize equipment bridges.

5. Design and maintain equipment bridges to prevent sediment from entering the waterbody.

6. Remove temporary equipment bridges as soon as practicable after permanent seeding.

7. If there will be more than 1 month between final cleanup and the beginning of permanent seeding and reasonable alternative access to the ROW is available, remove temporary equipment bridges as soon as practicable after final cleanup.

8. Obtain any necessary approval or authorization from the COE and/or the appropriate state agency for temporary and permanent bridges.

5.1.3 Clearing and Grading near Waterbodies

1. Confine construction activities and ground disturbance to the construction ROW boundaries, as shown on the construction drawings. Restrict extra work areas (such as staging areas and additional spoil storage areas) to only those shown on the construction drawings.

2. If the pipeline parallels a waterbody, maintain at least 15 feet of undisturbed vegetation between the waterbody (and any adjacent wetland) and the ROW except where maintaining this offset will result in greater environmental impact.

3. Clear the ROW adjacent to all waterbodies *up to the high water bank* (where discernible). *Within 10 feet of the high water bank*, trees shall be cut to ground level and with little to no ground disturbance. **Do not grub** this 10-foot vegetative strip with equipment.

4. Immediately remove all cut trees and branches that inadvertently fall into a waterbody and stockpile in an upland area within the construction ROW for disposal.

5. Grade the ROW adjacent to waterbodies *up to within 10 feet of the high water bank*, leaving an ungrubbed vegetative strip intact.

6. Clearing and grading operations may proceed through the 10-foot vegetative strip **only on the working side of the ROW** in order to install the equipment bridge and travel lane. Use temporary sediment barriers to prevent the flow of bank spoil into the waterbody.

5.1.4 Temporary Erosion and Sediment Controls at Waterbodies

Install sediment barriers immediately after initial disturbance of the waterbody or adjacent upland. Sediment barriers must be properly maintained throughout construction and repaired or reinstalled as necessary (such as after backfilling of the trench), until replacement by permanent erosion controls or restoration of adjacent upland areas is complete. Temporary erosion and sediment control measures are addressed in more detail in Section 3.5, however, the following specific measures must be implemented at stream crossings:

1. Install sediment barriers across the entire construction ROW at all waterbody crossings, where necessary to prevent the flow of sediments into the waterbody.

2. Install sediment barriers along the edge of the construction ROW as necessary to contain spoil within the construction ROW and prevent sediment flow into the waterbody where waterbodies are adjacent to the construction ROW or parallel to the construction ROW and the ROW slopes toward the waterbody.

3. Removable or temporary sediment barriers, such as slope breakers or drivable berms as described in Section 3.5.4, may be used in lieu of sediment barriers in front of equipment bridges or timber mats across the travel lane. Removable sediment barriers can be removed during the

construction day, but must be reinstalled after construction has stopped for the day or whenever heavy precipitation is imminent.

4. Use temporary trench plugs at all waterbody crossings, as necessary, to prevent diversion of water into upland portions of the pipeline trench and to keep any accumulated trench water out of the waterbody. Trench plugs shall be of sufficient size to withstand upslope water pressure.

5.2 TYPES OF WATERBODY CROSSING METHODS

Waterbody crossing techniques allowed for use on a project will be determined by agency consultations and permits. Construction at waterbodies will be conducted using two principal crossing methods, a “dry” crossing and a “wet” crossing. The “dry” or “dry-ditch” crossing procedure is further divided into a flume crossing and a dam-and-pump crossing methods. These methods are designed to maintain downstream flow at all times and to isolate the construction zone from the stream flow by channeling the water flow through a flume pipe or by damming the flow and pumping the water around the construction area. The overall objective is to minimize siltation of the waterbody and to facilitate trench excavation of saturated spoil. The two “dry” crossings are further described below in Sections 5.2.1 and 5.2.2.

The “wet” or “open-cut” crossing method involves trenching in the waterbody without isolating the construction zone from the stream flow. The objective of this method is to complete the waterbody crossing as quickly as practical in order to minimize the duration of impacts to aquatic resources. The wet crossing method is further described below in Section 5.2.3.

All streams, their classifications, timing windows, applicable permits and crossing procedures will be identified in the Project Clearance Packageconstruction drawings. Unless approved otherwise by the appropriate federal or state agency, pipeline construction and installation must occur using one of the two “dry” crossing methods for waterbodies state-designated as either coldwater or significant coolwater or warmwater fisheries, or federally designated as critical habitat. The flume and dam-and-pump crossing methods are applicable to waterbodies up to 30 feet wide (possibly wider depending on flow volume and rate) at the water’s edge at the time of construction.

5.2.1 Flume Crossing

The flume crossing method utilizes a flume pipe(s) to transport stream flow across the disturbed area and allows trenching to be done in drier conditions (Figure WC-3). The flume pipe(s) installed across the trench will be sized to accommodate anticipated stream flows. Flumes are generally not recommended for use on a waterbody with a broad unconfined channel, unstable banks, a permeable substrate, excessive stream flow, or where the installation and construction of the flume crossing will adversely affect the bed or banks of the stream.

The flume waterbody crossing shall be installed as follows:

1. Install flume pipe(s) after blasting and other rock breaking measures (if required), but before trenching;

2. Properly align flume pipe(s) to prevent bank erosion and streambed scour;

3. Use sand bags or equivalent dam diversion structure to provide a seal at either end of the flume to channel water flow (some modifications to the stream bottom may be required to achieve an effective seal);
4. **Do not remove flume pipe** during trenching, pipe laying (thread pipe underneath the flume pipe(s)), or backfilling activities, or initial streambed restoration efforts, except for crossings where a dam-and-pump method (as described in Section 5.2.2 below) has been established as an alternative measure to redirect stream flow; and
5. Remove all flume pipes and dams that are not also part of the equipment bridge as soon as final cleanup of the stream bed and bank is complete.

5.2.2 Dam-and-Pump Crossing

The dam-and-pump crossing method is presented as an alternative dry crossing procedure to the flume crossing (in limited cases, it may be used in combination with a flume crossing). The dam-and-pump method is accomplished by utilizing pumps to transport stream flow across the disturbed area (Figure WC-4). This method involves placing sandbags across the existing stream channel upstream from the proposed crossing to stop water flow and downstream from the crossing to isolate the work area. Pumps are used to pump the water across the disturbed area and back into the stream further downstream.

The dam-and-pump procedure allows for more space and flexibility during trenching and pipe installation, which shortens the duration of time spent at the waterbody. The dam-and-pump method may be used for crossings of waterbodies where pumps can adequately transfer stream flow volumes around the work area, and where there are no concerns about sensitive species passage.

The dam-and-pump crossing method shall be installed as follows:

1. Install and properly seal sandbags at the upstream and downstream location of the crossing;
2. Create an in-stream sump using sandbags if a natural sump is unavailable for the intake hose;
3. Initiate pumping of the stream around the work area prior to excavating the trench;
4. Monitor dam and pumps at all times to ensure proper operation until the waterbody crossing is completed; and,
5. Remove the sandbag dams, pumps and hoses and return normal flow back to the waterbody following installation and restoration of the streambed.

Implementation of the dam-and-pump crossing method will meet the following performance criteria:

- Use sufficient pumps, including onsite backup pumps, to maintain downstream flows;
- Construct dams with materials that prevent sediment and other pollutants from entering the waterbody (e.g., sandbags or clean gravel with plastic liner);
- Screen all intake hoses to minimize the entrainment of fish and other aquatic life
- Prevent streambed scour at pump discharge; and

- Continuously monitor the dam and pumps to ensure proper operation throughout the waterbody crossing.

5.2.3 Wet Crossing

Open-cut crossings involve excavating a trench for the pipeline across the bottom of the waterbody to be crossed (Figure WC-2). Depending on the depth of the water, construction equipment may be placed on barges or other floating platforms to excavate the pipe trench.

This construction technique is typically used to cross waterbodies that are not state-designated, such as ephemeral drainage ditches, and ephemeral and intermittent streams, as well as intermediate and major waterbodies with substantial flows that cannot be effectively flumed or pumped around the construction zone using one of the dry crossing techniques.

5.3 FERC WATERBODY CLASSIFICATIONS

In the FERC Procedures, a “waterbody” is defined to include any natural or artificial stream, river, or drainage with perceptible flow at the time of crossing, and other permanent waterbodies such as ponds and lakes. Waterbodies have been further divided into three classifications by FERC depending on the width of the feature, which dictate construction limitations or requirements.

5.3.1 Minor Waterbodies

FERC defines a "minor waterbody” as a waterbody less than or equal to 10 feet wide at the water’s edge at the time of crossing. Minor waterbodies shall be crossed in accordance with the following requirements:

1. All spoil from minor waterbody crossings must be placed in the construction ROW at least 10 feet from the water’s edge or in additional extra work areas as described above in Section 5.1.

2. Unless approved otherwise by the appropriate federal or state agency, utilize a dry crossing construction technique to install crossings at all minor waterbodies that are state-designated fisheries or federally designated as critical habitat, as identified in the Project Clearance Package (Figures WC-3 or WC-4).

    a. All construction equipment must use an equipment bridge to cross state-designated fisheries as specified in Section 5.1.2.

3. Where a dry-ditch crossing is not required, minor waterbodies may be crossed using the wet crossing method, with the following restrictions:

    a. Except for blasting and other rock breaking measures, complete instream construction activities (including trenching, pipe installation, backfill, and restoration of the streambed contours) within 24 hours. Streambanks and unconsolidated streambeds may require additional restoration after this period;

    b. Limit use of equipment operating in the waterbody to that needed to construct the crossing;

c. If a flume is installed within the waterbody during mainline activities, it can be removed just prior to lowering in the pipeline (The 24-hour timeframe starts as soon as the flume is removed.); and,

d. Equipment bridges are not required at minor waterbodies that do not have a state-designated fishery classification or protected status (e.g., agricultural or intermittent drainage ditches). However, if an equipment bridge is used it must be constructed as described in Section 5.1.2.

5.3.2 Intermediate Waterbodies

FERC defines an "intermediate waterbody" as a waterbody greater than 10 feet wide but less than or equal to 100 feet wide at the water's edge at the time of crossing. Intermediate waterbodies shall be crossed in accordance with the following requirements:

1. All spoil from intermediate waterbody crossings must be placed in the construction ROW at least 10 feet from the water's edge or in additional extra work areas as described above in Section 5.1.

2. Unless approved otherwise by the appropriate federal or state agency, install the pipeline using a dry crossing method for crossings of waterbodies up to 30 feet wide (at the water's edge at the time of construction) that are
    a. state-designated as either coldwater or significant coolwater or warmwater fisheries, or
    b. federally designated as critical habitat.

3. Where a dry-ditch crossing is not required, intermediate waterbodies may be crossed using the wet crossing method, with the following restrictions:
    a. Complete instream construction activities (not including blasting and other rock breaking measures) within 48 hours, unless site-specific conditions make completion within 48 hours infeasible;
    b. Limit use of equipment operating in the waterbody to that needed to construct the crossing; and,
    c. All other construction equipment must cross on an equipment bridge as specified in Section 5.1.2.

5.3.3 Major Waterbodies

FERC defines a "major waterbody" as a waterbody greater than 100 feet wide at the water's edge at the time of crossing. Before construction, the Company shall prepare and file for the review and written approval by the FERC a detailed, site-specific construction plan and scaled drawings identifying all areas to be disturbed by construction for each major waterbody crossing, however the scaled drawings are not required for any offshore portions of pipeline projects. (The requirement to file major waterbody crossing plans does not apply to projects constructed under the automatic authorization provisions of the FERC's regulations.) This site-specific plan must be developed in

consultation with the appropriate state and federal agencies and shall include extra work areas, spoil storage areas, sediment control structures, etc., as well as mitigation for navigational issues.

Upland spoil from major waterbody crossings must be placed in the construction ROW at least 10 feet from the water's edge or in additional extra work areas as described in Section 5.2.

5.4 Restoration

Restore and stabilize the waterbody banks and channel in accordance with this section.

1. Return all waterbody banks to preconstruction contours or to stable angle of repose as approved by the EI.

2. Use clean gravel or native cobbles for the upper 12 inches of trench backfill in all waterbodies identified in the Project Clearance Package as coldwater fisheries, unless otherwise specified by state-specific agency recommendations or permit conditions.

3. For wet crossings, stabilize waterbody banks and install temporary sediment barriers within 24 hours of completing the crossing.

4. For dry crossings, complete bank stabilization before returning flow to the waterbody channel.

5. Limit the use of rock riprap to areas where flow conditions preclude effective vegetation stabilization techniques such as seeding and erosion control fabric, unless otherwise specified by COE and state permits. Limit the placement of rock riprap to the slopes along the disturbed waterbody crossing. Application of riprap for bank stabilization must comply with COE, or its delegated agency, permit terms and conditions.

6. Install erosion control fabric, in accordance with Section 3.6.1.2, or a functional equivalent on waterbody banks at the time of final bank contouring (Figure EC-13, WC-5). Do not use synthetic monofilament mesh/netted erosion control materials in areas designated as sensitive wildlife habitat unless the product is specifically designed to minimize harm to wildlife.

7. Revegetate disturbed riparian areas with native species of conservation grasses, legumes and woody species similar in density to adjacent undisturbed lands.

8. In the event that final cleanup is deferred more than 20 days after the trench is backfilled, all slopes within 100 feet of waterbodies shall be mulched with 3 tons/acre of straw.

9. Remove all temporary sediment barriers when replaced by permanent erosion controls or when restoration of adjacent upland areas is successful as specified in Section 8.1.

10. Install a permanent slope breaker and a trench breaker at the base of slopes greater than 5% that are less than 50 feet from each waterbody crossed.

6. WETLAND CROSSINGS

The term “wetland” as used in this plan includes any area that satisfies the requirements of the current federal methodology for identifying and delineating wetlands. The requirements outlined below do not apply to wetlands in actively cultivated or rotated cropland. Standard upland protective measures, including workspace and topsoil segregation requirements, apply to these agricultural wetlands.

Wetland boundaries are identified on the construction drawings and within the Project Clearance Package. Wetlands are delineated prior to construction using current federal methodology and summarized within a wetland delineation report, which identifies the following information for all wetlands that would be affected by the construction ROW:

- Location, including pipeline milepost if crossed by centerline;
- National Wetland Inventory (NWI) classification;
- Crossing length in feet;
- Area of permanent and temporary disturbance that would occur in each wetland, sorted by NWI classification type.

6.1 General Wetland Procedures

Crossing procedures are to comply with COE, or its delegated agency, permit terms and conditions. Project-specific permits or authorizations issued by the COE or other appropriate agenc(ies) are provided in the Project Clearance Package. Implement the following general requirements during planning and construction near or across wetlands:

1. Route the pipeline to avoid wetland areas to the maximum extent possible.

2. If a wetland cannot be avoided or crossed by following an existing right-of-way, route the new pipeline in a manner that minimizes disturbance to wetlands. Where looping an existing pipeline, overlap the existing pipeline right-of-way with the new construction right-of-way. In addition, locate the loop line no more than 25 feet away from the existing pipeline unless site-specific constraints would adversely affect the stability of the existing pipeline.

3. Identify site-specific areas where excessively wide trenches could occur and/or where spoil piles could be difficult to maintain because existing soils lack adequate unconfined compressive strength.

4. Limit construction activity and ground disturbance in wetland areas to a construction ROW width of 75 feet or as shown on the construction drawings. Only with prior written approval from the FERC, construction ROW width within the boundaries of federally delineated wetlands may be expanded beyond 75 feet if required by site-specific topographic conditions or soil limitations.

5. All extra work areas must be located at least 50 feet away from wetland boundaries, except where the adjacent upland consists of cultivated or rotated cropland or other disturbed land. Only with prior written approval from the FERC, the Company can locate extra work areas closer than 50 feet from the wetland if site-specific conditions justify a less than 50-foot setback.

6. Aboveground facilities shall not be located in any wetland, except as permitted or where the location of such facilities outside of wetlands would prohibit compliance with U.S.DOT regulations.

7. In the event a waterbody crossing is located within or adjacent to a wetland crossing, the Company must file a site-specific crossing plan for review and obtain written approval by the FERC before construction if all measures of Sections V. and VI. of the FERC Procedures cannot be met.

8. Limit construction equipment operating in wetland areas to that needed to clear the ROW, dig the trench, fabricate and install the pipeline, backfill the trench, and restore the construction ROW. All other construction equipment shall use access roads located in upland areas to the maximum extent practical. Refer to Section 3.2 for other requirements and restrictions pertaining to access to the construction ROW or use of roads across wetlands.

6.2 Clearing and Grading at Wetlands

1. Wetland boundaries and buffers (e.g., extra work area setbacks, refueling restrictions) must be clearly marked in the field with signs and /or highly visible flagging until construction-related ground disturbing activities are complete.

2. If standing water or saturated soils are present, or if construction equipment causes ruts or mixing of the topsoil and subsoil in wetlands, use low-ground-weight construction equipment or operate normal equipment on timber riprap, prefabricated equipment mats or terra mats on the working side of the ROW during clearing operations.

3. Attempt to use no more than two layers of timber riprap to stabilize the ROW. If approved by the COE, woody debris can be burned in wetlands as long as it is in accordance with state and local regulations, ensuring that all woody debris is removed for disposal.

4. Cut vegetation just above ground level and grind stumps to ground level, leaving existing root systems in place and remove any excess vegetation (e.g., wood chips). Immediately remove all cut trees, limbs and branches from the wetland and stockpile in an upland area on ROW for disposal.

5. Limit pulling of tree stumps and grading activities to directly over the trenchline. Do not grade or remove stumps or root systems from the rest of the construction ROW in wetlands unless the Chief Inspector and EI determine that safety-related construction constraints require grading or the removal of tree stumps from under the working side of the construction ROW.

6. Do not cut trees outside of the construction ROW to obtain timber for riprap or equipment mats.

7. Cleared materials, such as slash, logs, brush, and wood chips, shall not be permanently placed within wetland areas.

6.3 Temporary Erosion & Sediment Control at Wetlands

Install sediment barriers immediately after initial ground disturbance at the following locations:

- Within the ROW at the edge of the boundary between wetland and upland;
- At the base of slopes greater than 5% where the base of the slope is less than 50 feet from a wetland;
- Across the entire ROW immediately upslope of the wetland boundary to contain spoil within the construction ROW and prevent sediment flow into the wetland;
- Along the edge of the ROW, where the ROW slopes toward the wetland, to protect adjacent, off ROW wetland; and
- Along the edge of the ROW as necessary to contain spoil and prevent sediment from migrating outside the construction ROW in areas where a wetland is both within and adjacent to the construction ROW.

Maintain all sediment barriers throughout construction and reinstall as necessary (such as after backfilling of the trench) until replaced by permanent erosion controls or restoration of adjacent upland areas is complete in accordance with Section 8.1. Remove the sediment barriers during right-of-way cleanup.

6.4 Wetland Crossing Procedure

Procedures used to install a pipeline across wetlands vary depending on the level of soil stability and saturation encountered during construction. The following best management practices are to be employed during standard wetland crossings:

1. Assemble the pipeline in an upland area unless the wetland is dry enough to adequately support skids and pipe.
2. Do not use rock, soil imported from outside the wetland, tree stumps, or brush riprap to stabilize the ROW.
3. Perform topsoil segregation in accordance with Section 3.5.3.1, including segregating the top 1 foot of topsoil from the area disturbed by trenching, except in areas where standing water is present or soils are saturated. Immediately after backfilling is complete, restore the segregated topsoil to its original location.
4. If required, dewatering should be conducted as described in Section 3.5.6.
5. Minimize the length of time that topsoil is segregated and the trench is open. Do not trench the wetland until the pipeline is assembled and ready for lowering-in.
6. Use “push-pull” or “float” construction techniques to place the pipe in the trench where water and other site conditions allow (Refer to Section 6.4.1 below).
7. Install permanent trench breakers at the wetland boundaries and/or seal the trench bottom as

necessary to maintain the original wetland hydrology at locations where the pipeline trench may drain a wetland.

8. Install a permanent slope breaker and a trench breaker at the base of slopes near the boundary between the wetland and adjacent upland areas for each wetland crossed.

9. Install a permanent slope breaker across the construction right-of-way at the base of slopes greater than 5% where the base of the slope is less than 50 feet from the wetland, or as needed to prevent sediment transport into the wetland. In some areas, with the approval of the EI, an earthen berm may be suitable as a sediment barrier adjacent to the wetland.

10. Restore segregated topsoil to its original position after backfilling is complete. When required, additional fill material imported from off the ROW must be approved by the EI.

11. Preconstruction wetland contours and flow regimes will be restored to the extent practical.

6.4.1 Push-pull Technique

The “push-pull” or “float” or “drag section” method may be utilized during wetland crossings if conditions are suitable at the time of construction. Sufficient, naturally present groundwater volumes that fill the excavated trench are required to facilitate this installation method. This method may be used to install the pipeline if the wetland to be crossed contains standing water or saturated and/or unstable soils.

- Trenching equipment will excavate a trench across the wetland, either using low-ground-weight equipment or working on timber matting.
- While the trench is being excavated, the pipeline crossing sections will be assembled and welded together in uplands.
- Prefabricated pipeline crossing sections will then be pushed or pulled into the trench; floated across the wetland and released into the trench if the trench is filled with water; or, carried into position with sideboom tractors supported on equipment mats.
- The excavating equipment will “walk through” the wetland by carrying timber mats and repositioning the mats as it operates from one mat to the next through the wetland during trenching, backfilling, and cleanup activities.

6.5 Wetland Cleanup and Restoration

1. Restore pre-construction wetland contours to maintain the wetland hydrology.

2. Revegetate the ROW with annual ryegrass at 40 lbs/acre PLS or with the recommended Wetland Seed Mix in Appendix C or project-specific seed mix where applicable, unless standing water is present or unless prohibited by state or land management agency.

3. **Do not use lime, mulch or fertilizer in wetland areas** unless required in writing by the appropriate federal or state agency**,** as identified in the Project Clearance Package.

4. In the event that final cleanup is deferred more than 20 days after the trench is backfilled, all slopes adjacent to wetlands shall be mulched with 3 tons/acre of straw for a minimum of 100 feet on each side

of the crossing.

5. Remove all project-related material used to support equipment on the construction ROW, including timber riprap and prefabricated equipment mats, upon completion of construction.

6. Develop specific procedures in coordination with the appropriate federal or state agency, where necessary, to prevent the invasion or spread of invasive vegetation (such as purple loosestrife and phragmites).

7. Ensure that all disturbed areas permanently revegetate in accordance with Section 8.1.

8. Remove temporary sediment barriers located at the boundary between wetland and adjacent upland areas after upland revegetation and stabilization of adjacent upland areas are successful as specified in Section 8.1.

7. SPILL PREVENTION & RESPONSE

7.1 SPCC / PPC Plan

The Company and Contractor shall adhere to the SPCC/PPC Plan at all times. This plan has been prepared to meet the requirements of several federal regulations and guidelines: the FERC's Plan and Procedures; Oil Pollution Act; Federal Water Pollution Control Act; Comprehensive Environmental Response, Compensation and Liability Act of 1980; the Resource Conservation and Recovery Act; Toxic Substances Control Act; and, the Clean Water Act.

The purpose of the SPCC/PPC Plan is to reduce the probability and risk of a potential spill or release of oil or hazardous materials during construction-related activities. The objectives of this plan are to identify and address:

- The type and quantity of material handled, stored, or used on site during construction;
- Measures to be taken for spill preparedness and prevention;
- Emergency response procedures;
- Spill incident reporting/notification procedures; and
- Local emergency response team arrangements.

7.2 Spill Prevention Measures

Structure operations in a manner that reduce the risk of spills or the accidental exposure of fuels or hazardous materials to waterbodies or wetlands. At a minimum,

1. All employees handling fuels and other hazardous materials are to be properly trained.
2. All equipment shall be in good operating order and inspected on a regular basis.
3. Fuel trucks transporting fuel to on-site equipment should travel only on approved access roads.
4. All equipment is to be parked overnight and/or fueled at least 100 feet from any wetland or waterbody. These activities can occur closer only if the EI determines that there is no reasonable alternative, and appropriate steps have been taken (including secondary containment structures) to prevent spills and provide for prompt cleanup in the event of a spill.
5. Do not store hazardous materials, including chemicals, fuels, and lubricating oils within 100 feet of a wetland, waterbody or designated municipal watershed area, unless the location is designated for such use by an appropriate governmental authority. This applies to storage of these materials and does not apply to normal operation or use of equipment in these areas. If the 100-foot setback cannot be met, this activity can be performed within the 100-foot setback, with EI approval, if done in accordance with the SPCC/PPC Plan.
6. Do not perform fondu or concrete coating activities within 100 feet of any wetland or waterbody boundary, unless the location is an existing industrial site designated for such use. If the 100-foot setback cannot be met, these activities can be performed within the 100-foot setback, if the EI

determines that there is no reasonable alternative and appropriate steps have been taken (including secondary containment structures) to prevent spills and provide for prompt cleanup in the event of a spill.

7. Pumps operating within 100 feet of a waterbody or wetland boundary shall utilize appropriate secondary containment systems to prevent spills; and

8. Bulk storage of hazardous materials, including chemicals, fuels, and lubricating oils have appropriate secondary containment systems to prevent spills.

7.3 Spill Cleanup & Response

Structure operations in a manner that provides for the prompt and effective cleanup of spills of fuel and other hazardous materials. At a minimum,

1. Ensure that each construction crew (including cleanup crews) has on hand sufficient supplies of absorbent and barrier materials to allow the rapid containment and recovery of spilled materials and knows the procedure for reporting spills and unanticipated discoveries of contamination;

2. Ensure that each construction crew has on hand sufficient tools and material to stop leaks; and,

3. Know the contact names and telephone numbers for all local, state, and federal agencies (including, if necessary, the U. S. Coast Guard and the National Response Center) that must be notified of a spill; and follow the requirements of those agencies in cleaning up the spill, in excavating and disposing of soils or other materials contaminated by a spill, and in collecting and disposing of waste generated during spill cleanup.

8. POST-CONSTRUCTION ACTIVITIES

8.1 POST-CONSTRUCTION MONITORING

Projects conducted under the blanket certificate or a project-specific Section 7 Order, shall meet the monitoring requirements set forth in this section. Company personnel shall perform the following:

1. Establish and implement a program to monitor the success of restoration upon completion of construction and restoration activities.

2. Conduct follow-up inspections of all disturbed upland areas as necessary, to determine the success of revegetation and address landowner concerns. At a minimum, conduct inspections after the first and second growing seasons.

3. In nonagricultural upland areas, revegetation shall be considered successful if the vegetative cover is sufficient to prevent the erosion of soils on the disturbed ROW and density and cover are similar to that in adjacent undisturbed area. Sufficient coverage in upland areas is defined when vegetation has a uniform 70 percent vegetative coverage.

4. In agricultural areas, revegetation shall be considered successful when upon visual survey, growth and vigor are similar to adjacent undisturbed portions of the same field, unless the easement agreement specifies otherwise.

5. In wetlands, monitor and record the success of revegetation annually, until wetland revegetation is successful:

    a. Wetland revegetation will be considered successful when the affected wetland satisfies the current federal definition for a wetland (i.e. soils, hydrology, and vegetation);

    b. Vegetation should be at least 80 percent of either the cover documented for the wetland prior to construction, or at least 80 percent of the cover in adjacent wetland areas that were not disturbed by construction;

    c. If natural rather than active revegetation was used, the plant species composition must be consistent with early successional wetland plant communities in the affected ecoregion;

    d. Invasive species and noxious weeds should be absent unless they are abundant in adjacent areas that were not disturbed by construction; and,

    e. For any wetland where revegetation is not successful at the end of 3 years after construction, the Company shall develop and implement (in consultation with a professional wetland ecologist) a remedial plan to actively revegetate the wetland.

6. Inspect all remaining temporary erosion and sediment controls during routine patrols to ensure proper functioning. Any deficiencies found will be reported and corrected as needed. Once the area has revegetated and stabilized, the erosion controls will be removed.

7. Revegetation efforts (such as fertilizing or reseeding) will continue until revegetation is successful.

8. Restoration shall be considered successful if the ROW surface condition is similar to adjacent undisturbed lands, construction debris is removed (unless otherwise approved by the land owner or land managing agency), revegetation is successful, and proper drainage has been restored.

9. Monitor and correct problems with drainage and irrigation systems resulting from pipeline construction in agricultural areas until restoration is successful.

10. Make efforts to control unauthorized off-road vehicle use, in cooperation with the landowner, throughout the life of the project. Maintain signs, gates, and vehicle trails as necessary.

8.2 POST-CONSTRUCTION MAINTENANCE

Routine maintenance of the ROW is required to allow continued access for routine pipeline patrols, maintaining access in the event of emergency repairs, and visibility during aerial patrols. Where the newly established pipeline ROW is located on other existing ROWs not affiliated with the Company, the easement holder or owner will continue to maintain their ROWs using procedures specified in their vegetative management programs.

Projects conducted under this E&SCP and subject to the FERC Plan and Procedures, shall meet the maintenance requirements set forth in this section. The following requirements restrict the amount of vegetation maintenance that can occur within new ROW.

8.2.1 Uplands

In upland areas, maintenance of the ROW will involve clearing the entire ROW of woody vegetation.

1. Routine vegetation mowing or clearing over the full width of the permanent ROW in uplands shall be conducted no more frequently than once every 3 years. However, to facilitate periodic corrosion and leak surveys, a 10-foot wide corridor centered on the pipeline may be cleared at a frequency necessary to maintain the 10-foot corridor in an herbaceous state.

2. Routine vegetation mowing or clearing shall not occur between April 15 and August 1 of any year unless specifically approved in writing by the responsible land management agency of the U.S. Fish and Wildlife Service.

8.2.2 Waterbodies and Wetlands

1. Do not conduct routine vegetation mowing or clearing over the full width of the permanent ROW in wetlands or riparian areas.

    a. Limit routine vegetation mowing or clearing practices adjacent to waterbodies to allow a riparian strip that measures 25 feet back from the waterbody's mean high water mark. This riparian strip will be allowed to permanently revegetate with native plant species across the entire construction ROW.

    b. To facilitate periodic corrosion and leak surveys within wetlands and the 25-foot-wide riparian strip adjacent to waterbodies, a corridor up to 10 feet wide centered on the pipeline

may be cleared at a frequency necessary to maintain the 10-foot corridor in an herbaceous state.

c. Trees located within 15 feet of the pipeline that have roots that could compromise the integrity of the pipeline coating may be cut and removed from the permanent ROW.

2. Do not conduct any routine vegetation mowing or clearing in riparian areas or wetlands that are between HDD entry and exit points.

3. Herbicides or pesticides shall not be used in or within 100 feet of a wetland or waterbody, except as specified by the federal or state agency.

4. Time of year restrictions apply to routine mowing as well as selective clearing of trees within riparian or wetland areas. These activities are prohibited between April 15 – August 1 of any year.

8.3 REPORTING

The Company shall maintain records that identify by milepost:

1. Method of application, application rate, and type of fertilizer, pH modifying agent, seed, and mulch used;
2. Acreage treated;
3. Dates of backfilling and seeding;
4. The location of any subsurface drainage repairs or improvements made during restoration;
5. Names of landowners requesting special seeding treatment and a description of the follow-up actions; and
6. Any problem areas and how they were addressed.

The Contractor is responsible for providing the EI with the information and documentation on applications, rates, and types of fertilizer, pH modifying agents, seed and mulch that are used during a project.

For the FERC-authorized projects, other than projects conducted under the blanket certificate, the Company will file quarterly activity reports documenting problems, including those identified by the landowner, and corrective actions taken for at least 2 years following construction.

A wetland revegetation monitoring report identifying the status of the wetland revegetation efforts will be filed at the end of 3 years following construction, and annually thereafter documenting progress within the wetland until revegetation is successful. The requirements to file wetland restoration reports with FERC does not apply to projects authorized under the blanket certificate (i.e. automatic and prior notice) or advanced notice provisions in the FERC regulations.

APPENDIX A

E&SCP FIGURES

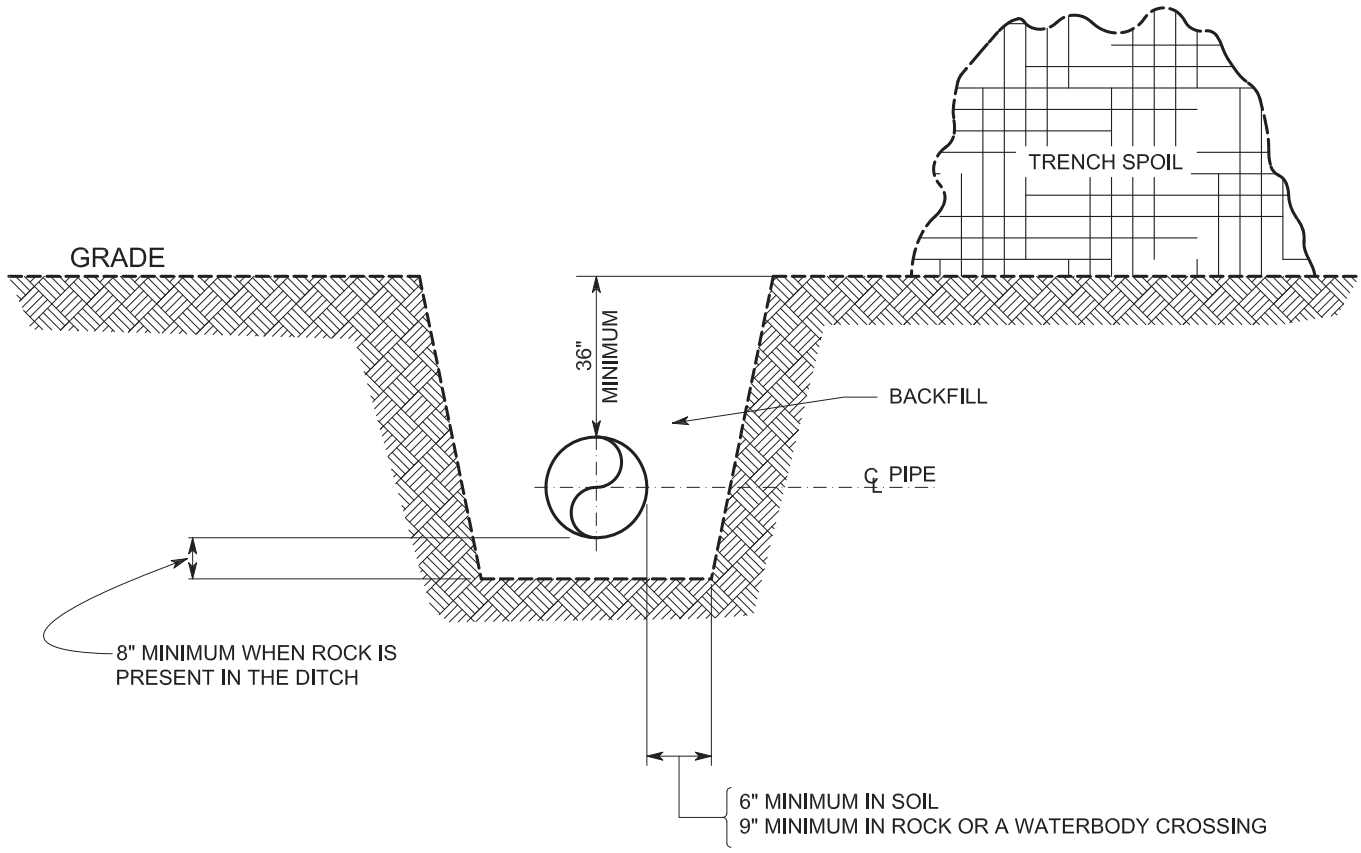
FIGURE NUMBER	STANDARD NUMBER	DRAWING TITLE
CONSTRUCTION WORKAREAS (CW)		
CW-1	ES-0001	TYPICAL TRENCH DETAIL
CW-2	ES-0002	RIGHT-OF-WAY TOPSOIL SEGREGATION TECHNIQUES
CW-3	ES-0003	TYPICAL CONSTRUCTION WIDTHS ACQUIRING NEW PERMANENT RIGHT-OF-WAY
CW-4	ES-0004	TYPICAL CONSTRUCTION WIDTHS NOT ACQUIRING NEW PERMANENT RIGHT-OF-WAY (SINGLE LINE SYSTEM)
CW-5	ES-0005	TYPICAL CONSTRUCTION WIDTHS NOT ACQUIRING NEW PERMANENT RIGHT-OF-WAY (MULTIPLE LINE SYSTEM)
ACCESS ROADS & ROAD CROSSINGS (RD)		
RD-1	ES-0006	ACCESS ROAD CROSS SECTION
RD-2	ES-0007	ROCK ACCESS PAD
RD-3	ES-0008	TYPICAL TEMPORARY ACCESS ROAD THROUGH WETLANDS
RD-4	ES-0009	TYPICAL PAVED ROAD CROSSING CONTROL MEASURES (OPEN CUT)
RD-5	ES-0010	TYPICAL PAVED ROAD CROSSING CONTROL MEASURES (BORED)
EROSION CONTROLS (EC)		
EC-1	ES-0011	SILT FENCE DETAIL
EC-2	ES-0012	STRAW BALE DETAIL
EC-3	ES-0013	STRAW BALE CHECK DAM IN A DRAINAGEWAY
EC-4	ES-0014	ROCK-LINED DRAINAGE SWALE
EC-5	ES-0015	STORM DRAIN INLET PROTECTION
EC-6	ES-0016	TEMPORARY TRENCH PLUG OPTIONS
EC-7	ES-0017	TEMPORARY SLOPE BREAKERS
EC-8	ES-0018	PERMANENT SLOPE BREAKERS
EC-9	ES-0019	CHEVRON SLOPE BREAKER
EC-10	ES-0020	TRENCH BREAKER DETAIL (SACK)
EC-11	ES-0021	TRENCH BREAKER DETAIL (FOAM)
EC-12	ES-0022	PERMANENT TRENCH BREAKER OPTIONS
EC-13	ES-0023	EROSION CONTROL FABRIC INSTALLATION
EC-14	ES-0024	TYPICAL EROSION CONTROL BLANKETS ON SLOPES
WATER DISCHARGES (WD)		
WD-1	ES-0025	FILTER BAG
WD-2	ES-0026	DISCHARGE STRUCTURE FOR HYDROSTATIC TEST WATER
WD-3	ES-0027	OPTIONS FOR SMALL WATER DISCHARGES
WD-4	ES-0028	DISCHARGE OF HYDROSTATIC TEST WATER TO A SURFACE WATER
BRIDGES (BR)		
BR-1	ES-0029	TEMPORARY EQUIPMENT BRIDGE (EQUIPMENT PADS WITH OR WITHOUT CULVERTS)
BR-2	ES-0030	TEMPORARY EQUIPMENT BRIDGE (CRUSHED STONE WITH CULVERTS)
BR-3	ES-0031	TEMPORARY EQUIPMENT BRIDGE (FLEXI-FLOAT OR PORTABLE BRIDGE)
WATERBODY AND WETLAND CROSSINGS (WC)		
WC-1	ES-0032	TYPICAL STANDARD WETLAND CROSSING
WC-2	ES-0033	TYPICAL WET WATERBODY CROSSING
WC-3	ES-0034	TYPICAL FLUME WATERBODY CROSSING
WC-4	ES-0035	TYPICAL DAM-AND-PUMP WATERBODY CROSSING
WC-5	ES-0036	TYPICAL EROSION CONTROL BLANKETS ON STREAMBANKS
WC-6	ES-0037	TYPICAL RIP-RAP PLACEMENT
SPECIAL USE / AGRICULTURAL AREAS (SU)		
SU-1	ES-0038	DRAIN TILE REPAIR PROCEDURE

Q:\S-U\SPE\2013-200.00\AutoCAD\Final\es0000.dwg
Wayne Sicora 6/9/2014 4:44 PM
I.G. ES0000.DWG

INDEX OF FIGURES

APPENDIX A

DWG. ES-0000 REV.



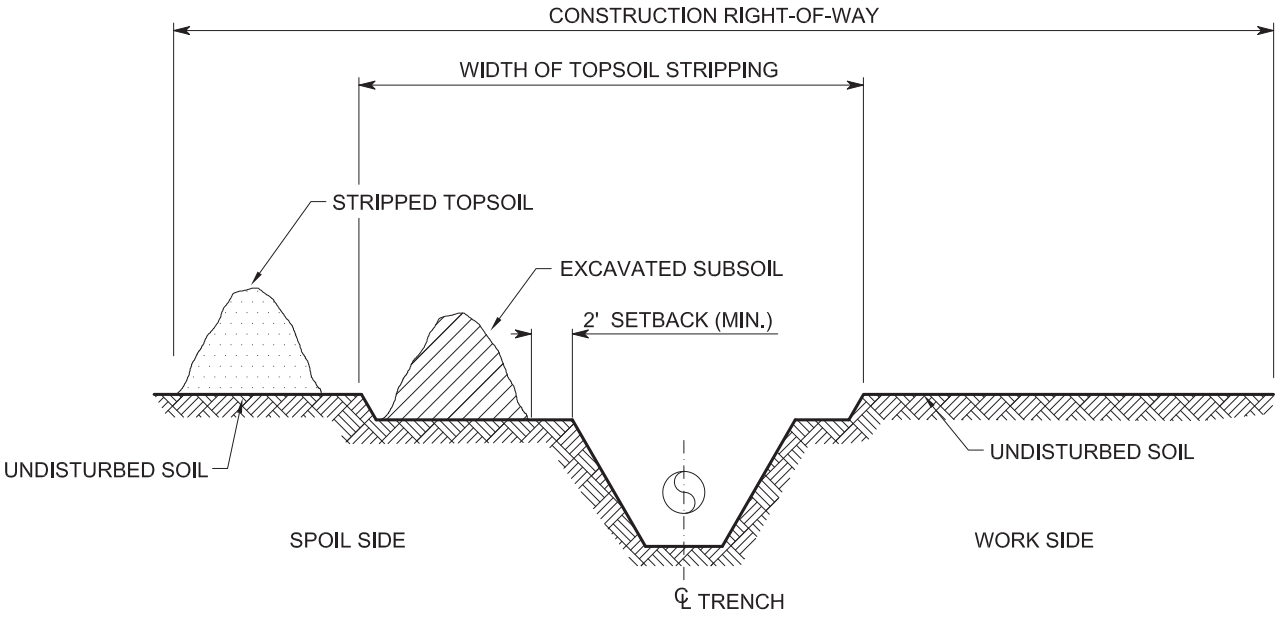
CROSS-SECTION VIEW

NOTES:

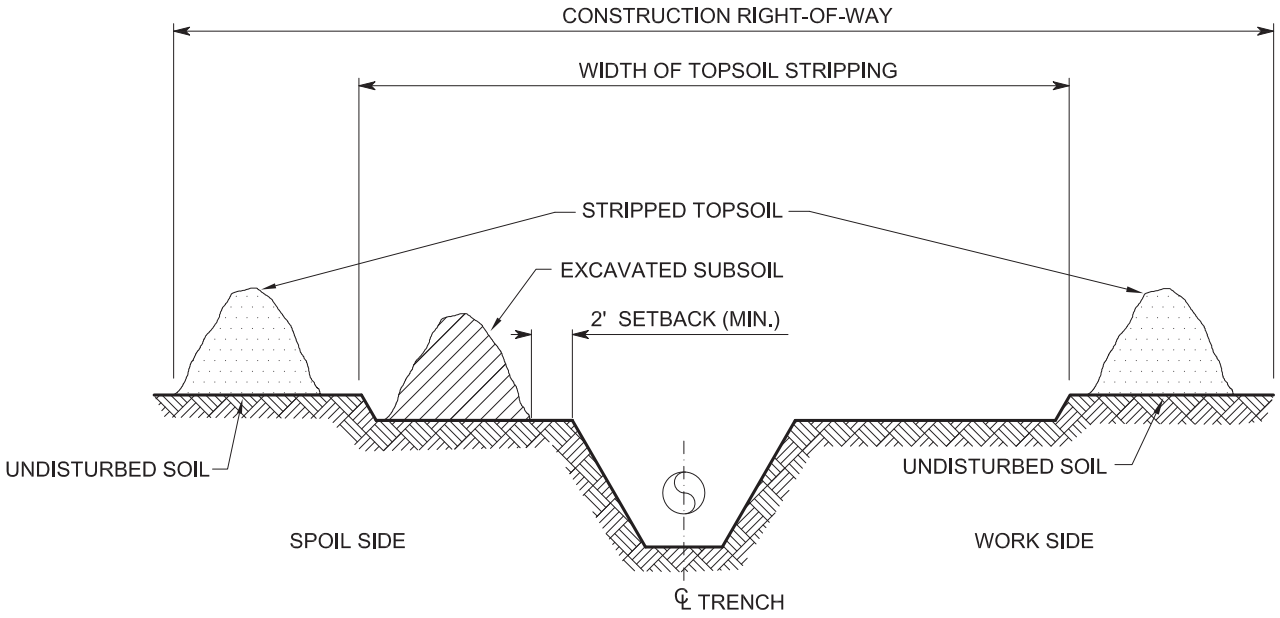
1. ALL PRECONSTRUCTION CONTOURS WILL BE RE-ESTABLISHED UPON COMPLETION OF PIPE INSTALLATION. EXCEPT IN WETLANDS, A CROWN MAY BE LEFT TO ACCOUNT FOR DITCH SETTLING, AS DIRECTED BY THE ENVIRONMENTAL INSPECTOR.
2. IN COLD WATER FISHERY STREAMS, THE TOP 12" OF THE TRENCH WILL BE BACKFILLED WITH CLEAN GRAVEL OR NATIVE COBBLES UNLESS OTHERWISE SPECIFIED BY THE PERMITTING AGENCY.

	TYPICAL TRENCH DETAIL	FIGURE CW-1
		DWG. ES-0001 REV.

Q:\S-U\SPE\2013-200.00\AutoCAD\Final\es0001.dwg
Wayne Sicora
5/28/2014 11:36 AM
I.G. ES0001.DWG



DITCH PLUS SPOILSIDE TOPSOIL SEGREGATION



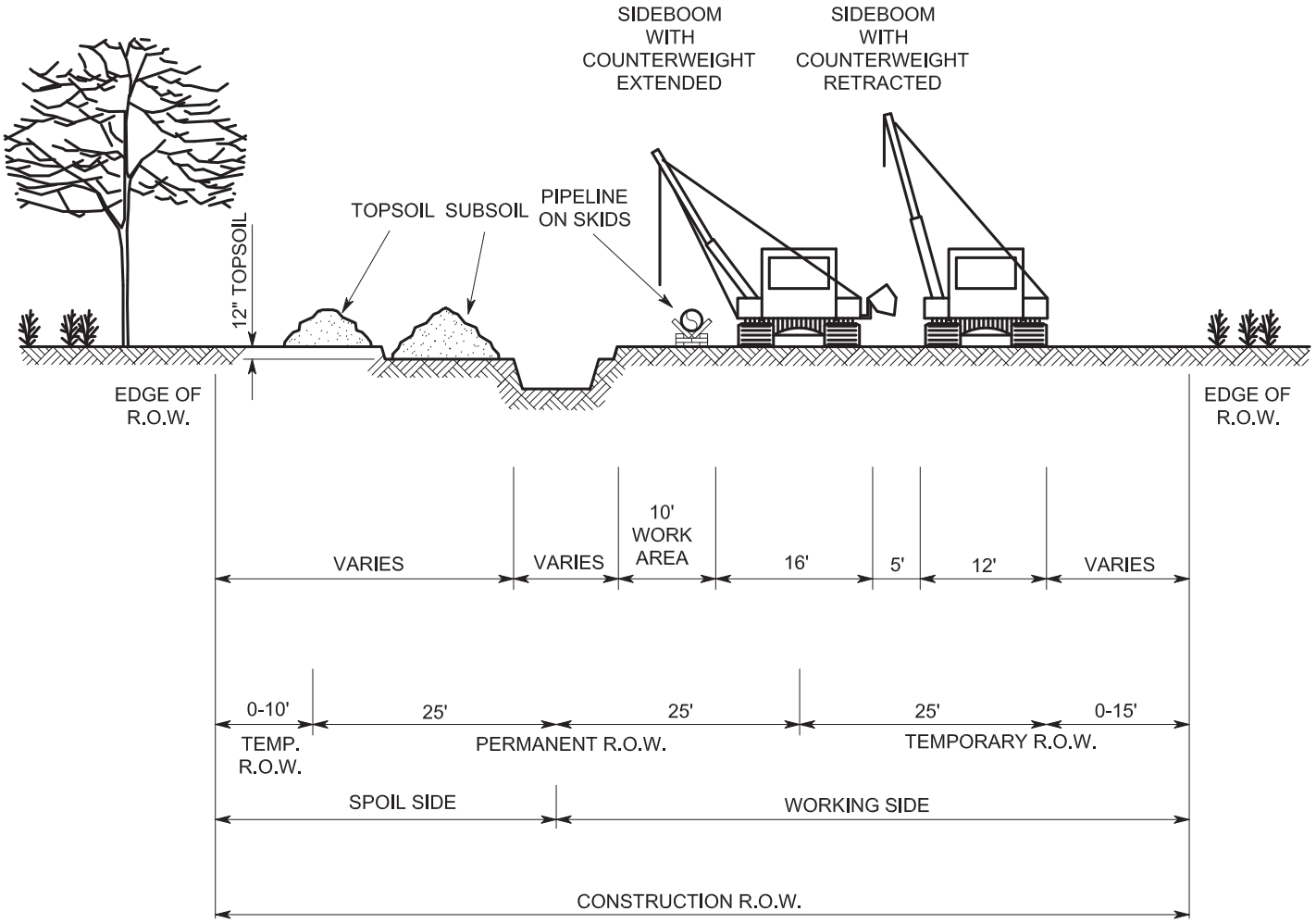
FULL RIGHT-OF-WAY TOPSOIL STRIPPING

NOTES:

1. TOPSOIL MAY BE STORED IN LOCATIONS AS SHOWN ABOVE OR AT OTHER COMPANY APPROVED LOCATIONS WITHIN THE CONSTRUCTION R.O.W.
2. LEAVE GAPS IN SPOIL PILES FOR WATER RUN-OFF.
3. MAINTAIN SEPARATION OF SALVAGED TOPSOIL AND SUBSOIL THROUGHOUT ALL CONSTRUCTION ACTIVITIES.
4. STABILIZE TOPSOIL PILES AND MINIMIZE LOSS DUE TO WATER OR WIND EROSION WITH USE OF SEDIMENT BARRIERS, MULCH, TEMPORARY SEEDING, TACKIFIERS OR FUNCTIONAL EQUIVALENTS, WHERE NECESSARY.

	RIGHT-OF-WAY TOPSOIL SEGREGATION TECHNIQUES	FIGURE CW-2
		DWG. ES-0002 REV.

Q:\S-U\SPE\2013-200.00\AutoCAD\Final\es0002.dwg
Wayne Sicora 6/9/2014 3:59 PM
I.G. ES0002.DWG



PIPE DIAMETER	SPOIL SIDE (FT.)	WORKING SIDE (FT.)	CONSTRUCTION R.O.W. (FT.)
12" OR LESS	25	50	75
14" - 30"	35	50	85
36" - 42"	35	65	100
WETLANDS	25	50	75

NOTES:

1. ALTHOUGH THE DIMENSIONS SHOWN ARE TYPICAL, SOME VARIATIONS MAY EXIST DUE TO SITE SPECIFIC CONDITIONS. UNLESS OTHERWISE INDICATED ON THE ALIGNMENT SHEETS, THE MAXIMUM WIDTH OF THE CONSTRUCTION RIGHT-OF-WAY SHALL BE AS SHOWN IN THE TABLE FOR THE APPROPRIATE PIPE DIAMETER.

2. TOPSOIL SEGREGATION METHODS WILL BE USED IN ALL RESIDENTIAL AREAS AND WHEN THE CONSTRUCTION ROW IS WIDER THAN 30 FEET IN CULTIVATED OR ROTATED AGRICULTURAL LANDS, MANAGED PASTURES, HAYFIELDS, AND OTHER AREAS AT THE LANDOWNER'S OR LAND MANAGEMENT AGENCY'S REQUEST. FOR WETLANDS, SEGREGATE THE TOP 12 INCHES OF TOPSOIL WITHIN THE DITCH LINE, EXCEPT IN AREAS WHERE STANDING WATER IS PRESENT OR SOILS ARE SATURATED.

TYPICAL CONSTRUCTION WIDTHS ACQUIRING NEW PERMANENT RIGHT-OF-WAY

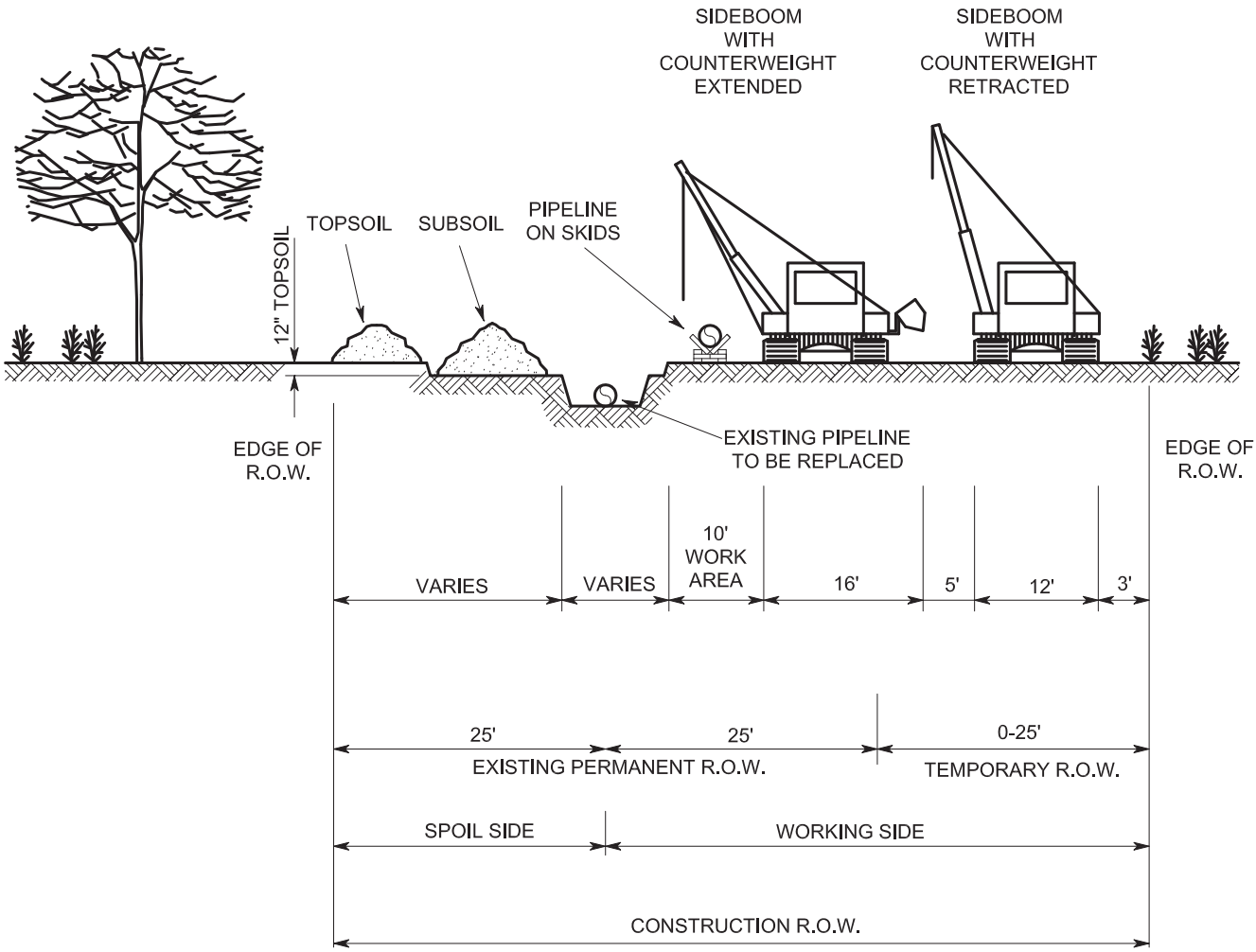
FIGURE CW-3

DWG. ES-0003 REV.

I.G. ES0003.DWG

Wayne Sicora 5/28/2014 11:44 AM

Q:\S-U\SPE\2013-200.00\AutoCAD\Final\es0003.dwg



PIPE DIAMETER	SPOIL SIDE (FT.)	WORKING SIDE (FT.)	CONSTRUCTION R.O.W. (FT.)
12" OR LESS	25	25	50
14" - 30"	25	50	75
36" - 42"	25	50	75
WETLANDS	25	50	75

NOTES:

1. ALTHOUGH THE DIMENSIONS SHOWN ARE TYPICAL, SOME VARIATIONS MAY EXIST DUE TO SITE SPECIFIC CONDITIONS. UNLESS OTHERWISE INDICATED ON THE ALIGNMENT SHEETS, THE MAXIMUM WIDTH OF THE CONSTRUCTION RIGHT-OF-WAY SHALL BE AS SHOWN IN THE TABLE FOR THE APPROPRIATE PIPE DIAMETER.

2. TOPSOIL SEGREGATION METHODS WILL BE USED IN ALL RESIDENTIAL AREAS AND WHEN THE CONSTRUCTION ROW IS WIDER THAN 30 FEET IN CULTIVATED OR ROTATED AGRICULTURAL LANDS, MANAGED PASTURES, HAYFIELDS, AND OTHER AREAS AT THE LANDOWNER'S OR LAND MANAGEMENT AGENCY'S REQUEST. FOR WETLANDS, SEGREGATE THE TOP 12 INCHES OF TOPSOIL WITHIN THE DITCH LINE, EXCEPT IN AREAS WHERE STANDING WATER IS PRESENT OR SOILS ARE SATURATED.

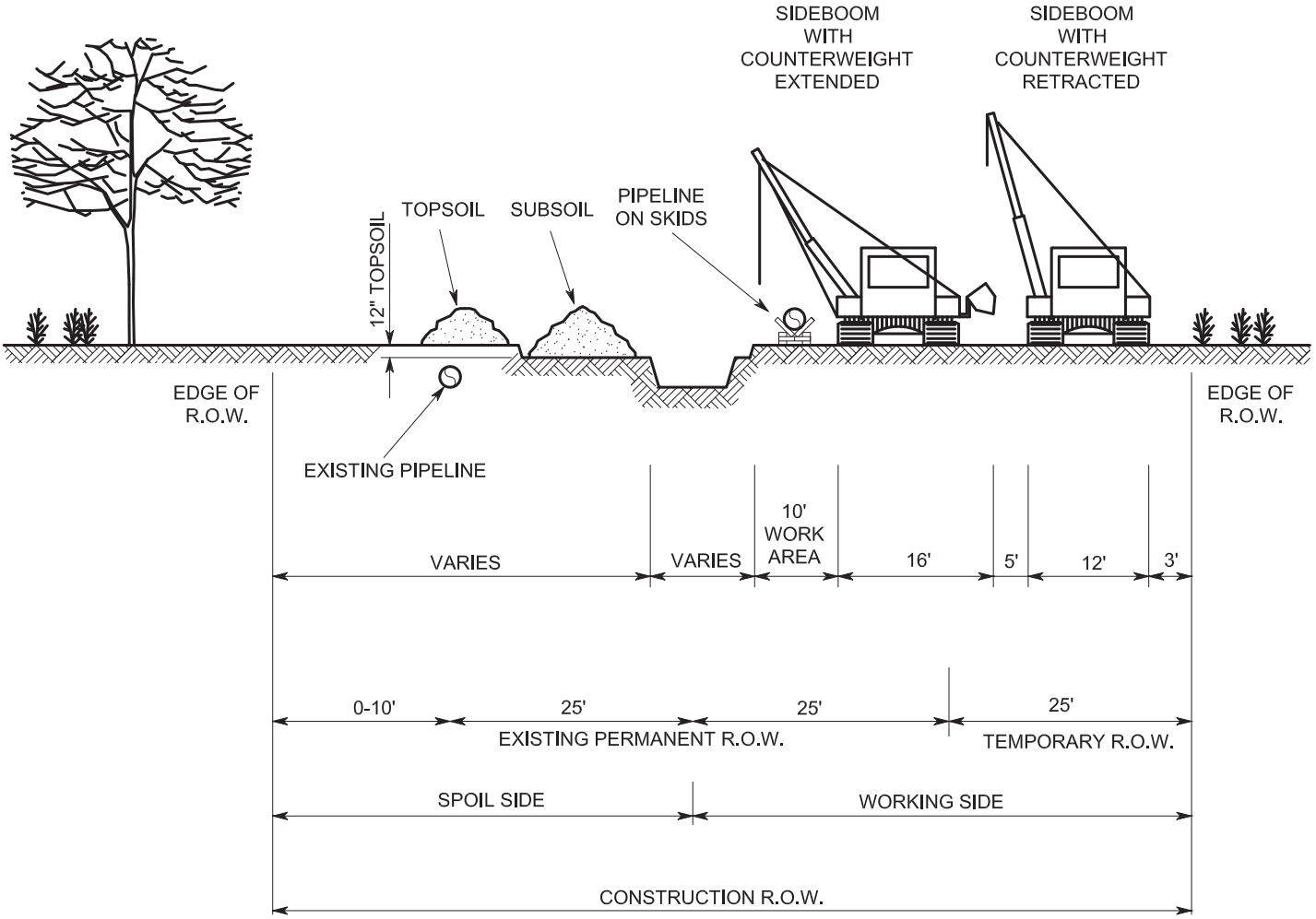
3. IF THE WORKING SIDE MUST BE GREATER THAN THE VALUES SHOWN IN THE TABLE, COMPANY MUST REQUEST APPROVAL FROM THE F.E.R.C.

TYPICAL CONSTRUCTION WIDTHS NOT ACQUIRING NEW PERMANENT RIGHT-OF-WAY (SINGLE LINE SYSTEM)

FIGURE CW-4

DWG. ES-0004 REV.

Q:\S-U\SPE\2013-200.00\AutoCAD\Final\es0004.dwg
Wayne Sicora 5/28/2014 11:46 AM
I.G. ES0004.DWG



PIPE DIAMETER	SPOIL SIDE (FT.)	WORKING SIDE (FT.)	CONSTRUCTION R.O.W. (FT.)
12" OR LESS	25	50	75
14" - 30"	35	50	85
36" - 42"	35	50	85
WETLANDS	25	50	75

NOTES:

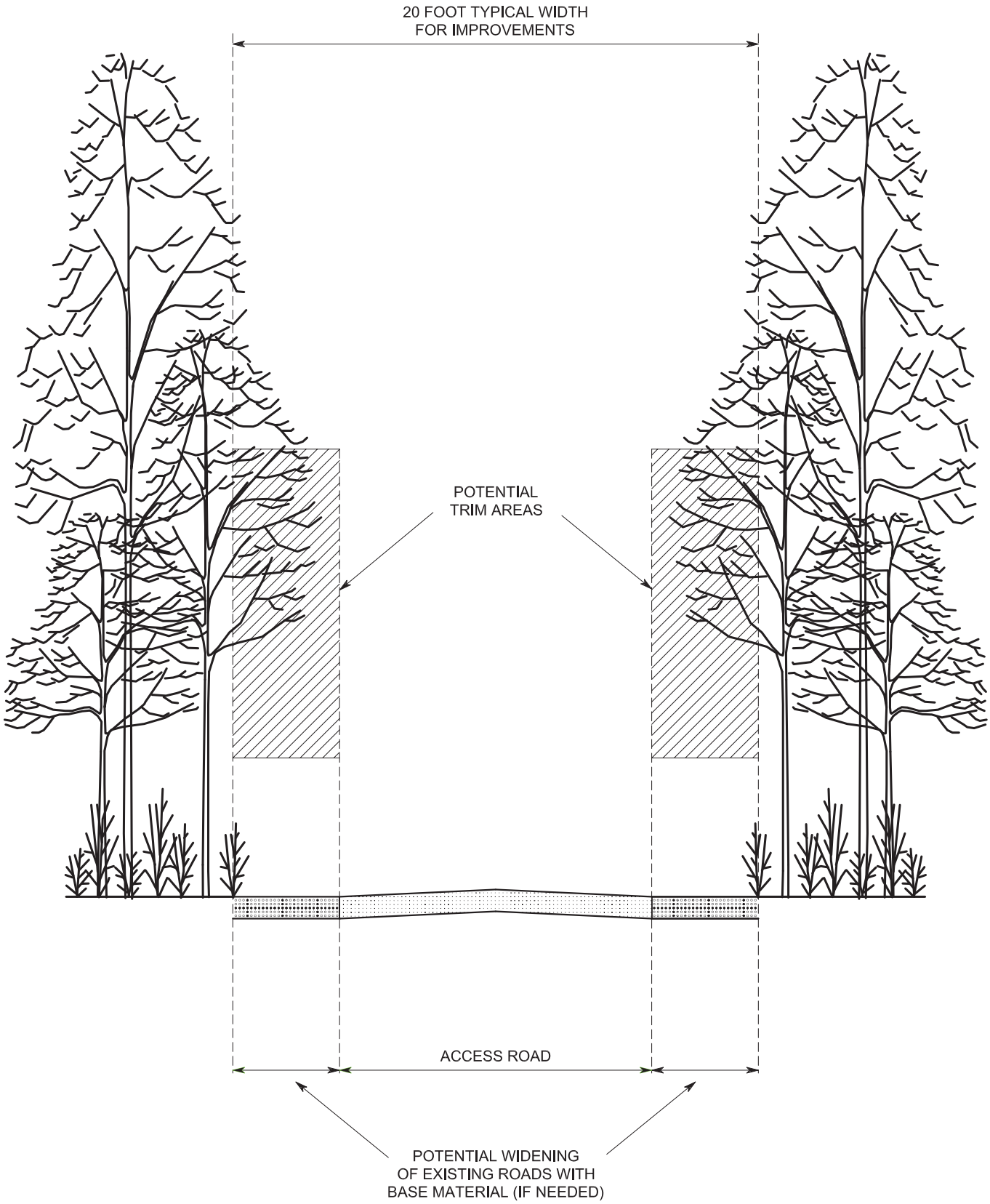
1. ALTHOUGH THE DIMENSIONS SHOWN ARE TYPICAL, SOME VARIATIONS MAY EXIST DUE TO SITE SPECIFIC CONDITIONS. UNLESS OTHERWISE INDICATED ON THE ALIGNMENT SHEETS, THE MAXIMUM WIDTH OF THE CONSTRUCTION RIGHT-OF-WAY SHALL BE AS SHOWN IN THE TABLE FOR THE APPROPRIATE PIPE DIAMETER.

2. TOPSOIL SEGREGATION METHODS WILL BE USED IN ALL RESIDENTIAL AREAS AND WHEN THE CONSTRUCTION ROW IS WIDER THAN 30 FEET IN CULTIVATED OR ROTATED AGRICULTURAL LANDS, MANAGED PASTURES, HAYFIELDS, AND OTHER AREAS AT THE LANDOWNER'S OR LAND MANAGEMENT AGENCY'S REQUEST. FOR WETLANDS, SEGREGATE THE TOP 12 INCHES OF TOPSOIL WITHIN THE DITCH LINE, EXCEPT IN AREAS WHERE STANDING WATER IS PRESENT OR SOILS ARE SATURATED.

3. IF THE WORKING SIDE MUST BE GREATER THAN 50 FEET (i.e. TEMPORARY WORKSPACE IS GREATER THAN 25 FEET), COMPANY MUST REQUEST APPROVAL FROM THE F.E.R.C.

	TYPICAL CONSTRUCTION WIDTHS NOT ACQUIRING NEW PERMANENT RIGHT-OF-WAY (MULTIPLE LINE SYSTEM)	FIGURE CW-5
		DWG. ES-0005 REV.

Q:\S-U\SPE\2013-200.00\AutoCAD\Final\es0005.dwg
Wayne Sicora 5/28/2014 11:47 AM
I.G. ES0005.DWG



ACCESS ROAD CROSS SECTION

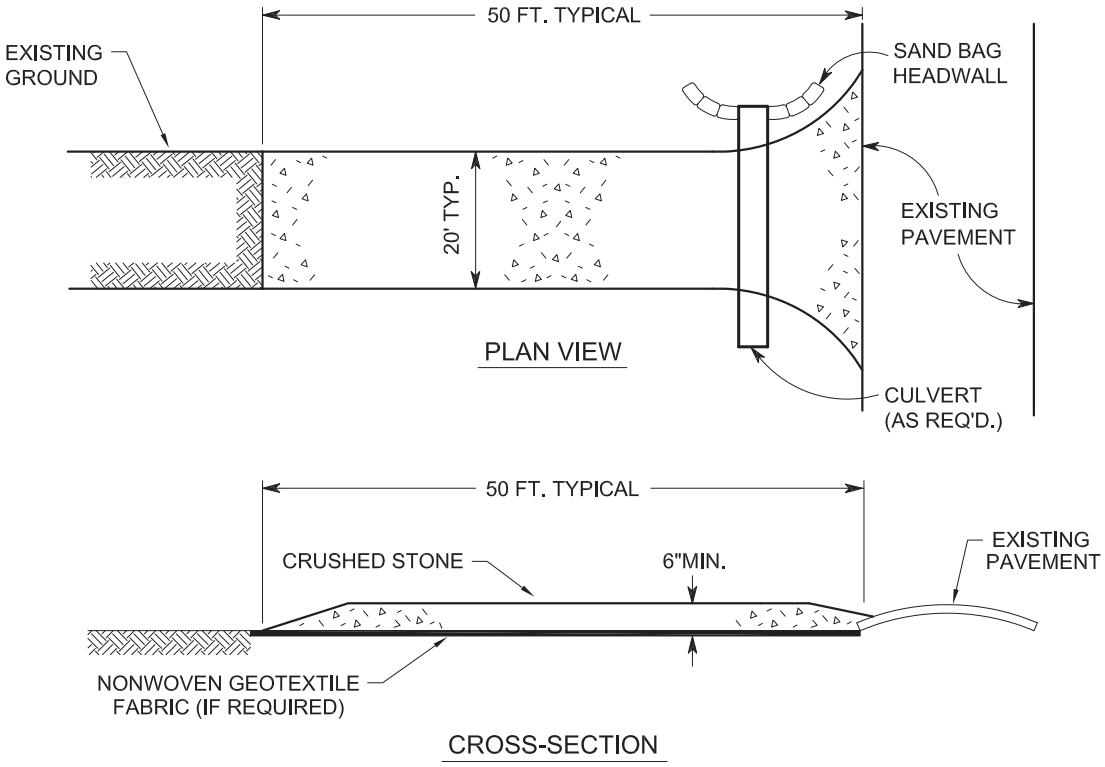
FIGURE RD-1

DWG. ES-0006 REV.

I.G. ES0006.DWG

Wayne Sicora
5/28/2014 12:43 PM

Q:\S-U\SPE\2013-200.00\AutoCAD\Final\es0006.dwg



CONSTRUCTION SPECIFICATIONS:

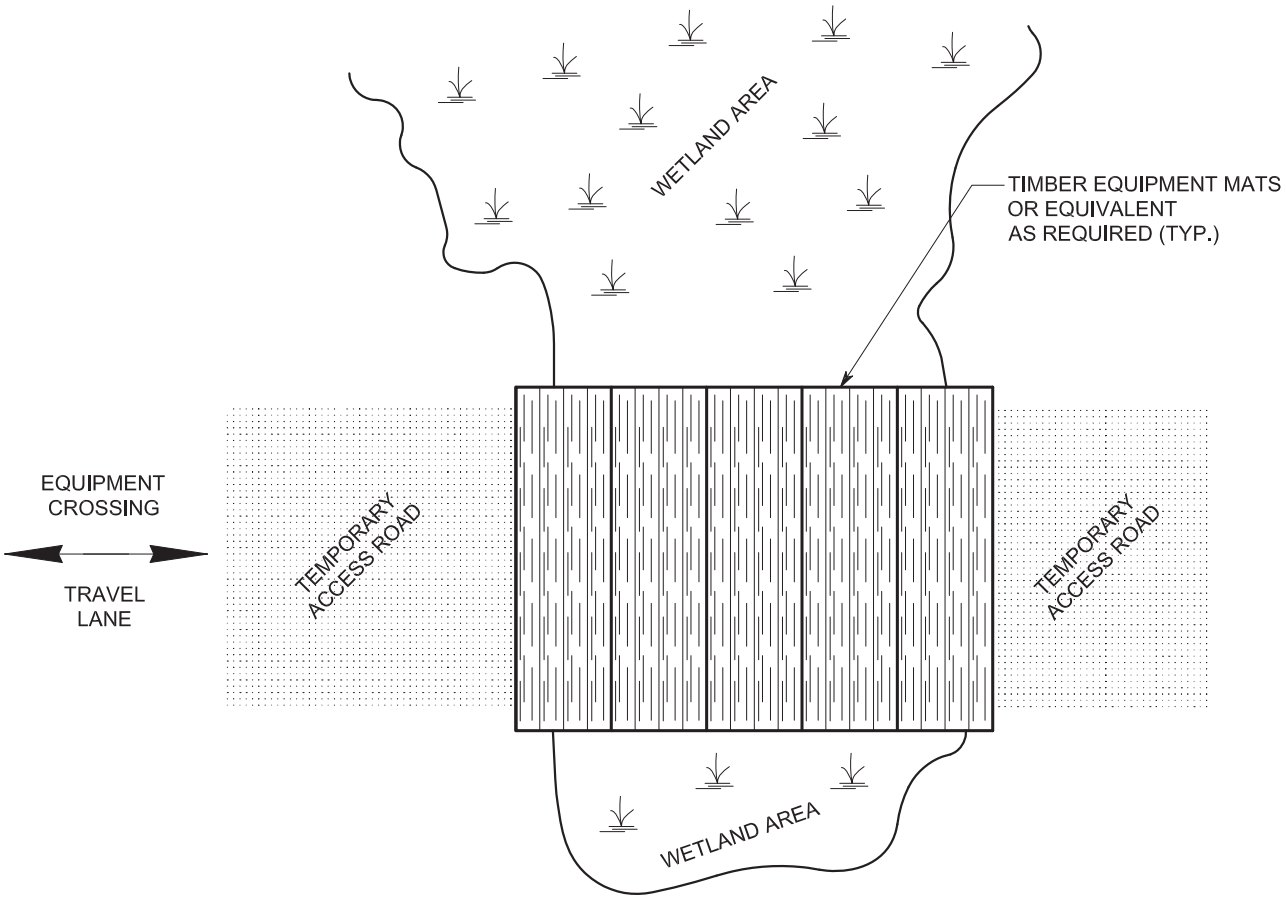
1. STONE SIZE = 4" - 6" AVG. DIAMETER
2. ALL STONE MUST BE PLACED ON NON-WOVEN GEOTEXILE FABRIC IF USED IN RESIDENTIAL OR AGRICULTURAL AREAS.
3. LENGTH = FIFTY (50) FOOT TYPICAL (IF SITE CONDITIONS ALLOW)
4. WIDTH = TWENTY (20) FOOT TYPICAL.
5. THICKNESS = SIX (6) INCHES MINIMUM.
6. ALL SURFACE WATER FLOWING OR DIVERTED TOWARD CONSTRUCTION ENTRANCES SHALL BE PIPED ACROSS THE ENTRANCE. IF PIPING IS IMPRACTICAL, A DRIVEABLE BERM OR OTHER TEMPORARY EROSION CONTROL DEVICE CAN BE USED.
7. THE ENTRANCE SHALL BE PERIODICALLY INSPECTED AND MAINTAINED IN A CONDITION THAT MINIMIZES TRACKING OR FLOWING OF SEDIMENT ONTO ROADWAYS. MAINTENANCE MAY INCLUDE PERIODIC TOP DRESSING WITH ADDITIONAL STONE OR THE REPAIR / CLEANOUT OF ANY MEASURES USED TO TRAP SEDIMENT. ANY SEDIMENT THAT IS SPILLED, DROPPED, WASHED OR TRACKED ONTO ROADWAYS MUST BE REMOVED AS SOON AS PRACTICAL.

Q:\S-U\SPE\2013-200.00\AutoCAD\Final\es0007.dwg
Wayne Sicora 6/9/2014 4:01 PM
I.G. ES0007.DWG

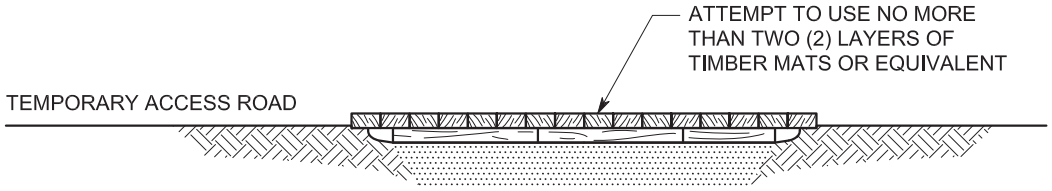
ROCK ACCESS PAD

FIGURE RD-2

DWG. ES-0007 REV.



PLAN VIEW
NOT TO SCALE



CROSS-SECTION
NOT TO SCALE

NOTE:

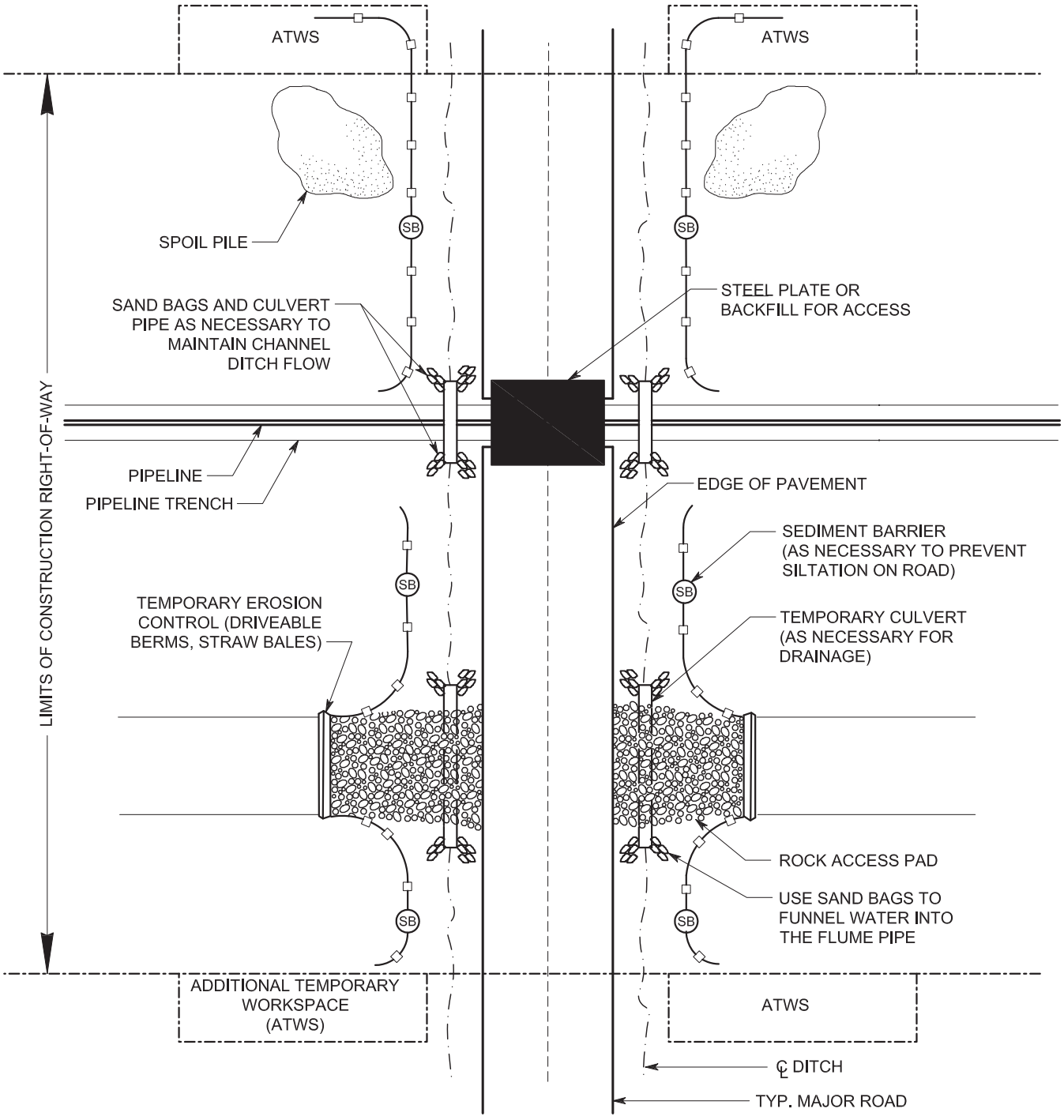
1. SILT FENCE OR STRAW BALES MAY BE USED, AS NECESSARY, TO PREVENT SEDIMENT FROM MIGRATING OUTSIDE OF ACCESS ROAD LIMITS.

Q:\S-U\SPE\2013-200.00\AutoCAD\Final\es0008.dwg
Wayne Sicora
5/28/2014 11:55 AM
I.G. ES0008.DWG

TYPICAL TEMPORARY ACCESS ROAD THROUGH WETLANDS

FIGURE RD-3

DWG. ES-0008 REV.



NOTES:

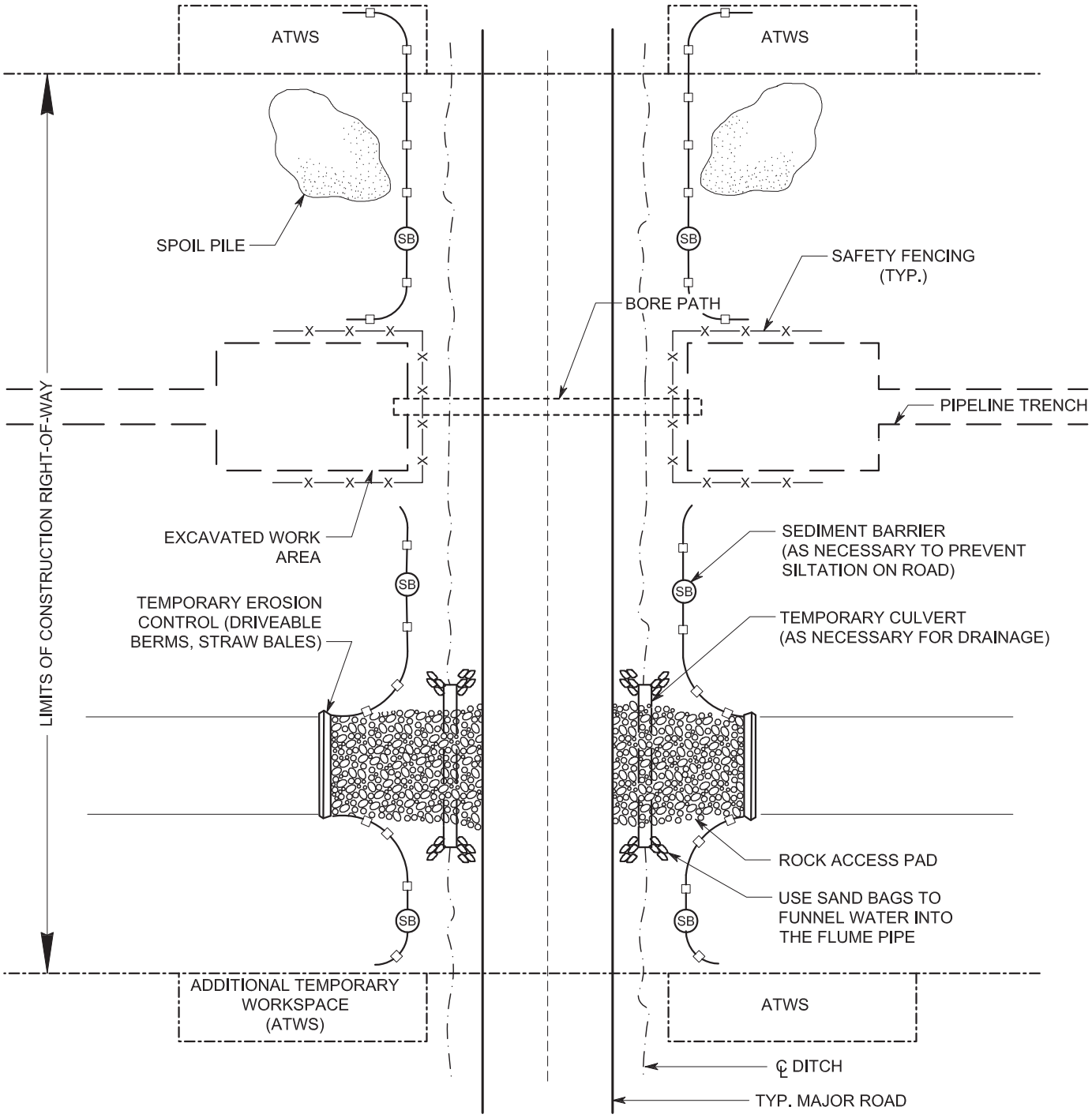
1. FIRST LAY SAND BAGS IN DITCH, THEN PLACE END OF CULVERT IN THE MIDDLE OF THE SAND BAGS BEFORE BUILDING HEAD WALLS TO CULVERT.
2. (SB) TEMPORARY SEDIMENT BARRIER OF SILT FENCE AND/OR STRAW BALES, OR OTHER APPROPRIATE MATERIALS.

	TYPICAL PAVED ROAD CROSSING CONTROL MEASURES (OPEN CUT)	FIGURE RD-4
		DWG. ES-0009 REV.

I.G. ES0009.DWG

Wayne Sicora 5/28/2014 11:57 AM

Q:\S-U\SPE\2013-200.00\AutoCAD\Final\es0009.dwg



NOTES:

1. BORE PIT DIMENSIONS WILL BE DICTATED BY SITE-SPECIFIC CONDITIONS (E.G. SOIL TYPE, WIDTH OF ROAD, DEPTH OF COVER).
2. (SB) TEMPORARY SEDIMENT BARRIER OF SILT FENCE AND/OR STRAW BALES, OR OTHER APPROPRIATE MATERIALS.

Q:\S-U\SPE\2013-200.00\AutoCAD\Final\es0010.dwg

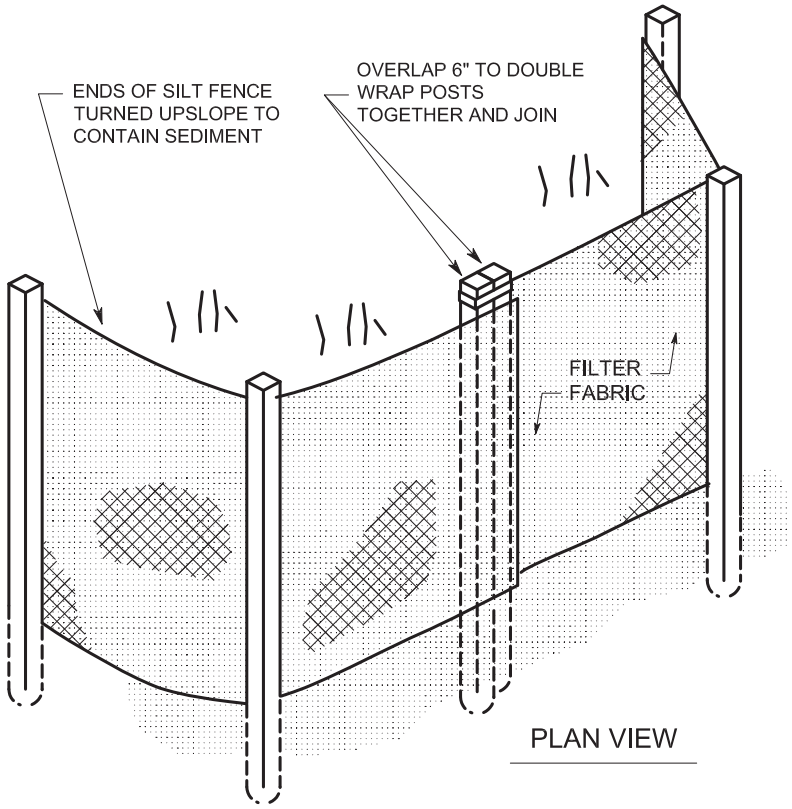
Wayne Sicora
2/28/2014 2:07 PM

I.G. ES0010.DWG

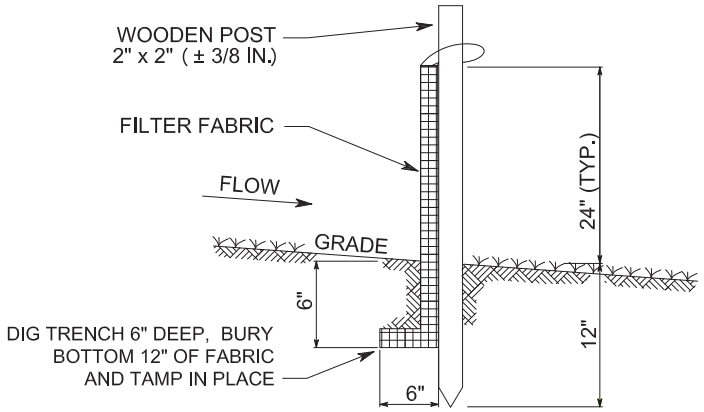
TYPICAL PAVED ROAD CROSSING CONTROL MEASURES (BORED)

FIGURE RD-5

DWG. ES-0010 REV.



PLAN VIEW



CROSS SECTION

INSTALLATION REQUIREMENTS:

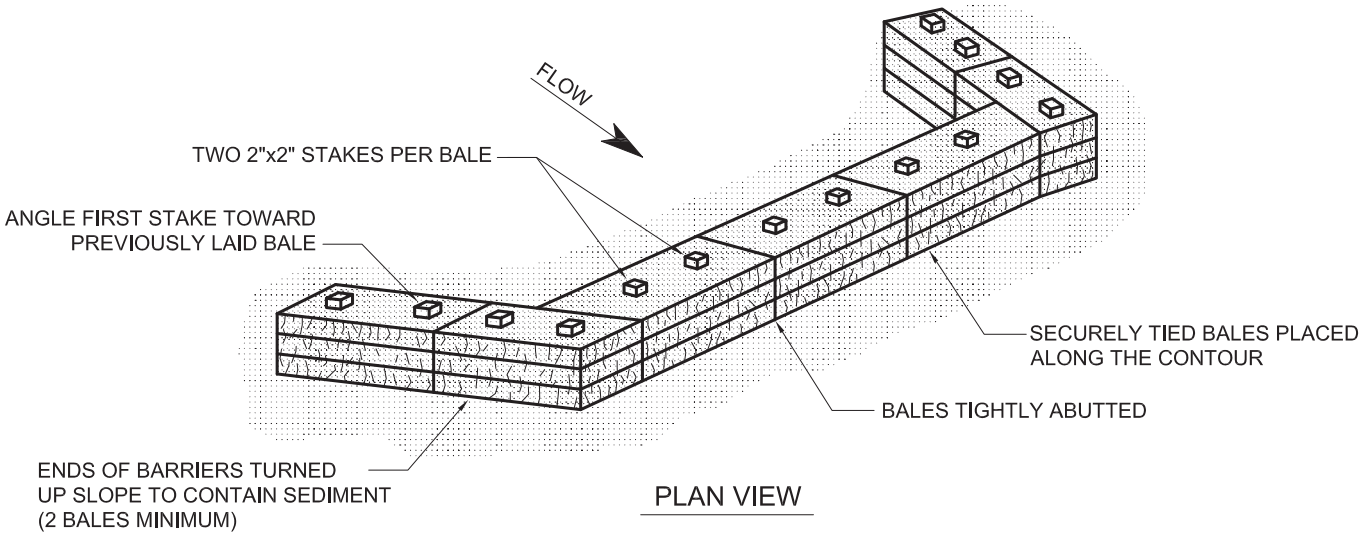
- WHEN USING SILT FENCE, PLACE IT:
  - BETWEEN DISTURBED AREAS AND DOWN-SLOPE ENVIRONMENTAL RESOURCE AREAS
  - AT THE BASE OF ALL SLOPES NEXT TO WETLANDS, WATERBODIES, AND ROAD CROSSINGS
  - AT THE INLET AND OUTLET OF OPEN DRAINAGE STRUCTURES
  - APPROXIMATELY 8 FEET BEYOND THE TOE OF THE SLOPE TO GIVE THE SEDIMENT ROOM TO COLLECT (IF POSSIBLE)
- USE SANDBAGS OR BACKFILLING TO KEY IN THE BOTTOM OF THE FABRIC WHERE IT IS NOT FEASIBLE TO TRENCH IT IN (LEDGES, ROCKY SOIL, LARGE ROOTS, ETC.)

MAINTENANCE REQUIREMENTS:

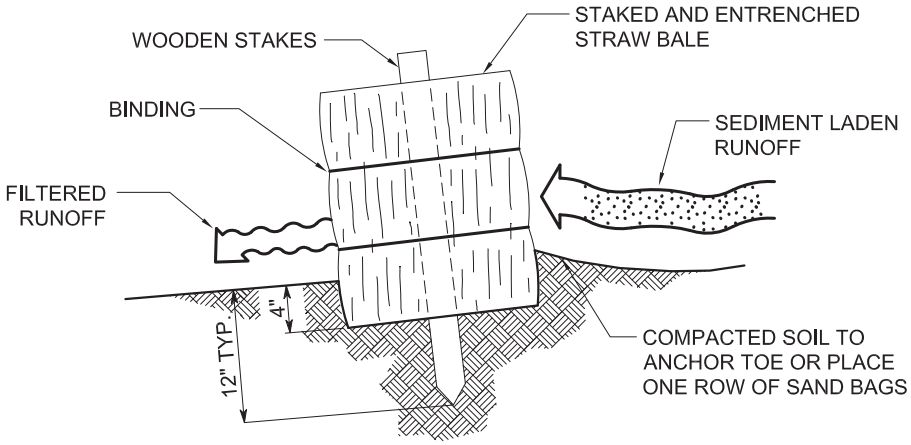
- INSPECT SILT FENCE:
  - DAILY IN AREAS OF ACTIVE CONSTRUCTION
  - WEEKLY IN AREAS WITH NO CONSTRUCTION
  - WITHIN 24 HOURS FOLLOWING EACH RAINFALL EVENT OF ≥ 0.5 INCH.
- REPAIR OR REPLACE SILT FENCE AS NEEDED
- REMOVE ACCUMULATED SEDIMENTS TO AN UPLAND AREA WHEN SEDIMENT REACHES 1/2 THE ABOVE GROUND HEIGHT OF THE SILT FENCE.

	SILT FENCE DETAIL	FIGURE EC-1
		DWG. ES-0011 REV.

Q:\S-U\SPE\2013-200.00\AutoCAD\Final\es0011.dwg
Wayne Sicora 6/5/2014 8:38 AM
I.G. ES0011.DWG



PLAN VIEW



CROSS-SECTION

INSTALLATION REQUIREMENTS:

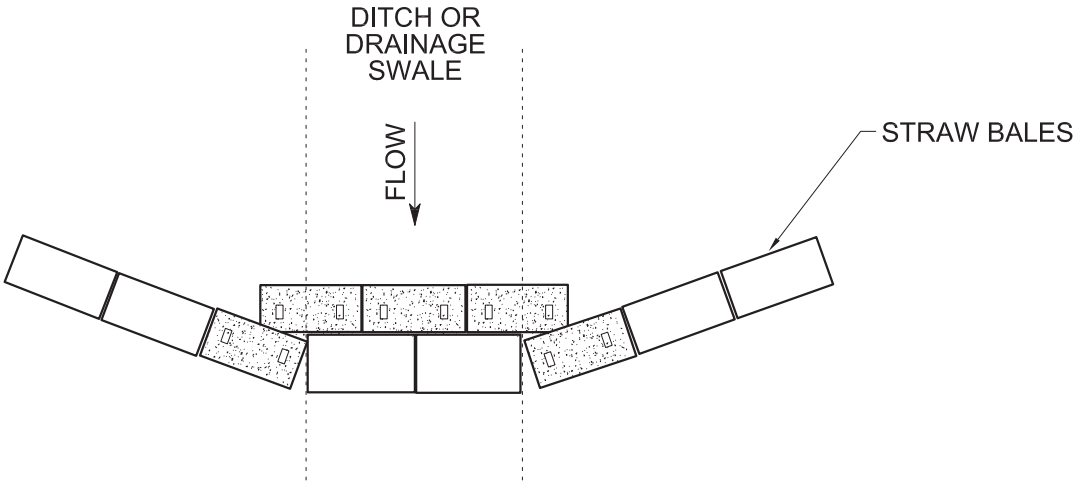
- WHEN USING STRAW BALES, PLACE THEM:
  - WITH THEIR ENDS TIGHTLY ABUTTING AND EMBEDDED IN THE SOIL A TYPICAL OF 4".
  - BETWEEN DISTURBED AREAS AND DOWN-SLOPE ENVIRONMENTAL RESOURCE AREAS.
  - AT THE BASE OF ALL SLOPES NEXT TO WETLANDS, WATERBODIES, AND ROAD CROSSINGS
  - AT THE INLET AND OUTLET OF OPEN DRAINAGE STRUCTURES.
  - APPROXIMATELY 6 FEET BEYOND THE TOE OF THE SLOPE TO GIVE THE SEDIMENT ROOM TO COLLECT.
- KEY IN THE BOTTOM OF THE BALE. IN AREAS WHERE IT IS NOT FEASIBLE TO TRENCH IT IN (LEDGES, ROCKY SOIL, LARGE TREE ROOTS, ETC.), USE NATIVE SOIL AS BACKFILL UP-SLOPE OF THE BALE OR PLACE ONE ROW OF SAND BAGS.
- DO NOT STAKE OR TRENCH IN PLACE STRAW BALES USED ON EQUIPMENT BRIDGES OR ON MATS ACROSS THE TRAVEL LANE.
- IF USED IN CONJUNCTION WITH SILT FENCE, BALES ARE PLACED DOWNSLOPE / UPSLOPE OF THE SILT FENCE AND DO NOT NEED TO BE TRENCHED IN.

MAINTENANCE REQUIREMENTS:

- INSPECT BALES:
  - DAILY IN AREAS OF ACTIVE CONSTRUCTION.
  - WEEKLY IN AREAS WITH NO CONSTRUCTION.
  - WITHIN 24 HOURS FOLLOWING EACH RAINFALL EVENT OF ≥ 0.5 INCH.
- REPAIR OR REPLACE BALES AS NEEDED.
- REMOVE ACCUMULATED SEDIMENTS TO AN UPLAND AREA AS NEEDED.

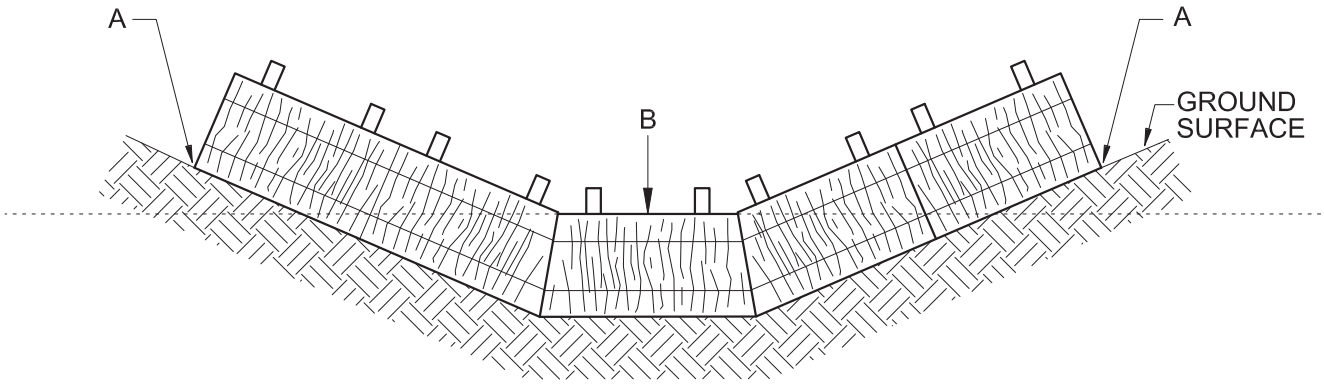
	STRAW BALE DETAIL	FIGURE EC-2
		DWG. ES-0012 REV.

Q:\S-U\SPE\2013-200.00\AutoCAD\Final\es0012.dwg
Wayne Sicora 5/29/2014 7:30 AM
I.G. ES0012.DWG



PLAN VIEW
NOT TO SCALE

POINTS A SHALL BE HIGHER THAN POINT B



CROSS-SECTION
NOT TO SCALE

NOTE:

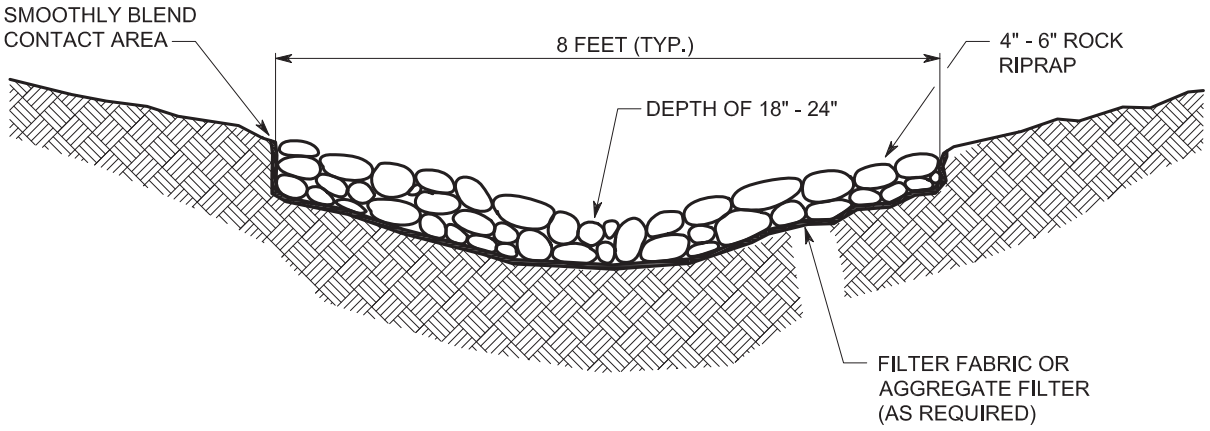
1. THE NUMBER OF BALES IS DETERMINED BASED ON SITE SPECIFIC FACTORS.

	STRAW BALE CHECK DAM IN A DRAINAGEWAY	FIGURE EC-3
		DWG. ES-0013 REV.

I.G. ES0013.DWG

Wayne Sicora
5/29/2014 7:35 AM

Q:\S-U\SPE\2013-200.00\AutoCAD\Final\es0013.dwg



INSTALLATION REQUIREMENTS:

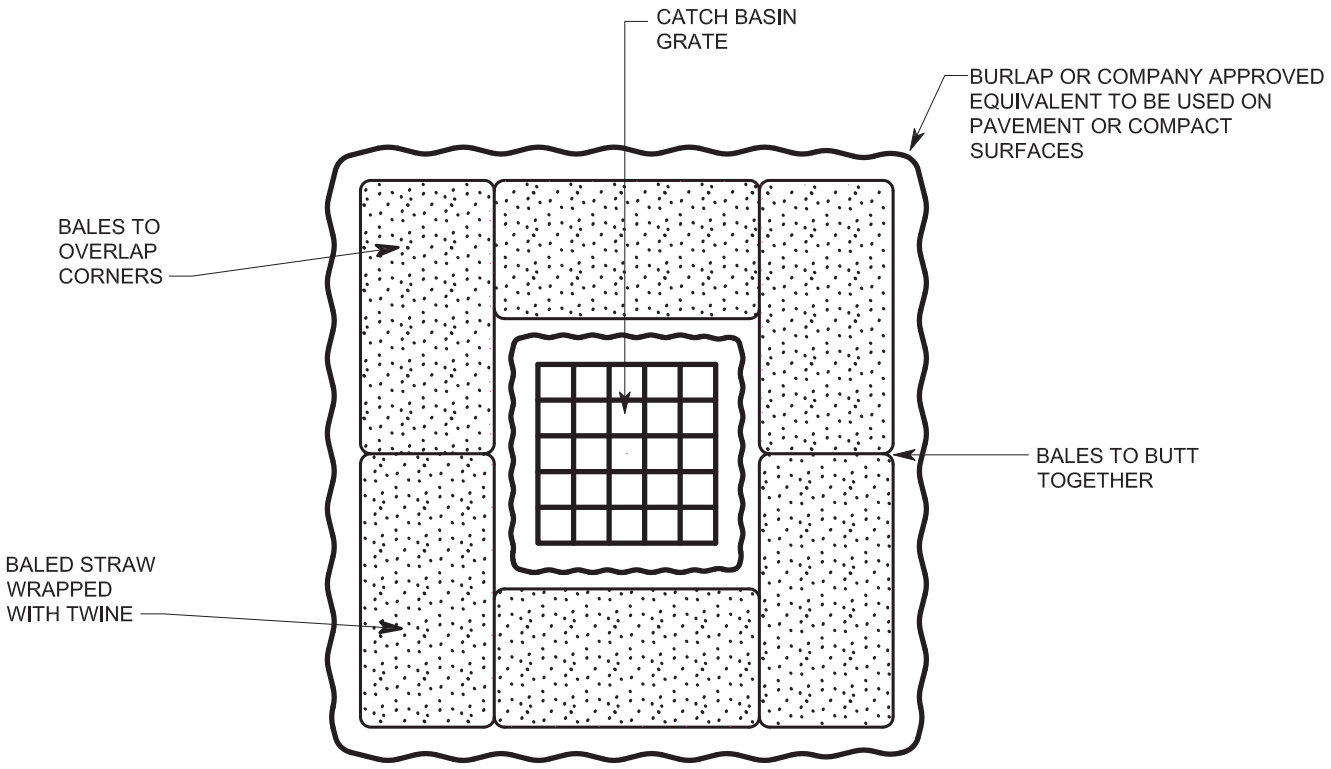
1. RIPRAP CHANNELS CAN BE CONSTRUCTED WITH GRASS-LINED SLOPES WHERE SITE CONDITIONS WARRANT.
2. STABILIZE CHANNEL INLET POINTS AND INSTALL OUTLET PROTECTION (AS NEEDED) DURING CHANNEL INSTALLATION.
3. INSTALL ENERGY DISSIPATING DEVICE (AS NEEDED) TO PREVENT SCOUR TO THE RECEIVING OUTLET.
4. REMOVE ALL TREES, BRUSH, AND OTHER OBJECTIONABLE MATERIAL FROM THE CHANNEL.
5. INSTALL FILTER FABRIC OR GRAVEL LAYER TO PREVENT PIPING (AS REQUIRED)

MAINTENANCE REQUIREMENTS:

1. INSPECT CHANNEL DURING AND FOLLOWING CONSTRUCTION AND MAKE REPAIRS AS NEEDED.
2. KEEP THE CHANNEL FREE OF DEBRIS AND OBSTRUCTIONS.

	ROCK-LINED DRAINAGE SWALE	FIGURE EC-4
		DWG. ES-0014 REV.

Q:\S-U\SPE\2013-200.00\AutoCAD\Final\es0014.dwg
Wayne Sicora 5/29/2014 8:06 AM
I.G. ES0014.DWG



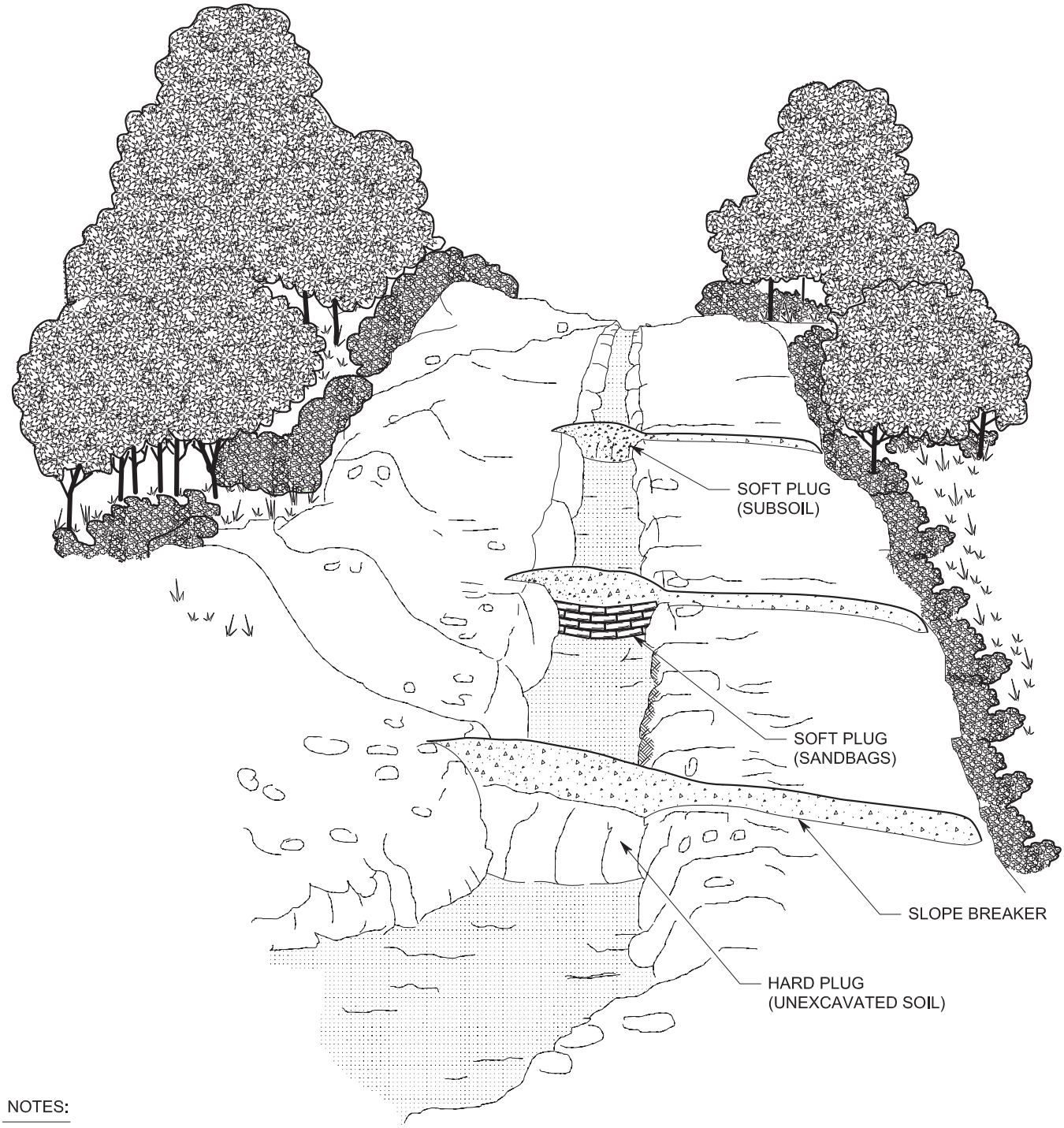
PLAN VIEW

NOTES:

1. SURROUND STREET DRAINAGE STRUCTURE INLET WITH STRAW BALES PRIOR TO CONSTRUCTION AND MAINTAIN UNTIL CONSTRUCTION IS COMPLETED.
2. FOR BALES PLACED ON PAVEMENT (OR COMPACT SURFACES), PLACE BURLAP OR COMPANY APPROVED EQUIVALENT BETWEEN PAVEMENT AND BALE.
3. REMOVE ACCUMULATED SEDIMENT.
4. AN ALTERNATIVE STORM DRAIN INLET PROTECTION MAY USE ONLY FABRIC LINING WITHOUT STRAW BALES BASED ON THE DISCRETION OF THE THE ENVIRONMENTAL INSPECTOR.

Q:\S-U\SPE\2013-200.00\AutoCAD\Final\es0015.dwg
Wayne Sicora
5/29/2014 8:23 AM
I.G. ES0015.DWG

	STORM DRAIN INLET PROTECTION	FIGURE EC-5
		DWG. ES-0015 REV.

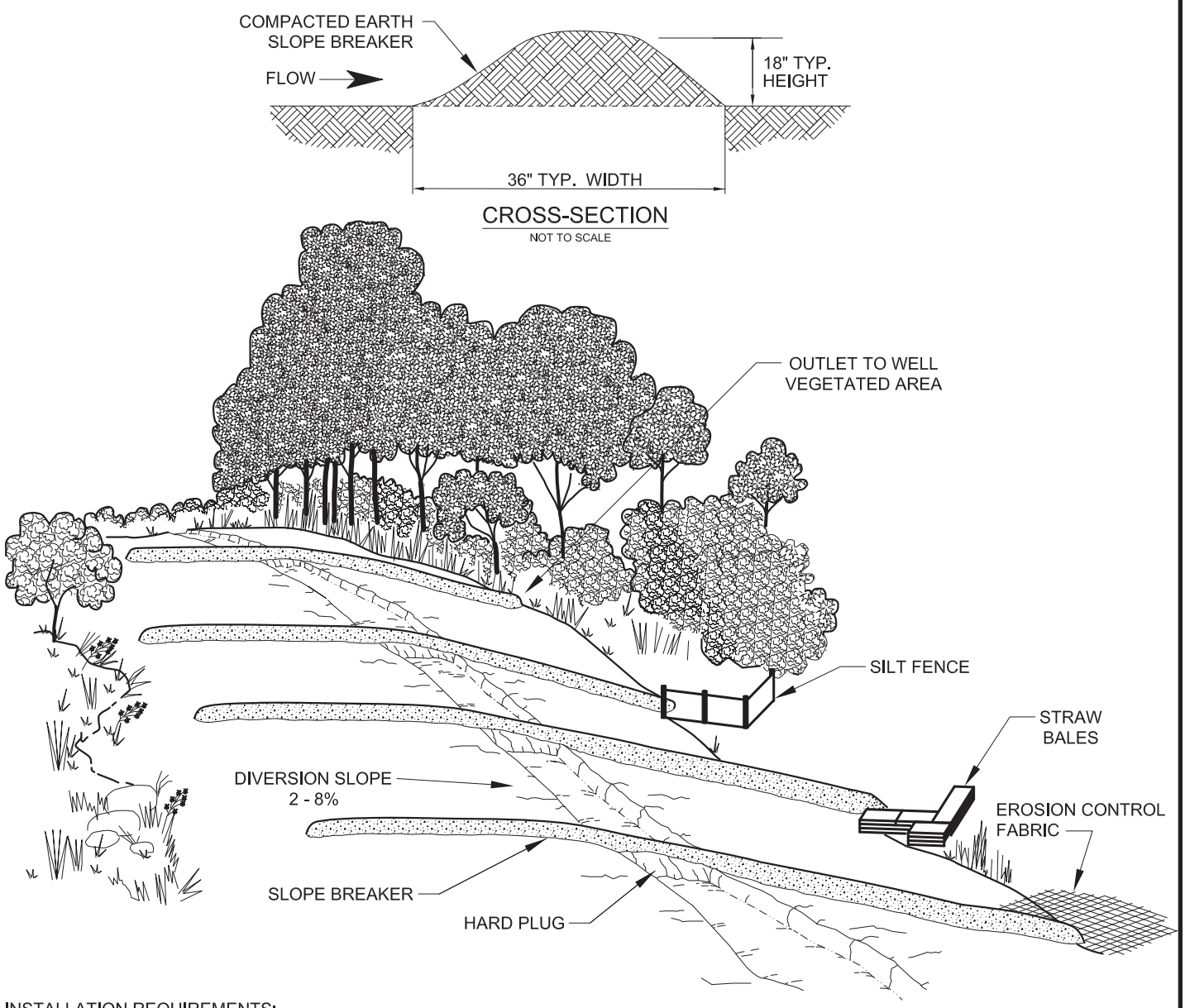


NOTES:

1. TEMPORARY TRENCH PLUG MATERIALS MAY CONSIST OF UNEXCAVATED PORTIONS OF THE TRENCH (HARD PLUG), COMPACTED SUBSOIL OR SANDBAGS PLACED ACROSS THE DITCH (SOFT PLUG), OR SOME FUNCTIONAL EQUIVALENT. THESE OPTIONS ARE DEPICTED ABOVE. DO NO USE TOPSOIL FOR TRENCH PLUGS.
2. POSITION TEMPORARY TRENCH PLUGS, AS NECESSARY, TO REDUCE TRENCHLINE EROSION AND MINIMIZE THE VOLUME AND VELOCITY OF TRENCH WATER FLOW AT THE BASE OF SLOPES.
3. TEMPORARY TRENCH PLUGS MAY BE USED IN CONJUNCTION WITH SLOPE BREAKERS TO DIVERT TRENCH WATER OVERFLOW AND PREVENT OVERFLOW INTO SENSITIVE RESOURCE AREAS.
4. DIVERT TRENCH OVERFLOW TO A WELL-VEGETATED OFF-R.O.W. LOCATION OR INSTALL APPROPRIATE ENERGY DISSIPATING DEVICE.
5. USE TEMPORARY TRENCH PLUGS AT WATERBODY CROSSINGS, AS NECESSARY.

	TEMPORARY TRENCH PLUG OPTIONS	FIGURE EC-6
		DWG. ES-0016 REV.

Q:\S-U\SPE\2013-200.00\AutoCAD\Final\es0016.dwg
Wayne Sicora
5/29/2014 8:49 AM
I.G. ES0016.DWG



INSTALLATION REQUIREMENTS:

- INSTALL SLOPE BREAKERS IN ALL DISTURBED AREAS AS NECESSARY TO AVOID EXCESSIVE EROSION AT THE LOCATIONS SHOWN ON THE CONSTRUCTION DRAWINGS OR AS APPROVED BY THE ENVIRONMENTAL INSPECTOR (EI).
- MUST BE INSTALLED ON SLOPES GREATER THAN 5% WHERE THE BASE OF THE SLOPE IS LESS THAN 50 FEET FROM A WATERBODY, WETLAND OR ROAD CROSSING AT THE FOLLOWING MINIMUM SPACING:

SLOPE (%)	SPACING (FT.)
5 - 15	300
> 15 - 30	200
> 30	100

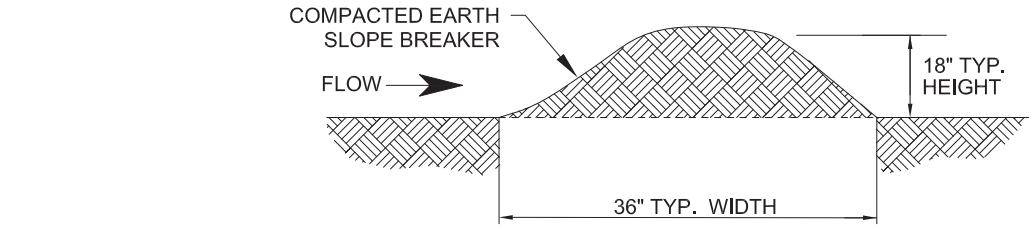
- CONSTRUCT USING SAND BAGS, STAKED STRAW BALES, SILT FENCE, OR SOIL.
- INSTALL WITH A 2 - 8% OUTFALL ANGLE.
- POSITION OUTFALL TO PREVENT SEDIMENT DISCHARGE INTO WETLANDS, WATERBODIES, OR OTHER SENSITIVE RESOURCES.
- FILTER RUN-OFF WATER BY CONSTRUCTING THE OUTLET IN A WELL VEGETATED STABLE AREA, OR BY USING AN ENERGY DISSIPATING DEVICE (SILT FENCE, STRAW BALES, EROSION CONTROL FABRIC). IF NEEDED, THE TYPE OF ENERGY DISSIPATION DEVICE WILL DEPEND ON SITE CONDITIONS (OPTIONS ARE DEPICTED ABOVE).

MAINTENANCE REQUIREMENTS:

- INSPECT DURING CONSTRUCTION AND MAKE REPAIRS AS NEEDED.
- KEEP THE CHANNEL FREE OF DEBRIS AND OBSTRUCTIONS.

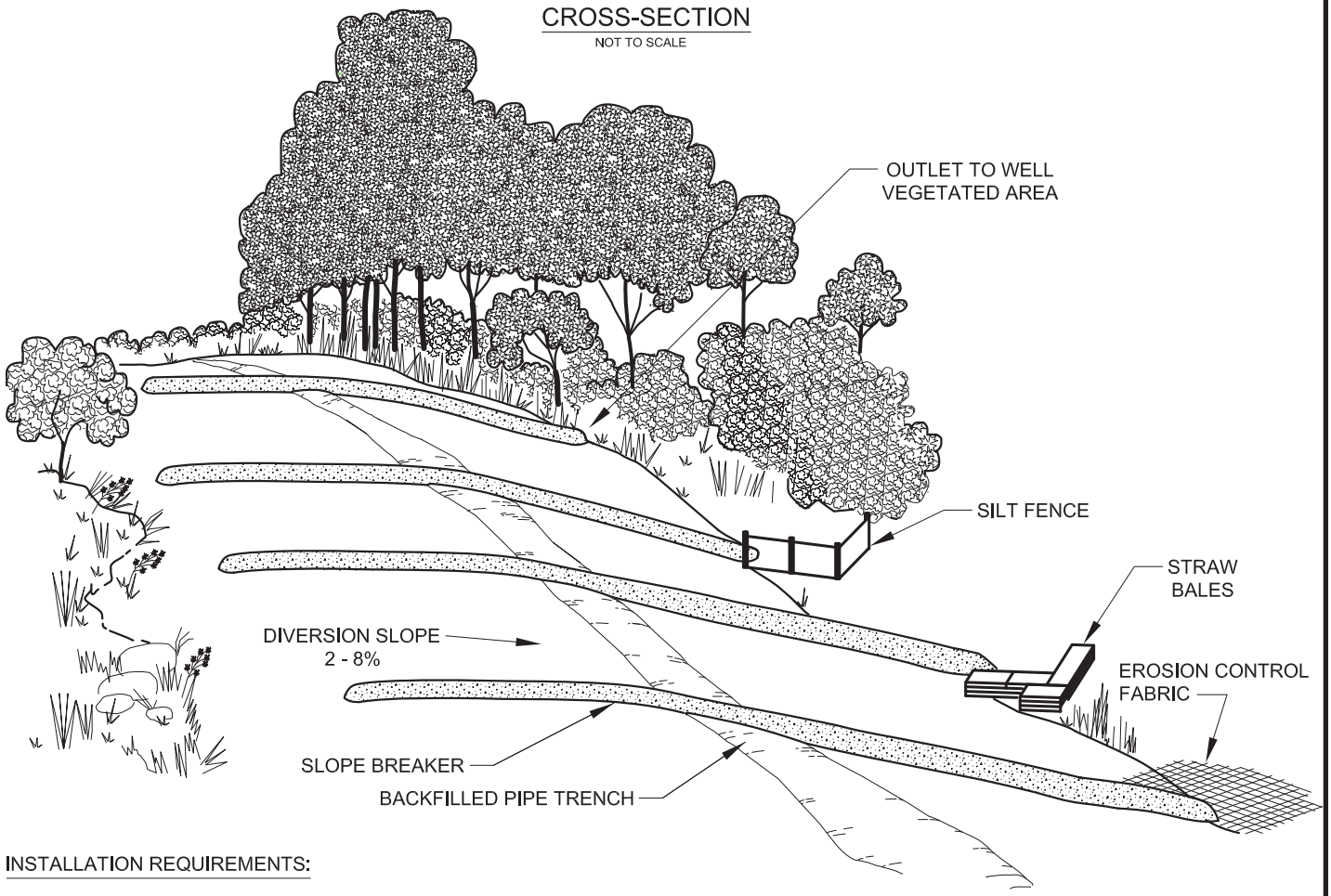
	TEMPORARY SLOPE BREAKERS	FIGURE EC-7
		DWG. ES-0017 REV.

Q:\S-U\SPE\2013-200.00\AutoCAD\Final\es0017.dwg
Wayne Sicora 6/3/2014 11:09 AM
I.G. ES0017.DWG



CROSS-SECTION

NOT TO SCALE



INSTALLATION REQUIREMENTS:

- INSTALL AND MAINTAIN IN ALL DISTURBED AREAS TO AVOID EXCESSIVE EROSION, EXCEPT CULTIVATED AREAS AND LAWNS (UNLESS REQUESTED BY THE LANDOWNER), USING SPACING RECOMMENDATIONS OBTAINED FROM THE LOCAL SOIL CONSERVATION AUTHORITY OR LAND MANAGEMENT AGENCY, AT THE LOCATIONS SHOWN ON THE CONSTRUCTION DRAWINGS OR AS APPROVED BY THE ENVIRONMENTAL INSPECTOR (EI).
- INSTALL ON SLOPES GREATER THAN 5% WHERE THE BASE OF THE SLOPE IS LESS THAN 50 FEET FROM A WATERBODY, WETLAND OR ROAD CROSSING AT THE FOLLOWING MINIMUM SPACING IN THE ABSENCE OF WRITTEN RECOMMENDATIONS:

SLOPE (%)	SPACING (FT.)
5 - 15	300
> 15 - 30	200
> 30	100

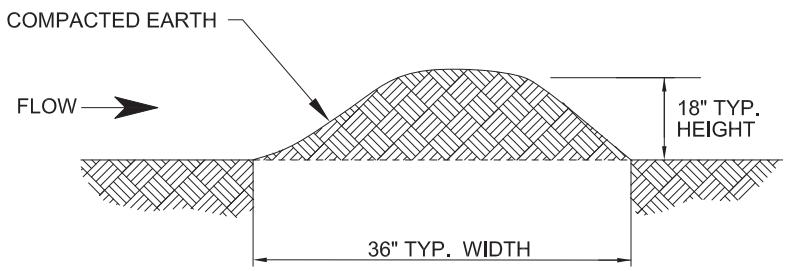
- CONSTRUCT USING SOIL, STONE, OR SOME FUNCTIONAL EQUIVALENT.
- INSTALL WITH A 2 - 8% OUTFALL ANGLE.
- POSITION OUTFALL TO PREVENT SEDIMENT DISCHARGE INTO WETLANDS, WATERBODIES, OR OTHER SENSITIVE RESOURCES.
- FILTER RUN-OFF WATER BY CONSTRUCTING THE OUTLET IN A WELL VEGETATED STABLE AREA, OR BY USING AN ENERGY DISSIPATING DEVICE (SILT FENCE, STRAW BALES, EROSION CONTROL FABRIC). IF NEEDED, THE TYPE OF ENERGY DISSIPATION DEVICE WILL DEPEND ON SITE CONDITIONS (OPTIONS ARE DEPICTED ABOVE).
- IF NECESSARY, OUTFALL MAY EXTEND SLIGHTLY, UP TO 4 FEET, BEYOND THE EDGE OF THE CONSTRUCTION RIGHT-OF-WAY, SUBJECT TO ALL APPLICABLE SURVEY REQUIREMENTS.

MAINTENANCE REQUIREMENTS:

- INSPECT DURING AND FOLLOWING CONSTRUCTION AND MAKE REPAIRS AS NEEDED.
- KEEP THE CHANNEL FREE OF DEBRIS AND OBSTRUCTIONS.
- SEED AND MULCH PERMANENT SLOPE BREAKERS FOLLOWING CONSTRUCTION.

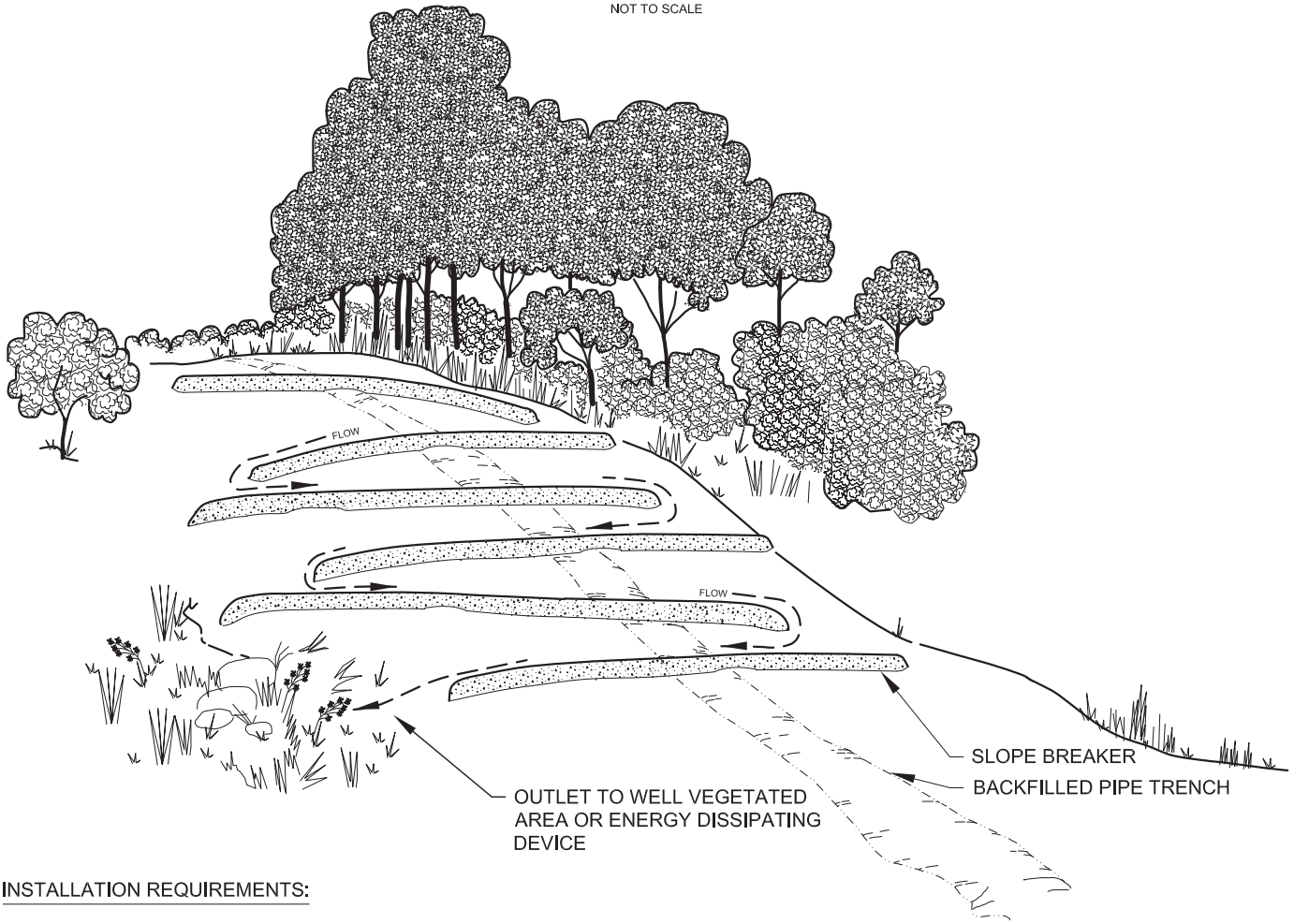
	PERMANENT SLOPE BREAKERS	FIGURE EC-8
		DWG. ES-0018 REV.

I.G. ES0018.DWG
Wayne Sicora 6/3/2014 11:29 AM
Q:\S-U\SPE\2013-200.00\AutoCAD\Final\es0018.dwg



CROSS-SECTION

NOT TO SCALE



INSTALLATION REQUIREMENTS:

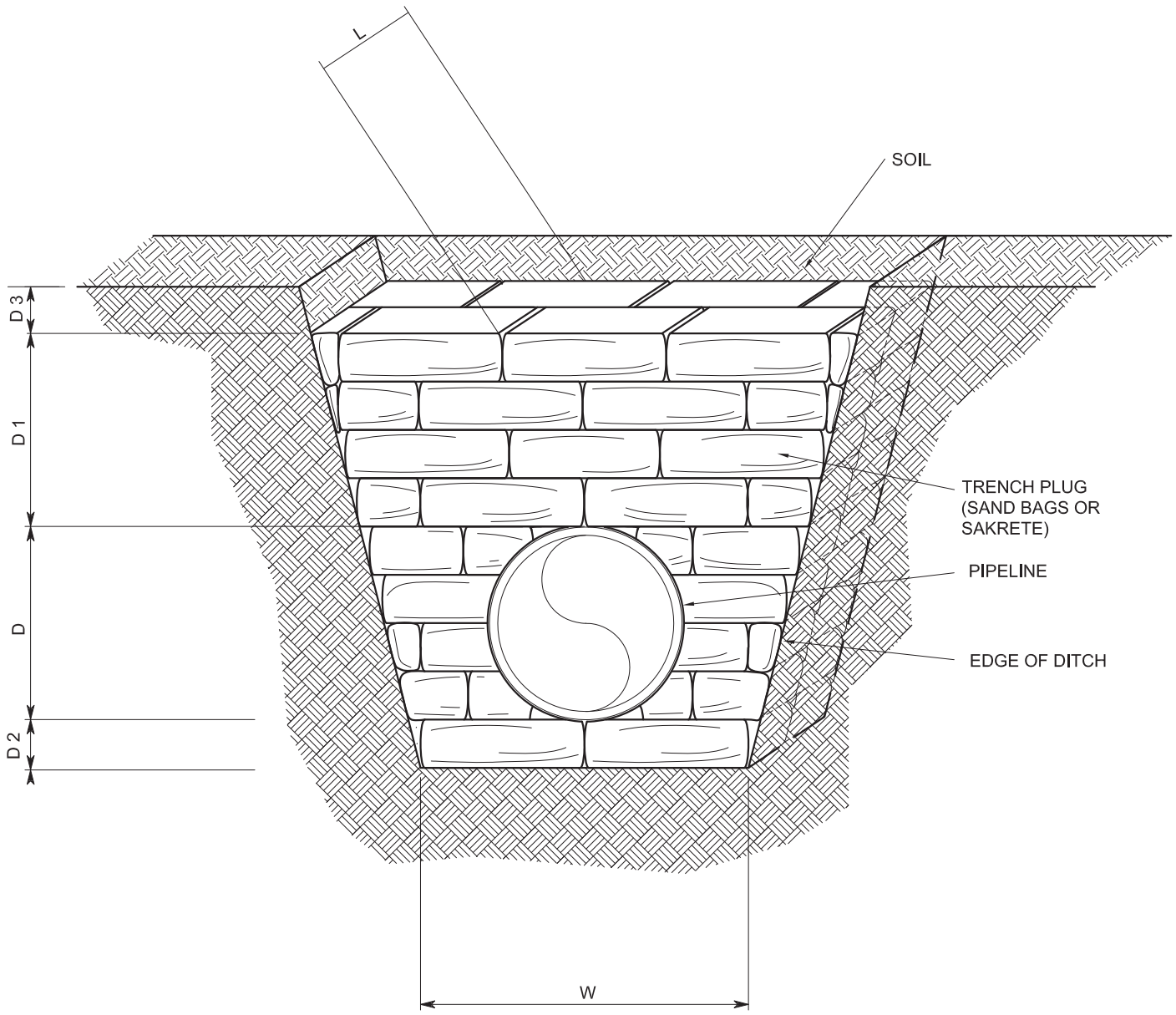
- INSTALL IN ALL AREAS EXCEPT RESIDENTIAL OR AGRICULTURAL (UNLESS AUTHORIZED BY LANDOWNER OR LAND MANAGING AGENCY).
- CONSTRUCT USING EARTH FILLED SACKS OR STAKED STRAW BALES FOR TEMPORARY OR COMPACTED EARTH AND ROCK FOR PERMANENT.
- INSTALL WITH A 2 - 8% OUTFALL ANGLE.
- FOR TEMPORARY CHEVRON SLOPE BREAKERS, POSITION OUTFALL TO PREVENT SEDIMENT DISCHARGE INTO WETLANDS, WATERBODIES, OR OTHER SENSITIVE RESOURCES.
- FILTER RUN-OFF WATER BY CONSTRUCTING AN OUTLET USING AN ENERGY DISSIPATING DEVICE (SILT FENCE, STRAW BALES, EROSION CONTROL FABRIC), AS APPROVED BY THE ENVIRONMENTAL INSPECTOR.

MAINTENANCE REQUIREMENTS:

- INSPECT DURING AND FOLLOWING CONSTRUCTION AND MAKE REPAIRS AS NEEDED.
- KEEP THE CHANNEL FREE OF DEBRIS AND OBSTRUCTIONS.
- SEED AND MULCH PERMANENT SLOPE BREAKERS FOLLOWING CONSTRUCTION.

	CHEVRON SLOPE BREAKER	FIGURE EC-9
		DWG. ES-0019 REV.

Q:\S-U\SPE\2013-200.00\AutoCAD\Final\es0019.dwg
Wayne Sicora 5/29/2014 10:44 AM
I.G. ES0019.DWG



D = PIPE DIAMETER
D1 = APPROXIMATELY 24"
D2 = APPROXIMATELY 6" (8" MIN. IN ROCK)
D3 = APPROXIMATELY 12"
W = D + 2 to 4 FEET
L = APPROXIMATELY 18" - 24"
D1 + D3 = 36" MINIMUM

NOTE:

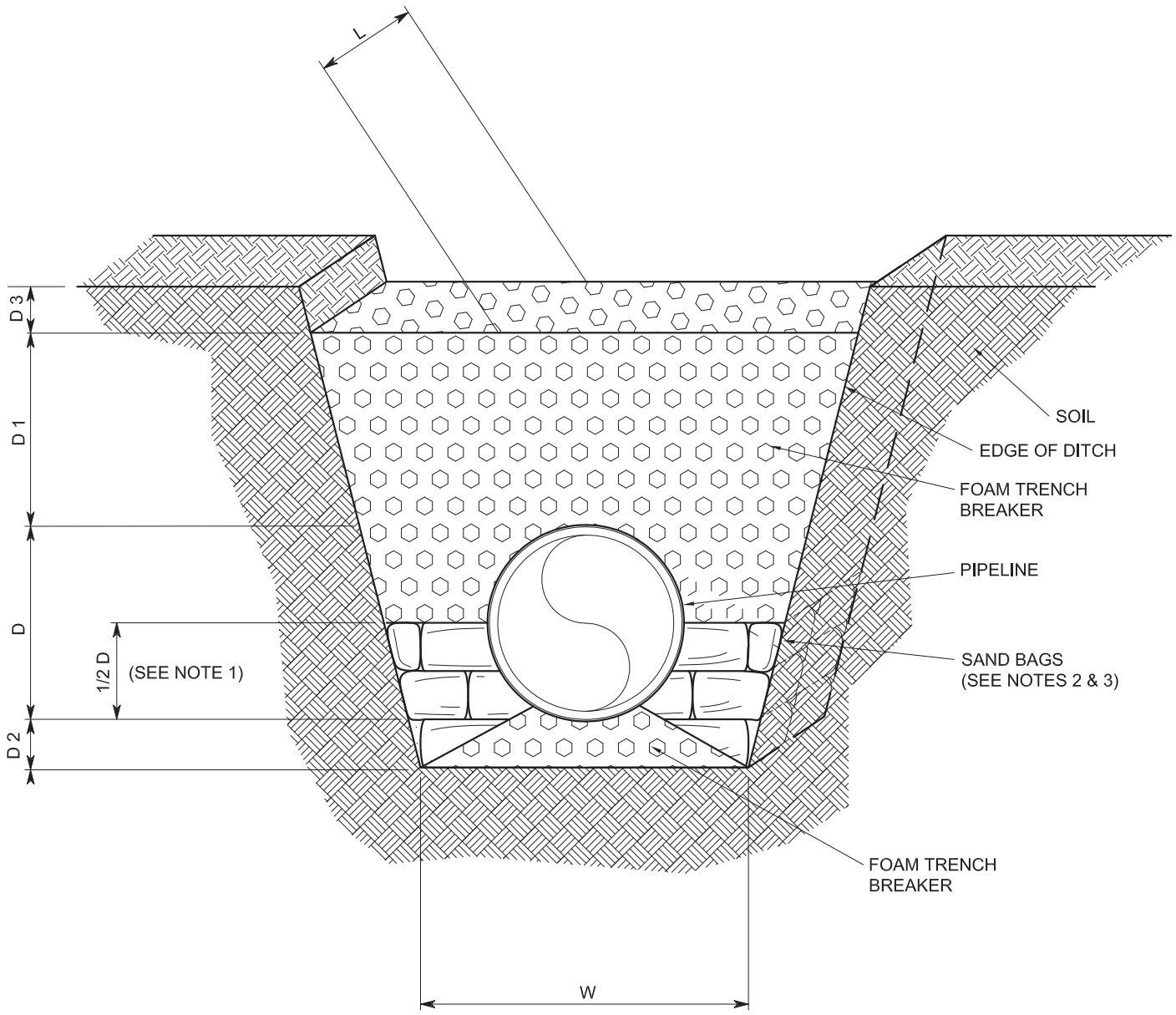
1. USE OF SAKRETE SHALL REQUIRE PRIOR COMPANY APPROVAL.
2. TOPSOIL SHALL NOT BE USED TO CONSTRUCT BREAKERS.
3. DO NOT INSTALL TRENCH BREAKERS WITHIN A WETLAND.

TRENCH BREAKER DETAIL (SACK)

FIGURE EC-10

DWG. ES-0020 REV.

Q:\S-U\SPE\2013-200.00\AutoCAD\Final\es0020.dwg
Wayne Sicora
5/29/2014 1:41 PM
I.G. ES0020.DWG



D = PIPE DIAMETER
D1 = APPROXIMATELY 24"
D2 = APPROXIMATELY 6" (8" MIN. IN ROCK)
D3 = APPROXIMATELY 12"
W = D + 2 to 4 FEET
L = APPROXIMATELY 18" - 24"
D1 + D3 = 36" MINIMUM

NOTE:

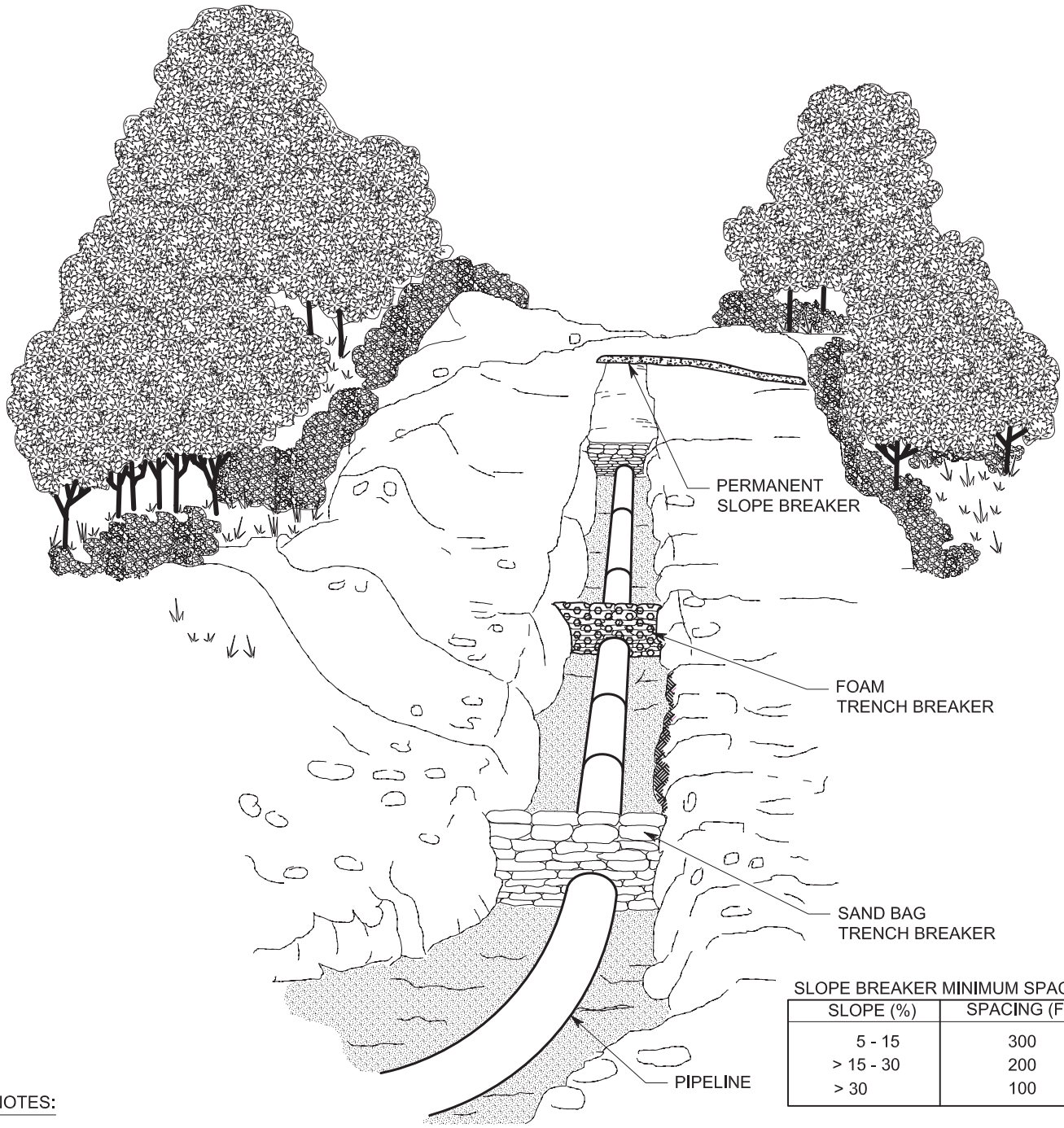
1. A MINIMUM OF TWO LAYERS OF BAGS SHALL BE INSTALLED.
2. THE ADDITION OF SAND BAGS UNDER THE FOAM WILL BE PLACED AS PRESCRIBED IN THE E&S PLAN OR AT THE DISCRETION OF THE ENVIRONMENTAL INSPECTOR (EI).
3. FOAM TRENCH BREAKERS ARE TO BE USED WITHIN UPLAND AREAS. DO NOT USE FOAM TRENCH BREAKERS AT WATERBODY OR WETLAND BOUNDARIES..

	TRENCH BREAKER DETAIL (FOAM)	FIGURE EC-11
		DWG. ES-0021 REV.

I.G. ES0021.DWG

Wayne Sicora 6/3/2014 11:07 AM

Q:\S-U\SPE\2013-200.00\AutoCAD\Final\es0021.dwg



SLOPE BREAKER MINIMUM SPACING

SLOPE (%)	SPACING (FT)
5 - 15	300
> 15 - 30	200
> 30	100

NOTES:

1. PERMANENT TRENCH BREAKER MATERIALS WILL CONSIST OF SAND BAGS, POLYURETHANE FOAM OR SOME FUNCTIONAL EQUIVALENT PLACED ACROSS THE DITCH AS IDENTIFIED IN PERMIT REQUIREMENTS. DO NOT USE TOPSOIL FOR TRENCH BREAKERS. THESE OPTIONS ARE DEPICTED ABOVE.
2. PERMANENT TRENCH BREAKERS, WHICH ARE USED IN CONJUNCTION WITH SLOPE BREAKERS, SHALL BE INSTALLED AT THE LOCATIONS SHOWN ON THE CONSTRUCTION DRAWINGS OR AS DETERMINED IN THE FIELD BY THE ENVIRONMENTAL INSPECTOR.
3. AT A MINIMUM, INSTALL A TRENCH BREAKER AT THE BASE OF SLOPES GREATER THAN 5 PERCENT WHERE THE BASE OF THE SLOPE IS LESS THAN 50 FEET FROM A WATERBODY OR WETLAND AND WHERE NEEDED TO AVOID DRAINING A WATERBODY OR WETLAND.
4. INSTALL TRENCH BREAKERS AT WETLAND BOUNDARIES AND/OR SEAL THE TRENCH BOTTOM AS NECESSARY TO MAINTAIN THE ORIGINAL WETLAND HYDROLOGY. DO NOT INSTALL TRENCH BREAKERS WITHIN A WETLAND.
5. IN AGRICULTURAL FIELDS AND RESIDENTIAL AREAS WHERE SLOPE BREAKERS ARE NOT TYPICALLY REQUIRED, INSTALL TRENCH BREAKERS AT THE SAME SPACING AS IF PERMANENT SLOPE BREAKERS WERE REQUIRED.

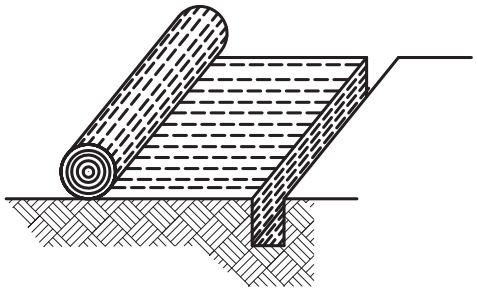
PERMANENT TRENCH BREAKER OPTIONS

FIGURE EC-12

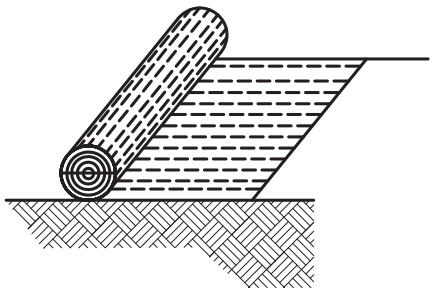
DWG. ES-0022 REV.

Q:\S-U\SPE\2013-200.00\AutoCAD\Final\es0022.dwg
Wayne Sicora 6/3/2014 11:13 AM
I.G. ES0022.DWG

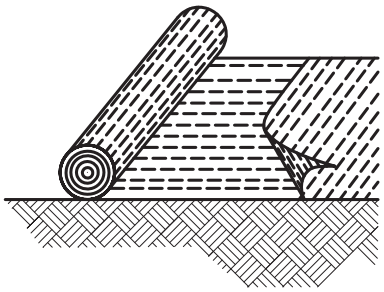
A. BURY THE TOP END OF THE ROLL IN A 6" TRENCH (TYPICAL)



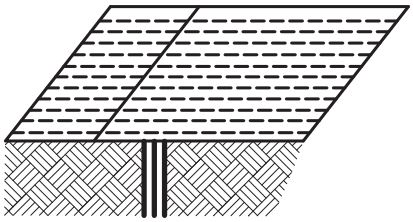
B. DOUBLE STAPLE EVERY 12" BEFORE BACKFILLING AND COMPACTING.

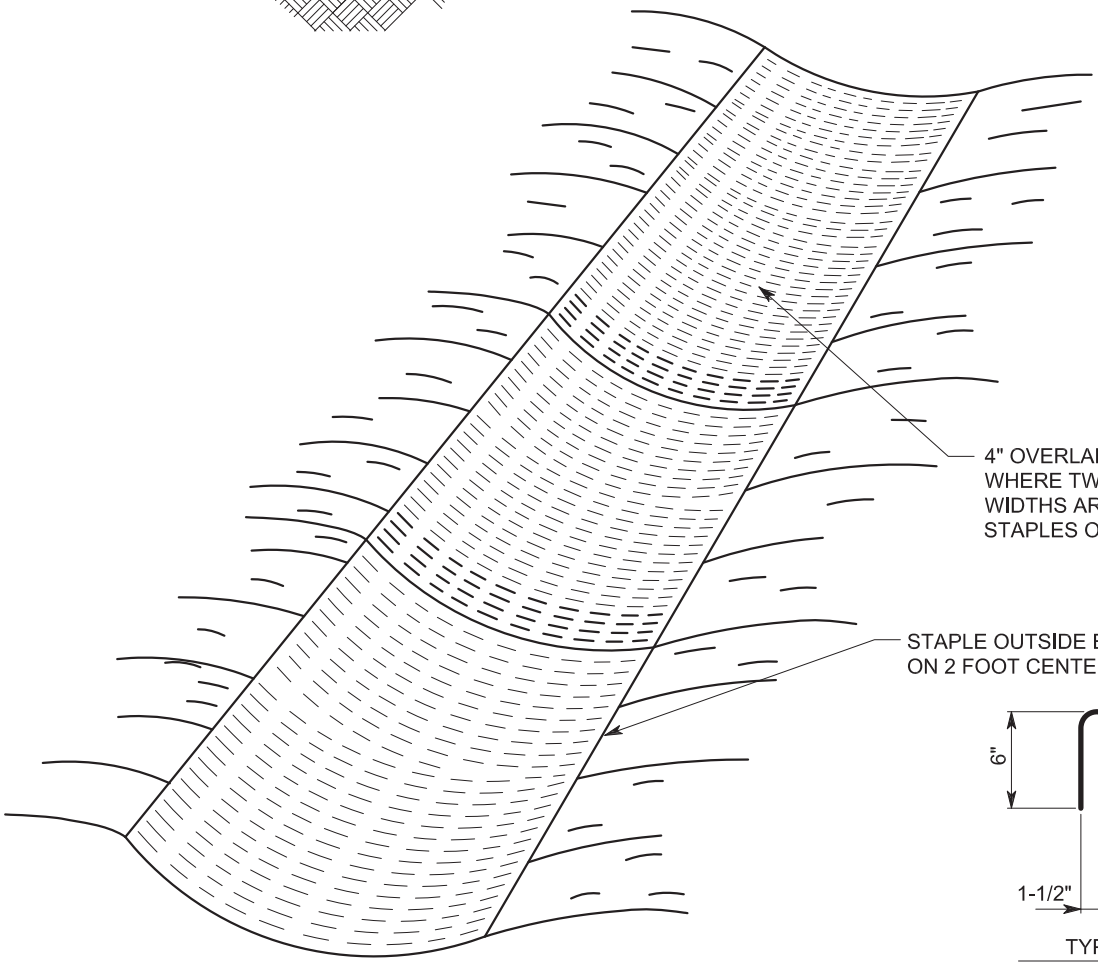


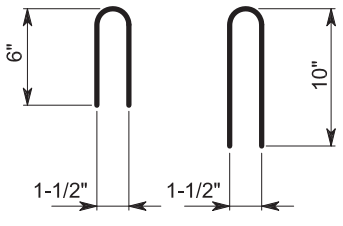
C. BURY AND TAMP UPPER END OF LOWER STRIP AS IN "A" AND "B". OVERLAP END OF TOP STRIP 4" AND STAPLE.



D. WHERE FABRIC STOPS, FOLD, BURY, AND TAMP ROLL IN SLIT TRENCH. PROVIDE DOUBLE ROW OF STAPLES







TYPICAL STAPLES
NO. 11 GAUGE WIRE

EROSION CONTROL FABRIC INSTALLATION

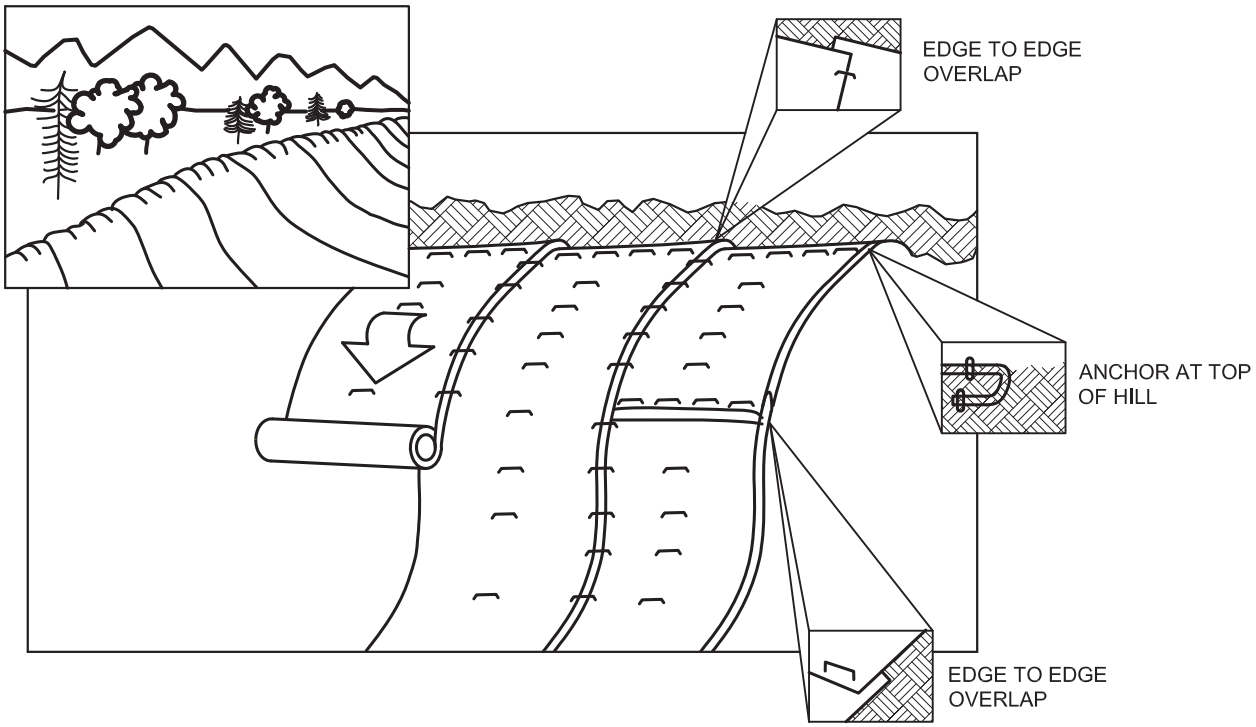
FIGURE EC-13

DWG. ES-0023 REV.

I.G. ES0023.DWG

Wayne Sicora
5/29/2014 12:06 PM

Q:\S-U\SPE\2013-200.00\AutoCAD\Final\es0023.dwg

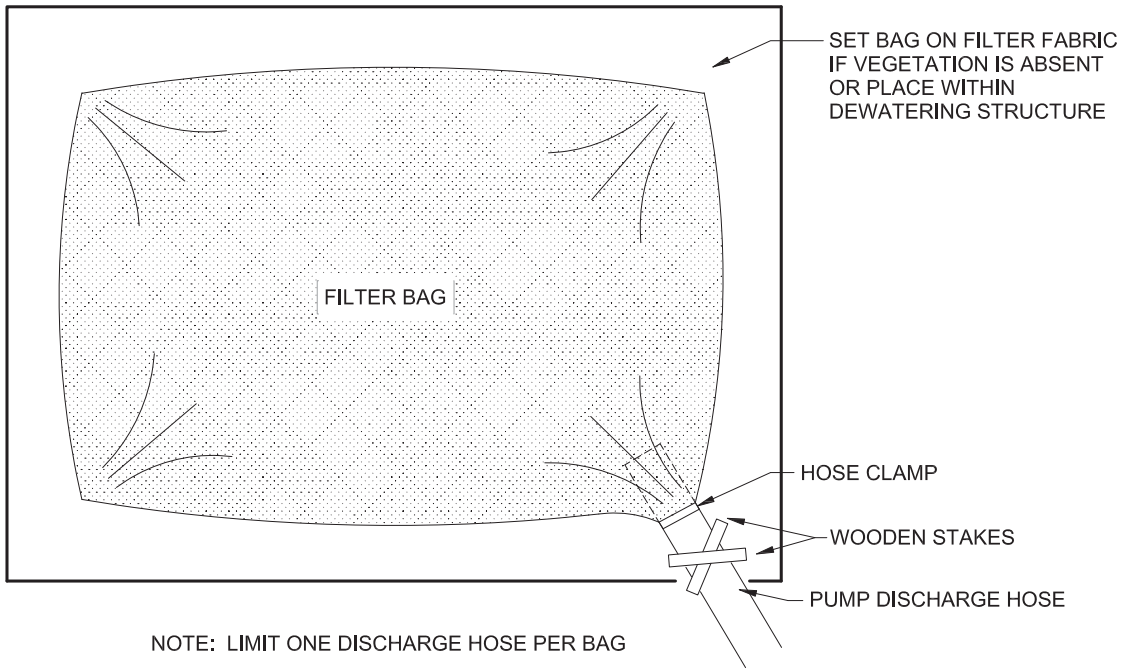


NOTES:

1. EROSION CONTROL BLANKETS (FABRIC) SHALL BE USED AT LOCATIONS IDENTIFIED IN THE PLAN AND/OR AS DIRECTED BY THE ENVIRONMENTAL INSPECTOR.
2. EROSION CONTROL BLANKETS SHALL MEET THE REQUIREMENTS SPECIFIED IN THE PLAN AND/OR AS DIRECTED BY THE ENVIRONMENTAL INSPECTOR.
3. STAPLES SHALL BE MADE OF 11 GAUGE WIRE, U-SHAPED WITH 6" LEGS AND A 1" CROWN. STAPLES SHALL BE DRIVEN INTO THE GROUND FOR THE FULL LENGTH OF THE STAPLE LEGS.
4. BLANKETS SHALL BE INSTALLED ACCORDING TO MANUFACTURER SPECIFICATIONS OR AS STATED BELOW:
   - EXTEND TOP OF BLANKET 3 FEET PAST THE UPPER EDGE OF THE SLOPE.
   - ANCHOR ("KEY") THE UPPER EDGE OF THE BLANKET INTO THE SLOPE USING A 6" DEEP TRENCH AND ROLL THE BLANKET DOWN THE HILL. DOUBLE STAPLE EVERY 12" BEFORE BACKFILLING AND COMPACTING TRENCH.
   - INSTALL LOOSELY ON SLOPE AND AVOID STRETCHING EROSION CONTROL BLANKETS DURING INSTALLATION.
   - BRING ROLL BACK OVER THE TOP OF THE TRENCH AND CONTINUE TO ROLL DOWN SLOPE. STAPLE EVERY 12" WHERE BLANKETS EXIT THE TRENCH AT THE TOP OF THE SLOPE.
   - WHEN BLANKETS ARE SPLICED DOWN-SLOPE TO ADJOINING BLANKETS (SLOPE OR STREAMBANK MATS), THE UPPER BLANKET SHALL BE PLACED OVER THE LOWER (SHINGLE STYLE) WITH APPROXIMATELY 6" OF OVERLAP. STAPLE THROUGH THE OVERLAPPED AREA EVERY 12".
   - OVERLAP ADJACENT BLANKETS 6". STAPLE EDGES OF BLANKETS AND CENTER EVERY 36".
5. IN LIVESTOCK AREAS WHERE EROSION CONTROL BLANKETS ARE APPLIED TO THE SLOPES, FENCING WILL BE USED IF NECESSARY TO EXCLUDE LIVESTOCK, WITH PERMISSION OF THE LANDOWNER.
6. MONITOR WASHOUTS, STAPLE INTEGRITY OR BLANKET MOVEMENT. REPLACE OR REPAIR AS NECESSARY.
7. DO NOT USE SYNTHETIC MONOFILAMENT MESH / NETTED MATERIALS IN AREAS DESIGNATED AS SENSITIVE WILDLIFE HABITAT, UNLESS THE PRODUCT IS SPECIFICALLY DESIGNED TO MINIMIZE HARM TO WILDLIFE.

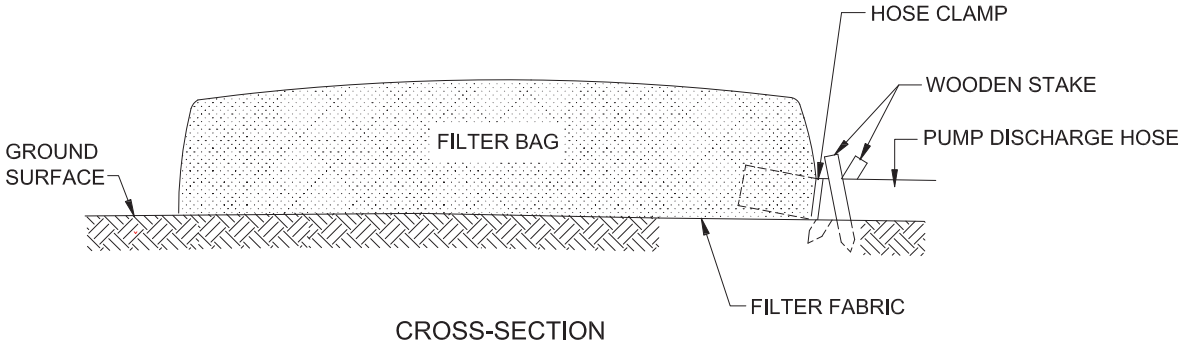
	TYPICAL EROSION CONTROL BLANKETS ON SLOPES	FIGURE EC-14
		DWG. ES-0024 REV.

Q:\S-U\SPE\2013-200.00\AutoCAD\Final\es0024.dwg
Wayne Sicora
6/10/2014 10:30 AM
I.G. ES0024.DWG



NOTE: LIMIT ONE DISCHARGE HOSE PER BAG

PLAN VIEW



CROSS-SECTION

NOTES:

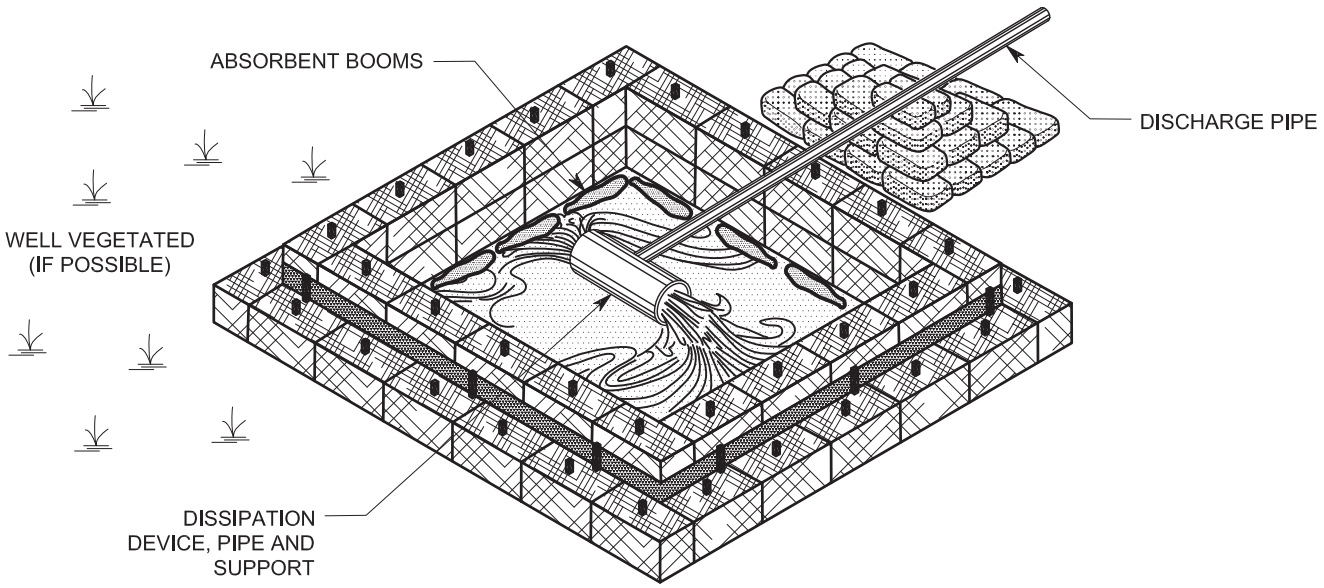
1. THE FILTER BAG OR STRUCTURE MUST BE MANNED WHEN THE PUMPING IS INITIATED TO ENSURE PROPER OPERATION AND FUNCTIONALITY.

2. REMOVE DEWATERING STRUCTURE AS SOON AS PRACTICABLE AFTER COMPLETION OF DEWATERING ACTIVITIES.

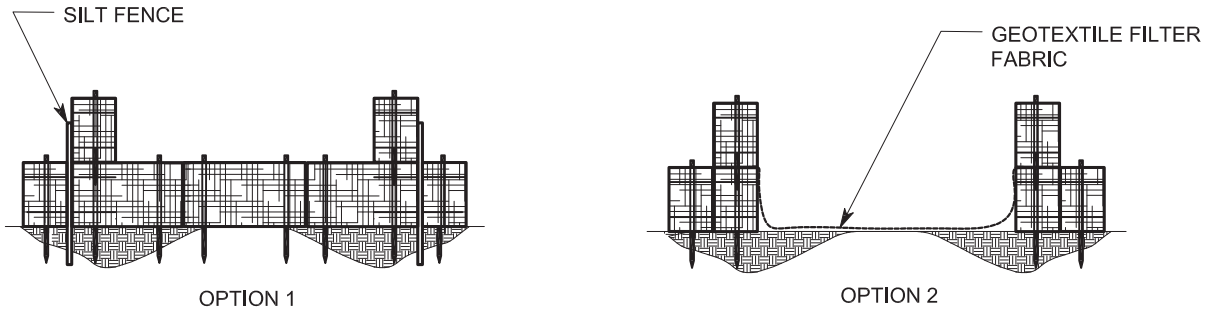
3. PLACEMENT OF FILTERBAGS SHOULD BE IN A MANNER THAT BAG USE DOES NOT CAUSE EROSION. IF SITE CONDITIONS ALLOW, PLACE FILTER BAG IN WELL-VEGETATED AREA, A MINIMUM OF 50 FEET FROM WETLANDS OR WATERBODIES.

	FILTER BAG	FIGURE WD-1
		DWG. ES-0025 REV.

Q:\S-U\SPE\2013-200.00\AutoCAD\Final\es0025.dwg
Wayne Sicora 5/29/2014 1:56 PM
I.G. ES0025.DWG



PLAN VIEW



CROSS SECTION VIEWS

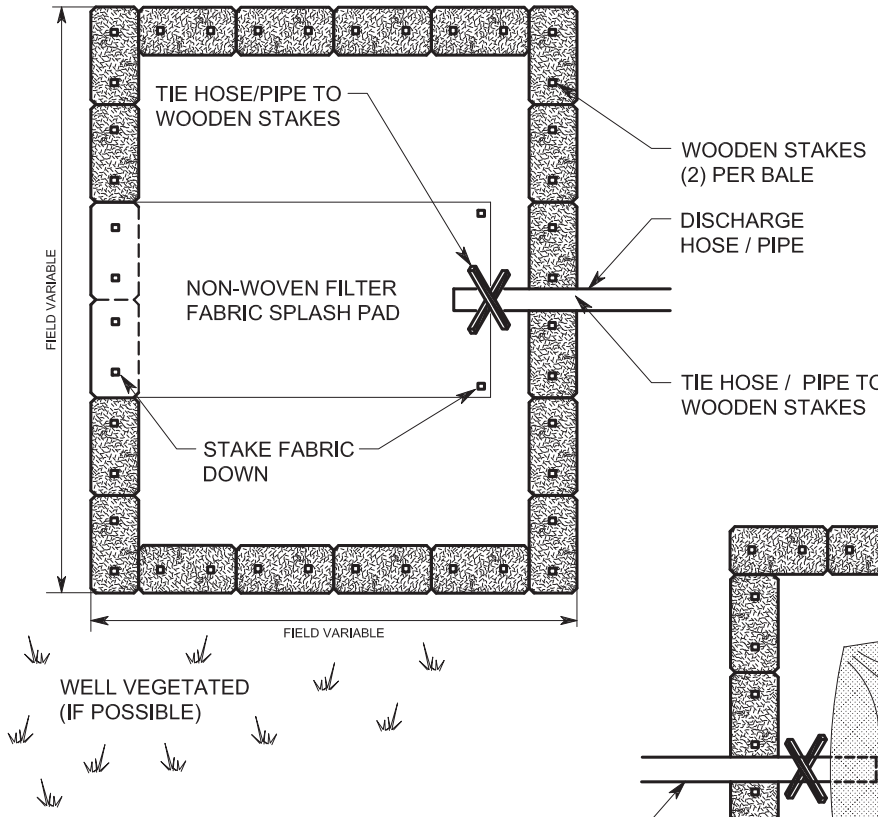
NOTES:

1. SIZE AND DIMENSION OF DEWATERING STRUCTURE WILL VARY DEPENDING ON THE VOLUME AND RATE OF DISCHARGE. STAGGER PLACEMENT OF STRAW BALES WHEN TWO ROWS ARE USED.
2. COVER THE BASE OF THE DISCHARGE STRUCTURE EITHER WITH STRAW BALES (OPTION 1) OR LINE WITH GEOTEXTILE FABRIC (OPTION 2).
3. PROVIDE SUPPORT TO ENSURE THAT DISCHARGE PIPE DOES NOT REST ON STRAW BALES.
4. PLASTIC SHEETING, WOODEN MATS OR STEEL PLATES MAY ALSO BE USED, AS DIRECTED BY THE ENVIRONMENTAL INSPECTOR, TO PREVENT EROSION, STREAMBED SCOUR, SUSPENSION OF SEDIMENTS OR EXCESSIVE STREAMFLOW.
5. ABSORBENT BOOMS MUST BE USED DURING DISCHARGES FROM EXISTING / USED PIPE OR AS DIRECTED BY PERMIT REQUIREMENTS.
6. PREVENT EROSION, STREAMBED SCOUR, SUSPENSION OF SEDIMENTS AND EXCESSIVE STREAMFLOW BY PROPER DESIGN OF STRUCTURE, REGULATING THE WATER DISCHARGE RATE AS WELL AS USE OF ENERGY DISSIPATION DEVICE(S) AND SEDIMENT BARRIERS, AS NECESSARY.

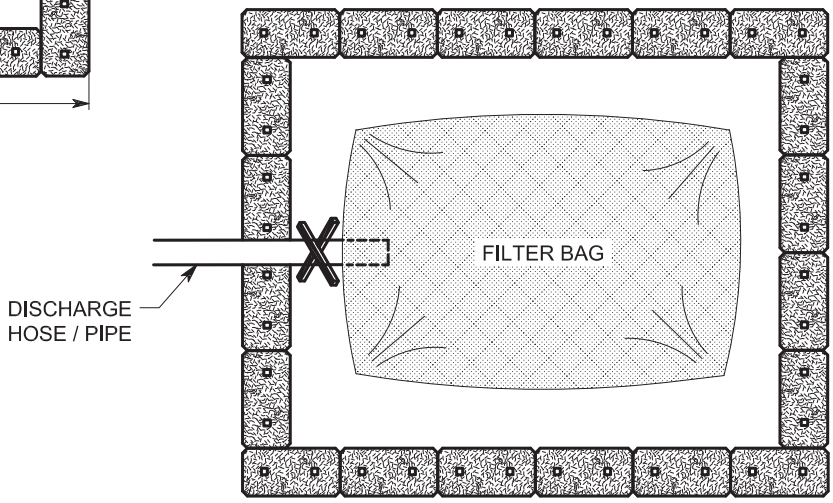
	DISCHARGE STRUCTURE FOR HYDROSTATIC TEST WATER	FIGURE WD-2
		DWG. ES-0026 REV.

Q:\S-U\SPE\2013-200.00\AutoCAD\Final\es0026.dwg
Wayne Sicora 5/29/2014 1:58 PM
I.G. ES0026.DWG

OPTION A



OPTION B



PLAN VIEW

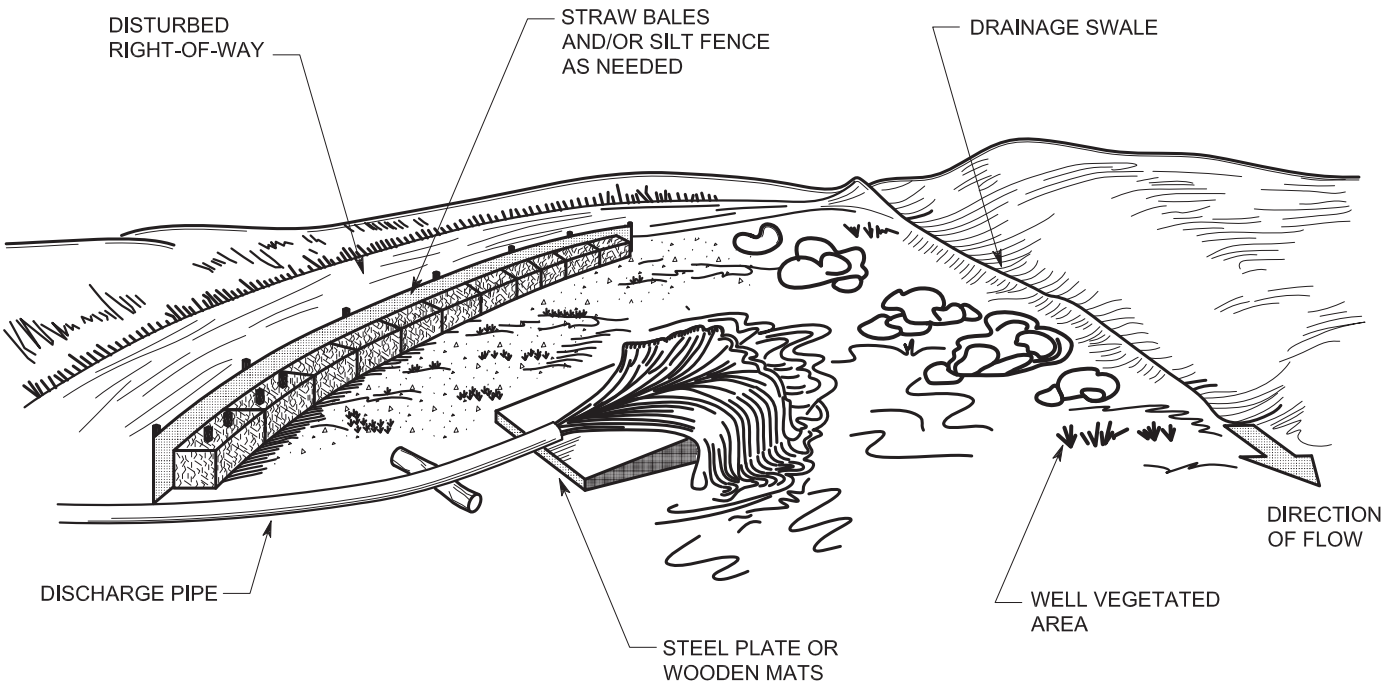
NOT TO SCALE

NOTES:

1. SIZE AND DIMENSION OF DEWATERING STRUCTURE, INCLUDING NUMBER OF STRAW BALES USED, WILL VARY DEPENDING ON VOLUME OF WATER DISCHARGED, RATE OF DISCHARGE AND SITE CONDITIONS, SUCH AS THE TYPE AND AMOUNT OF SEDIMENT WITHIN THE DISCHARGE WATER.
2. PREVENT EROSION, STREAMBED SCOUR, SUSPENSION OF SEDIMENTS AND EXCESSIVE STREAMFLOW BY PROPER DESIGN OF STRUCTURE, REGULATING THE WATER DISCHARGE RATE AS WELL AS USE OF ENERGY DISSIPATION DEVICE(S) AND SEDIMENT BARRIERS, AS NECESSARY.
3. MONITOR AND CONDUCT DISCHARGES IN A MANNER THAT DOES NOT CAUSE EROSION AND DOES NOT RESULT IN SILT-LADEN WATER FLOWING INTO ANY WATERBODY OR WETLAND.
4. DO NOT DEPOSIT SAND, SILT, AND/OR SEDIMENT INTO SENSITIVE ENVIRONMENTAL RESOURCE AREAS, INCLUDING WETLANDS, WATERBODIES, CULTURAL RESOURCE SITES, AND SENSITIVE SPECIES HABITATS. STOP DEWATERING ACTIVITIES IF SUCH DEPOSITION IS OCCURRING AND ENSURE THE DESIGN OF THE DISCHARGE IS CHANGED TO PREVENT REOCCURRENCE.
5. ABSORBENT BOOMS MUST BE USED DURING DISCHARGES FROM EXISTING / USED PIPE OR AS DIRECTED BY PERMIT REQUIREMENTS.
6. FILTER BAGS SHOULD BE INSTALLED ACCORDING TO THE DETAILS SHOWN IN "FILTER BAG" FIGURE.
7. REMOVE STRUCTURE AS SOON AS PRACTICABLE AFTER COMPLETION OF WATER DISCHARGES.

	OPTIONS FOR SMALL WATER DISCHARGES	FIGURE WD-3
		DWG. ES-0027 REV.

Q:\S-U\SPE\2013-200.00\AutoCAD\Final\es0027.dwg
Wayne Sicora
5/29/2014 2:09 PM
I.G. ES0027.DWG



NOTES:

1. USE BACKHOE BUCKET OR DOZER BLADE TO ANCHOR DISCHARGE PIPE.

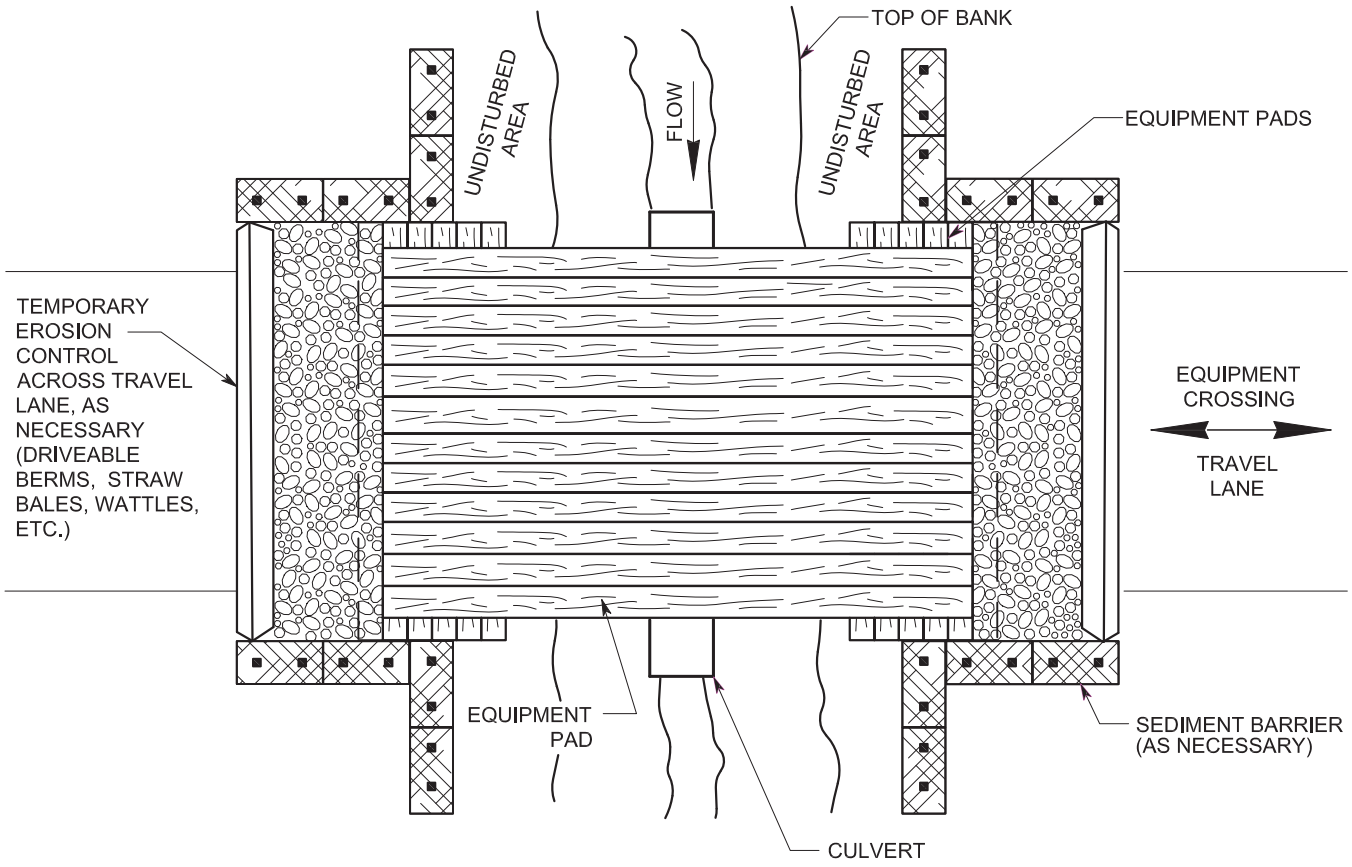
2. ON FLAT TERRAIN, USE STACKED STRAW BALES AND SILT FENCE AS NEEDED TO DIVERT WATER AWAY FROM DISTURBED RIGHT-OF-WAY.

	DISCHARGE OF HYDROSTATIC TEST WATER TO A SURFACE WATER	FIGURE WD-4
		DWG. ES-0028 REV.

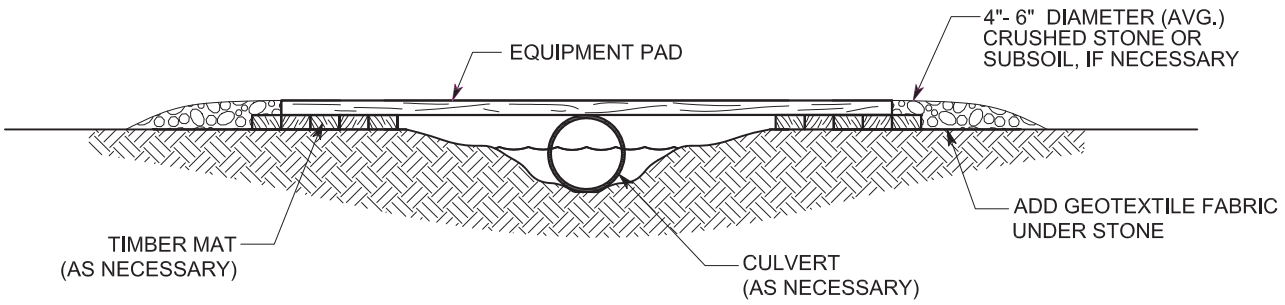
I.G. ES0028.DWG

Wayne Sicora 6/9/2014 4:22 PM

Q:\S-U\SPE\2013-200.00\AutoCAD\Final\es0028.dwg



PLAN VIEW



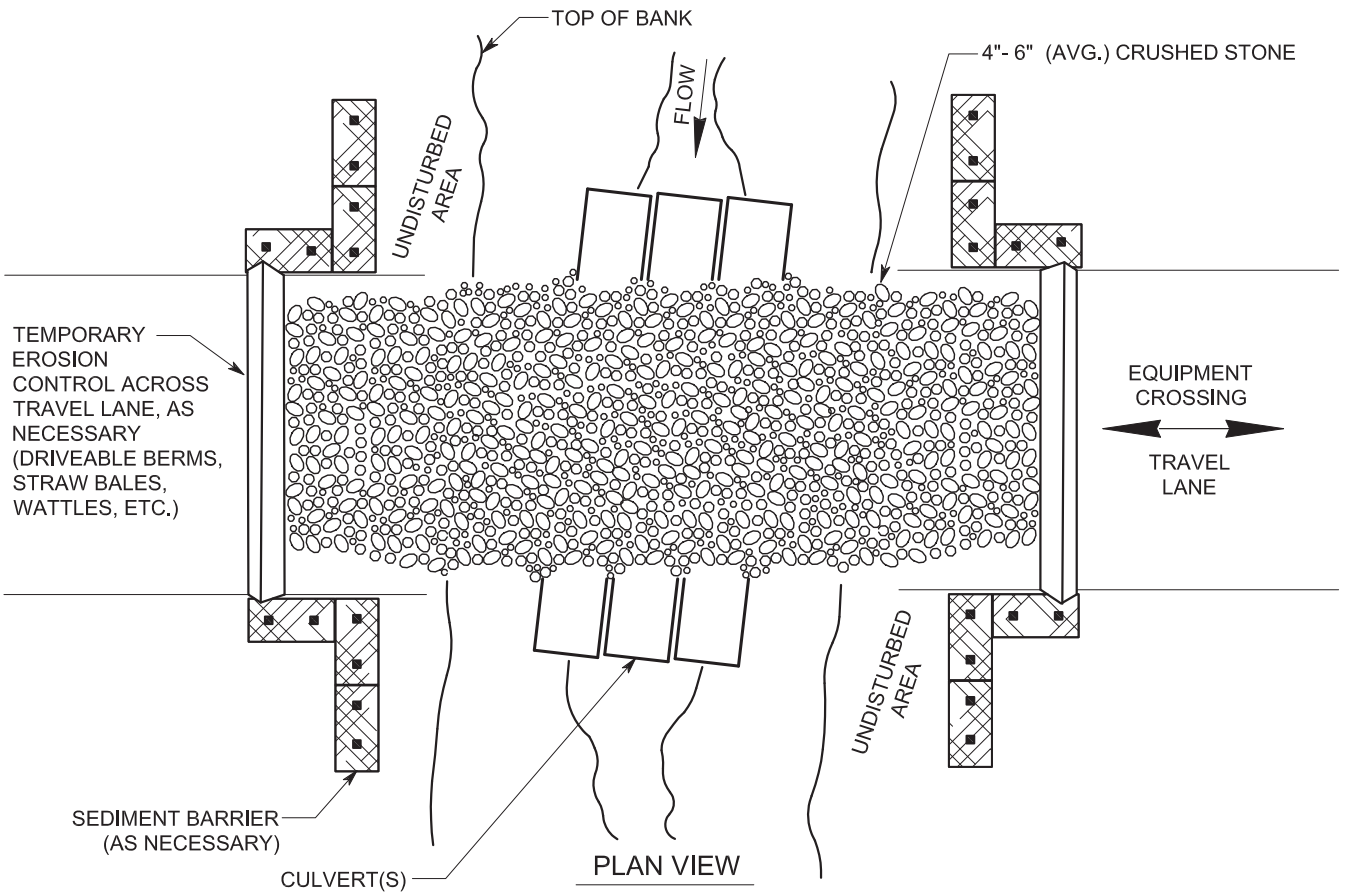
CROSS SECTION VIEW

NOTES:

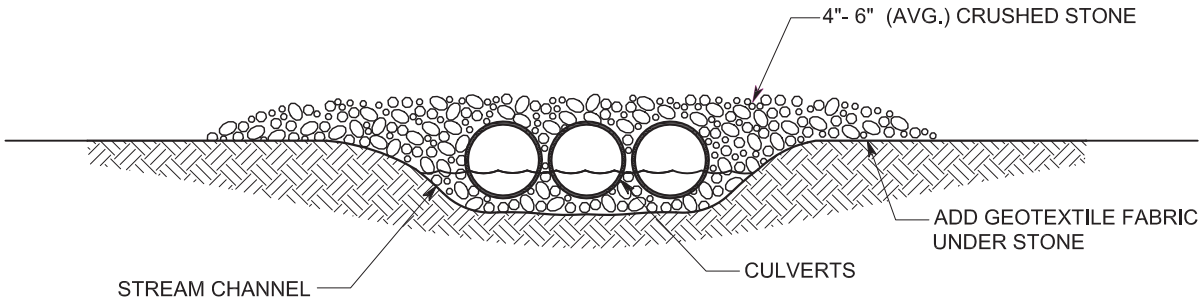
1. TEMPORARY SEDIMENT BARRIER CONSISTS OF SILT FENCE AND/ OR STRAW BALES, OR OTHER APPROPRIATE MATERIAL.
2. NUMBER AND DIAMETER OF CULVERTS, AS WELL AS USE OF CULVERTS, WILL DEPEND ON SITE-SPECIFIC CONDITIONS.
3. EQUIPMENT PAD, TYPICALLY CONSTRUCTED OF HARDWOOD, SHALL BE IN GOOD CONDITION AND MUST ACCOMMODATE THE LARGEST EQUIPMENT USED. ADDITIONAL EQUIPMENT PADS CAN BE PUT SIDE BY SIDE IF EXTRA WIDTH IS REQUIRED. BRIDGE MUST SPAN FROM TOP OF BANK TO TOP OF BANK.
4. CRUSHED STONE OR SUBSOIL MAY BE USED AS ILLUSTRATED, IF NECESSARY, WITHIN TRAVEL LANE AS RAMP.
5. CONSTRUCT AND MAINTAIN BRIDGE TO WITHSTAND THE HIGHEST EXPECTED FLOW WHILE BRIDGE IS IN USE AND PREVENT SOIL FROM ENTERING WATERBODY. DO NOT USE SOIL TO CONSTRUCT OR STABILIZE BRIDGE.

	TEMPORARY EQUIPMENT BRIDGE (EQUIPMENT PADS WITH OR WITHOUT CULVERTS)	FIGURE BR-1
		DWG. ES-0029 REV.

I.G. ES0029.DWG
Wayne Sicora 5/29/2014 2:43 PM
Q:\S-U\SPE\2013-200.00\AutoCAD\Final\es0029.dwg



PLAN VIEW



CROSS SECTION VIEW

NOTES:

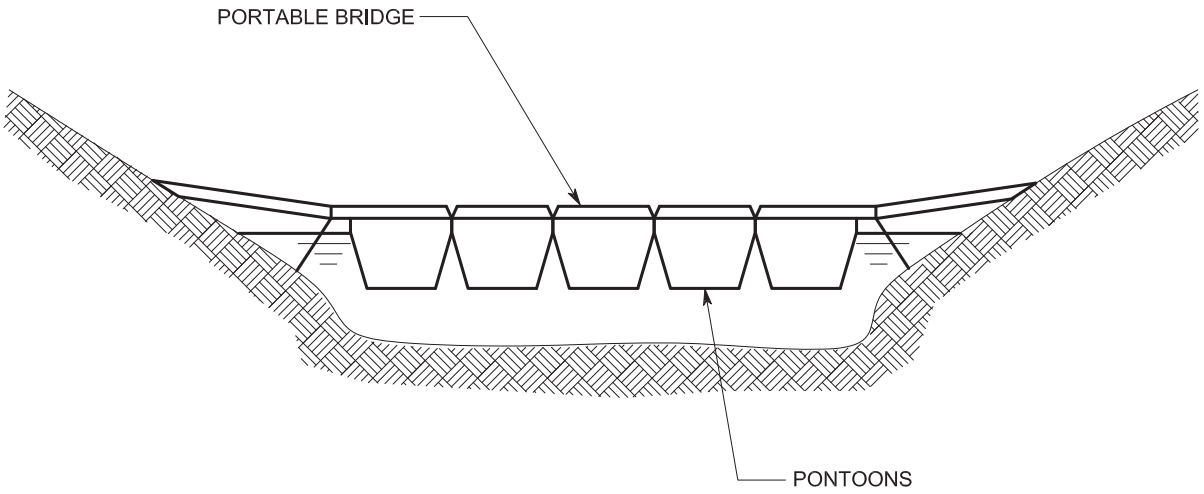
1. NUMBER AND DIAMETER OF CULVERTS WILL DEPEND ON SITE-SPECIFIC CONDITIONS. USE CULVERTS A MINIMUM OF 12-INCH DIAMETER.
2. ALIGN CULVERTS TO PREVENT EROSION AND STREAMBED SCOUR.
3. TEMPORARY SEDIMENT BARRIER CONSISTS OF SILT FENCES AND/OR STRAW BALES, OR OTHER APPROPRIATE MATERIALS.
4. ATTEMPT TO REMOVE ALL IMPORTED ROCK DURING REMOVAL OF THE BRIDGE.
5. DO NOT USE SOIL TO CONSTRUCT OR STABILIZE BRIDGES.

TEMPORARY EQUIPMENT BRIDGE (CRUSHED STONE WITH CULVERTS)

FIGURE BR-2

DWG. ES-0030 REV.

Q:\S-U\SPE\2013-200.00\AutoCAD\Final\es0030.dwg
Wayne Sicora 6/3/2014 11:36 AM
I.G. ES0030.DWG



NOTES:

1. STABILIZE EDGES WITH SANDBAGS OR STONE.

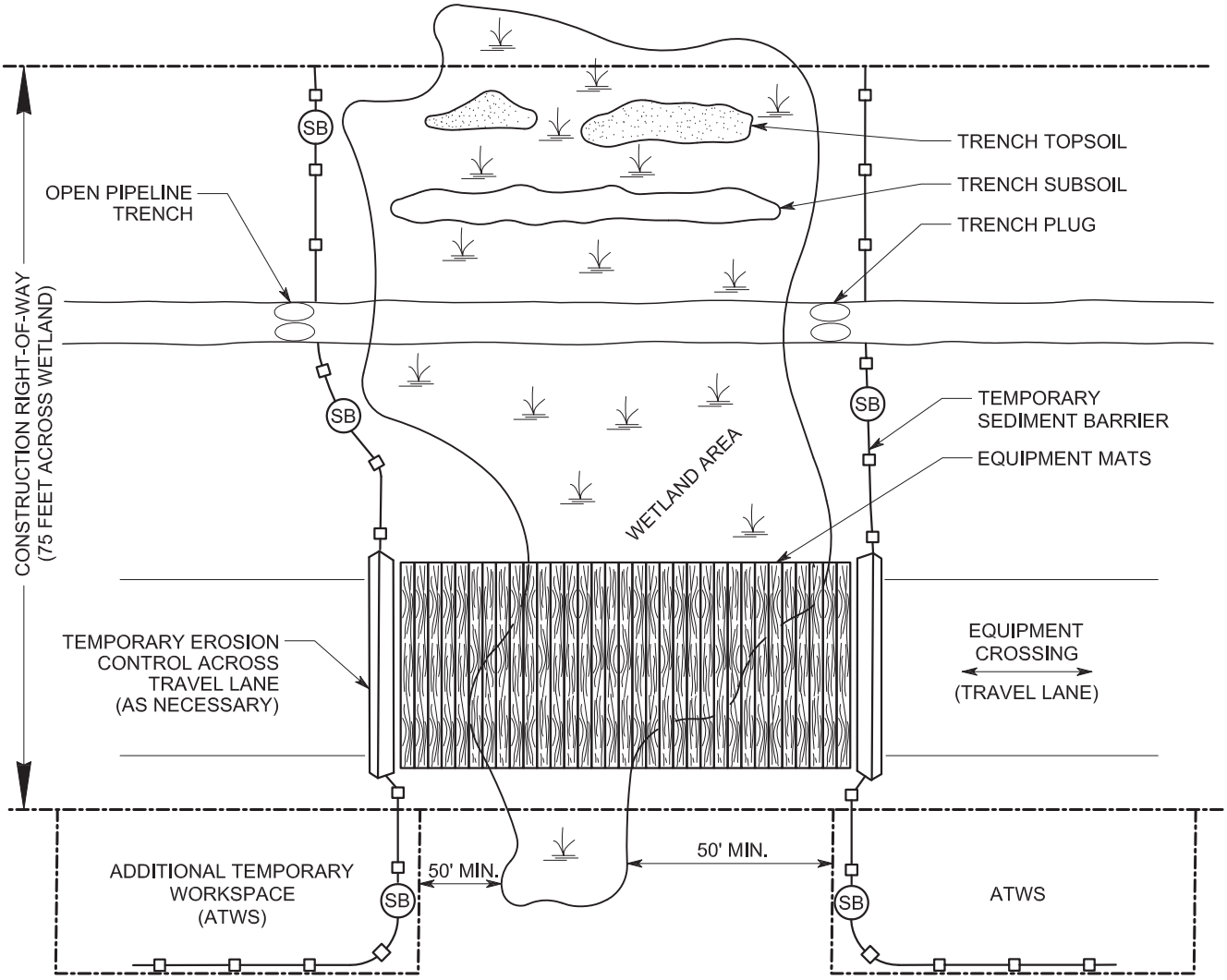
2. REMOVE BRIDGE DURING CLEANUP.

TEMPORARY EQUIPMENT BRIDGE (FLEXI-FLOAT OR PORTABLE BRIDGE)

FIGURE BR-3

DWG. ES-0031 REV.

I.G. ES0031.DWG
Wayne Sicora
5/29/2014 5:13 PM
Q:\S-U\SPE\2013-200.00\AutoCAD\Final\es0031.dwg



NOTES:

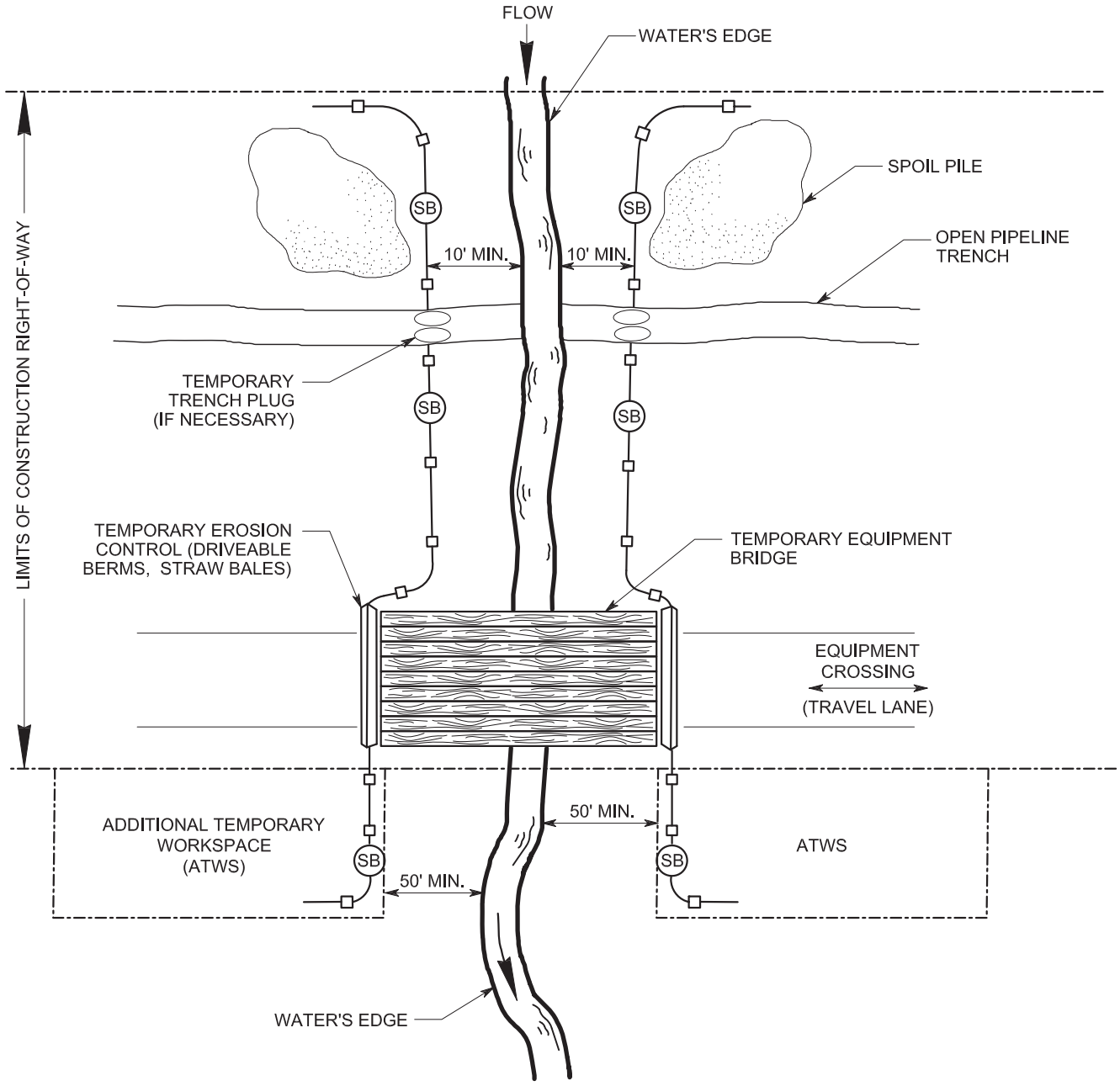
1. IN WETLANDS, EQUIPMENT MATS OR LOW GROUND WEIGHT EQUIPMENT SHALL BE UTILIZED IN SATURATED GROUND CONDITIONS.
2. LIMIT PULLING OF TREE STUMPS AND GRADING TO DIRECTLY OVER TRENCHLINE, EXCEPT IN SITUATIONS THAT THE CHIEF INSPECTOR AND ENVIRONMENTAL INSPECTOR DETERMINE SAFETY-RELATED CONSTRUCTION CONSTRAINTS REQUIRE GRADING OR THE REMOVAL OF STUMPS FROM UNDER THE WORKING SIDE.
3. SEGREGATE THE TOP 12 INCHES OF TOPSOIL WITHIN THE DITCHLINE IN WETLANDS, EXCEPT IN AREAS WHERE STANDING WATER IS PRESENT OR SOILS ARE SATURATED.
4. DO NOT TRENCH THE WETLAND UNTIL THE PIPELINE IS ASSEMBLED AND READY FOR LOWERING IN.
5. CONCRETE COATING OR PIPELINE WEIGHTS OF AN APPROPRIATE TYPE, WEIGHT AND SPACING WILL BE USED AS REQUIRED. NO CONCRETE COATING ACTIVITIES WITHIN 100 FEET OF A WETLAND OR WATERBODY BOUNDARY, UNLESS THE LOCATION IS AN EXISTING INDUSTRIAL SITE DESIGNATED FOR SUCH USE.
6. INSTALL SEDIMENT BARRIERS (SB) ALONG THE EDGE OF THE CONSTRUCTION RIGHT-OF-WAY AS NECESSARY TO CONTAIN SPOIL AND SEDIMENT WITHIN THE CONSTRUCTION RIGHT-OF-WAY THROUGH WETLANDS.
7. IN THE TRAVEL LANE, SEDIMENT BARRIERS MAY CONSIST OF REMOVABLE SEDIMENT BARRIERS OR DRIVABLE BERMS.
8. AT THE BASE OF SLOPES (GREATER THAN 5 PERCENT) THAT ARE LESS THAN 50 FEET FROM A WETLAND, INSTALL AND MAINTAIN TEMPORARY SEDIMENT BARRIERS ACROSS THE ENTIRE CONSTRUCTION RIGHT-OF-WAY UNTIL REVEGETATION IS SUCCESSFUL.
9. NO FERTILIZER OR LIME SHALL BE USED WITHIN WETLANDS.
10. DEWATER THE TRENCH IN A MANNER THAT DOES NOT CAUSE EROSION OR RESULT IN SILT-LADEN WATER FLOWING INTO ANY WETLAND.

TYPICAL STANDARD WETLAND CROSSING

FIGURE WC-1

DWG. ES-0032 REV.

Q:\S-U\SPE\2013-200.00\AutoCAD\Final\es0032.dwg
Wayne Sicora 6/10/2014 10:32 AM
I.G. ES0032.DWG

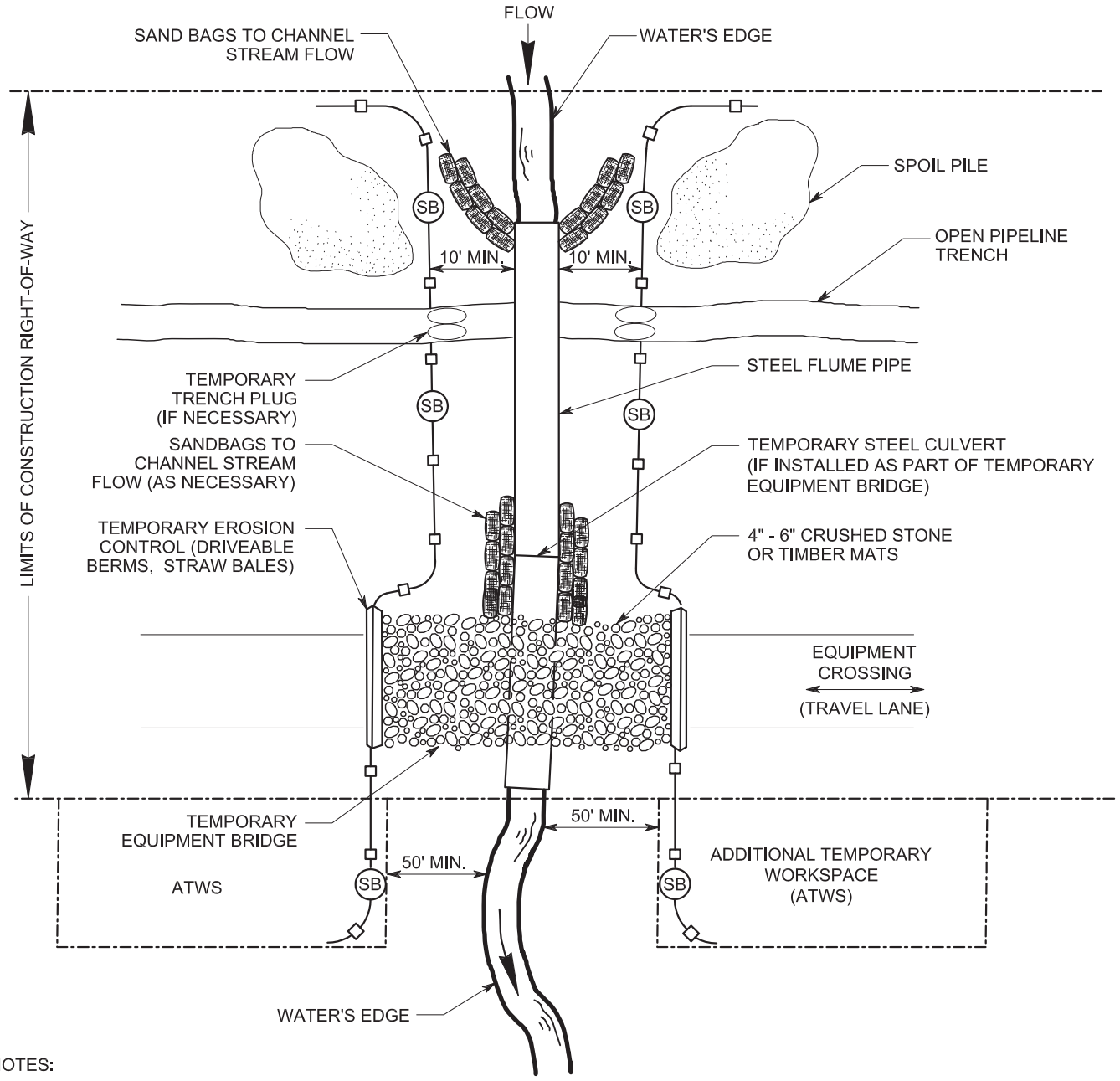


NOTES:

1. (SB) TEMPORARY SEDIMENT BARRIER OF SILT FENCE AND/OR STRAW BALES, OR APPROPRIATE MATERIALS.
2. FOR MINOR WATERBODIES, COMPLETE TRENCHING AND BACKFILLING IN THE WATERBODY (NOT INCLUDING BLASTING OR OTHER ROCK BREAKING MEASURES) WITHIN 24 CONTINUOUS HOURS. IF A FLUME IS INSTALLED WITHIN THE WATERBODY DURING MAINLINE ACTIVITIES, IT CAN BE REMOVED JUST PRIOR TO LOWERING IN THE PIPELINE. THE 24-HOUR TIMEFRAME STARTS AS SOON AS THE FLUME IS REMOVED.
3. FOR INTERMEDIATE WATERBODIES (>10 FEET TO 100 FEET WIDE MEASURED WATER'S EDGE TO EDGE), COMPLETE TRENCHING AND BACKFILLING IN THE WATERBODY (NOT INCLUDING BLASTING OR OTHER ROCK BREAKING MEASURES) WITHIN 48 CONTINUOUS HOURS, UNLESS SITE-SPECIFIC CONDITIONS MAKE COMPLETION WITHIN 48 HOURS INFEASIBLE.

Q:\S-U\SPE\2013-200.00\AutoCAD\Final\es0033.dwg
Wayne Sicora 5/29/2014 5:28 PM
I.G. ES0033.DWG

	TYPICAL WET WATERBODY CROSSING	FIGURE WC-2
		DWG. ES-0033 REV.



NOTES:

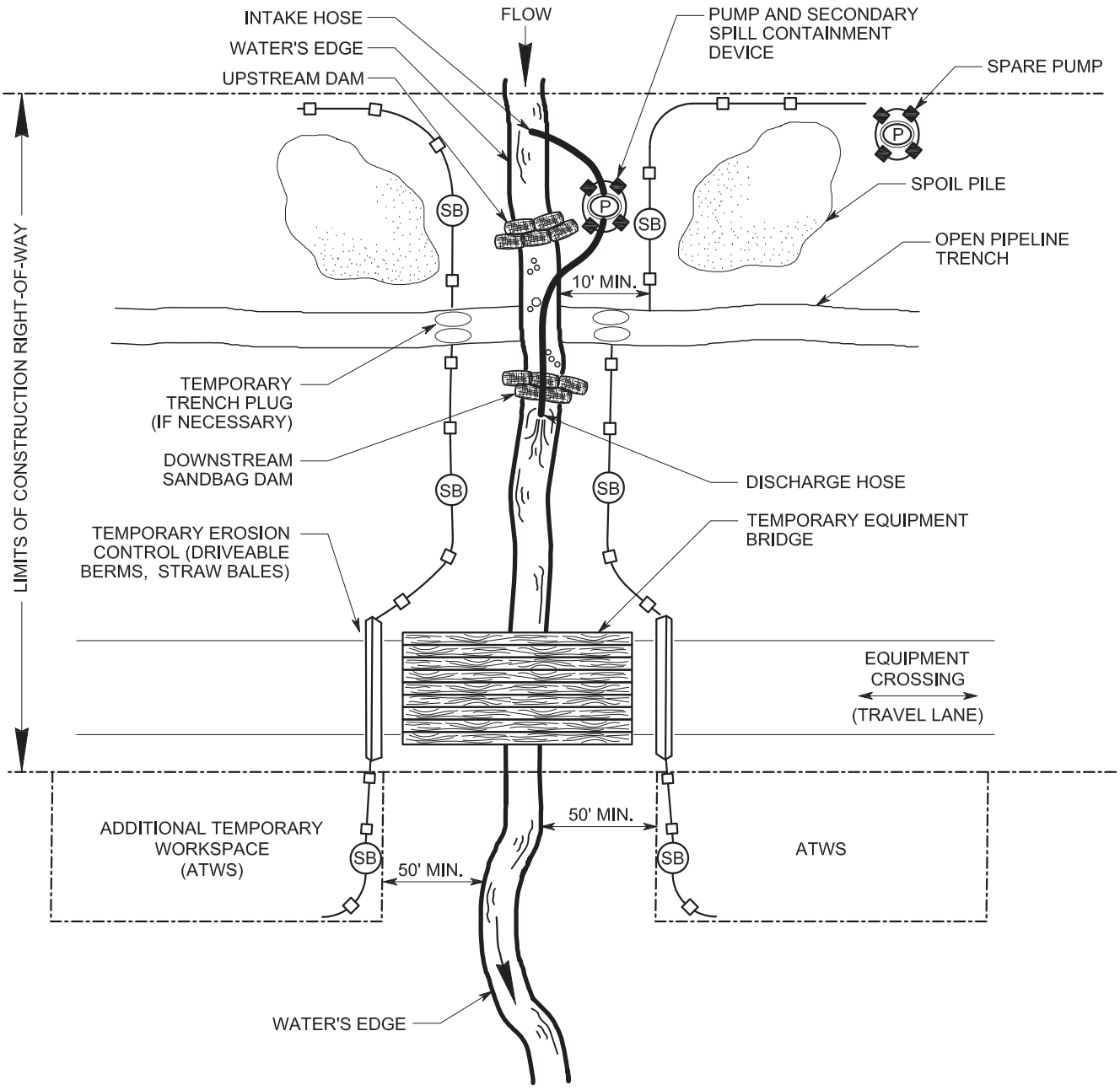
1. (SB) TEMPORARY SEDIMENT BARRIER OF SILT FENCE AND/ OR STRAW BALES, OR OTHER APPROPRIATE MATERIALS.
2. SAND BAGS MUST BE FILLED WITH SAND FREE OF SILT, ORGANICS, AND OTHER MATERIAL.
3. ENSURE SANDBAGS ARE INSTALLED BEFORE PLACING FLUME PIPE.
4. ALIGN FLUME(S) TO PREVENT BANK EROSION AND STREAM SCOUR.
5. CONDUCT ALL IN-STREAM ACTIVITY (EXCEPT BLASTING OR OTHER ROCK BREAKING MEASURES) WITH THE FLUME(S) IN PLACE. FLUME PIPE(S) MAY NOT BE REMOVED FOR LOWERING IN PIPE OR INITIAL STREAMBED RESTORATION EFFORTS.
6. THE ENDS OF THE FLUME AND CULVERT MUST EXTEND TO AN UNDISTURBED AREA.
7. CONTRACTOR TO DETERMINE ACTUAL NUMBER AND SIZE OF FLUMES AND CULVERTS REQUIRED BASED ON STREAM WIDTH AND STREAM FLOW RATE AT THE TIME OF CROSSING.
8. WATER ACCUMULATING WITHIN THE WORK AREA SHALL BE PUMPED TO A FILTER BAG OR DEWATERING STRUCTURE PRIOR TO DISCHARGING INTO ANY SURFACE WATER.

TYPICAL FLUME WATERBODY CROSSING

FIGURE WC-3

DWG. ES-0034 REV.

I.G. ES0034.DWG
Wayne Sicora 6/3/2014 11:38 AM
Q:\S-U\SPE\2013-200.00\AutoCAD\Final\es0034.dwg



NOTES:

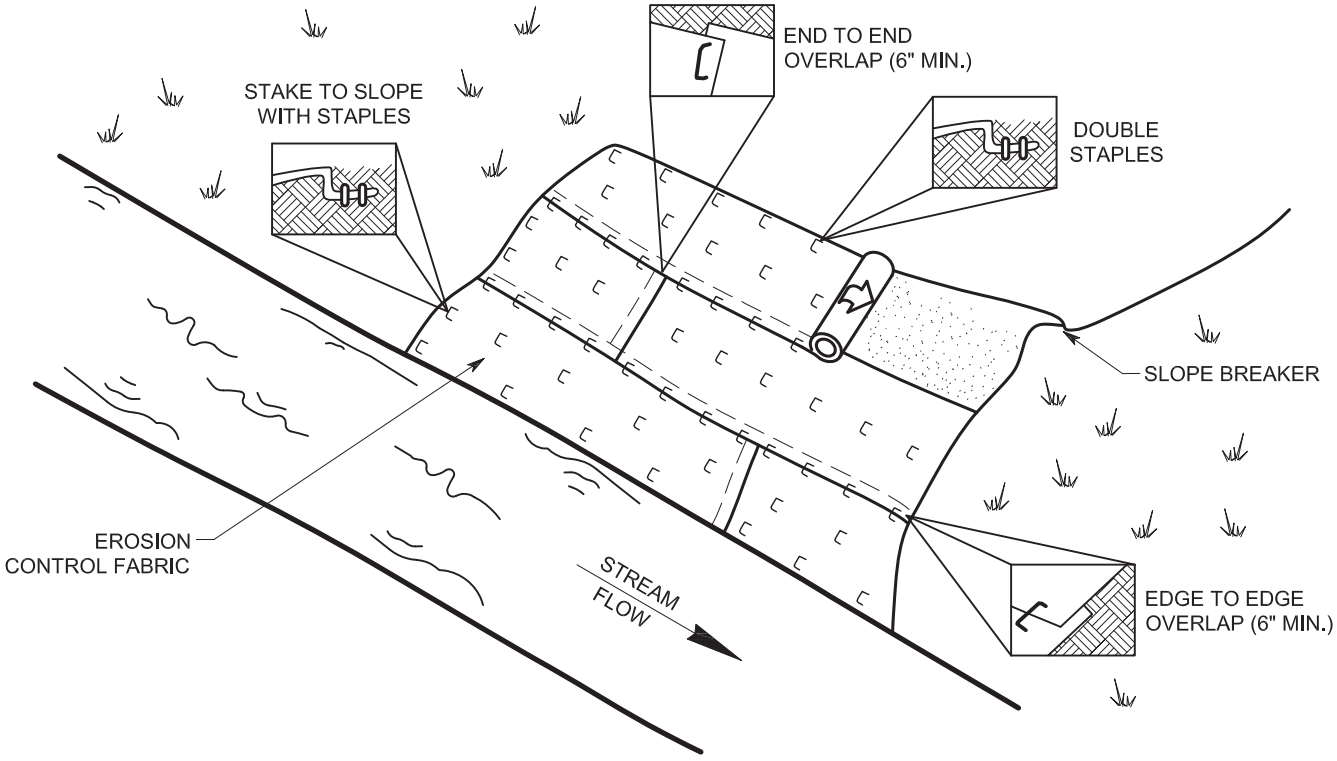
1. (SB) TEMPORARY SEDIMENT BARRIER OF SILT FENCE AND/ OR STRAW BALES, OR OTHER APPROPRIATE MATERIALS
2. INSTALL AND SEAL SANDBAGS UPSTREAM AND DOWNSTREAM OF THE CROSSING.
3. CREATE AN UPSTREAM SUMP USING SANDBAGS IF NATURAL SUMP IS UNAVAILABLE FOR THE INTAKE HOSE.
4. EXCAVATE ACROSS STREAM CHANNEL FOLLOWING WATER REROUTING.
5. DO NOT REFUEL OR STORE FUEL WITHIN 100 FEET OF THE WATERBODY. IF NOT FEASIBLE, ALTERNATIVE METHODS MUST BE APPROVED BY ENVIRONMENTAL INSPECTOR.
6. MONITOR PUMPS AT ALL TIMES DURING STREAM CROSSING PROCEDURE.
7. (P) USE SUFFICIENT PUMPS, INCLUDING ONSITE BACKUP PUMPS, TO MAINTAIN DOWNSTREAM FLOW.
8. SCREEN PUMP INTAKES. PREVENT SCOURING WITHIN WATERBODY BY HOSE DISCHARGE.

TYPICAL DAM-AND-PUMP WATERBODY CROSSING

FIGURE WC-4

DWG. ES-0035 REV.

Q:\S-U\SPE\2013-200.00\AutoCAD\Final\es0035.dwg
Wayne Sicora 6/3/2014 11:41 AM
I.G. ES0035.DWG



NOTES:

1. EROSION CONTROL BLANKETS (FABRIC) SHALL BE PLACED ON THE BANKS OF FLOWING STREAMS WHERE VEGETATION HAS BEEN REMOVED OR AS DIRECTED BY THE ENVIRONMENTAL INSPECTOR.

2. EROSION CONTROL BLANKETS SHALL MEET THE REQUIREMENTS SPECIFIED IN THE E&S PLAN AND/OR AS DIRECTED BY THE ENVIRONMENTAL INSPECTOR.

3. STAPLES SHALL BE MADE OF 11 GAUGE WIRE, U-SHAPED WITH 6" LEGS AND A 1" CROWN. STAPLES SHALL BE DRIVEN INTO THE GROUND FOR THE FULL LENGTH OF THE STAPLE LEGS. ALTERNATELY 1" WOODEN PEGS 6" LONG AND BEVELED TO SECURE MATTING.

4. BLANKETS SHALL BE INSTALLED ACCORDING TO MANUFACTURER SPECIFICATIONS OR AS STATED BELOW:

   - EXTEND TOP OF BLANKET 2 FEET PAST THE UPPER EDGE OF THE HIGH WATER MARK. IF A SLOPE BREAKER IS PRESENT ON THE APPROACH SLOPE, BEGIN THE BLANKET ON THE UPHILL SIDE OF THE SLOPE BREAKER.
   - INSTALL BLANKET(S) ACROSS THE SLOPE IN THE DIRECTION OF THE WATER FLOW.
   - ANCHOR ("KEY") THE UPSTREAM EDGE OF THE BLANKET(S) INTO THE SLOPE USING A 6" DEEP TRENCH. DOUBLE STAPLE EVERY 12" BEFORE BACKFILLING AND COMPACTING TRENCH
   - OVERLAP THE EDGES OF PARALLEL BLANKETS A MINIMUM OF 6". PLACE THE UPPER BLANKET OVER THE LOWER BLANKET (SHINGLE STYLE) AND STAPLE EVERY 12" ALONG THE LENGTH OF THE EDGE.
   - WHEN BLANKET ENDS ARE ADJOINED, PLACE THE UPSTREAM BLANKET OVER THE DOWNSTREAM BLANKET (SHINGLE STYLE) WITH APPROXIMATELY 6" OF OVERLAP AND STAPLE THROUGH THE OVERLAPPED AREA EVERY 12".
   - STAPLE DOWN THE CENTER OF THE BLANKET(S), THREE STAPLES IN EVERY SQUARE YARD.

5. IN LIVESTOCK AREAS WHERE EROSION CONTROL BLANKETS ARE APPLIED TO THE STREAMBANKS, FENCING MAY BE USED IF NECESSARY TO EXCLUDE LIVESTOCK, WITH PERMISSION OF THE LANDOWNER.

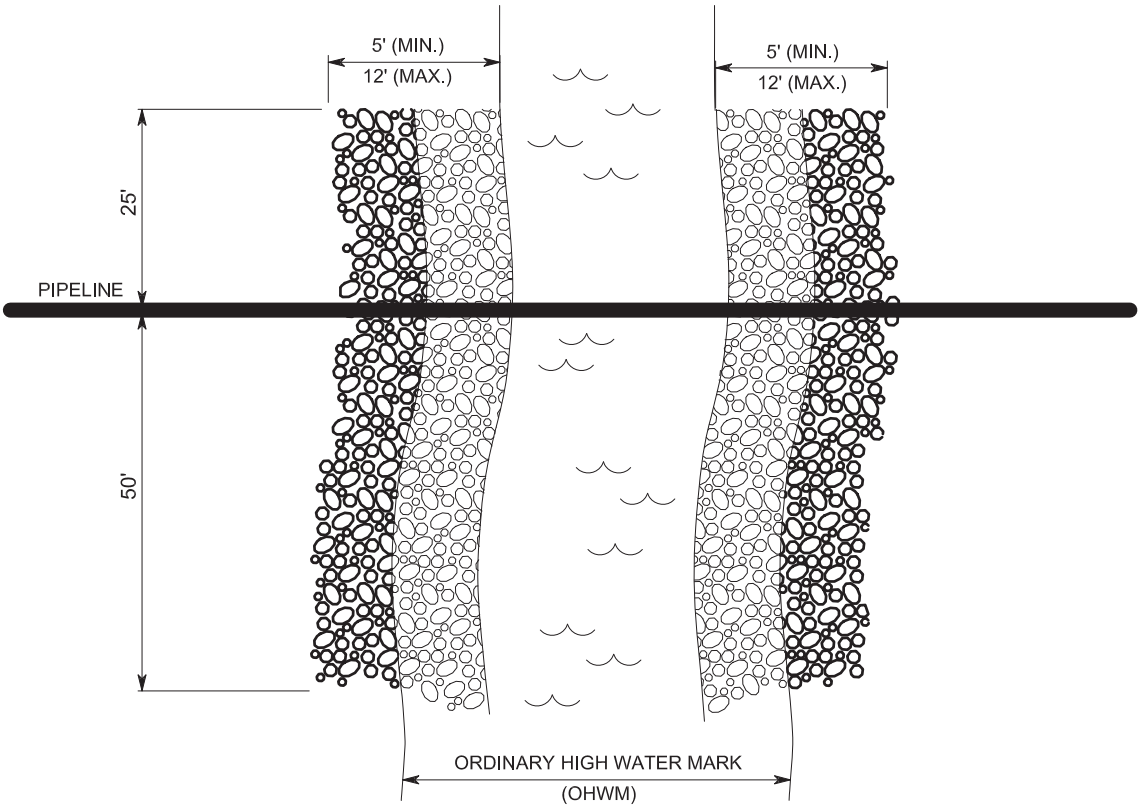
6. MONITOR WASHOUTS, STAPLE INTEGRITY OR BLANKET MOVEMENT. REPLACE OR REPAIR AS NECESSARY.

7. DO NOT USE SYNTHETIC MONOFILAMENT MESH / NETTED MATERIALS IN AREAS DESIGNATED AS SENSITIVE WILDLIFE HABITAT, UNLESS THE PRODUCT IS SPECIFICALLY DESIGNED TO MINIMIZE HARM TO WILDLIFE.

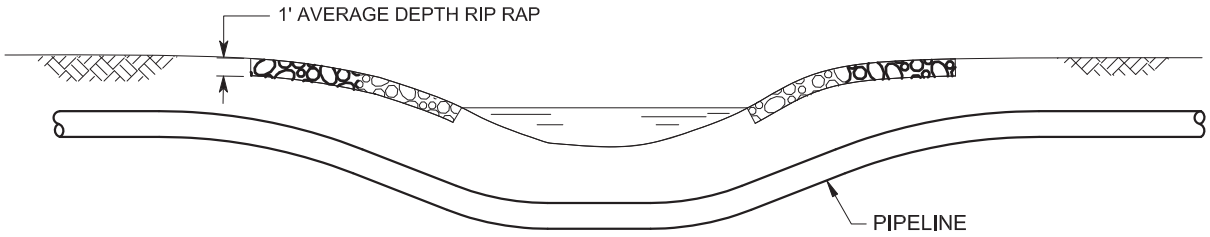
NOT TO SCALE

	TYPICAL EROSION CONTROL BLANKETS ON STREAMBANKS	FIGURE WC-5
		DWG. ES-0036 REV.

Q:\S-U\SPE\2013-200.00\AutoCAD\Final\es0036.dwg
Wayne Sicora 6/9/2014 4:33 PM
I.G. ES0036.DWG



PLAN VIEW



CROSS-SECTION VIEW

NOTES:

1. RIP-RAP SHALL NOT EXCEED 500 FEET IN LENGTH ALONG THE BANK.
2. RIP-RAP WILL NOT EXCEED AN AVERAGE OF ONE CUBIC YARD PER RUNNING FOOT BELOW THE OHWM.
3. RIP-RAP INSTALLATION SHALL BE IN COMPLIANCE WITH ALL APPLICABLE PERMITS.
4. RIP-RAP MUST BE CLEAN AND FREE OF SOIL AND DEBRIS.
5. RIP-RAP SHALL NOT BE PLACED IN A MANNER THAT IMPAIRS SURFACE WATER FLOW.
6. GEOTEXTILE FABRIC MAY BE INSTALLED BELOW RIP-RAP.

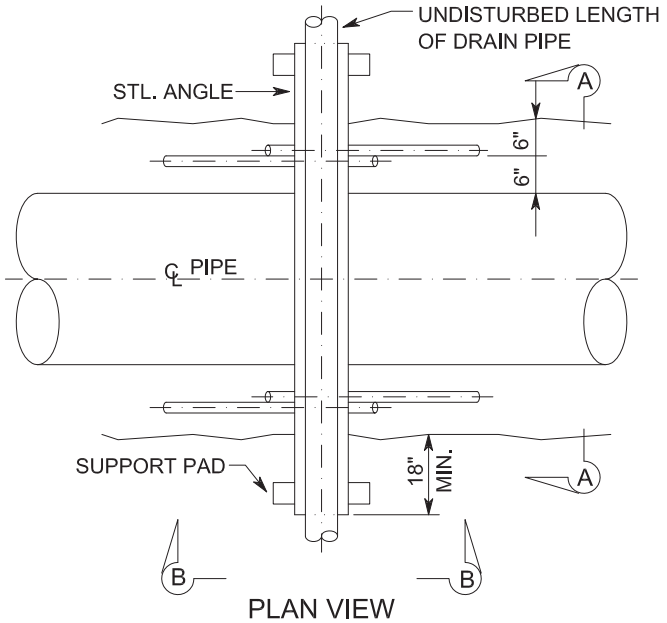
NOT TO SCALE

TYPICAL RIP-RAP PLACEMENT

FIGURE WC-6

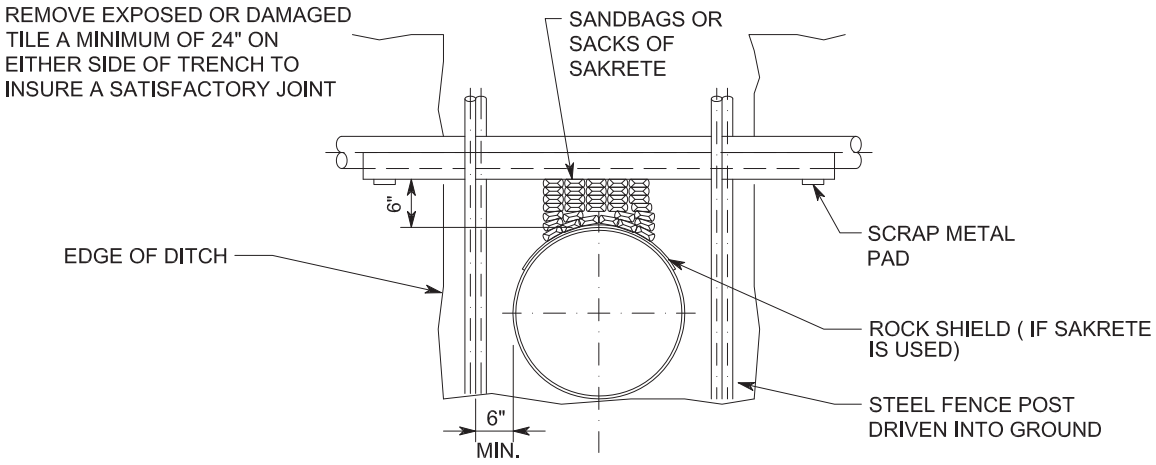
DWG. ES-0037 REV.

Q:\S-U\SPE\2013-200.00\AutoCAD\Final\es0037.dwg
Wayne Sicora 5/29/2014 5:44 PM
I.G. ES0037.DWG



PLAN VIEW

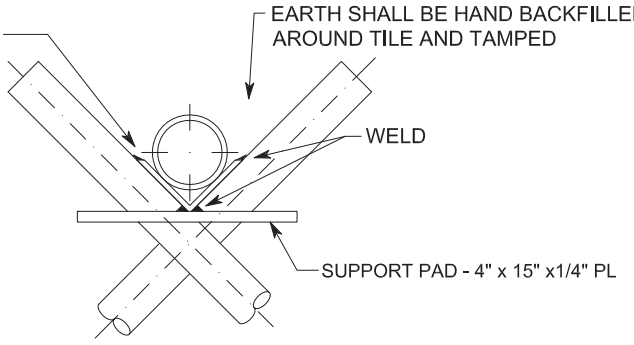
N.T.S.



SECTION "A-A"

N.T.S.

TO SUPPORT 4" & 6" TILE USE 4" x 1 / 4" ANGLE
" 8" " 6" x 7/ 16" "
" 10" " 6" x 7/ 16" "
" 12" " 8" x 1 / 2" "
" 16" " 8" x 1 / 2" "



SECTION "B-B"

N.T.S.

NOTE:
USE OF SAKRETE SHALL REQUIRE PRIOR
COMPANY APPROVAL.

DRAIN TILE REPAIR PROCEDURE

FIGURE SU-1

DWG. ES-0038 REV.

I.G. ES0038.DWG

Wayne Sicora
5/29/2014 6:08 PM

Q:\S-U\SPE\2013-200.00\AutoCAD\Final\es0038.dwg

ENBRIDGE

APPENDIX B

WATERBODY REFERENCE CITING FERC REQUIREMENTS

ENBRIDGE

APPENDIX B: Waterbody Reference Citing FERC Requirements

Waterbodies may be specifically identified or recognized by the States or authorized Indian Tribe for water use, value or quality, such as fisheries. FERC's *Wetland and Waterbody Construction and Mitigation Procedures* (Procedures) contain specific requirements with regards to state-designated fisheries which are summarized in the table below. This table is a general reference of waterbody construction techniques and restrictions required by the FERC Procedures, 2013 version. Project-specific permits obtained for a given project may be more restrictive and must be followed (Refer to project-specific Clearance Package/Permit Book).

FERC Waterbody Type[a]	Crossing Width[b]	Construction Crossing Method[c]	Seasonal Timing Restriction[d]	Waterbody Construction Duration[e]
Not Designated Fisheries				
MINOR	*≤ 10 feet*	Dry or Wet	No	24 hours
INTERMEDIATE	*> 10 feet but ≤ 100 feet*	Dry or Wet	No	48 hours
MAJOR	*> 100 feet*	Refer to site-specific plan	No	N/A
Designated Fisheries				
MINOR	*≤ 10 feet*	Dry only	Yes	N/A
INTERMEDIATE	*> 10 feet but ≤ 100 feet*	Dry or Wet	Yes	N/A
MAJOR	*> 100 feet*	Refer to site-specific plan	Yes	N/A

a) Waterbody types or classifications as defined in the FERC Procedures. Refer to Section 5.3 of E&SCP.

b) Measured from the water's edge at the time of crossing.

c) "Dry" = Dry crossing includes dam-and-pump or flume crossing methods where the stream flow is isolated from the construction area. A dry crossing is generally required for crossings up to 30 feet wide for state designated fisheries or federally designated critical habitat.
"Wet" = Wet crossing generally refers to the open-cut method that allows continuous flow of the stream across the construction area.
"Refer to site-specific plan" = A plan is required for each major crossing as well as each waterbody or wetland that would be crossed using the HDD method requires a project-specific HDD Plan (refer to Section 4.4).

d) For designated fisheries, instream work must occur during the following seasonal time windows, unless expressly permitted or further restricted by the appropriate federal or state agency in writing on a site-specific basis:
- coldwater fisheries construction must occur from June 1 through September 30.
- coolwater and warmwater fisheries construction must occur from June 1 through November 30.

NOTE: project-specific waterbody crossings may have other federal and state agency timing restrictions. Seasonal timing windows will be indicated within the project-specific waterbody crossing table and/or within the Environmental Clearance/Permit Book for the project. The FERC seasonal timing window restrictions do not apply to the installation or removal of equipment bridges.

e) The construction duration of the crossing officially begins with in-stream activities, including in-stream trenching, pipe installation, backfill, and restoration of the streambed contours. Duration does not apply to in-stream work for dry crossings, and does not apply to blasting activities.

APPENDIX C

SEED MIX RECOMMENDATIONS

SEED MIX RECOMMENDATIONS: *"NORTHERN ZONE"*

The Northern Zone is generally defined as areas north of the northern borders of Arkansas and Tennessee.

UPLAND AREAS

Lime	4.0 tons/acre
Fertilizer	1000 lbs./acre (10-20-20)
Mulch (Wheat Straw)	3.0 tons/acre

Upland Seed Mix		75 lbs./acre Pure Live Seed (PLS)
Kentucky Bluegrass		20%
Red Fescue [1]	20%	
Kentucky 31 Tall Fescue [1]		15%
Redtop		10%
Perennial ryegrass		20%
White clover	5%	
Birdsfoot Trefoil (Minimum 20% hard seed)		10%

[1] Fescue must be endophyte-free.

Pasture Mix	20 lbs./acre PLS
(For use only in disturbed pasture areas with landowner's permission.)	
Kentucky Bluegrass	31%
Medium Red clover	26%
Norcen Trefoil	17%
Poly Perennial Rye	26%

Recommended Seeding Dates

(For the establishment of temporary or permanent vegetation.)

Spring: March 15 - May 30

Fall: August 1 - October 15

WINTER STABILIZATION

If restoration does not occur prior to October 15, seed the construction ROW with 1.5 bushels per acre of winter rye or similar variety of rye as requested by the landowner. Mulch the construction ROW at 3.0 tons per acre with wheat straw, including areas adjacent to streams and wetland crossings. Seed segregated topsoil piles with winter rye and mulch at a rate of 3.0 tons per acre.

WETLAND AREAS

DO NOT USE LIME OR FERTILIZER !!!

Do not use fertilizer, lime, or mulch within wetlands unless required in writing by the appropriate federal or state agency (as identified in the Clearance Package/Permit Book). Mulch consists of weed-free straw, wood fiber hydromulch or some functional equivalent as approved by the EI and Chief Inspector. When used, apply mulch (wheat straw) at a rate of 3.0 tons/acre.

Wetland Seed Mix	
Annual Ryegrass	40 lbs./acre PLS

SEED MIX RECOMMENDATIONS: *"SOUTHERN ZONE"*

The Southern Zone is generally defined as areas south of the northern borders of Arkansas and Tennessee.

UPLAND AREAS

Lime (agricultural limestone)	2.5 tons/acre
Fertilizer (6-12-12)	950 lbs./acre
Mulch (Oats, Wheat or Bermudagrass Straw)	3.0 tons/acre

Seed Mixture[1]

Sorghum, Sudangrass, or Sudangrass Hybrids[2]	40 lbs/acre Pure Live Seed (PLS)
Kentucky 31 Tall Fescue[3]	10 lbs/acre PLS
Big Bluestem	10 lbs/acre PLS
Indiangrass	10 lbs/acre PLS
Bermudagrass	10 lbs/acre PLS
Sericea Lespedeza[4]	10 lbs/acre PLS
White Clover[4]	5 lbs/acre PLS
Birdsfoot Trefoil[4]	10 lbs/acre PLS

[1] An alternative seed mixture may be requested by the landowner(s).

[2] These species may be sold under the following trade names: DeKalb SX17, Greentreat II, Greentreat III, Tastemaker DR, Tastemaker III, FFR202, or Sordan 79.

[3] Fescue must be endophyte-free.

[4] Legumes should be treated with a species specific inoculate prior to seeding. Legume seed and soil should be scarified.

Recommended seeding dates

(For establishment of temporary or permanent vegetation.)

Spring: March 15 - May 30

Fall: August 1 - October 15

WINTER STABILIZATION

If restoration does not occur prior to October 15, seed the construction ROW with 1.5 bushels per acre of winter rye or similar variety of rye as requested by the landowner. Mulch construction ROW at 3.0 tons per acre with wheat straw, including areas adjacent to stream and wetland crossings. Seed segregated topsoil piles with winter rye and mulch at a rate of 3.0 tons per acre.

WETLAND AREAS

DO NOT USE LIME OR FERTILIZER !!!

Do not use fertilizer, lime, or mulch within wetlands unless required in writing by the appropriate federal or state agency (as identified in the Clearance Package/Permit Book). Mulch consists of weed-free straw, wood fiber hydromulch or some functional equivalent as approved by the EI and Chief Inspector. When used, apply mulch (Oats, Wheat, or Bermudagrass straw) at a rate of 3.0 tons/acre.

Wetland Seed Mix:

Annual Ryegrass	40 lbs/acre PLS

Spill Prevention Control and Countermeasure (SPCC) Plan &

Preparedness, Prevention, and Contingency (PPC) Plan for Construction Projects

Project: **Sakonnet River HDD Replacement Project**

Location: Portsmouth and Little Compton, Rhode Island

Revised October 2017

ENBRIDGE

Environmental Construction Permitting
5400 Westheimer Court
Houston, Texas 77056-5310

TABLE OF CONTENTS

1.0 PURPOSE/PLAN OBJECTIVE.....1

2.0 TRAINING.....2

3.0 PRE-PLANNING - MATERIAL INVENTORY AND DOCUMENTATION 3

4.0 SPILL AND LEAK PREPAREDNESS AND PREVENTION 4

4.1 Prevention and Preparedness.....4

4.1.1 Secondary Containment 4

4.1.2 Storage/Inspection (Tanks/Containers) 5

4.1.3 Loading/Unloading Areas 5

5.0 CONTINGENCY PLAN AND EMERGENCY PROCEDURES.....7

6.0 SPILL CLEAN-UP/WASTE DISPOSAL PROCEDURES OF HYDROSTATIC TEST WATER 9

6.1 Oil/Fuel and Hazardous Material Spills and Unanticipated Releases.....9

6.2 Disposal of Contaminated Materials/Soils.....10

6.3 Notification 10

7.0 HOUSEKEEPING PROGRAM 11

7.1 Construction Area 11

7.2 Contractor Yards/Ware Yards.....11

7.3 Security 11

LIST OF APPENDICES

APPENDIX A - TABLES

TABLE I – MATERIAL AND WASTE INVENTORY

TABLE II – EMERGENCY RESPONSE AND PERSONAL PROTECTIVE EQUIPMENT

TABLE III – KEY EMERGENCY CONTACTS

TABLE IV – TANK AND CONTAINER STORAGE EXCEPTION AREAS

TABLE V – WASTE STORAGE SECURITY INFORMATION

TABLE VI– AREAS FOR POTENTIAL LEAKS AND SPILLS

APPENDIX B – MATERIAL SAFETY DATA SHEETS (MSDS)

APPENDIX C – EH&S INCIDENT INVESTIGATION FORM

APPENDIX D – REQUIRED SIGNATURE FORMS

APPENDIX E – PIPE YARD / FACILITY STORAGE DRAWING

ABBREVIATIONS AND DEFINITIONS

CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CI	Chief Inspector (Company employee or Contractor Employee performing the duties of the onsite Construction Manager or Engineer)
Company	Enbridge, Inc.
Company SC	Company Spill Coordinator (The Environmental Inspector or the Chief Inspector)
Contractor	Third party service provider performing construction activities for the Company on property owned or under the control of the Company. This role may be filled by the Company on small projects constructed by Company personnel and equipment.
Contractor SC	Contractor Spill Coordinator
CWA	Clean Water Act
DOT	U. S. Department of Transportation
E&C	Engineering & Construction
ECP	Environmental Construction Permitting
EHS, EH&S	Environmental Health and Safety
EI	Environmental Inspector (Company employee or Contractor Employee performing the duties of onsite environmental specialist overseeing Contractor compliance with environmental permit conditions, laws and regulations)
E&SCP	Erosion & Sedimentation Control Plan
FERC	Federal Energy Regulatory Commission
FWPC	Federal Water Pollution Control Act
HDD	Horizontal Directional Drill
JSA	Job Safety Analysis
MSDS	Material Safety Data Sheets
ppm	Parts per Million
Environmental Lead	Environmental Construction Permitting Specialist assigned to the project
OPA	Oil Pollution Act
RCRA	Resource Conservation and Recovery Act
SPCC Plan or Plan	Spill Prevention, Control and Countermeasure Plan
TSCA	Toxic Substances Control Act

1.0 PURPOSE/PLAN OBJECTIVE

Enbridge, Inc. ("Company") has prepared this Spill Prevention, Control and Countermeasure ("SPCC") Plan ("Plan") for construction projects in the United States. The purpose of this Plan is to reduce the probability and risk of a potential spill or release of oil or hazardous materials by the Company or Contractor during construction-related activities, by providing training to the Company and Contractor and expediting spill response and cleanup. This plan is not intended to meet the requirements of existing facility operations.

The Plan's specific objectives are to identify and address:

- The type and quantity of material handled, stored, or used on site during construction;
- The measures to be taken for spill preparedness and prevention;
- Emergency response procedures;
- Spill incident reporting/notification procedures; and
- Local emergency response team arrangements.

This plan has been prepared to meet the requirements of the Federal Energy Regulatory Commission's ("FERC's") *Upland Erosion Control, Revegetation, and Maintenance Plan* (Plan) and *Wetland and Waterbody Construction and Mitigation Procedures* (Procedures), the Oil Pollution Act ("OPA"), the Federal Water Pollution Control Act ("FWPC"), the Comprehensive Environmental Response, Compensation and Liability Act ("CERCLA") of 1980, the Resource Conservation and Recovery Act ("RCRA"), the Toxic Substances Control Act ("TSCA") and the Clean Water Act ("CWA").

The Company Environmental Construction Permitting ("ECP") group is responsible for the development and maintenance of this Plan. The Plan will be distributed to the Company Engineering & Construction ("E&C") Department's teams and associated Company personnel and will be included in the construction contract. It is the responsibility of the E&C teams to distribute to any necessary Contractors for implementation.

This Plan outlines both Company and Contractor responsibilities by topic. The Contractor is responsible for implementation of the Plan. In the absence of a Contractor, the Company will be responsible for both Company and Contractor responsibilities as they are laid out in this Plan.

A copy of the Plan must be on site during active construction and should also be maintained at the closest construction field office.

2.0 TRAINING

The Company requires all Contractor and Company personnel engaged in any construction activity to receive training in the implementation of the Plan prior to the commencement of on-site construction related activities.

Site visitors are to be given a brief review of the Plan as part of their orientation on safety and emergency procedures prior to the start of any on-site activities.

Contractor Responsibility

The Contractor will be responsible for the following:

- Keep training records
- Perform training briefings through ongoing meetings like tailgates and the daily project Job Safety Analysis ("JSA") that include:
  - Precautionary measures to prevent spills;
  - Potential sources of spills, including equipment failure or malfunction;
  - Standard operating procedures in the event of a spill;
  - Applicable notification requirements;
  - Equipment, materials and supplies available for clean-up of a spill;
  - Hazardous waste identification procedures;
  - Generation and proper handling of all non-hazardous waste, hazardous waste, and other toxic substances;
  - Proper storage, labeling, transportation and disposal of non hazardous and hazardous waste; and
  - Sample collection procedures.

Company Responsibility

The Company Chief Inspector ("CI"), Environmental Inspector ("EI"), or their designate will perform the following:

- Teach awareness-level training at the initial project environmental training session;
- Ensure further training is available for other new project personnel; and
- Audit training records kept by the Contractor as necessary.

3.0 PRE-PLANNING - MATERIAL INVENTORY AND DOCUMENTATION

Contractor Responsibility

The Contractor will be responsible for the following **prior** to the start of construction:

- Develop an inventory of all oil/hazardous material stored or used during construction;
- Complete Tables I, II, IV, V and VI (see Appendix A);
- Obtain material safety data sheets ("MSDS") (Appendix B) for all hazardous and non-hazardous substances listed in Table I (see Appendix A);
- Prepare a basic facility diagram or sketch for any storage areas, including pipe yards and temporary storage areas. The diagram should include locations of oil-filled containers, direction of run-off, emergency evacuation routes and assembly areas (see Appendix E); and
- Submit the required Tables, MSDS, and signature pages to the ECP's Environmental Lead for review and approval.

Company Responsibility

- Complete Tables III (see Appendix A);
- Review the Tables, MSDS, and signature pages submitted by the Contractor for approval; and
- Distribute approved Tables, MSDS, and signature pages to include in Plan as Appendices A, B and D.
- Fill out any signature pages or forms (see Appendix D)
    - Management Approval and Cleanup Commitment
    - Certificate of Determination of Substantial Harm Criteria

4.0 SPILL AND LEAK PREPAREDNESS AND PREVENTION

4.1 Prevention and Preparedness

Contractor Responsibility

- Complete Appendix A, Table I, Material and Waste Storage Inventory, and Table VI, Areas for Potential Leaks and Spills, prior to construction;
- Provide spill prevention, containment, and clean up equipment, and keep it available on-site;
- Perform daily inspections of all equipment, storage tanks, and/or container storage areas;
- Repair all leaking equipment, machinery or tools immediately. If items cannot be repaired, remove them immediately from the project site;
- Maintain a minimal spill kit (absorbent diapers, plastic bags, gloves, etc.) for each piece of hydraulically operated equipment and personnel vehicles within the project area;
- Store materials as indicated in the storage facility diagram or sketch provided by the Contractor in Appendix E;
- Submit a secondary containment plan for any hazardous material storage within the project area to the Company for approval **prior** to storage; and
- Obtain written approval from the project CI or EI for hazardous material storage within 100 feet of a wetland or waterbody.

Company Responsibility

- Review any secondary containment or storage plans submitted by the Contractor for approval.

4.1.1 Secondary Containment

Contractor Responsibility

- PCB (50 parts per million (“ppm”) or greater) storage tanks shall be double-walled or have secondary containment that will hold 200 percent of the tank capacity;
- All containers with a storage capacity greater than 55 gallons shall have temporary containment (see Appendix A, Table I for type of temporary containment); and
- Pumps and other portable fuel burning equipment used within 100 feet of a jurisdictional wetland or waterbody will be placed and operated within appropriate secondary containment systems to prevent spills. Secondary containment will hold at least 110% of the tank capacity of the largest tank inside the containment area.

4.1.2 Storage/Inspection (Tanks/Containers)

Contractor Responsibility

- Operate only those tanks for fuel and material storage that meet the approval of the Company;
- Elevate tanks a maximum of two feet above grade;
- Inspect vehicle-mounted tanks to ensure all are equipped with flame/spark arrestors on all vents to prevent self-ignition;
- Locate tank storage in areas that are at least 100 feet from all waterbodies, wetlands, and designated municipal watershed areas, with certain exceptions as approved by ECP and listed in Appendix A, Table IV;
- Complete Appendix A, Table IV, Tank and Container Storage Exception Areas, and submit to the Company for approval prior to construction;
- Inspect all tanks daily for leaks and deterioration. The results of all inspections shall be made available to the Company upon request;
- Do not store incompatible materials in sequence in tanks prior to decontamination (A general list of potentially incompatible materials that may be used during construction are included in Appendix A, Table I);
- Store small cans of gasoline, diesel, solvents, etc., within the temporary secondary containment or within secured trailers or vehicles when not in use;
- Replace leaking and/or deteriorated containers as soon as the condition is first detected; and
- Ensure that all container storage and containment areas being used to store hazardous materials or wastes are in compliance with applicable local, state and federal requirements.

4.1.3 Loading/Unloading Areas

Contractor Responsibility

- Transfer liquids and refuel only in pre-designated and pre-approved locations that are at least 100 feet from all waterbodies and wetlands, with certain exceptions as approved by the EI and listed in Appendix A;
- Inspect the area beneath loading/unloading location for spills before and after each use;
- Utilize drip pans at all hose connections while loading/unloading liquids. If a leak or spill occurs, the loading/unloading operation will be stopped and the spill will be contained, cleaned up and collected prior to continuing the operation;
- Inspect all outlets of the tank trucks prior to leaving the loading and unloading area to prevent possible leakage from the truck while in transit;
- Equip any service vehicle used to transport lubricants and fuel with an emergency response spill kit. At a minimum, this kit must include:
  - 25 lbs of granular oil absorbent
  - 10, 48" x 3" oil socks

- 5, 17" x 17" oil pillows
- 1, 10" x 4" oil boom
- 20, 24" x 24" x 3/8" oil mats
- Garden size, 6 mil, polyethylene bags
- 10 pair of latex gloves
- 1, 55-gallon polyethylene open-head drum;

- Equip any service vehicle used to transport lubricants and fuel with a chemical response kit. At a minimum, this kit must include:
  - 1 bag of loose chemical pulp
  - 2 to 3, 17" x 17" chemical pillows
  - 2, 48" x 3" chemical socks
  - 5, 18" x 18" x 3/8" adsorbent mats
  - garden-size, 6 mil, polyethylene bags
  - 10 pair of latex gloves
  - 1, 30-gallon polyethylene open-head drum
  - hazardous waste labels

Company Responsibility

- Personnel shall be present during loading and unloading activities.

5.0 CONTINGENCY PLAN AND EMERGENCY PROCEDURES

All Company and Contractor personnel have responsibilities for spill prevention, control, and countermeasure.

Contractor Responsibility

- Maintain adequate manpower and equipment at the pipe yard or contractor ware yard necessary to divert any spill from reaching waterbodies and wetland areas; and
- Complete Appendix A, Table I, Emergency Response and Personal Protective Equipment, with a list of emergency equipment and storage location.

Company Responsibility

- Complete Appendix A, Table III, Key Emergency Contacts, prior to construction, and update as necessary.

First Responder Responsibility

The first responder is the person who first observes a spill or release of oil or other hazardous materials to the environment.

This person will take the following steps:

- Assess the situation to determine if the situation poses an immediate threat to human health or the environment;
- Identify hazardous material involved, if any;
- Report the spill to the Company Spill Coordinator ("Company SC") and Contractor Spill Coordinator ("Contractor SC") immediately; and
- Standby at a safe distance and keep others away.

Contractor SC Responsibility

- Coordinate the response to all spills which occur as a result of Contractor operations;
- Report the spill to the Company;
- Coordinate with the Company SC; and
- Conduct subsequent site investigations and associated incident reports unless otherwise directed by the Company.

The Contractor SC may be removed by the Company SC as spill response coordinator at the discretion of the Company.

The Contractor SC will direct Contractor personnel to:

- Shut off source of spill or leak as quickly as possible;
- Minimize affected area with appropriate containment or dike/berm;
- Assemble required spill response equipment as required (protective clothing, gear, heavy equipment, pumps, absorbent material, empty drums, etc.);
- Ensure that spilled material is placed in appropriate containers, in accordance with the best management practices and applicable laws and regulations;
- Properly label and store containers in accordance with applicable requirements; and
- Ensure that all spill response equipment is fully functional. Any equipment that cannot be reused shall be replaced.

Company SC Responsibility

The Company SC will be responsible for overseeing the Contractor SC's clean up of all spills of oil or hazardous materials.

Upon notification, the Company SC shall:

- Assess situation for potential threat to human health, environment and the neighboring community;
- Implement evacuation, if necessary;
- Activate emergency shutdown, if necessary;
- Control source as conditions warrant;
- Ensure that incompatible materials are kept away from the impacted area;
- Keep any potential ignition source away from the impact area, if spilled material is flammable;
- Coordinate sampling, disposal and equipment decontamination with Environmental Health and Safety ("EHS") in Houston, if necessary;
- For spills of PCBs, contact EHS for special spill response requirements related to PCB spills;
- Assist with the coordination of cleanup and disposal activities;
- If necessary, contact outside remediation services, in coordination with EHS, to assist with clean up;
- Notify EHS of all quantities and description of wastes to be handled by EHS;
- Complete the *EH&S Incident Investigation Form* (see Appendix C) and distribute accordingly;
- For unanticipated release of hydrostatic test waters, notify state contact if required by state permit, in accordance with timeframes required by state permit;
- Review permits to determine if immediate water sampling of test water is required and arrange if necessary; and
- Determine if local Right of Way agent will notify public officials (e.g. township manager and/or mayor).

6.0 SPILL CLEAN-UP/WASTE DISPOSAL PROCEDURES OF HYDROSTATIC TEST WATER

6.1 Oil/Fuel a;nd Hazardous Material Spills and Unanticipated Releases

Contractor Responsibility

- Ensure no immediate threat to surrounding landowners or environment;
- Identify/verify the material and quantity released;
- Review MSDS to determine the proper handling;
- Ensure that Personal Protective Equipment and containers are compatible with the substance;
- Remediate small spills and leaks as soon as feasible. Use adsorbent pads whenever possible to reduce the amount of contaminated articles;
- Restrict the spill by stopping or diverting flow to the oil/fuel tank;
- If the release exceeds the containment system capacity, immediately construct additional containment using sandbags or fill material. Every effort must be made to prevent the seepage of oil into soils, wetlands and surface waters;
- Block off drains and containment areas to limit the extent of the spill. For chemical spills, never wash down a spill with water;
- If a release occurs into a storm drain or stream, immediately pump any floating layer into drums. For high velocity streams, place oil booms or hay bales between the release area and the site boundary and downstream of affected area. As soon as possible, excavate contaminated soils and sediments within approved work areas;
- Collect and reclaim as much of the spill as possible using a hand pump or similar device. Containerize contaminated soils in an appropriate Department of Transportation ("DOT") container in accordance with applicable requirements. Never place incompatible materials in the same drum;
- For larger quantities of soils, construct temporary waste piles using plastic liners placing the contaminated soils on top of the plastic and covered by plastic. Plastic-lined roll-off bins should be leased for storing this material as soon as feasible;
- Properly label any drums, containers or storage piles in accordance with applicable requirements;
- Move drum to secure staging or storage area;
- Decontaminate all equipment in a contained area and collect fluids in drums;
- Document and report cleanup activities to the Company SC as soon as feasible; and
- If environmentally sensitive resources (wetlands, waterbodies) exist in the area, ensure that Best Management Practices as described in Company's Erosion &Sedimentation Control Plan ("E&SCP") are utilized to minimize impact to these resources.

Company Responsibility

- If necessary, arrange for sampling the substance for analysis and waste profiling, according to instructions from the Company Standard Operating Procedures, and/ or EHS;
- Document and report activities to EHS as soon as feasible.

6.2 Disposal of Contaminated Materials/Soils

For Company and Contractor protocol on the disposal of contaminated materials, soils, or any other waste materials, please see the Company Waste Management Plan.

6.3 Notification

Company Responsibility

- The Company SC shall notify the Emergency Spill Hotline at (800) 735-6364 and those listed in Appendix A, Table III, immediately for spills that meet any of the following criteria:
  - one pound or more of a solid material (excluding Horizontal Directional Drill ("HDD") mud) spilled on land;
  - five gallons or more of a liquid spilled on land;
  - creates a sheen on water; or
  - unanticipated release of hydrostatic test water.
- If necessary, notify the local fire department, law enforcement authority, or health authority as appropriate. The following information should be provided:
  - the name of the caller and callback number;
  - the exact location and nature of the incident;
  - the extent of personnel injuries and damage;
  - the extent of release; and
  - the material involved and appropriate safety information.
- An incident report form should be filled out following containment and cleanup of the spill or release. Incident data should be gathered using the *EH&S Incident Investigation Form* (see Appendix C) and should be sent to the appropriate ECP project manager for records retention and entry into the EPASS/ILP database.

7.0 HOUSEKEEPING PROGRAM

7.1 Construction Area

Contractor Responsibility

- Maintain construction area in neat and orderly manner; and
- Routinely collect and properly dispose of all trash off-site.

7.2 Contractor Yards/Ware Yards

Contractor Responsibility

- Produce a "site specific" plan to address storage, spill prevention and overall yard organization for all contractor yards and ware yards. Contractor yard "site specific" plans should include the following:
    - facility name;
    - physical address;
    - longitude and latitude coordinates;
    - directions to facility (including road names);
    - date of first oil and hazardous material storage;
    - location of oil and hazardous material containers greater than 55 gallons;
    - loading/unloading areas;
    - direction of drainage flow; and
    - primary and secondary evacuation routes.
- Provide adequate aisle spacing to allow unobstructed movement of personnel, fire protection equipment, spill control equipment, and decontamination equipment as necessary in storage areas;
- Ensure similar housekeeping practices enforced in construction areas are also implemented in storage areas; and
- Any facility with an aggregate aboveground oil storage capacity greater than 1,320 US gallons but less than 10,000 gallons must have the plan self-certified by the owner or operator of the qualified facility or a licensed Professional Engineer. Any facility with an aggregate aboveground oil storage capacity greater than 10,000 gallons must have the plan reviewed and certified by a licensed Professional Engineer.

7.3 Security

Contractor Responsibility

- Hazardous wastes and waste containing PCBs greater than 50 ppm will be stored in a secured location (i.e. fenced, locked, etc.). Fuel storage areas will be located to minimize, as much as possible, tampering by unauthorized personnel during non-operational hours.
- Complete Table V, Waste Storage Security Information, in Appendix A, prior to construction.

Company Responsibility

- Review Table V, Waste Storage Security Information in Appendix A, that has been prepared by the Contractor prior to construction.

Project Signatures:

Company Spill Coordinator:

Print Name

Signature Date

Contractor Spill Coordinator

Print Name

Signature Date

APPENDIX A - TABLES

TABLE I – MATERIAL AND WASTE INVENTORY

Oil and Fuel to be used or stored on site during construction:

STORAGE CAPACITY OF OIL FILLED-CONTAINERS

Container Number[a/]	Storage capacity (volume)	Location

[a/] The reference container numbers should correspond to the facility diagram in Appendix E.

Commercial Chemicals to be used or stored on site during construction:

Hazardous and Non-Hazardous Wastes to be used or stored on site during construction:

Incompatible Materials to be used or stored on site during construction:

Type of Temporary Containment containers to be used:

TABLE I TO BE COMPLETED BY CONTRACTOR
Prior to the Start of Construction and updated as necessary

TABLE II – EMERGENCY RESPONSE AND PERSONAL PROTECTIVE EQUIPMENT

Spill Response:

Equipment	Quantity	Location

Fire Protection:

Equipment	Quantity	Location

Personnel Protection:

Equipment	Quantity	Location

TABLE II TO BE COMPLETED BY CONTRACTOR
Prior to the Start of Construction and updated as necessary

TABLE III – KEY EMERGENCY CONTACTS

The list of key personnel who will be contacted in the event of an emergency or spill incident include:

1. ***Company Emergency Contacts*** Contact Name Phone Number

Company Spill Coordinator & Environmental
Inspector (within 15 minutes identifying of incident)

24-hour Emergency Spill Hotline -- 1-800-735-6364
(within 15 minutes of identifying incident)

Regional Environmental Coordinator
(within 15 minutes of identifying incident)

ECP's Project Environmental Lead / PM
(notify within 60 minutes of incident & submit
Spill Report Form within 24 hours to ECP PM)

Company Project Manager

Company Environmental Coordinator

Field Construction
Company Construction Coordinator

2. ***Contractor Emergency Contact***

Contractor Spill Coordinator

3. ***Local Authorities*** – As necessary

Emergency contact for Police, Fire & Medical assistance ***Dial 911***

Non-Emergency Local Authorities or Contacts		
Location	**Contact**	**Phone Number**

4. ***Environmental Agencies***

Notification to be made by Regional Environmental Coordinator and ECP's PM

5. ***Potential Environmental Remedial Service Contractors***

Clean Harbors Environmental Services, Inc.	Howard Alexander	(800) 782-8805
Safety-Kleen (FS), Inc	Edward A. Mitchell	(281) 478-7700
U.S.A. Environment	Cesar Garcia	(713) 425-6925 or (832) 473-5354
WRS Infrastructure and Environment Inc	Steve Maxwell	(281) 731-0886

TABLE III TO BE COMPLETED BY COMPANY
Prior to the Start of Construction and updated as necessary

TABLE IV – TANK AND CONTAINER STORAGE EXCEPTION AREAS

Tank and container storage shall be located in areas that are at least 100 feet from all waterbodies and wetlands.

The below exceptions have been approved by ECP and EHS:

1.

2.

3.

4.

TABLE IV TO BE COMPLETED BY CONTRACTOR
Prior to the Start of Construction and updated as necessary

TABLE V – WASTE STORAGE SECURITY INFORMATION

TABLE V TO BE COMPLETED BY CONTRACTOR
Prior to the Start of Construction and updated as necessary

TABLE VI–AREAS FOR POTENTIAL LEAKS AND SPILLS

1.

2.

3.

4.

TABLE VI TO BE COMPLETED BY CONTRACTOR Prior to the Start of Construction and updated as necessary

APPENDIX B - MSDS

APPENDIX C – EH&S INCIDENT INVESTIGATION FORM

HSF-004 1/1/2011
AVAILABLE ELECTRONICALLY

Enbridge, Inc.

EHS Incident Investigation/Data Collection Form

This form replaces: C-23 Occupational Injury and Illness Report, 19-06 Field Spill Report, 19-20 Outside Agency Inspection, 19-21 Natural Gas Release Record, and 19-25 Contamination Encounter Report

(Must Be Completed)

BUSINESS UNIT	REGION (Circle One)	AREA	LOCATION (Entity)
US	Northeast / Southeast / Corporate		

Complete each section and field as applicable for the Incident Type you are entering. *All required fields **(bold)** are EPASS ILP system required and must be completed.*

Common fields applicable to all types of incidents.

Incident Type: ☐ Injury / Illness ☐ Vehicle ☐ Environmental ☐ Complaint ☐ Near Miss
(Check multiple incident types as appropriate)

Category: ☐ Incident with Loss ☐ Incident without Loss Initiating Event: _____

Status: Open ☐ **Do not include in rates and counts:** ☐ Note: (Pertains to all incidents without loss.)

Date Reported: _____ **Date Occurred:** _____ Time Occurred: _____ AM ☐ PM ☐

Describe exactly how the incident occurred. Be very specific in details without reference to individual(s) names.

Employee Name: _____ **Incident Owner (Supervisor) Name:** _____

Contractor Incident: ☐ Yes ☐ No **Dependent** ☐ **Independent** ☐

Contract Employee Name: _____ **Phone Number:** _____

Contractor Contact Name: _____ **Contractor Company Name:** _____

Contractor Address, City, State, Zip code _____

Time Work Began: _____ AM ☐ PM ☐ **Time work began cannot be confirmed:** ☐

Response Agency Involved: ☐ Police ☐ Fire ☐ Ambulance ☐ HazMat ☐ Insurance ☐ External Response Support

Emergency Response Coordination: ☐ Internal ☐ External **Third Party Damage:** _____

Description of Immediate Response: (Note: This information is included in the ILP e-mail initial incident notification.)

Section A

Injury / Illness Incident Detail **SRS TeleClaim Contact #: 1-866-880-1777** Enbridge, Inc. Account #: 57568

Classification: ☐ First Aid ☐ Medical Treatment ☐ Modified / Restricted Work ☐ Lost Time ☐ Fatality

NOTE: Contact Human Resources to determine if Certificate of Disability is appropriate.

Event/Exposure (i.e. fall, slip/trip, strain) _____ **Injury source (i.e. tool, chemicals)** _____

Body Part (i.e. R/L leg, hand, back) _____ **Nature of Injury (i.e. cut, bruise, burn)** _____

Reported to Case Manager / SRS : ☐ Yes ☐ No **OSHA Log Injury Type(i.e. injury, illness, hearing loss)** _____

OSHA Log Injury Short Description: _____

Section B

Vehicle Incident Detail Driver **MUST CALL** PHH @ 800-446-7052 and provide vehicle unit #.
For any other claims, contact SRS Teleclaim @ 866-880-1777 w/Enbridge, Inc. Account #: 57568

Vehicle Type: (i.e. car, pickup) _____ **Ownership (i.e. company, rental)** _____

Activity (i.e. turning, passing, backing): _____ **Location:(i.e. urban, ROW, highway):** _____

Collision Location (i.e. ROW, parking lot, intersection) _____ **Road Type (i.e. concrete, dirt)** _____

Contributing Factors (i.e. failure to yield, keep safe distance): _____

Traffic Controls (i.e. stop sign, traffic signal, railroad crossing): _____

Collision Type i.e. backing, turning, rear ended) _____ **Collision Object (i.e. vehicle, animal, object)** _____

Road Conditions (i.e. dry, wet, ice, snow) _____ **Weather Conditions (i.e. rain, snow, clear)** _____

Journey Purpose (i.e. Business, Personal, T/F Work) _____ Lighting (i.e. dawn, day, night): _____

Third Party Name _____ Address: _____

Environmental Incident Detail

Section C

Spill/release Source: _____ **Reportable:** ☐ Yes ☐ No **Unplanned Release:** ☐ Yes ☐ No

Unexpected Contaminated Soil Encountered: ☐ Yes ☐ No

Medium: ☐ Air ☐ Containment ☐ Ground ☐ Treatment System ☐ Water

Units: ☐ Gallons ☐ Pounds ☐ mmscf (millions) ☐ mcf (thousands) **Spill / Release Amount:** _____

Material (i.e. natural gas, oil, pipeline condensate, glycol) _____ Occur near wetlands: ☐

Environmental Impact: _____ Wind: Direction: _____ Speed: _____ Temperature: _____

Line Size: _____ Line Pressure: _____ Start Time: _____ End Time: _____

Section D

Transportation Incident Detail

Type of Shipment:

☐ Hazardous Material Shipment ☐ Undeclared shipment with no release ☐ Specification cargo tank

Type of Report: ☐ Initial Report ☐ Follow-up Report

Mode of Transportation: ☐ Air ☐ Highway/Roadway ☐ Rail ☐ Water

Spill Occurred: ☐ In transit ☐ Loading ☐ Unloading ☐ In Transit Storage

Carrier: _____ **Shipper:** _____

Spill Location - Address, City, State, Zip code: _____

Hazardous Material: _____ **Quantity:** _____ **Units (i.e. gallons)** _____

Comments: _____

Section E

Regulatory Information / Notification / Outside Agency Inspection Detail

Regulatory Notification: ☐ **Date:** _____ **Routine Inspection:** ☐ **Tests conducted:** ☐ **Explain:** _____

Regulatory Agency: _____ **Officer Name:** _____

Warning Issued: ☐ **Fine Issued:** ☐ **Amount:** _____ **Order / NOV Issued:** ☐ **Date:** _____

Reference #: _____ **Extension:** ☐ **Date:** _____ **Rescind:** ☐ **Date:** _____

Found During Inspection: ☐ **Suspect Soil:** ☐ **Sampling Required:** ☐ **Permit Exceedance:**

Accompanied by (name): _____ **Comments:** _____

Section F

EHS Complaint Detail

Complaint type (i.e. noise, odor, property damage): _____ ☐ New ☐ Ongoing

Parameters of Concern: _____

Attach any additional doctor injury status, police or agency reports as appropriate for the incident.

FAX OR EMAIL THIS DOCUMENT TO YOUR REGION EHS SPECIALIST for data entry into ILP within 24 hours of an environmental or safety incident AND fax a copy to Houston EHS at 713-386-4249.

Reported by: _____ Signature: _____ Phone: _____

Causal Factors (TapRoot®) and Corrective Actions*

(Contact Region EHS Specialist for help in completing this section.)
(EHS Specialist will utilize the most current version of the TapRoot® Root Cause Tree® Dictionary*)

Section G

ILP Incident #: _____ **Investigation End Date:** _____

It is essential to record the unique identifying number from the ILP database.

Risk Rank: ☐ 1 ☐ 2 ☐ 3 ☐ 4 (Check only one box.)
(See Risk Matrix)

TapRoot® Cause Outcome*

Causal Factor: A problem or issue that, if corrected, could have prevented and incident from occurring or significantly reduced the incident's consequences.*

Effective Corrective Action is **SMART**, effective, and reviewed for unintended consequences.*
- **S**pecific
- **M**easureable
- **A**ccountable
- **R**easonable
- **T**imely

1. Identify causal factors - up to 4 cause codes. (Free form text.)
2. Select from the following menu. Note: the line number on this form relates to text on the drop down menu in the ILP database. The number is not found in ILP.

Section H

No. Cause Code Menu (Not inclusive of all TapRoot® Cause Codes*)

1	Human Performance Difficulty	Procedures	Not Used/Not Followed
2	Human Performance Difficulty	Procedures	Wrong
3	Human Performance Difficulty	Procedures	Followed Incorrectly
4	Human Performance Difficulty	Training	No Training
5	Human Performance Difficulty	Training	Understanding NI (Needs Improvement)
6	Human Performance Difficulty	Quality Control	No Inspection
7	Human Performance Difficulty	Quality Control	QC NI (Quality Control Needs Improvement)
8	Human Performance Difficulty	Communications	No Communication or Not Timely
9	Human Performance Difficulty	Communications	Turnover NI
10	Human Performance Difficulty	Communications	Misunderstood Verbal Communication
11	Human Performance Difficulty	Management System	SPAC NI (Standard Practices and Controls Need Improvement)
12	Human Performance Difficulty	Management System	SPAC Not Used (Standard Practices and Controls Not Used)
13	Human Performance Difficulty	Management System	Oversight/Employee Relations
14	Human Performance Difficulty	Management System	Corrective Action
15	Human Performance Difficulty	Human Engineering	Human/Machine Interface
16	Human Performance Difficulty	Human Engineering	Work Environment
17	Human Performance Difficulty	Human Engineering	Complex System
18	Human Performance Difficulty	Human Engineering	Non Fault Tolerant System
19	Human Performance Difficulty	Human Engineering	Preparation
20	Human Performance Difficulty	Work Direction	Selection of Worker
21	Human Performance Difficulty	Work Direction	Supervision During Work
22	Equipment Difficulty	Tolerable Failure	
23	Equipment Difficulty	Design	Design Specs
24	Equipment Difficulty	Design	Design Review
25	Equipment Difficulty	Design	Independent Review NI (Needs Improvement
26	Equipment Difficulty	Equipment/Parts Defective	Procurement
27	Equipment Difficulty	Equipment/Parts Defective	Manufacturing
28	Equipment Difficulty	Equipment/Parts Defective	Handling
29	Equipment Difficulty	Equipment/Parts Defective	Storage
30	Equipment Difficulty	Equipment/Parts Defective	Quality Control
31	Equipment Difficulty	Preventive/Predictive Maintenance	PM NI (Preventive Maintenance Needs Improvement)
32	Equipment Difficulty	Repeat Failure	Management System
33	Natural Disaster	Sabotage	
34	Other		

Complete the Causal Factors and Cause Code on page 4.

Causal Factors free form text box. Cause Code Number i.e. 1 through 34

Section H

Causal Factor 1: _____

- **Cause Code Number:** _____
- **Cause Code Number:** _____
- **Cause Code Number:** _____

Causal Factor 2: _____

- **Cause Code Number:** _____
- **Cause Code Number:** _____
- **Cause Code Number:** _____

Causal Factor 3: _____

- **Cause Code Number:** _____
- **Cause Code Number:** _____
- **Cause Code Number:** _____

Causal Factor 4: _____

- **Cause Code Number:** _____
- **Cause Code Number:** _____
- **Cause Code Number:** _____

Section I

Corrective Action Information:

Title: _____

Author: _____

Author Date: _____

Origin Cause: _____

Proposed Corrective Action: _____

Proposed Completion Date: _____

Assigned to: _____

Actual Corrective Action: _____

Actual Completion Date: _____

After the investigation is complete, and when a corrective action is developed, ensure the causal factors, codes and corrective action information in this document is sent to the person responsible for data entry into ILP i.e. Region EHS Specialist or Supervisor.

FAX OR EMAIL THIS DOCUMENT TO YOUR REGION EHS SPECIALIST for data entry into ILP AND fax a copy to Houston EHS at 713-386-4249.

Prepared by: _____ Signature: _____ Phone: _____

* © System Improvements, Inc.

DISTRIBUTION:

Original - Station ENV File 9.2 or 10.0
Original - S&H File # 22.1, 22.2, or 22.5 as appropriate per H&S SOP
Copy - Region EHS
Copy - Houston EHS - fax 713-386-4249
Copy - Houston Fleet Services

RETENTION:

Original - See SOP 3 or 5 years
Original - See EHS Retention Rule
Copy - As needed
Copy - Permanent
Copy - As needed

ENBRIDGE, INC. EHS RISK MATRIX

Frequency	Likelihood *(facility, region, major project)*	Likelihood Category		C1	C2	C3	C4	C5
> 1/yr	Expected to occur more than once per year at a facility/project		L5	III	II	II	I	I
>1/10yrs	Expected to occur several times in facility/project lifetime		L4	III	III	II	II	I
>1/100yrs	Expected to occur once in the facility/project lifetime		L3	IV	III	III	II	II
>1/1,000 yrs	May occur in the facility/project lifetime		L2	IV	IV	III	III	II
>1/10,000 yrs	Remote chance of happening		L1	IV	IV	IV	III	III
				Consequence Category →				
Consequence			**Injury Outcome**	First Aid or Minor Illness	Medical Aid / OSHA Recordable Restricted Work.	Lost Time Injury	Permanent Disability	Fatality
			Environment	Insignificant onsite / localized impact	Negligible onsite or offsite impact below	Environmental impact resulting in regulatory	Significant impact leading to enforcement	Catastrophic impact, long-term liability,
			Financial	<$1K	$1-10K	$10-100K	$100K-$1M	>$1M
			Reputation	Individual concern, no media attention	Community concern with local media attention	State / Provincial concern with regional media attention	Response causing impact on share price	Response causing major impact on share price

Risk Ranking	Guideline Interpretation
I	It is recommended that no activity be permitted without immediate mitigation taken to lower the risk rank.
II	Further risk controls should be considered to lower either the probability or consequence of the risk.
III	Some risk controls may be required.
IV	No further reduction in risk is required.

APPENDIX D – REQUIRED SIGNATURE FORMS

Management Approval and Cleanup Commitment
40 CFR §112.7

This Spill Prevention, Control and Countermeasures Plan (Plan), including the Spill Procedures Chart and Supplemental Document, which has been prepared in accordance with 40 CFR 112, has been reviewed and approved by the Project Manager. The Project Manager has the level of authority to commit the necessary resources to fully implement this Plan and to contain and clean up any oil discharged at this facility. By signing below, the **Project Manager** also **authorizes station supervisors to expediently commit manpower, equipment, and materials necessary to contain and remove any harmful quantity of oil discharged from this facility** (40 CFR §112.7). **This commitment includes the authority to use company and/or contract personnel and equipment.**

Facility Name: _____

Location: _____

Signature: _____

Name: _____

Date: _____

Title: _____

ENBRIDGE

CERTIFICATE OF DETERMINATION OF SUBSTANTIAL HARM CRITERIA

Facility Name: _____

Location: _____

Does the facility transfer oil over water to or from vessels and does the facility have a total oil storage capacity greater than or equal to 42,000 gallons? Yes___ No ___

Does the facility have a total oil storage capacity greater than or equal to 1 million gallons and does the facility lack secondary containment that is large enough to contain the capacity of the largest aboveground oil storage tank plus sufficient freeboard to allow for precipitation within any aboveground oil storage tank area?
Yes___ No ___

Does the facility have a total oil storage capacity greater than or equal to 1 million gallons and is the facility located at a distance (as calculated using the appropriate formula in rule 40 CFR 112 Attachment C-III or a comparable formula) such that a discharge from the facility could cause injury to fish and wildlife and sensitive environments? For further description of fish and wildlife and sensitive environments, see Appendices I, II, and III to DOC/NOAA's "Guidance for Facility and Vessel Response Plans: Fish and Wildlife and Sensitive Environments" (see Appendix E to this Part, Section 13, for availability) and the applicable Area Contingency Plan.

Yes___ No ___

Does the facility have a total oil storage capacity greater than or equal to 1 million gallons and is the facility located at a distance (as calculated using the appropriate formula in Attachment C-III to this appendix or a comparable formula) such that a discharge from the facility would shut down public drinking water intake? For the purpose of 40 CFR 112, public drinking water intakes are analogous to public water systems as described in 40 CFR 143.2(c)

Yes___ No ___

Does the facility have a total oil storage capacity greater than or equal to 1 million gallons and has the facility experienced a reportable oil discharge in an amount greater than or equal to 10,000 gallons within the last five years?

Yes___ No ___

Certification

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document, and that based on my inquiry of those individuals responsible for this information, I believe that the submitted information is true, accurate, and complete.

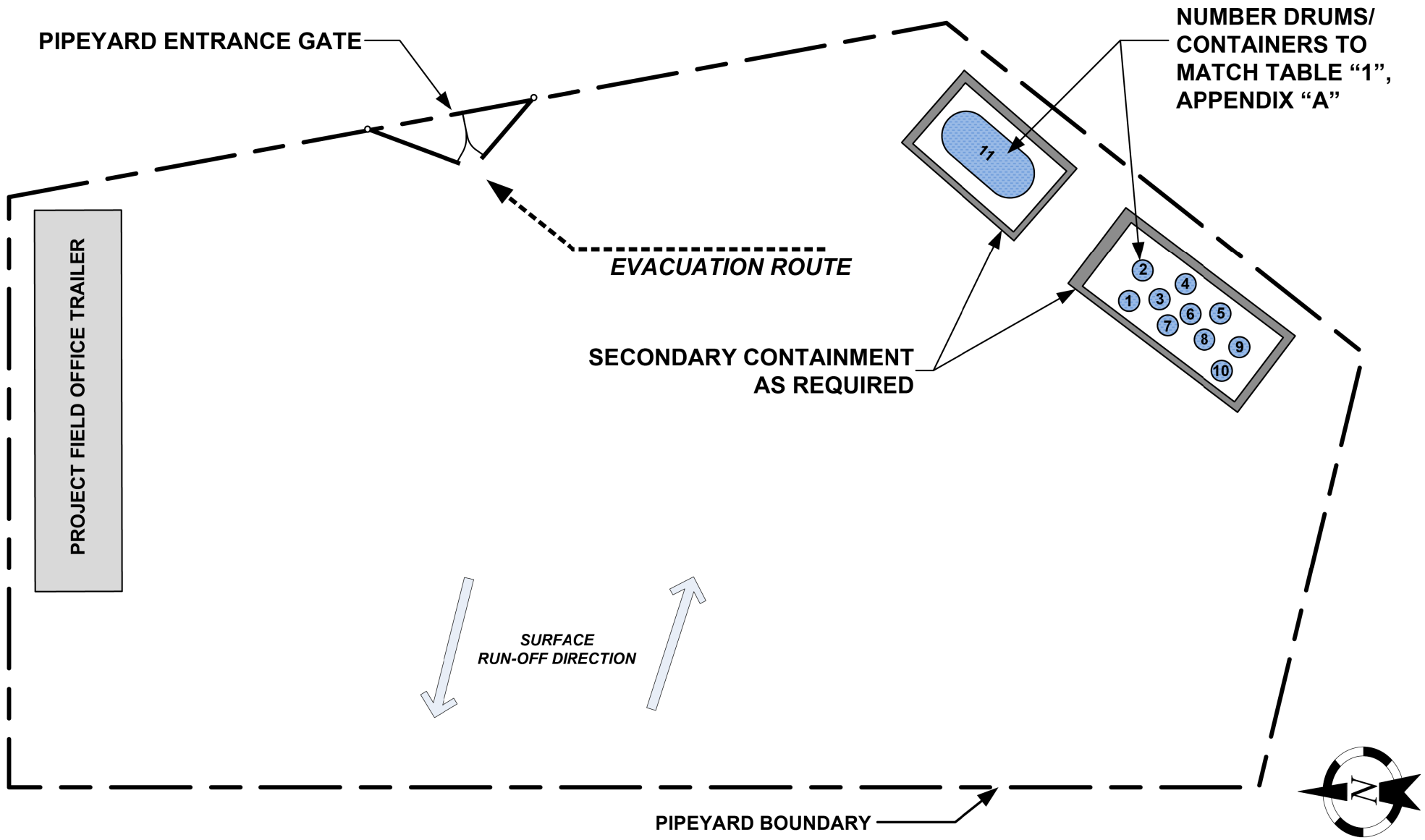
Signature: _____

Title: _____

Name (please type or print): _____

Date: _____

APPENDIX E – PIPEYARD / FACILITY STORAGE DRAWING



LEGEND

PIPEYARD BOUNDARY

STORAGE CONTAINERS

OFFICE TRAILER

SAMPLE
PIPEYARD: FACILITY STORAGE DRAWING

REV.	REV. DATE		REV. APRVD.
CKD.BY	ENG.	DATE 1/6/2011	W.O.
DRN.BY J.M.F.	SCALE NONE	DWG.NO .	

ENBRIDGE

5400 Westheimer Ct.
Houston, TX. 77056-5310
713.627.5400

ATTACHMENT 4

Algonquin Best Drilling Practices, Monitoring, and Clean-up of Horizontal Directional Drilling Inadvertent Returns Plan

CAPE COD CANAL PIPELINE RELOCATION PROJECT

Best Drilling Practices, Monitoring and Clean-up of Horizontal Directional Drilling Inadvertent Returns

June 2025

TABLE OF CONTENTS

1.0 INTRODUCTION 1

2.0 BEST AVAILABLE DRILLING PRACTICES 1

2.1 DESCRIPTION OF THE WORK 1
2.2 BACKGROUND 1
2.3 DRILLING FLUID COMPOSITION 1
2.4 DRILLING FLUID DISPOSAL 2
2.5 HDD WORKING PROCEDURES 2
2.6 HDD CONTINGENCY PLAN 3

3.0 DRILLING AND MONITORING PROCEDURES 4

3.1 PERSONNEL AND RESPONSIBILITIES 4
3.2 TRAINING 4
3.3 MONITORING PROCEDURE FOR FULL CIRCULATION 5
3.4 MONITORING PROCEDURE FOR LOSS OF CIRCULATION 5
3.5 MONITORING PROCEDURE FOR INADVERTENT RETURNS 6

4.0 RESPONSE TO INADVERTENT RETURNS 6

4.1 UPLAND LOCATION 7
4.2 WETLAND LOCATION 7

5.0 NOTIFICATIONS 7

6.0 CLEAN-UP 8

1.0 INTRODUCTION

Algonquin Gas Transmission, LLC ("Algonquin") developed the enclosed Best Drilling Practices Plan for monitoring and clean-up of the horizontal directional drilling ("HDD") inadvertent returns ("HDD Plan"). This HDD Plan will be kept on-site at HDD locations and will be available and implemented by all proposed personnel described in the following sections of this HDD Plan. All drilling during each pipeline installation will be managed in accordance with this HDD Plan. In addition, prior to initiation of the HDD activities, Algonquin will provide timely notification to the appropriate regulatory agencies, landowners, and FERC, as applicable, of the planned activities and estimated timeframes.

2.0 BEST AVAILABLE DRILLING PRACTICES

2.1 Description of the Work

The HDD method typically involves establishing land-based staging areas along both sides of the proposed crossing. The process commences with the boring of a pilot hole beneath the feature (e.g., waterbody, roadway) to the opposite side of the crossing and then enlarging the hole with one or more passes of a reamer until the hole is the necessary diameter to facilitate the pull-back (installation) of the pipeline.

Once the reaming passes are completed, a prefabricated pipe segment is then pulled through the hole to complete the crossing. While the HDD method is a proven technology, there are certain impacts that could occur as a result of the drilling such as the inadvertent return of drilling fluid, which is a slurry of bentonite clay and water and is classified as non-toxic to the aquatic environment and is a non-hazardous substance. Drilling fluids that are returned typically contain a lower concentration of bentonite when they surface because the bentonite is filtered out as it passes through existing sediments of varying types. The following sections provide the process of HDD and procedures to be implemented in the case of drill failure or the inadvertent return of drilling fluid.

2.2 Background

The HDD process uses bentonite-based drilling fluids. The drilling fluids are tested for specific engineering properties to ensure a successful HDD installation. An environmental impact associated with HDD is the inadvertent return of drilling fluids to the surface along the drill alignment during drilling operations.

2.3 Drilling Fluid Composition

The major component of drilling fluids used in HDD pipeline installation is fresh water, which will be obtained from municipal sources. In order for water to perform the required drilling functions, it is generally necessary to modify its properties by adding a viscosifier, which is used almost exclusively in HDD drilling fluids and is a naturally occurring bentonite clay typically mined by "open pit" methods.

Bentonite is soft clay, formed by the weathering of volcanic ash, with the unique characteristic of swelling to several times its original volume when mixed with water. It is not a hazardous material as defined by the U.S. Environmental Protection Agency's ("USEPA") characteristics of ignitability, corrosivity, reactivity, or commercial chemicals. It can also be used to seal earth structures (e.g., ponds or dams), and as a suspending component in livestock feeds. The

properties of bentonite used in drilling fluids are often enhanced by the addition of polymers. Enhancement typically results in increasing the yield, reducing the amount of dry bentonite required to produce a given amount of drilling fluid and augmenting its rheologic properties to maximize the effectiveness within a given formation. Non-treated bentonite yields in excess of 85 barrels (3,570 gallons) of drilling fluid per ton of material. The addition of non-toxic polymers to produce high yield bentonite can increase the yield to more than 200 barrels (8,400 gallons) per ton of material. Typical HDD drilling fluids are made with high yield bentonite and are composed of less than 4 percent viscosifier by volume, with the remaining components being water and drilled spoil. Drilling fluid consists of non-toxic bentonite, but, depending on the drilling conditions, may also contain drilling fluid additives. The bentonite and any additives must meet the National Sanitation Foundation International/American National Standards Institute ("ANSI") Standard 60 for safe drinking water requirements. This is the same drilling fluid used for drilling drinking water wells, so there is no risk to drinking water from its use.

Typically, the drilling fluid contains no more than 5 percent bentonite (95 percent fresh water). The slurry is designed to:

- Stabilize the hole against collapse;
- Lubricate, cool, and clean the cutters;
- Transport cuttings by suspension and flow to entry and exit points; and
- Reduce soil friction and required pull loads.

2.4 Drilling Fluid Disposal

Waste drilling fluid and cuttings will be collected, temporarily stored in the construction workspace, and then disposed of off-site at an approved facility. Disposal of excess drilling fluid will be the responsibility of the selected HDD contractor. Prior to beginning HDD operations, the HDD contractor will be required to submit its proposed drilling fluid disposal procedures and disposal facility to Algonquin for approval. Algonquin will review these procedures and verify that they comply with all environmental regulations, easement and workspace agreements, and permit requirements.

2.5 HDD Working Procedures

Prior to drilling operations, site-specific HDD Procedures will be prepared by the HDD contractor and submitted to Algonquin for review and approval. As a minimum, the HDD Procedures will address the following:

Annular Pressure or Return Mitigation – Once it is indicated to the driller that annular pressures are abnormally high or that a return has occurred (via use of a downhole annular pressure monitoring tool), the driller has the following options (or any combination of these options):

- Decrease pump pressure;
- Decrease penetration rate;
- Retract the drill string a distance to restore circulation ("swab" the hole);
- Introduce additional flow along the borehole using "weeper" subs; and
- Modify the drilling mud with lost circulation additives.

2.6 HDD Contingency Plan

Several possible scenarios and/or conditions exist that could prevent the successful completion of a pilot hole, reaming or pipeline pullback operation. Examples of these possible scenarios and/or conditions are as follows:

1. Inability to maintain mud circulation during pilot drilling due to uncontrolled fluid loss into subterranean voids or fissures.
2. Inability to steer the down hole pilot assembly on the prescribed drill profile due to deflection that could occur when geological obstructions such as boulders and cobble are encountered.
3. Inability to steer the down hole pilot assembly on the prescribed drill profile due to deflection that could occur in areas where a geologic formation is encountered that will not provide adequate resistance to support the weight of the down hole pilot assembly.
4. Inability to complete reaming due to geological obstructions such as boulders or cobble that could migrate into the path that has already been piloted or reamed.
5. Inability to retrieve drilling or reaming equipment components and/or drill pipe that could be left down hole due mechanical failure.
6. Inability to pull the entire product pipeline section through the bore hole due to the collapse of the completed bore hole.

In the unlikely event that an HDD bore hole profile must be abandoned, Algonquin will implement one the following alternate installation procedures:

1. The pilot hole will be offset and drilled on a different profile from the same location;
2. Algonquin will relocate the HDD to another location on the existing permanent easement; or
3. Algonquin will acquire additional permanent easement to perform the HDD in an alternate location (the necessary clearance and permit amendments will be obtained prior to the initiation of this option).

In the event that a bore hole must be abandoned, the following remedial steps will be implemented:

1. The HDD contractor will fill the abandoned hole with a drilling mud/grout mixture. Once this is accomplished, Algonquin would offset to another location and resume the HDD process as specified in steps 1-3 above.
2. Drilling mud from the pit at the abandoned location will be pumped into a tank for reuse or disposal and the pit will be backfilled.

3.0 DRILLING AND MONITORING PROCEDURES

3.1 Personnel and Responsibilities

The actions in this HDD Plan are to be implemented by the following personnel:

Chief Inspector – Algonquin will designate a Chief Inspector ("CI") for the Project. The CI will have overall authority for construction activities that occur on the Project.

Environmental Inspector – At least one Environmental Inspector ("EI") will be designated by Algonquin to monitor the HDD activities. The EI will have peer status with all other activity inspectors and will report directly to the CI who has overall authority. The EI will have the authority to stop activities that violate the environmental conditions of the FERC certificate (if applicable), other federal and state permits, or landowner requirements, and to order corrective action.

HDD Superintendent – is the senior on-site representative of the HDD contractor. The HDD Superintendent has overall responsibility for implementing this HDD Plan on behalf of the HDD contractor. The HDD Superintendent will be familiar with the aspects of the drilling activity, the contents of the HDD Plan and the conditions of approval under which the activity is permitted to take place. The HDD Superintendent will make available a copy of this HDD Plan to the appropriate construction personnel. The HDD Superintendent will ensure that workers are properly trained and familiar with the necessary procedures for response to an inadvertent return.

HDD Operator – is HDD contractor's driller operating the drilling rig and mud pumps. The HDD Operator is responsible for monitoring circulation back to the entry and exit locations and for monitoring annular pressures during pilot-hole drilling. In the event of loss of circulation or higher than expected annular pressures, the HDD Operator must communicate the event to the HDD Superintendent and HDD contractor field crews. The HDD Operator is responsible for stoppage or changes to the drilling program in the event of observed inadvertent returns.

HDD Contractor Personnel – during HDD installation, field crews will be responsible to monitor the HDD alignment along with the Algonquin's field representatives'. Field crews in coordination with the EI are responsible for timely notifications and responses to observed returns in accordance with this HDD Plan. The EI ultimately must sign off on the action plan for mitigating the return.

3.2 Training

Prior to drilling, the HDD Superintendent, CI and the EI will verify that the HDD Operator and field crew receive the following site-specific training but not limited to:

- Project specific safety training;
- Review provisions of this HDD Plan and site-specific permit requirements;
- Review location of sensitive environmental resources at the site;
- Review drilling procedures for return prevention;
- Review the site-specific monitoring requirements;
- Review the location and operation of return control equipment and materials; and
- Review procedures for reporting observed inadvertent returns.

To ensure that HDD operations are conducted in accordance with established requirements and standard HDD industry practice, Algonquin will provide an inspector experienced in HDD construction (HDD Superintendent, see Section 4.0 below) to monitor the HDD contractor's performance at the HDD site. Established requirements to which the HDD contractor must conform include, but are not limited to, the construction drawings, technical specifications, permits, easement and workspace agreements, and HDD contractor submittals. The drilling fluid monitoring procedures to be applied will vary depending upon the following operational conditions: full circulation; loss of circulation; and inadvertent returns.

3.3 Monitoring Procedure for Full Circulation

When HDD operations are in progress and full drilling fluid circulation is being maintained at one or both of the HDD endpoints, the following monitoring procedures will be implemented:

- The presence of drilling fluid returns at one or both of the HDD endpoints will be periodically documented;
- Land-based portions of the drilled alignment will be periodically walked and visually inspected for signs of inadvertent drilling fluid returns as well as surface heaving and settlement.
- Waterways will be visually inspected from the banks for a visible drilling fluid plume; and
- Drilling fluid products present at the jobsite will be documented.

If an inadvertent drilling fluid return is detected during routine monitoring, the monitoring procedure described below will be implemented immediately.

3.4 Monitoring Procedure for Loss of Circulation

When HDD operations are in progress and drilling fluid circulation to the HDD endpoints is lost or severely diminished, the following monitoring procedure will be implemented. Lost circulation is common and anticipated during HDD installation and does not necessarily indicate that drilling fluid is inadvertently returning to a point on the surface.

- The HDD Superintendent will notify Algonquin if drilling fluid circulation to the HDD endpoints has been lost or severely diminished.
- The HDD Superintendent will document steps taken by the HDD contractor to restore circulation. If the HDD contractor fails to comply with the requirements of the HDD specification, the HDD Superintendent will notify Algonquin so that appropriate actions can be taken. If circulation is regained, Algonquin’s inspector will inform Algonquin and resume the monitoring procedure described herein.
- If circulation is not re-established, the HDD Superintendent will increase the frequency of visual inspection along the drilled path alignment as appropriate. Additionally, Algonquin’s Superintendent will document periods of HDD contractor downtime (during which no drilling fluid is pumped) and the HDD contractor’s drilling fluid pumping rate should it become necessary to estimate lost circulation volumes.

3.5 Monitoring Procedure for Inadvertent Returns

If an inadvertent return of drilling fluids is detected, the following monitoring procedure will be implemented:

- If the HDD Operator observes an increase in annular fluid pressure or loss of circulation, the Operator will notify the HDD Superintendent and field crews of the event and approximate position of the cutting head;
- Where practical, a member of the field crew will visually inspect the ground surface near the position of the cutting head;
- If an inadvertent return is observed:
    - Field crew will notify (via hand-held radio or cell phone) the HDD Operator;
    - The HDD Operator will temporarily cease pumping of the drilling fluid and notify the HDD Superintendent and CI;
    - The CI will notify and coordinate a response with the EI;
    - The EI will notify appropriate permit authorities as necessary of the event and proposed response and provide required documentation within 24 hours; and
- The CI will prepare a report that summarizes the incident.

4.0 RESPONSE TO INADVERTENT RETURNS

Typically, inadvertent returns are most often detected in an area near the entry or exit points of the drill alignment when the pilot bore is at shallow depths, above bedrock, and in permeable/porous soils. In these occurrences the return will be assessed by the HDD Superintendent, EI and CI to determine an estimated volume and footprint of the return. They will also assess the potential of the return to reach adjacent waterbodies, wetlands, or other types of infrastructure.

The HDD Superintendent will assess the drilling parameters (depth, annular pressures, fluid flow rate and drill fluid characteristics) and incorporate appropriate changes.

The HDD Superintendent, EI, and CI will implement installation of appropriate containment structures and additional response measures. Access for personnel and equipment to the return site is a major factor in determining the methods used for containment and disposal. Typically, containment is achieved by excavating a small sump pit (5 cubic yards) at the site of the return and to surround the return with hay bales, silt fence and/or sandbags. Once contained, the drilling fluid is either collected by vacuum trucks or pumped to a location where vacuum trucks can be accessed. The fluids are then transported either back to the HDD Drilling Rig or to a disposal site.

If the return is mitigated and controlled, forward progress of the drilling will be approved by the EI in coordination with the HDD Superintendent and CI.

The site-specific response will follow these guidelines:

4.1 Upland Location

- Evaluate the amount of return to determine if containment structures are warranted and if they will effectively contain the return.
- Promptly implement appropriate containment measures as needed to contain and recover the slurry.
- If the return is within 50-foot of a wetland or waterbody, silt fence and/or hay bales will be installed between the return site and the wetland or waterbody.
- If the return cannot be contained, then the HDD Operator must suspend drilling operations until appropriate containment is in place.
- Remove the fluids using either a vacuum truck or by pumping to a location where a vacuum truck is accessible.
- After the HDD installation is complete, perform final clean-up (see Section 6).

4.2 Wetland Location

- Evaluate the amount of return to determine if containment structures are warranted and if they will effectively contain the return.
- Promptly implement appropriate containment measures to contain and recover the slurry;
    - Efforts to contain and recover slurry in wetlands may result in further disturbance by equipment and personnel, and possibly offset the benefit gained in removing the slurry.
    - If the amount of the slurry is too small to allow the practical collection from the affected area, the fluid will be diluted with fresh water or allowed to dry and dissipate naturally.
- If the return cannot be controlled or contained, immediately suspend drilling operations until appropriate containment is in place.
- Remove the fluids using either a vacuum truck or by pumping to a location where a vacuum truck is accessible.
- After the HDD installation is complete, perform final clean-up (see Section 6).

5.0 NOTIFICATIONS

In the event of an inadvertent drilling fluid return within a waterway, wetland, or sensitive environmental resource area, Algonquin will contact FERC, and or the FERC representative, and the applicable federal and state agencies that regulate returns according to permit reporting requirements, but no later than 24 hours after detection. Once Algonquin selects it's HDD contractor, a more specific notification system will be developed to comply with permit conditions. Details of the inadvertent return will contain, at a minimum:

- The location, nature of the return and estimated volume;

- Take immediate corrective actions that may include, but are not limited to, installation of erosion control devices to contain the return, determination of any permit reporting limits, a temporary shutdown of the drilling operations to determine the cause of the return, and coordination with Algonquin's HDD Superintendent and CI and contractor to determine if there are other drilling techniques that can be used to eliminate the return such as the use of additives or lower drilling pressures.

Once a return has been identified, the appropriate agency notifications will be made. Notification protocols will be determined during the permitting process with state and federal agencies, and these protocols will be provided to the drilling contractor, the Algonquin inspection staff, and will be part of the environmental training to be conducted prior to construction. During the permitting process, it will be determined if agency approval is needed to commence drilling operations after a return. If so, a detailed communication protocol will be established in consultation with the contractor, Algonquin staff, and the agencies. The protocol will include agency contact names, Algonquin contacts, reporting limits, reporting time schedules, reporting tracking, and approval tracking.

6.0 CLEAN-UP

After completion of the HDD installation, site-specific clean-up measures will be developed by the CI, HDD Superintendent, for approval by the EI. Potential for secondary impact from the clean-up process is to be evaluated and benefits of clean-up activities.

The following measures are considered appropriate:

- Drilling mud will be cleaned up by hand using hand shovels, buckets and soft bristled brooms minimizing damage to existing vegetation.
- Fresh water washes may be employed if deemed beneficial and feasible.
- Containment structures will be pumped out and the ground surface scraped to bare topsoil minimizing loss of topsoil or damage to adjacent vegetation.
- The recovered drilling fluid will be recycled or disposed of at an approved upland location or disposal facility. No recovered drilling fluid will be disposed of in streams or storm drains.
- All containment structures will be removed.
- Recovered materials will be collected in containers for temporary storage prior to removal from the site.
- Disturbed areas will be stabilized by seeding and mulching as approved by the EI.

ATTACHMENT 5

Stormwater Management Reports

July 8, 2026

CAPE COD CANAL PIPELINE REPLACEMENT PROJECT

STORMWATER REPORT FOR THE PAVE PAWS METER STATION

SAGAMORE, MA

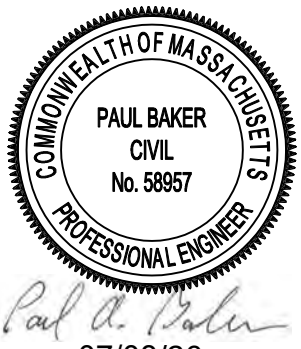
Prepared For: Algonquin Gas Transmission, LLC

Prepared By:

Audubon Companies, LC

3505 W. Sam Houston Pkwy N., Ste 150

Houston, TX 77043



07/08/26

Table of Contents

1 Checklist for Stormwater Report 1
2 Stormwater Report Narrative 8
2.1 Project Description 8
2.1.1 Site Description 8
2.1.2 Wetland Resources 9
2.1.3 Subsurface Soil Investigations 9
2.2 Existing Drainage Conditions 9
2.3 Proposed Drainage Conditions 10
3 Regulatory Compliance 14
3.1 Massachusetts Department of Environmental Protection (DEP) – Stormwater Management Standards 14
3.1.1 Standard 1: No New Untreated Discharges or Erosion to Wetlands 14
3.1.2 Standard 2: Peak Rate Attenuation 14
3.1.3 Standard 3: Stormwater Recharge 15
3.1.4 Standard 4: Water Quality 17
3.1.5 Standard 5: Land Uses and High Potential Pollutant Loads (LUHPPLs) 17
3.1.6 Standard 6: Critical Areas 17
3.1.7 Standard 7: Redevelopments and Other Projects Subject to the Standards only to the Maximum Extent Practicable 18
3.1.8 Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Controls 18
3.1.9 Standard 9: Operation and Maintenance Plan 18
3.1.10 Standard 10: Prohibition of Illicit Discharges 19
4 Local Municipal Rules and Regulations 19
5 FEMA Floodplain 20

Figure 1 - Site Location Map (Aerial)
Figure 2 - Site Location Map (Topo)

Table 1 - Existing Conditions Hydrologic Data
Table 2 - Proposed Conditions Hydrologic Data
Table 3 - NOAA Atlas 14 Volume 10 Design Depths for the 24 Hour Storm (inches)
Table 4 - Peak Discharge Rates
Table 5 - Summary of Recharge Calculations

Table 6 - Drainage Swales Design Summary

Attachment A - Existing and Proposed Drainage Conditions 15
Attachment B - Standard 1 Supporting Information 20
Attachment C - Standard 2 Supporting Information 34
Attachment D - Standard 3 Supporting Information 40
Attachment E - Standard 4 Supporting Information 40
Attachment F - Standard 8 Supporting Information 52
Attachment G - Standard 9 Supporting Information 57

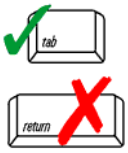
1 Checklist for Stormwater Report

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

A. Introduction

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.



A Stormwater Report must be submitted with the Notice of Intent permit application to document compliance with the Stormwater Management Standards. The following checklist is NOT a substitute for the Stormwater Report (which should provide more substantive and detailed information) but is offered here as a tool to help the applicant organize their Stormwater Management documentation for their Report and for the reviewer to assess this information in a consistent format. As noted in the Checklist, the Stormwater Report must contain the engineering computations and supporting information set forth in Volume 3 of the Massachusetts Stormwater Handbook. The Stormwater Report must be prepared and certified by a Registered Professional Engineer (RPE) licensed in the Commonwealth.

The Stormwater Report must include:

- The Stormwater Checklist completed and stamped by a Registered Professional Engineer (see page 2) that certifies that the Stormwater Report contains all required submittals.[1] This Checklist is to be used as the cover for the completed Stormwater Report.
- Applicant/Project Name
- Project Address
- Name of Firm and Registered Professional Engineer that prepared the Report
- Long-Term Pollution Prevention Plan required by Standards 4-6
- Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan required by Standard 8[2]
- Operation and Maintenance Plan required by Standard 9

In addition to all plans and supporting information, the Stormwater Report must include a brief narrative describing stormwater management practices, including environmentally sensitive site design and LID techniques, along with a diagram depicting runoff through the proposed BMP treatment train. Plans are required to show existing and proposed conditions, identify all wetland resource areas, NRCS soil types, critical areas, Land Uses with Higher Potential Pollutant Loads (LUHPPL), and any areas on the site where infiltration rate is greater than 2.4 inches per hour. The Plans shall identify the drainage areas for both existing and proposed conditions at a scale that enables verification of supporting calculations.

As noted in the Checklist, the Stormwater Management Report shall document compliance with each of the Stormwater Management Standards as provided in the Massachusetts Stormwater Handbook. The soils evaluation and calculations shall be done using the methodologies set forth in Volume 3 of the Massachusetts Stormwater Handbook.

To ensure that the Stormwater Report is complete, applicants are required to fill in the Stormwater Report Checklist by checking the box to indicate that the specified information has been included in the Stormwater Report. If any of the information specified in the checklist has not been submitted, the applicant must provide an explanation. The completed Stormwater Report Checklist and Certification must be submitted with the Stormwater Report.

---

[1] The Stormwater Report may also include the Illicit Discharge Compliance Statement required by Standard 10. If not included in the Stormwater Report, the Illicit Discharge Compliance Statement must be submitted prior to the discharge of stormwater runoff to the post-construction best management practices.

[2] For some complex projects, it may not be possible to include the Construction Period Erosion and Sedimentation Control Plan in the Stormwater Report. In that event, the issuing authority has the discretion to issue an Order of Conditions that approves the project and includes a condition requiring the proponent to submit the Construction Period Erosion and Sedimentation Control Plan before commencing any land disturbance activity on the site.

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

B. Stormwater Checklist and Certification

The following checklist is intended to serve as a guide for applicants as to the elements that ordinarily need to be addressed in a complete Stormwater Report. The checklist is also intended to provide conservation commissions and other reviewing authorities with a summary of the components necessary for a comprehensive Stormwater Report that addresses the ten Stormwater Standards.

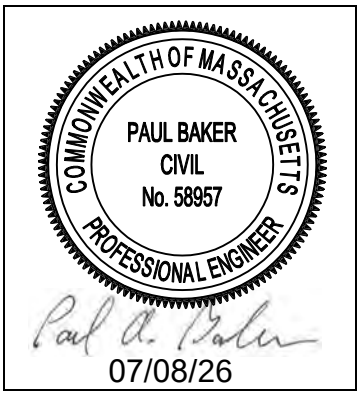
Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the item is not applicable (N.A.) and provide the reasons for that determination.

A complete checklist must include the Certification set forth below signed by the Registered Professional Engineer who prepared the Stormwater Report.

Registered Professional Engineer's Certification

I have reviewed the Stormwater Report, including the soil evaluation, computations, Long-term Pollution Prevention Plan, the Construction Period Erosion and Sedimentation Control Plan (if included), the Long-term Post-Construction Operation and Maintenance Plan, the Illicit Discharge Compliance Statement (if included) and the plans showing the stormwater management system, and have determined that they have been prepared in accordance with the requirements of the Stormwater Management Standards as further elaborated by the Massachusetts Stormwater Handbook. I have also determined that the information presented in the Stormwater Checklist is accurate and that the information presented in the Stormwater Report accurately reflects conditions at the site as of the date of this permit application.

Registered Professional Engineer Block and Signature



07/08/2026

Signature and Date

Checklist

Project Type: Is the application for new development, redevelopment, or a mix of new and redevelopment?

☒ New development

☐ Redevelopment

☐ Mix of New Development and Redevelopment

Checklist for Stormwater Report

Checklist (continued)

LID Measures: Stormwater Standards require LID measures to be considered. Document what environmentally sensitive design and LID Techniques were considered during the planning and design of the project:

- [X] No disturbance to any Wetland Resource Areas
- [ ] Site Design Practices (e.g. clustered development, reduced frontage setbacks)
- [ ] Reduced Impervious Area (Redevelopment Only)
- [ ] Minimizing disturbance to existing trees and shrubs
- [ ] LID Site Design Credit Requested:
  - [ ] Credit 1
  - [ ] Credit 2
  - [ ] Credit 3
- [ ] Use of "country drainage" versus curb and gutter conveyance and pipe
- [ ] Bioretention Cells (includes Rain Gardens)
- [ ] Constructed Stormwater Wetlands (includes Gravel Wetlands designs)
- [ ] Treebox Filter
- [ ] Water Quality Swale
- [X] Grass Channel
- [ ] Green Roof
- [X] Other (describe): Infiltration Basins

Standard 1: No New Untreated Discharges

- [X] No new untreated discharges
- [X] Outlets have been designed so there is no erosion or scour to wetlands and waters of the Commonwealth
- [X] Supporting calculations specified in Volume 3 of the Massachusetts Stormwater Handbook included.

Checklist for Stormwater Report

Checklist (continued)

Standard 2: Peak Rate Attenuation

☐ Standard 2 waiver requested because the project is located in land subject to coastal storm flowage and stormwater discharge is to a wetland subject to coastal flooding.

☐ Evaluation provided to determine whether off-site flooding increases during the 100-year 24-hour storm.

☒ Calculations provided to show that post-development peak discharge rates do not exceed pre-development rates for the 2-year and 10-year 24-hour storms. If evaluation shows that off-site flooding increases during the 100-year 24-hour storm, calculations are also provided to show that post-development peak discharge rates do not exceed pre-development rates for the 100-year 24-hour storm.

Standard 3: Recharge

☒ Soil Analysis provided.

☒ Required Recharge Volume calculation provided.

☐ Required Recharge volume reduced through use of the LID site Design Credits.

☒ Sizing the infiltration, BMPs is based on the following method: Check the method used.

☒ Static ☐ Simple Dynamic ☐ Dynamic Field[1]

☐ Runoff from all impervious areas at the site discharging to the infiltration BMP.

☒ Runoff from all impervious areas at the site is *not* discharging to the infiltration BMP and calculations are provided showing that the drainage area contributing runoff to the infiltration BMPs is sufficient to generate the required recharge volume.

☒ Recharge BMPs have been sized to infiltrate the Required Recharge Volume.

☐ Recharge BMPs have been sized to infiltrate the Required Recharge Volume *only* to the maximum extent practicable for the following reason:

- ☐ Site is comprised solely of C and D soils and/or bedrock at the land surface
- ☐ M.G.L. c. 21E sites pursuant to 310 CMR 40.0000
- ☐ Solid Waste Landfill pursuant to 310 CMR 19.000
- ☐ Project is otherwise subject to Stormwater Management Standards only to the maximum extent practicable.

☒ Calculations showing that the infiltration BMPs will drain in 72 hours are provided.

☐ Property includes a M.G.L. c. 21E site or a solid waste landfill and a mounding analysis is included.

[1] 80% TSS removal is required prior to discharge to infiltration BMP if Dynamic Field method is used.

Checklist for Stormwater Report

Checklist (continued)

Standard 3: Recharge (continued)

☐ The infiltration BMP is used to attenuate peak flows during storms greater than or equal to the 10-year 24-hour storm and separation to seasonal high groundwater is less than 4 feet and a mounding analysis is provided.

☐ Documentation is provided showing that infiltration BMPs do not adversely impact nearby wetland resource areas.

Standard 4: Water Quality

The Long-Term Pollution Prevention Plan typically includes the following:

- Good housekeeping practices;
- Provisions for storing materials and waste products inside or under cover;
- Vehicle washing controls;
- Requirements for routine inspections and maintenance of stormwater BMPs;
- Spill prevention and response plans;
- Provisions for maintenance of lawns, gardens, and other landscaped areas;
- Requirements for storage and use of fertilizers, herbicides, and pesticides;
- Pet waste management provisions;
- Provisions for operation and management of septic systems;
- Provisions for solid waste management;
- Snow disposal and plowing plans relative to Wetland Resource Areas;
- Winter Road Salt and/or Sand Use and Storage restrictions;
- Street sweeping schedules;
- Provisions for prevention of illicit discharges to the stormwater management system;
- Documentation that Stormwater BMPs are designed to provide for shutdown and containment in the event of a spill or discharges to or near critical areas or from LUHPPL;
- Training for staff or personnel involved with implementing Long-Term Pollution Prevention Plan;
- List of Emergency contacts for implementing Long-Term Pollution Prevention Plan.

☒ A Long-Term Pollution Prevention Plan is attached to Stormwater Report and is included as an attachment to the Wetlands Notice of Intent.

☒ Treatment BMPs subject to the 44% TSS removal pretreatment requirement and the one inch rule for calculating the water quality volume are included, and discharge:

- ☐ is within the Zone II or Interim Wellhead Protection Area
- ☐ is near or to other critical areas
- ☒ is within soils with a rapid infiltration rate (greater than 2.4 inches per hour)
- ☐ involves runoff from land uses with higher potential pollutant loads.

☐ The Required Water Quality Volume is reduced through use of the LID site Design Credits.

☒ Calculations documenting that the treatment train meets the 80% TSS removal requirement and, if applicable, the 44% TSS removal pretreatment requirement, are provided.

Checklist for Stormwater Report

Checklist (continued)

Standard 4: Water Quality (continued)

☒ The BMP is sized (and calculations provided) based on:

- ☒ The ½" or 1" Water Quality Volume or
- ☐ The equivalent flow rate associated with the Water Quality Volume and documentation is provided showing that the BMP treats the required water quality volume.

☐ The applicant proposes to use proprietary BMPs, and documentation supporting use of proprietary BMP and proposed TSS removal rate is provided. This documentation may be in the form of the propriety BMP checklist found in Volume 2, Chapter 4 of the Massachusetts Stormwater Handbook and submitting copies of the TARP Report, STEP Report, and/or other third party studies verifying performance of the proprietary BMPs.

☐ A TMDL exists that indicates a need to reduce pollutants other than TSS and documentation showing that the BMPs selected are consistent with the TMDL is provided.

Standard 5: Land Uses With Higher Potential Pollutant Loads (LUHPPLs)

☐ The NPDES Multi-Sector General Permit covers the land use and the Stormwater Pollution Prevention Plan (SWPPP) has been included with the Stormwater Report.

☐ The NPDES Multi-Sector General Permit covers the land use and the SWPPP will be submitted ***prior to*** the discharge of stormwater to the post-construction stormwater BMPs.

☒ The NPDES Multi-Sector General Permit does ***not*** cover the land use.

☐ LUHPPLs are located at the site and industry specific source control and pollution prevention measures have been proposed to reduce or eliminate the exposure of LUHPPLs to rain, snow, snow melt and runoff, and been included in the long term Pollution Prevention Plan.

☐ All exposure has been eliminated.

☐ All exposure has ***not*** been eliminated and all BMPs selected are on MassDEP LUHPPL list.

☐ The LUHPPL has the potential to generate runoff with moderate to higher concentrations of oil and grease (e.g. all parking lots with >1000 vehicle trips per day) and the treatment train includes an oil grit separator, a filtering bioretention area, a sand filter or equivalent.

Standard 6: Critical Areas

☐ The discharge is near or to a critical area and the treatment train includes only BMPs that MassDEP has approved for stormwater discharges to or near that particular class of critical area.

☐ Critical areas and BMPs are identified in the Stormwater Report.

Checklist for Stormwater Report

Checklist (continued)

Standard 7: Redevelopments and Other Projects Subject to the Standards only to the maximum extent practicable

☐ The project is subject to the Stormwater Management Standards only to the maximum Extent Practicable as a:

- ☐ Limited Project
- ☐ Small Residential Projects: 5-9 single family houses or 5-9 units in a multi-family development provided there is no discharge that may potentially affect a critical area.
- ☐ Small Residential Projects: 2-4 single family houses or 2-4 units in a multi-family development with a discharge to a critical area
- ☐ Marina and/or boatyard provided the hull painting, service and maintenance areas are protected from exposure to rain, snow, snow melt and runoff
- ☐ Bike Path and/or Foot Path
- ☐ Redevelopment Project
- ☐ Redevelopment portion of mix of new and redevelopment.

☐ Certain standards are not fully met (Standard No. 1, 8, 9, and 10 must always be fully met) and an explanation of why these standards are not met is contained in the Stormwater Report.

☐ The project involves redevelopment and a description of all measures that have been taken to improve existing conditions is provided in the Stormwater Report. The redevelopment checklist found in Volume 2 Chapter 3 of the Massachusetts Stormwater Handbook may be used to document that the proposed stormwater management system (a) complies with Standards 2, 3 and the pretreatment and structural BMP requirements of Standards 4-6 to the maximum extent practicable and (b) improves existing conditions.

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control

A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan must include the following information:

- Narrative;
- Construction Period Operation and Maintenance Plan;
- Names of Persons or Entity Responsible for Plan Compliance;
- Construction Period Pollution Prevention Measures;
- Erosion and Sedimentation Control Plan Drawings;
- Detail drawings and specifications for erosion control BMPs, including sizing calculations;
- Vegetation Planning;
- Site Development Plan;
- Construction Sequencing Plan;
- Sequencing of Erosion and Sedimentation Controls;
- Operation and Maintenance of Erosion and Sedimentation Controls;
- Inspection Schedule;
- Maintenance Schedule;
- Inspection and Maintenance Log Form.

☒ A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan containing the information set forth above has been included in the Stormwater Report.

Checklist for Stormwater Report

Checklist (continued)

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control (continued)

☐ The project is highly complex and information is included in the Stormwater Report that explains why it is not possible to submit the Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan with the application. A Construction Period Pollution Prevention and Erosion and Sedimentation Control has ***not*** been included in the Stormwater Report but will be submitted ***before*** land disturbance begins.

☒ The project is ***not*** covered by a NPDES Construction General Permit.

☐ The project is covered by a NPDES Construction General Permit and a copy of the SWPPP is in the Stormwater Report.

☐ The project is covered by a NPDES Construction General Permit but no SWPPP been submitted. The SWPPP will be submitted BEFORE land disturbance begins.

Standard 9: Operation and Maintenance Plan

☒ The Post Construction Operation and Maintenance Plan is included in the Stormwater Report and includes the following information:

- ☒ Name of the stormwater management system owners;
- ☒ Party responsible for operation and maintenance;
- ☒ Schedule for implementation of routine and non-routine maintenance tasks;
- ☒ Plan showing the location of all stormwater BMPs maintenance access areas;
- ☒ Description and delineation of public safety features;
- ☒ Estimated operation and maintenance budget; and
- ☒ Operation and Maintenance Log Form.

☐ The responsible party is ***not*** the owner of the parcel where the BMP is located and the Stormwater Report includes the following submissions:

- ☐ A copy of the legal instrument (deed, homeowner's association, utility trust or other legal entity) that establishes the terms of and legal responsibility for the operation and maintenance of the project site stormwater BMPs;
- ☐ A plan and easement deed that allows site access for the legal entity to operate and maintain BMP functions.

Standard 10: Prohibition of Illicit Discharges

☐ The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges;

☒ An Illicit Discharge Compliance Statement is attached;

☐ NO Illicit Discharge Compliance Statement is attached but will be submitted ***prior to*** the discharge of any stormwater to post-construction BMPs.

2 Stormwater Report Narrative

This stormwater report has been prepared to demonstrate compliance with the Massachusetts Stormwater Management Standards in accordance with the Massachusetts Wetland Protection Act Regulations (310 CMR 10.00). This report also demonstrates compliance with applicable Cape Cod Commission regulatory requirements and guidance for stormwater management, including the protection of groundwater quality, surface water resources, and natural resource areas consistent with the Commission's Regional Policy Plan and Development of Regional Impact (DRI) review criteria, as applicable.

2.1 Project Description

The proposed project is part of the Massachusetts Department of Transportation (MassDOT) Cape Cod Canal Bridges Replacement Project and involves the construction of a new greenfield Metering and Regulating (M&R) Station along Pave Paws Road in Bourne, Massachusetts.

The purpose of the project is to relocate existing gas infrastructure to maintain uninterrupted delivery of natural gas to National Grid and its customers during and after bridge replacement activities. The new facility will replace impacted infrastructure and support continued operation of the regional gas transmission system.

The proposed M&R station will include process and support equipment such as a filter separator, meter and control valve skids, regulator systems, water bath heaters, odorization systems, and associated electrical, control, and utility systems. The facility will also include associated pig launcher and receiver assemblies. Site development will include clearing, grading, access roads, equipment pads, retaining wall areas, and stormwater management infrastructure designed to meet applicable regulatory requirements.

2.1.1 Site Description

The proposed Pave Paws Road Meter and Regulator (M&R) Station will be constructed west of Pave Paws Road at the eastern terminus (MP 2.15) of Algonquin's proposed G-31 pipeline. The project site is located on Joint Base Cape Cod in Bourne, Barnstable County, Massachusetts, northwest of the intersection of Pave Paws Road and an existing utility corridor. The surrounding area consists primarily of undeveloped woodland, with nearby roadway infrastructure and an established utility corridor.

The site is currently undeveloped and consists of wooded land. Access to the proposed M&R Station will be provided by a new access road extending from Pave Paws Road. Site topography is relatively flat, forming a plateau with localized slopes that descend toward the surrounding woodland. Subsurface conditions generally consist of a thin layer of topsoil and subsoil overlying native sand deposits, with occasional cobbles and boulders. Groundwater was not encountered during subsurface investigations.

Groundwater was not observed during subsurface investigations, although seasonal variations may occur.

2.1.2 Wetland Resources

On February 3, 2025, SWCA representatives conducted a wetland delineation on the subject property. Based on the results of the delineation, the proposed Bourne M&R Station site is not located within, or in proximity to, any resource areas regulated under the Massachusetts Wetlands Protection Act.

2.1.3 Subsurface Soil Investigations

The Natural Resource Conservation Service (NRCS) identifies the land cover of the site Project Site as Plymouth-Barnstable complex soils (Map Units 483C, 484C, and 484D), which are characterized by coarse-grained, sandy and gravelly glaciofluvial deposits. The USDA NRCS soil report along with the Site Geotechnical Report are included in Attachment D. Soil infiltration characteristics were evaluated using NRCS Web Soil Survey mapping and conservative design assumptions for infiltration BMP sizing.

Soil infiltration characteristics were evaluated using NRCS Web Soil Survey mapping and conservative design assumptions for infiltration BMP sizing.

These soils are well to excessively drained, with high to very high permeability (Ksat) and depth to groundwater greater than 80 inches, indicating deep, freely draining conditions. The subsurface profile generally consists of loamy coarse sand transitioning to gravelly coarse sand at depth.

The soils are classified as Hydrologic Soil Group A, indicating low runoff potential when undisturbed, but due to coarse textures, steep slopes (8–25%), and very high runoff classification, exposed soils may be highly susceptible to erosion during storm events.

No hydric soils are mapped within the project area, and the soils are not subject to flooding or ponding.

2.2 Existing Drainage Conditions

The project site encompasses approximately 2.45 acres and is currently heavily wooded and undeveloped. Access to the site is provided by an existing unpaved road located along the eastern portion of the property, where the proposed access drive will tie into the existing roadway network. Based on available NRCS Soil Survey mapping, the site consists of Plymouth-Barnstable complex soils, including rolling and hilly classifications with very bouldery to extremely bouldery characteristics. These soils are classified as Hydrologic Soil Group A.

Site topography generally slopes from north to south, with runoff entering the site from higher ground to the north and additional localized runoff shedding from the existing access road to the east. Although minor shallow depressional areas are present throughout the site, these features are poorly defined from a drainage perspective and do not create distinct drainage subareas. During runoff events, these shallow depressions are expected to temporarily store stormwater before overflowing and continuing to drain southward following the natural topographic gradient.

Under existing conditions, the site is therefore characterized as a single drainage area identified as Drainage Area E01. This approach was maintained due to the relatively uniform and undefined drainage patterns observed across the forested landscape. Existing times of concentration were

developed to correspond with the proposed drainage configurations and anticipated runoff flow paths.

No formal stormwater management systems or drainage infrastructure are present on site. Due to the undeveloped and heavily vegetated nature of the property, stormwater runoff primarily occurs as sheet flow through the wooded landscape, with no evidence of concentrated or channelized flow within the site boundaries.

Overall, the proposed drainage system formalizes existing flow paths and introduces water quality and infiltration-based stormwater management practices, resulting in improved runoff control compared to existing conditions. A drawing of the Proposed Drainage Conditions is provided in Attachment A

Table 1 - Existing Conditions Hydrologic Data

Drainage Area	Area (acres)	Curve Number	Time of Concentration (min)	Existing Outlet Discharge 2070-50 year (cfs)
E01	0.76	43	28.81	0.87
E03.3	0.35	43	21.10	0.45
E03.2	0.51	43	22.21	0.65

2.3 Proposed Drainage Conditions

The proposed project will develop approximately 2.45 acres of the site with the construction of a gravel equipment pad and associated gravel access roadway improvements. The proposed access drive will tie into the existing unpaved roadway located along the eastern portion of the property. The design incorporates a series of vegetated swales, pretreatment forebays, and infiltration basins to provide stormwater management, groundwater recharge, and water quality treatment. Stormwater runoff will be managed through a combination of sheet flow, vegetated swales, forebays, and infiltration basins designed to maintain drainage patterns generally consistent with existing conditions while improving water quality and reducing peak runoff rates

Under proposed conditions, portions of the site will be selectively cleared and regraded to direct runoff toward defined conveyance and treatment systems.

The proposed drainage system divides the site into four drainage areas, each utilizing a similar treatment train consisting of sheet flow to a vegetated swale, conveyance to a pretreatment forebay, and discharge to an infiltration basin. Each infiltration basin is designed with an overflow weir to safely convey larger storm events while maintaining stable downgradient drainage conditions.

Drainage Area A1, located generally within the northwest portion of the site, will drain towards the north and west. Runoff from this area will enter a vegetated swale via sheet flow before discharging to a forebay and subsequently to an infiltration basin providing storage, infiltration, and water quality treatment. Overflow from the basin during larger storm events will discharge in a controlled manner consistent with existing site drainage patterns.

Drainage Area A2 will primarily capture runoff from the proposed access roadway along with a small portion of the northeastern section of the gravel pad. Runoff from this drainage area will be conveyed via vegetated swale to a forebay prior to discharging to an infiltration basin designed to provide pretreatment, attenuation, and groundwater recharge. Overflow from the basin will discharge through a stabilized overflow structure during extreme storm events.

Drainage Area A3 will capture runoff from the existing roadway located east of the site as well as runoff from the southeastern portion of the proposed gravel pad. Runoff from this area will be conveyed through a vegetated swale to a forebay and infiltration basin system. The basin will provide infiltration and peak flow attenuation, with overflow directed along stabilized discharge paths consistent with existing downgradient drainage conditions.

Drainage Area A4 will capture runoff from the southwestern portion of the proposed gravel pad. Stormwater runoff will enter a vegetated swale as sheet flow and discharge to a forebay prior to entering the associated infiltration basin. This system will provide water quality treatment, infiltration, and controlled overflow management for larger storm events.

To prevent off-site runoff from entering the proposed developed areas, a perimeter swale has been incorporated along the northern boundary of the facility. The swale is designed to intercept and convey existing upstream runoff associated with Drainage Areas E01 and E02 around the northern extent of the proposed infiltration basins and discharge flows toward the west in a manner generally consistent with existing drainage patterns.

Overall, the proposed drainage system formalizes existing site runoff patterns through the use of infiltration-based stormwater management practices designed to promote groundwater recharge, improve water quality, and reduce peak runoff rates. The inclusion of vegetated swales and pretreatment forebays provides sediment and pollutant removal prior to infiltration, improving long-term system performance and maintainability. No adverse impacts to downgradient properties or natural resource areas are anticipated.

A plan depicting Proposed Drainage Conditions is included in Attachment A

Table 2 - Proposed Conditions Hydrologic Data

Drainage Area	Discharge Location	Design Event	Existing Area Distributions (acres)	Area (acres)	Curve Number	Time of Concentration (min)	Proposed Outlet (cfs)
A1	West	8.8 in, 50Year (2070)	E01 (0.27 ac) E05 (0.32 ac)	0.73	76	6.0	0.39
A2	North West	8.8 in, 50Year (2070)	E02.1 (0.65 ac)	0.64	76	6.0	0.52
A3	South	8.8 in, 50Year (2070)	E03 (1.33 ac)	1.08	76	6.0	0.79
A4	South	8.8 in, 50Year (2070)	E04 (0.13 ac)	0.25	76	6.0	0.18



Name: WGS 1984 Web Mercator Auxiliary Sphere
PCS: WGS 1984 Web Mercator Auxiliary Sphere; Authority: EPSG; WKID: 3857

0 12.5 25 50 Miles

FIGURE 1		SITE LOCATION MAP	Rev. No: 2
Drawn By: MH	Approved By: SR	CAPE COD CANAL PIPELINE REPLACEMENT PROJECT PAVE PAWS METER STATION SAGAMORE, MA	Rev. By:
Date: 6/24/26	Job No:		Rev. Date: 6/25/26
Sheet No: ___ of ___		N audubon	Revision Description, Per OCM Request:



Name: WGS 1984 Web Mercator Auxiliary Sphere
PCS: WGS 1984 Web Mercator Auxiliary Sphere; Authority: EPSG; WKID: 3857

0 12.5 25 50 Miles

FIGURE 1		SITE LOCATION MAP	Rev. No: 2
Drawn By: MH	Approved By: SR	CAPE COD CANAL PIPELINE REPLACEMENT PROJECT PAVE PAWS METER STATION SAGAMORE, MA	Rev. By:
Date: 6/24/26	Job No:		Rev. Date: 6/25/26
Sheet No: ___ of ___		N audubon	Revision Description, Per OCM Request:

3 Regulatory Compliance

3.1 Massachusetts Department of Environmental Protection (DEP) – Stormwater Management Standards

As demonstrated in the sections below, the proposed Project Complies with the DEP Stormwater Management Standards.

3.1.1 Standard 1: No New Untreated Discharges or Erosion to Wetlands

The Project has been designed to comply with Standard 1

The Best Management Practices (BMPs) included in the proposed stormwater management system have been designed in accordance with the Massachusetts Stormwater Handbook (MSH). Supporting information and computation demonstrating that no new untreated discharges will result from the Project are presented through compliance with Standards 4 through 6.

All proposed Project Stormwater Outlets and conveyances have been designed to not cause erosion or scour to wetlands or receiving waters.

Computations and supporting information for the sizing and selection of materials used to protect from scour and erosion are included in Attachment B.

3.1.2 Standard 2: Peak Rate Attenuation

The Project has been designed to comply with Standard 2. The project is not subject to coastal storm flowage; the Project is proposing to reduce peak flow rates from existing to proposed conditions. Future precipitation conditions were evaluated using projected 2070 rainfall depths in accordance with current guidance.

A hydrologic and hydraulic model was developed using Autodesk Storm and Sanitary Analysis (SSA) to evaluate the existing and proposed drainage conditions for the Site. The analysis utilizes the NRCS TR-20 hydrologic methodology, with time of concentration (Tc) calculated in accordance with NRCS TR-55 procedures, and a minimum Tc of 6 minutes applied across all subcatchments. Runoff hydrographs were generated using the NRCS dimensionless unit hydrograph approach, and hydraulic routing was performed using dynamic (hydrodynamic) wave routing within the SSA model. The results of the analyses indicate that there is no increase in peak discharge rates between pre- and post-development conditions at the evaluated design points for the 2-, 10-, 25-, 50- and 100-year storm events, as well as the 50-year (2070) climate-adjusted storm event. Rainfall distributions utilized in the analysis are based on the NRCS Type III storm distribution. Precipitation depths for each storm event were obtained from the NOAA Atlas 14, Volume 10. Runoff curve numbers (CNs) for both existing and proposed conditions, as summarized in Tables 1 and 2, were determined in accordance with NRCS TR-55 methodology. Detailed model input parameters, assumptions, and computational results are provided in Attachment C.

Table 3 - NOAA Atlas 14 Volume 10 Design Depths for the 24 Hour Storm (inches)

2-year	10-year	25-year	50-year	100-year	50-year (2070)
3.42	4.99	5.97	6.71	7.48	8.80

Table 4 - Peak Discharge Rates

Proposed Area	Storm Event	Design Point	Existing Areas (Acre)	Existing Peak Discharge (cfs)	Proposed Areas (Acre)	Proposed Peak flow-Weir (cfs)	Proposed Peak Discharge (cfs)
A1 & A2	2-year	DP-1	E01 (0.76)	0.00	A1(0.73) & A2(0.69)	0.00	0.00
	10-year	DP-1	E01 (0.76)	0.08	A1(0.73) & A2(0.69)	0.00	0.03
	25-year	DP-1	E01 (0.76)	0.21	A1(0.73) & A2(0.69)	0.00	0.09
	50-year	DP-1	E01 (0.76)	0.34	A1(0.73) & A2(0.69)	0.12	0.15
	100-year	DP-1	E01 (0.76)	0.52	A1(0.73) & A2(0.69)	0.30	0.33
	50-year 2070	DP-1	E01 (0.76)	0.87	A1(0.73) & A2(0.69)	0.80	0.87

Proposed Area	Storm Event	Design Point	Existing Areas (Acre)	Existing Peak Discharge (cfs)	Proposed Areas	Proposed Peak flow-Weir (cfs)	Proposed Peak Discharge (cfs)
A3	2-year	DP-3	E03.3 (0.35)	0.00	A3 (1.05)	0.00	0.00
	10-year	DP-3	E03.3 (0.35)	0.04	A3 (1.05)	0.00	0.02
	25-year	DP-3	E03.3 (0.35)	0.11	A3 (1.05)	0.00	0.05
	50-year	DP-3	E03.3 (0.35)	0.18	A3 (1.05)	0.05	0.08
	100-year	DP-3	E03.3 (0.35)	0.27	A3 (1.05)	0.14	0.15
	50-year 2070	DP-3	E03.3 (0.35)	0.45	A3 (1.05)	0.42	0.45

Proposed Area	Storm Event	Design Point	Existing Areas (Acre)	Existing Peak Discharge (cfs)	Proposed Areas	Proposed Peak flow-Weir (cfs)	Proposed Peak Discharge (cfs)
A4	2-year	DP-4	E03.2 (0.51)	0.00	A4 (0.22)	0.00	0.00
	10-year	DP-4	E03.2 (0.51)	0.06	A4 (0.22)	0.00	0.04
	25-year	DP-4	E03.2 (0.51)	0.15	A4 (0.22)	0.00	0.12
	50-year	DP-4	E03.2 (0.51)	0.25	A4 (0.22)	0.03	0.20
	100-year	DP-4	E03.2 (0.51)	0.38	A4 (0.22)	0.08	0.30
	50-year 2070	DP-4	E03.2 (0.51)	0.65	A4 (0.22)	0.28	0.51

3.1.3 Standard 3: Stormwater Recharge

Recharge of Stormwater has been provided through the use of the stormwater infiltration basis which has been sized using the Static Method. Each infiltration BMP has been designed to drain completely within 72 hours. An analysis of the drawdown of the Infiltration Basin is included in Attachment D. Table 5 below provides a summary of the proposed infiltration BMPs utilized for the Project. In the absence of site-specific geotechnical infiltration testing, design infiltration rates were conservatively selected based on NRCS Web Soil Survey data and reduced using an appropriate safety factor of 2.0. The proposed system was intentionally sized conservatively to

ensure robust recharge performance and compliance with the required 72-hour drawdown standard under variable field conditions.

Field verification of subsurface conditions may be completed prior to construction to confirm consistency with the assumptions used for design.

In the absence of site-specific geotechnical infiltration testing, design infiltration rates were estimated using published NRCS Web Soil Survey data for the mapped on-site soil units, including Plymouth-Barnstable complex, rolling, very bouldery (Map Unit 483C), Plymouth-Barnstable complex, rolling, extremely bouldery (Map Unit 484C), and Plymouth-Barnstable complex, hilly, extremely bouldery (Map Unit 484D), all classified as Hydrologic Soil Group A. A saturated hydraulic conductivity (Ksat) value was obtained for the representative soil horizons and converted to inches per hour. A conservative safety factor of 2.0 was applied to account for variability and uncertainty associated with generalized soil mapping data.

Although a minimum design infiltration rate of approximately 6.88 inches per hour was calculated based on the NRCS soil data and the applied safety factor, an additional level of conservatism has been incorporated into the design. A reduced infiltration rate of 3.0 inches per hour has been utilized for sizing all infiltration BMPs. This reduced rate reflects conservative assumptions regarding subsurface variability and long-term system performance and was used in the project drawdown analysis to evaluate dewatering performance and confirm compliance with required drawdown timeframes. Refer to the drawdown analysis for detailed calculations.

Table 5 - Summary of Recharge Calculations

Infiltration Basin	Provided Volume (cf)
1	10490.21
2	7119.15
3	11746.88
4	2357.85
Total Provided Recharge	31714.09
Total Required Recharge	2717.00

Table 6 - Drainage Swales Design Summary

Drainage area	Peak flow (cfs) 2070 - 50 Year Event	Capacity	Max depth (ft)	Slope (%)	Velocity (ft/s)	Section Geometry
Ditch - North	0.65	3.81	1.00	0.30	1.90	Triangular, side slope max 2:1
Ditch A1 N	0.92	20.22	1.50	0.40	3.00	Triangular, side slope max 3:1
Ditch A1 W	0.13	2.06	0.50	0.50	1.65	Triangular, side slope max 5:1
Ditch A2	0.15	1.46	0.50	0.73	1.94	Triangular, side slope max 3:1
Ditch A3 E	0.45	5.93	1.00	0.30	1.98	Triangular, side slope max 3:1

Drainage area	Peak flow (cfs) 2070 - 50 Year Event	Capacity (cfs)	Max depth (ft)	Slope (%)	Velocity (ft/s)	Section Geometry
Ditch A3 S	0.39	1.38	1.00	0.65	1.84	Triangular, side slope max 3:1
Ditch A4	0.26	23.20	1.30	1.13	4.58	Triangular, side slope max 2:1

3.1.4 Standard 4: Water Quality

The Project has been designed to comply with Standard 4.

During construction of the project a comprehensive stormwater management system that includes; fiber rolls and silt-fence for slope and perimeter control, a stabilized construction entrance to minimize off-site transport of sediment on to local roadways, inlet protection to prevent sediment from entering the existing roadway stormwater management system, and a dedicated concrete washout and containment area.

Following construction, permanent stormwater BMPs will include Vegetative Swales to slow, convey, and treat stormwater runoff by promoting sediment removal and pollutant filtration; Sediment Forebays provide pretreatment by capturing coarse sediment and debris before runoff enters the primary stormwater BMP; Riprap Aprons to protect outlet soil from erosion due to concentrated runoff; and Stabilized Riprap Slopes to prevent potential future erosion where the velocity of flow from structures exceeds the capacity of the downstream area to resist erosion.

Treatment Train

Swales → Forebays → Infiltration Basins → Overflow

Roles:

- Vegetated swales provide conveyance and initial filtration.
- Sediment forebays provide pretreatment and sediment capture.
- Infiltration basins provide primary water quality treatment and recharge.

Pretreatment is provided upstream of infiltration BMPs through sediment forebays and vegetated conveyance systems in accordance with MassDEP Stormwater Handbook guidance.

The Massachusetts Stormwater Handbook assigns an 80% TSS removal credit to infiltration basins. Additional guidance and literature sources indicate that infiltration systems may achieve higher removal efficiencies under favorable site conditions.

Computations and supporting information, including the Long-Term Pollution Prevention Plan, are included in Attachment E

3.1.5 Standard 5: Land Uses and High Potential Pollutant Loads (LUHPPLs)

The proposed facility does not include industrial process areas or outdoor pollutant handling activities that would constitute a LUHPPL under the Massachusetts Stormwater Handbook. Operational areas are limited and supported by spill prevention and maintenance procedures

intended to minimize pollutant exposure to stormwater. While the Project is not considered a LUHPPL it has been designed with suitable BMPs sized to treat the 1-inch Water Quality Volume and 44% TSS pretreatment prior to infiltration.

3.1.6 Standard 6: Critical Areas

The Project will discharge treated stormwater through a treatment train, where runoff will be contained within a properly sized infiltration basin designed to infiltrate the 72-hour water quality volume. In the event that runoff exceeds the basin's storage capacity during larger storm events, overflow will be directed through a stabilized spillway to a relatively flat, vegetated area that promotes non-erosive sheet flow and additional infiltration. There are no jurisdictional wetlands or other critical resource areas on or adjacent to the Project Site.

Overflow from the infiltration basin will occur only during storm events that exceed the design storage volume. Overflow will be conveyed through stabilized riprap outlet protection and discharged as shallow sheet flow across vegetated areas, minimizing erosive velocities, promoting infiltration, and reducing sediment transport prior to leaving the site. Proposed source controls and pollution prevention measures have been identified in the Long-Term Pollution Prevention Plan included in Attachment E

3.1.7 Standard 7: Redevelopments and Other Projects Subject to the Standards only to the Maximum Extent Practicable

The Project has been designed to comply with all ten of the Stormwater Management Standards. Refer directly to each Standard for applicable computations and supporting information demonstrating compliance with each.

3.1.8 Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Controls

The Project is associated with regulated oil and gas transmission activities and is therefore not subject to coverage under the EPA Construction General Permit. Nevertheless, construction-period erosion and sediment controls and stormwater pollution prevention measures will be implemented consistent with applicable permitting requirements. Construction-period erosion and sediment controls will be implemented consistent with applicable permitting requirements. During construction of the project a comprehensive stormwater management system that includes; fiber rolls and silt-fence for slope, perimeter control, and stormwater inlet protection if applicable, and stabilized construction entrances to minimize off-site transport of sediment on to local roadways, and a dedicated concrete washout and containment area.

Recommended construction period pollution prevention and erosion and sedimentation controls are included in Attachment F.

3.1.9 Standard 9: Operation and Maintenance Plan

In compliance with Standard 9, a Post-Construction Stormwater Operation and Maintenance (O&M) Plan has been developed for the Project to ensure the long-term functionality of the proposed stormwater management system. Following construction, permanent stormwater BMPs will include vegetated swales for conveyance and sediment reduction, sediment forebays for

pretreatment and sediment capture, infiltration basins for recharge and water quality treatment, riprap aprons for outlet protection, and stabilized riprap slopes to minimize the potential for future erosion.

The O&M Plan establishes inspection frequencies, maintenance procedures, and responsible parties for all stormwater BMPs. Vegetated swales, infiltration basins, and stabilized overflow areas will be inspected at least semi-annually and following major storm events to identify erosion, sediment accumulation, vegetation loss, debris buildup, or evidence of impaired drainage. Sediment forebays will be inspected quarterly and cleaned when sediment accumulation reaches approximately 50 percent of the forebay storage depth or otherwise impairs pretreatment performance. Infiltration basins will also be monitored for standing water, and if ponded water remains for greater than 72 hours following a storm event, the system will be evaluated for potential clogging and corrective maintenance performed as necessary.

Maintenance activities may include sediment and debris removal, stabilization of eroded areas, restoration of vegetative cover, and repair or replacement of damaged stabilization materials. Stabilized overflow and riprap outlet areas will be inspected following overflow-producing storm events to confirm that erosion, scour, or sediment transport has not occurred. Access to all stormwater BMPs will be maintained to facilitate inspection and maintenance activities throughout the operational life of the Project.

The O&M Plan is included in Attachment G as part of the Long-Term Pollution Prevention Plan.

3.1.10 Standard 10: Prohibition of Illicit Discharges

The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges. A copy of the Long-term Pollution Prevention Plan is included in Attachment E

4 Local Municipal Rules and Regulations

As a FERC-regulated interstate natural gas pipeline, Algonquin Gas Transmission LLC's proposed Project facilities are not subject to review under local ordinances and bylaws.

5 FEMA Floodplain

The proposed project is part of the Massachusetts Department of Transportation (MassDOT) Cape Cod Canal Bridges Replacement Project and involves the construction of a new Metering and Regulating (M&R) Station along Pave Paws Road in Bourne, Massachusetts.

Based on a review of the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRMs), the project site is located within Zone X (Area of Minimal Flood Hazard). The site lies entirely outside the 1-percent-annual-chance floodplain (100-year floodplain) and outside all Special Flood Hazard Areas (SFHAs).

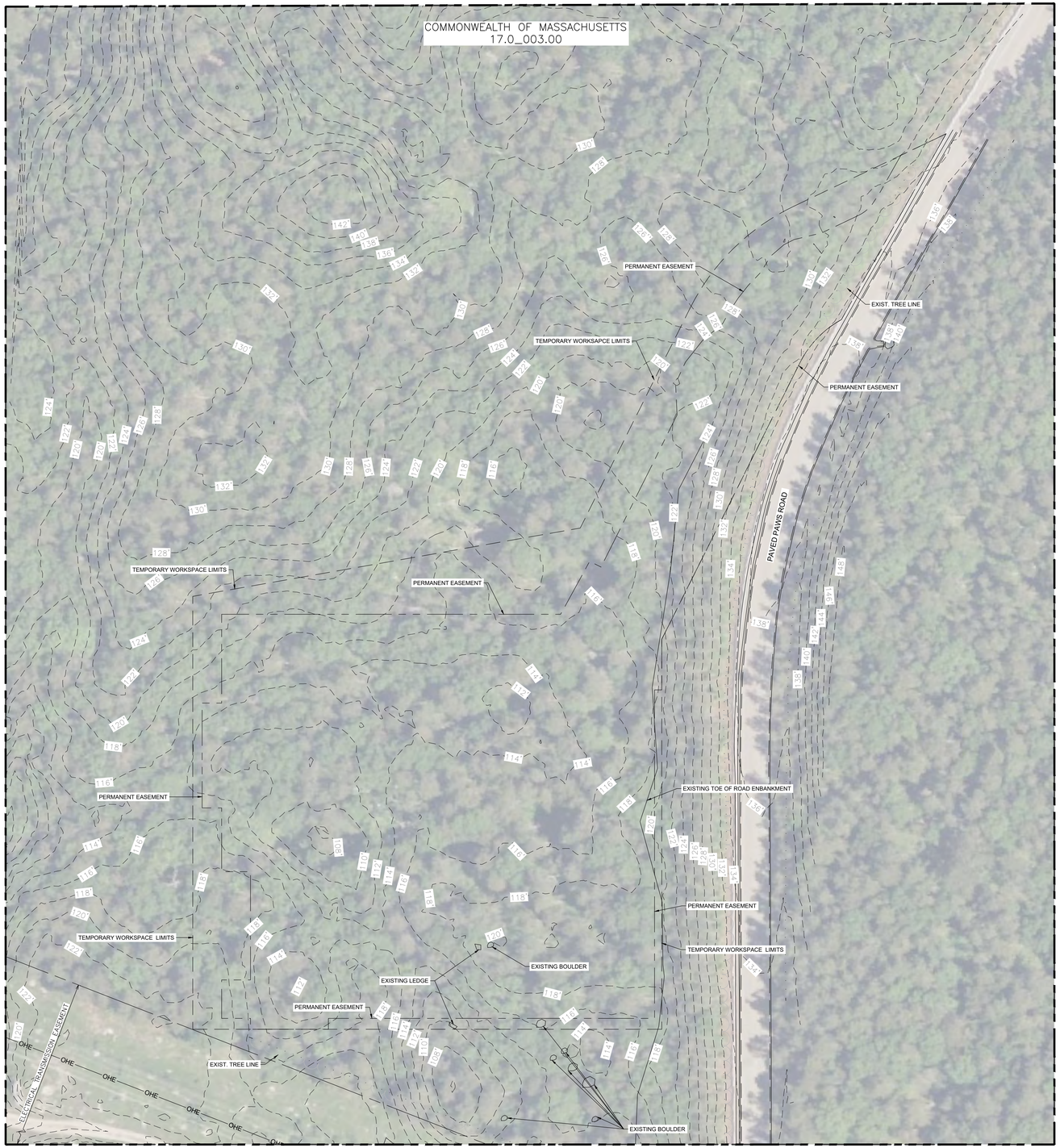
The nearest mapped Special Flood Hazard Area is associated with the Cape Cod Canal, where Zone AE is mapped along the canal corridor. Zone AE represents areas subject to inundation during the 1-percent-annual-chance flood event for which Base Flood Elevations (BFEs) have been established. This flood hazard area remains outside the project limits and does not extend onto the proposed M&R Station site.

No Zone VE (coastal high hazard areas subject to wave action) or Zone AO (areas of shallow flooding) are mapped within or adjacent to the project site.

Because the project is located entirely within Zone X, the proposed work is not expected to affect flood storage capacity, flood elevations, or flood conveyance, and no impacts to FEMA-mapped flood hazard areas are anticipated.

Attachment A - Existing and Proposed Drainage Conditions

Existing Conditions



PAVE PAWS ROAD METER STATION

EXISTING CONDITIONS PLAN

SCALE: 1" = 40'

0 40' 80'
Scale: 1" = 40'

NN 6.757°

STATION NORTH

NOTES:

1. ALL CONTOUR LABELS AND ELEVATION CALLOUTS ARE IN FEET.
2. PROPOSED SITE BOUNDARY WAS PROVIDED BY ALGONQUIN 3RD PARTY CONSULTANT.
3. SUPPLEMENTAL TAX PARCEL DATA IS SHOWN FOR REFERENCE ONLY AND WAS OBTAINED FROM THE CAPE COD COMMISSION OPEN GIS DATA HUB WEBSITE. PROJECT AREA IS WITHIN THE COMMONWEALTH OF MASSACHUSETTS PROPERTY.
4. PROPERTY CONVEYED TO ALGONQUIN GAS TRANSMISSION, LLC.
5. TOPOGRAPHIC SURVEY INFORMATION WAS PROVIDED BY ALGONQUIN GAS TRANSMISSION, LLC. ALL COORDINATES AND DISTANCES SHOWN HEREON ARE REFERENCED TO THE MASSACHUSETTS STATE PLANE COORDINATE SYSTEM, US FEET.ELEVATIONS ARE REFERENCED TO NAVD 88.
6. ADDITIONAL CONTOUR DATA WAS OBTAINED FROM 2022 USGS LIDAR POINT CLOUD DATA SETS.
7. THIS PROPERTY IS LOCATED IN ZONE X (AREA OF MINIMAL FLOOD HAZARD) AS DEPICTED ON FLOOD INSURANCE RATE MAP 25001C0318K DATED JULY 6, 2021.
8. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT NATURAL RESOURCE STUDY THE SITE IS WITHIN THE NATURAL HERITAGE AND ENDANGERED SPECIES PROGRAM (NHESP), PRIORITY HABITATS OF RARE WILDLIFE, OR THE NHESP ESTIMATED HABITATS OF RARE WILDLIFE.
9. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THE SITE THERE IS NOT A WETLAND WITHIN 100 FEET OF THE PROJECT LIMITS.
10. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THE SITE IS NOT LOCATED WITHIN AN AREA OF CRITICAL ENVIRONMENTAL CONCERN.
11. THIS PLAN SET IS PRELIMINARY. FOR PERMITTING PURPOSES ONLY. THIS PLAN IS NOT INTENDED FOR CONSTRUCTION PURPOSES.

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
No. 59857
PROFESSIONAL ENGINEER

07/07/26

ISSUED FOR PERMIT
07/07/2026

LEGEND
EXISTING OVERHEAD ELECTRIC — OHE — OHE —
EXISTING CONTOUR LINE – – – – – – 115' – –
WORKSPACE LIMITS — — — — — —

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		D	07/07/26	JA	DT	REISSUED FOR PERMIT
		C	06/24/26	JA	DT	ISSUED FOR PERMIT
		B	05/15/26	JA	DT	ISSUE FOR BID
		A	05/15/26	JA	DT	ISSUED FOR PERMIT

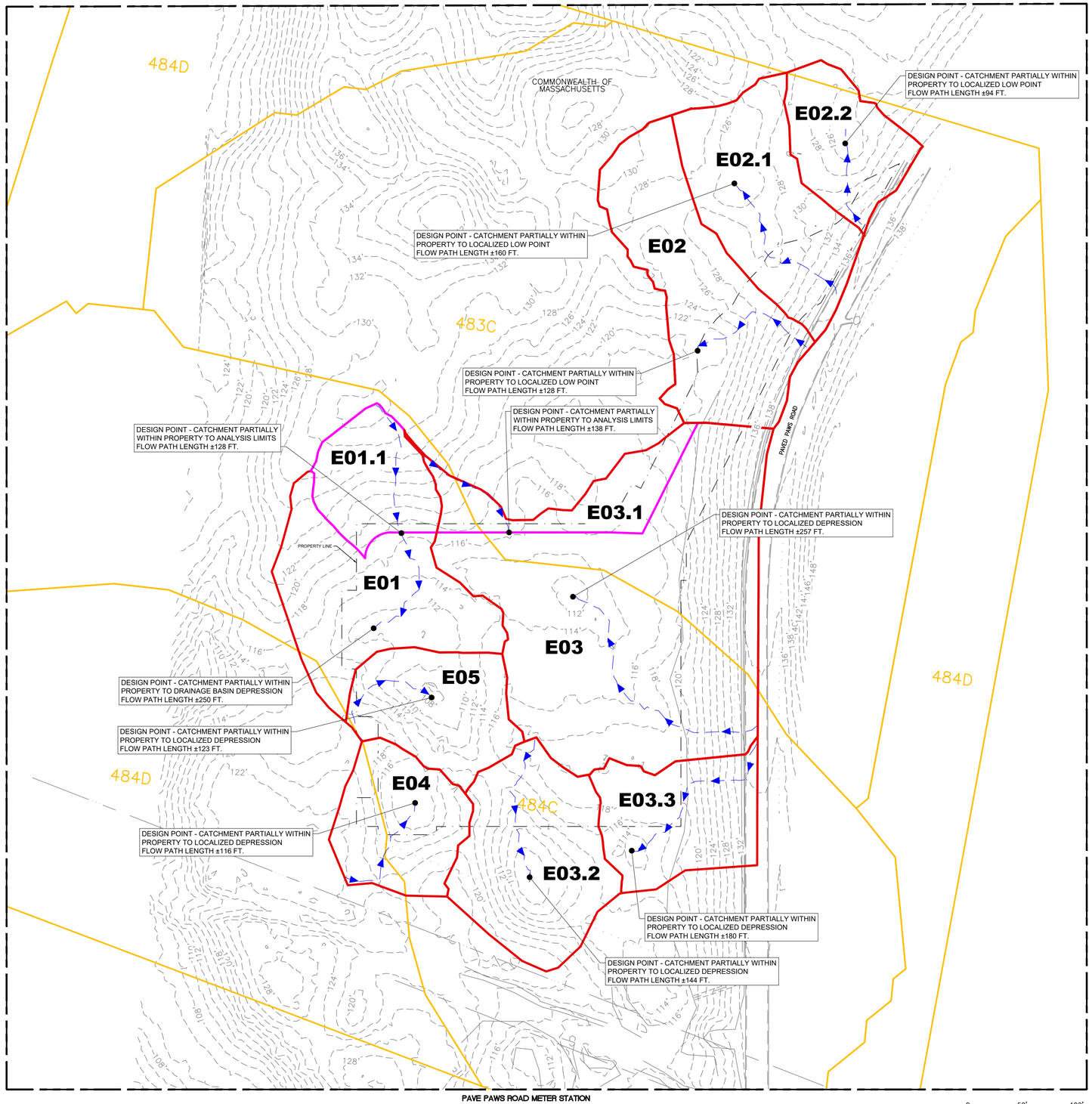
audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

DRAWN BY:	JA	05/15/26	CAPE COD CANAL PIPELINE RELOCATION PROJECT
DESIGN CHECKER:	DT	07/07/26	PAVE PAWS ROAD METER STATION
DESIGN ENGINEER:	PB	07/07/26	M&R 00845
PROJECT MANAGER:	AC	07/07/26	TITLE: EXISTING CONDITIONS PLAN
TITLE	INITIALS	DATE	LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

YEAR: 2026 | W.O.: | SCALE: 1"=40' | DWG.: 00845-C.320-0001 | REV.: D

ENBRIDGE
AIgonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

S:\AE\Projects\Enbridge\Mass\026356-001\200_Civil_Structural\170_Drawings\E&S Plans\Pave Paws Road M&R\00845-C.320-0001.dwg — PLOT TIME: 7/7/2026 10:27 AM



PAVE PAWS ROAD METER STATION

EXISTING SUBCATCHMENT AREAS PLAN

SCALE: 1" = 50'

0 50' 100'

Scale: 1" = 50'

NN 6.757°

STATION NORTH

NOTES:

1. ALL CONTOUR LABELS AND ELEVATION CALLOUTS ARE IN FEET.
2. PROPOSED SITE BOUNDARY WAS PROVIDED BY ALGONQUIN 3RD PARTY CONSULTANT.
3. SUPPLEMENTAL TAX PARCEL DATA IS SHOWN FOR REFERENCE ONLY AND WAS OBTAINED FROM THE CAPE COD COMMISSION OPEN GIS DATA HUB WEBSITE. PROJECT AREA IS WITHIN THE COMMONWEALTH OF MASSACHUSETTS PROPERTY.
4. PROPERTY CONVEYED TO ALGONQUIN GAS TRANSMISSION, LLC.
5. TOPOGRAPHIC SURVEY INFORMATION WAS PROVIDED BY ALGONQUIN GAS TRANSMISSION, LLC. ALL COORDINATES AND DISTANCES SHOWN HEREON ARE REFERENCED TO THE MASSACHUSETTS STATE PLANE COORDINATE SYSTEM, US FEET.ELEVATIONS ARE REFERENCED TO NAVD 88.
6. ADDITIONAL CONTOUR DATA WAS OBTAINED FROM 2022 USGS LIDAR POINT CLOUD DATA SETS.
7. THIS PROPERTY IS LOCATED IN ZONE X (AREA OF MINIMAL FLOOD HAZARD) AS DEPICTED ON FLOOD INSURANCE RATE MAP 25001C0318K DATED JULY 6, 2021.
8. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT NATURAL RESOURCE STUDY THE SITE IS WITHIN THE NATURAL HERITAGE AND ENDANGERED SPECIES PROGRAM (NHESP), PRIORITY HABITATS OF RARE WILDLIFE, OR THE NHESP ESTIMATED HABITATS OF RARE WILDLIFE.
9. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THE SITE THERE IS NOT A WETLAND WITHIN 100 FEET OF THE PROJECT LIMITS.
10. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THE SITE IS NOT LOCATED WITHIN AN AREA OF CRITICAL ENVIRONMENTAL CONCERN.
11. THIS PLAN SET IS PRELIMINARY. FOR PERMITTING PURPOSES ONLY. THIS PLAN IS NOT INTENDED FOR CONSTRUCTION PURPOSES.
12. REFER TO THE "EROSION & SEDIMENT GENERAL NOTES" (DWG. 00845-C.020-0001) FOR SOIL TYPES INFORMATION.

LEGEND

- EXISTING MAJOR CONTOUR 70'
- EXISTING MINOR CONTOUR 72'
- PROPERTY LINE
- GIS TAX PARCELS
- SUBCATCHMENT AREA BOUNDARY
- ANALYSIS LIMITS BOUNDARY
- NRCS SOIL BOUNDARY
- TIME OR CONCENTRATION LINE

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
No. 58957
PROFESSIONAL ENGINEER

07/08/26

ISSUED FOR PERMIT
06/24/2026

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		C	06/24/26	JA	DT	ISSUED FOR PERMIT
		B	05/15/26	JA	DT	ISSUE FOR BID
		A	05/15/26	JA	DT	ISSUED FOR PERMIT

audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

DRAWN BY:	JA	05/15/26	CAPE COD CANAL PIPELINE RELOCATION PROJECT
DESIGN CHECKER:	DT	06/24/26	PAVE PAWS ROAD METER STATION
DESIGN ENGINEER:	PB	06/24/26	M&R 00845
PROJECT MANAGER:	AC	06/24/26	TITLE: EXISTING SUBCATCHMENT AREAS PLAN
			LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

TITLE	INITIALS	DATE	YEAR: 2026	W.O.:	SCALE: 1"=50'	DWG.: 00845-C.320-0002	REV.: C

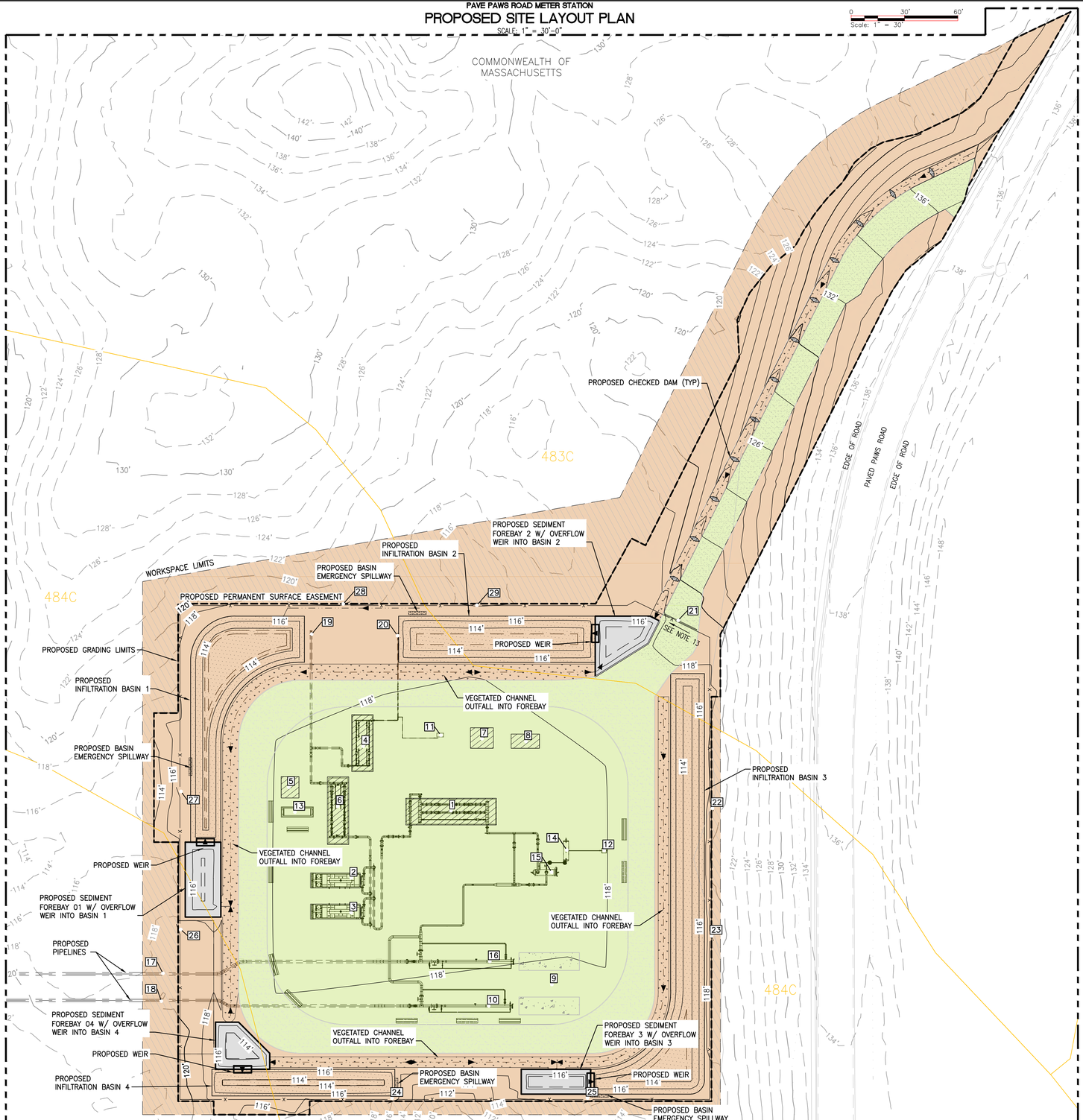
ENBRIDGE
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

S:\AE\Projects\Enbridge\Mass\026356-001\200_Civil_Structural\170_Drawings\E&S Plans\Pave Paws Road M&R\00845-C.320-0002.dwg — PLOT TIME: 6/24/2026 2:28 PM

PAVE PAWS ROAD METER STATION

PROPOSED SITE LAYOUT PLAN

SCALE: 1" = 30'-0"



NN 6.757°

STATION NORTH

NOTES:

1. ALL CONTOUR LABELS AND ELEVATION CALLOUTS ARE IN FEET.
2. PROPOSED SITE BOUNDARY WAS PROVIDED BY ALGONQUIN GAS TRANSMISSION, LLC 3RD PARTY CONSULTANT.
3. SUPPLEMENTAL TAX PARCEL DATA IS SHOWN FOR REFERENCE ONLY AND WAS OBTAINED FROM THE CAPE COD COMMISSION OPEN GIS DATA HUB WEBSITE. PROJECT AREA IS WITHIN THE COMMONWEALTH OF MASSACHUSETTS PROPERTY.
4. PROPERTY CONVEYED TO ALGONQUIN GAS TRANSMISSION, LLC.
5. TOPOGRAPHIC SURVEY INFORMATION WAS PROVIDED BY ALGONQUIN GAS TRANSMISSION, LLC. ALL COORDINATES AND DISTANCES SHOWN HEREON ARE REFERENCED TO THE MASSACHUSETTS STATE PLANE COORDINATE SYSTEM, US FEET. ELEVATIONS ARE REFERENCED TO NAVD 88.
6. ADDITIONAL CONTOUR DATA WAS OBTAINED FROM 2022 USGS LIDAR POINT CLOUD DATA SETS.
7. THIS PROPERTY IS LOCATED IN ZONE X (AREA OF MINIMAL FLOOD HAZARD) AS DEPICTED ON FLOOD INSURANCE RATE MAP 25001C0318K DATED JULY 6, 2021.
8. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT NATURAL RESOURCE STUDY THE SITE IS WITHIN THE NATURAL HERITAGE AND ENDANGERED SPECIES PROGRAM (NHESP), PRIORITY HABITATS OF RARE WILDLIFE, OR THE NHESP ESTIMATED HABITATS OF RARE WILDLIFE.
9. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THERE IS NOT A WETLAND WITHIN 100 FEET OF THE PROJECT LIMITS.
10. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THE SITE IS NOT LOCATED WITHIN AN AREA OF CRITICAL ENVIRONMENTAL CONCERN.
11. THIS PLAN SET IS PRELIMINARY. FOR PERMITTING PURPOSES ONLY. THIS PLAN IS NOT INTENDED FOR CONSTRUCTION PURPOSES.
12. SEE GRADING PLAN DRAWING 00845-C.301-0001 FOR DETAILS ON SITE GRADING AND STORM WATER MANAGEMENT.
13. INSTALL SLIDE GATE ASSEMBLY TO ENSURE IT DOES NOT INTERFERE WITH THE PROPOSED DRAINAGE CHANNEL DURING INSTALLATION OR OPERATION.

KEY NOTE ID	
POINT #	DESCRIPTION
1	30'x50' METER BUILDING
2	HEATER
3	HEATER
4	32'x12' REGULATOR BUILDING
5	12'x10' ODORIZIER BUILDING
6	32'x12' REGULATOR BUILDING
7	10'x12' N.G. EGM BUILDING
8	8'x8' ENBRIDGE EGM BUILDING
9	34'x10' MAINTANANCE SLABS
10	PIPELINE TRAP
11	GENERATOR
12	TRUCK BOX
13	TANK
14	FILTER SEPERATOR
15	AUX SUMP

KEY NOTE ID	
POINT #	DESCRIPTION
16	PIPELINE TRAP
17	PIPELINE (BY OTHERS)
18	PIPELINE (BY OTHERS)
19	PIPELINE CONNECTION POINT
20	PIPELINE CONNECTION POINT
21	SLIDE GATE
22	ACCESS GATE
23	ACCESS GATE
24	ACCESS GATE
25	ACCESS GATE
26	ACCESS GATE
27	ACCESS GATE
28	ACCESS GATE
29	ACCESS GATE

LEGEND

- PROPOSED ACCESS ROAD
- PROPOSED CONCRETE
- PROPOSED STRUCTURE
- PROPOSED ROCK (FACILITY)
- PROPOSED VEGETATED
- PROPOSED INFILTRATION BASIN
- PROPOSED SEDIMENT FOREBAY
- WORKSPACE
- INFILTRATION >2.4"/HR
- INFILTRATION <2.4"/HR
- EMERGENCY SPILL WAY
- PROPOSED DRAINAGE AREAS
- PROPOSED FENCE
- PROPOSED UG PIPING
- PERMANENT EASEMENT
- GIS TAX PARCELS
- NRCS SOIL BOUNDARY
- WORKSPACE LIMITS
- PROPOSED GRADE LIMITS
- EDGE OF ROAD
- EXISTING MAJOR CONTOUR 70
- EXISTING MINOR CONTOUR 72
- PROPOSED MAJOR CONTOUR 70
- PROPOSED MINOR CONTOUR 72
- PROPOSED FLOW LINE
- PROPOSED WIER
- PROPOSED ROCK CHECK DAM

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
No. 58957
PROFESSIONAL ENGINEER

07/07/26

ISSUED FOR PERMIT
07/07/2026

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		D	07/07/26	JA	DT	REISSUED FOR PERMIT
		C	06/24/26	JA	DT	ISSUED FOR PERMIT
		B	05/15/26	JA	DT	ISSUED FOR BID
		A	05/15/26	JA	DT	ISSUED FOR PERMIT

audubon Engineering
3505 W. SAM HOUSTON PKWY. N., SUITE 100
HOUSTON, TX 77043
PHONE: (281) 669-0590

DRAWN BY:	JA	05/15/26
DESIGN CHECKER:	DT	07/07/26
DESIGN ENGINEER:	PB	07/07/26
PROJECT MANAGER:	AC	07/07/26

CAPE COD CANAL PIPELINE RELOCATION PROJECT
PAVE PAWS ROAD METER STATION
M&R 00845
TITLE: PROPOSED SITE LAYOUT PLAN
LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

TITLE	INITIALS	DATE	YEAR:	W.O.:	SCALE:	DWG.:	REV.:
			2026		1"=30'	00845-C.320-0003	D

ENBRIDGE

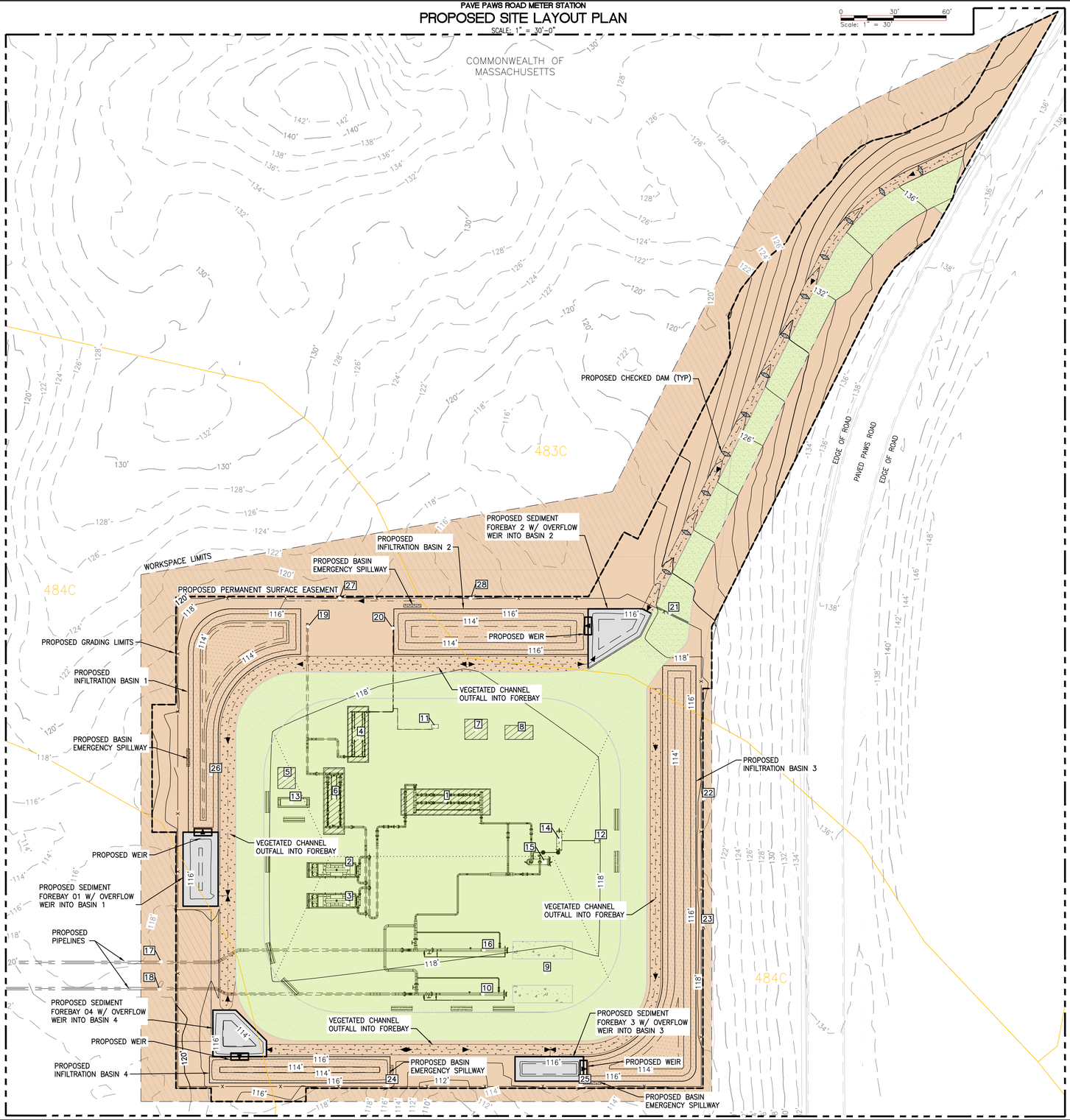
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

S:\AE\Projects\Enbridge\Mass\026356-001\200_Civil_Structural\170_Drawings\E&S Plans\Pave Paws Road M&R\00845-C.320-0003.dwg - PLOT TIME: 7/7/2026 1:56 PM

PAVE PAWS ROAD METER STATION

PROPOSED SITE LAYOUT PLAN

SCALE: 1" = 30'-0"



NN 6.757°

STATION NORTH

NOTES:

1. ALL CONTOUR LABELS AND ELEVATION CALLOUTS ARE IN FEET.
2. PROPOSED SITE BOUNDARY WAS PROVIDED BY ALGONQUIN GAS TRANSMISSION, LLC 3RD PARTY CONSULTANT.
3. SUPPLEMENTAL TAX PARCEL DATA IS SHOWN FOR REFERENCE ONLY AND WAS OBTAINED FROM THE CAPE COD COMMISSION OPEN GIS DATA HUB WEBSITE. PROJECT AREA IS WITHIN THE COMMONWEALTH OF MASSACHUSETTS PROPERTY.
4. PROPERTY CONVEYED TO ALGONQUIN GAS TRANSMISSION, LLC.
5. TOPOGRAPHIC SURVEY INFORMATION WAS PROVIDED BY ALGONQUIN GAS TRANSMISSION, LLC. ALL COORDINATES AND DISTANCES SHOWN HEREON ARE REFERENCED TO THE MASSACHUSETTS STATE PLANE COORDINATE SYSTEM, US FEET. ELEVATIONS ARE REFERENCED TO NAVD 88.
6. ADDITIONAL CONTOUR DATA WAS OBTAINED FROM 2022 USGS LIDAR POINT CLOUD DATA SETS.
7. THIS PROPERTY IS LOCATED IN ZONE X (AREA OF MINIMAL FLOOD HAZARD) AS DEPICTED ON FLOOD INSURANCE RATE MAP 25001C0318K DATED JULY 6, 2021.
8. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT NATURAL RESOURCE STUDY THE SITE IS WITHIN THE NATURAL HERITAGE AND ENDANGERED SPECIES PROGRAM (NHESP), PRIORITY HABITATS OF RARE WILDLIFE, OR THE NHESP ESTIMATED HABITATS OF RARE WILDLIFE.
9. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THERE IS NOT A WETLAND WITHIN 100 FEET OF THE PROJECT LIMITS.
10. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THE SITE IS NOT LOCATED WITHIN AN AREA OF CRITICAL ENVIRONMENTAL CONCERN.
11. THIS PLAN SET IS PRELIMINARY. FOR PERMITTING PURPOSES ONLY. THIS PLAN IS NOT INTENDED FOR CONSTRUCTION PURPOSES.
11. SEE GRADING PLAN DRAWING 00845-C.301-0001 FOR DETAILS ON SITE GRADING AND STORM WATER MANAGEMENT.

KEY NOTE ID	
POINT #	DESCRIPTION
1	30'x50' METER BUILDING
2	HEATER
3	HEATER
4	32'x12' REGULATOR BUILDING
5	12'x10' ODORIZIER BUILDING
6	32'x12' REGULATOR BUILDING
7	10'x12' N.G. EGM BUILDING
8	8'x8' ENBRIDGE EGM BUILDING
9	34'x10' MAINTANANCE SLABS
10	PIPELINE TRAP
11	GENERATOR
12	TRUCK BOX
13	TANK
14	FILTER SEPERATOR
15	AUX SUMP

KEY NOTE ID	
POINT #	DESCRIPTION
16	PIPELINE TRAP
17	PIPELINE (BY OTHERS)
18	PIPELINE (BY OTHERS)
19	PIPELINE CONNECTION POINT
20	PIPELINE CONNECTION POINT
21	SLIDE GATE
22	ACCESS GATE
23	ACCESS GATE
24	ACCESS GATE
25	ACCESS GATE
26	ACCESS GATE
27	ACCESS GATE
28	ACCESS GATE

LEGEND

- PROPOSED ACCESS ROAD
- PROPOSED CONCRETE
- PROPOSED STRUCTURE
- PROPOSED ROCK (FACILITY)
- PROPOSED VEGETATED
- PROPOSED INFILTRATION BASIN
- PROPOSED SEDIMENT FOREBAY
- WORKSPACE
- INFILTRATION >2.4"/HR
- INFILTRATION <2.4"/HR
- EMERGENCY SPILL WAY
- PROPOSED DRAINAGE AREAS
- PROPOSED FENCE
- PROPOSED UG PIPING
- PERMANENT EASEMENT
- GIS TAX PARCELS
- NRCS SOIL BOUNDARY
- WORKSPACE LIMITS
- PROPOSED GRADE LIMITS
- EDGE OF ROAD
- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- PROPOSED FLOW LINE
- PROPOSED WIER
- PROPOSED ROCK CHECK DAM

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
No. 58957
PROFESSIONAL ENGINEER

07/08/26

ISSUED FOR PERMIT
06/24/2026

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		C	06/24/26	JA	DT	ISSUED FOR PERMIT
		B	05/15/26	JA	DT	ISSUED FOR BID
		A	05/15/26	JA	DT	ISSUED FOR PERMIT

audubon Engineering
3505 W. SAM HOUSTON PKWY. N., SUITE 100
HOUSTON, TX 77043
PHONE: (281) 669-0590

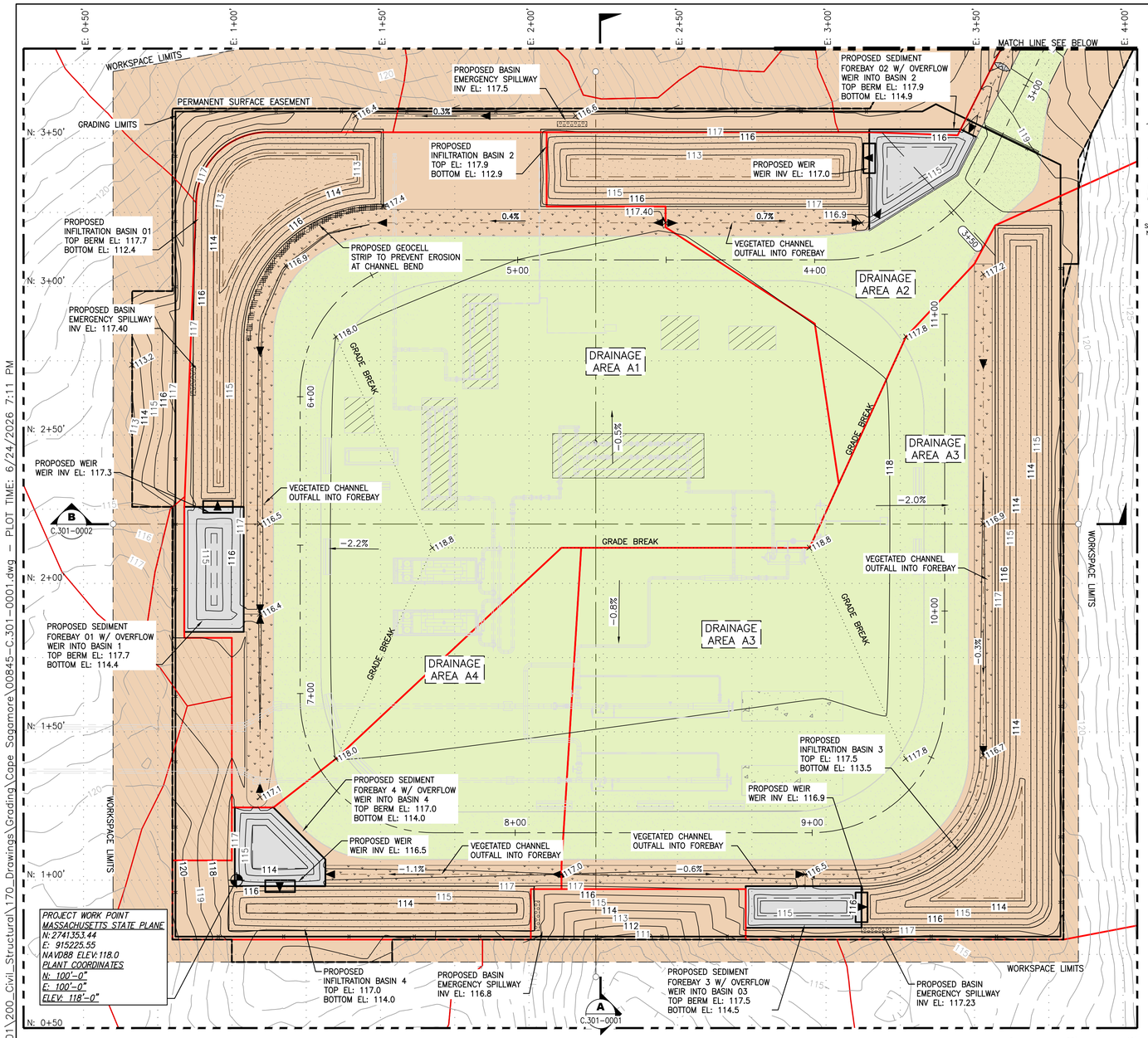
DRAWN BY:	JA	05/15/26
DESIGN CHECKER:	DT	06/24/26
DESIGN ENGINEER:	PB	06/24/26
PROJECT MANAGER:	AC	06/24/26

CAPE COD CANAL PIPELINE RELOCATION PROJECT
PAVE PAWS ROAD METER STATION
M&R 00845
TITLE: PROPOSED SITE LAYOUT PLAN
LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

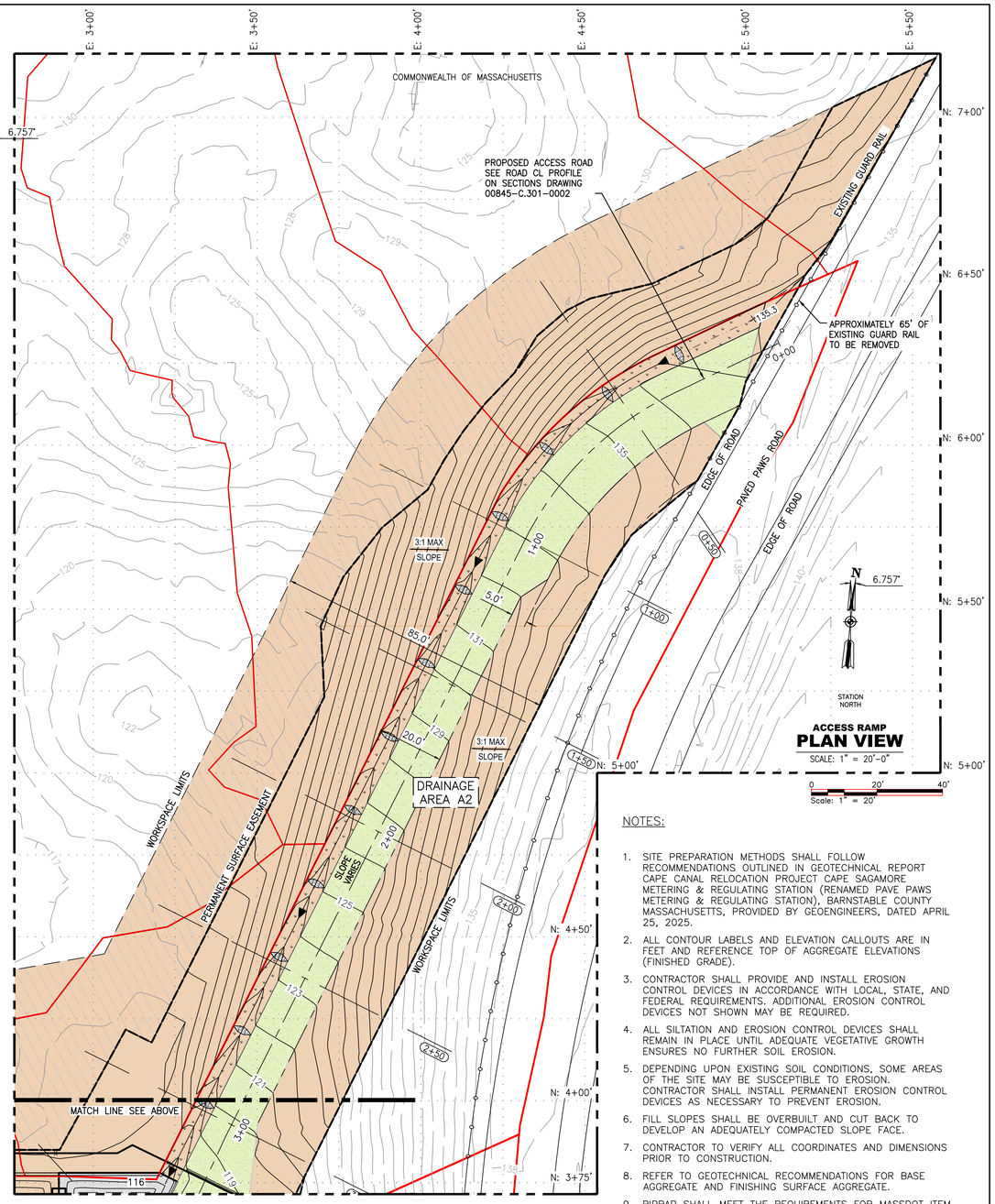
ENBRIDGE
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

TITLE	INITIALS	DATE	YEAR: 2026	W.O.:	SCALE: 1"=30'	DWG.: 00845-C.320-0003	REV.: C

S:\AE_Projects\Enbridge\Mass_026356-001\200_Civil_Structural\170_Drawings\E&S Plans\Pave Paws Road M&R\00845-C.320-0003.dwg - PLOT TIME: 6/24/2026 4:36 PM



METER STATION
PLAN VIEW
SCALE: 1" = 20'-0"



ACCESS RAMP
PLAN VIEW
SCALE: 1" = 20'-0"

0 20' 40'
Scale: 1" = 20'

NOTES:

1. SITE PREPARATION METHODS SHALL FOLLOW RECOMMENDATIONS OUTLINED IN GEOTECHNICAL REPORT CAPE CANAL RELOCATION PROJECT CAPE SAGAMORE METERING & REGULATING STATION (RENAMED PAVE PAWS METERING & REGULATING STATION), BARNSTABLE COUNTY MASSACHUSETTS, PROVIDED BY GEOENGINEERS, DATED APRIL 25, 2025.
2. ALL CONTOUR LABELS AND ELEVATION CALLOUTS ARE IN FEET AND REFERENCE TOP OF AGGREGATE ELEVATIONS (FINISHED GRADE).
3. CONTRACTOR SHALL PROVIDE AND INSTALL EROSION CONTROL DEVICES IN ACCORDANCE WITH LOCAL, STATE, AND FEDERAL REQUIREMENTS. ADDITIONAL EROSION CONTROL DEVICES NOT SHOWN MAY BE REQUIRED.
4. ALL SILTATION AND EROSION CONTROL DEVICES SHALL REMAIN IN PLACE UNTIL ADEQUATE VEGETATIVE GROWTH ENSURES NO FURTHER SOIL EROSION.
5. DEPENDING UPON EXISTING SOIL CONDITIONS, SOME AREAS OF THE SITE MAY BE SUSCEPTIBLE TO EROSION. CONTRACTOR SHALL INSTALL PERMANENT EROSION CONTROL DEVICES AS NECESSARY TO PREVENT EROSION.
6. FILL SLOPES SHALL BE OVERBUILT AND CUT BACK TO DEVELOP AN ADEQUATELY COMPACTED SLOPE FACE.
7. CONTRACTOR TO VERIFY ALL COORDINATES AND DIMENSIONS PRIOR TO CONSTRUCTION.
8. REFER TO GEOTECHNICAL RECOMMENDATIONS FOR BASE AGGREGATE AND FINISHING SURFACE AGGREGATE.
9. RIPRAP SHALL MEET THE REQUIREMENTS FOR MASSDOT ITEM M2.02.0 RIPRAP.
10. MIRAFI 140N, OR EQUIVALENT AND OVERLAIN WITH MIN. 18-INCHES OF RIPRAP SHALL BE PLACED IN FILL SLOPES 3.0H:1V TO 2.0H:V AND STEEPER.
11. CONTRACTOR TO PROVIDE ENGINEER OF RECORD GEOGRID AND GEOTEXTILE FABRIC SAMPLES, SPECIFICATIONS, AND INSTALLATION PROCEDURE PRIOR TO CONSTRUCTION.
12. ALL GEOGRID AND GEOTEXTILE FABRIC SHALL BE INSTALLED ACCORDING TO MANUFACTURER'S REQUIREMENTS AND RECOMMENDATIONS.
13. PROVIDE ENGINEER OF RECORD EQUIVALENT GEOTEXTILE FABRIC DATA SHEET AND SPECIFICATIONS.

EARTHWORK QUANTITIES:

CUT:	1452	CUBIC YARDS
FILL:	9592	CUBIC YARDS
NET (FILL):	8140	CUBIC YARDS

EARTHWORK QUANTITIES WERE DETERMINED BY COMPARING EXISTING GRADE WITH PROPOSED FINISH GRADE. PROPOSED CUT/FILL QUANTITIES ARE APPROXIMATE AND DO NOT ACCOUNT FOR STONE COVERAGE, STRIPPING TOPSOIL, SHRINKAGE FACTORS, BULK FACTORS, FINAL GRAVEL SURFACE LAYER, OR UNSUITABLE MATERIALS ENCOUNTERED.

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
No. 58957
PROFESSIONAL ENGINEER
07/08/26

ISSUED FOR PERMIT
06/24/2026

SURVEY NOTES:

1. BACKGROUND INFORMATION IS BASED ON THE FOLLOWING:
   1.1. TOPOGRAPHIC SURVEY INFORMATION WAS PROVIDED BY ENBRIDGE.
   1.2. ALL COORDINATES AND DISTANCES SHOWN HEREON ARE REFERENCED TO THE MAINE STATE PLANE COORDINATE SYSTEM, US FEET. ELEVATIONS ARE REFERENCED TO NAVD 88.

LEGEND

PROPOSED ACCESS ROAD
PROPOSED CONCRETE
PROPOSED STRUCTURE
PROPOSED ROCK (FACILITY)
PROPOSED FENCE
EXISTING CONTOUR LINE
FINISH CONTOUR LINE
DRAINAGE AREA BOUNDARY
WORKSPACE LIMITS
LIMITS OF GRADING
PROPOSED VEGETATED
PROPOSED INFILTRATION BASIN
PROPOSED SEDIMENT FOREBAY
GRADE BREAK
INFILTRATION >2.4"/HR
PROPOSED FLOW LLINE
PROPOSED EMERGENCY SPILLWAY
PROPOSED WEIR
PROPOSED ROCK CHECK DAM
INFILTRATION <2.4"/HR

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		E	06/24/26	JA	DT	ISSUED FOR PERMIT
		D	05/15/26	JA	DT	ISSUED FOR BID
		C	05/15/26	CR	DT	ISSUED FOR PERMIT
		B	02/17/26	CR	PB	ISSUED FOR REVIEW – 90% REVIEW
00845-C.301-0001	CIVIL GRADING SECTIONS	A	06/24/26	CR	PB	ISSUED FOR REVIEW – 60% REVIEW

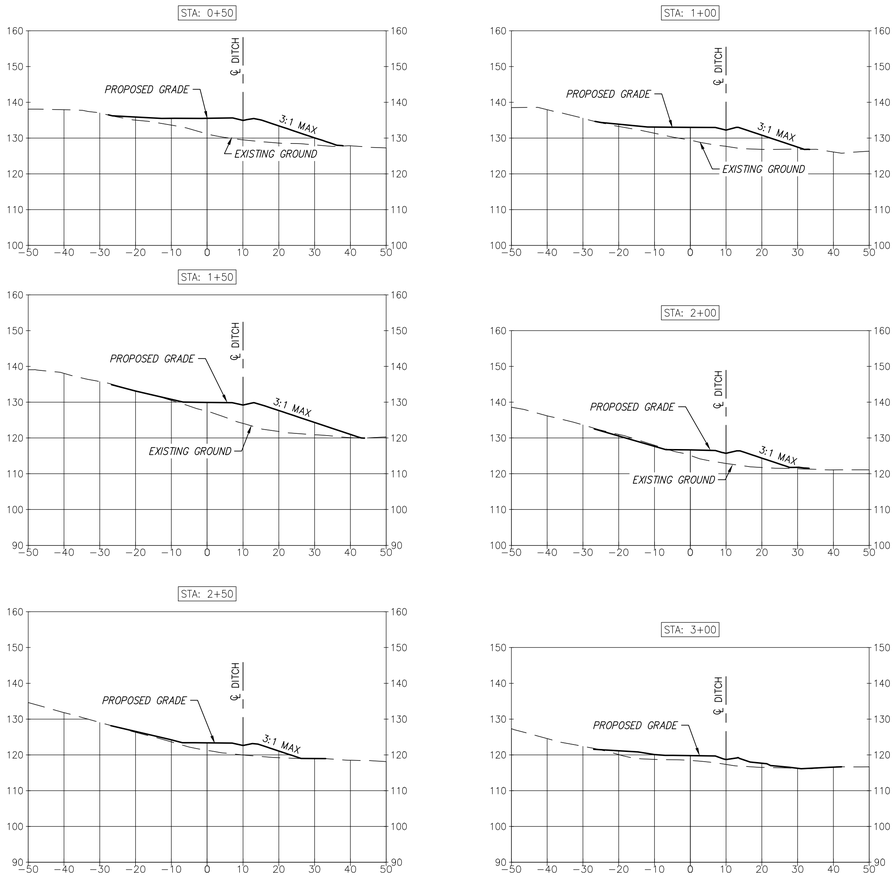
audubon Engineering
3505 W. SAM HOUSTON PKWY. N., SUITE 100
HOUSTON, TX 77043
PHONE: (281) 669-0590

DRAWN BY:	CR	01/08/25	CAPE COD CANAL PIPELINE RELOCATION PROJECT
DESIGN CHECKER:	AE	06/24/26	PAVE PAWS ROAD METER STATION
DESIGN ENGINEER:	PB	06/24/26	GRADING PLAN
PROJECT MANAGER:	AC	06/24/26	TITLE:

ENBRIDGE
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

TITLE	INITIALS	DATE	YEAR:	W.O.:	SCALE:	DWG.:	REV.:
			2026		AS NOTED	00845-C.301-0001	E

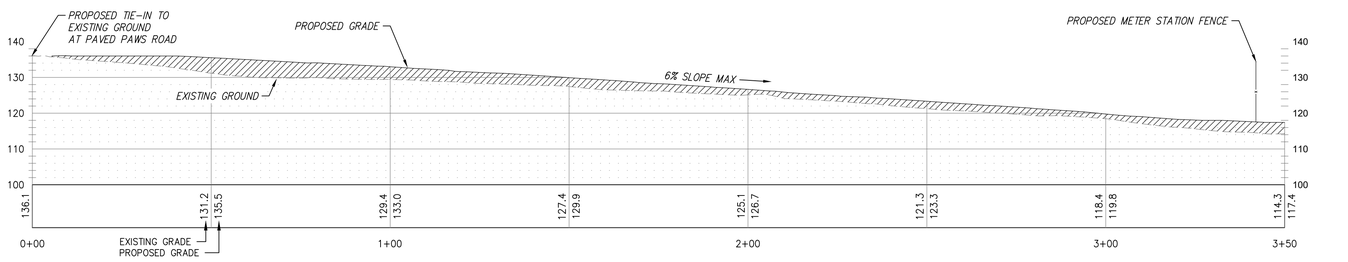
S:\AE\Projects\Enbridge\Mass\026356-001\200_Civil_Structural\170_Drawings\Grading\Cape Sagamore\00845-C.301-0001.dwg – PLOT TIME: 6/24/2026 7:11 PM



REFER TO GRADING PLAN 00845-C.301-0001

ACCESS ROAD RAMP CROSS SECTIONS

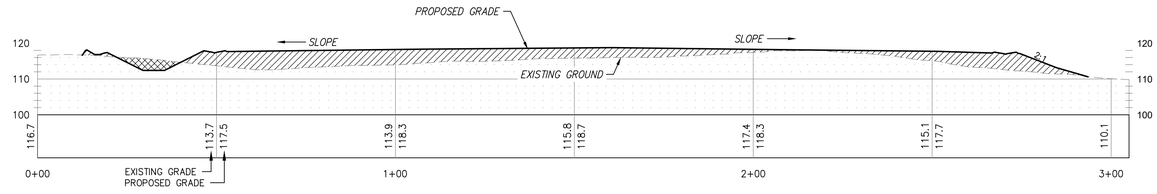
HORZ. & VERT. SCALE: 1" = 20'-0"



REFER TO GRADING PLAN 00845-C.301-0001

ACCESS ROAD RAMP C/L PROFILE

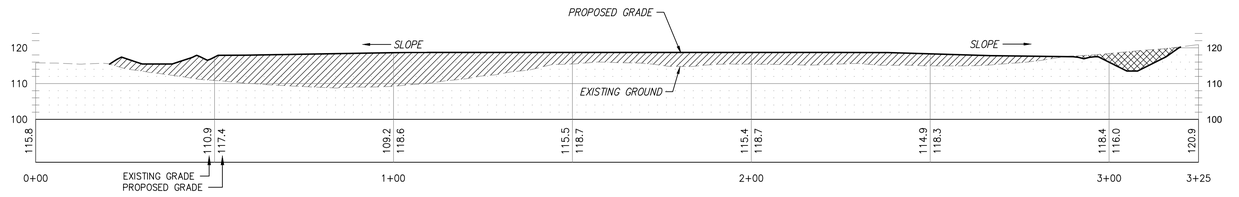
SCALE: 1" = 20'-0"



REFER TO GRADING PLAN 00845-C.301-0001

SECTION A

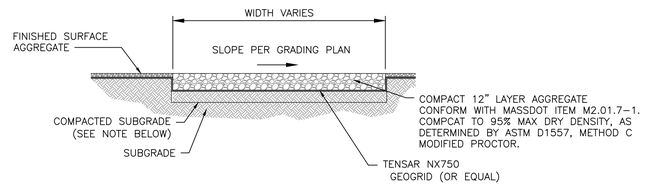
SCALE: 1" = 20'-0"



REFER TO GRADING PLAN 00845-C.301-0001

SECTION B

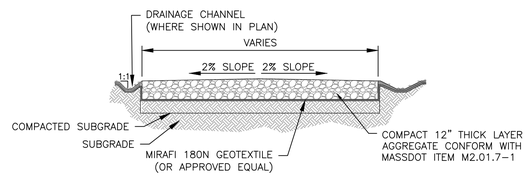
SCALE: 1" = 20'-0"



DETAIL B – TYPICAL AGGREGATE DRIVE AISLE

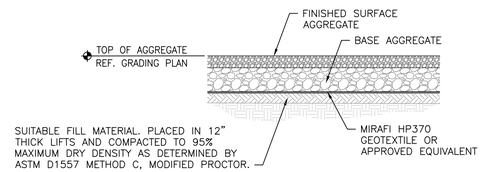
SCALE: NOT TO SCALE

NOTE: SITE PREPARATION SHALL CONFORM TO THE RECOMMENDATIONS OF THE GEOTECHNICAL REPORT REFERENCED.



DETAIL C – TYPICAL AGGREGATE ACCESS ROAD

SCALE: NOT TO SCALE



TYPICAL AGGREGATE YARD SURFACE SECTION

SCALE: NOT TO SCALE

SURVEY NOTES:

1. BACKGROUND INFORMATION IS BASED ON THE FOLLOWING:
   - 1.1. TOPOGRAPHIC SURVEY INFORMATION WAS PROVIDED BY ENBRIDGE.
   - 1.2. ALL COORDINATES AND DISTANCES SHOWN HEREON ARE REFERENCED TO THE MASSACHUSETTS STATE PLANE COORDINATE SYSTEM, US FEET. ELEVATIONS ARE REFERENCED TO NAVD 88.

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
No. 58957
PROFESSIONAL ENGINEER

07/08/26

ISSUED FOR PERMIT
06/24/26

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		E	06/24/26	JA	DT	ISSUED FOR PERMIT
		D	05/15/26	JA	DT	ISSUED FOR BID
		C	05/15/26	CR	DT	ISSUED FOR PERMIT
		B	02/17/26	CR	PB	ISSUED FOR REVIEW – 90% REVIEW
00845-C.301-0001	GRADING PLAN	A	05/09/25	CR	PB	ISSUED FOR REVIEW – 60% REVIEW

audubon Engineering
3505 W. SAM HOUSTON PKWY. N., SUITE 100
HOUSTON, TX 77043
PHONE: (281) 669-0590

TITLE	INITIALS	DATE
DRAWN BY:	JA	05/15/26
DESIGN CHECKER:	DT	06/24/26
DESIGN ENGINEER:	PB	06/24/26
PROJECT MANAGER:	AC	06/24/26

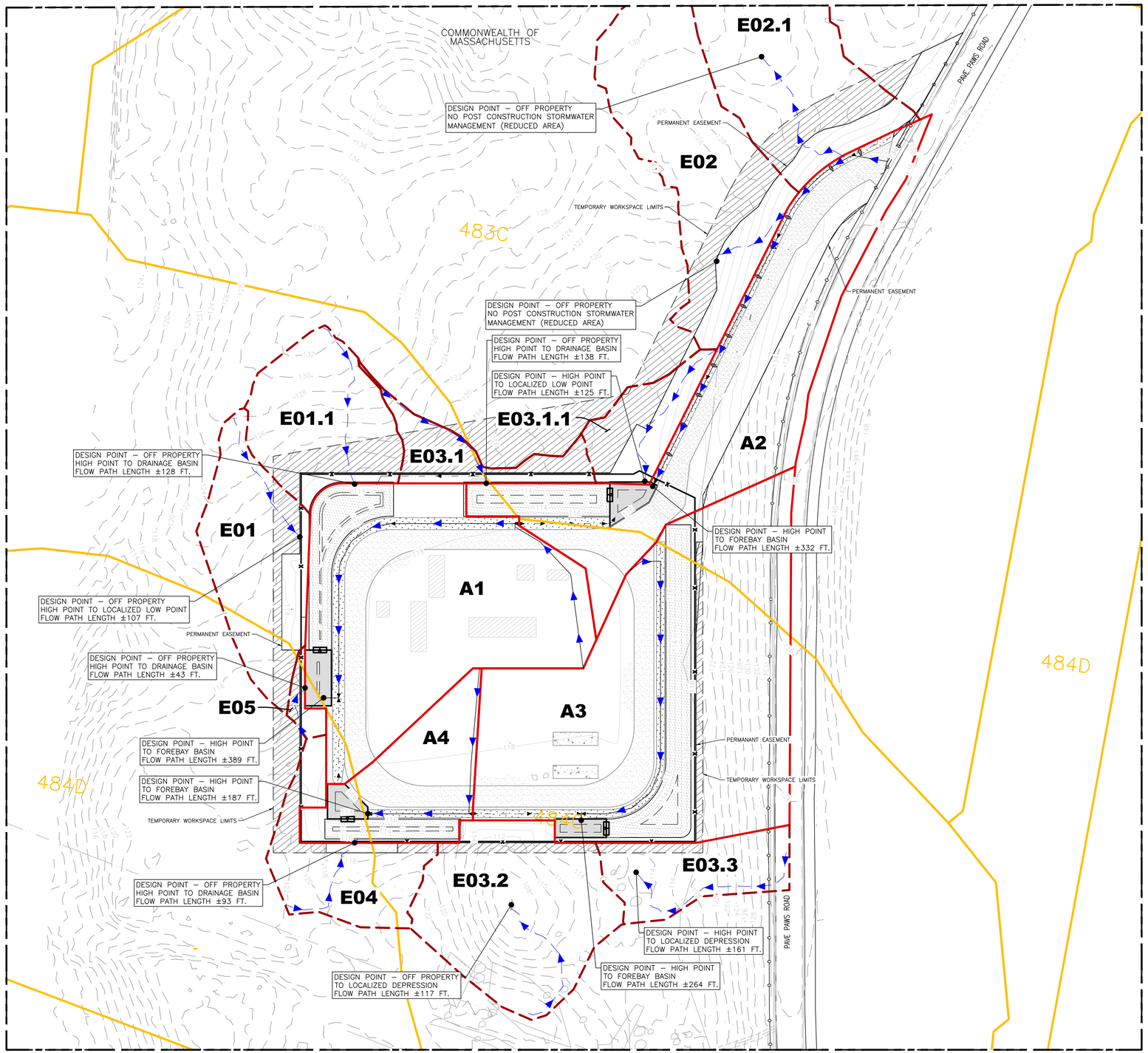
CAPE COD CANAL PIPELINE RELOCATION PROJECT
PAVE PAWS ROAD METER STATION
M&R 0845
TITLE: GRADING CROSS SECTIONS

LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

YEAR: 2026 | W.O.: | SCALE: AS NOTED | DWG.: 00845-C.301-0002 | REV.: E

ENBRIDGE
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

S:\AE\Projects\Enbridge\Mass\026356-001\200_Civil_Structural\170_Drawings\Grading\Cape Sagamore\00845-C.301-0002.dwg – PLOT TIME: 6/24/2026 12:09 PM



PAVE PAWS ROAD METER STATION

PROPOSED SUBCATCHMENT AREAS PLAN

SCALE: 1" = 40'

N

6.757°

STATION NORTH

0 40' 80'

Scale: 1" = 40'

NOTES:

1. ALL CONTOUR LABELS AND ELEVATION CALLOUTS ARE IN FEET.
2. PROPOSED SITE BOUNDARY WAS PROVIDED BY ALGONQUIN 3RD PARTY CONSULTANT.
3. SUPPLEMENTAL TAX PARCEL DATA IS SHOWN FOR REFERENCE ONLY AND WAS OBTAINED FROM THE CAPE COD COMMISSION OPEN GIS DATA HUB WEBSITE. PROJECT AREA IS WITHIN THE COMMONWEALTH OF MASSACHUSETTS PROPERTY.
4. PROPERTY CONVEYED TO ALGONQUIN GAS TRANSMISSION, LLC.
5. TOPOGRAPHIC SURVEY INFORMATION WAS PROVIDED BY ALGONQUIN GAS TRANSMISSION, LLC. ALL COORDINATES AND DISTANCES SHOWN HEREON ARE REFERENCED TO THE MASSACHUSETTS STATE PLANE COORDINATE SYSTEM, US FEET. ELEVATIONS ARE REFERENCED TO NAVD 88.
6. ADDITIONAL CONTOUR DATA SHOWN IS BASED ON THE TOPOGRAPHIC SURVEY REFERENCED ABOVE. ADDITIONAL CONTOUR DATA WAS OBTAINED FROM 2022 USGS LIDAR POINT CLOUD DATA SETS.
7. THIS PROPERTY IS LOCATED IN ZONE X (AREA OF MINIMAL FLOOD HAZARD) AS DEPICTED ON FLOOD INSURANCE RATE MAP 25001C0318K DATED JULY 6, 2021.
8. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT NATURAL RESOURCE STUDY THE SITE IS WITHIN THE NATURAL HERITAGE AND ENDANGERED SPECIES PROGRAM (NHESP), PRIORITY HABITATS OF RARE WILDLIFE, OR THE NHESP ESTIMATED HABITATS OF RARE WILDLIFE.
9. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THE SITE THERE IS NOT A WETLAND WITHIN 100 FEET OF THE PROJECT LIMITS.
10. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THE SITE IS NOT LOCATED WITHIN AN AREA OF CRITICAL ENVIRONMENTAL CONCERN.
11. THIS PLAN SET IS PRELIMINARY. FOR PERMITTING PURPOSES ONLY. PROPOSED GRADING MAY BE FURTHER OPTIMIZED TO ENSURE PROPER SHEET FLOW AROUND ASSUMED BUILDING LOCATIONS, FOUNDATIONS, AND MECHANICAL EQUIPMENT. THIS PLAN IS NOT INTENDED FOR CONSTRUCTION PURPOSES.
12. REFER TO THE "EROSION & SEDIMENT GENERAL NOTES" (DWG. 00845-C.020-0001) FOR SOIL TYPES INFORMATION.

LEGEND

- PROPOSED ACCESS ROAD
- PROPOSED CONCRETE
- PROPOSED STRUCTURE
- PROPOSED ROCK (FACILITY)
- PROPOSED VEGETATED
- PROPOSED INFILTRATION BASIN
- PROPOSED SEDIMENT FOREBAY
- PROPOSED ROCK
- PROPOSED DRAINAGE AREAS
- EXISTING DRAINAGE AREAS
- PROPOSED FENCE
- PERMANENT EASEMENT LINE
- GIS TAX PARCELS
- NRCS SOIL BOUNDARY
- WORKSPACE LIMITS
- PROPOSED GRADE LIMITS
- EDGE OF ROAD
- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- TIME OF CONCENTRATION LINE
- PROPOSED SWALE FLOW LLINE

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
No. 58957
PROFESSIONAL ENGINEER

07/08/26

ISSUED FOR PERMIT
06/24/2026

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		C	06/24/26	JA	DT	ISSUED FOR PERMIT
		B	05/15/26	JA	DT	ISSUED FOR BID
		A	05/15/26	JA	DT	ISSUED FOR PERMIT

audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

DRAWN BY:	JA	05/15/26	CAPE COD CANAL PIPELINE RELOCATION PROJECT
DESIGN CHECKER:	DT	06/24/26	PAVE PAWS ROAD METER STATION
DESIGN ENGINEER:	PB	06/24/26	M&R 00845
PROJECT MANAGER:	AC	06/24/26	TITLE: PROPOSED SUBCATCHMENT AREAS PLAN
TITLE	INITIALS	DATE	LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

YEAR: 2026 | W.O.: | SCALE: 1"=40' | DWG.: 00845-C.320-0005 | REV.: C

ENBRIDGE
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

S:\AE\Projects\Enbridge\Mass\026356-001\200_Civil_Structural\170_Drawings\E&S Plans\Pave Paws Road M&R\00845-C.320-0005.dwg — PLOT TIME: 6/24/2026 6:25 PM

Attachment B - Standard 1 Supporting Information

Vegetative Swales

Sediment Forebays

Infiltration Basin

Vegetative Filter Strips

Outlet Protection

Riprap

Grassed Channel



Description

Grassed Channels are treatment systems with a longer hydraulic residence time than drainage channels. The removal mechanisms are sedimentation and gravity separation, rather than filtration. To receive TSS credit, a sediment forebay or equivalent must be provided for pretreatment. Note that the sediment forebay does not receive a separate TSS removal credit.

Ability to Meet Massachusetts Stormwater Management Standards

Standard	Description
2 - Peak Flow	N/A
3 - Recharge	No infiltration credit
4 - TSS Removal	50% TSS with adequate pretreatment
5 - Higher Pollutant Loading	N/A
6 - Discharges near or to Critical Areas	Not suitable for vernal pools or bathing beaches. At other critical areas, may be used as a pretreatment device.
7 - Redevelopment	Typically not suited for retrofits.

Advantages/Benefits

- Provides pretreatment if used as the first part of a treatment train.
- Open drainage system aids maintenance
- Accepts sheet or pipe flow
- Compatible with LID design measures.
- Little or no entrapment hazard for amphibians or other small animals
- Disadvantages/Limitations
- Short retention time does not allow for full gravity separation
- Limited biofiltration provided by grass lining.
- Cannot alone achieve 80% TSS removal
- Must be designed carefully to achieve low flow rates for Water Quality Volume purposes (<1.0 fps)
- Mosquito control considerations
- Pollutant Removal Efficiencies
- Total Suspended Solids (TSS) 50%[1] for Regulatory Purposes (47%)[2]
- Total phosphorus (TP) -121%[2]
- Total Nitrogen Insufficient Data
- Metals (copper, lead, zinc, cadmium) insufficient Data
- Pathogens (coliform, e. coli) Insufficient Data

Maintenance

Activity	Frequency
Remove sediment from forebay	Annually
Remove sediment from grass channel	Annually
Mow	Once a month during growing season
Repair areas of erosion and revegetate	As needed, but no less than once a year

Special Features

Reduces volume and rate of runoff.

Maintenance

Access

Maintenance access must be designed as part of the grass channel. If located adjacent to a roadway, make the maintenance access at least 15 feet wide, which can also be combined with a breakdown lane along a highway or on- street parking along a residential street. When combined

with on-street parking, post signs prohibiting parking when the swale is to be inspected and cleaned. Do not use travel lanes along highways and streets as the required maintenance access.

Mowing

Set the mower blades no lower than 3 to 4 inches above the ground. Do not mow beneath the depth of the design flow during the storm associated with the water quality event (e.g., if the design flow is no more than 4 inches, do not cut the grass shorter than 4 inches). Mow on an as-needed basis during the growing season so that the grass height does not exceed 6 inches. Inspection: Inspect semi-annually the first year, and at least once a year thereafter. Inspect the grass for growth and the side slopes for signs of erosion and formation of rills and gullies. Plant an alternative grass species if the original grass cover is not successfully established. If grass growth is impaired by winter road salt or other deicer use, re-establish the grass in the spring. Trash/Debris Removal: Remove accumulated trash and debris prior to mowing.

Sediment Removal

Check on a yearly basis and clean as needed. Use hand methods (i.e., a person with a shovel) when cleaning to minimize disturbance to vegetation and underlying soils. Sediment build-up in the grass channel reduces its capacity to treat and convey the water quality event, 2-year and 10-year 24-hour storm.

Sediment Forebays



Description

A sediment forebay is a post-construction practice consisting of an excavated pit, bermed area, or cast structure combined with a weir, designed to slow incoming stormwater runoff and facilitating the gravity separation of suspended solids. This practice is different from a sediment trap used as a construction period BMP.

Ability to Meet Massachusetts Stormwater Management Standards

Standard	Description
2 - Peak Flow	Provides no peak flow attenuation
3 - Recharge	Provides no groundwater recharge
4 - TSS Removal	MassDEP requires a sediment forebay as pretreatment before stormwater is discharged to an extended dry detention basin, wet basin, constructed stormwater wetland or infiltration basin. No separate credit is given for the sediment forebay. For example, extended dry detention basins with sediment forebays receive a credit for 50% TSS removal. Wet basins and constructed stormwater wetlands with sediment forebays receive a credit for 80% TSS removal. When they provide pretreatment for other BMPs, sediment forebays receive a 25% TSS removal credit.
5 - Higher Pollutant Loading	Recommended as a pretreatment BMP
6 - Discharges near or to Critical Areas	Recommended as a pretreatment BMP
7 - Redevelopment	Usually not suitable due to land use constraints

Advantages/Benefits

- Provides pretreatment of runoff before delivery to other BMPs.
- Slows velocities of incoming stormwater.
- Easily accessed for sediment removal.
- Longevity is high with proper maintenance.
- Relatively inexpensive compared to other BMPs.
- Greater detention time than proprietary separators.
- Disadvantages/Limitations
- Removes only coarse sediment fractions.
- No removal of soluble pollutants.
- Provides no recharge to groundwater.
- No control of the volume of runoff.
- Frequent maintenance is essential.
- Pollutant Removal Efficiencies
- Total Suspended Solids (TSS) - 25%.
- Nutrients (Nitrogen, phosphorus) - Insufficient data.
- Metals (copper, lead, zinc, cadmium) - Insufficient data.
- Pathogens (coliform, e coli) - Insufficient data

Maintenance

Sediments and associated pollutants are removed only when sediment forebays are actually cleaned out, so regular maintenance is essential. Frequently removing accumulated sediments will make it less likely that sediments will be resuspended. At a minimum, inspect sediment forebays monthly and clean them out at least four times per year. Stabilize the floor and sidewalls of the sediment forebay before making it operational, otherwise the practice will discharge excess amounts of suspended sediments. When mowing grasses, keep the grass height no greater than 6 inches. Set mower blades no lower than 3 to 4 inches. Check for signs of rilling and gullying and repair as needed. After removing the sediment, replace any vegetation damaged during the clean-out by either reseeding or re-sodding. When reseeding, incorporate practices such as hydroseeding with a tackifier, blanket, or similar practice to ensure that no scour occurs in the forebay, while the seeds germinate and develop roots.

Activity	Frequency
Inspect sediment forebays	Monthly
Clean sediment forebays	Four times per year and when sediment depth is between 3 to 6 feet.

Infiltration-Recharge Basins

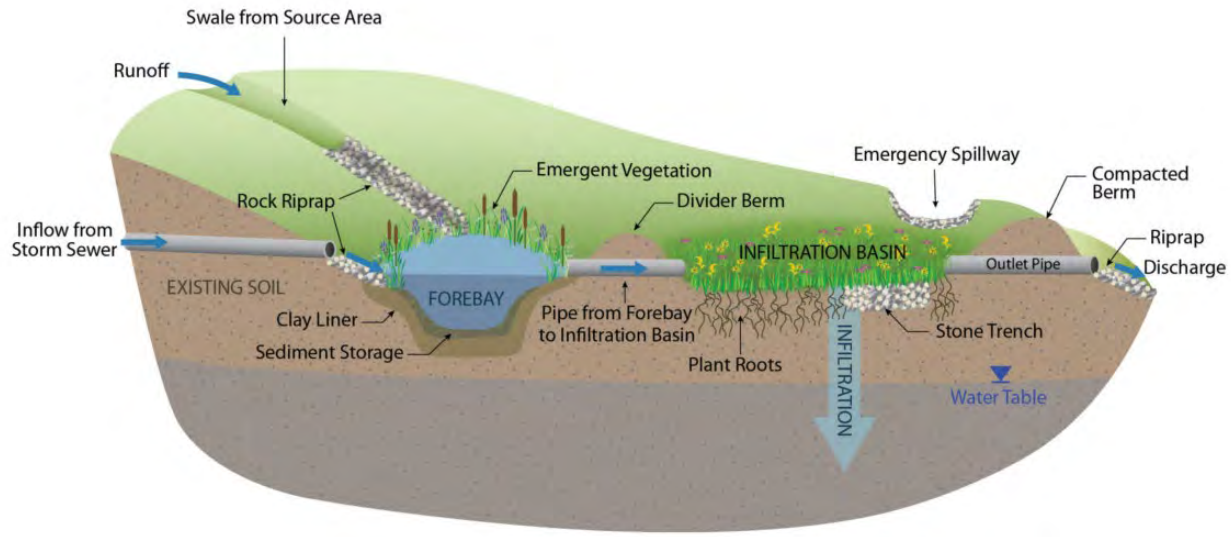


Illustration by Geosyntec Consultants, Inc.

Description

Recharge basins temporarily store runoff, but release at least a portion of that runoff by infiltrating the water into the ground. The recharge volume is stored and allowed to infiltrate into the underlying soils over a period of time following a storm event. The storage volume above this level may be released by an outlet structure designed to bypass all excess flows. Recharge Basins may be designed on-line or off-line. To maintain proper function of an infiltration-recharge basin, it is important to avoid soil compaction.

General Information		
Applicable DEP Stormwater Management Policy Performance Standards	Standards #3 and #4.	
TSS Removal	DEP Credit:	80% (for infiltration basin)
	Estimated Range from Literature:	>90%
Relative Cost	Construction: Moderate to high; varies depending on types soils of contributing drainage area, soils at site of system, storage depth, and type of outlet structure	

	Maintenance: Moderate to high
Potential Constraints to Use	Depth to groundwater Depth to bedrock or other impermeable stratum Suitability of site soils for infiltration
Other Considerations	Pre-treatment must be provided, to prevent clogging of soils surface by sediments in the influent storm water. Frequent maintenance may be required, to remove accumulated sediment and restore infiltrative capacity. Recharge systems can provide high levels of treatment of other pollutants, in addition to TSS removal.
Maintenance Requirements	Inspect a minimum of twice annually. Periodic mowing of embankments Removal of woody vegetation from embankments Removal of debris from outlet structures Clean forebay as required. Clean basin of accumulated sediment as required. Clean flow control structures at least once annually, or as indicated by inspection. Maintain vegetation in healthy condition.

Several of the design criteria regarding setbacks from slopes, foundations, and other site features have been adapted from the requirements for on-site sewage disposal systems described in Massachusetts Title 5 (310 CMR 15.000). However, storm water quantities and flow durations differ markedly from the hydraulic loadings to septic systems. The design engineer should be aware of these differences and may need to consider additional setbacks to provide for slope stability, protect structures, and provide for the satisfactory performance of the recharge system.

Vegetated Filter Strips



Description

Vegetated filter strips, also known as filter strips, grass buffer strips and grass filters, are uniformly graded vegetated surfaces (i.e., grass or close-growing native vegetation) that receive runoff from adjacent impervious areas. Vegetated filter strips typically treat sheet flow or small concentrated flows that can be distributed along the width of the strip using a level spreader. Vegetated filter strips are designed to slow runoff velocities, trap sediment, and promote infiltration, thereby reducing runoff volumes.

Design

Do not locate vegetated filter strips in soils with high clay content that have limited infiltration or in soils that cannot sustain grass cover.

The filter strip cannot extend more than 50 feet into a Buffer Zone to a wetland resource area.

The contributing drainage area to a vegetated filter strip is limited to one acre of less.

Design vegetated filter strips with slopes between 2 and 6 percent. Steeper slopes tend to create concentrated flows. Flatter slopes can cause ponding and create mosquito-breeding habitat.

Design the top and toe of the slope to be as flat as possible. Use a level spreader at the top of the slope to evenly distribute overland flows or concentrated runoff across the entire length of the filter strip. Many variations of level spreader designs may be used including level trenches, curbing and concrete weirs. The key to any level spreader design is creating a continuous overflow elevation along the entire width of the filter strip.

Velocity dissipation (e.g. by using riprap) may be required for concentrated flows.

Design the filter strip to drain within 24 hours after a storm. The design flow depth must not exceed 0.5 inches.

To receive TSS removal credit, make the filter strip at least 25 feet long and generally as wide as the area draining to the strip. To prevent high-velocity concentrated flows, the length of the flow path must be limited to 75 feet if the filter strip handles runoff from impervious surfaces, and 150

feet if the filter strip handles runoff from pervious surfaces. The minimum width of the filter strip must be 20% of the length of the flow path or 8 feet, whichever is greater.

To prevent groundwater contamination, the filter strip must be constructed at least 2 feet above seasonal high groundwater and 2 to 4 feet above bedrock.

The filter strip must be planted with grasses that are relatively salt-tolerant. Select grasses to withstand high flow velocities under wet weather conditions.

A vegetated filter strip may be used as a qualifying pervious area for purposes of the LID Site Design Credits for disconnecting rooftop and nonroof top runoff.

Construction

Proper grading is essential to establish sheet flow from the level spreader and throughout the filter strip.

Implement soil stabilization measures until permanent vegetation is established.

Protect the area to be used for the filter strip by using upstream sediment traps.

Use as much of the existing topsoil on the site as possible to enhance plant growth.

Maintenance

Regular maintenance is critical for filter strips to be effective and to ensure that flow does not short- circuit the system. Conduct semi-annual inspections during the first year (and annually thereafter). Inspect the level spreader for sediment buildup and the vegetation for signs of erosion, bare spots, and overall health. Regular, frequent mowing of the grass is required. Remove sediment from the toe of slope or level spreader, and reseed bare spots as necessary. Periodically, remove sediment that accumulates near the top of the strip to maintain the appropriate slope and prevent formation of a "berm" that could impede the distribution of runoff as sheet flow.

When the filter strip is located in the buffer zone to a wetland resource area, the operation and maintenance plan must include strict measures to ensure that maintenance operations do not alter the wetland resource areas. Please note, filter strips are restricted to the outer 50 feet of the buffer zone.

Cold Climate Considerations

In cold climates such as Massachusetts, the depth of soil media that serves as the planting bed must extend below the frost line to minimize the effects of freezing. Avoid using peat and compost media, which retain water and freeze during the winter, and become impermeable and ineffective

Outlet Protection and Stabilization



Definition

A structure designed to control erosion at the outlet of a channel or conduit by reducing the velocity of flow and dissipating the energy.

Outlet protection should be installed at all pipe, culverts, swales, diversions, or other water conveyances where the velocity of flow may cause erosion at the pipe outlet and in the receiving channel. Outlet protection should be installed early during construction activities, but may be added at any time, as necessary.

Installation

Excavate subgrade below design elevation to allow for thickness of filter and riprap. Install riprap to minimum thickness of 1.5 times maximum stone diameter. Final structure should be to lines and elevations shown in plans.

Construct apron on zero grade. If there is no well-defined channel, cross section may be level or slightly depressed in the middle. In a well-defined channel, extend riprap and filter to the top of the bank or as shown on plans. Blend riprap smoothly to the surrounding land.

Apron should be straight and properly aligned with the receiving stream. If a curve is necessary to fit site conditions, curve the apron near the upstream end.

Compact any fill used in the subgrade to the density of the surrounding undisturbed material.

Subgrade should be smooth enough to protect fabric from tearing.

Install a continuous section of extra-strength filter fabric on smooth, compacted foundation.

Protect filter fabric from tearing while placing riprap with machinery. Repair any damage immediately by removing riprap and installing another section of filter fabric. Upstream section of fabric should overlap downstream section a minimum of one foot.

Make sure top of riprap apron is level with receiving stream or slightly below it. Riprap should not restrict the channel or produce an overfall.

Immediately following installation, stabilize all disturbed areas with vegetation as shown in plans.

Maintenance

Inspect riprap outlet structures after heavy rains for erosion at sides and ends of apron and for stone displacement.

Rock may need to be added if sediment builds up in the pore spaces of the outlet pad.

Make repairs immediately using appropriate stone sizes. Do not place stones above finished grade

Riprap



A permanent, erosion-resistant ground cover of large, loose, angular stone to protect slopes, streambanks, channels, or areas subject to erosion by wave action.

Rock riprap protects soil from erosion due to concentrated runoff. It is used to stabilize slopes that are unstable due to seepage. It is also used to slow the velocity of concentrated runoff which in turn increases the potential for infiltration.

Where Practice Applies

Cut or fill slopes subject to seepage or weathering, particularly where conditions prohibit establishment of vegetation.

Channel side slopes and bottom.

Inlets and outlets for culverts, bridges, slope drains, grade stabilization structures, and storm drains; where the velocity of flow from these structures exceeds the capacity of the downstream area to resist erosion.

Planning Considerations

Well-graded riprap forms a dense, flexible, self-healing cover that will adapt well to uneven surfaces. Care must be exercised in the design so that stones are of good quality, sized correctly, and placed to proper thickness.

Riprap should be placed on a proper filter material of sand, gravel, or fabric to prevent soil from "piping" through the stone.

Rock riprap is used where erosion potential is often high. The rock should be placed as soon as possible after disturbing the site, before additional water is concentrated into the drainage system. Properly sized bedding or geotextile fabric is needed to prevent erosion or undermining of the natural underlying material.

Riprap is classified as either graded or uniform. Graded riprap contains a mixture of stones which vary in size. A sample of uniform riprap would contain stones which are all fairly close in size. For most applications, graded riprap is preferred to uniform riprap. Graded riprap forms a flexible self-healing cover, while uniform riprap is more rigid and cannot withstand movement of the stones. Graded riprap is cheaper to install, requiring only that the stones be dumped so that they remain in a well-graded mass.

Hand or mechanical placement of individual stones is limited to that necessary to achieve the proper thickness and line. Uniform riprap requires placement in a more or less uniform pattern, requiring more hand or mechanical labor.

Design Recommendations

As graded riprap consists of a variety of stone sizes, a method is needed to specify the size range of the mixture of stone. This is done by specifying a diameter of stone in mixture for which some percentage, by weight, will be smaller. For example, d 85 refers to a mixture of stones in which 85 percent of the stone by weight would be smaller than the diameter specified. Most designs are based on "d." The design, therefore, is based on the median size of stone in the mixture. A well graded mixture of rock sizes should be used for riprap rather than rocks of a uniform size. Rock riprap sizes are specified by either weight or diameter. Stone should be hard, angular, weather-resistant; specific gravity at least 2.5.

Stone Placement

Place riprap immediately after installing filter.

Install riprap to full thickness in one operation. Do not dump through chutes or use any method that causes segregation of stone sizes. Avoid dislodging or damaging underlying filter material when placing stone.

If fabric is damaged, remove riprap and repair fabric by adding another layer, overlapping the damaged area by 12 inches.

Place smaller stones in voids to form a dense, uniform, well-graded mass. Selective loading at the quarry and some hand placement may be necessary to obtain an even distribution of stone sizes.

Blend the stone surface smoothly with the surrounding area, allowing no protrusions or overfall.

Since riprap is used where erosion potential is high, construction must be sequenced so that the riprap is put in place with the minimum possible delay. Disturbance of areas where riprap is to be placed should be undertaken only when final preparation and placement of the riprap can follow immediately behind the initial disturbance.

Where riprap is used for outlet protection, the riprap should be placed before or in conjunction with the construction of the pipe or channel so that it is in place when the pipe or channel begins to operate.

Maintenance

Riprap should be checked at least annually and after every major storm for displaced stones, slumping, and erosion at edges, especially downstream or downslope. If the riprap has been damaged, it should be repaired immediately before further damage can take place.

Woody vegetation should be removed from the rock riprap annually because tree roots will eventually dislodge the riprap.

If the riprap is on a channel bank, the stream should be kept clear of obstructions such as fallen trees, debris, and sediment bars that may change flow patterns, which could damage or displace the riprap.

Attachment C - Standard 2 Supporting Information

NOAA Altas Rainfall Data

SSA Analysis: Existing and Proposed Conditions – Drainage Area A1

SSA Analysis: Existing and Proposed Conditions – Drainage Area A2

SSA Analysis: Existing and Proposed Conditions – Drainage Area A3

SSA Analysis: Existing and Proposed Conditions – Drainage Area A4

NOAA ATLAS RAINFALL DATA

NOAA Atlas 14, Volume 10, Version 3
Location name: Gilbertville, Massachusetts, USA*
Latitude: 42.3621°, Longitude: -72.1625°
Elevation: 636 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sandra Pavlovic, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Orlan Wilhite

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.338 (0.265-0.430)	0.393 (0.308-0.501)	0.483 (0.377-0.617)	0.558 (0.434-0.717)	0.662 (0.496-0.883)	0.742 (0.543-1.01)	0.822 (0.581-1.15)	0.906 (0.612-1.31)	1.02 (0.661-1.52)	1.10 (0.699-1.69)
10-min	0.479 (0.376-0.609)	0.557 (0.437-0.710)	0.685 (0.535-0.876)	0.791 (0.615-1.02)	0.938 (0.703-1.25)	1.05 (0.770-1.43)	1.16 (0.824-1.63)	1.28 (0.866-1.85)	1.44 (0.937-2.16)	1.56 (0.990-2.39)
15-min	0.563 (0.442-0.716)	0.655 (0.514-0.835)	0.806 (0.630-1.03)	0.931 (0.722-1.20)	1.10 (0.827-1.47)	1.24 (0.905-1.68)	1.37 (0.969-1.92)	1.51 (1.02-2.18)	1.70 (1.10-2.54)	1.84 (1.16-2.81)
30-min	0.761 (0.597-0.968)	0.886 (0.695-1.13)	1.09 (0.851-1.39)	1.26 (0.980-1.62)	1.50 (1.12-2.00)	1.68 (1.23-2.28)	1.86 (1.31-2.60)	2.04 (1.38-2.96)	2.30 (1.49-3.44)	2.50 (1.58-3.81)
60-min	0.959 (0.752-1.22)	1.12 (0.876-1.42)	1.38 (1.08-1.76)	1.59 (1.24-2.04)	1.89 (1.42-2.52)	2.12 (1.55-2.88)	2.34 (1.66-3.29)	2.58 (1.75-3.74)	2.90 (1.88-4.34)	3.15 (1.99-4.81)
2-hr	1.21 (0.956-1.53)	1.42 (1.12-1.79)	1.75 (1.38-2.22)	2.03 (1.58-2.59)	2.41 (1.82-3.22)	2.69 (2.00-3.68)	3.00 (2.16-4.26)	3.36 (2.28-4.84)	3.91 (2.54-5.82)	4.38 (2.78-6.64)
3-hr	1.38 (1.09-1.74)	1.62 (1.28-2.04)	2.02 (1.59-2.55)	2.34 (1.84-2.98)	2.80 (2.13-3.73)	3.13 (2.34-4.27)	3.49 (2.54-4.98)	3.95 (2.68-5.67)	4.67 (3.04-6.92)	5.29 (3.36-8.00)
6-hr	1.70 (1.36-2.13)	2.03 (1.62-2.55)	2.57 (2.04-3.23)	3.02 (2.38-3.82)	3.64 (2.79-4.84)	4.09 (3.08-5.57)	4.59 (3.38-6.55)	5.24 (3.57-7.48)	6.29 (4.11-9.28)	7.23 (4.61-10.9)
12-hr	2.07 (1.66-2.58)	2.52 (2.02-3.14)	3.26 (2.61-4.07)	3.88 (3.08-4.86)	4.72 (3.64-6.24)	5.34 (4.04-7.23)	6.02 (4.45-8.53)	6.90 (4.72-9.79)	8.32 (5.45-12.2)	9.57 (6.12-14.3)
24-hr	2.45 (1.98-3.02)	3.02 (2.44-3.73)	3.96 (3.19-4.91)	4.75 (3.79-5.91)	5.82 (4.51-7.64)	6.61 (5.03-8.89)	7.48 (5.55-10.5)	8.59 (5.89-12.1)	10.4 (6.81-15.1)	11.9 (7.65-17.7)
2-day	2.81 (2.28-3.44)	3.48 (2.83-4.28)	4.60 (3.72-5.66)	5.52 (4.44-6.82)	6.78 (5.29-8.84)	7.71 (5.90-10.3)	8.74 (6.52-12.2)	10.0 (6.92-14.1)	12.1 (8.01-17.5)	14.0 (9.00-20.6)
3-day	3.06 (2.50-3.74)	3.80 (3.10-4.64)	5.01 (4.07-6.14)	6.01 (4.85-7.40)	7.38 (5.78-9.59)	8.39 (6.44-11.2)	9.51 (7.11-13.2)	10.9 (7.55-15.2)	13.2 (8.74-19.0)	15.2 (9.82-22.3)
4-day	3.30 (2.70-4.01)	4.08 (3.34-4.97)	5.36 (4.36-6.55)	6.42 (5.19-7.89)	7.88 (6.18-10.2)	8.94 (6.88-11.9)	10.1 (7.59-14.1)	11.6 (8.04-16.2)	14.1 (9.30-20.2)	16.2 (10.4-23.6)
7-day	3.97 (3.27-4.80)	4.83 (3.98-5.86)	6.25 (5.12-7.60)	7.43 (6.04-9.08)	9.05 (7.12-11.6)	10.2 (7.90-13.5)	11.5 (8.67-15.9)	13.2 (9.16-18.2)	15.8 (10.5-22.6)	18.1 (11.7-26.3)
10-day	4.63 (3.83-5.59)	5.54 (4.57-6.69)	7.04 (5.78-8.52)	8.27 (6.76-10.1)	9.98 (7.87-12.8)	11.2 (8.67-14.7)	12.6 (9.45-17.2)	14.3 (9.95-19.7)	16.9 (11.3-24.1)	19.2 (12.5-27.8)
20-day	6.67 (5.55-7.99)	7.64 (6.34-9.16)	9.22 (7.62-11.1)	10.5 (8.65-12.7)	12.3 (9.75-15.5)	13.7 (10.6-17.6)	15.1 (11.2-20.1)	16.7 (11.7-22.8)	19.1 (12.8-26.9)	21.0 (13.6-30.2)
30-day	8.38 (7.00-10.0)	9.37 (7.82-11.2)	11.0 (9.13-13.2)	12.3 (10.2-14.9)	14.2 (11.2-17.7)	15.6 (12.0-19.9)	17.0 (12.6-22.4)	18.5 (13.0-25.1)	20.6 (13.8-28.9)	22.2 (14.5-31.8)
45-day	10.5 (8.81-12.5)	11.5 (9.66-13.7)	13.2 (11.0-15.8)	14.6 (12.1-17.5)	16.5 (13.1-20.5)	18.0 (13.9-22.7)	19.5 (14.4-25.3)	20.9 (14.7-28.1)	22.6 (15.3-31.6)	23.9 (15.6-34.1)
60-day	12.3 (10.3-14.5)	13.3 (11.2-15.8)	15.1 (12.6-17.9)	16.5 (13.7-19.8)	18.5 (14.7-22.8)	20.1 (15.5-25.2)	21.6 (15.9-27.8)	22.9 (16.2-30.8)	24.5 (16.6-34.1)	25.6 (16.7-36.4)

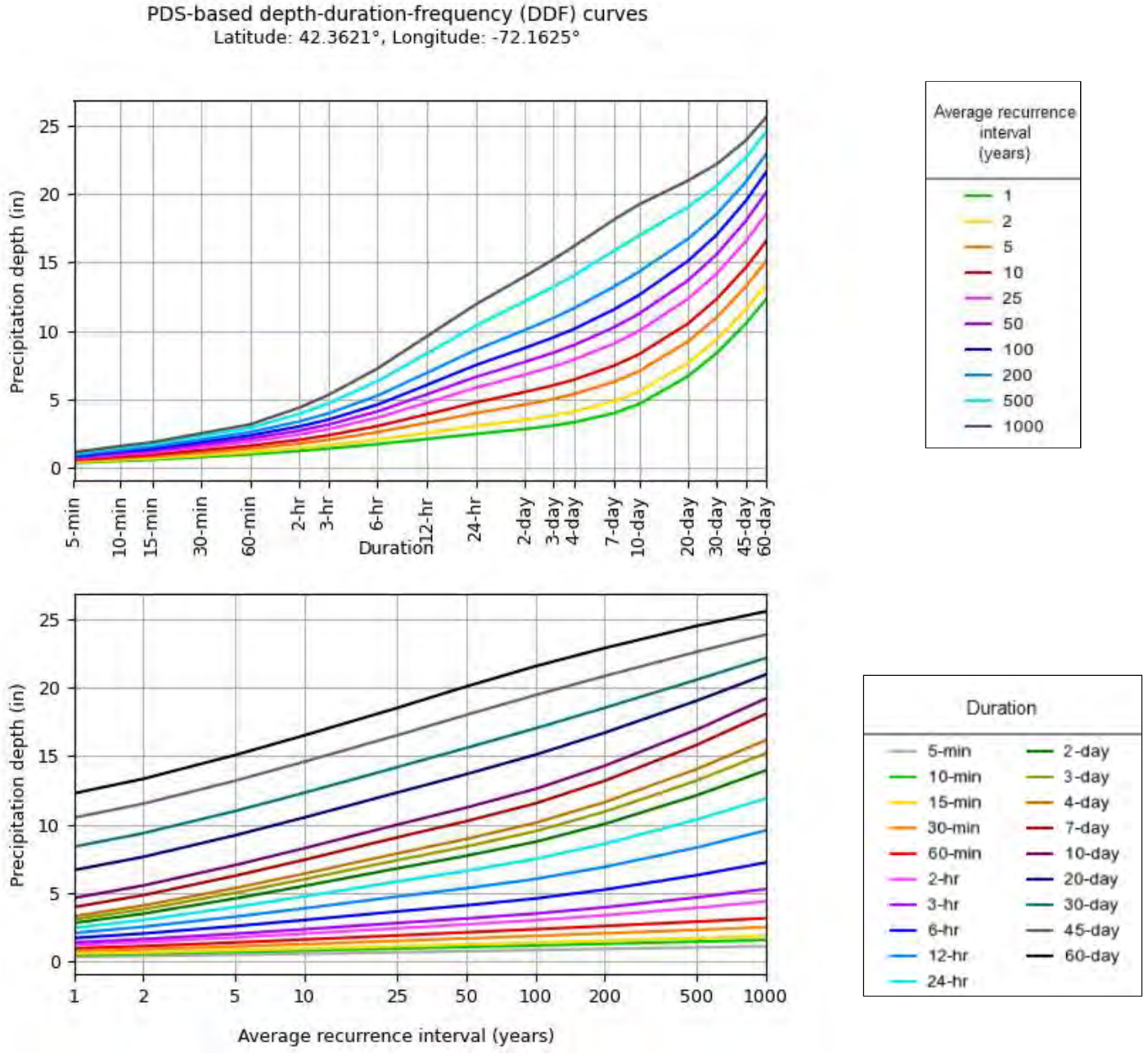
[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

Back to Top

PF graphical



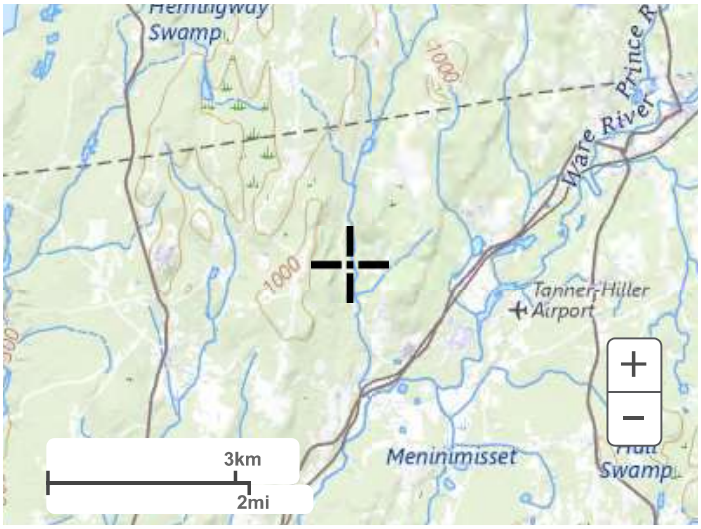
NOAA Atlas 14, Volume 10, Version 3

Created (GMT): Tue Apr 21 16:16:51 2026

Back to Top

Maps & aerials

Small scale terrain



Large scale terrain



Large scale map



Large scale aerial



Back to Top

US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer

SSA Analysis – Drainage Area A1 and A2– Existing and Proposed

Project Description

File Name ..... Pave.Paws_A1_A2.SPF

Project Options

Flow Units ..... CFS
Elevation Type ..... Elevation
Hydrology Method ..... SCS TR-20
Time of Concentration (TOC) Method ..... SCS TR-55
Link Routing Method ..... Hydrodynamic
Enable Overflow Ponding at Nodes ..... YES
Skip Steady State Analysis Time Periods .... NO

Analysis Options

Start Analysis On 00:00:00 0:00:00
End Analysis On 00:00:00 0:00:00
Start Reporting On 00:00:00 0:00:00
Antecedent Dry Days ..... 0 days
Runoff (Dry Weather) Time Step ..... 0 01:00:00 days hh:mm:ss
Runoff (Wet Weather) Time Step ..... 0 00:05:00 days hh:mm:ss
Reporting Time Step ..... 0 00:05:00 days hh:mm:ss
Routing Time Step ..... 30 seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	7
Nodes	7
Junctions	1
Outfalls	2
Flow Diversions	0
Inlets	0
Storage Nodes	4
Links	5
Channels	1
Pipes	0
Pumps	0
Orifices	0
Weirs	4
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	2 years	Intensity	inches	Massachusetts	None	2.00	3.02	SCS Type III 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Sub-A1	0.73	484.00	76.00	3.42	1.31	0.96	0.99	0 00:06:00
2	Sub-A2	0.69	484.00	76.00	3.42	1.31	0.90	0.92	0 00:06:00
3	Sub-E01	0.76	484.00	43.00	3.42	0.04	0.03	0.00	0 00:28:48
4	Sub-E01.1	0.25	484.00	43.00	3.42	0.02	0.01	0.00	0 00:17:56
5	Sub-E01_Ex	0.26	484.00	43.00	3.42	0.03	0.01	0.00	0 00:17:28
6	Sub-E03.1	0.10	484.00	43.00	3.42	0.00	0.00	0.00	0 00:21:30
7	Sub-E05.1	0.02	0.00	43.00	3.42	0.00	0.00	0.00	0 00:09:00

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	1-Jun	Junction	116.60	117.90	0.00	0.00	0.00	0.00	116.60	0.00	5.10	0 00:00	0.00	0.00
2	Out-E01	Outfall	116.00					0.00	116.00					
3	Out-Prop-A1	Outfall	116.00					0.00	116.00					
4	Basin-A1	Storage Node	112.40	117.70	112.40		0.00	0.58	114.43				0.00	0.00
5	Basin-A2	Storage Node	112.90	117.90	112.90		0.00	0.80	115.25				0.00	0.00
6	Forebay-A1	Storage Node	114.40	117.70	114.40		0.00	0.95	117.38				0.00	0.00
7	Forebay-A2	Storage Node	114.90	117.90	114.90		0.00	0.88	117.08				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length (ft)	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Average Slope (%)	Diameter or Height (ft)	Manning's Roughness	Peak Flow (cfs)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Reported Condition
1	Ditch-01	Channel	1-Jun	Basin-A1	81.45	116.60	116.36	0.2900	1.300	0.0250	0.00	11.76	0.00	0.00	0.00	0.00	0.00	
2	Weir-B-A1	Weir	Basin-A1	Out-Prop-A1		112.40	116.00				0.00							
3	Weir-B-A2	Weir	Basin-A2	1-Jun		112.90	116.60				0.00							
4	Weir-F-A1	Weir	Forebay-A1	Basin-A1		114.40	112.40				0.58							
5	Weir-F-A2	Weir	Forebay-A2	Basin-A2		114.90	112.90				0.80							

Subbasin Hydrology

Subbasin : Sub-A1

Input Data

Area (ac) 0.73
Peak Rate Factor 484
Weighted Curve Number 76
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	0.73	A	76
Composite Area & Weighted CN	0.73		76

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft^2)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	132.16	0	0
Slope (%) :	0.71	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.78	0	0
Computed Flow Time (min) :	2.84	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	257.27	0	0
Channel Slope (%) :	0.4	0	0
Cross Section Area (ft^2) :	2.067	0	0
Wetted Perimeter (ft) :	5.25	0	0
Velocity (ft/sec) :	1.69	0	0
Computed Flow Time (min) :	2.54	0	0

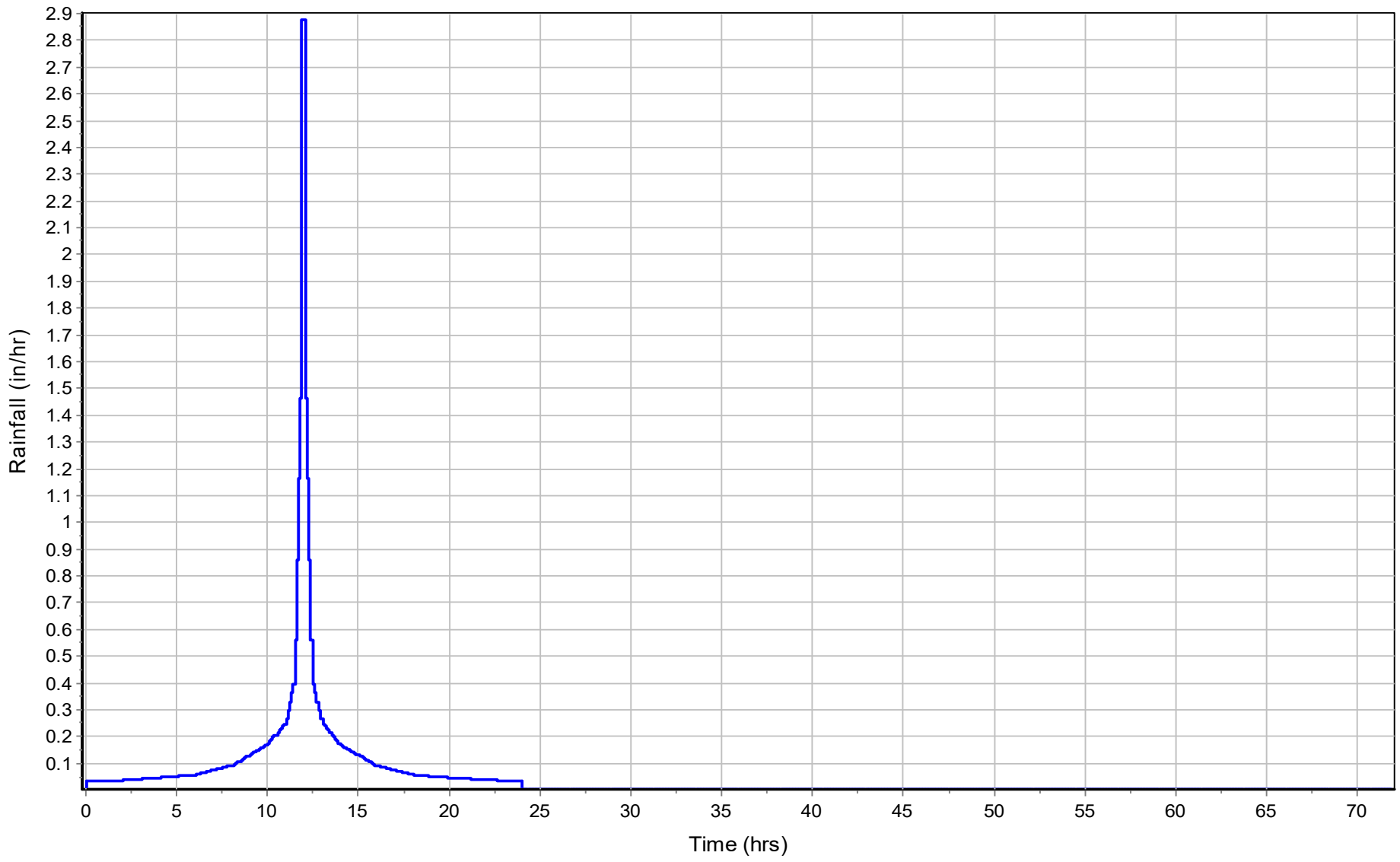
Total TOC (min) 5.38

Subbasin Runoff Results

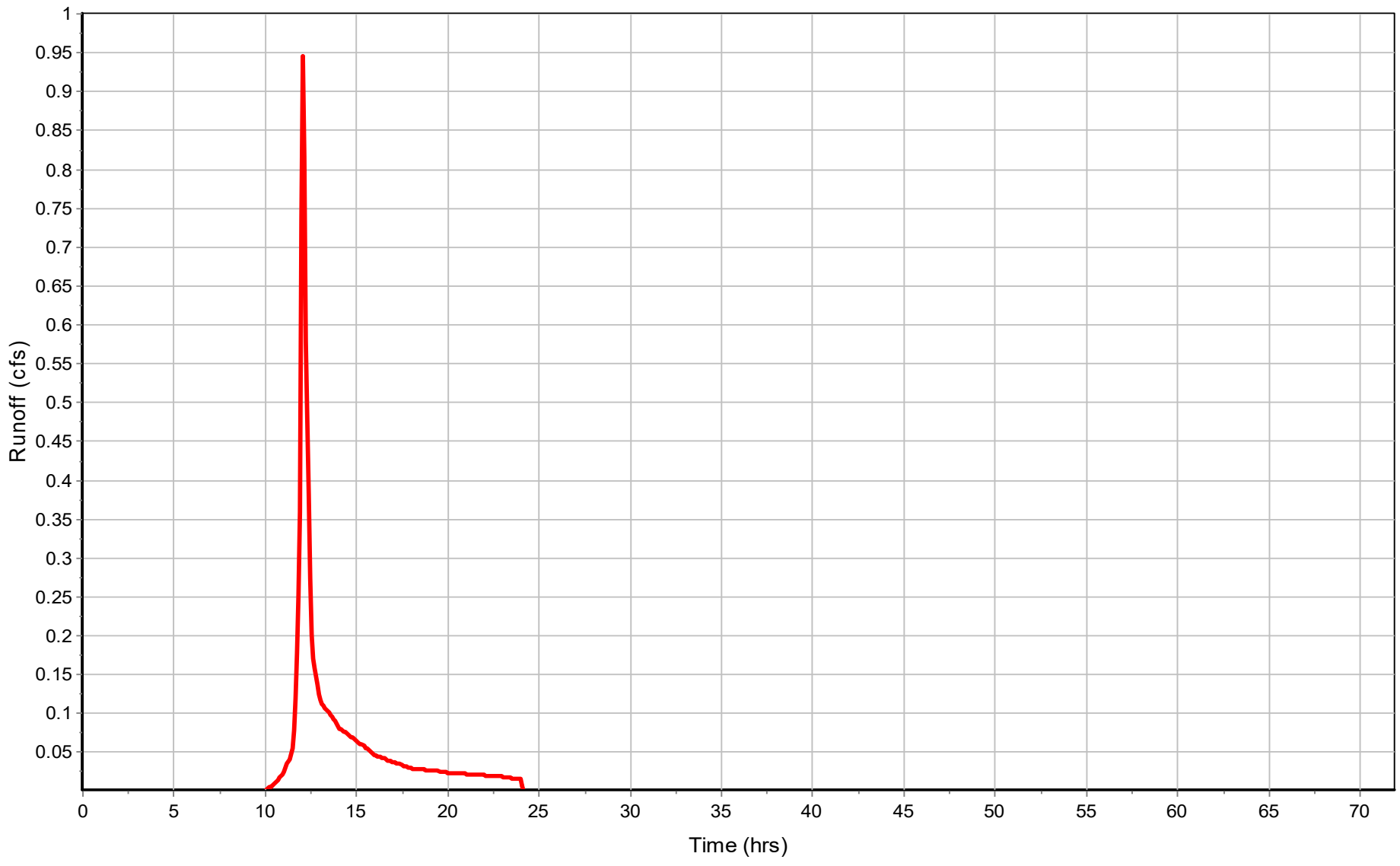
Total Rainfall (in)	3.02
Total Runoff (in)	1.31
Peak Runoff (cfs)	0.99
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:05:23

Subbasin : Sub-A1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-A2

Input Data

Area (ac) 0.69
Peak Rate Factor 484
Weighted Curve Number 76
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	0.69	A	76
Composite Area & Weighted CN	0.69		76

Time of Concentration

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	331.61	0	0
Channel Slope (%) :	5.4	0	0
Cross Section Area (ft^2) :	3	0	0
Wetted Perimeter (ft) :	6.32	0	0
Velocity (ft/sec) :	7.02	0	0
Computed Flow Time (min) :	0.79	0	0

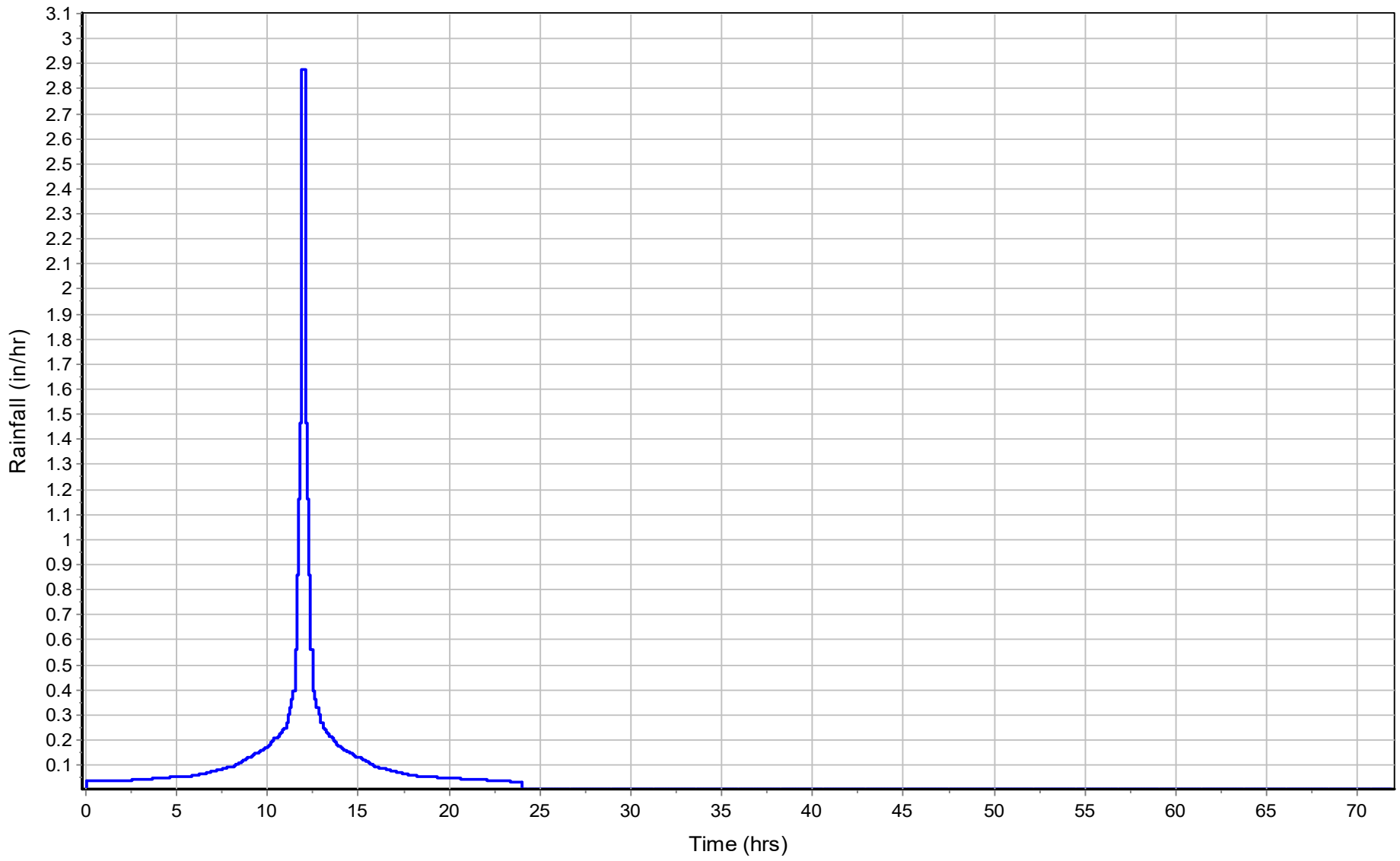
Total TOC (min) 0.79

Subbasin Runoff Results

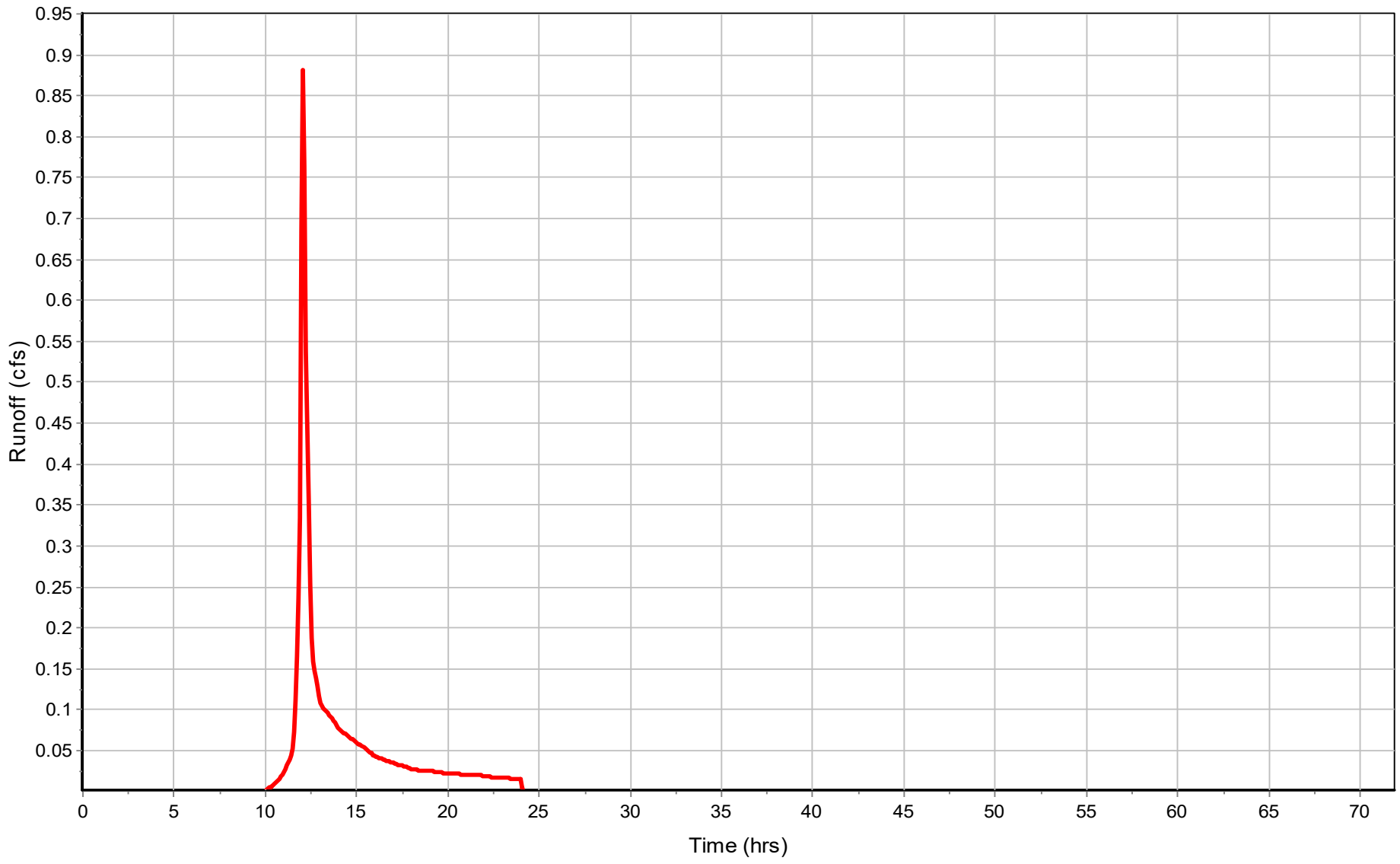
Total Rainfall (in) 3.02
Total Runoff (in) 1.31
Peak Runoff (cfs) 0.92
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:00:47

Subbasin : Sub-A2

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E01

Input Data

Area (ac) 0.76
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.76	A	43
Composite Area & Weighted CN	0.76		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	249.61	0	0
Slope (%) :	22	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.14	0	0
Computed Flow Time (min) :	28.81	0	0

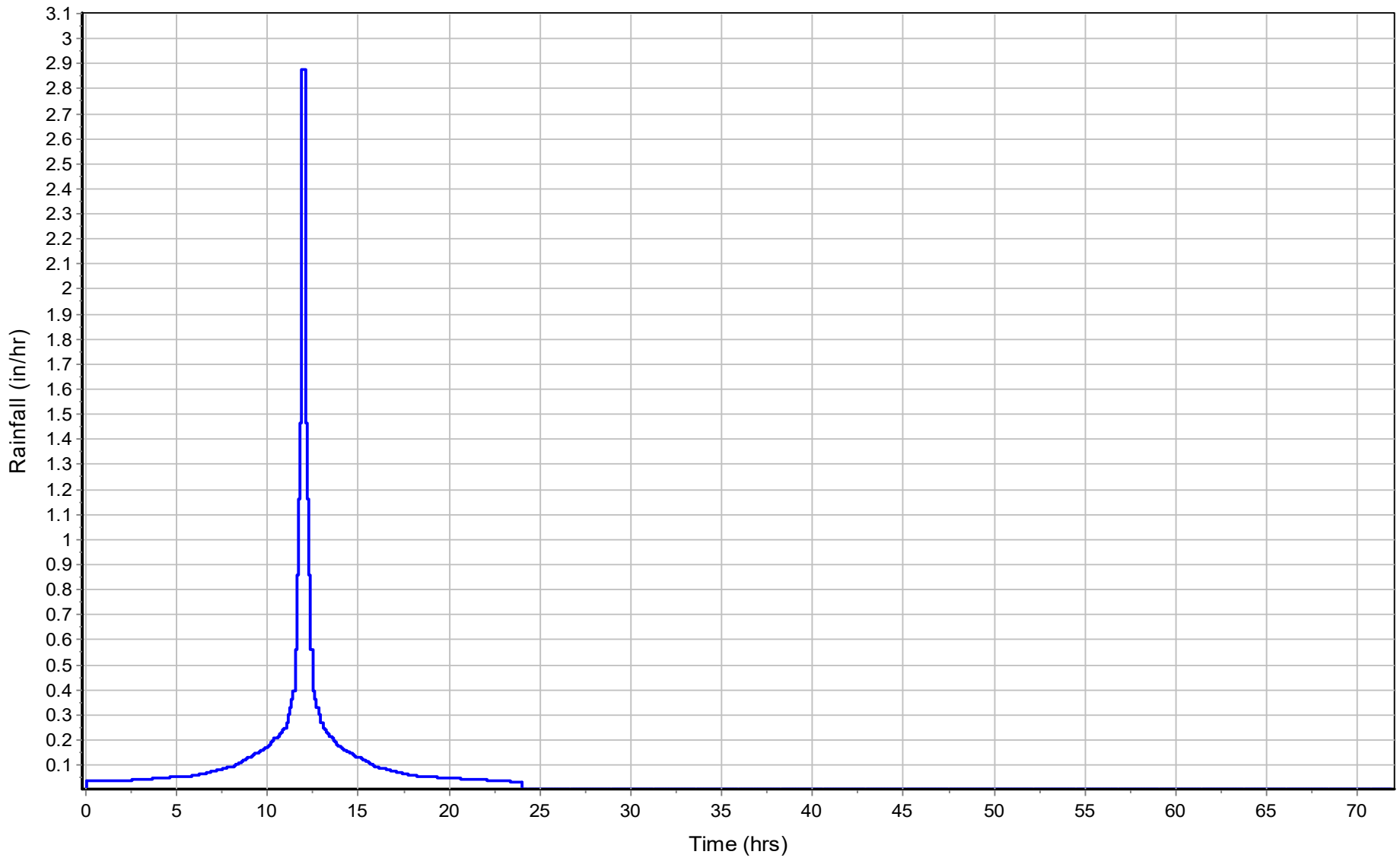
Total TOC (min) 28.81

Subbasin Runoff Results

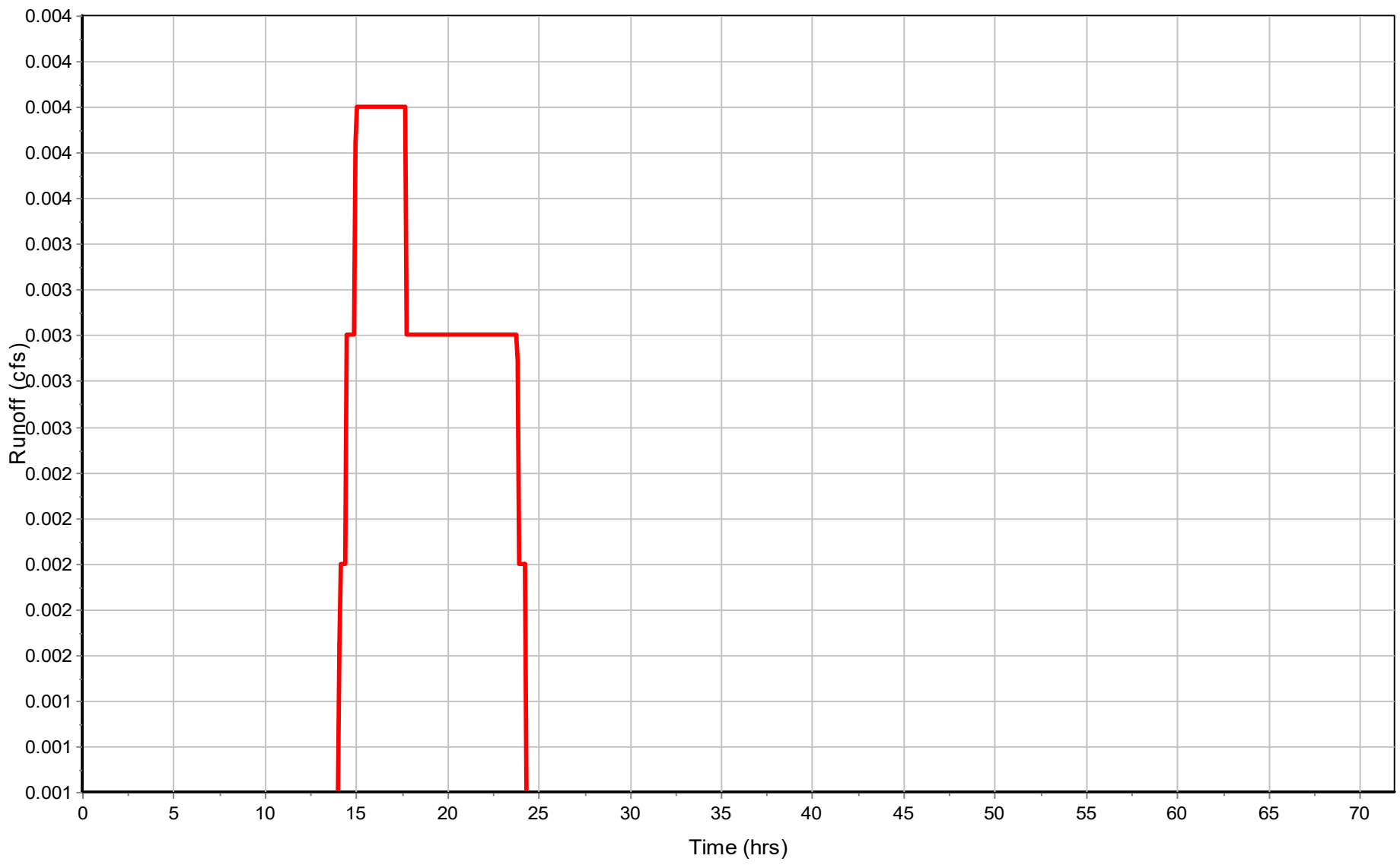
Total Rainfall (in) 3.02
Total Runoff (in) 0.04
Peak Runoff (cfs) 0
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:28:49

Subbasin : Sub-E01

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E01.1

Input Data

Area (ac) 0.25
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.25	A	43
Composite Area & Weighted CN	0.25		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	128.34	0	0
Slope (%) :	19	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.12	0	0
Computed Flow Time (min) :	17.94	0	0

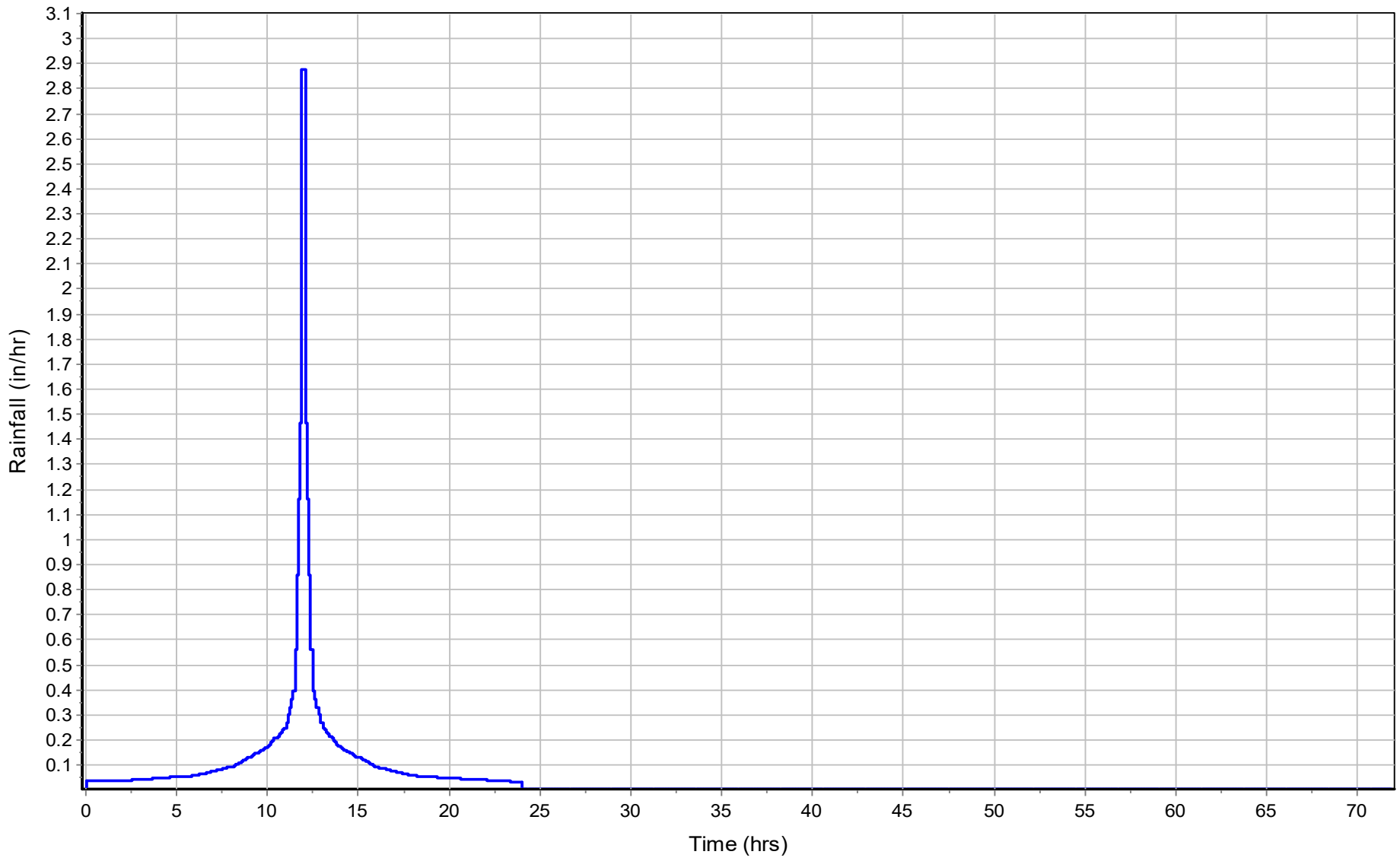
Total TOC (min) 17.94

Subbasin Runoff Results

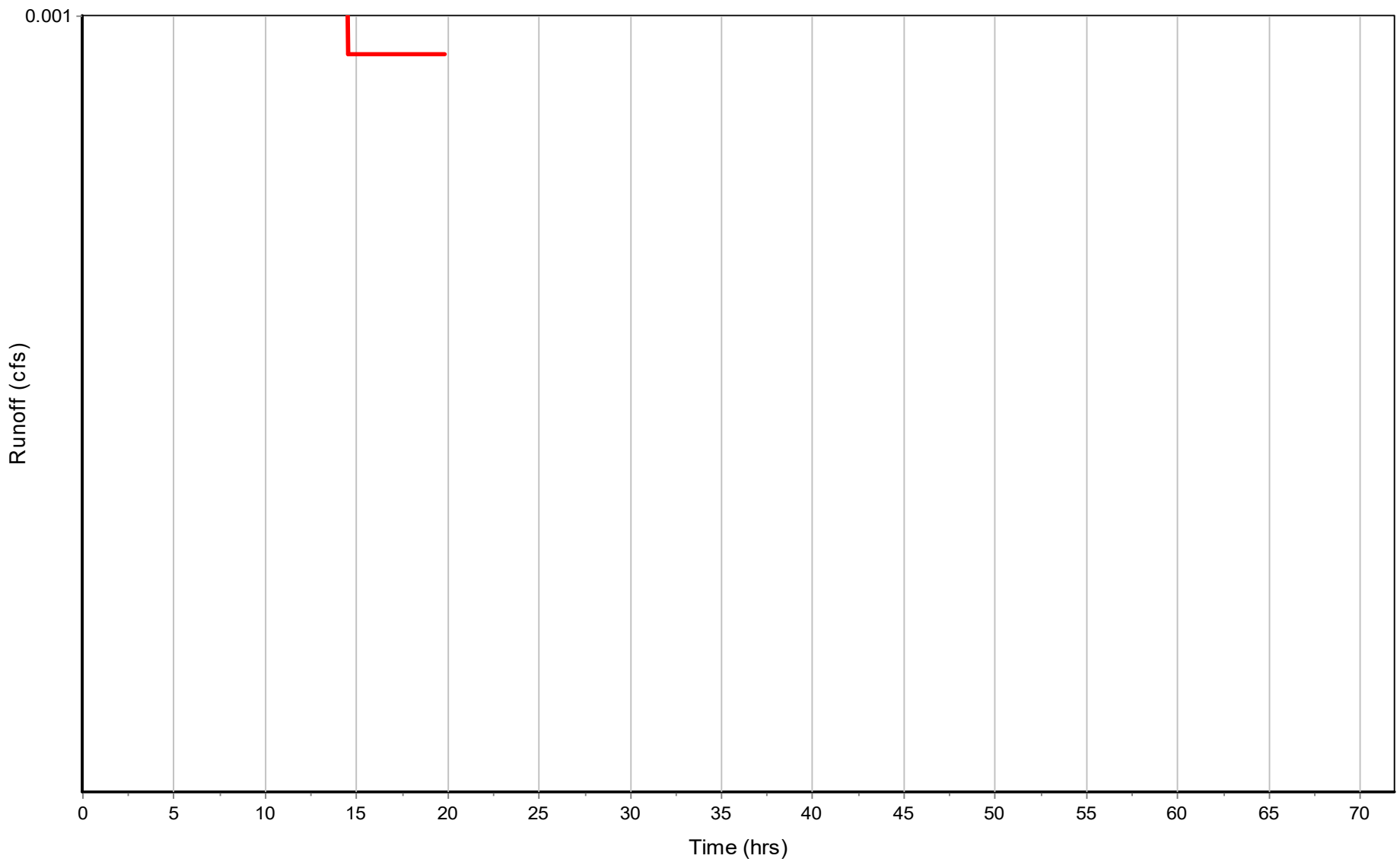
Total Rainfall (in) 3.02
Total Runoff (in) 0.02
Peak Runoff (cfs) 0
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:17:56

Subbasin : Sub-E01.1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E01_Ex

Input Data

Area (ac) 0.26
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.26	A	43
Composite Area & Weighted CN	0.26		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	106.59	0	0
Slope (%) :	14	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.1	0	0
Computed Flow Time (min) :	17.48	0	0

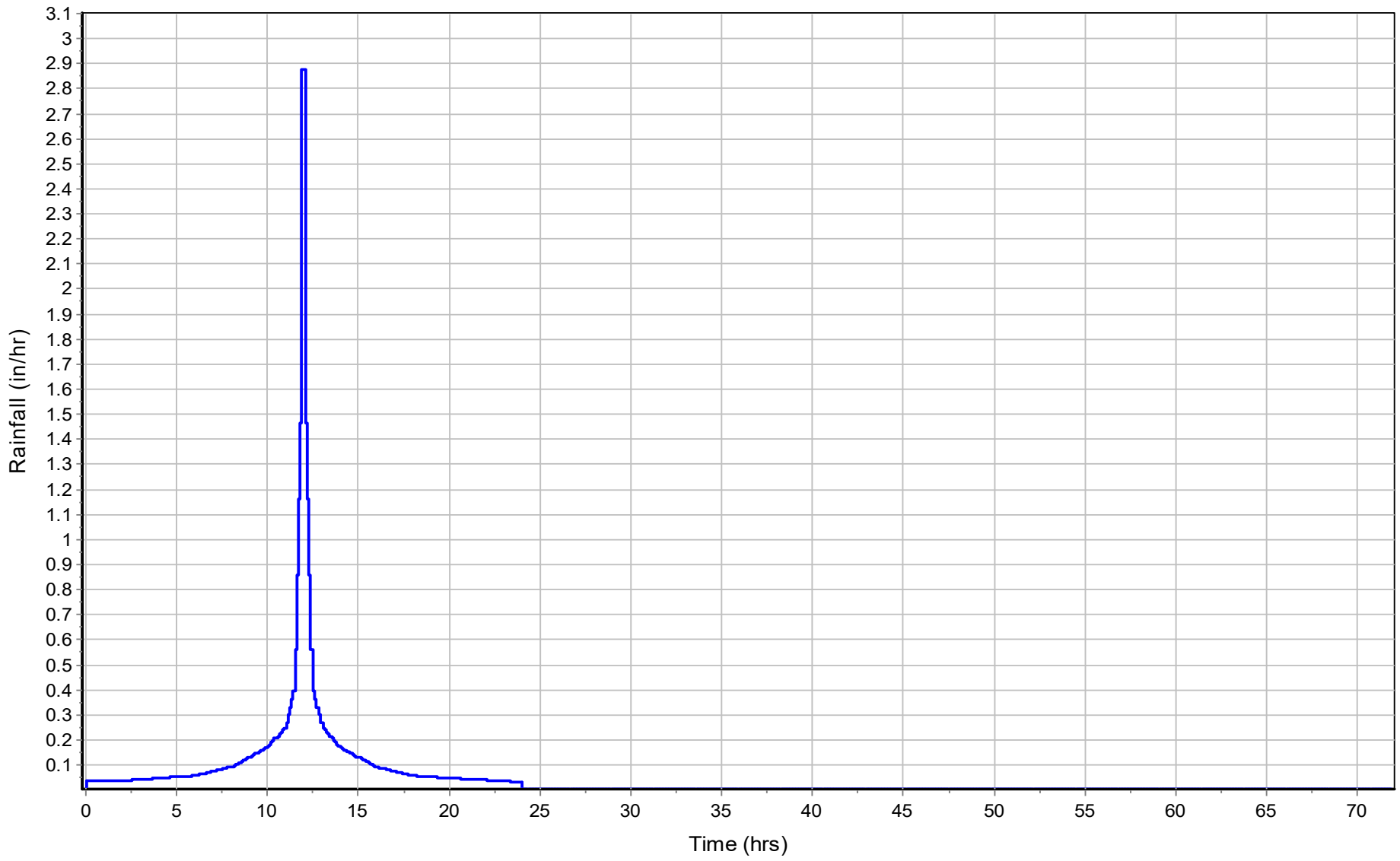
Total TOC (min) 17.48

Subbasin Runoff Results

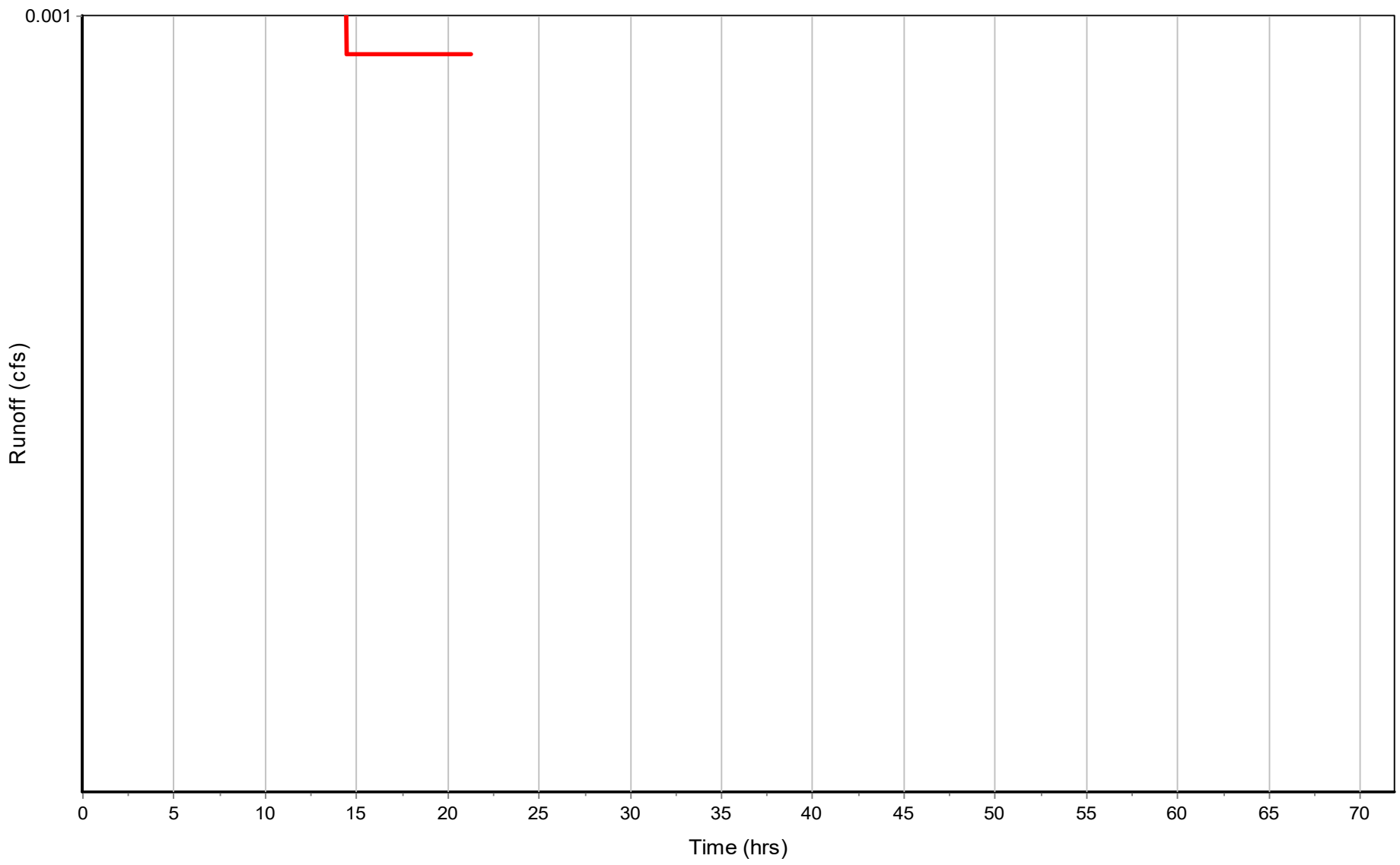
Total Rainfall (in) 3.02
Total Runoff (in) 0.03
Peak Runoff (cfs) 0
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:17:29

Subbasin : Sub-E01_Ex

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E03.1

Input Data

Area (ac) 0.1
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.1	A	43
Composite Area & Weighted CN	0.1		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	138.1	0	0
Slope (%) :	14	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.11	0	0
Computed Flow Time (min) :	21.5	0	0

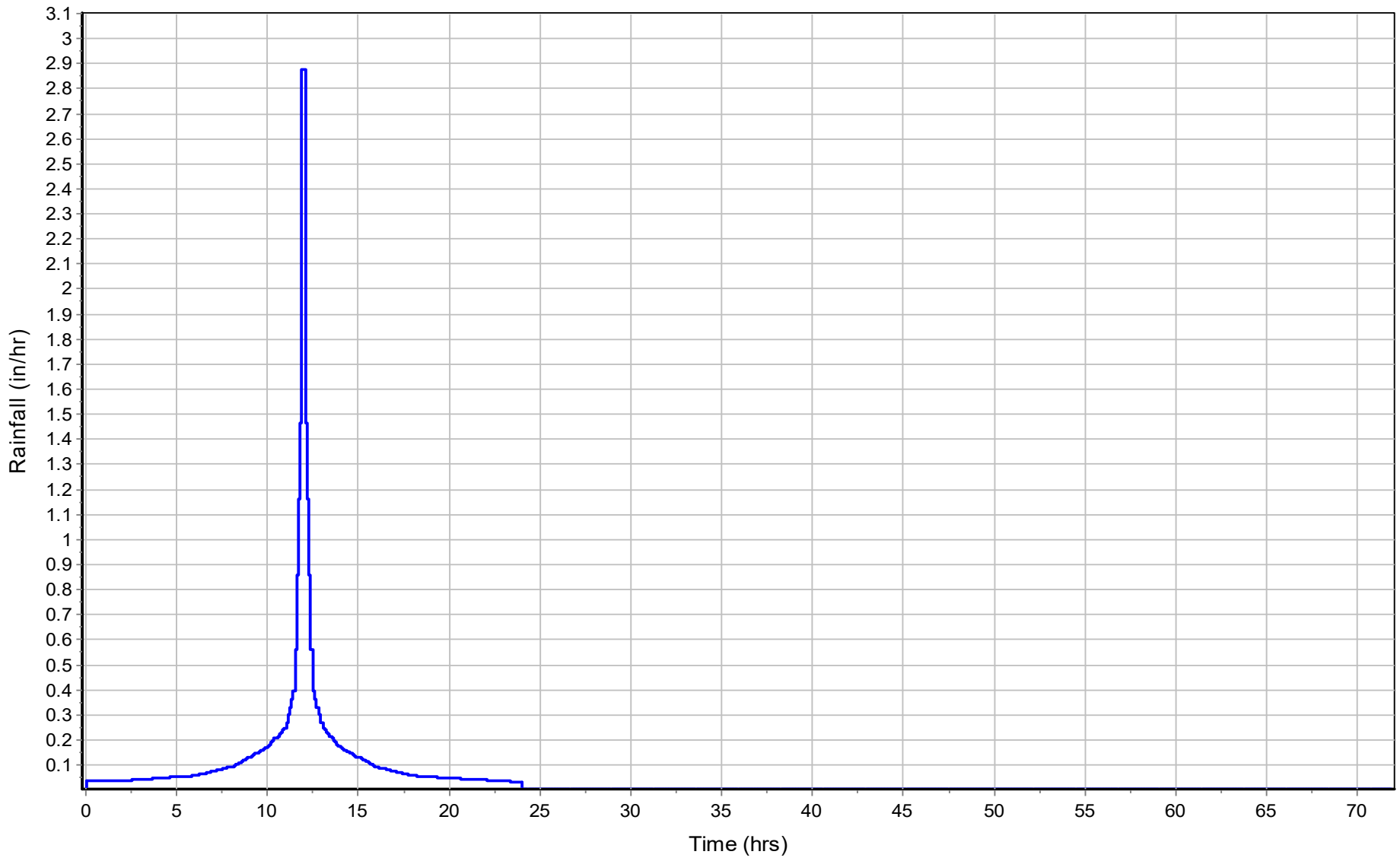
Total TOC (min) 21.50

Subbasin Runoff Results

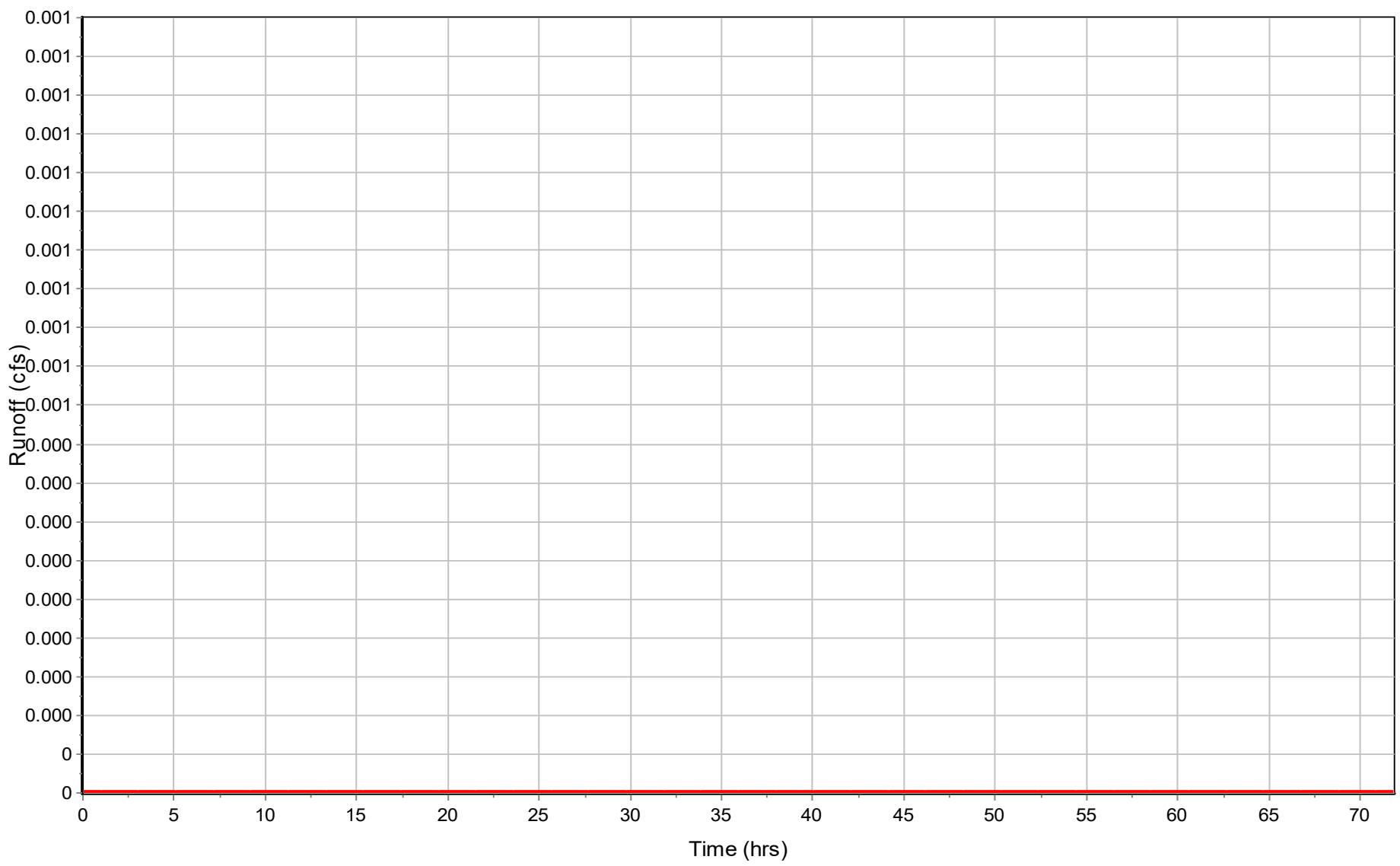
Total Rainfall (in) 3.02
Total Runoff (in) 0
Peak Runoff (cfs) 0
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:21:30

Subbasin : Sub-E03.1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E05.1

Input Data

Area (ac) 0.02
Peak Rate Factor 0
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.02	A	43
Composite Area & Weighted CN	0.02		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	43.1	0	0
Slope (%) :	12	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.08	0	0
Computed Flow Time (min) :	9.01	0	0

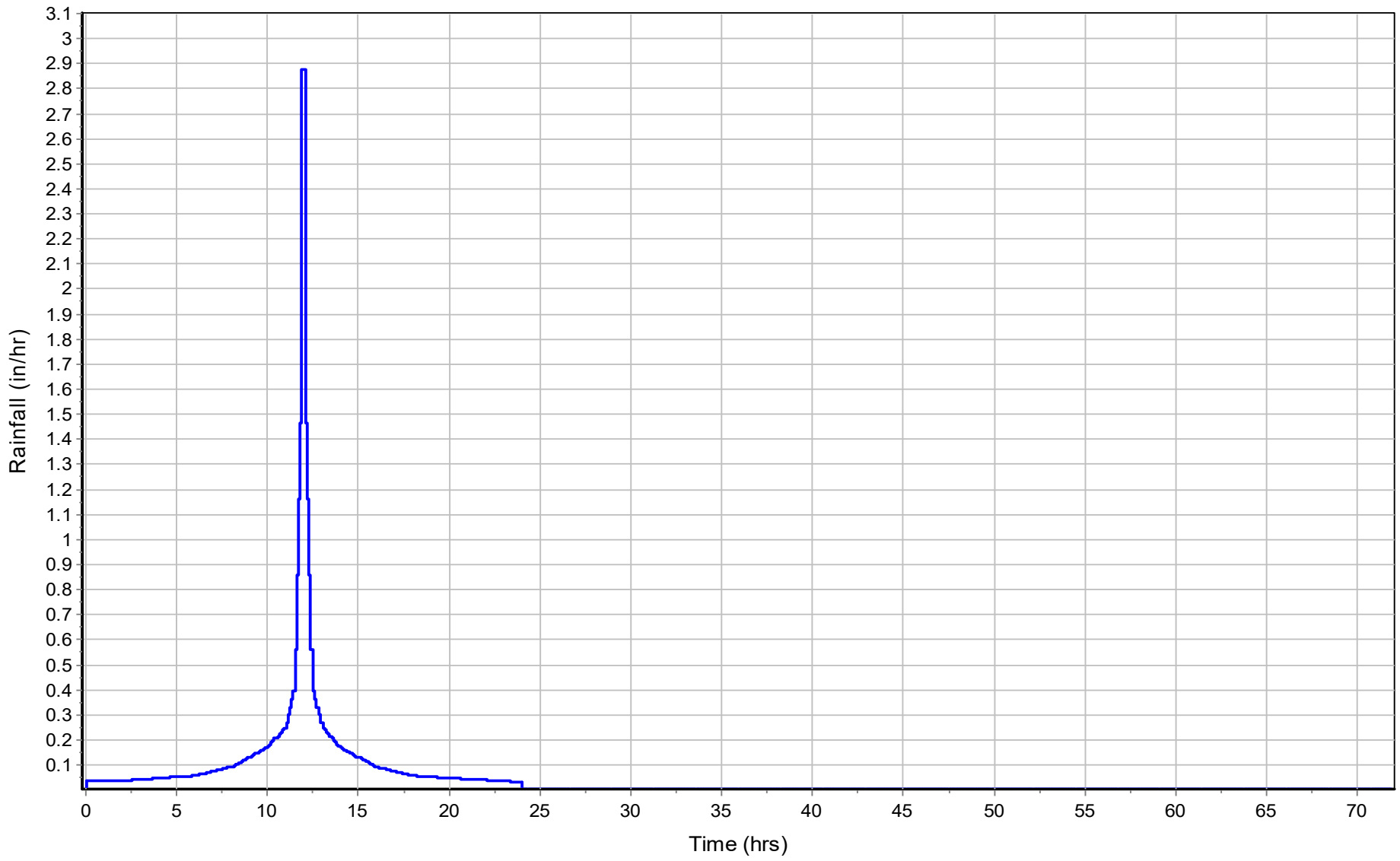
Total TOC (min) 9.01

Subbasin Runoff Results

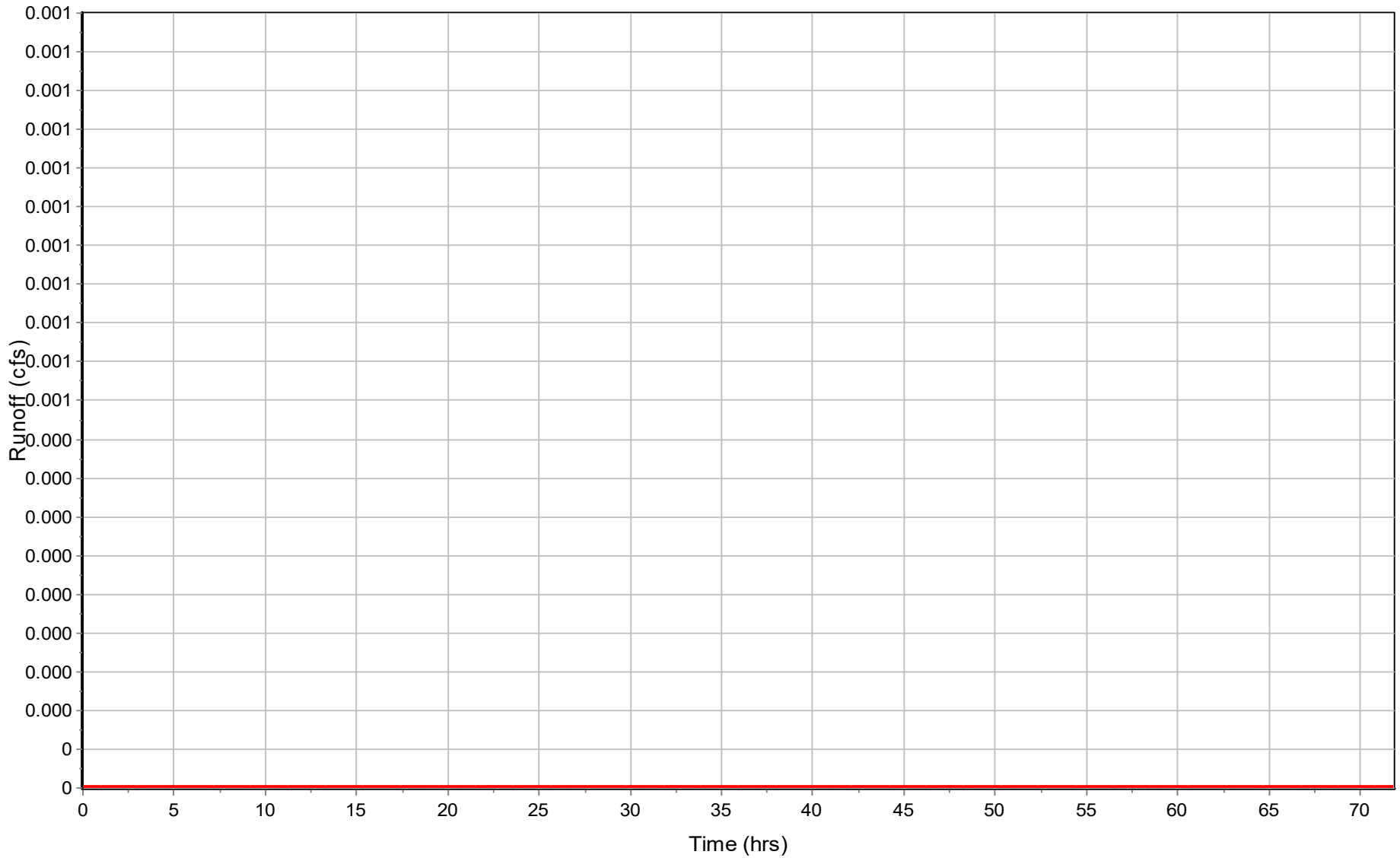
Total Rainfall (in) 3.02
Total Runoff (in) 0
Peak Runoff (cfs) 0
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:09:01

Subbasin : Sub-E05.1

Rainfall Intensity Graph



Runoff Hydrograph



Junction Input

SN	Element ID	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Ground/Rim (Max) Offset (ft)	Initial Water Elevation (ft)	Initial Water Depth (ft)	Surcharge Elevation (ft)	Surcharge Depth (ft)	Ponded Area (ft^2)	Minimum Pipe Cover (ft)
1	1-Jun	116.60	117.90	1.30	0.00	-116.60	0.00	-117.90	0.00	0.00

Junction Results

SN	Element ID	Peak Inflow (cfs)	Peak Lateral Inflow (cfs)	Max HGL Elevation Attained (ft)	Max HGL Depth Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Average HGL Elevation Attained (ft)	Average HGL Depth Attained (ft)	Time of Max HGL Occurrence (days hh:mm)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	1-Jun	0.00	0.00	116.60	0.00	0.00	5.10	116.60	0.00	0 00:00	0 00:00	0.00	0.00

Channel Input

SN	Element ID	Length (ft)	Inlet Invert Elevation (ft)	Inlet Invert Offset (ft)	Outlet Invert Elevation (ft)	Outlet Invert Offset (ft)	Total Drop (ft)	Average Slope (%)	Shape	Height (ft)	Width (ft)	Manning's Roughness	Entrance Losses	Exit/Bend Losses	Additional Losses	Initial Flow (cfs)	Flap Gate
1	Ditch-01	81.45	116.60	0.00	116.36	3.96	0.24	0.2900	Trapezoidal	1.300	6.200	0.0250	0.5000	0.5000	0.0000	0.00	No

Channel Results

SN	Element ID	Peak Flow (cfs)	Time of Peak Flow Occurrence (days hh:mm)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Travel Time (min)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Froude Number	Reported Condition
1	Ditch-01	0.00	0 00:00	11.76	0.00	0.00		0.00	0.00	0.00		

Storage Nodes

Storage Node : Basin-A1

Input Data

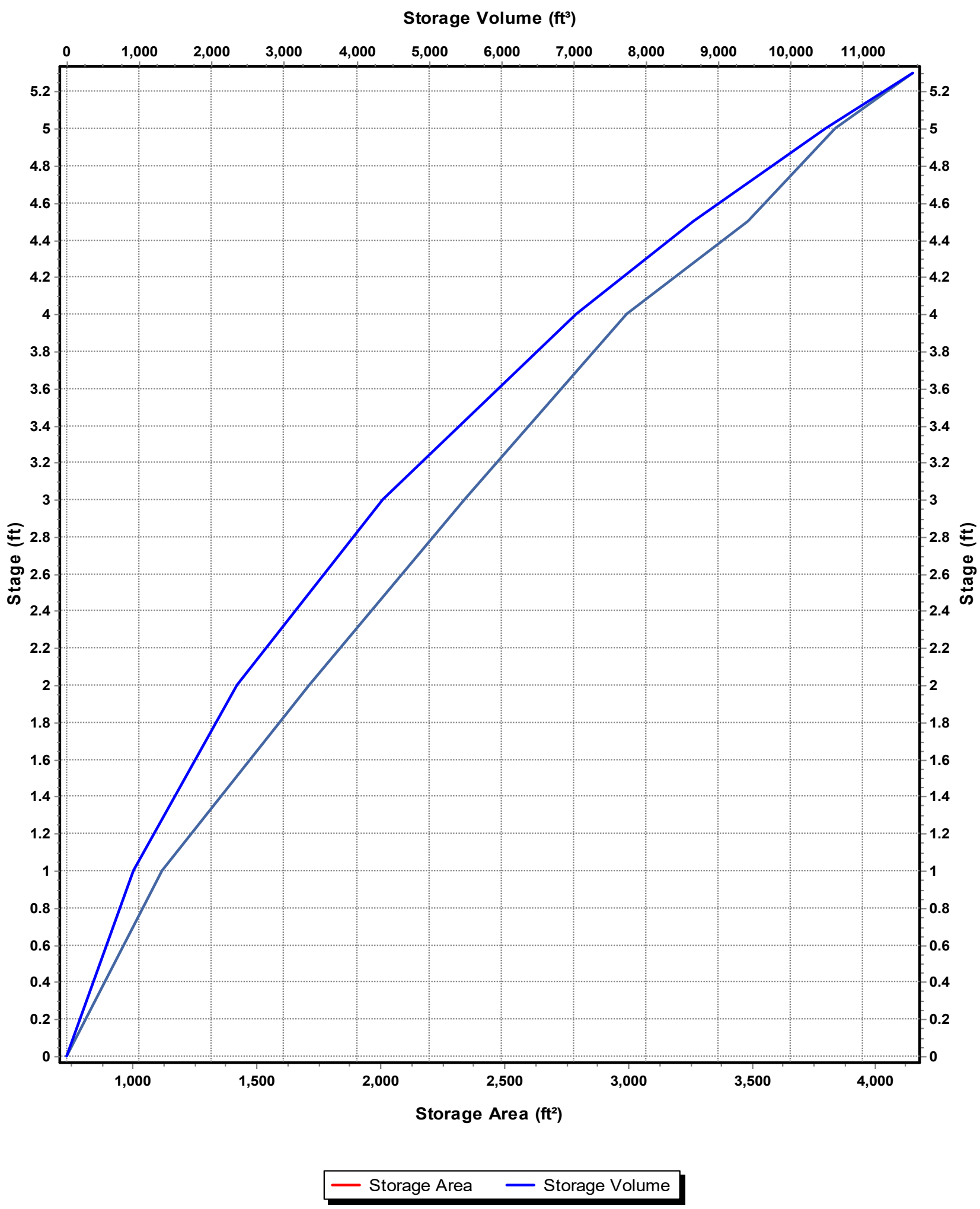
Invert Elevation (ft)	112.40
Max (Rim) Elevation (ft)	117.70
Max (Rim) Offset (ft)	5.30
Initial Water Elevation (ft)	112.40
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Basin-01

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	734.2	0
1	1121.14	927.67
2	1714.29	2345.39
3	2339.15	4372.11
4	2995.85	7039.61
4.5	3484.76	8659.76
5	3837.05	10490.21
5.3	4151.91	11688.55

Storage Area Volume Curves



Storage Node : Basin-A1 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-B-A1	Trapezoidal	No	117.40	5.00	4.00	0.30	3.33

Output Summary Results

Peak Inflow (cfs)	0.58
Peak Lateral Inflow (cfs)	0
Peak Outflow (cfs)	0
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	114.43
Max HGL Depth Attained (ft)	2.03
Average HGL Elevation Attained (ft)	114.02
Average HGL Depth Attained (ft)	1.62
Time of Max HGL Occurrence (days hh:mm)	1 01:38
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Basin-A2

Input Data

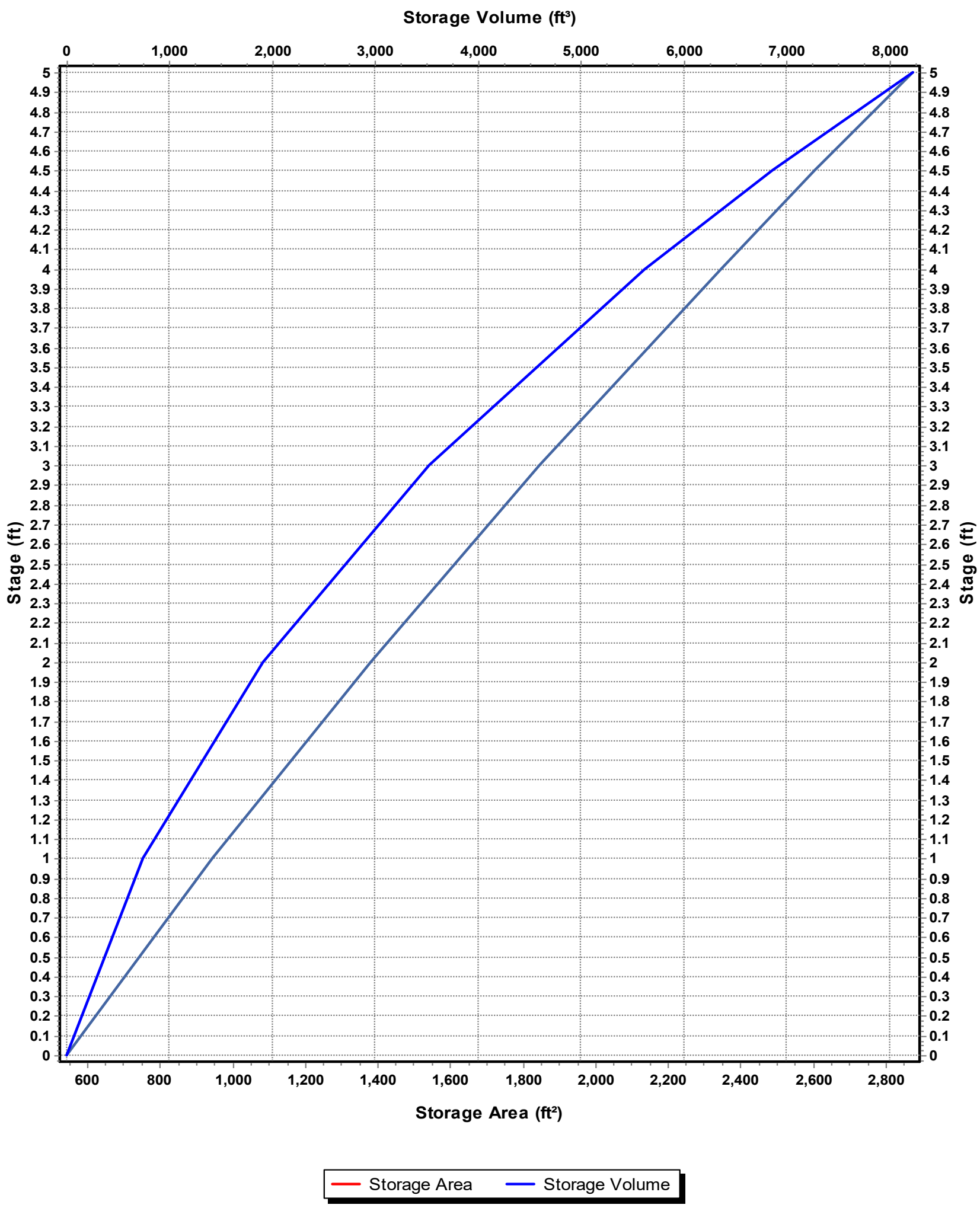
Invert Elevation (ft)	112.90
Max (Rim) Elevation (ft)	117.90
Max (Rim) Offset (ft)	5.00
Initial Water Elevation (ft)	112.90
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Basin-02

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	543.55	0
1	946	744.78
2	1380.46	1908.01
3	1846.91	3521.7
4	2345.37	5617.84
4.5	2606.6	6855.83
5	2875.82	8226.44

Storage Area Volume Curves



Storage Node : Basin-A2 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-B-A2	Trapezoidal	No	117.50	4.60	5.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	0.8
Peak Lateral Inflow (cfs)	0
Peak Outflow (cfs)	0
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	115.25
Max HGL Depth Attained (ft)	2.35
Average HGL Elevation Attained (ft)	114.78
Average HGL Depth Attained (ft)	1.88
Time of Max HGL Occurrence (days hh:mm)	1 01:00
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Forebay-A1

Input Data

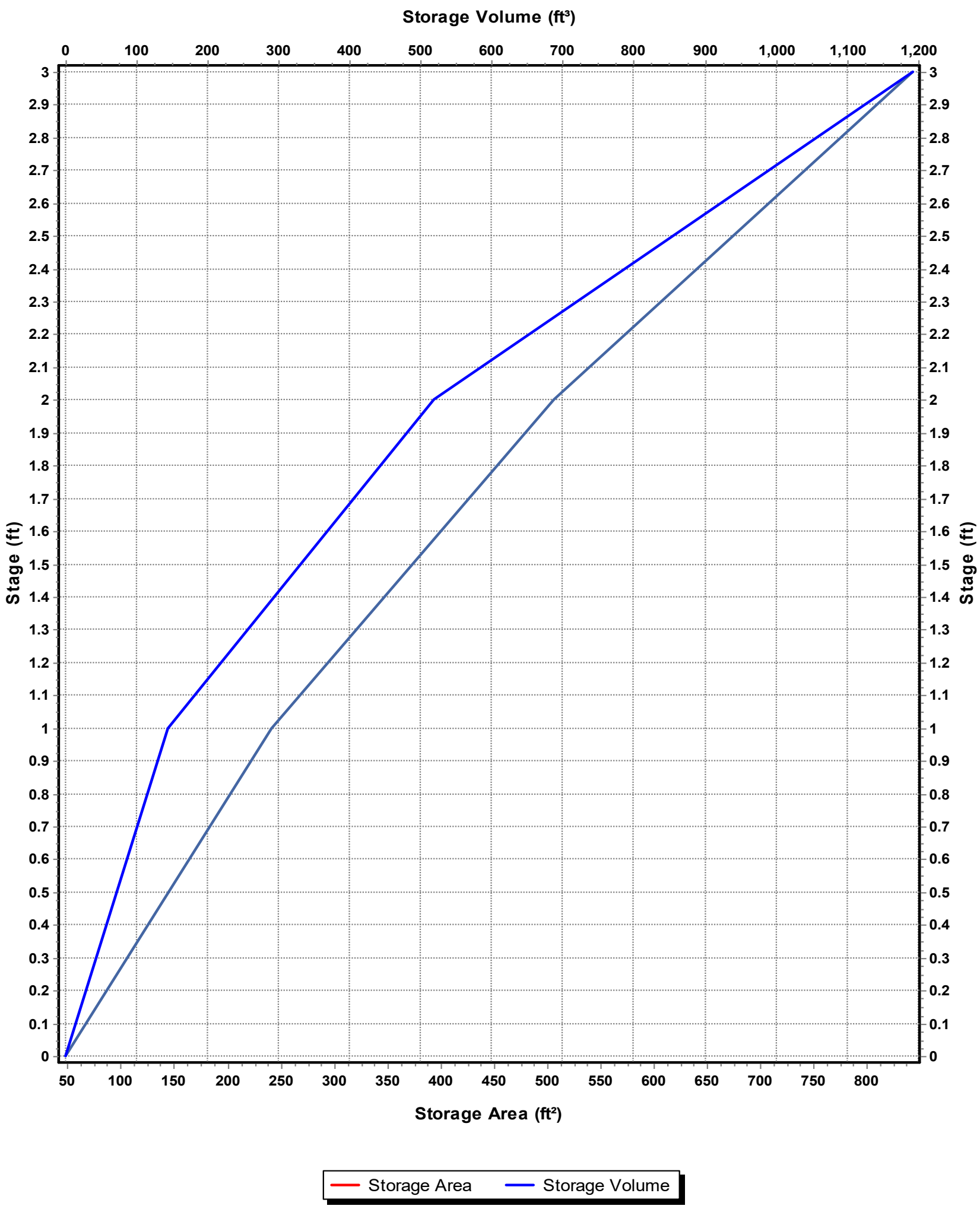
Invert Elevation (ft)	114.40
Max (Rim) Elevation (ft)	117.70
Max (Rim) Offset (ft)	3.30
Initial Water Elevation (ft)	114.40
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Forebay-01

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	48.29	0
1	241.18	144.74
2	506.06	518.36
3	842.94	1192.86

Storage Area Volume Curves



Storage Node : Forebay-A1 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-F-A1	Trapezoidal	No	117.30	2.90	8.00	2.00	3.33

Output Summary Results

Peak Inflow (cfs)	0.95
Peak Lateral Inflow (cfs)	0.95
Peak Outflow (cfs)	0.58
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	117.38
Max HGL Depth Attained (ft)	2.98
Average HGL Elevation Attained (ft)	116.83
Average HGL Depth Attained (ft)	2.43
Time of Max HGL Occurrence (days hh:mm)	0 12:20
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Forebay-A2

Input Data

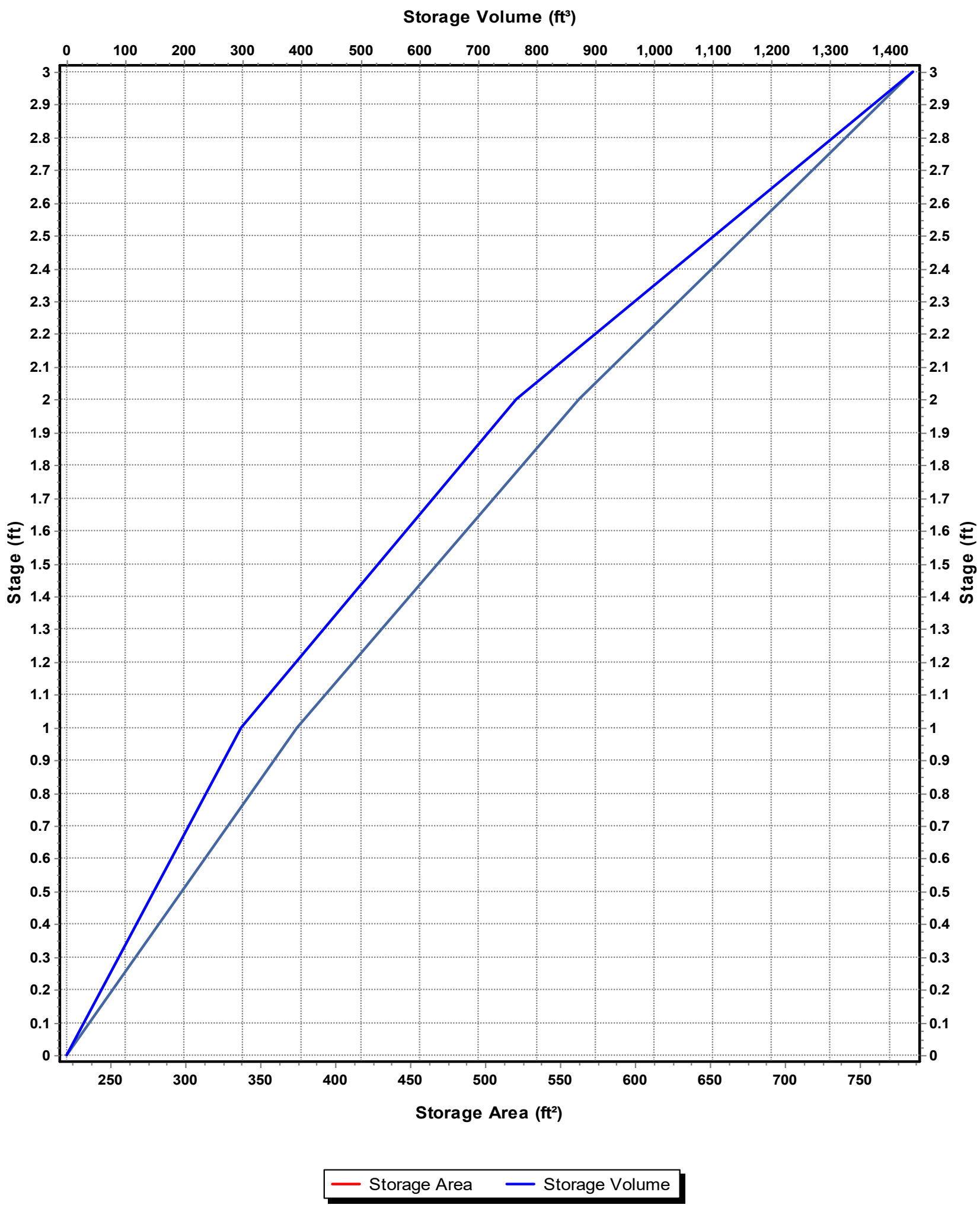
Invert Elevation (ft)	114.90
Max (Rim) Elevation (ft)	117.90
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.90
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Forebay-02

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	221.26	0
1	374.45	297.86
2	562.72	766.45
3	785.55	1440.59

Storage Area Volume Curves



Storage Node : Forebay-A2 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-F-A2	Trapezoidal	No	117.00	2.10	10.00	1.00	3.33

Output Summary Results

Peak Inflow (cfs)	0.88
Peak Lateral Inflow (cfs)	0.88
Peak Outflow (cfs)	0.8
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	117.08
Max HGL Depth Attained (ft)	2.18
Average HGL Elevation Attained (ft)	116.66
Average HGL Depth Attained (ft)	1.76
Time of Max HGL Occurrence (days hh:mm)	0 12:14
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Project Description

File Name ..... Pave.Paws_A1_A2.SPF

Project Options

Flow Units ..... CFS
Elevation Type ..... Elevation
Hydrology Method ..... SCS TR-20
Time of Concentration (TOC) Method ..... SCS TR-55
Link Routing Method ..... Hydrodynamic
Enable Overflow Ponding at Nodes ..... YES
Skip Steady State Analysis Time Periods .... NO

Analysis Options

Start Analysis On 00:00:00 0:00:00
End Analysis On 00:00:00 0:00:00
Start Reporting On 00:00:00 0:00:00
Antecedent Dry Days ..... 0 days
Runoff (Dry Weather) Time Step ..... 0 01:00:00 days hh:mm:ss
Runoff (Wet Weather) Time Step ..... 0 00:05:00 days hh:mm:ss
Reporting Time Step ..... 0 00:05:00 days hh:mm:ss
Routing Time Step ..... 30 seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	7
Nodes	7
Junctions	1
Outfalls	2
Flow Diversions	0
Inlets	0
Storage Nodes	4
Links	5
Channels	1
Pipes	0
Pumps	0
Orifices	0
Weirs	4
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	10 years	Intensity	inches	Massachusetts	None	10.00	4.99	SCS Type III 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Sub-A1	0.73	484.00	76.00	4.99	2.53	1.86	1.92	0 00:06:00
2	Sub-A2	0.69	484.00	76.00	4.99	2.53	1.73	1.79	0 00:06:00
3	Sub-E01	0.76	484.00	43.00	4.99	0.35	0.27	0.08	0 00:28:48
4	Sub-E01.1	0.25	484.00	43.00	4.99	0.35	0.09	0.03	0 00:17:56
5	Sub-E01_Ex	0.26	484.00	43.00	4.99	0.35	0.09	0.03	0 00:17:28
6	Sub-E03.1	0.10	484.00	43.00	4.99	0.35	0.04	0.01	0 00:21:30
7	Sub-E05.1	0.02	0.00	43.00	4.99	0.10	0.00	0.00	0 00:09:00

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	1-Jun	Junction	116.60	117.90	0.00	0.00	0.00	0.01	116.65	0.00	5.05	0 00:00	0.00	0.00
2	Out-E01	Outfall	116.00					0.08	116.00					
3	Out-Prop-A1	Outfall	116.00					0.03	116.00					
4	Basin-A1	Storage Node	112.40	117.70	112.40		0.00	1.84	116.07				0.00	0.00
5	Basin-A2	Storage Node	112.90	117.90	112.90		0.00	1.73	116.83				0.00	0.00
6	Forebay-A1	Storage Node	114.40	117.70	114.40		0.00	1.87	117.47				0.00	0.00
7	Forebay-A2	Storage Node	114.90	117.90	114.90		0.00	1.74	117.14				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length (ft)	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Average Slope (%)	Diameter or Height (ft)	Manning's Roughness	Peak Flow (cfs)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Reported Condition
1	Ditch-01	Channel	1-Jun	Basin-A1	81.45	116.60	116.36	0.2900	1.300	0.0250	0.01	11.76	0.00	0.32	0.03	0.02	0.00	
2	Weir-B-A1	Weir	Basin-A1	Out-Prop-A1		112.40	116.00				0.00							
3	Weir-B-A2	Weir	Basin-A2	1-Jun		112.90	116.60				0.00							
4	Weir-F-A1	Weir	Forebay-A1	Basin-A1		114.40	112.40				1.84							
5	Weir-F-A2	Weir	Forebay-A2	Basin-A2		114.90	112.90				1.73							

Subbasin Hydrology

Subbasin : Sub-A1

Input Data

Area (ac) 0.73
Peak Rate Factor 484
Weighted Curve Number 76
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	0.73	A	76
Composite Area & Weighted CN	0.73		76

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft^2)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	132.16	0	0
Slope (%) :	0.71	0	0
2 yr, 24 hr Rainfall (in) :	3.42	0	0
Velocity (ft/sec) :	0.78	0	0
Computed Flow Time (min) :	2.84	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	257.27	0	0
Channel Slope (%) :	0.4	0	0
Cross Section Area (ft^2) :	2.067	0	0
Wetted Perimeter (ft) :	5.25	0	0
Velocity (ft/sec) :	1.69	0	0
Computed Flow Time (min) :	2.54	0	0

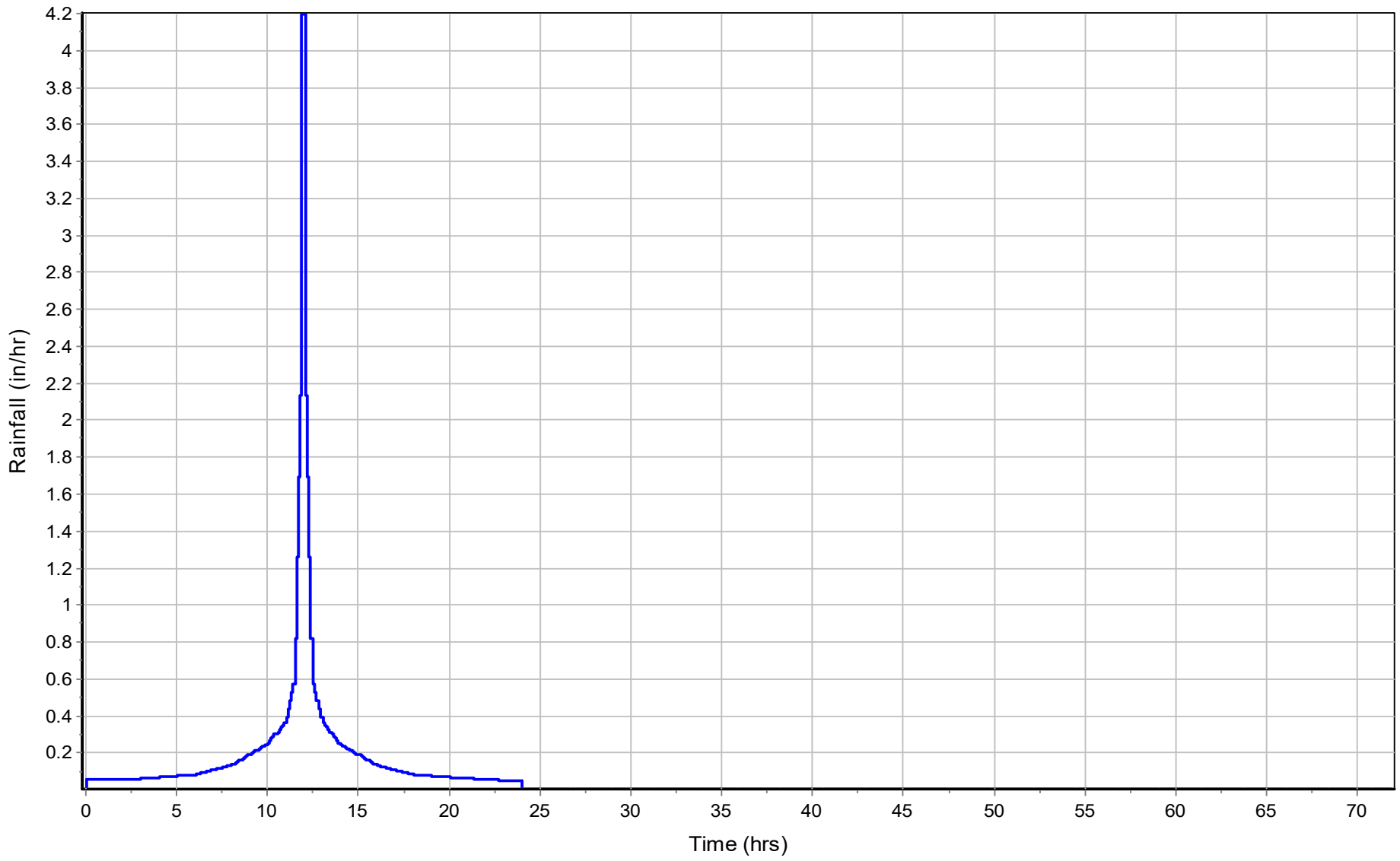
Total TOC (min) 5.38

Subbasin Runoff Results

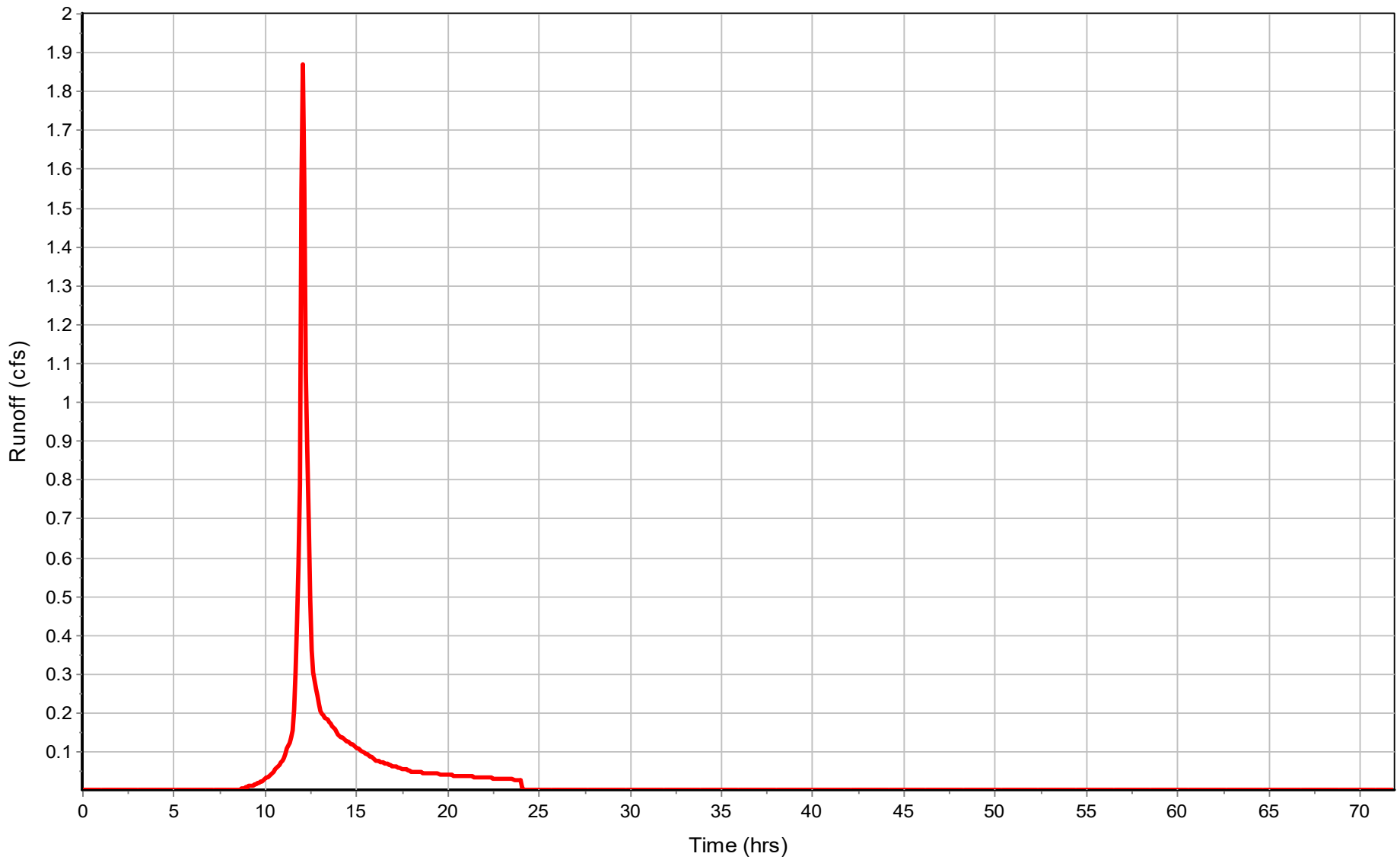
Total Rainfall (in)	4.99
Total Runoff (in)	2.53
Peak Runoff (cfs)	1.92
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:05:23

Subbasin : Sub-A1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-A2

Input Data

Area (ac) 0.69
Peak Rate Factor 484
Weighted Curve Number 76
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	0.69	A	76
Composite Area & Weighted CN	0.69		76

Time of Concentration

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	331.61	0	0
Channel Slope (%) :	5.4	0	0
Cross Section Area (ft^2) :	3	0	0
Wetted Perimeter (ft) :	6.32	0	0
Velocity (ft/sec) :	7.02	0	0
Computed Flow Time (min) :	0.79	0	0

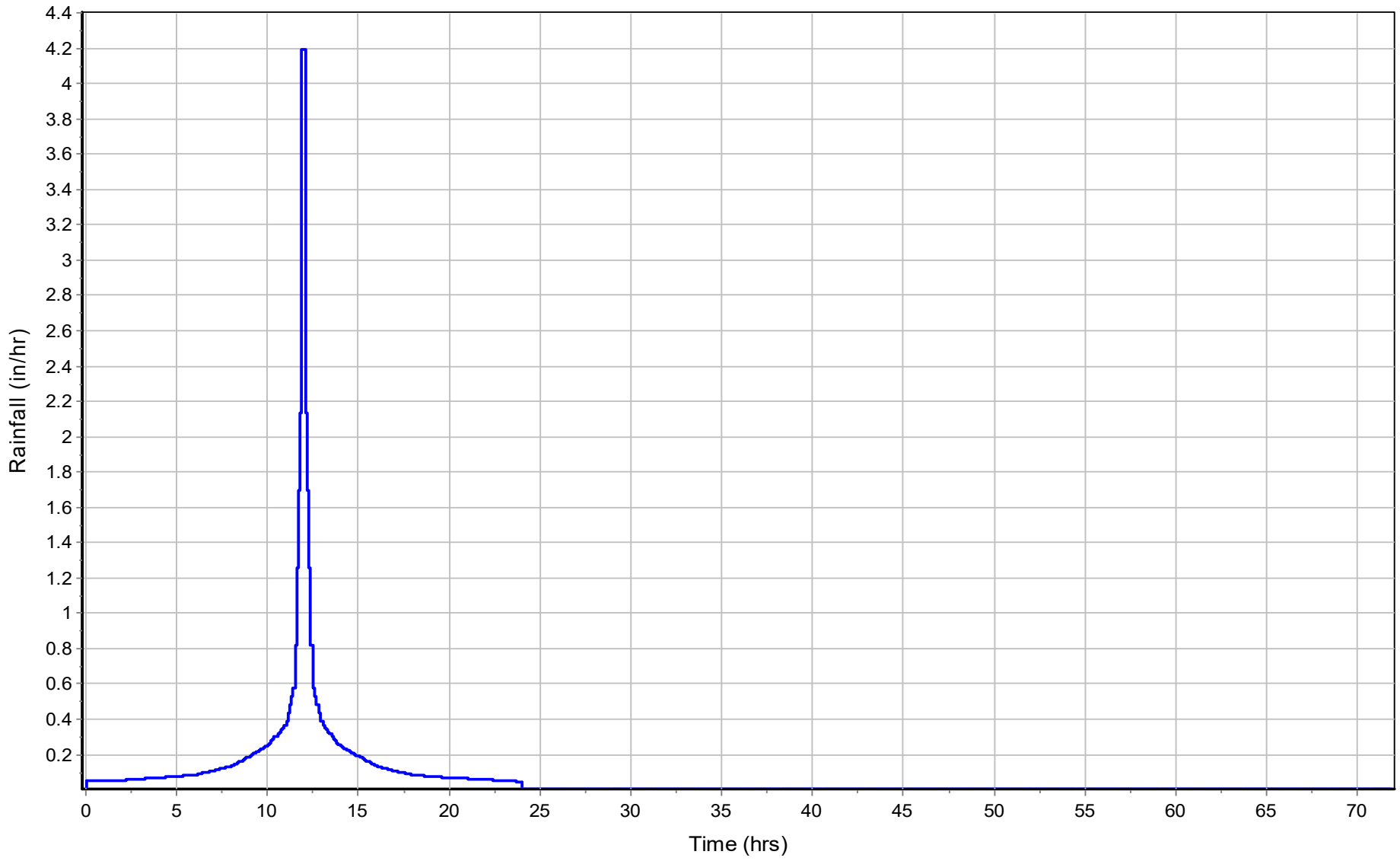
Total TOC (min) 0.79

Subbasin Runoff Results

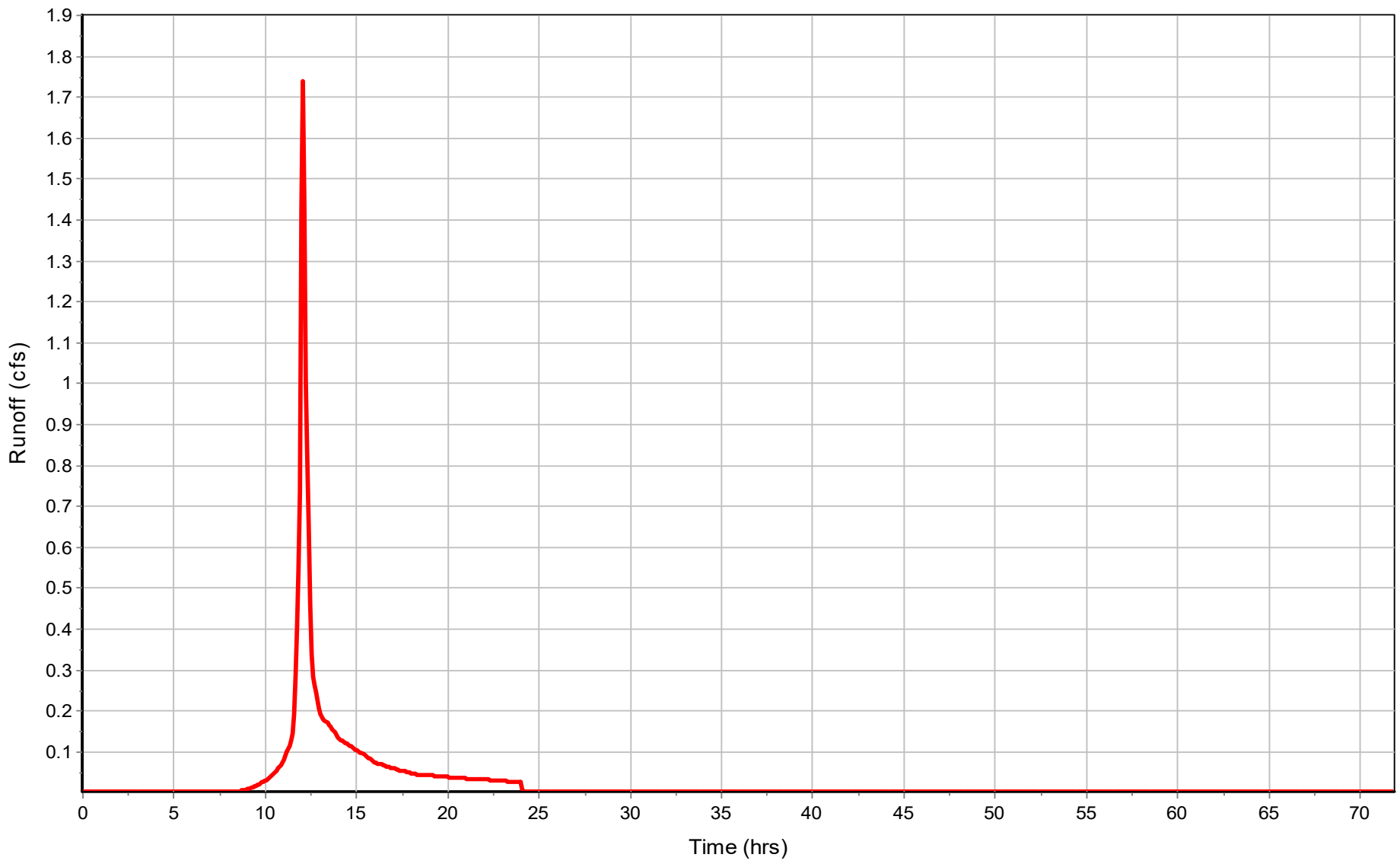
Total Rainfall (in) 4.99
Total Runoff (in) 2.53
Peak Runoff (cfs) 1.79
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:00:47

Subbasin : Sub-A2

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E01

Input Data

Area (ac) 0.76
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.76	A	43
Composite Area & Weighted CN	0.76		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	249.61	0	0
Slope (%) :	22	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.14	0	0
Computed Flow Time (min) :	28.81	0	0

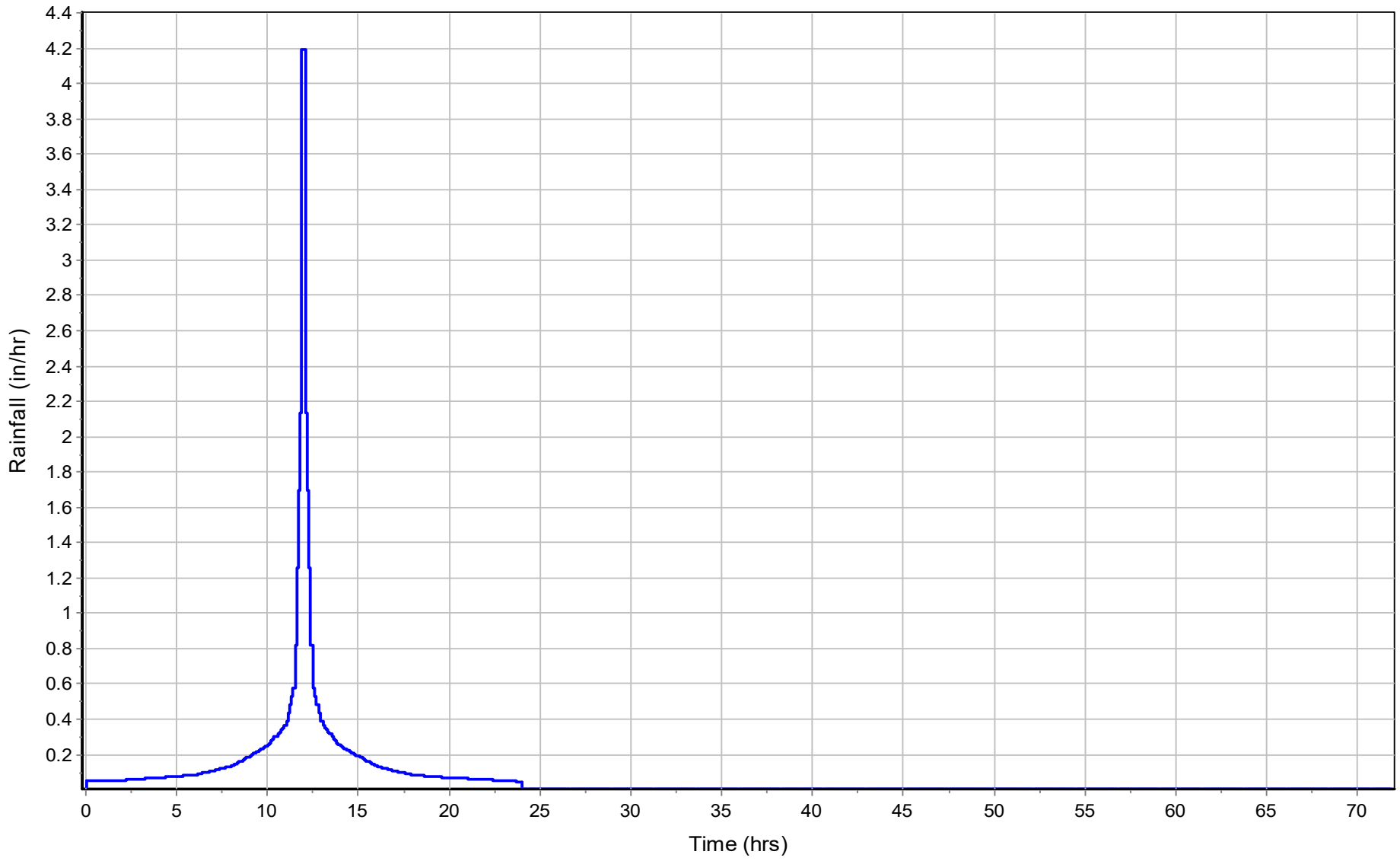
Total TOC (min) 28.81

Subbasin Runoff Results

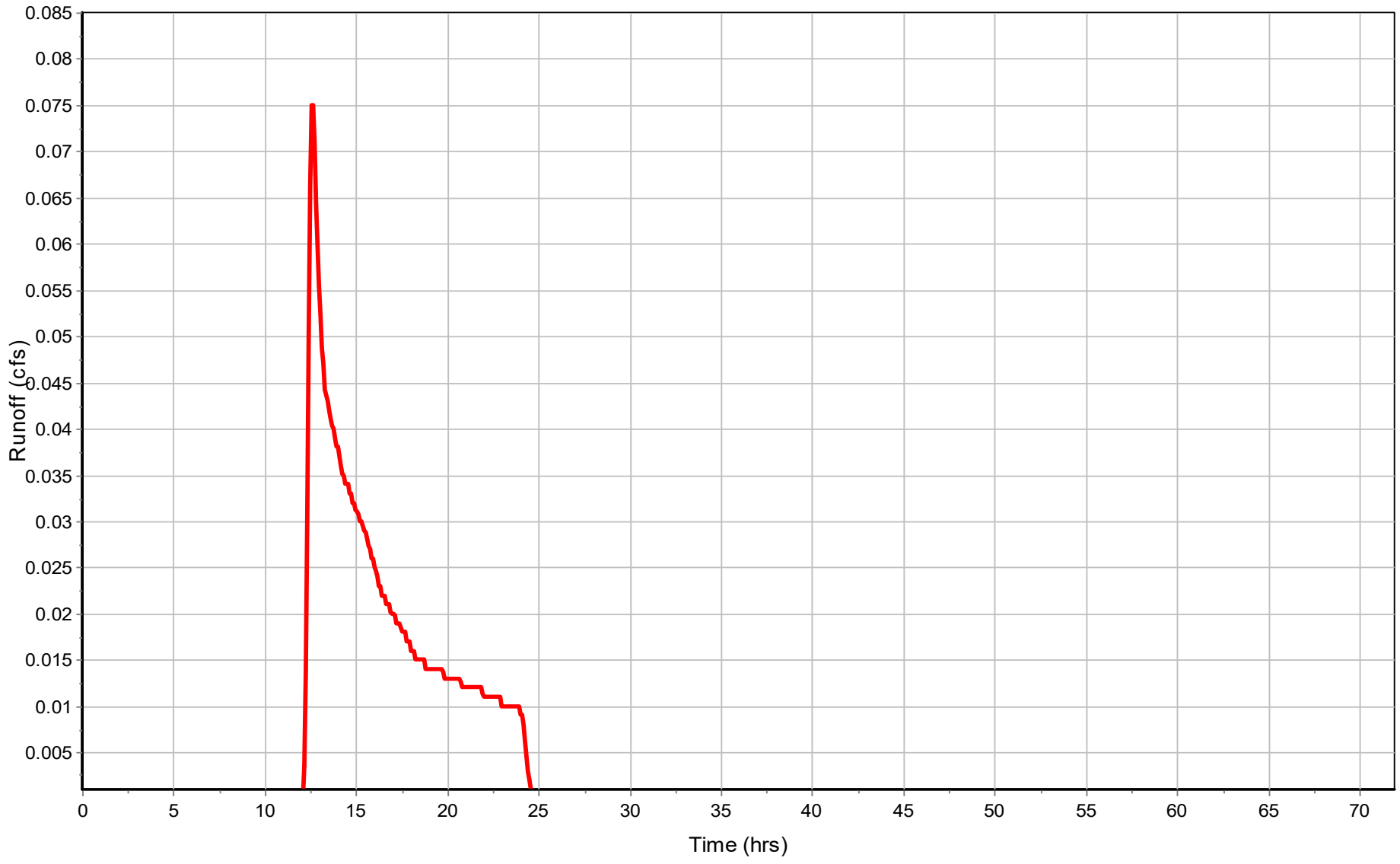
Total Rainfall (in) 4.99
Total Runoff (in) 0.35
Peak Runoff (cfs) 0.08
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:28:49

Subbasin : Sub-E01

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E01.1

Input Data

Area (ac) 0.25
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.25	A	43
Composite Area & Weighted CN	0.25		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	128.34	0	0
Slope (%) :	19	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.12	0	0
Computed Flow Time (min) :	17.94	0	0

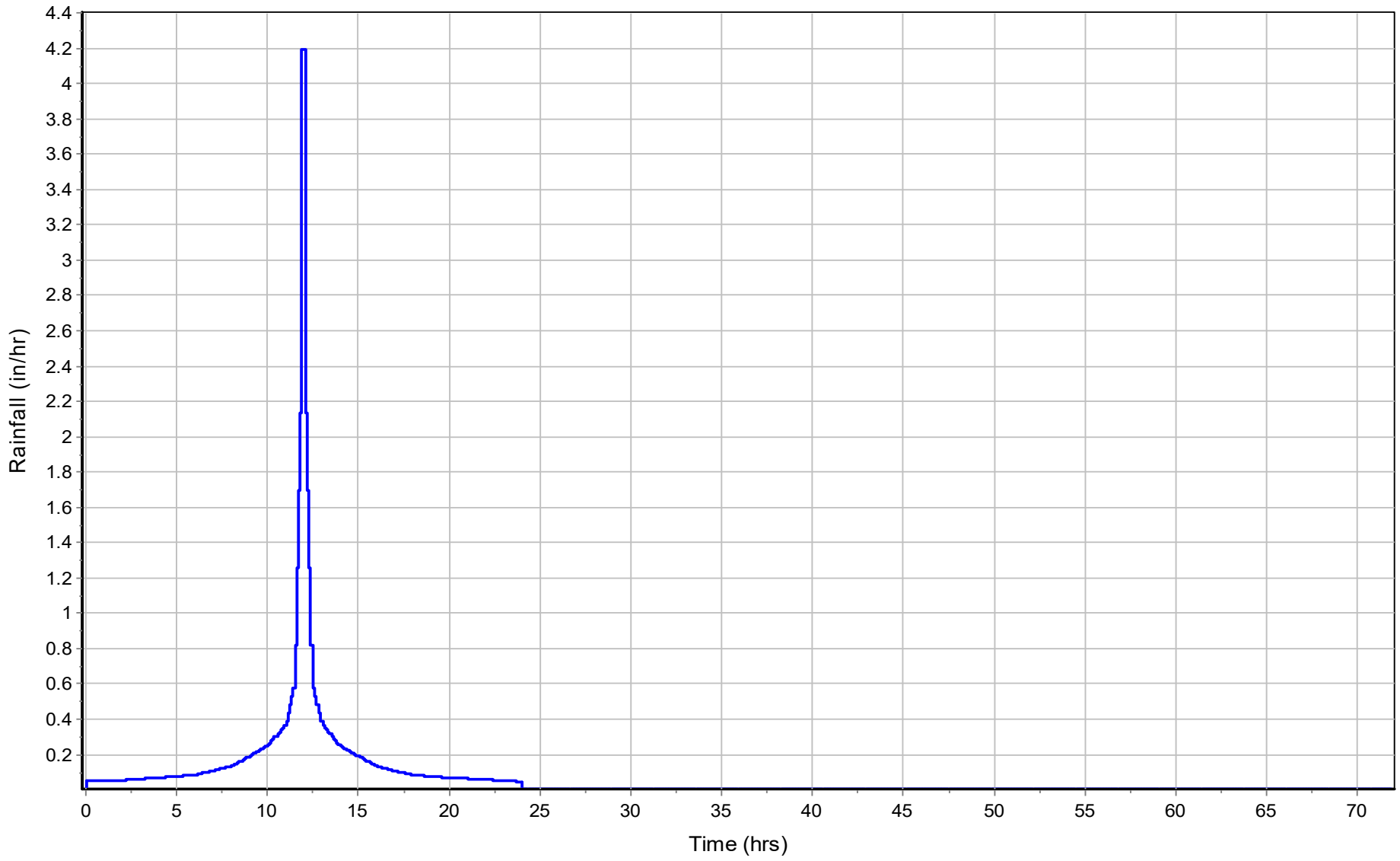
Total TOC (min) 17.94

Subbasin Runoff Results

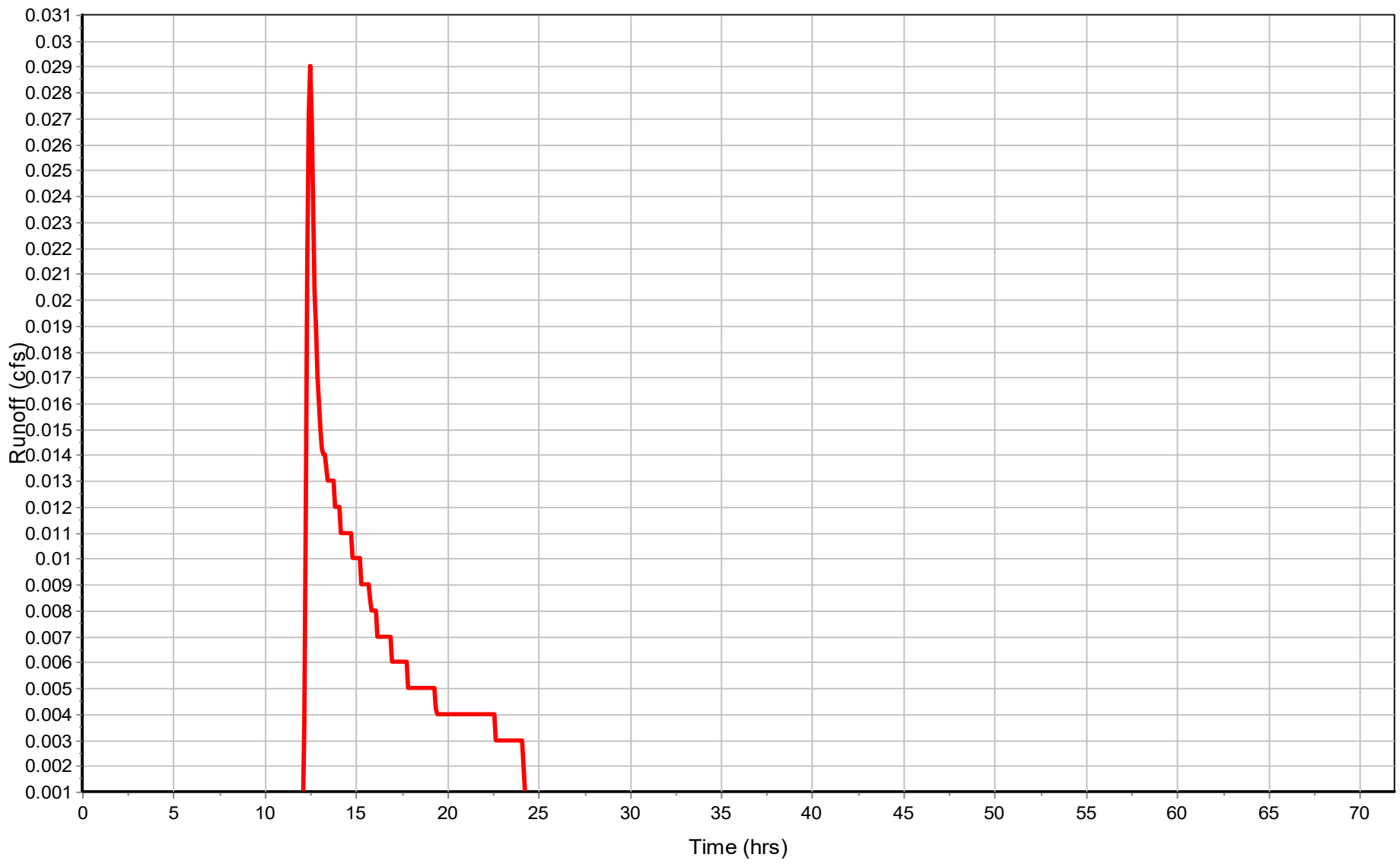
Total Rainfall (in) 4.99
Total Runoff (in) 0.35
Peak Runoff (cfs) 0.03
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:17:56

Subbasin : Sub-E01.1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E01_Ex

Input Data

Area (ac) 0.26
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.26	A	43
Composite Area & Weighted CN	0.26		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	106.59	0	0
Slope (%) :	14	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.1	0	0
Computed Flow Time (min) :	17.48	0	0

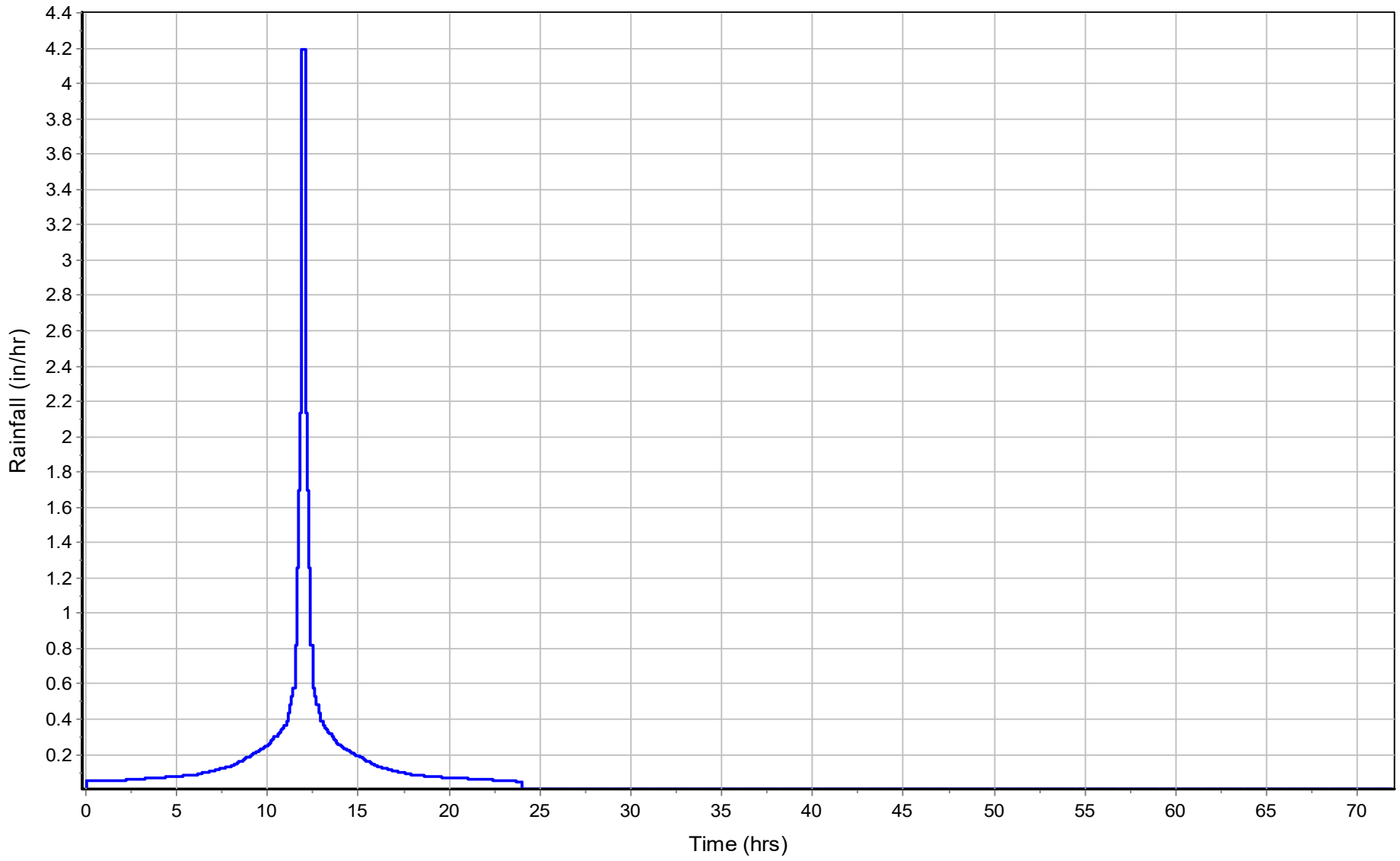
Total TOC (min) 17.48

Subbasin Runoff Results

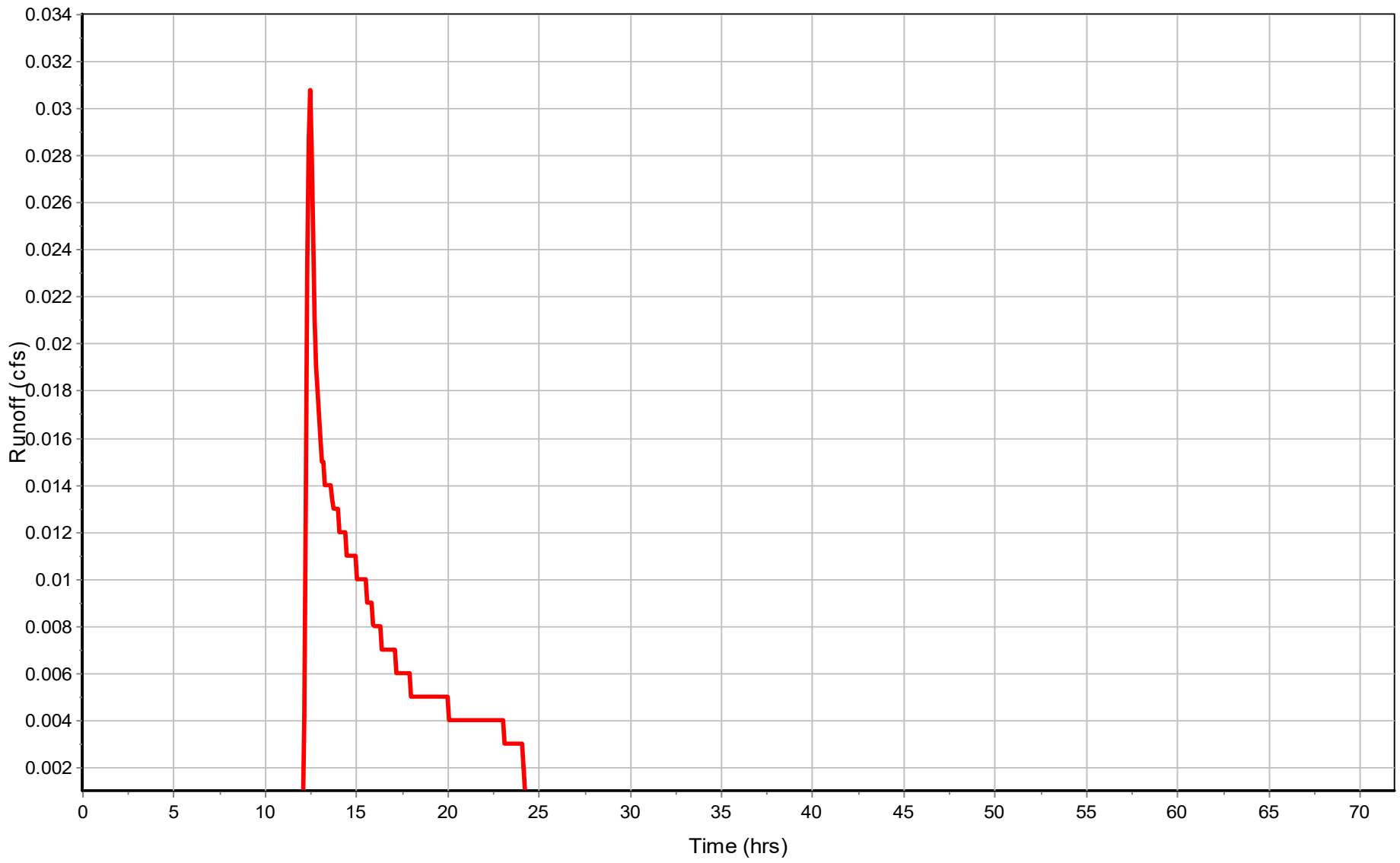
Total Rainfall (in) 4.99
Total Runoff (in) 0.35
Peak Runoff (cfs) 0.03
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:17:29

Subbasin : Sub-E01_Ex

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E03.1

Input Data

Area (ac) 0.1
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.1	A	43
Composite Area & Weighted CN	0.1		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	138.1	0	0
Slope (%) :	14	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.11	0	0
Computed Flow Time (min) :	21.5	0	0

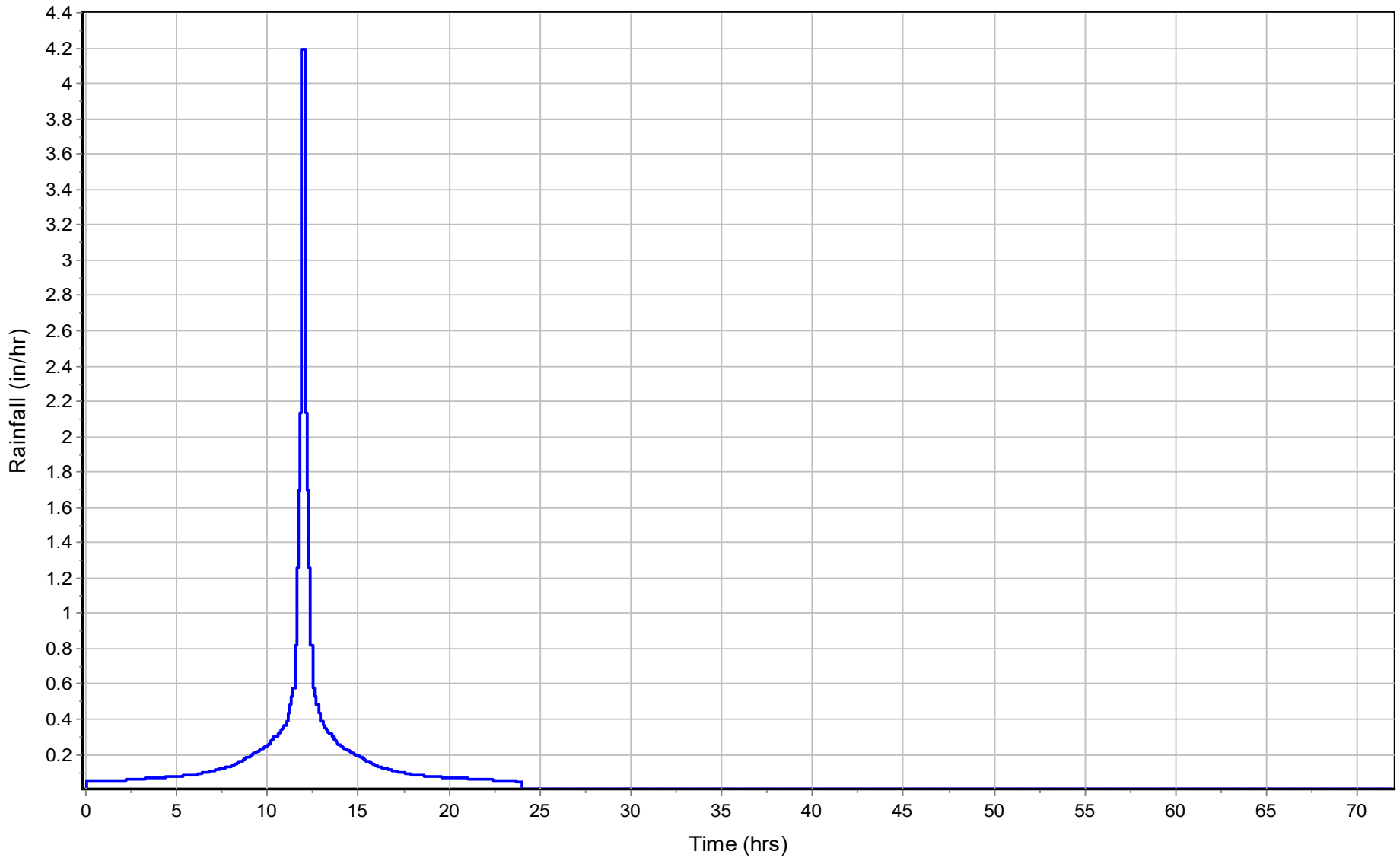
Total TOC (min) 21.50

Subbasin Runoff Results

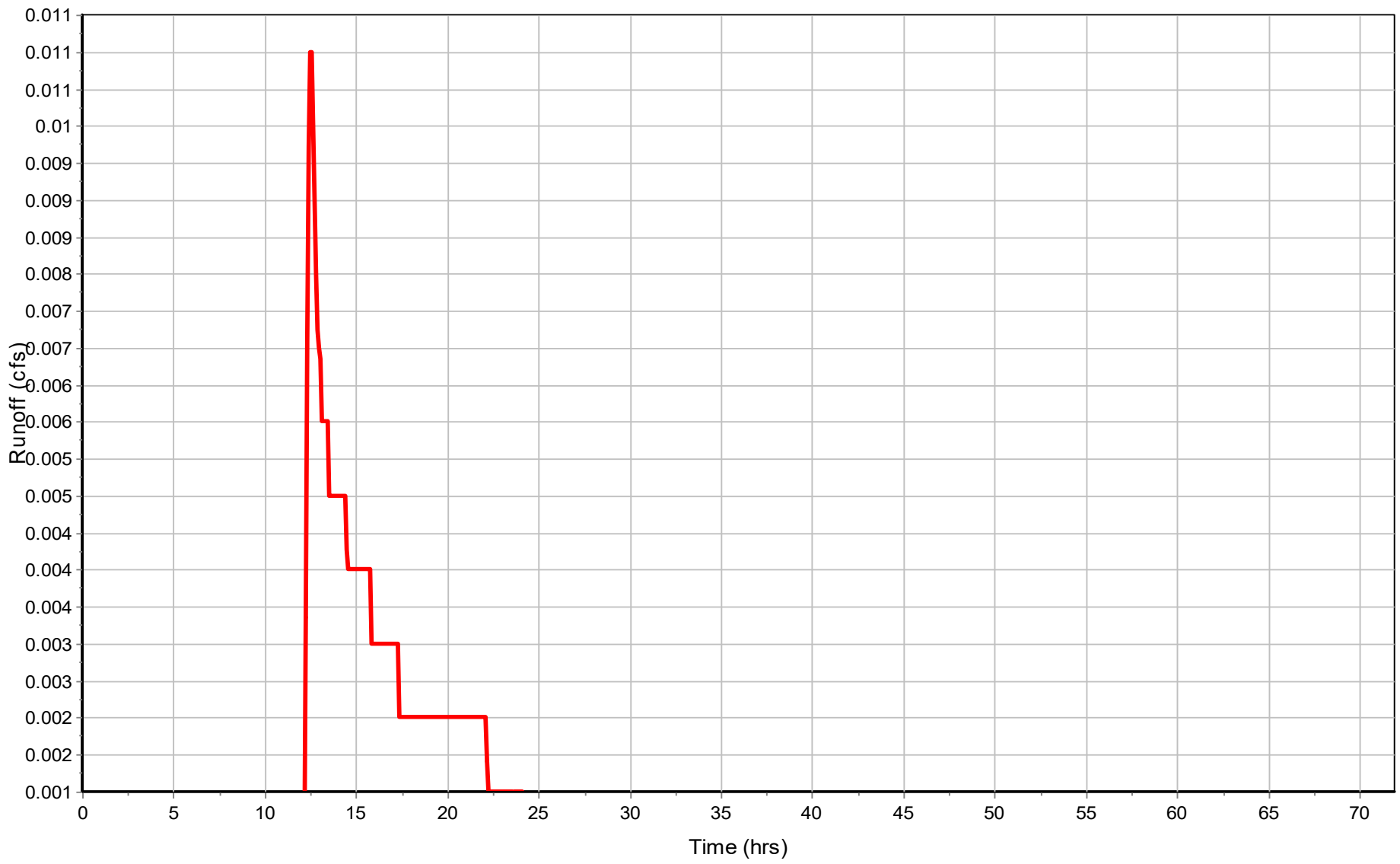
Total Rainfall (in) 4.99
Total Runoff (in) 0.35
Peak Runoff (cfs) 0.01
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:21:30

Subbasin : Sub-E03.1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E05.1

Input Data

Area (ac) 0.02
Peak Rate Factor 0
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.02	A	43
Composite Area & Weighted CN	0.02		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	43.1	0	0
Slope (%) :	12	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.08	0	0
Computed Flow Time (min) :	9.01	0	0

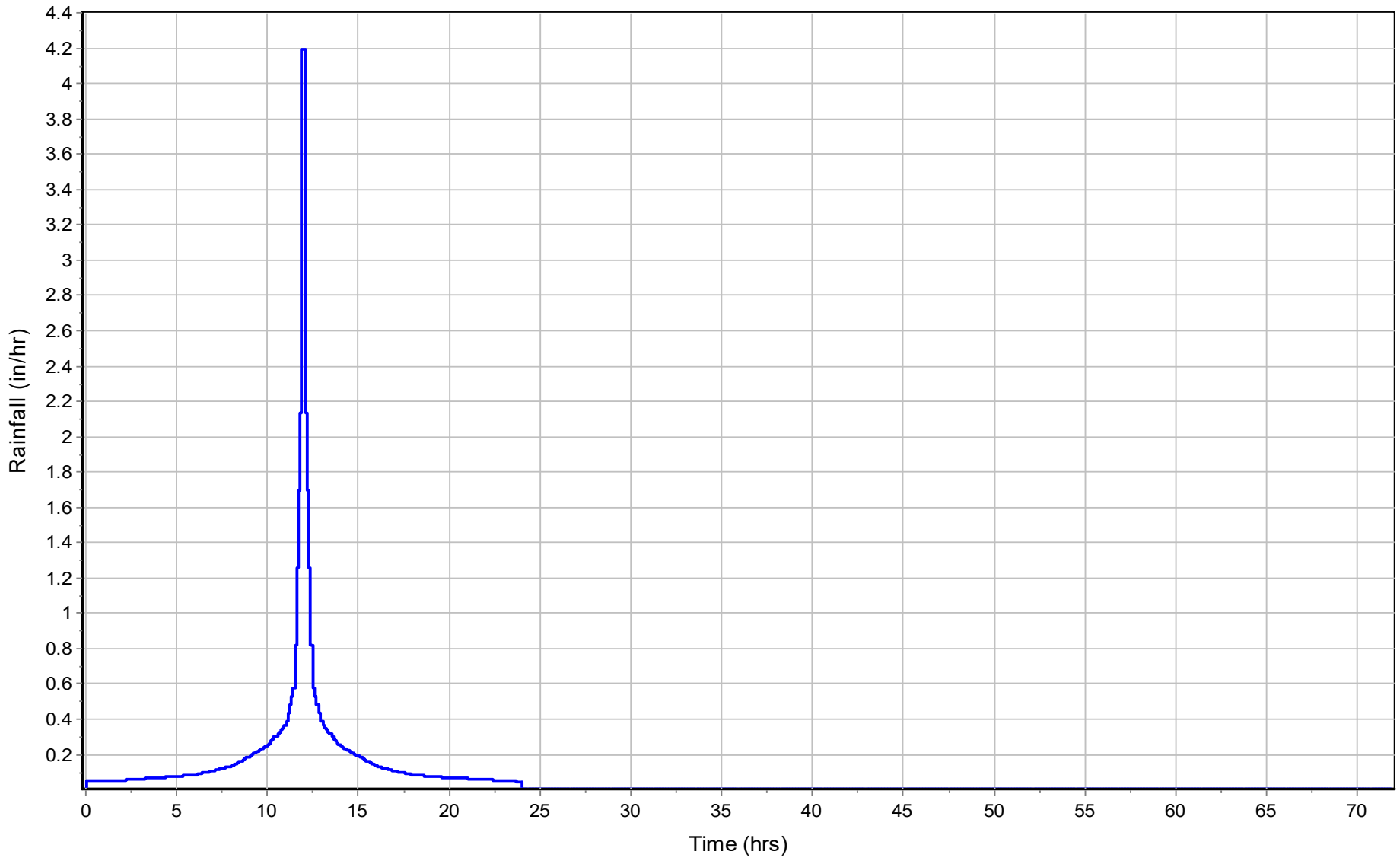
Total TOC (min) 9.01

Subbasin Runoff Results

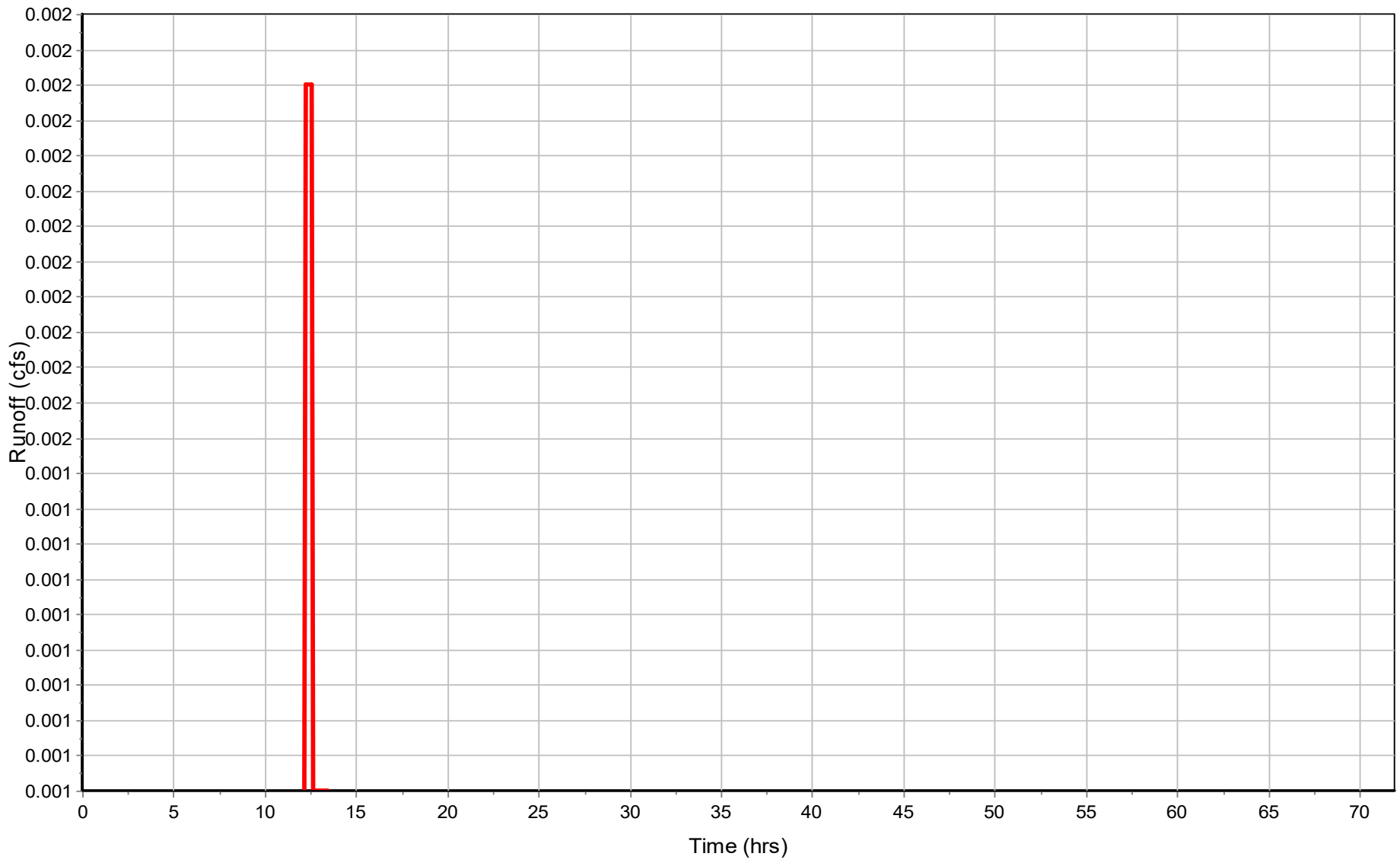
Total Rainfall (in) 4.99
Total Runoff (in) 0.1
Peak Runoff (cfs) 0
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:09:01

Subbasin : Sub-E05.1

Rainfall Intensity Graph



Runoff Hydrograph



Junction Input

SN	Element ID	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Ground/Rim (Max) Offset (ft)	Initial Water Elevation (ft)	Initial Water Depth (ft)	Surcharge Elevation (ft)	Surcharge Depth (ft)	Ponded Area (ft^2)	Minimum Pipe Cover (ft)
1	1-Jun	116.60	117.90	1.30	0.00	-116.60	0.00	-117.90	0.00	0.00

Junction Results

SN	Element ID	Peak Inflow (cfs)	Peak Lateral Inflow (cfs)	Max HGL Elevation Attained (ft)	Max HGL Depth Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Average HGL Elevation Attained (ft)	Average HGL Depth Attained (ft)	Time of Max HGL Occurrence (days hh:mm)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	1-Jun	0.01	0.01	116.65	0.05	0.00	5.05	116.60	0.00	0 12:42	0 00:00	0.00	0.00

Channel Input

SN	Element ID	Length (ft)	Inlet Invert Elevation (ft)	Inlet Invert Offset (ft)	Outlet Invert Elevation (ft)	Outlet Invert Offset (ft)	Total Drop (ft)	Average Slope (%)	Shape	Height (ft)	Width (ft)	Manning's Roughness	Entrance Losses	Exit/Bend Losses	Additional Losses	Initial Flow (cfs)	Flap Gate
1	Ditch-01	81.45	116.60	0.00	116.36	3.96	0.24	0.2900	Trapezoidal	1.300	6.200	0.0250	0.5000	0.5000	0.0000	0.00	No

Channel Results

SN	Element ID	Peak Flow (cfs)	Time of Peak Flow Occurrence (days hh:mm)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Travel Time (min)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Froude Number	Reported Condition
1	Ditch-01	0.01	0 12:43	11.76	0.00	0.32	4.24	0.03	0.02	0.00		

Storage Nodes

Storage Node : Basin-A1

Input Data

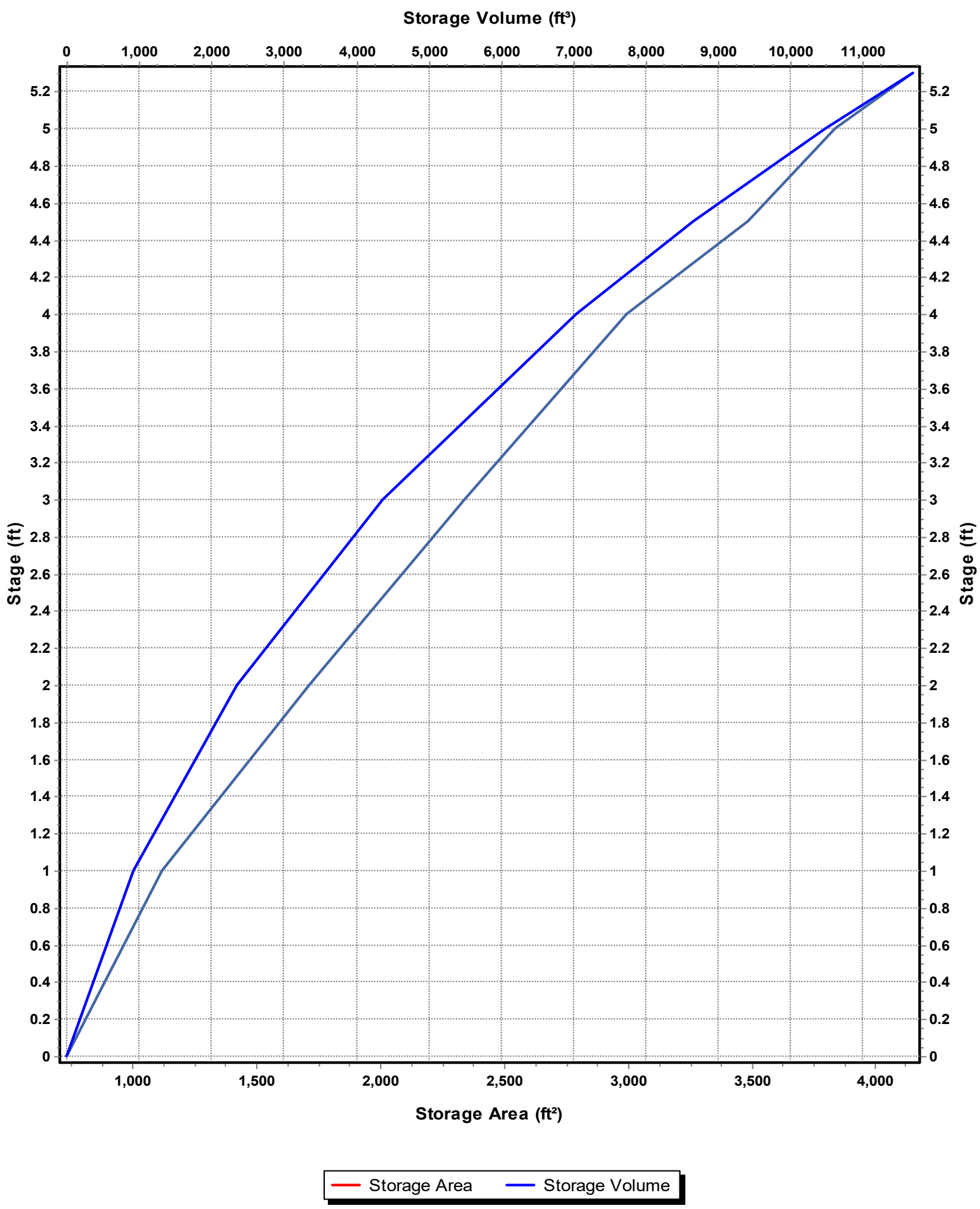
Invert Elevation (ft)	112.40
Max (Rim) Elevation (ft)	117.70
Max (Rim) Offset (ft)	5.30
Initial Water Elevation (ft)	112.40
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Basin-01

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	734.2	0
1	1121.14	927.67
2	1714.29	2345.39
3	2339.15	4372.11
4	2995.85	7039.61
4.5	3484.76	8659.76
5	3837.05	10490.21
5.3	4151.91	11688.55

Storage Area Volume Curves



Storage Node : Basin-A1 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-B-A1	Trapezoidal	No	117.40	5.00	4.00	0.30	3.33

Output Summary Results

Peak Inflow (cfs)	1.84
Peak Lateral Inflow (cfs)	0.03
Peak Outflow (cfs)	0
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	116.07
Max HGL Depth Attained (ft)	3.67
Average HGL Elevation Attained (ft)	115.36
Average HGL Depth Attained (ft)	2.96
Time of Max HGL Occurrence (days hh:mm)	1 05:19
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Basin-A2

Input Data

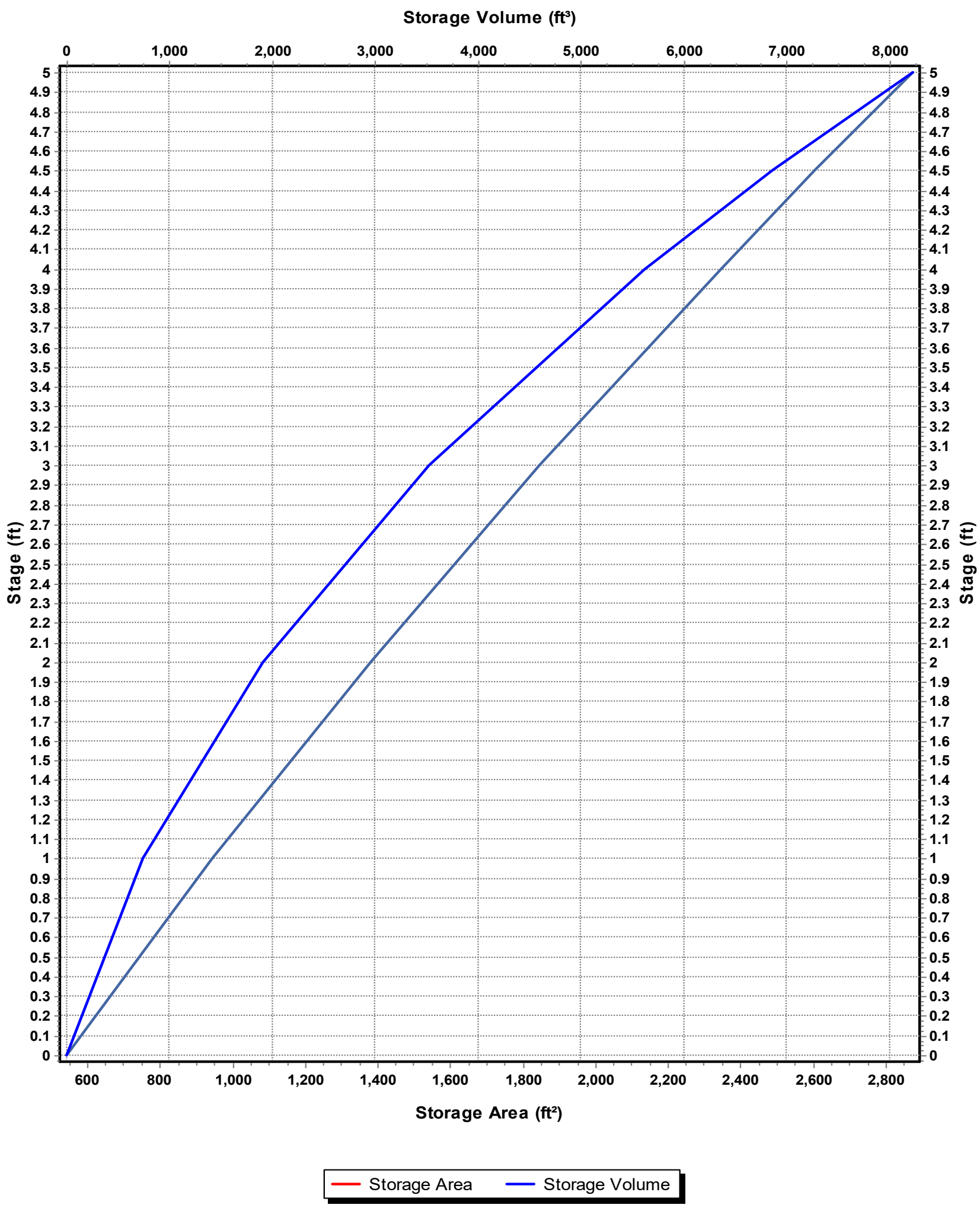
Invert Elevation (ft)	112.90
Max (Rim) Elevation (ft)	117.90
Max (Rim) Offset (ft)	5.00
Initial Water Elevation (ft)	112.90
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Basin-02

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	543.55	0
1	946	744.78
2	1380.46	1908.01
3	1846.91	3521.7
4	2345.37	5617.84
4.5	2606.6	6855.83
5	2875.82	8226.44

Storage Area Volume Curves



Storage Node : Basin-A2 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-B-A2	Trapezoidal	No	117.50	4.60	5.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	1.73
Peak Lateral Inflow (cfs)	0
Peak Outflow (cfs)	0
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	116.83
Max HGL Depth Attained (ft)	3.93
Average HGL Elevation Attained (ft)	116.09
Average HGL Depth Attained (ft)	3.19
Time of Max HGL Occurrence (days hh:mm)	1 01:02
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Forebay-A1

Input Data

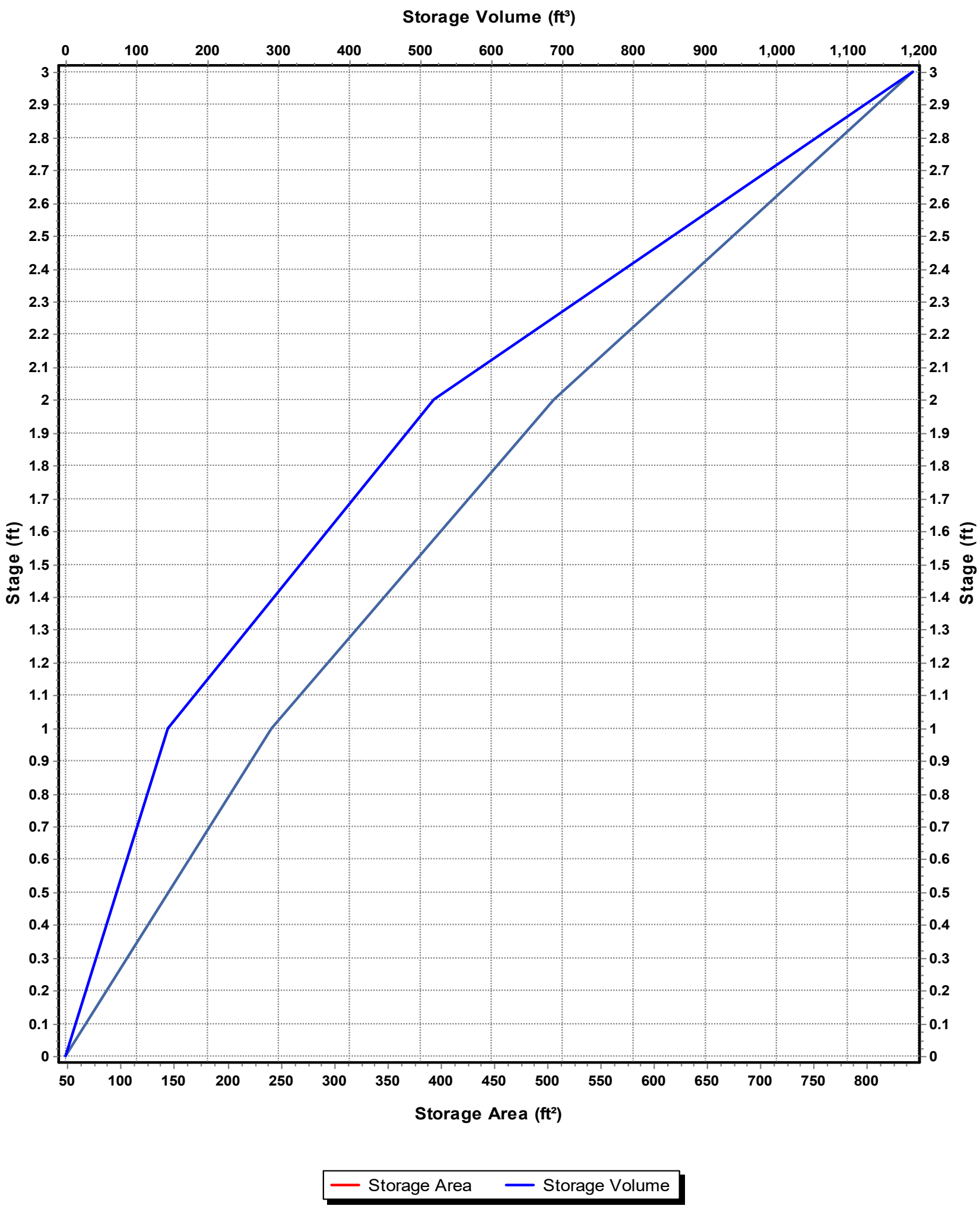
Invert Elevation (ft)	114.40
Max (Rim) Elevation (ft)	117.70
Max (Rim) Offset (ft)	3.30
Initial Water Elevation (ft)	114.40
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Forebay-01

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	48.29	0
1	241.18	144.74
2	506.06	518.36
3	842.94	1192.86

Storage Area Volume Curves



Storage Node : Forebay-A1 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-F-A1	Trapezoidal	No	117.30	2.90	8.00	2.00	3.33

Output Summary Results

Peak Inflow (cfs)	1.87
Peak Lateral Inflow (cfs)	1.87
Peak Outflow (cfs)	1.84
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	117.47
Max HGL Depth Attained (ft)	3.07
Average HGL Elevation Attained (ft)	116.86
Average HGL Depth Attained (ft)	2.46
Time of Max HGL Occurrence (days hh:mm)	0 12:10
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Forebay-A2

Input Data

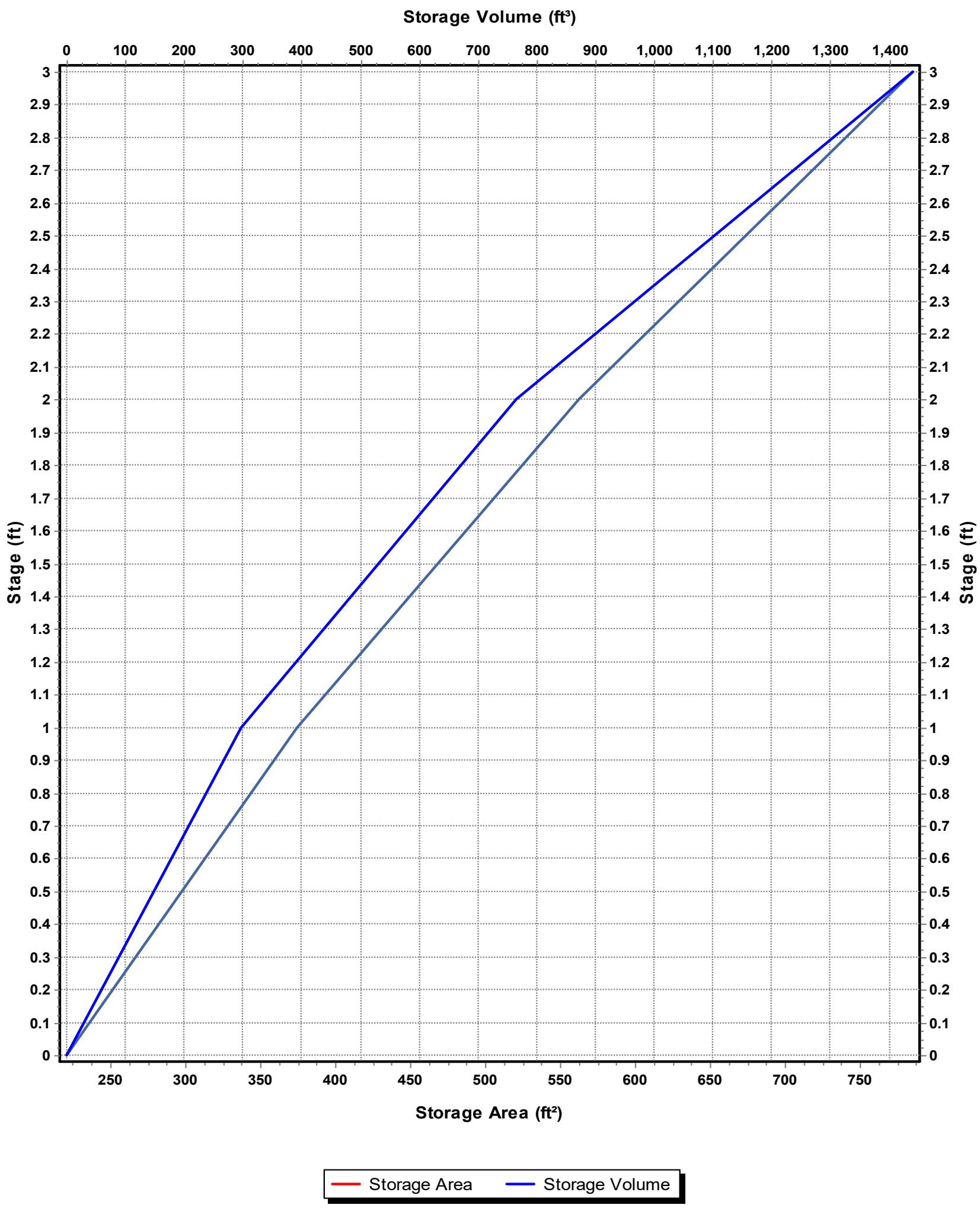
Invert Elevation (ft)	114.90
Max (Rim) Elevation (ft)	117.90
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.90
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Forebay-02

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	221.26	0
1	374.45	297.86
2	562.72	766.45
3	785.55	1440.59

Storage Area Volume Curves



Storage Node : Forebay-A2 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-F-A2	Trapezoidal	No	117.00	2.10	10.00	1.00	3.33

Output Summary Results

Peak Inflow (cfs)	1.74
Peak Lateral Inflow (cfs)	1.74
Peak Outflow (cfs)	1.73
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	117.14
Max HGL Depth Attained (ft)	2.24
Average HGL Elevation Attained (ft)	116.68
Average HGL Depth Attained (ft)	1.78
Time of Max HGL Occurrence (days hh:mm)	0 12:10
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Project Description

File Name ..... Pave.Paws_A1_A2.SPF

Project Options

Flow Units ..... CFS
Elevation Type ..... Elevation
Hydrology Method ..... SCS TR-20
Time of Concentration (TOC) Method ..... SCS TR-55
Link Routing Method ..... Hydrodynamic
Enable Overflow Ponding at Nodes ..... YES
Skip Steady State Analysis Time Periods .... NO

Analysis Options

Start Analysis On 00:00:00 0:00:00
End Analysis On 00:00:00 0:00:00
Start Reporting On 00:00:00 0:00:00
Antecedent Dry Days ..... 0 days
Runoff (Dry Weather) Time Step ..... 0 01:00:00 days hh:mm:ss
Runoff (Wet Weather) Time Step ..... 0 00:05:00 days hh:mm:ss
Reporting Time Step ..... 0 00:05:00 days hh:mm:ss
Routing Time Step ..... 30 seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	7
Nodes	7
Junctions	1
Outfalls	2
Flow Diversions	0
Inlets	0
Storage Nodes	4
Links	5
Channels	1
Pipes	0
Pumps	0
Orifices	0
Weirs	4
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	25 years	Intensity	inches	Massachusetts	None	25.00	5.97	SCS Type III 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Sub-A1	0.73	484.00	76.00	5.97	3.35	2.46	2.54	0 00:06:00
2	Sub-A2	0.69	484.00	76.00	5.97	3.35	2.30	2.36	0 00:06:00
3	Sub-E01	0.76	484.00	43.00	5.97	0.66	0.51	0.21	0 00:28:48
4	Sub-E01.1	0.25	484.00	43.00	5.97	0.66	0.16	0.08	0 00:17:56
5	Sub-E01_Ex	0.26	484.00	43.00	5.97	0.66	0.18	0.08	0 00:17:28
6	Sub-E03.1	0.10	484.00	43.00	5.97	0.66	0.07	0.03	0 00:21:30
7	Sub-E05.1	0.02	0.00	43.00	5.97	0.43	0.01	0.01	0 00:09:00

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	1-Jun	Junction	116.60	117.90	0.00	0.00	0.00	0.04	117.27	0.00	4.43	0 00:00	0.00	0.00
2	Out-E01	Outfall	116.00					0.21	116.00					
3	Out-Prop-A1	Outfall	116.00					0.09	116.00					
4	Basin-A1	Storage Node	112.40	117.70	112.40		0.00	2.46	117.26				0.00	0.00
5	Basin-A2	Storage Node	112.90	117.90	112.90		0.00	2.29	117.50				0.00	0.00
6	Forebay-A1	Storage Node	114.40	117.70	114.40		0.00	2.48	117.50				0.00	0.00
7	Forebay-A2	Storage Node	114.90	117.90	114.90		0.00	2.31	117.55				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length (ft)	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Average Slope (%)	Diameter or Height (ft)	Manning's Roughness	Peak Flow (cfs)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Reported Condition
1	Ditch-01	Channel	1-Jun	Basin-A1	81.45	116.60	116.36	0.2900	1.300	0.0250	0.04	11.76	0.00	0.48	0.78	0.60	0.00	
2	Weir-B-A1	Weir	Basin-A1	Out-Prop-A1		112.40	116.00				0.00							
3	Weir-B-A2	Weir	Basin-A2	1-Jun		112.90	116.60				0.03							
4	Weir-F-A1	Weir	Forebay-A1	Basin-A1		114.40	112.40				2.45							
5	Weir-F-A2	Weir	Forebay-A2	Basin-A2		114.90	112.90				2.29							

Subbasin Hydrology

Subbasin : Sub-A1

Input Data

Area (ac) 0.73
Peak Rate Factor 484
Weighted Curve Number 76
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	0.73	A	76
Composite Area & Weighted CN	0.73		76

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft^2)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	132.16	0	0
Slope (%) :	0.71	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.78	0	0
Computed Flow Time (min) :	2.84	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	257.27	0	0
Channel Slope (%) :	0.4	0	0
Cross Section Area (ft^2) :	2.067	0	0
Wetted Perimeter (ft) :	5.25	0	0
Velocity (ft/sec) :	1.69	0	0
Computed Flow Time (min) :	2.54	0	0

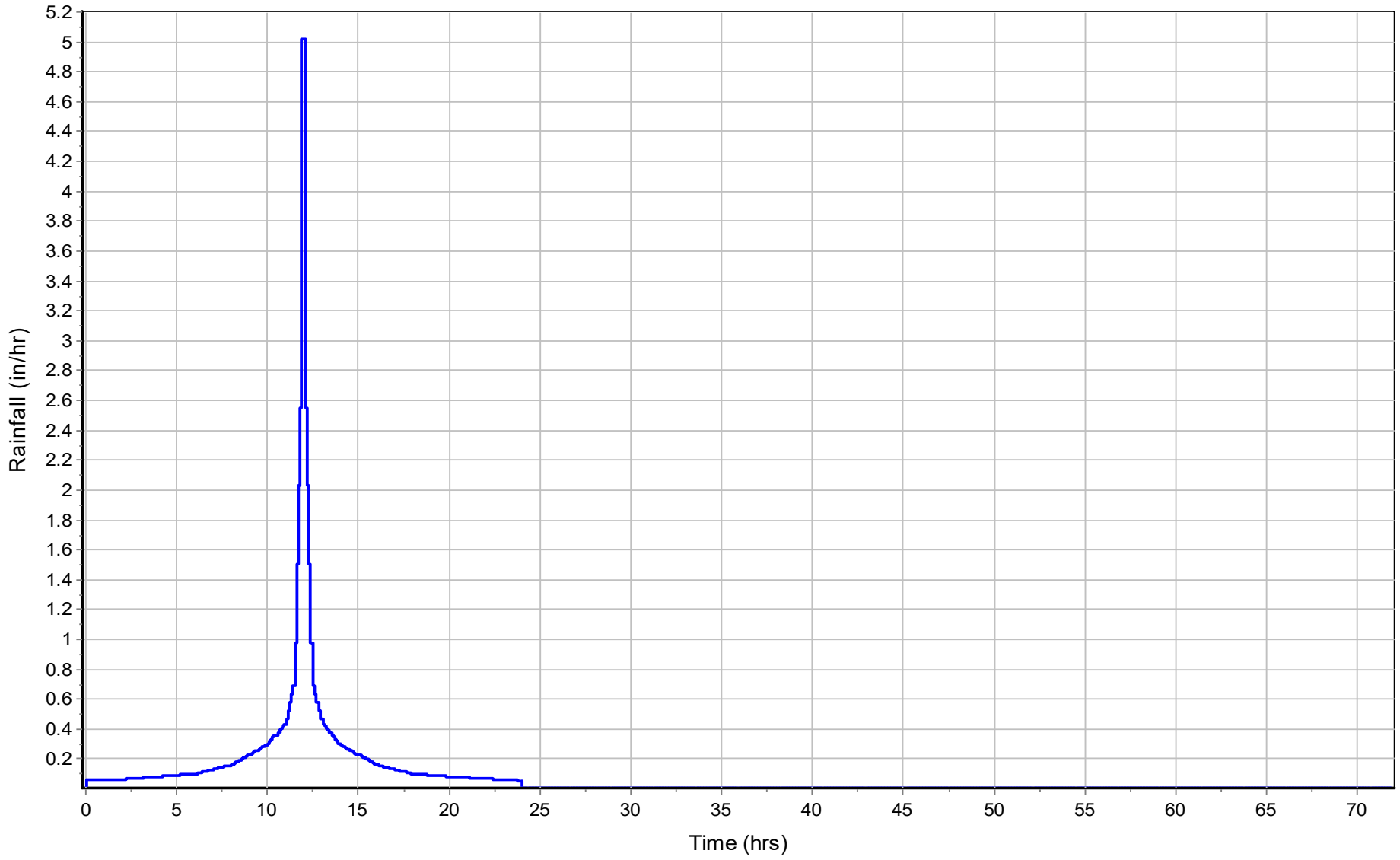
Total TOC (min) 5.38

Subbasin Runoff Results

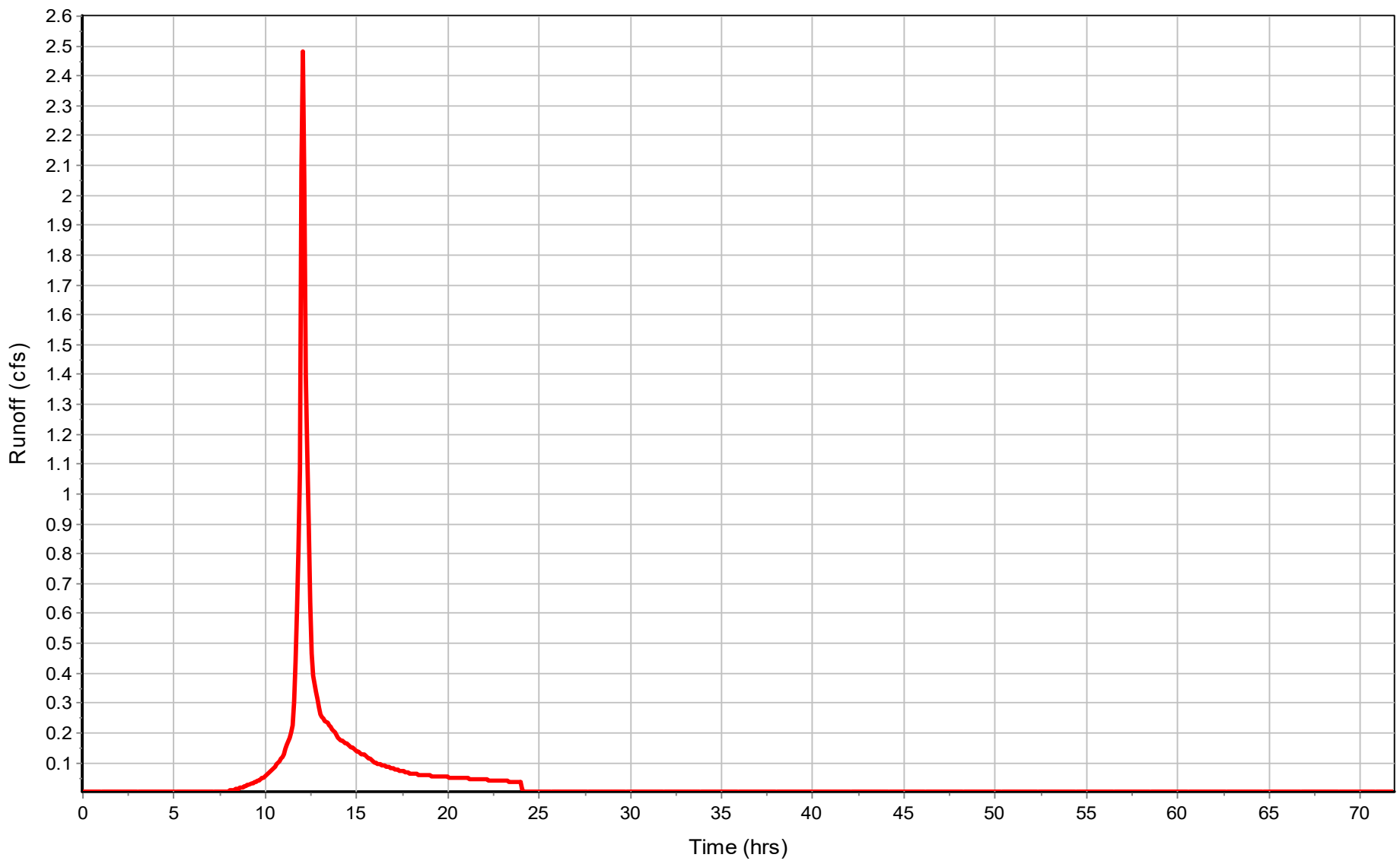
Total Rainfall (in)	5.97
Total Runoff (in)	3.35
Peak Runoff (cfs)	2.54
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:05:23

Subbasin : Sub-A1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-A2

Input Data

Area (ac) 0.69
Peak Rate Factor 484
Weighted Curve Number 76
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	0.69	A	76
Composite Area & Weighted CN	0.69		76

Time of Concentration

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	331.61	0	0
Channel Slope (%) :	5.4	0	0
Cross Section Area (ft^2) :	3	0	0
Wetted Perimeter (ft) :	6.32	0	0
Velocity (ft/sec) :	7.02	0	0
Computed Flow Time (min) :	0.79	0	0

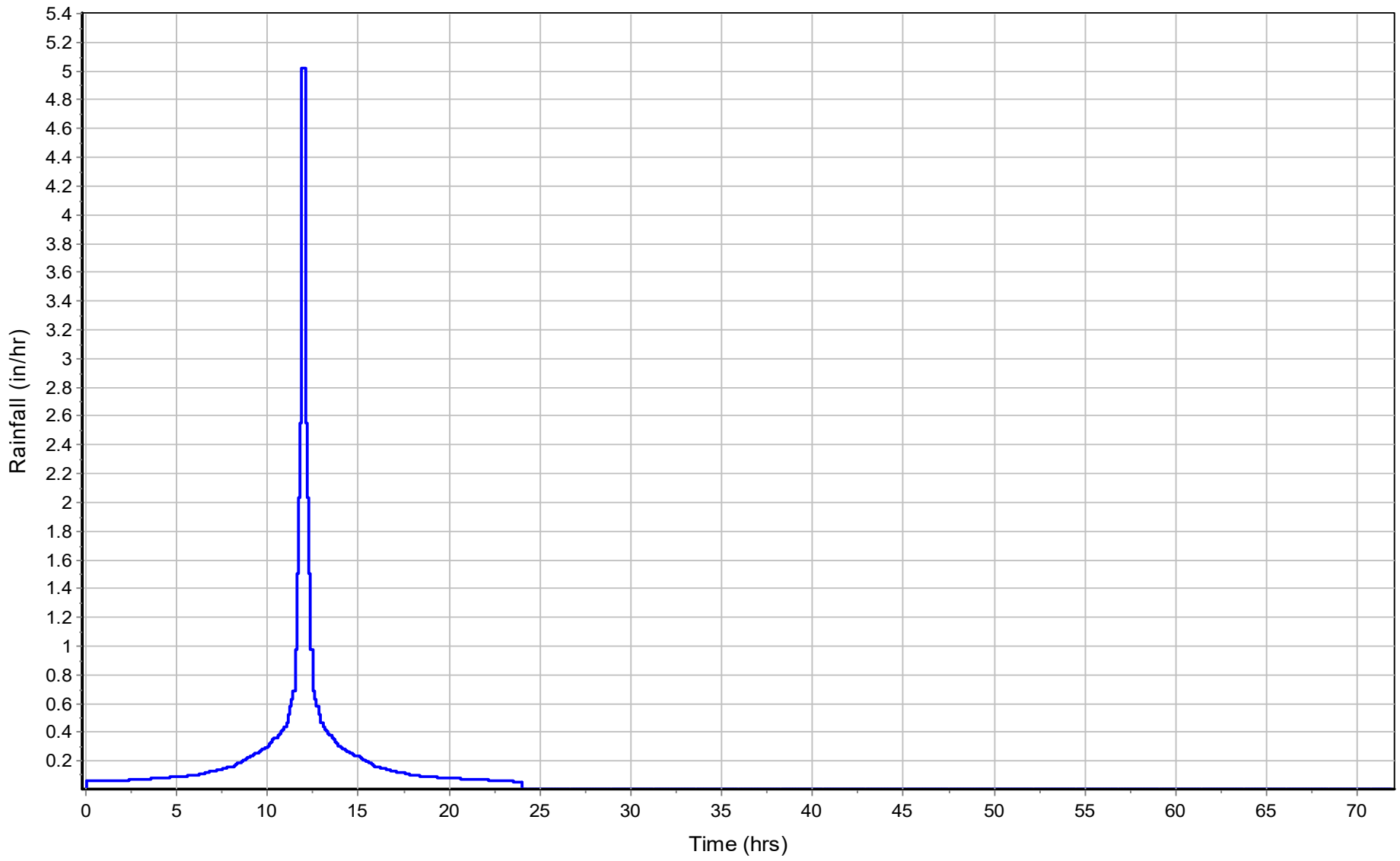
Total TOC (min) 0.79

Subbasin Runoff Results

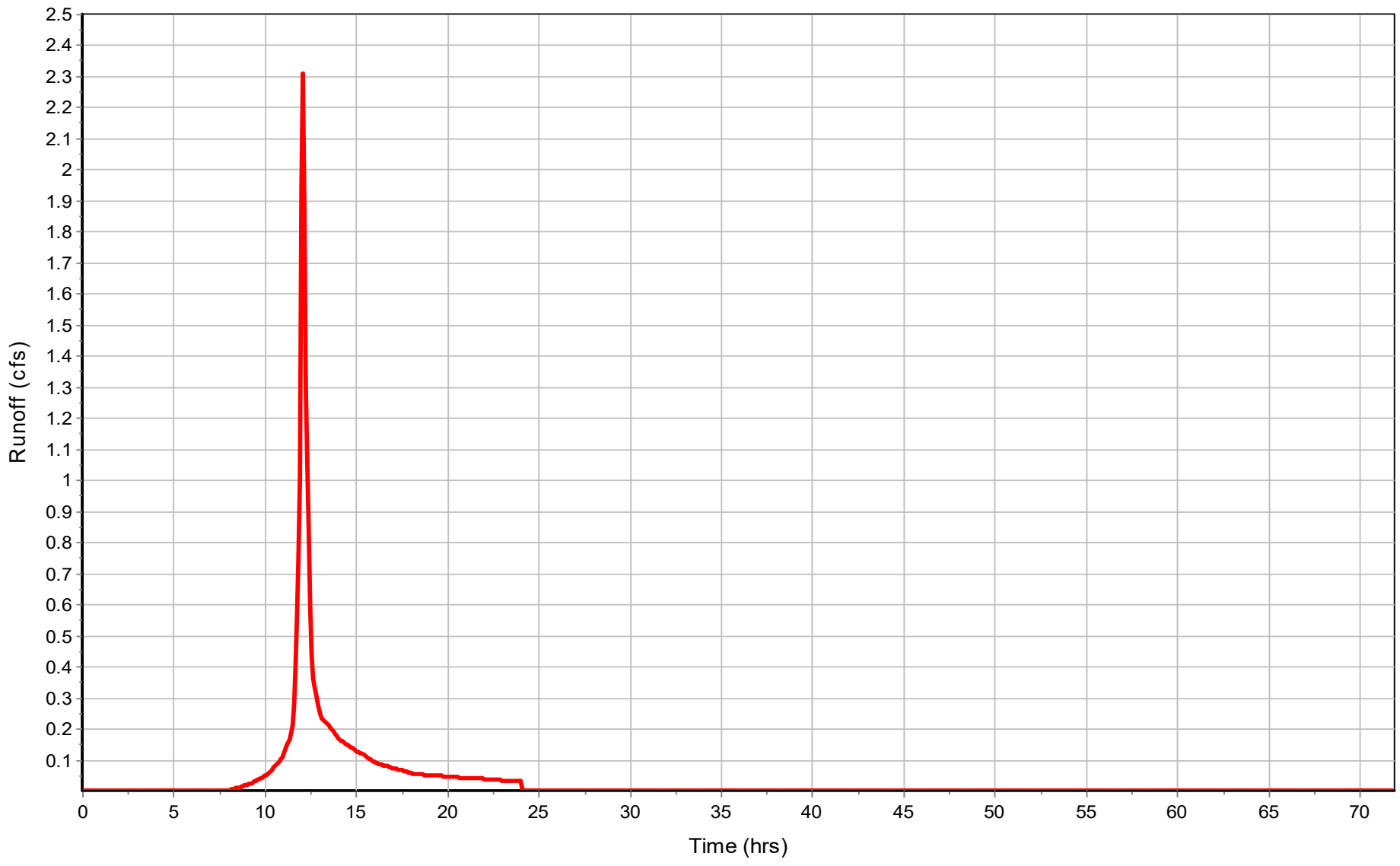
Total Rainfall (in) 5.97
Total Runoff (in) 3.35
Peak Runoff (cfs) 2.36
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:00:47

Subbasin : Sub-A2

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E01

Input Data

Area (ac) 0.76
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.76	A	43
Composite Area & Weighted CN	0.76		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	249.61	0	0
Slope (%) :	22	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.14	0	0
Computed Flow Time (min) :	28.81	0	0

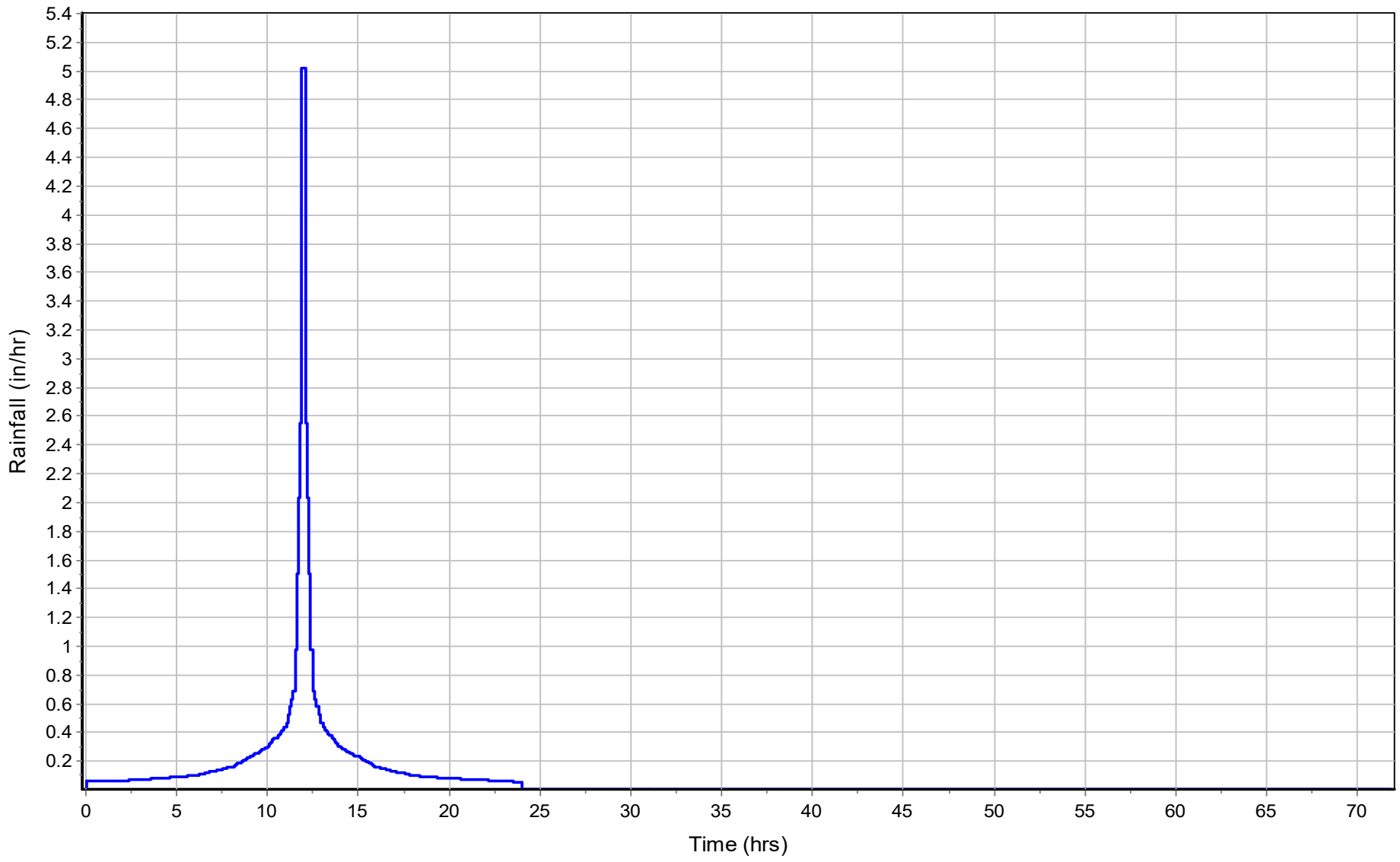
Total TOC (min) 28.81

Subbasin Runoff Results

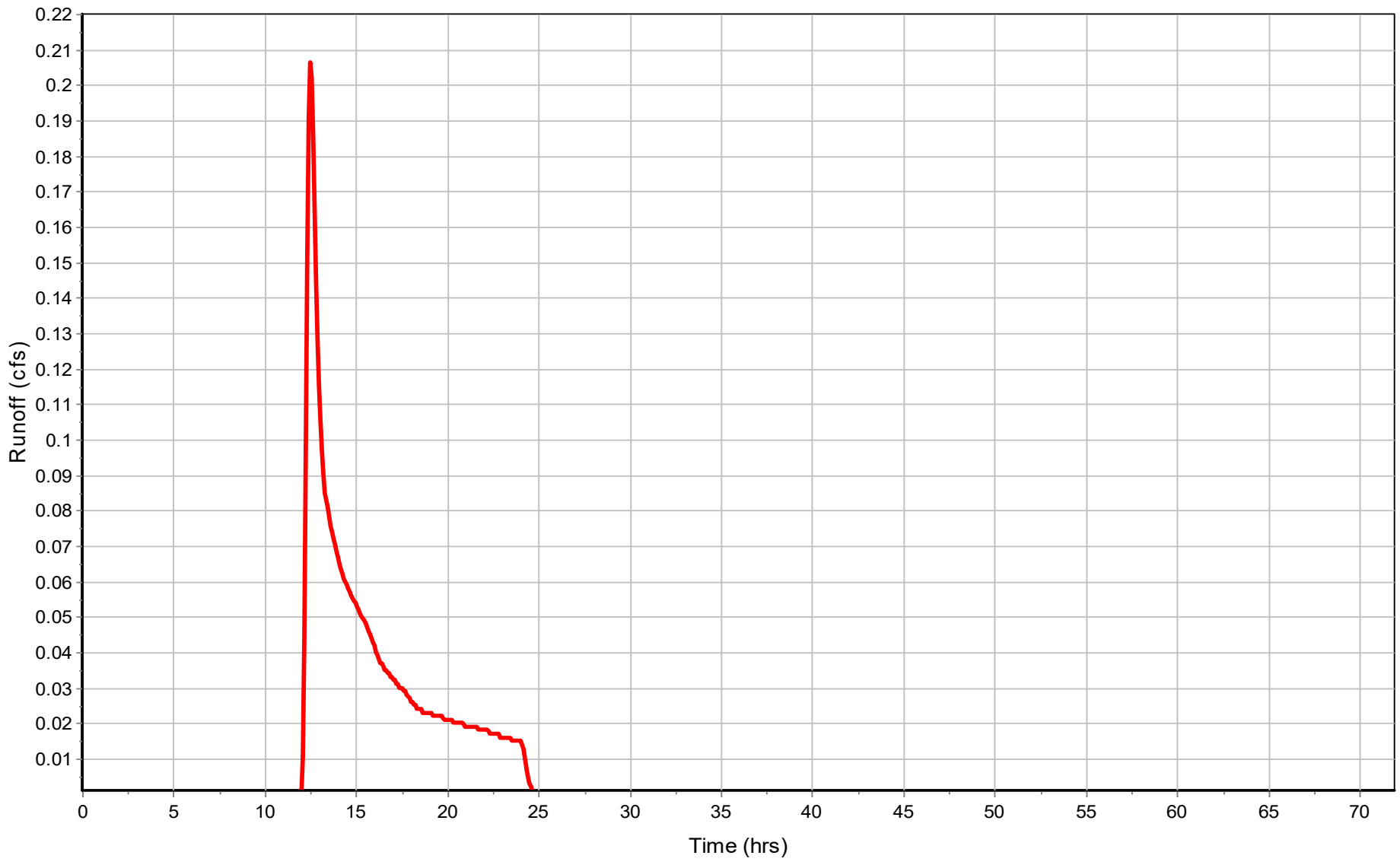
Total Rainfall (in) 5.97
Total Runoff (in) 0.66
Peak Runoff (cfs) 0.21
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:28:49

Subbasin : Sub-E01

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E01.1

Input Data

Area (ac) 0.25
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.25	A	43
Composite Area & Weighted CN	0.25		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	128.34	0	0
Slope (%) :	19	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.12	0	0
Computed Flow Time (min) :	17.94	0	0

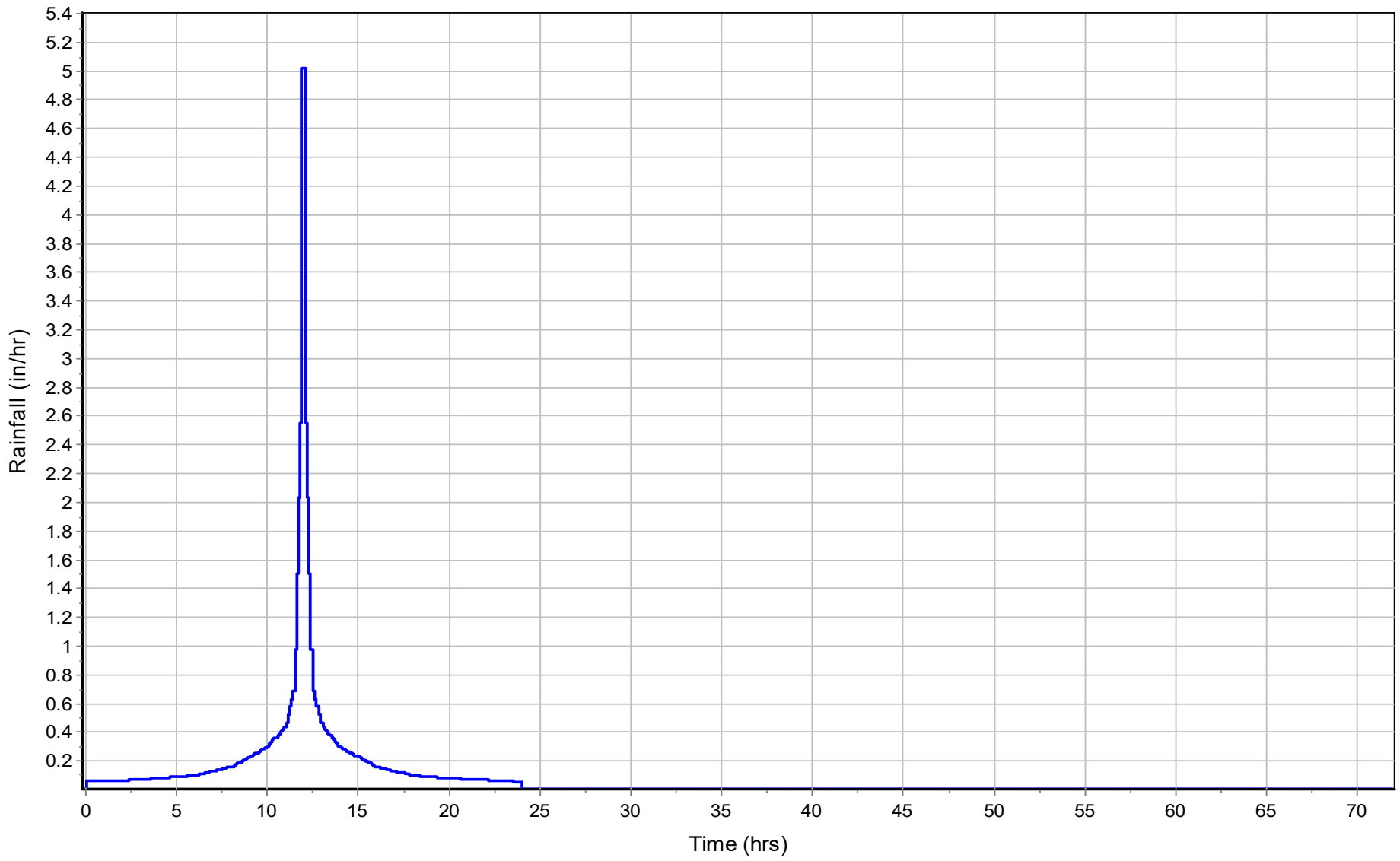
Total TOC (min) 17.94

Subbasin Runoff Results

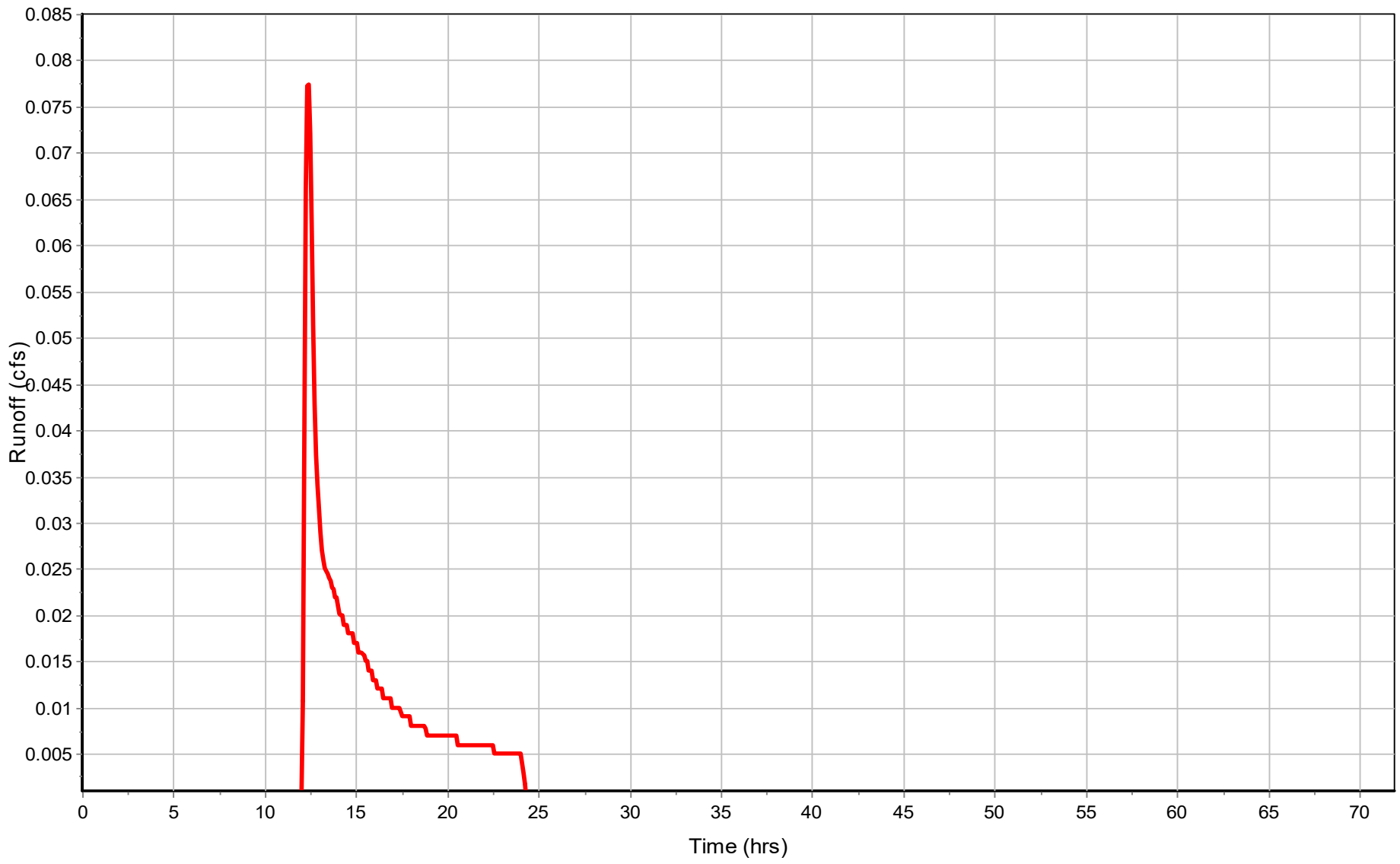
Total Rainfall (in) 5.97
Total Runoff (in) 0.66
Peak Runoff (cfs) 0.08
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:17:56

Subbasin : Sub-E01.1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E01_Ex

Input Data

Area (ac) 0.26
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.26	A	43
Composite Area & Weighted CN	0.26		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	106.59	0	0
Slope (%) :	14	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.1	0	0
Computed Flow Time (min) :	17.48	0	0

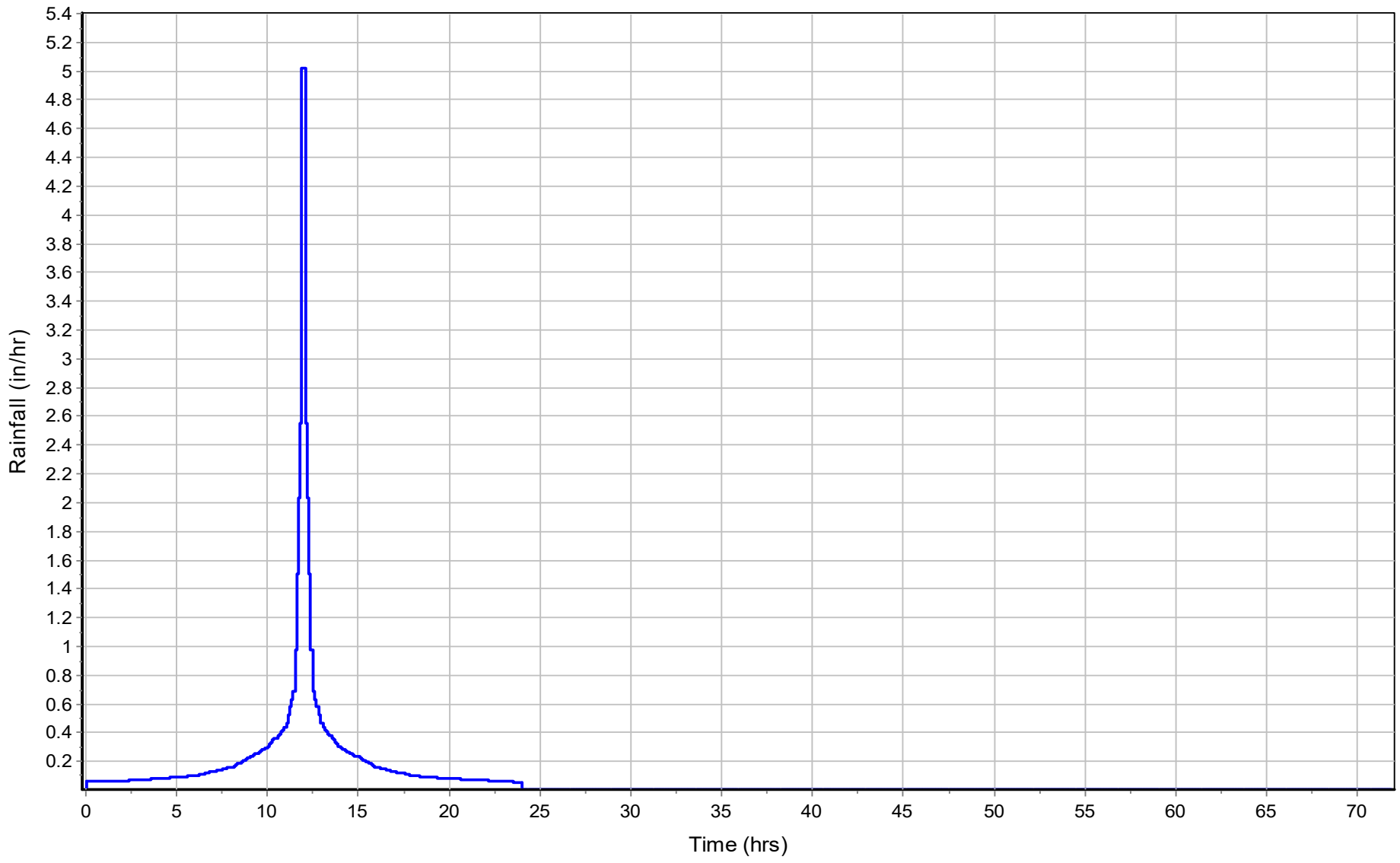
Total TOC (min) 17.48

Subbasin Runoff Results

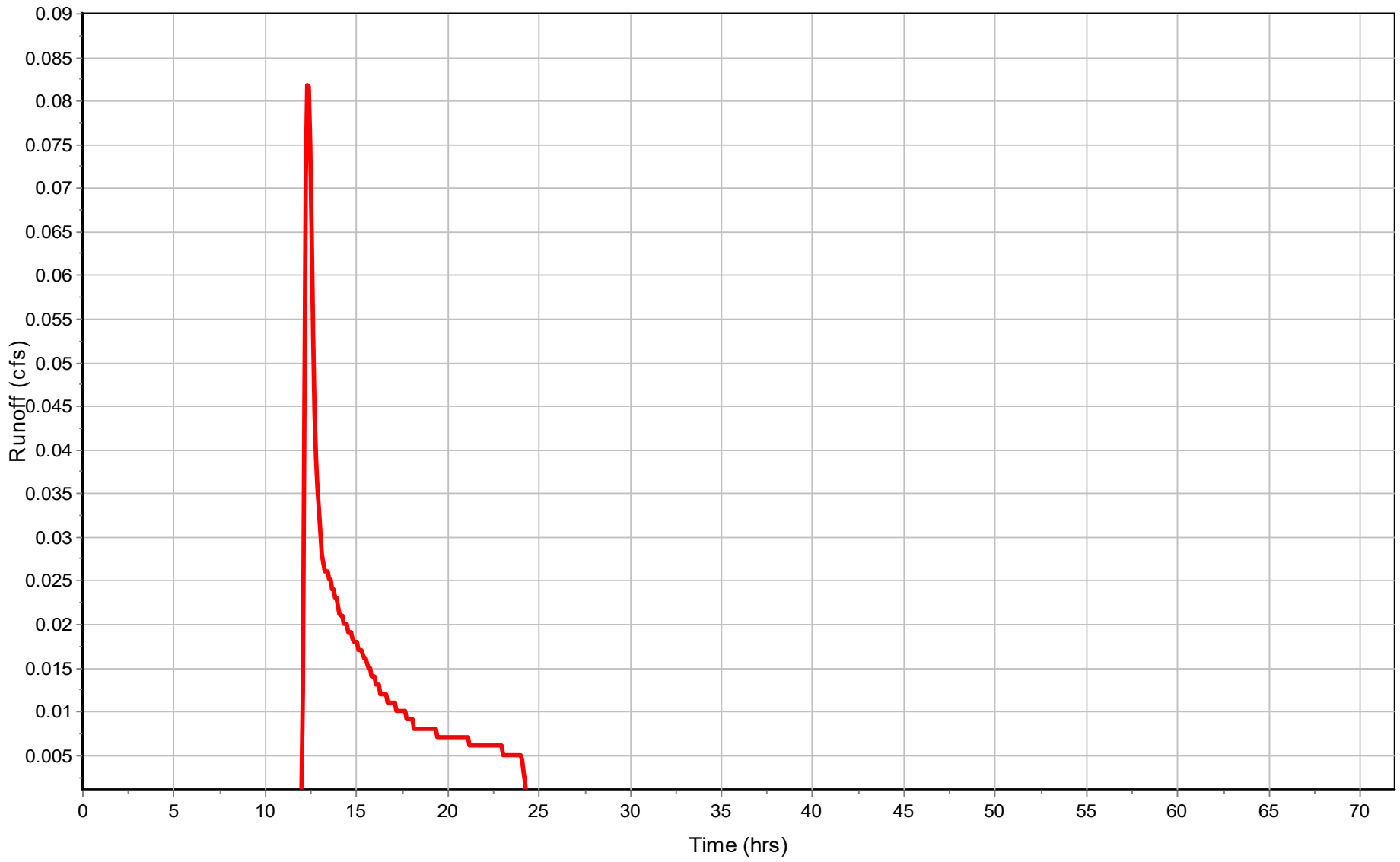
Total Rainfall (in) 5.97
Total Runoff (in) 0.66
Peak Runoff (cfs) 0.08
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:17:29

Subbasin : Sub-E01_Ex

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E03.1

Input Data

Area (ac) 0.1
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.1	A	43
Composite Area & Weighted CN	0.1		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	138.1	0	0
Slope (%) :	14	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.11	0	0
Computed Flow Time (min) :	21.5	0	0

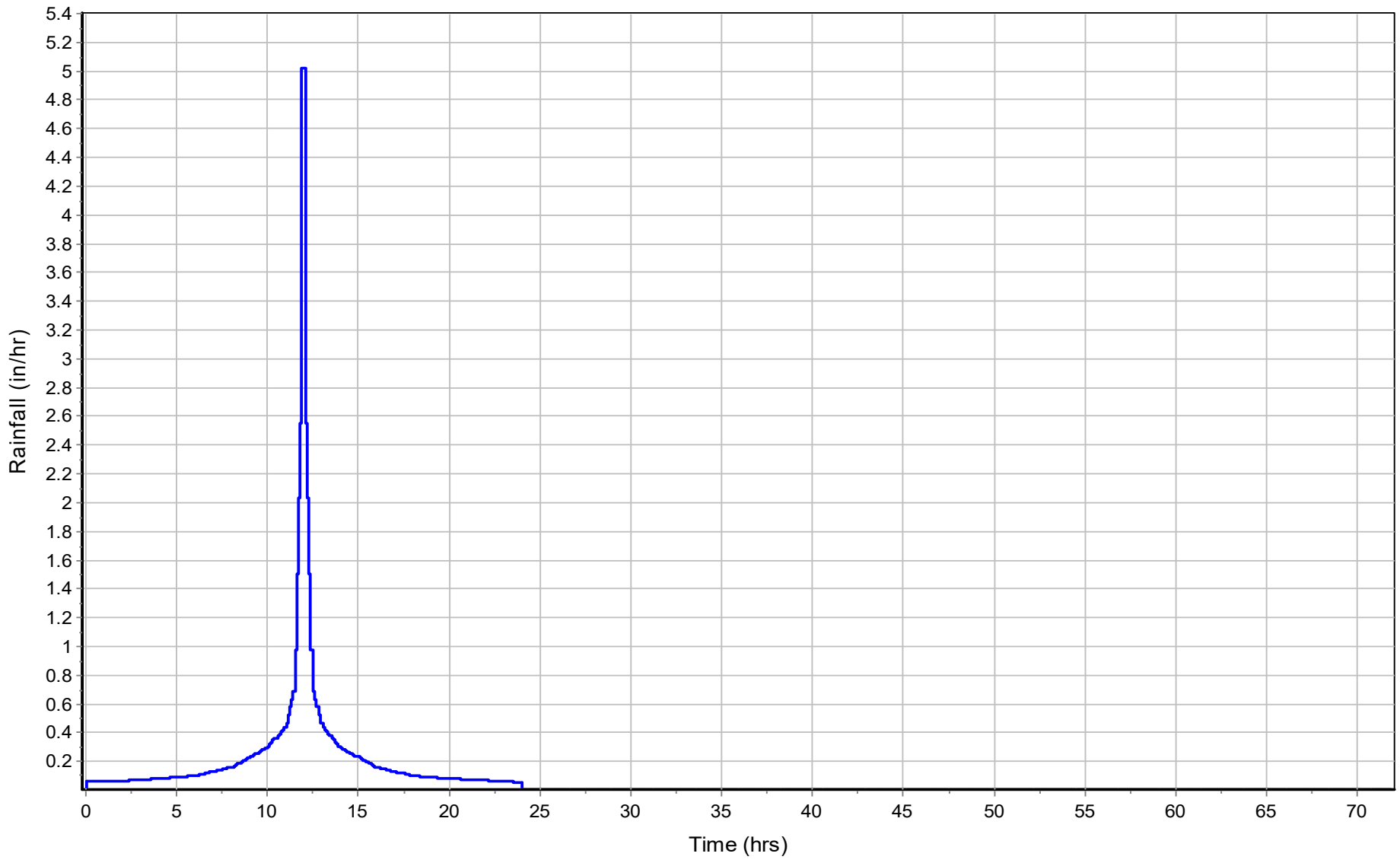
Total TOC (min) 21.50

Subbasin Runoff Results

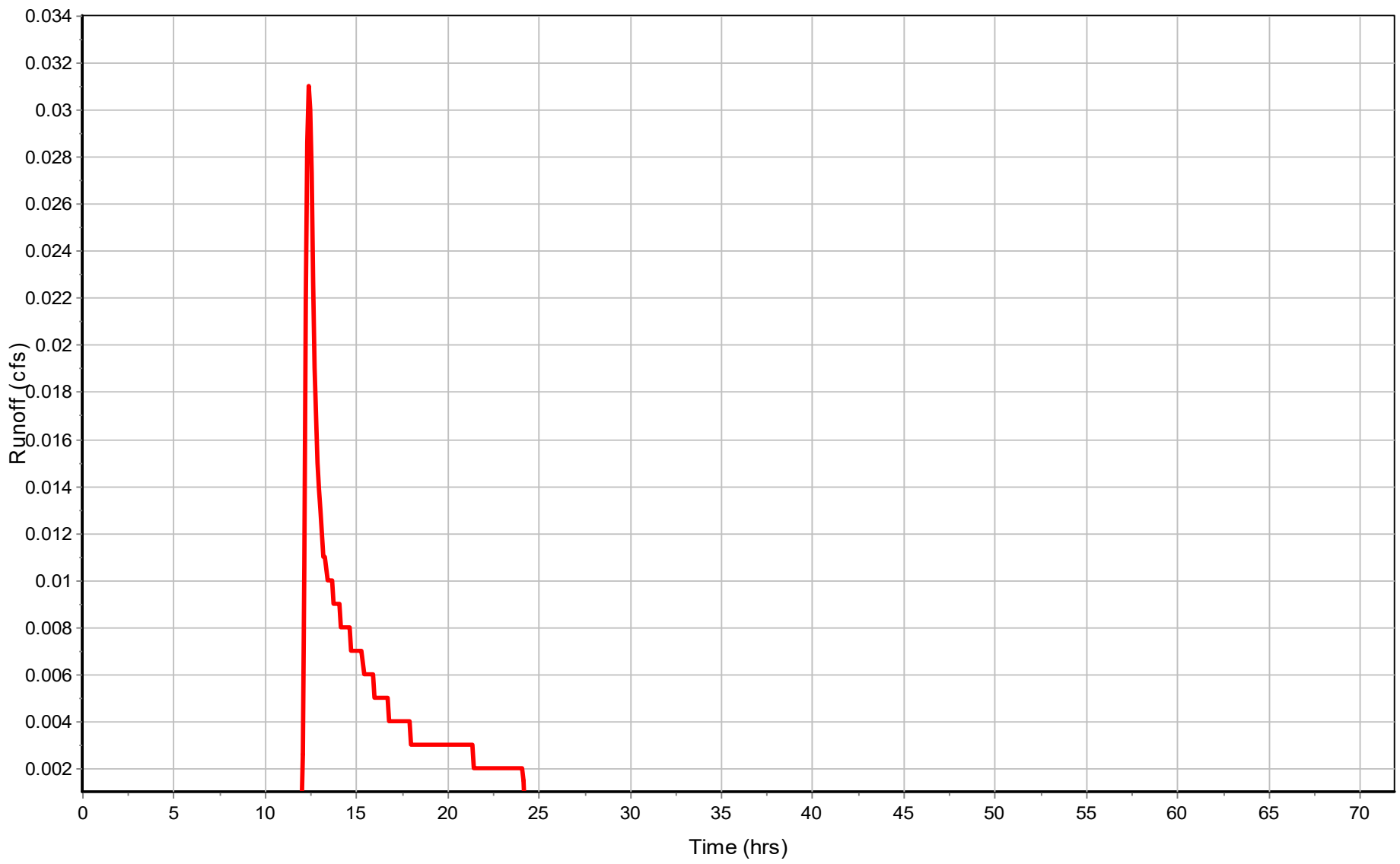
Total Rainfall (in) 5.97
Total Runoff (in) 0.66
Peak Runoff (cfs) 0.03
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:21:30

Subbasin : Sub-E03.1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E05.1

Input Data

Area (ac) 0.02
Peak Rate Factor 0
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.02	A	43
Composite Area & Weighted CN	0.02		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	43.1	0	0
Slope (%) :	12	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.08	0	0
Computed Flow Time (min) :	9.01	0	0

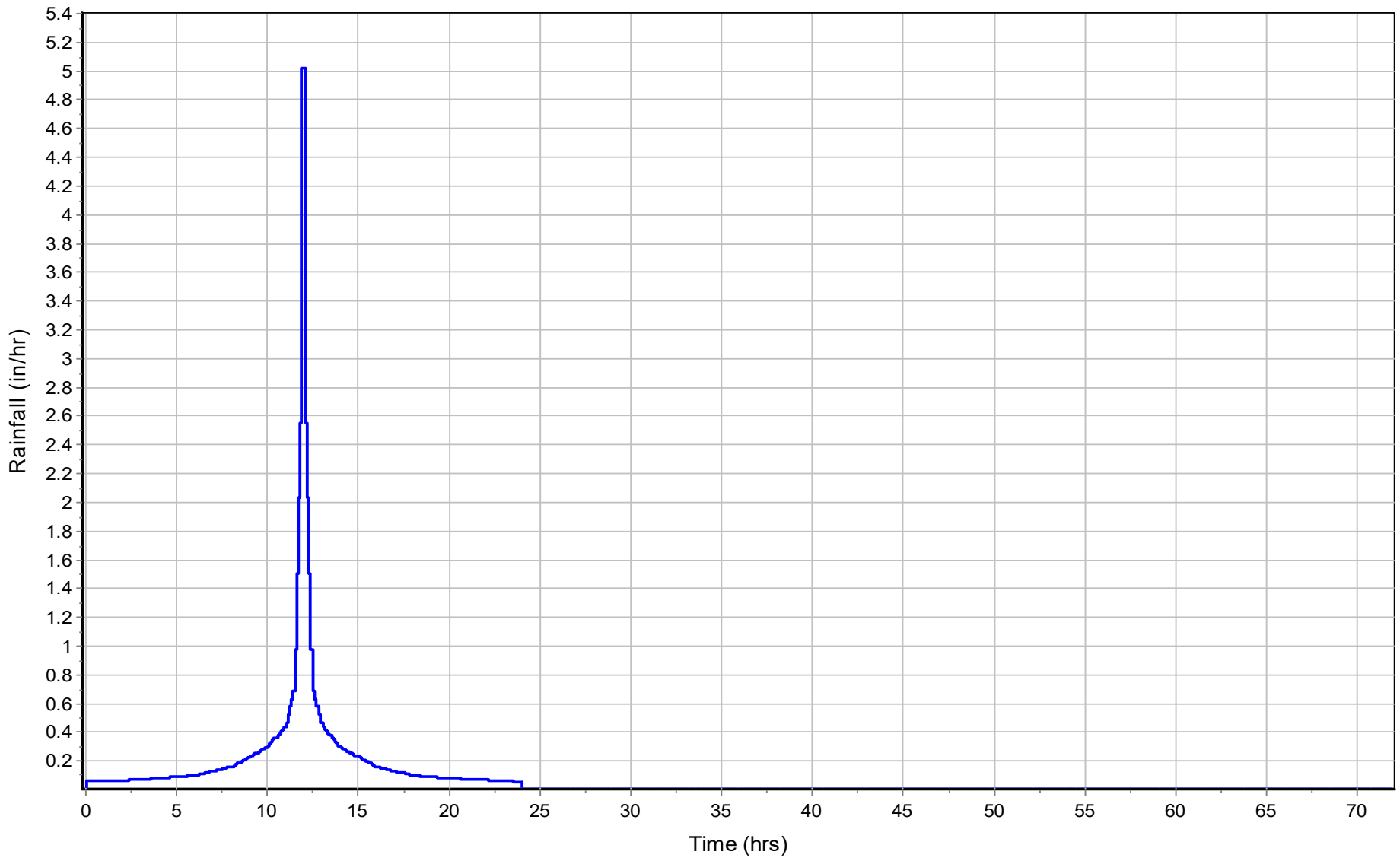
Total TOC (min) 9.01

Subbasin Runoff Results

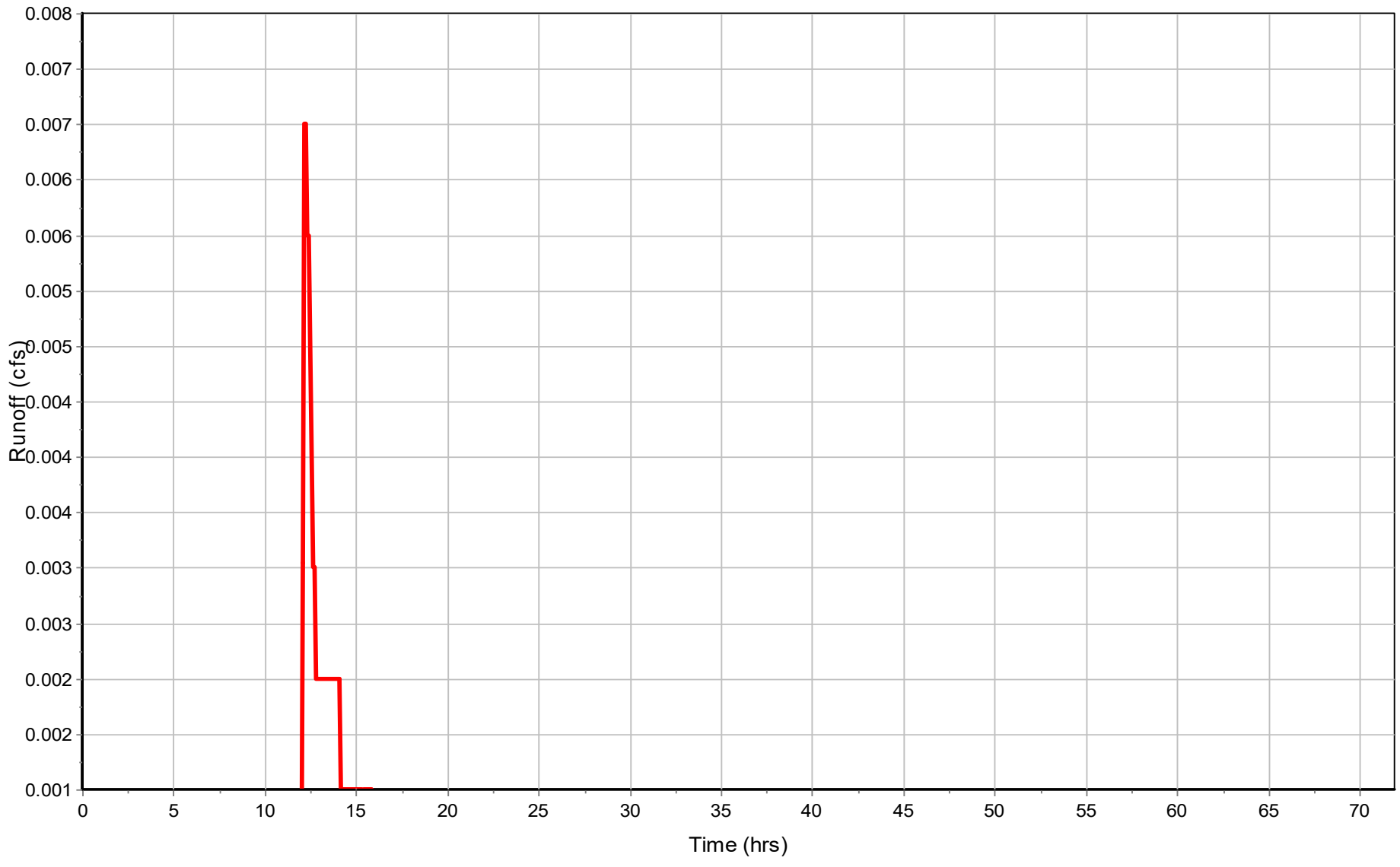
Total Rainfall (in) 5.97
Total Runoff (in) 0.43
Peak Runoff (cfs) 0.01
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:09:01

Subbasin : Sub-E05.1

Rainfall Intensity Graph



Runoff Hydrograph



Junction Input

SN	Element ID	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Ground/Rim (Max) Offset (ft)	Initial Water Elevation (ft)	Initial Water Depth (ft)	Surcharge Elevation (ft)	Surcharge Depth (ft)	Ponded Area (ft^2)	Minimum Pipe Cover (ft)
1	1-Jun	116.60	117.90	1.30	0.00	-116.60	0.00	-117.90	0.00	0.00

Junction Results

SN	Element ID	Peak Inflow (cfs)	Peak Lateral Inflow (cfs)	Max HGL Elevation Attained (ft)	Max HGL Depth Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Average HGL Elevation Attained (ft)	Average HGL Depth Attained (ft)	Time of Max HGL Occurrence (days hh:mm)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	1-Jun	0.04	0.03	117.27	0.67	0.00	4.43	116.95	0.35	3 00:00	0 00:00	0.00	0.00

Channel Input

SN	Element ID	Length (ft)	Inlet Invert Elevation (ft)	Inlet Invert Offset (ft)	Outlet Invert Elevation (ft)	Outlet Invert Offset (ft)	Total Drop (ft)	Average Slope (%)	Shape	Height (ft)	Width (ft)	Manning's Roughness	Entrance Losses	Exit/Bend Losses	Additional Losses	Initial Flow (cfs)	Flap Gate
1	Ditch-01	81.45	116.60	0.00	116.36	3.96	0.24	0.2900	Trapezoidal	1.300	6.200	0.0250	0.5000	0.5000	0.0000	0.00	No

Channel Results

SN	Element ID	Peak Flow (cfs)	Time of Peak Flow Occurrence (days hh:mm)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Travel Time (min)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Froude Number	Reported Condition
1	Ditch-01	0.04	1 00:06	11.76	0.00	0.48	2.83	0.78	0.60	0.00		

Storage Nodes

Storage Node : Basin-A1

Input Data

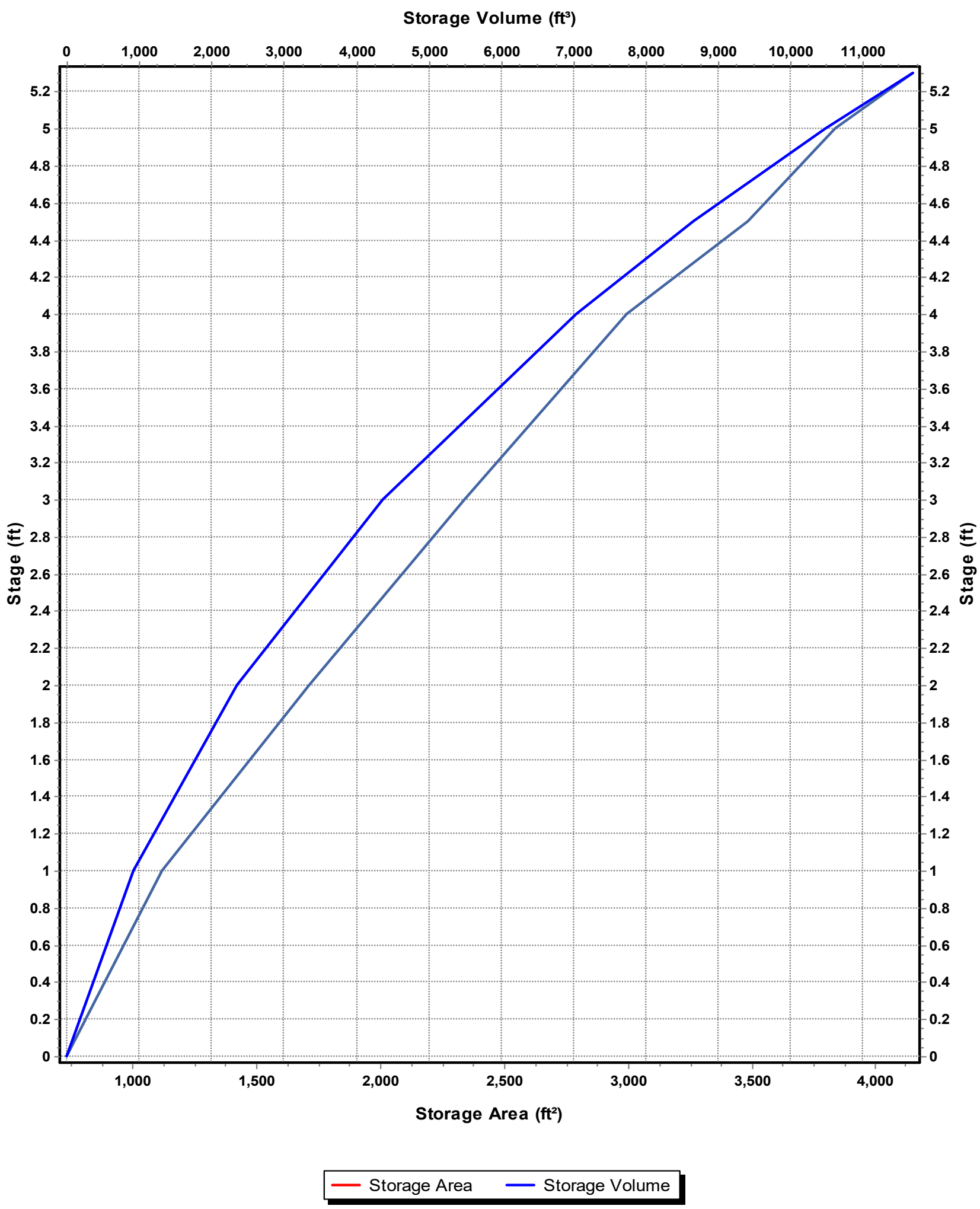
Invert Elevation (ft)	112.40
Max (Rim) Elevation (ft)	117.70
Max (Rim) Offset (ft)	5.30
Initial Water Elevation (ft)	112.40
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Basin-01

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	734.2	0
1	1121.14	927.67
2	1714.29	2345.39
3	2339.15	4372.11
4	2995.85	7039.61
4.5	3484.76	8659.76
5	3837.05	10490.21
5.3	4151.91	11688.55

Storage Area Volume Curves



Storage Node : Basin-A1 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-B-A1	Trapezoidal	No	117.40	5.00	4.00	0.30	3.33

Output Summary Results

Peak Inflow (cfs)	2.46
Peak Lateral Inflow (cfs)	0.08
Peak Outflow (cfs)	0
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	117.26
Max HGL Depth Attained (ft)	4.86
Average HGL Elevation Attained (ft)	116.19
Average HGL Depth Attained (ft)	3.79
Time of Max HGL Occurrence (days hh:mm)	3 00:00
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Basin-A2

Input Data

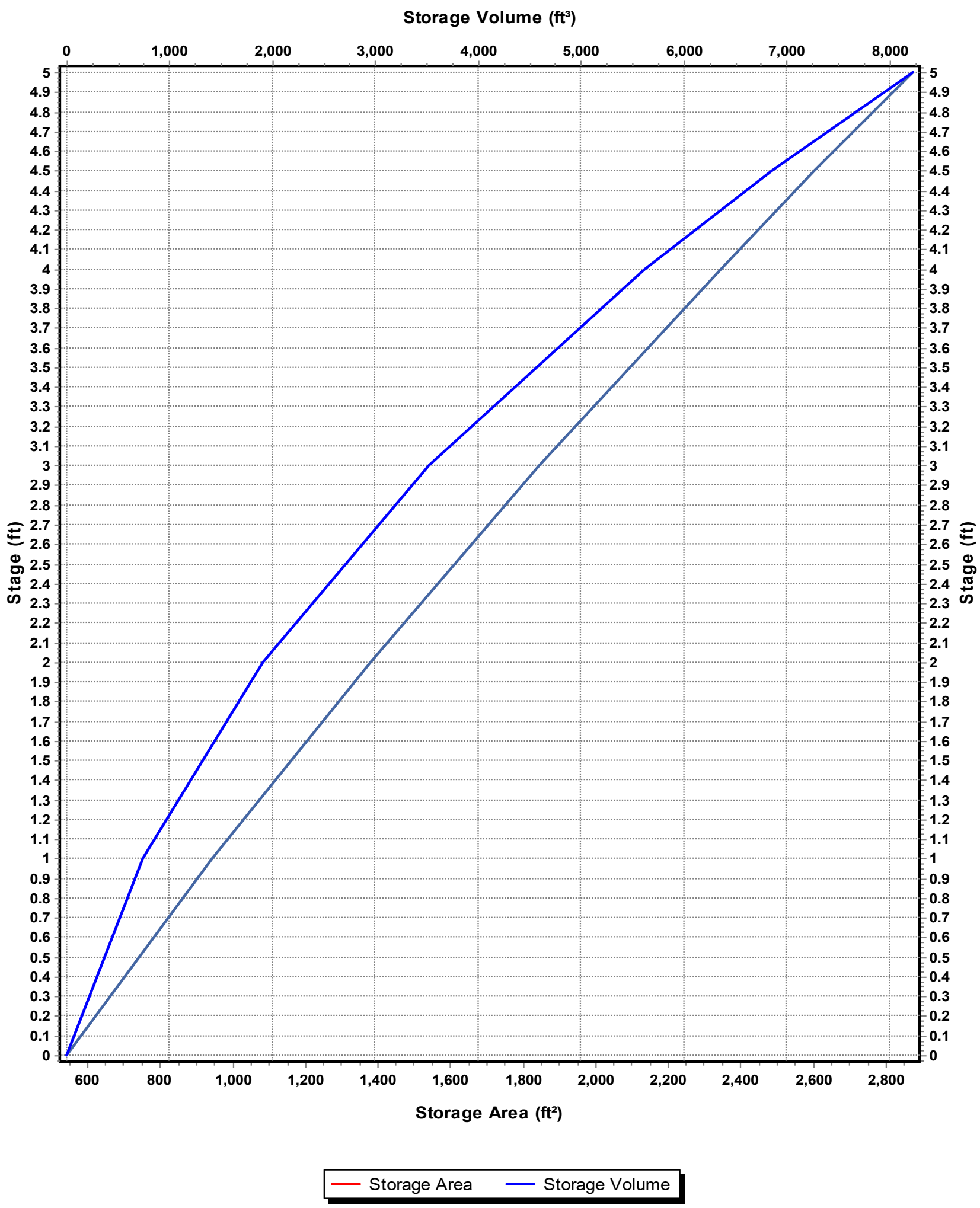
Invert Elevation (ft)	112.90
Max (Rim) Elevation (ft)	117.90
Max (Rim) Offset (ft)	5.00
Initial Water Elevation (ft)	112.90
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Basin-02

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	543.55	0
1	946	744.78
2	1380.46	1908.01
3	1846.91	3521.7
4	2345.37	5617.84
4.5	2606.6	6855.83
5	2875.82	8226.44

Storage Area Volume Curves



Storage Node : Basin-A2 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-B-A2	Trapezoidal	No	117.50	4.60	5.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	2.29
Peak Lateral Inflow (cfs)	0
Peak Outflow (cfs)	0.44
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	117.5
Max HGL Depth Attained (ft)	4.6
Average HGL Elevation Attained (ft)	116.65
Average HGL Depth Attained (ft)	3.75
Time of Max HGL Occurrence (days hh:mm)	1 00:06
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Forebay-A1

Input Data

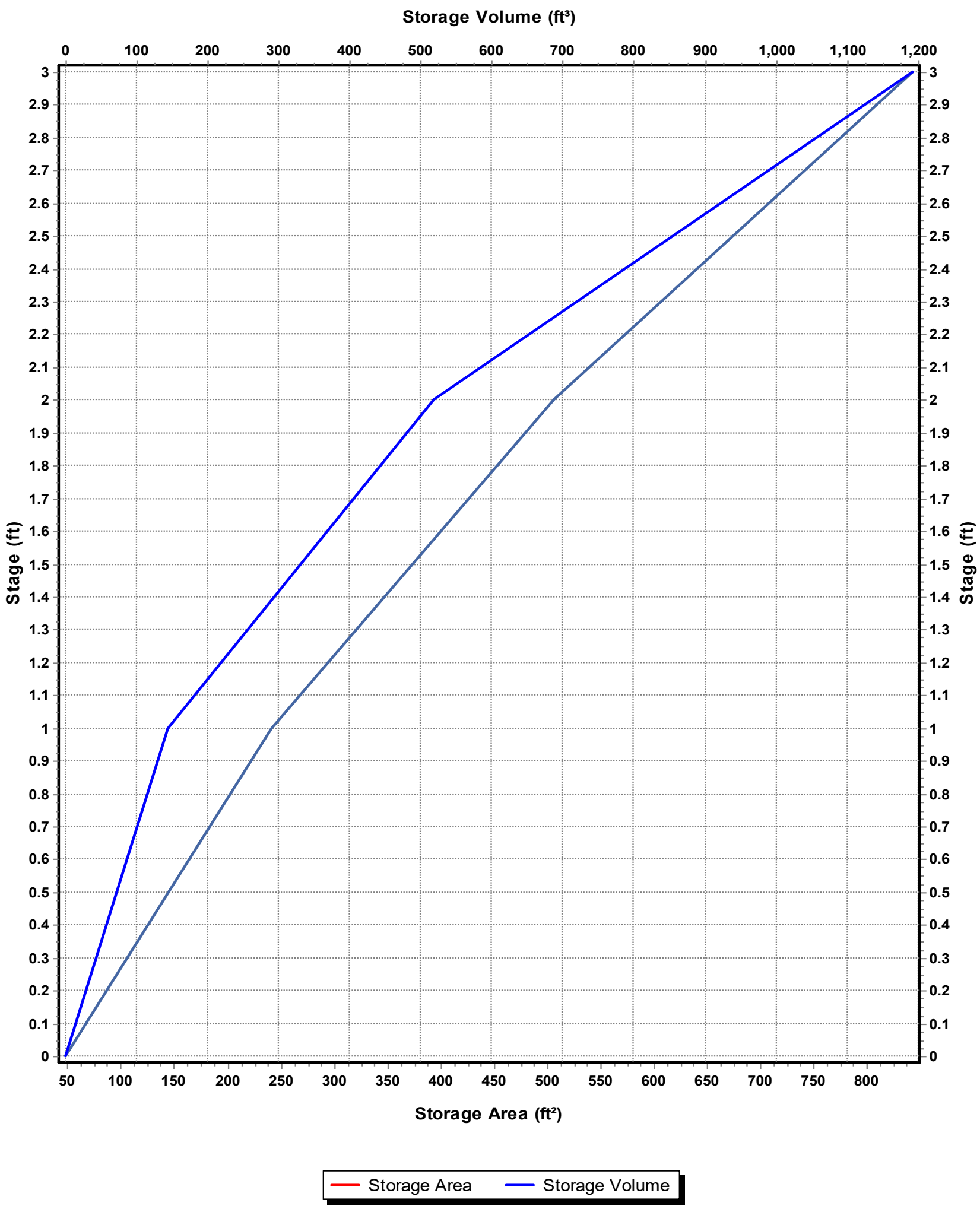
Invert Elevation (ft)	114.40
Max (Rim) Elevation (ft)	117.70
Max (Rim) Offset (ft)	3.30
Initial Water Elevation (ft)	114.40
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Forebay-01

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	48.29	0
1	241.18	144.74
2	506.06	518.36
3	842.94	1192.86

Storage Area Volume Curves



Storage Node : Forebay-A1 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-F-A1	Trapezoidal	No	117.30	2.90	8.00	2.00	3.33

Output Summary Results

Peak Inflow (cfs)	2.48
Peak Lateral Inflow (cfs)	2.48
Peak Outflow (cfs)	2.45
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	117.5
Max HGL Depth Attained (ft)	3.1
Average HGL Elevation Attained (ft)	116.89
Average HGL Depth Attained (ft)	2.49
Time of Max HGL Occurrence (days hh:mm)	0 12:10
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Forebay-A2

Input Data

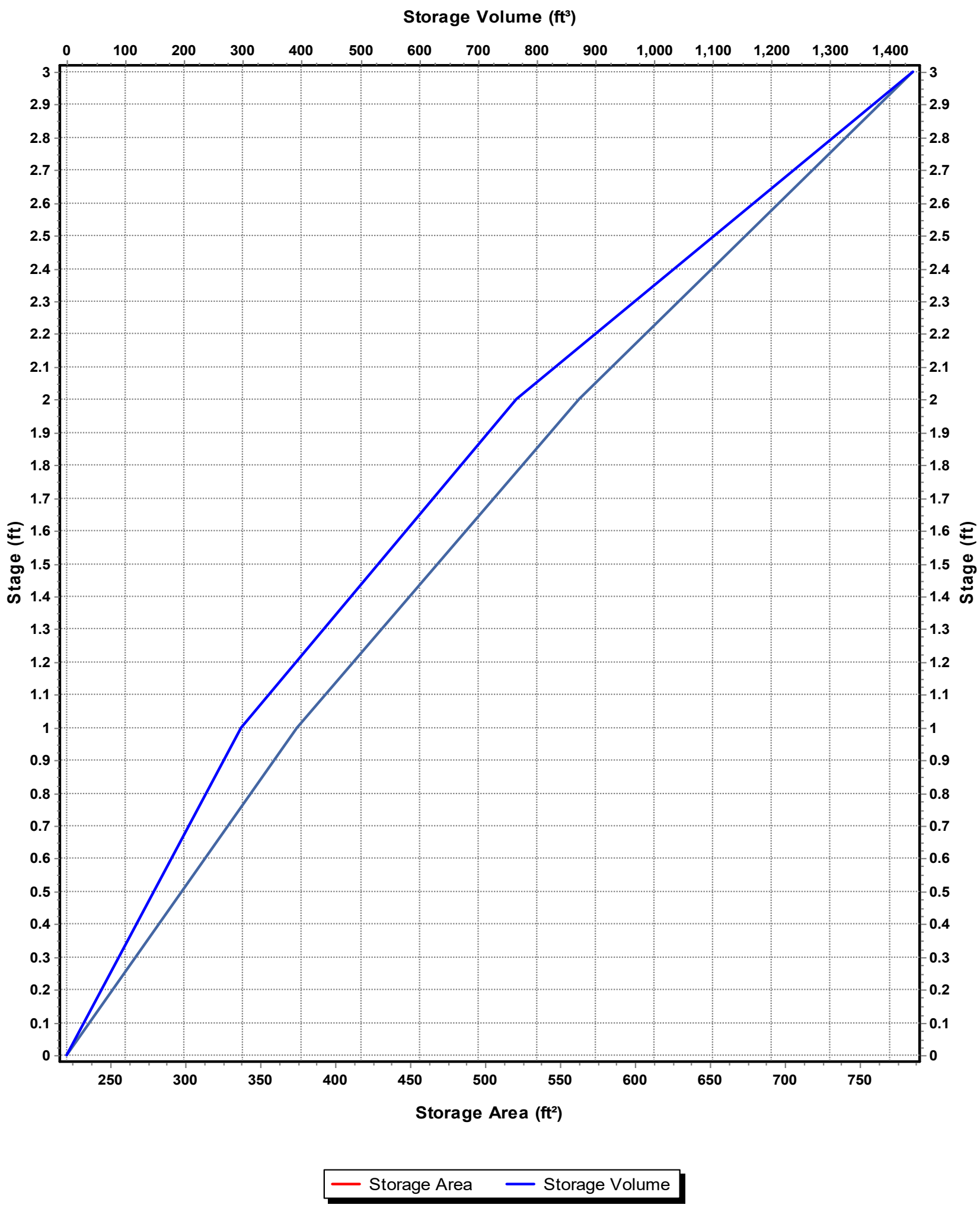
Invert Elevation (ft)	114.90
Max (Rim) Elevation (ft)	117.90
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.90
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Forebay-02

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	221.26	0
1	374.45	297.86
2	562.72	766.45
3	785.55	1440.59

Storage Area Volume Curves



Storage Node : Forebay-A2 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-F-A2	Trapezoidal	No	117.00	2.10	10.00	1.00	3.33

Output Summary Results

Peak Inflow (cfs)	2.31
Peak Lateral Inflow (cfs)	2.31
Peak Outflow (cfs)	2.29
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	117.55
Max HGL Depth Attained (ft)	2.65
Average HGL Elevation Attained (ft)	117.08
Average HGL Depth Attained (ft)	2.18
Time of Max HGL Occurrence (days hh:mm)	1 00:05
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Project Description

File Name ..... Pave.Paws_A1_A2.SPF

Project Options

Flow Units ..... CFS
Elevation Type ..... Elevation
Hydrology Method ..... SCS TR-20
Time of Concentration (TOC) Method ..... SCS TR-55
Link Routing Method ..... Hydrodynamic
Enable Overflow Ponding at Nodes ..... YES
Skip Steady State Analysis Time Periods .... NO

Analysis Options

Start Analysis On 00:00:00 0:00:00
End Analysis On 00:00:00 0:00:00
Start Reporting On 00:00:00 0:00:00
Antecedent Dry Days ..... 0 days
Runoff (Dry Weather) Time Step ..... 0 01:00:00 days hh:mm:ss
Runoff (Wet Weather) Time Step ..... 0 00:05:00 days hh:mm:ss
Reporting Time Step ..... 0 00:05:00 days hh:mm:ss
Routing Time Step ..... 30 seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	7
Nodes	7
Junctions	1
Outfalls	2
Flow Diversions	0
Inlets	0
Storage Nodes	4
Links	5
Channels	1
Pipes	0
Pumps	0
Orifices	0
Weirs	4
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	50 years	Intensity	inches	Massachusetts	None	50.00	6.71	SCS Type III 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Sub-A1	0.73	484.00	76.00	6.71	4.00	2.94	3.02	0 00:06:00
2	Sub-A2	0.69	484.00	76.00	6.71	4.00	2.74	2.81	0 00:06:00
3	Sub-E01	0.76	484.00	43.00	6.71	0.95	0.72	0.34	0 00:28:48
4	Sub-E01.1	0.25	484.00	43.00	6.71	0.95	0.24	0.13	0 00:17:56
5	Sub-E01_Ex	0.26	484.00	43.00	6.71	0.95	0.25	0.14	0 00:17:28
6	Sub-E03.1	0.10	484.00	43.00	6.71	0.95	0.10	0.05	0 00:21:30
7	Sub-E05.1	0.02	0.00	43.00	6.71	0.72	0.01	0.01	0 00:09:00

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	1-Jun	Junction	116.60	117.90	0.00	0.00	0.00	0.10	117.45	0.00	4.25	0 00:00	0.00	0.00
2	Out-E01	Outfall	116.00					0.34	116.00					
3	Out-Prop-A1	Outfall	116.00					0.15	116.00					
4	Basin-A1	Storage Node	112.40	117.70	112.40		0.00	2.96	117.44				0.00	0.00
5	Basin-A2	Storage Node	112.90	117.90	112.90		0.00	2.73	117.52				0.00	0.00
6	Forebay-A1	Storage Node	114.40	117.70	114.40		0.00	2.95	117.53				0.00	0.00
7	Forebay-A2	Storage Node	114.90	117.90	114.90		0.00	2.74	117.58				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length (ft)	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Average Slope (%)	Diameter or Height (ft)	Manning's Roughness	Peak Flow (cfs)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Reported Condition
1	Ditch-01	Channel	1-Jun	Basin-A1	81.45	116.60	116.36	0.2900	1.300	0.0250	0.19	11.76	0.02	0.58	0.97	0.74	0.00	
2	Weir-B-A1	Weir	Basin-A1	Out-Prop-A1		112.40	116.00				0.12							
3	Weir-B-A2	Weir	Basin-A2	1-Jun		112.90	116.60				0.09							
4	Weir-F-A1	Weir	Forebay-A1	Basin-A1		114.40	112.40				2.92							
5	Weir-F-A2	Weir	Forebay-A2	Basin-A2		114.90	112.90				2.73							

Subbasin Hydrology

Subbasin : Sub-A1

Input Data

Area (ac) 0.73
Peak Rate Factor 484
Weighted Curve Number 76
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	0.73	A	76
Composite Area & Weighted CN	0.73		76

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft^2)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	132.16	0	0
Slope (%) :	0.71	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.78	0	0
Computed Flow Time (min) :	2.84	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	257.27	0	0
Channel Slope (%) :	0.4	0	0
Cross Section Area (ft^2) :	2.067	0	0
Wetted Perimeter (ft) :	5.25	0	0
Velocity (ft/sec) :	1.69	0	0
Computed Flow Time (min) :	2.54	0	0

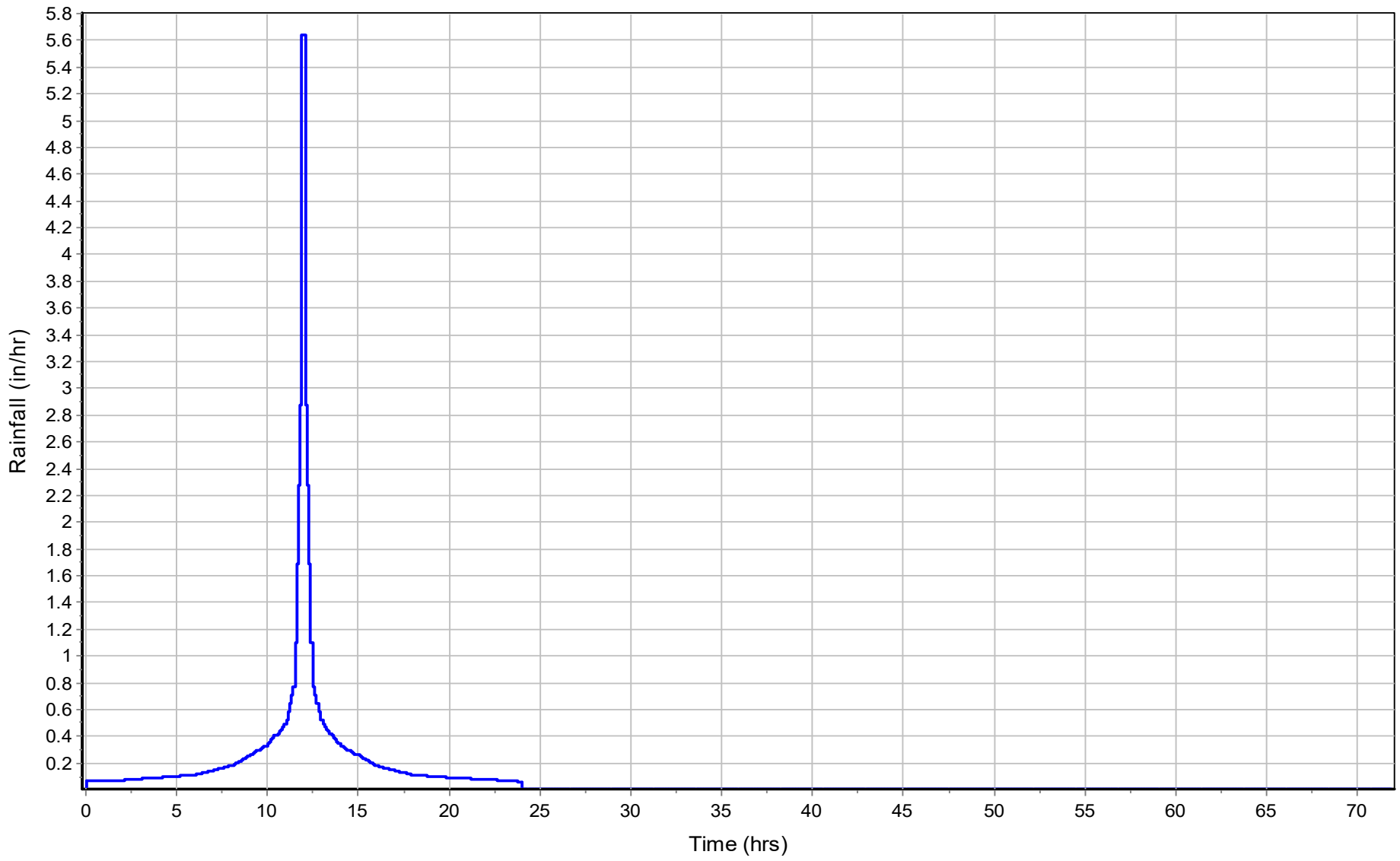
Total TOC (min) 5.38

Subbasin Runoff Results

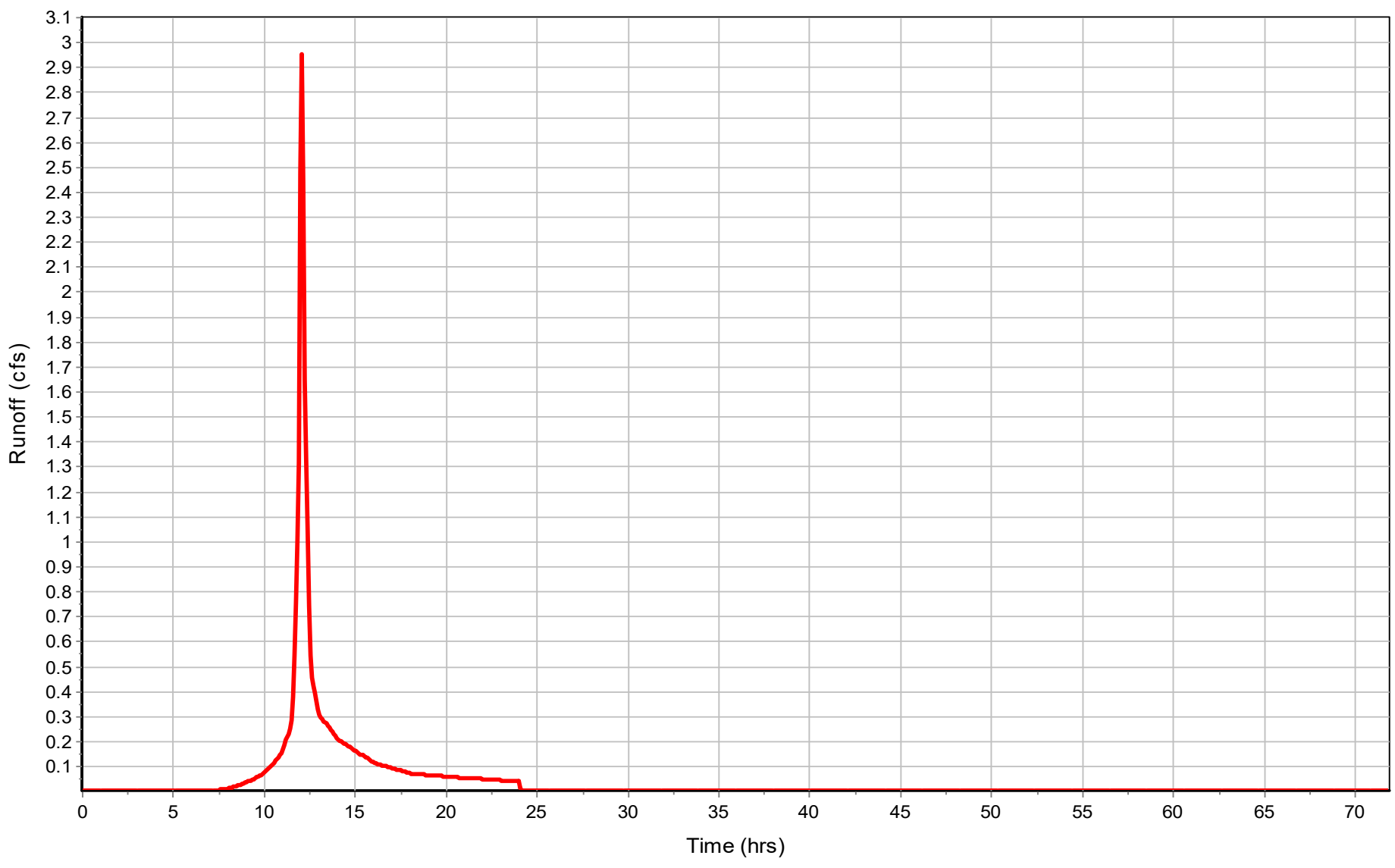
Total Rainfall (in)	6.71
Total Runoff (in)	4
Peak Runoff (cfs)	3.02
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:05:23

Subbasin : Sub-A1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-A2

Input Data

Area (ac) 0.69
Peak Rate Factor 484
Weighted Curve Number 76
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	0.69	A	76
Composite Area & Weighted CN	0.69		76

Time of Concentration

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	331.61	0	0
Channel Slope (%) :	5.4	0	0
Cross Section Area (ft^2) :	3	0	0
Wetted Perimeter (ft) :	6.32	0	0
Velocity (ft/sec) :	7.02	0	0
Computed Flow Time (min) :	0.79	0	0

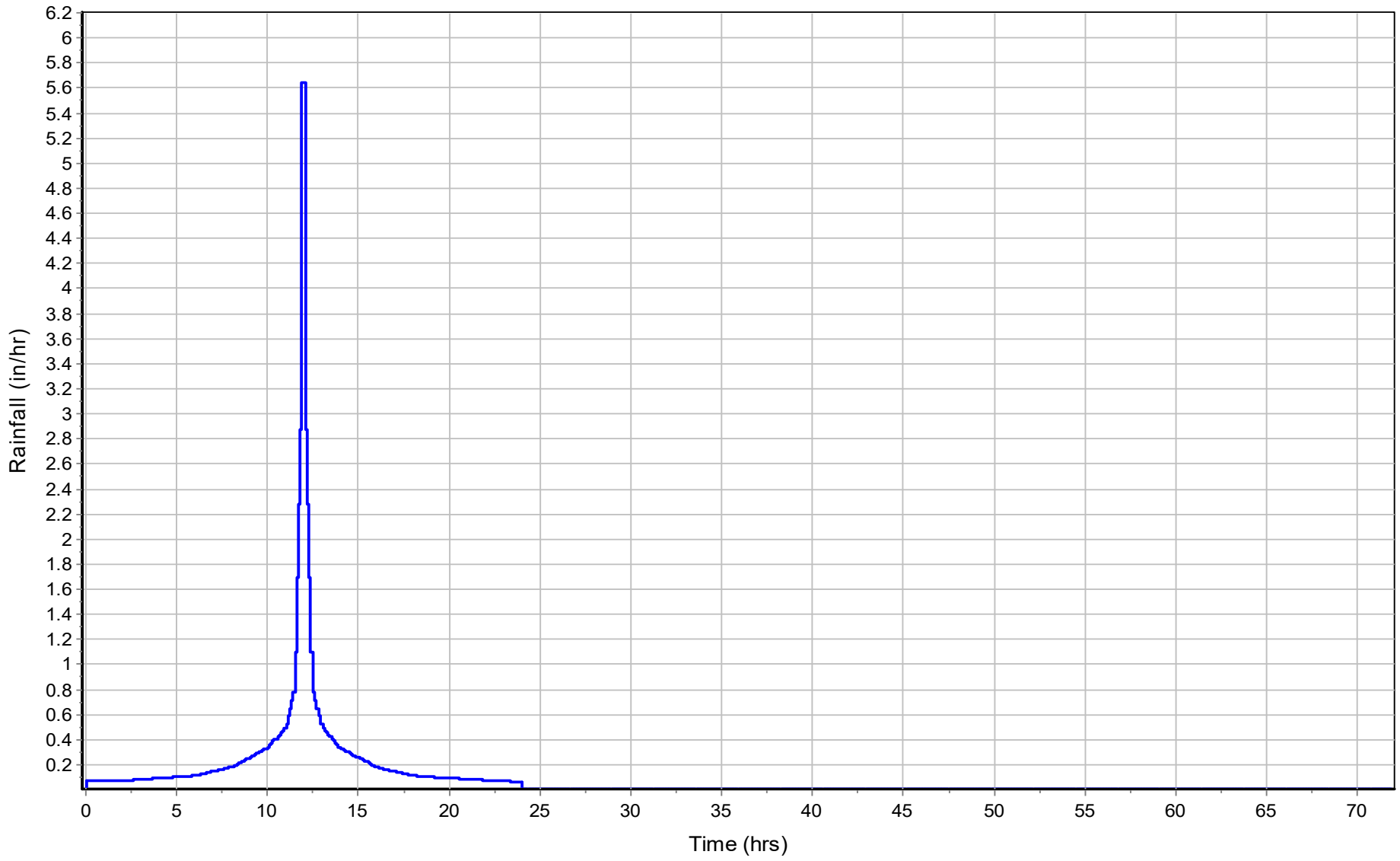
Total TOC (min) 0.79

Subbasin Runoff Results

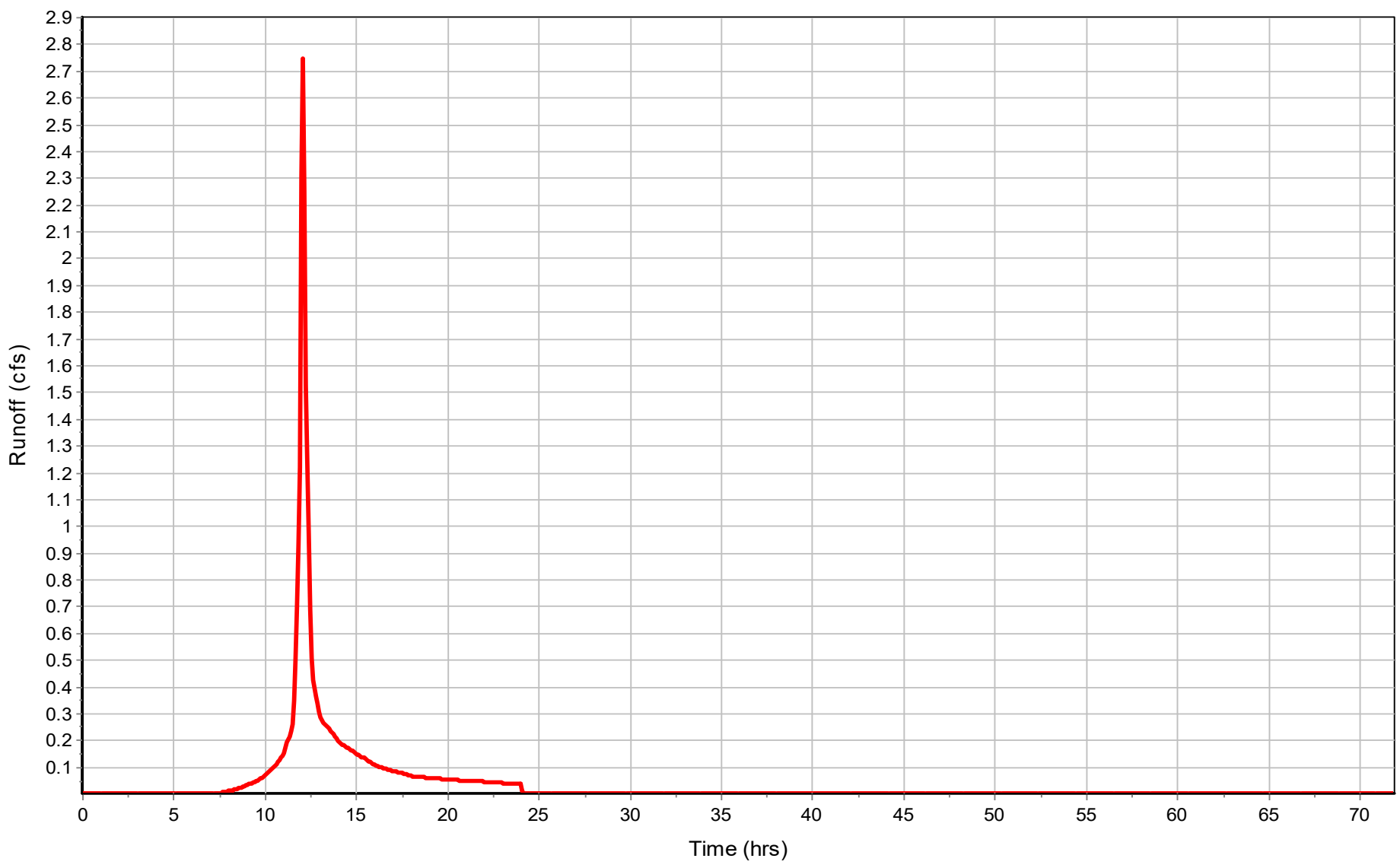
Total Rainfall (in) 6.71
Total Runoff (in) 4
Peak Runoff (cfs) 2.81
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:00:47

Subbasin : Sub-A2

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E01

Input Data

Area (ac) 0.76
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.76	A	43
Composite Area & Weighted CN	0.76		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	249.61	0	0
Slope (%) :	22	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.14	0	0
Computed Flow Time (min) :	28.81	0	0

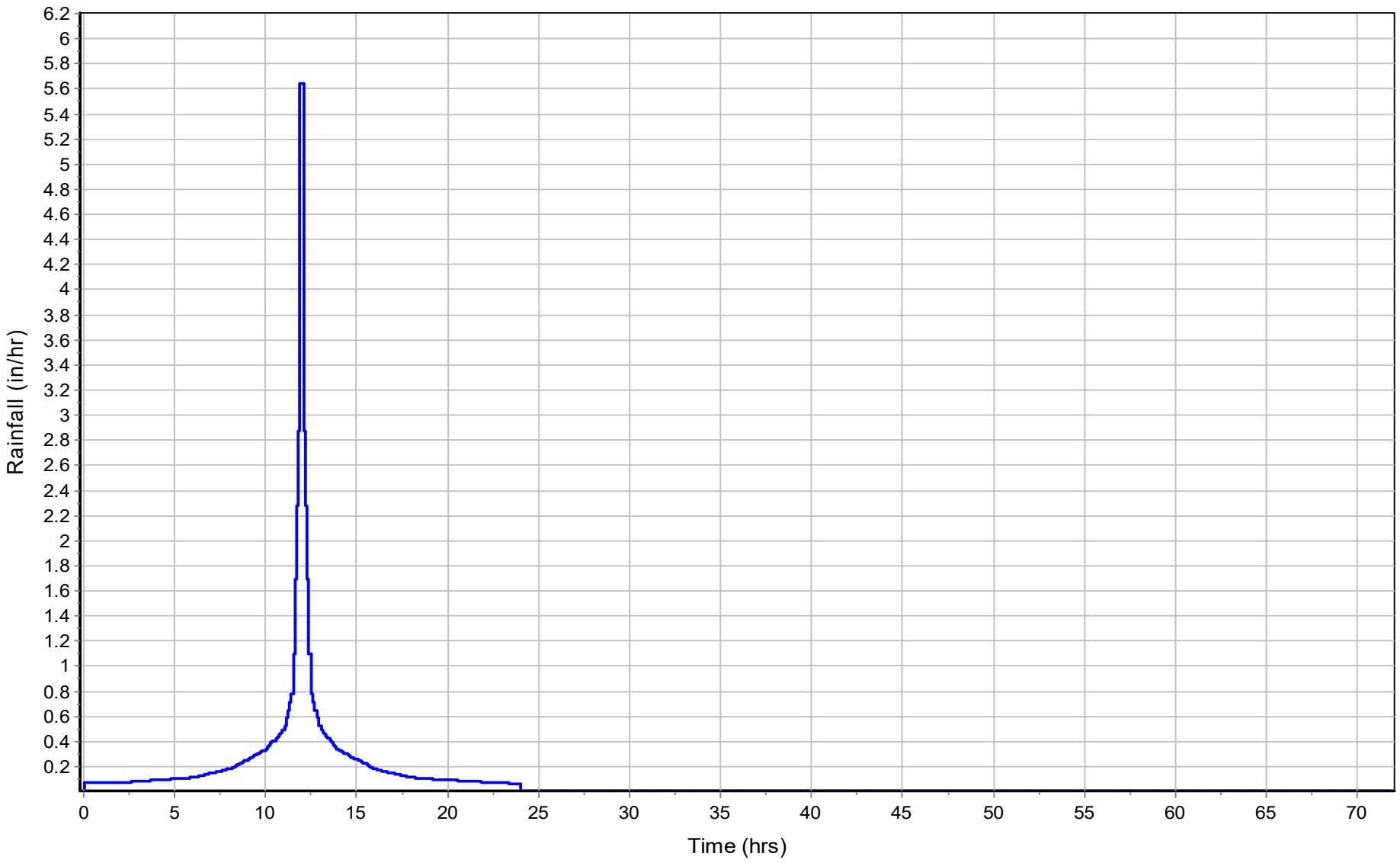
Total TOC (min) 28.81

Subbasin Runoff Results

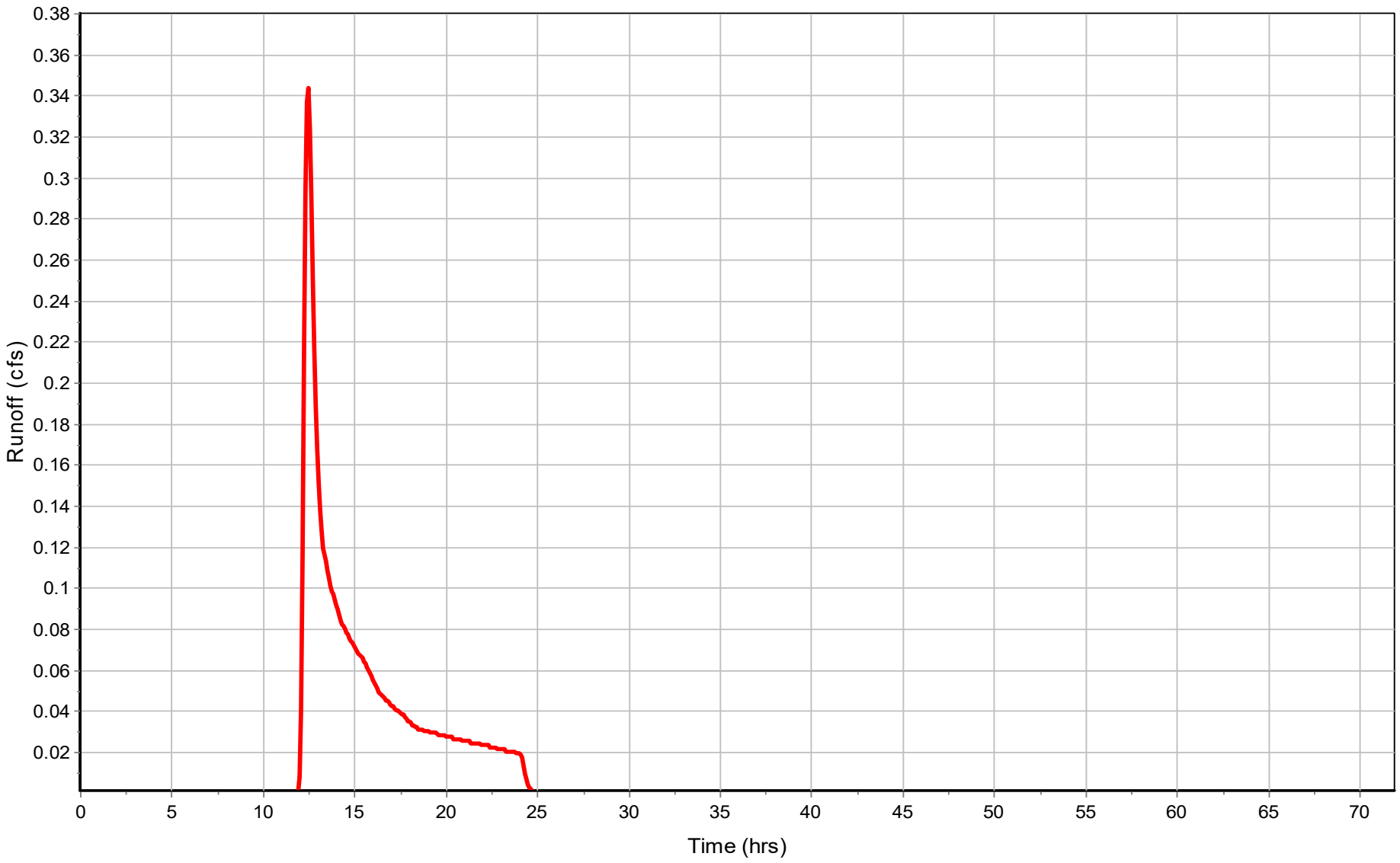
Total Rainfall (in) 6.71
Total Runoff (in) 0.95
Peak Runoff (cfs) 0.34
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:28:49

Subbasin : Sub-E01

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E01.1

Input Data

Area (ac) 0.25
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.25	A	43
Composite Area & Weighted CN	0.25		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	128.34	0	0
Slope (%) :	19	0	0
2 yr, 24 hr Rainfall (in) :	3.42	0	0
Velocity (ft/sec) :	0.12	0	0
Computed Flow Time (min) :	17.94	0	0

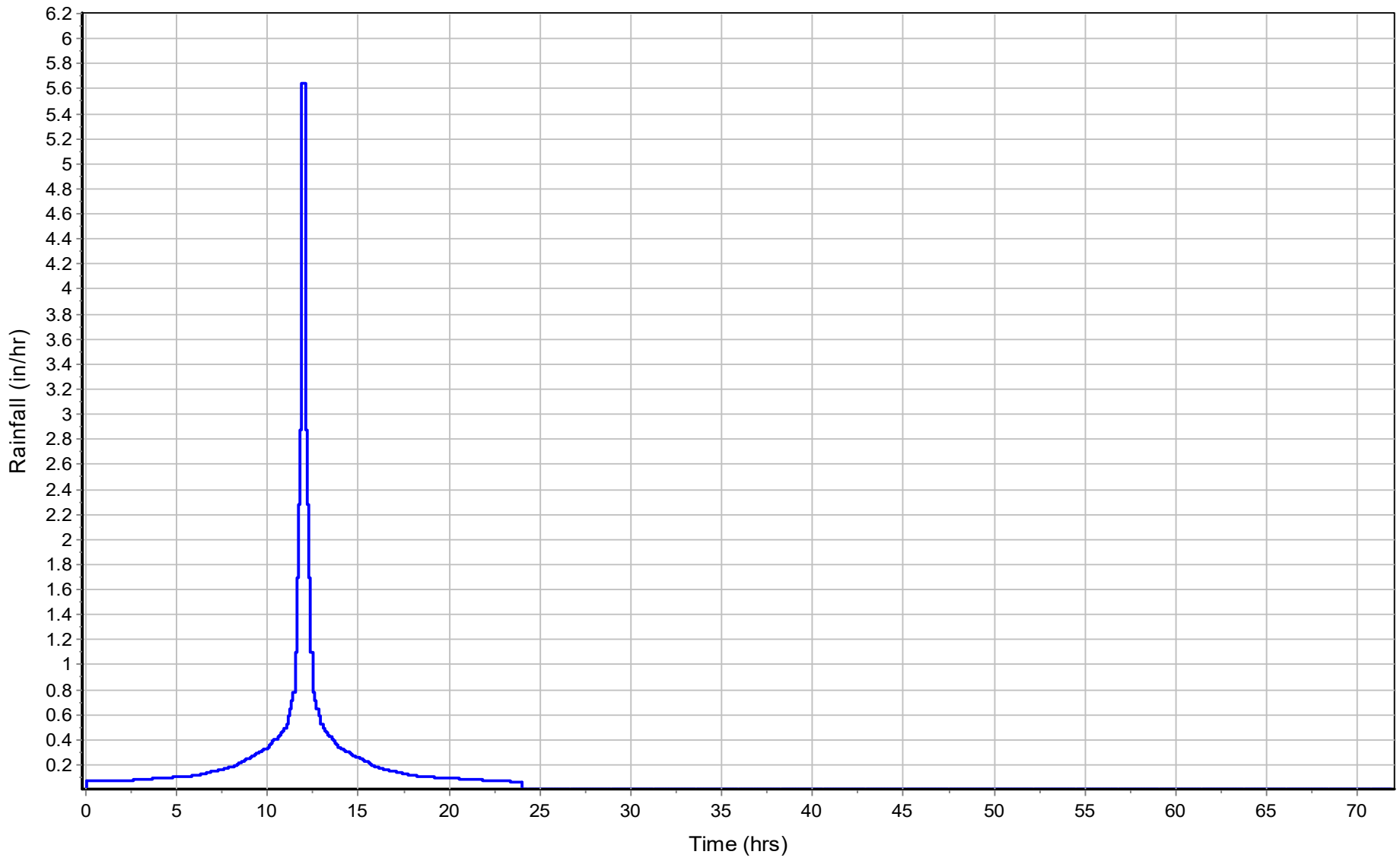
Total TOC (min) 17.94

Subbasin Runoff Results

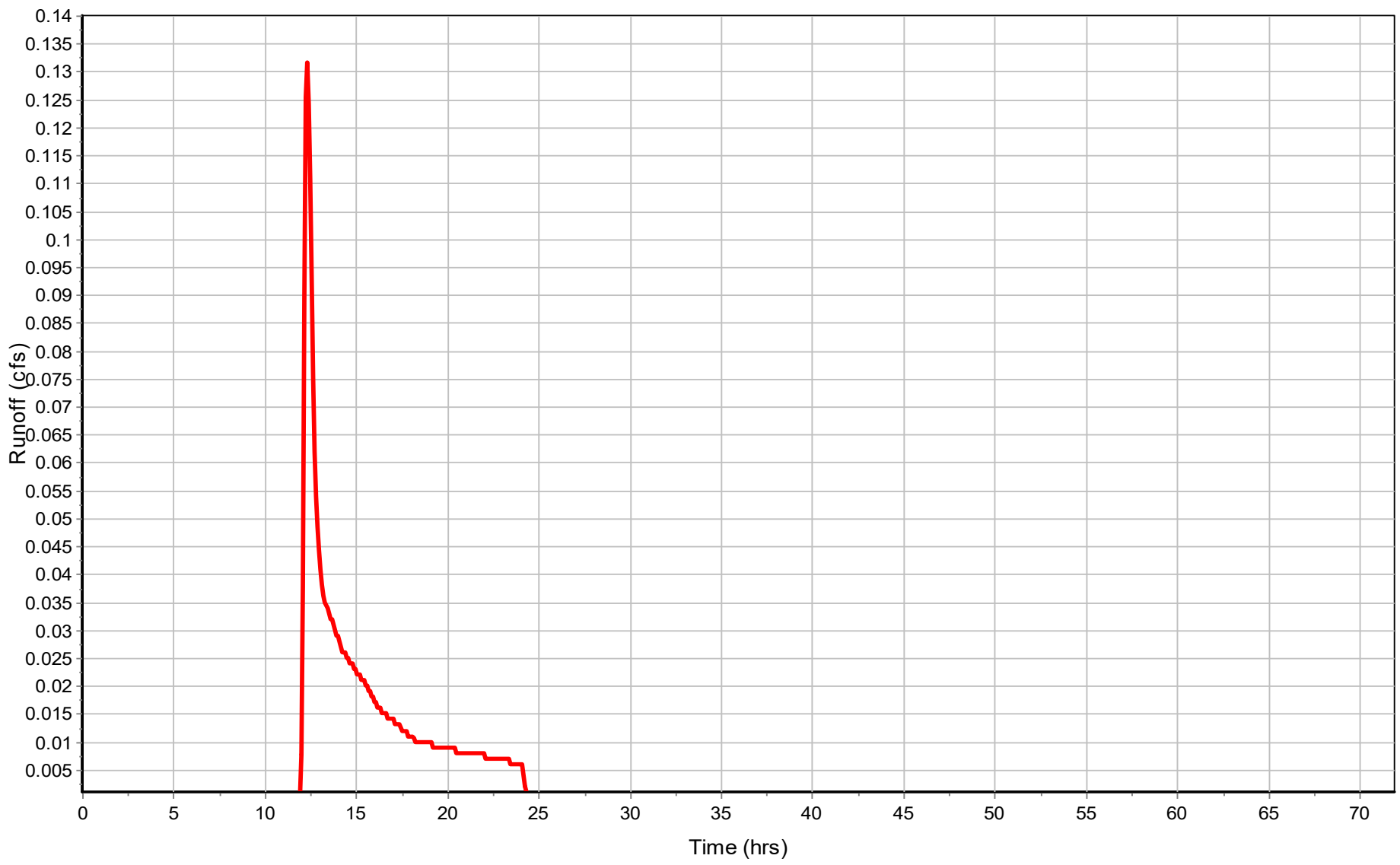
Total Rainfall (in) 6.71
Total Runoff (in) 0.95
Peak Runoff (cfs) 0.13
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:17:56

Subbasin : Sub-E01.1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E01_Ex

Input Data

Area (ac) 0.26
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.26	A	43
Composite Area & Weighted CN	0.26		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	106.59	0	0
Slope (%) :	14	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.1	0	0
Computed Flow Time (min) :	17.48	0	0

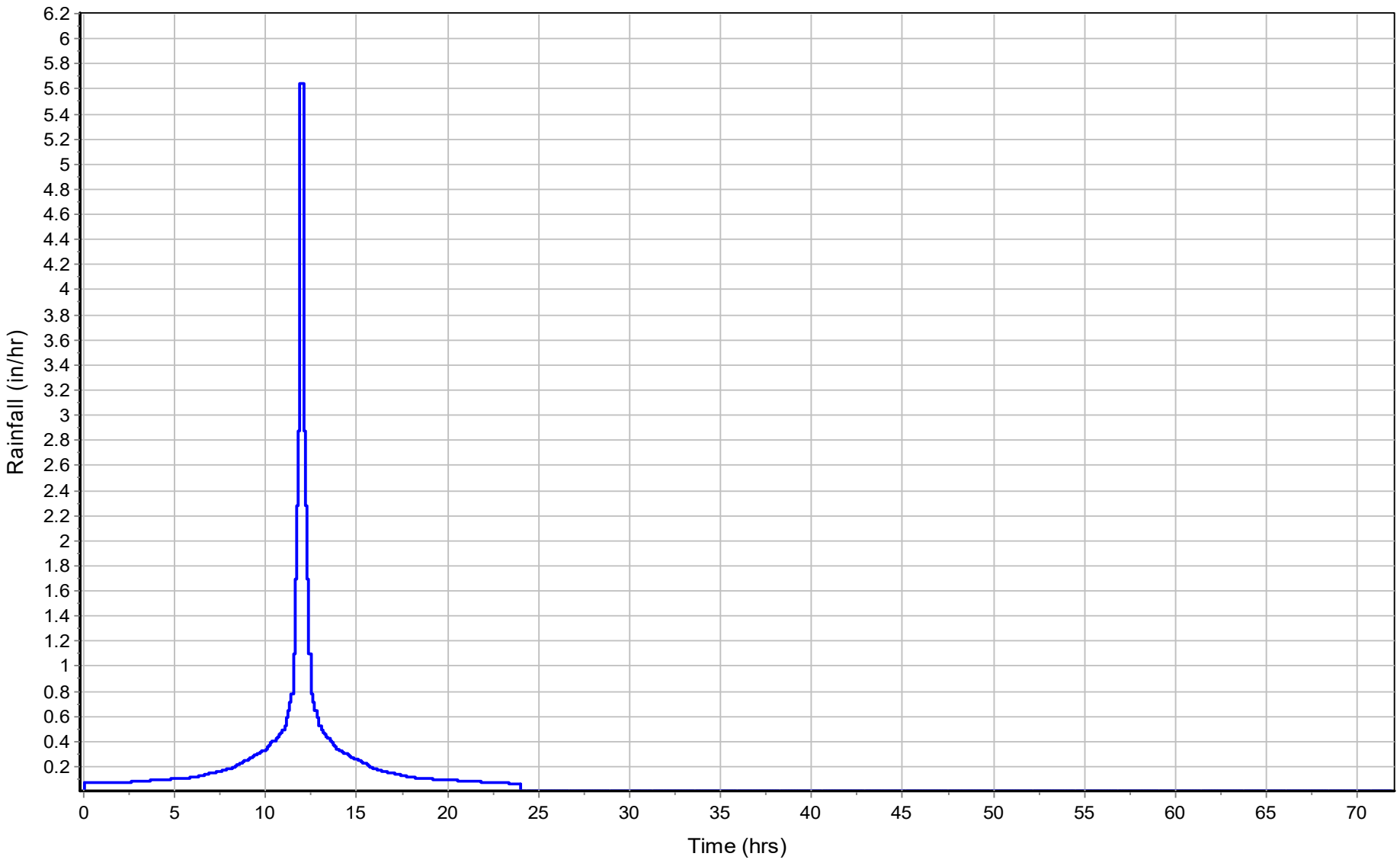
Total TOC (min) 17.48

Subbasin Runoff Results

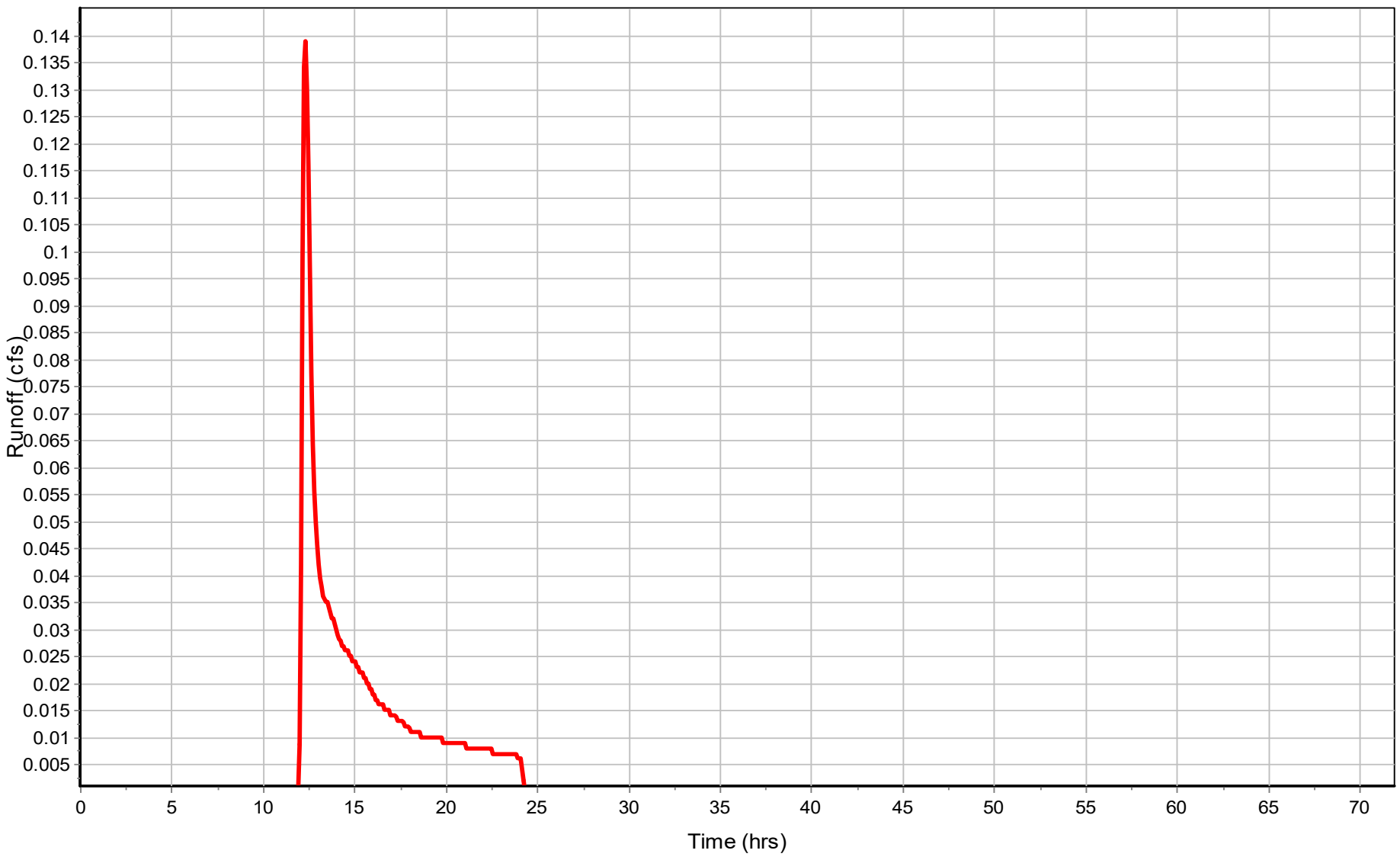
Total Rainfall (in) 6.71
Total Runoff (in) 0.95
Peak Runoff (cfs) 0.14
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:17:29

Subbasin : Sub-E01_Ex

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E03.1

Input Data

Area (ac) 0.1
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.1	A	43
Composite Area & Weighted CN	0.1		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	138.1	0	0
Slope (%) :	14	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.11	0	0
Computed Flow Time (min) :	21.5	0	0

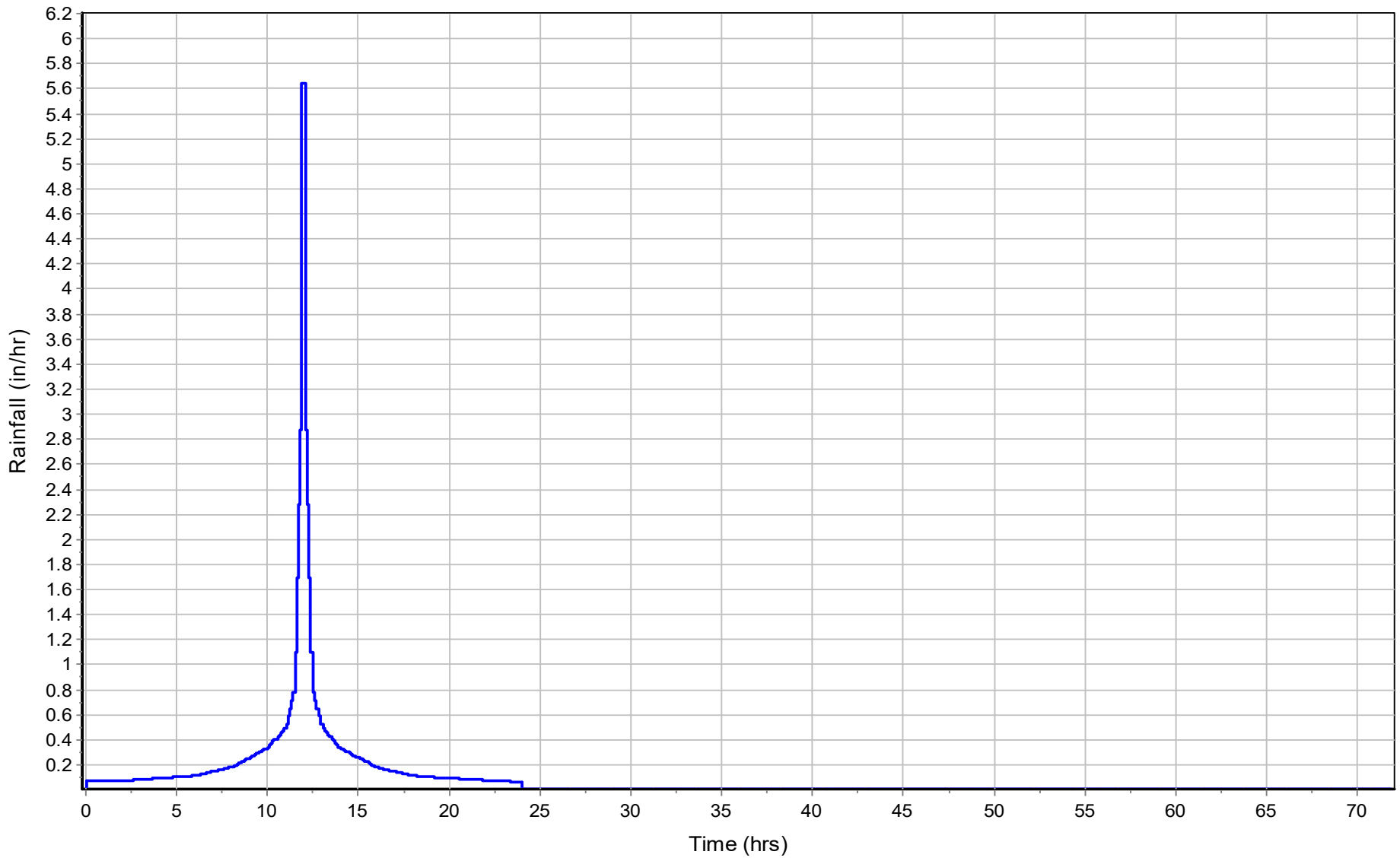
Total TOC (min) 21.50

Subbasin Runoff Results

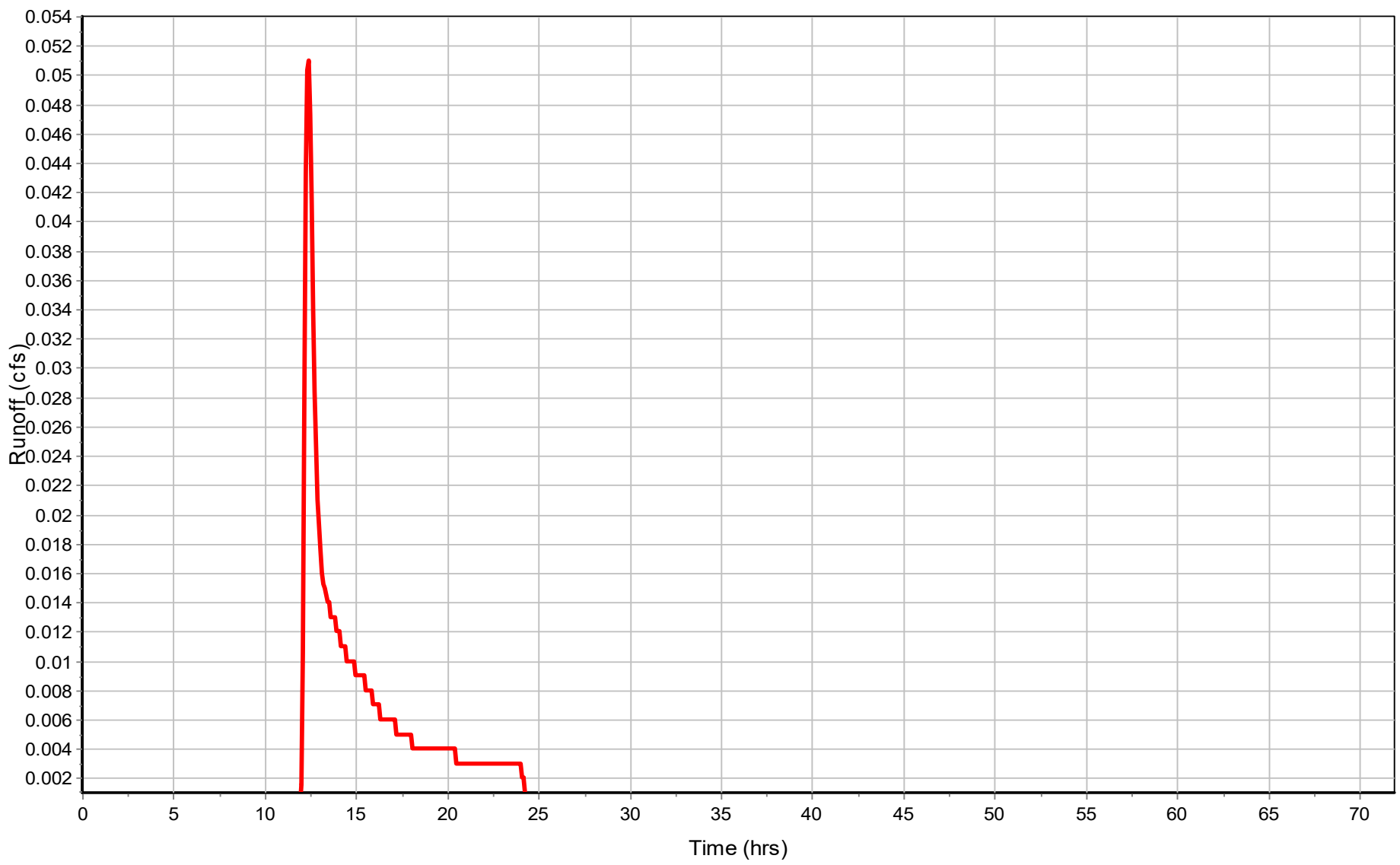
Total Rainfall (in) 6.71
Total Runoff (in) 0.95
Peak Runoff (cfs) 0.05
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:21:30

Subbasin : Sub-E03.1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E05.1

Input Data

Area (ac) 0.02
Peak Rate Factor 0
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.02	A	43
Composite Area & Weighted CN	0.02		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	43.1	0	0
Slope (%) :	12	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.08	0	0
Computed Flow Time (min) :	9.01	0	0

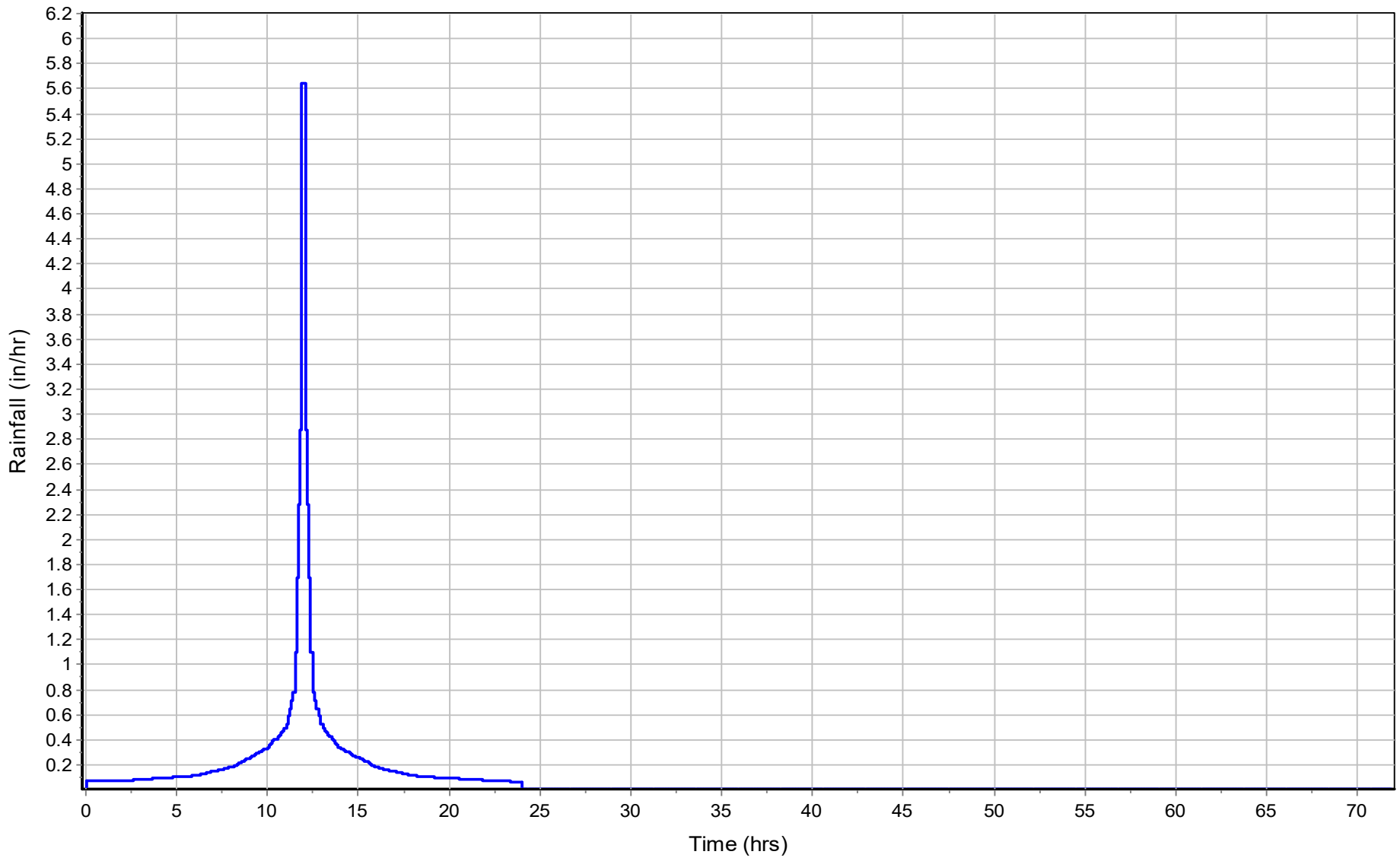
Total TOC (min) 9.01

Subbasin Runoff Results

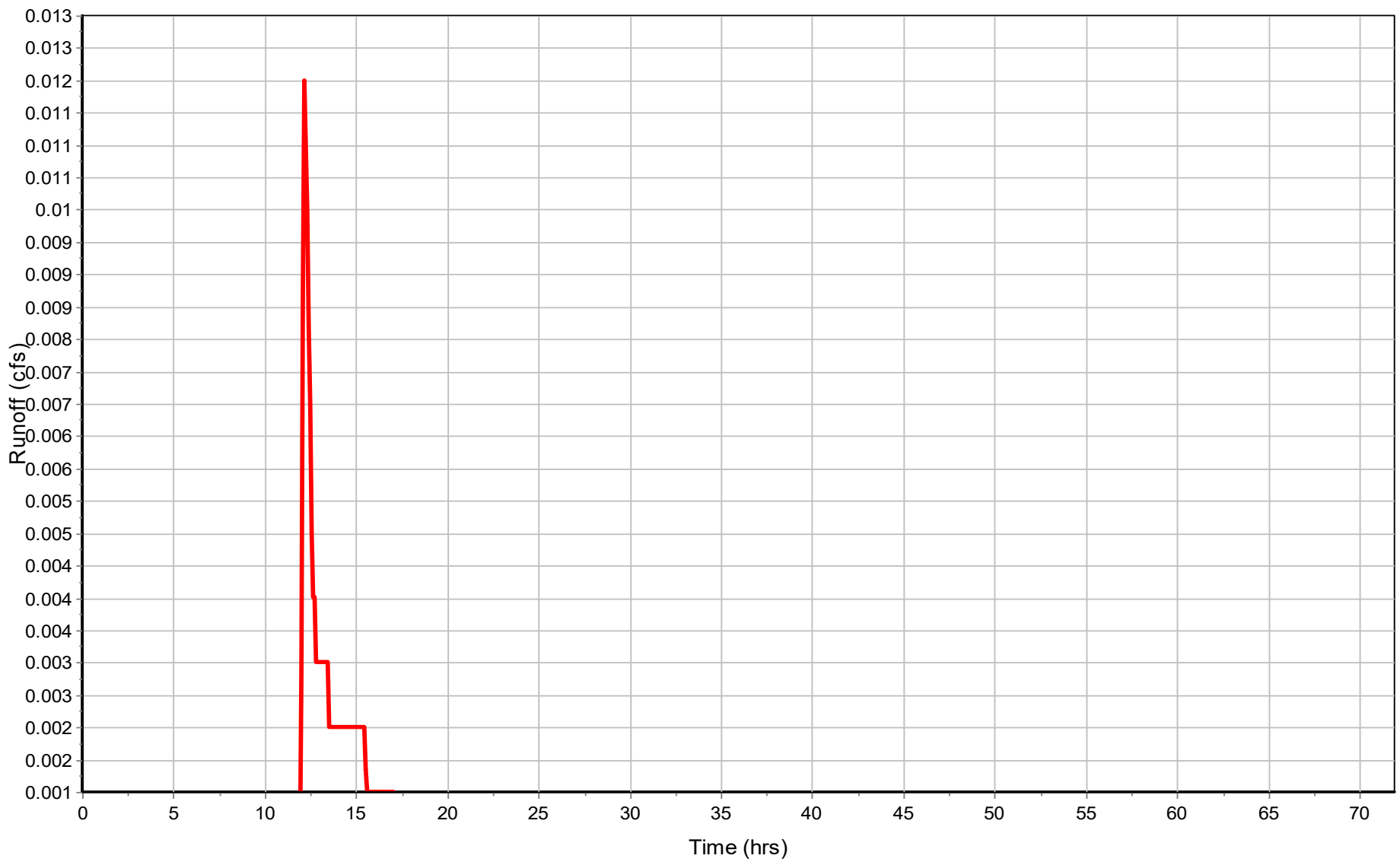
Total Rainfall (in) 6.71
Total Runoff (in) 0.72
Peak Runoff (cfs) 0.01
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:09:01

Subbasin : Sub-E05.1

Rainfall Intensity Graph



Runoff Hydrograph



Junction Input

SN	Element ID	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Ground/Rim (Max) Offset (ft)	Initial Water Elevation (ft)	Initial Water Depth (ft)	Surcharge Elevation (ft)	Surcharge Depth (ft)	Ponded Area (ft^2)	Minimum Pipe Cover (ft)
1	1-Jun	116.60	117.90	1.30	0.00	-116.60	0.00	-117.90	0.00	0.00

Junction Results

SN	Element ID	Peak Inflow (cfs)	Peak Lateral Inflow (cfs)	Max HGL Elevation Attained (ft)	Max HGL Depth Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Average HGL Elevation Attained (ft)	Average HGL Depth Attained (ft)	Time of Max HGL Occurrence (days hh:mm)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	1-Jun	0.10	0.05	117.45	0.85	0.00	4.25	117.22	0.62	0 20:59	0 00:00	0.00	0.00

Channel Input

SN	Element ID	Length (ft)	Inlet Invert Elevation (ft)	Inlet Invert Offset (ft)	Outlet Invert Elevation (ft)	Outlet Invert Offset (ft)	Total Drop (ft)	Average Slope (%)	Shape	Height (ft)	Width (ft)	Manning's Roughness	Entrance Losses	Exit/Bend Losses	Additional Losses	Initial Flow (cfs)	Flap Gate
1	Ditch-01	81.45	116.60	0.00	116.36	3.96	0.24	0.2900	Trapezoidal	1.300	6.200	0.0250	0.5000	0.5000	0.0000	0.00	No

Channel Results

SN	Element ID	Peak Flow (cfs)	Time of Peak Flow Occurrence (days hh:mm)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Travel Time (min)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Froude Number	Reported Condition
1	Ditch-01	0.19	0 23:47	11.76	0.02	0.58	2.34	0.97	0.74	0.00		

Storage Nodes

Storage Node : Basin-A1

Input Data

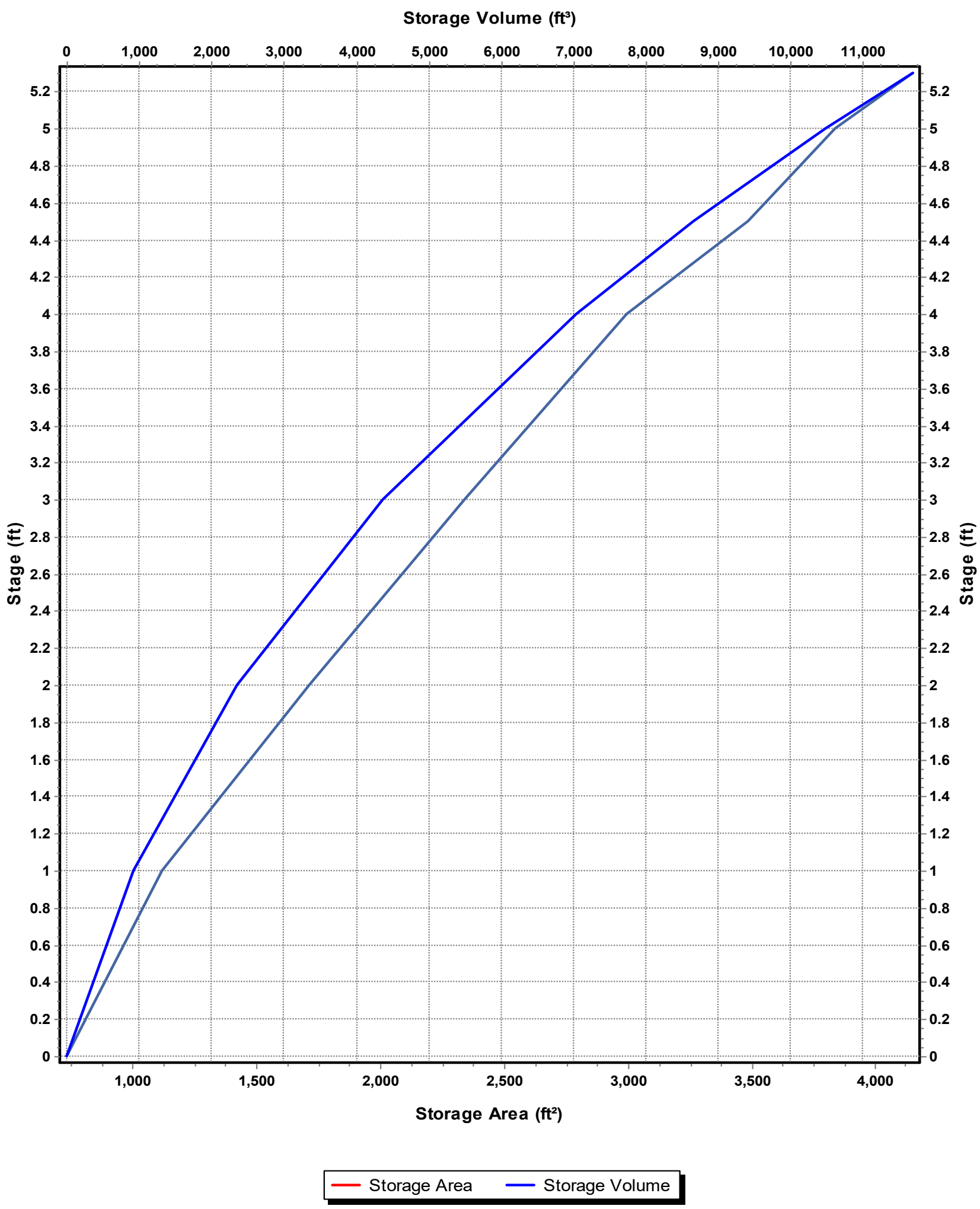
Invert Elevation (ft)	112.40
Max (Rim) Elevation (ft)	117.70
Max (Rim) Offset (ft)	5.30
Initial Water Elevation (ft)	112.40
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Basin-01

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	734.2	0
1	1121.14	927.67
2	1714.29	2345.39
3	2339.15	4372.11
4	2995.85	7039.61
4.5	3484.76	8659.76
5	3837.05	10490.21
5.3	4151.91	11688.55

Storage Area Volume Curves



Storage Node : Basin-A1 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-B-A1	Trapezoidal	No	117.40	5.00	4.00	0.30	3.33

Output Summary Results

Peak Inflow (cfs)	2.96
Peak Lateral Inflow (cfs)	0.13
Peak Outflow (cfs)	0.14
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	117.44
Max HGL Depth Attained (ft)	5.04
Average HGL Elevation Attained (ft)	116.5
Average HGL Depth Attained (ft)	4.1
Time of Max HGL Occurrence (days hh:mm)	0 21:01
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Basin-A2

Input Data

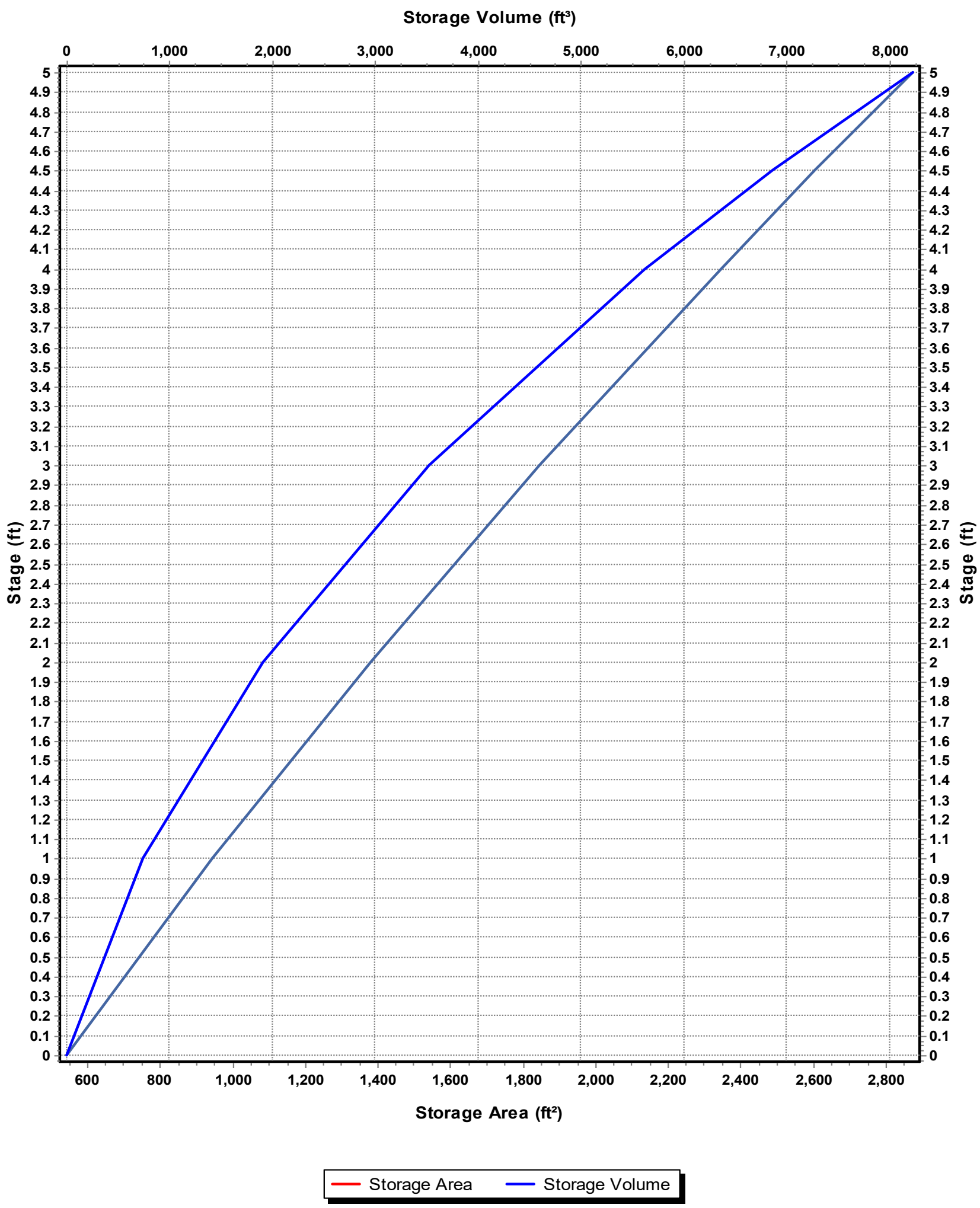
Invert Elevation (ft)	112.90
Max (Rim) Elevation (ft)	117.90
Max (Rim) Offset (ft)	5.00
Initial Water Elevation (ft)	112.90
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Basin-02

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	543.55	0
1	946	744.78
2	1380.46	1908.01
3	1846.91	3521.7
4	2345.37	5617.84
4.5	2606.6	6855.83
5	2875.82	8226.44

Storage Area Volume Curves



Storage Node : Basin-A2 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-B-A2	Trapezoidal	No	117.50	4.60	5.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	2.73
Peak Lateral Inflow (cfs)	0
Peak Outflow (cfs)	1.49
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	117.52
Max HGL Depth Attained (ft)	4.62
Average HGL Elevation Attained (ft)	116.7
Average HGL Depth Attained (ft)	3.8
Time of Max HGL Occurrence (days hh:mm)	0 16:57
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Forebay-A1

Input Data

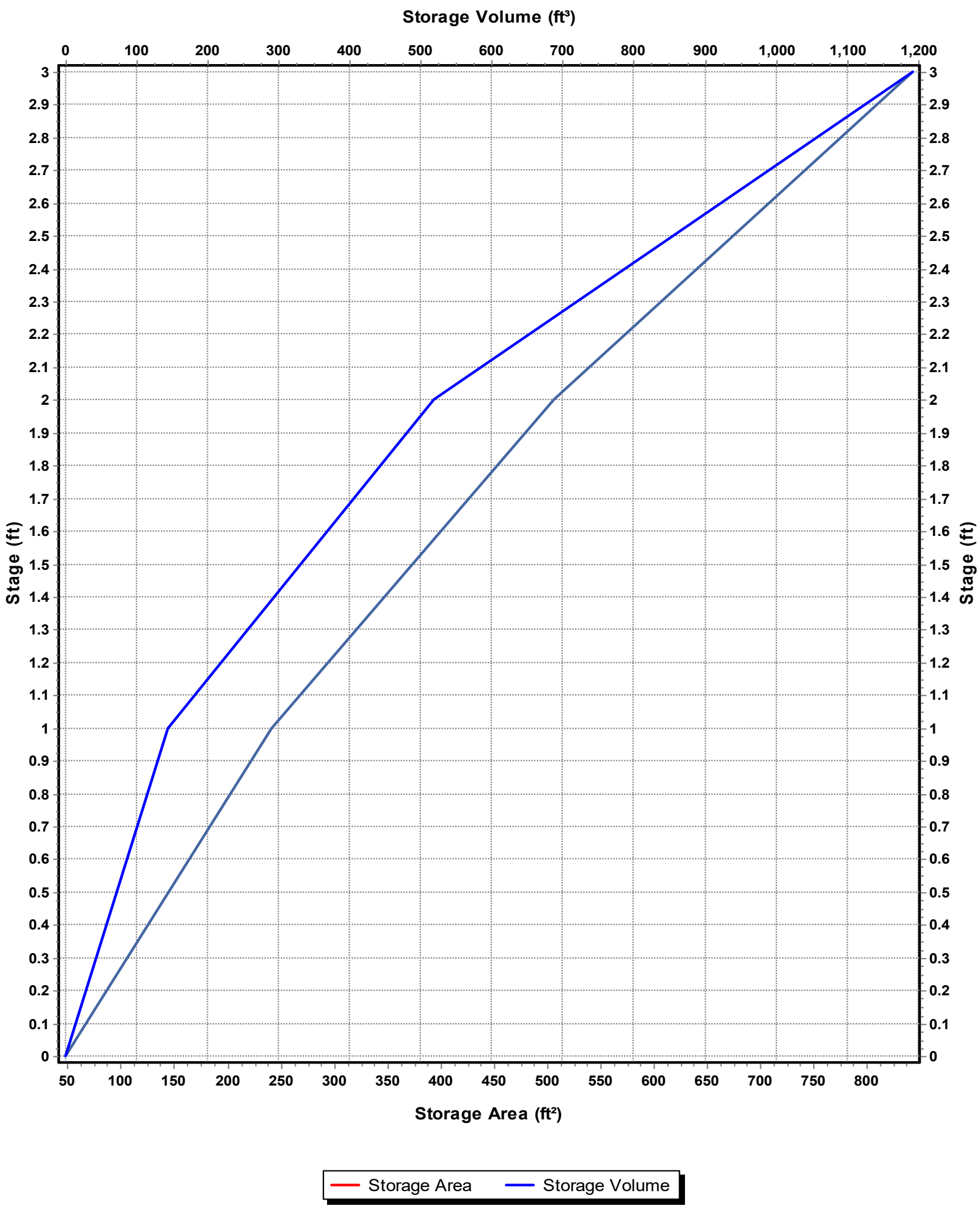
Invert Elevation (ft)	114.40
Max (Rim) Elevation (ft)	117.70
Max (Rim) Offset (ft)	3.30
Initial Water Elevation (ft)	114.40
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Forebay-01

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	48.29	0
1	241.18	144.74
2	506.06	518.36
3	842.94	1192.86

Storage Area Volume Curves



Storage Node : Forebay-A1 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-F-A1	Trapezoidal	No	117.30	2.90	8.00	2.00	3.33

Output Summary Results

Peak Inflow (cfs)	2.95
Peak Lateral Inflow (cfs)	2.95
Peak Outflow (cfs)	2.92
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	117.53
Max HGL Depth Attained (ft)	3.13
Average HGL Elevation Attained (ft)	116.98
Average HGL Depth Attained (ft)	2.58
Time of Max HGL Occurrence (days hh:mm)	0 12:10
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Forebay-A2

Input Data

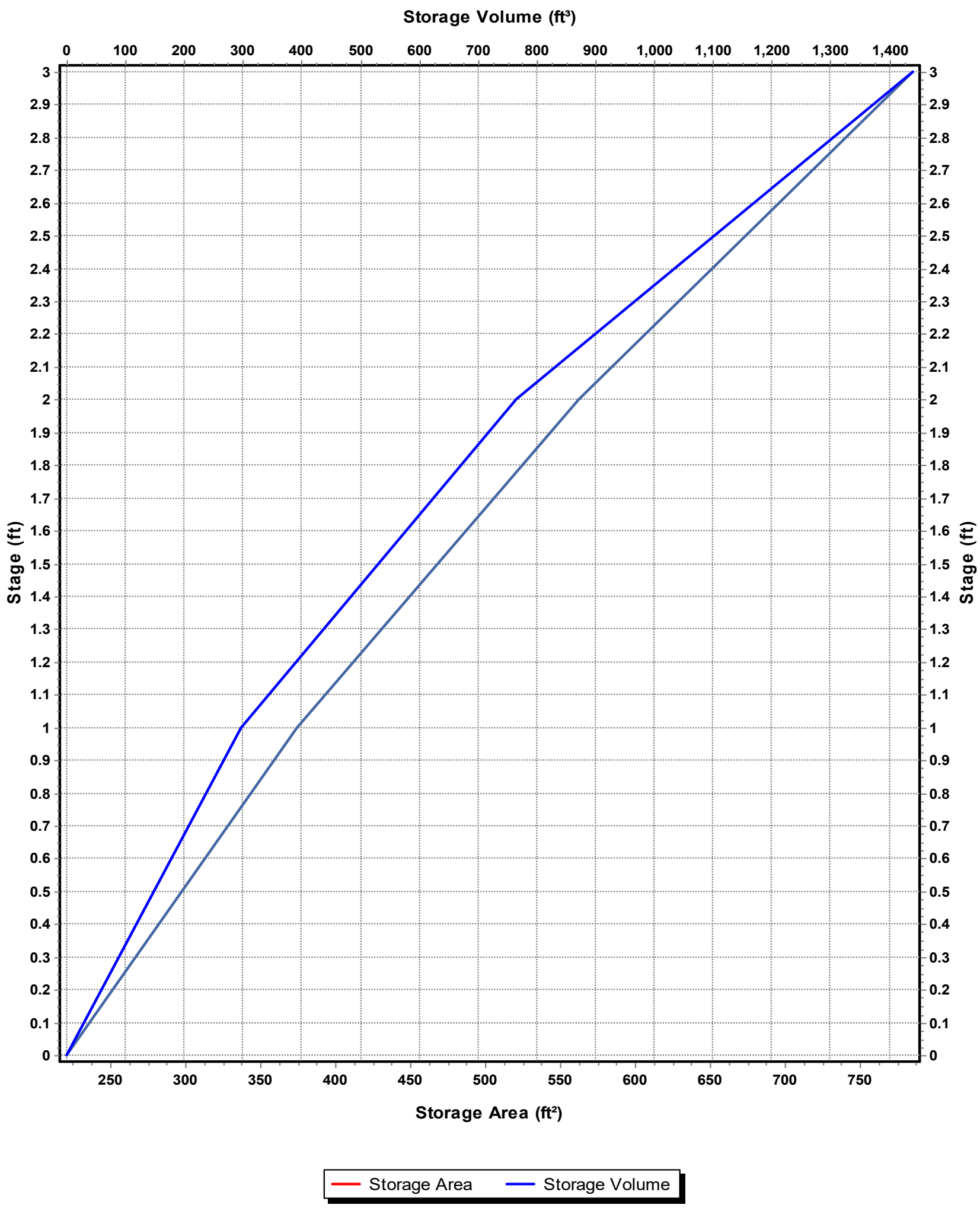
Invert Elevation (ft)	114.90
Max (Rim) Elevation (ft)	117.90
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.90
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Forebay-02

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	221.26	0
1	374.45	297.86
2	562.72	766.45
3	785.55	1440.59

Storage Area Volume Curves



Storage Node : Forebay-A2 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-F-A2	Trapezoidal	No	117.00	2.10	10.00	1.00	3.33

Output Summary Results

Peak Inflow (cfs)	2.74
Peak Lateral Inflow (cfs)	2.74
Peak Outflow (cfs)	2.73
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	117.58
Max HGL Depth Attained (ft)	2.68
Average HGL Elevation Attained (ft)	117.13
Average HGL Depth Attained (ft)	2.23
Time of Max HGL Occurrence (days hh:mm)	0 16:52
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Project Description

File Name ..... Pave.Paws_A1_A2.SPF

Project Options

Flow Units ..... CFS
Elevation Type ..... Elevation
Hydrology Method ..... SCS TR-20
Time of Concentration (TOC) Method ..... SCS TR-55
Link Routing Method ..... Hydrodynamic
Enable Overflow Ponding at Nodes ..... YES
Skip Steady State Analysis Time Periods ..... NO

Analysis Options

Start Analysis On	00:00:00	0:00:00
End Analysis On	00:00:00	0:00:00
Start Reporting On	00:00:00	0:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins.....	7
Nodes.....	7
Junctions	1
Outfalls	2
Flow Diversions	0
Inlets	0
Storage Nodes	4
Links.....	5
Channels	1
Pipes	0
Pumps	0
Orifices	0
Weirs	4
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	50 years (2070)	Intensity	inches	Massachusetts	None	50.00	8.80	SCS Type III 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Sub-A1	0.73	484.00	76.00	8.80	5.89	4.32	4.37	0 00:06:00
2	Sub-A2	0.69	484.00	76.00	8.80	5.89	4.04	4.07	0 00:06:00
3	Sub-E01	0.76	484.00	43.00	8.80	1.95	1.48	0.87	0 00:28:48
4	Sub-E01.1	0.25	484.00	43.00	8.80	1.95	0.48	0.34	0 00:17:56
5	Sub-E01_Ex	0.26	484.00	43.00	8.80	1.95	0.51	0.36	0 00:17:28
6	Sub-E03.1	0.10	484.00	43.00	8.80	1.95	0.20	0.13	0 00:21:30
7	Sub-E05.1	0.02	0.00	43.00	8.80	1.84	0.04	0.03	0 00:09:00

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	1-Jun	Junction	116.60	117.90	0.00	0.00	0.00	0.72	117.57	0.00	4.13	0 00:00	0.00	0.00
2	Out-E01	Outfall	116.00					0.87	116.00					
3	Out-Prop-A1	Outfall	116.00					0.87	116.00					
4	Basin-A1	Storage Node	112.40	117.70	112.40		0.00	4.50	117.55				0.00	0.00
5	Basin-A2	Storage Node	112.90	117.90	112.90		0.00	5.11	117.61				0.00	0.00
6	Forebay-A1	Storage Node	114.40	117.70	114.40		0.00	4.30	117.59				0.00	0.00
7	Forebay-A2	Storage Node	114.90	117.90	114.90		0.00	4.43	117.66				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length (ft)	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Average Slope (%)	Diameter or Height (ft)	Manning's Roughness	Peak Flow (cfs)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Reported Condition
1	Ditch-01	Channel	1-Jun	Basin-A1	81.45	116.60	116.36	0.2900	1.300	0.0250	0.65	11.76	0.06	0.82	1.08	0.83	0.00	
2	Weir-B-A1	Weir	Basin-A1	Out-Prop-A1		112.40	116.00				0.80							
3	Weir-B-A2	Weir	Basin-A2	1-Jun		112.90	116.60				0.64							
4	Weir-F-A1	Weir	Forebay-A1	Basin-A1		114.40	112.40				4.26							
5	Weir-F-A2	Weir	Forebay-A2	Basin-A2		114.90	112.90				5.11							

Subbasin Hydrology

Subbasin : Sub-A1

Input Data

Area (ac) 0.73
Peak Rate Factor 484
Weighted Curve Number 76
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	0.73	A	76
Composite Area & Weighted CN	0.73		76

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft^2)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	132.16	0	0
Slope (%) :	0.71	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.78	0	0
Computed Flow Time (min) :	2.84	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	257.27	0	0
Channel Slope (%) :	0.4	0	0
Cross Section Area (ft^2) :	2.067	0	0
Wetted Perimeter (ft) :	5.25	0	0
Velocity (ft/sec) :	1.69	0	0
Computed Flow Time (min) :	2.54	0	0

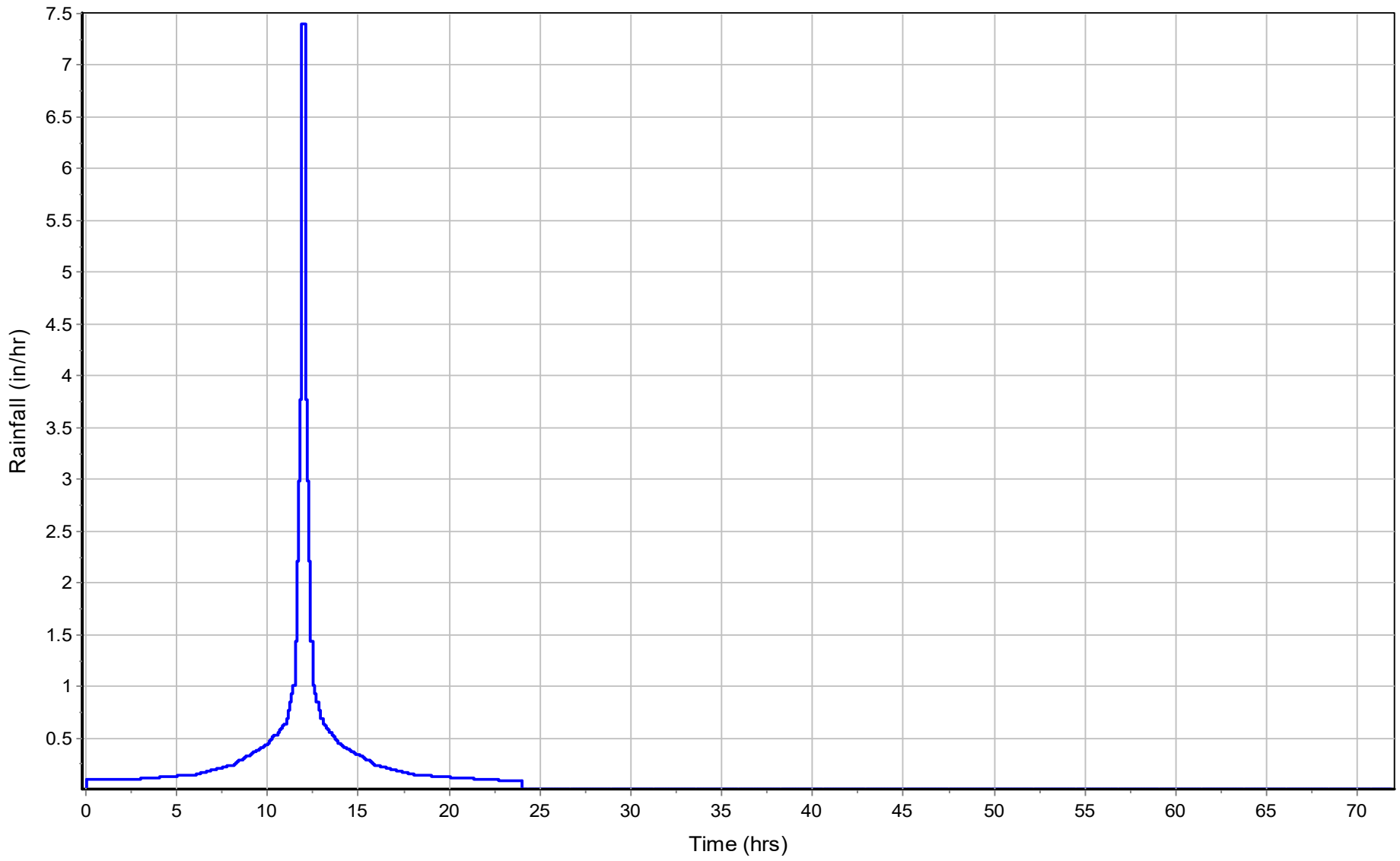
Total TOC (min) 5.38

Subbasin Runoff Results

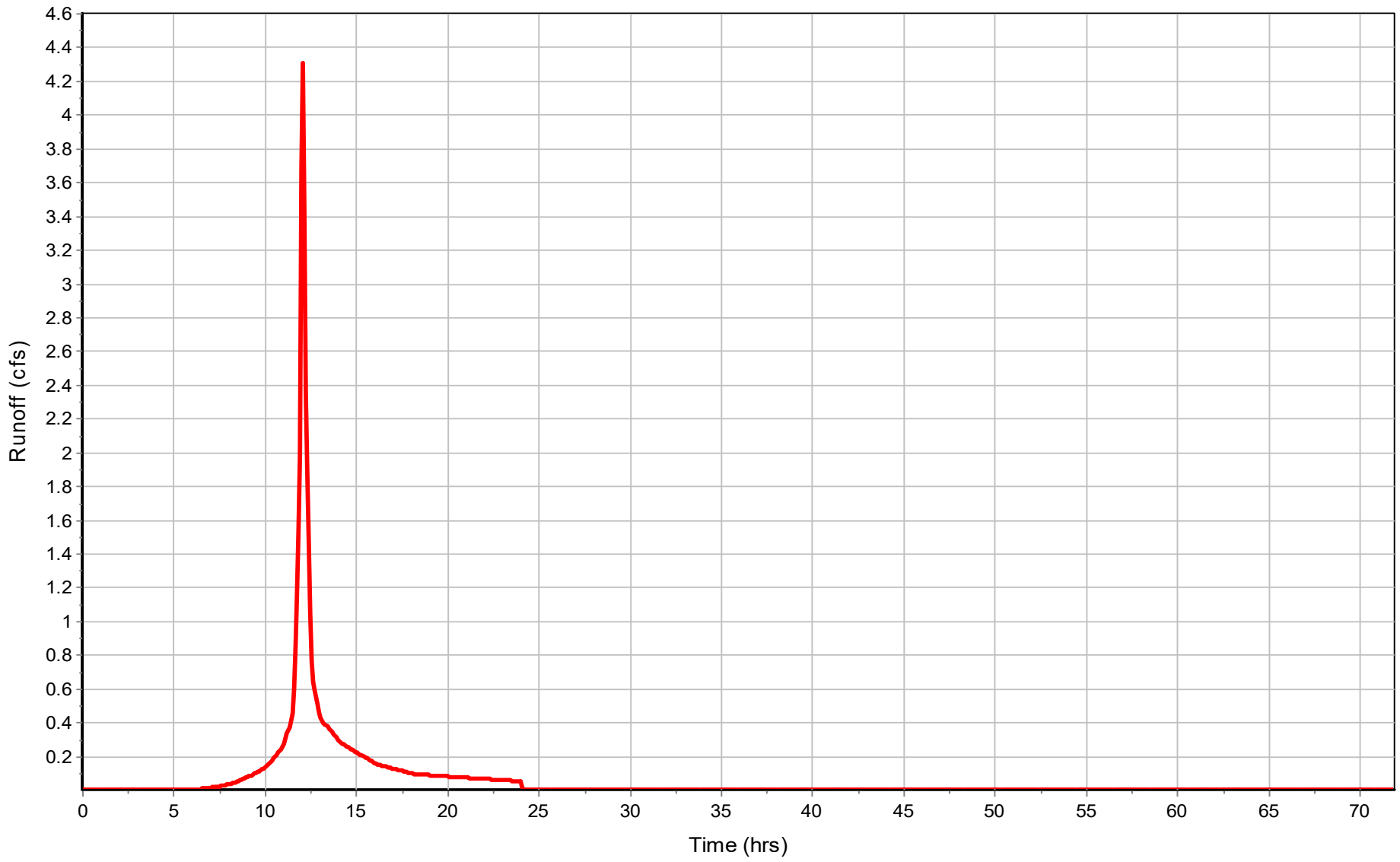
Total Rainfall (in)	8.8
Total Runoff (in)	5.89
Peak Runoff (cfs)	4.37
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:05:23

Subbasin : Sub-A1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-A2

Input Data

Area (ac) 0.69
Peak Rate Factor 484
Weighted Curve Number 76
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	0.69	A	76
Composite Area & Weighted CN	0.69		76

Time of Concentration

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	331.61	0	0
Channel Slope (%) :	5.4	0	0
Cross Section Area (ft^2) :	3	0	0
Wetted Perimeter (ft) :	6.32	0	0
Velocity (ft/sec) :	7.02	0	0
Computed Flow Time (min) :	0.79	0	0

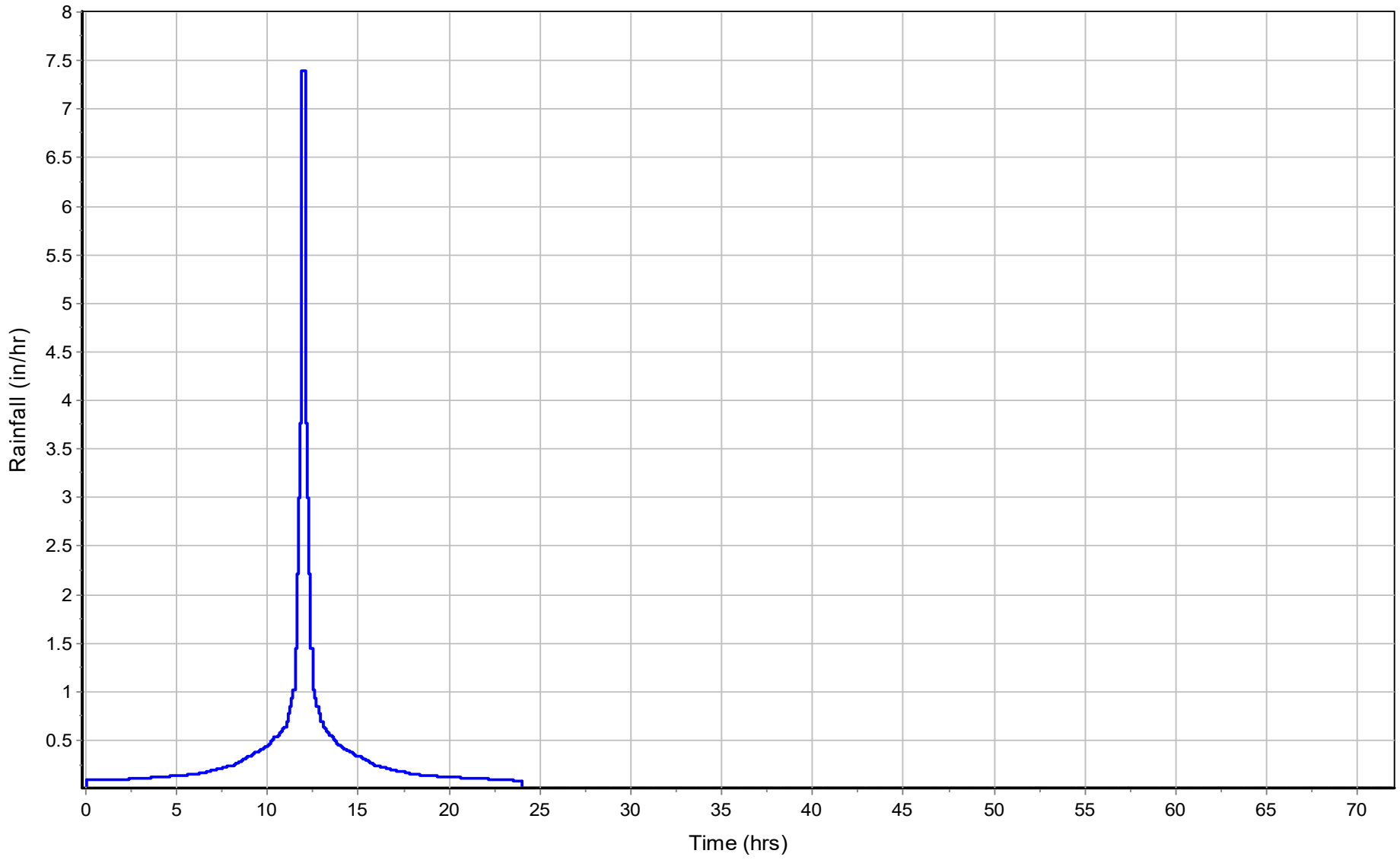
Total TOC (min) 0.79

Subbasin Runoff Results

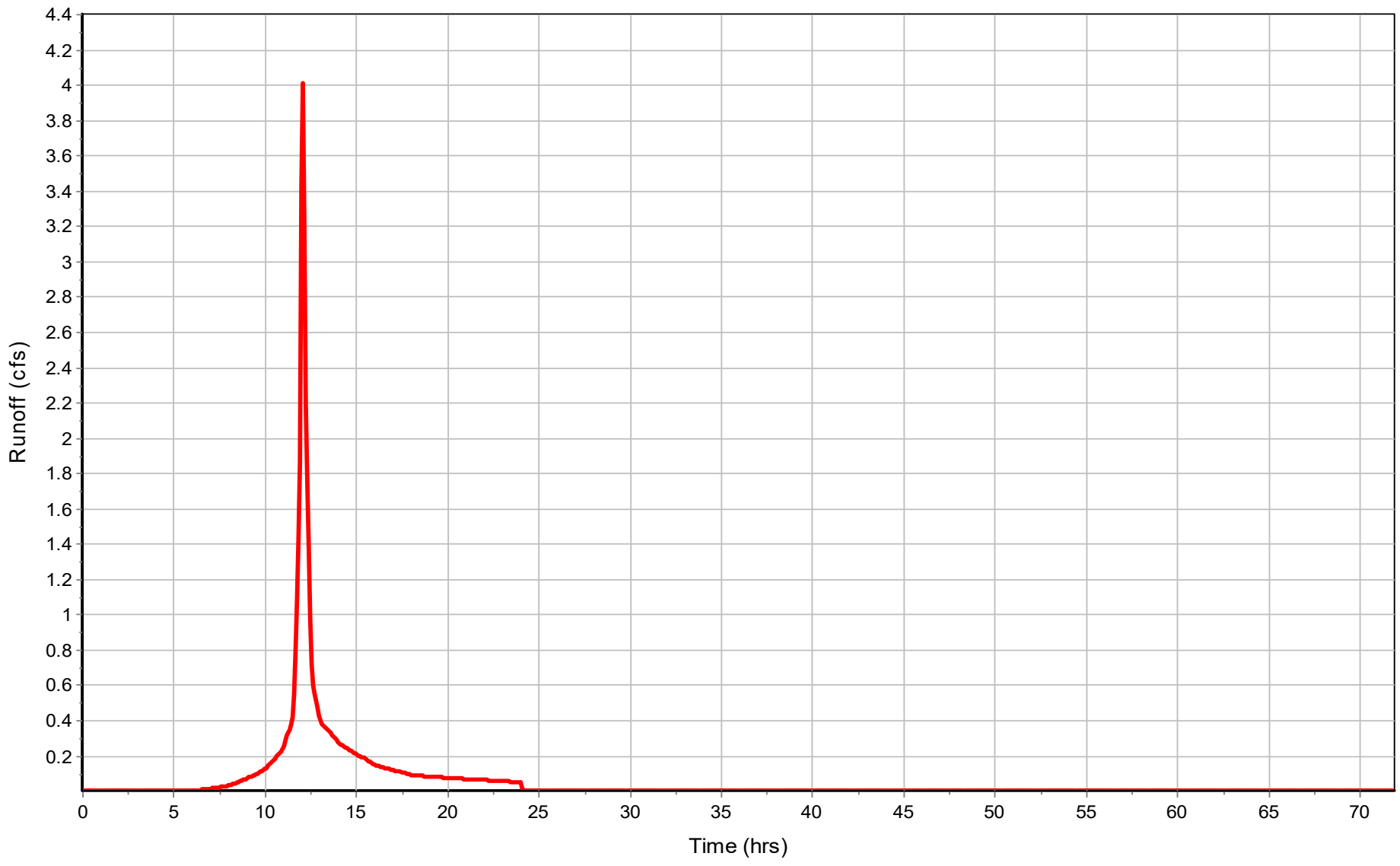
Total Rainfall (in) 8.8
Total Runoff (in) 5.89
Peak Runoff (cfs) 4.07
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:00:47

Subbasin : Sub-A2

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E01

Input Data

Area (ac) 0.76
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.76	A	43
Composite Area & Weighted CN	0.76		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	249.61	0	0
Slope (%) :	22	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.14	0	0
Computed Flow Time (min) :	28.81	0	0

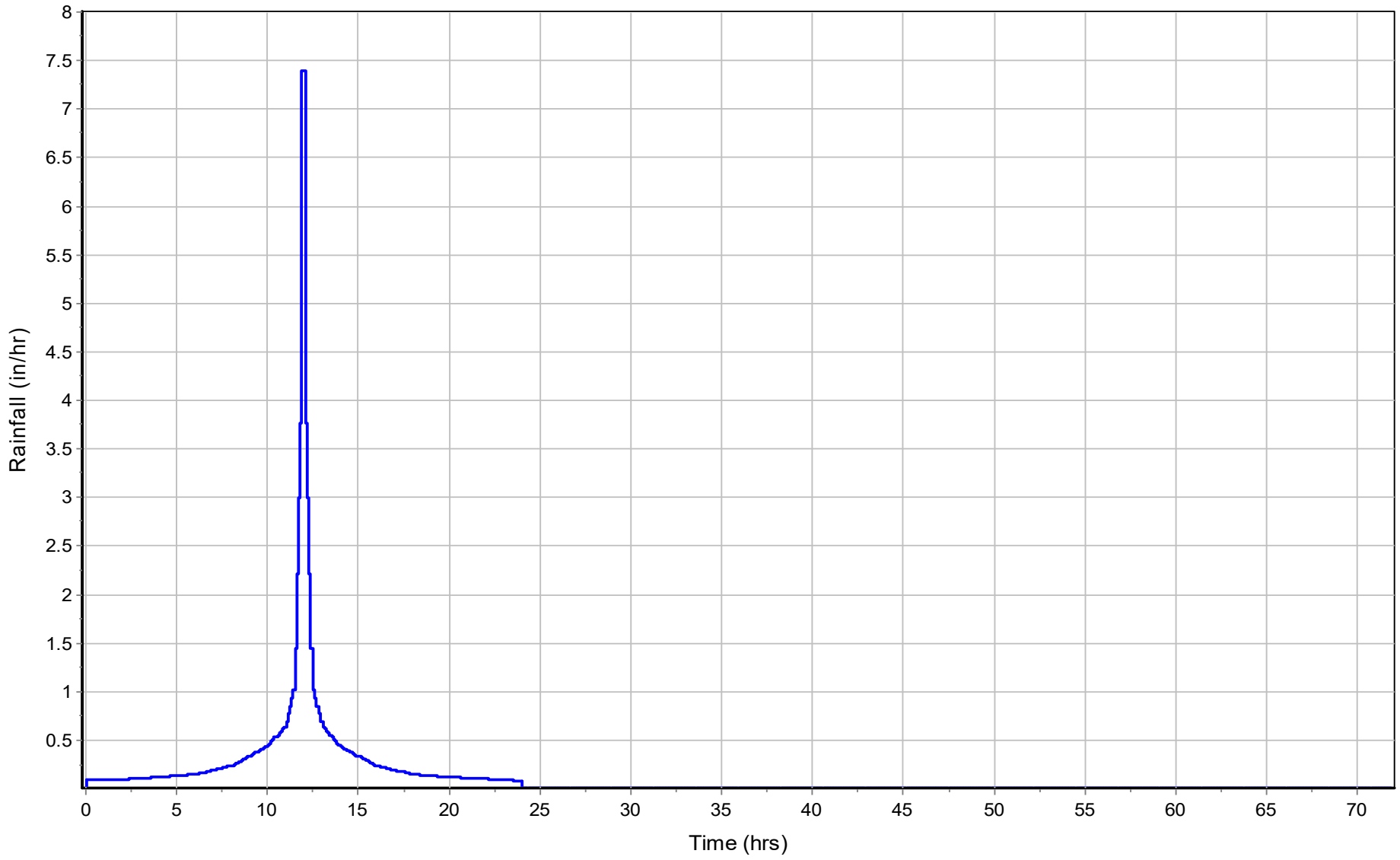
Total TOC (min) 28.81

Subbasin Runoff Results

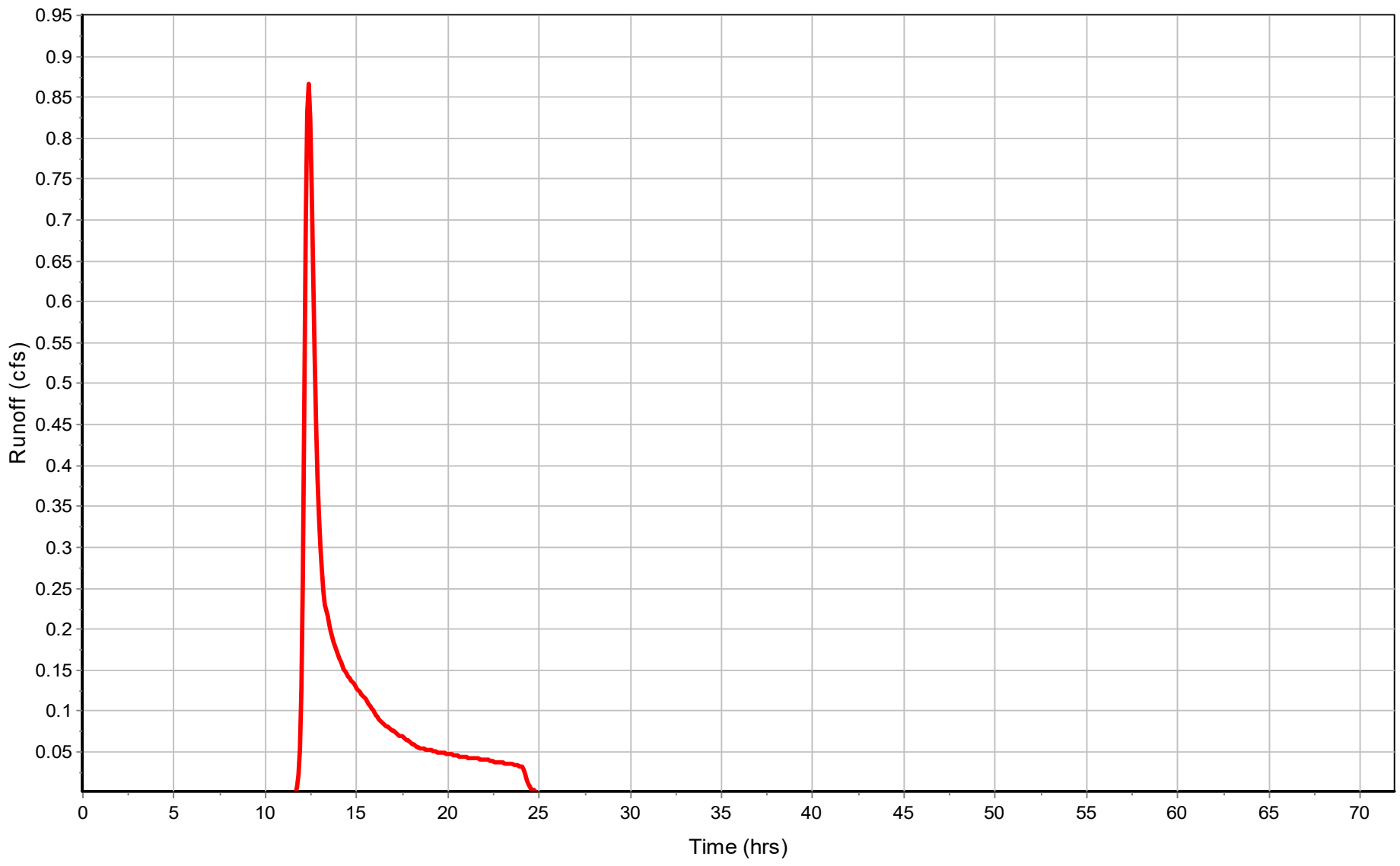
Total Rainfall (in) 8.8
Total Runoff (in) 1.95
Peak Runoff (cfs) 0.87
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:28:49

Subbasin : Sub-E01

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E01.1

Input Data

Area (ac) 0.25
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.25	A	43
Composite Area & Weighted CN	0.25		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	128.34	0	0
Slope (%) :	19	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.12	0	0
Computed Flow Time (min) :	17.94	0	0

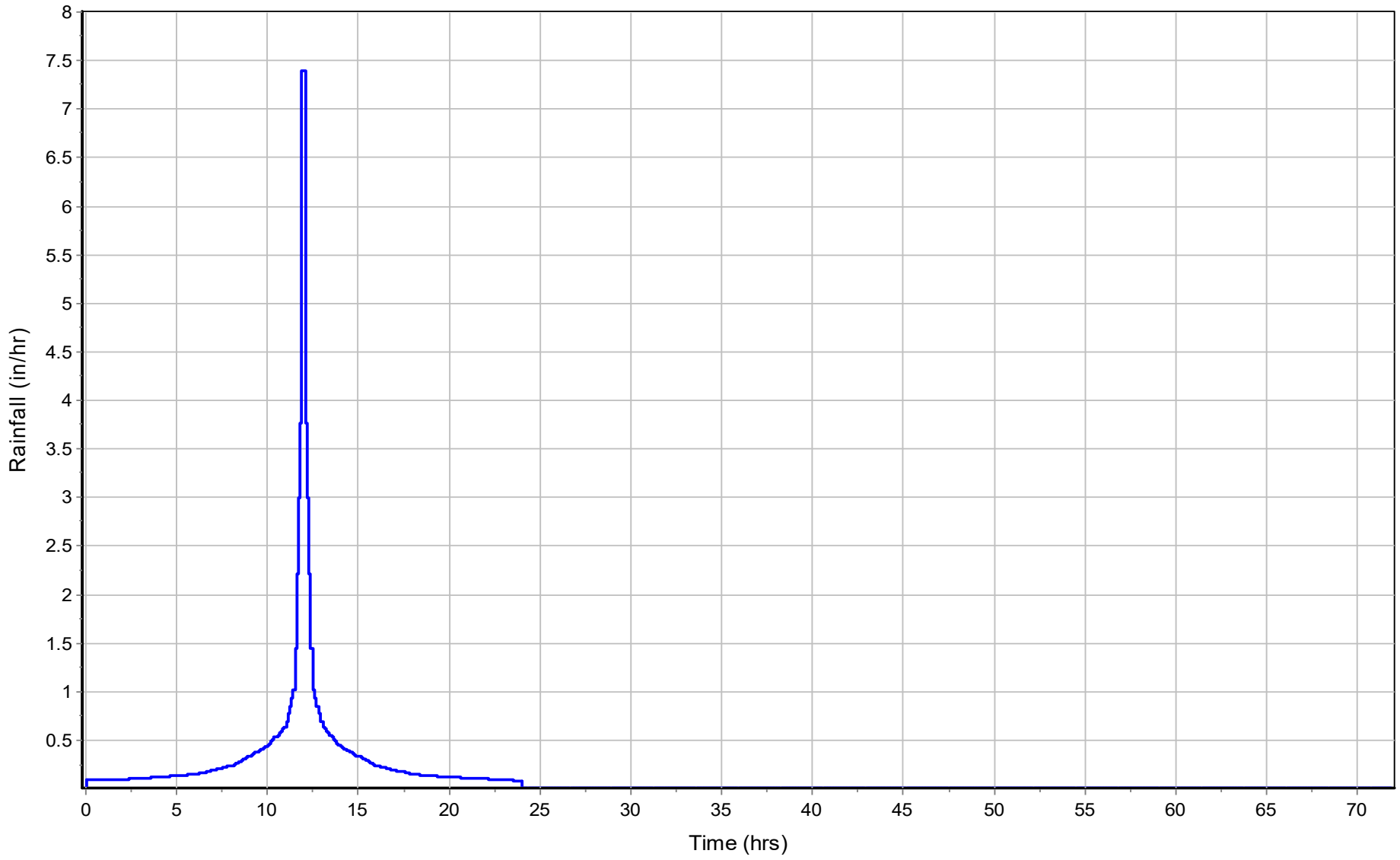
Total TOC (min) 17.94

Subbasin Runoff Results

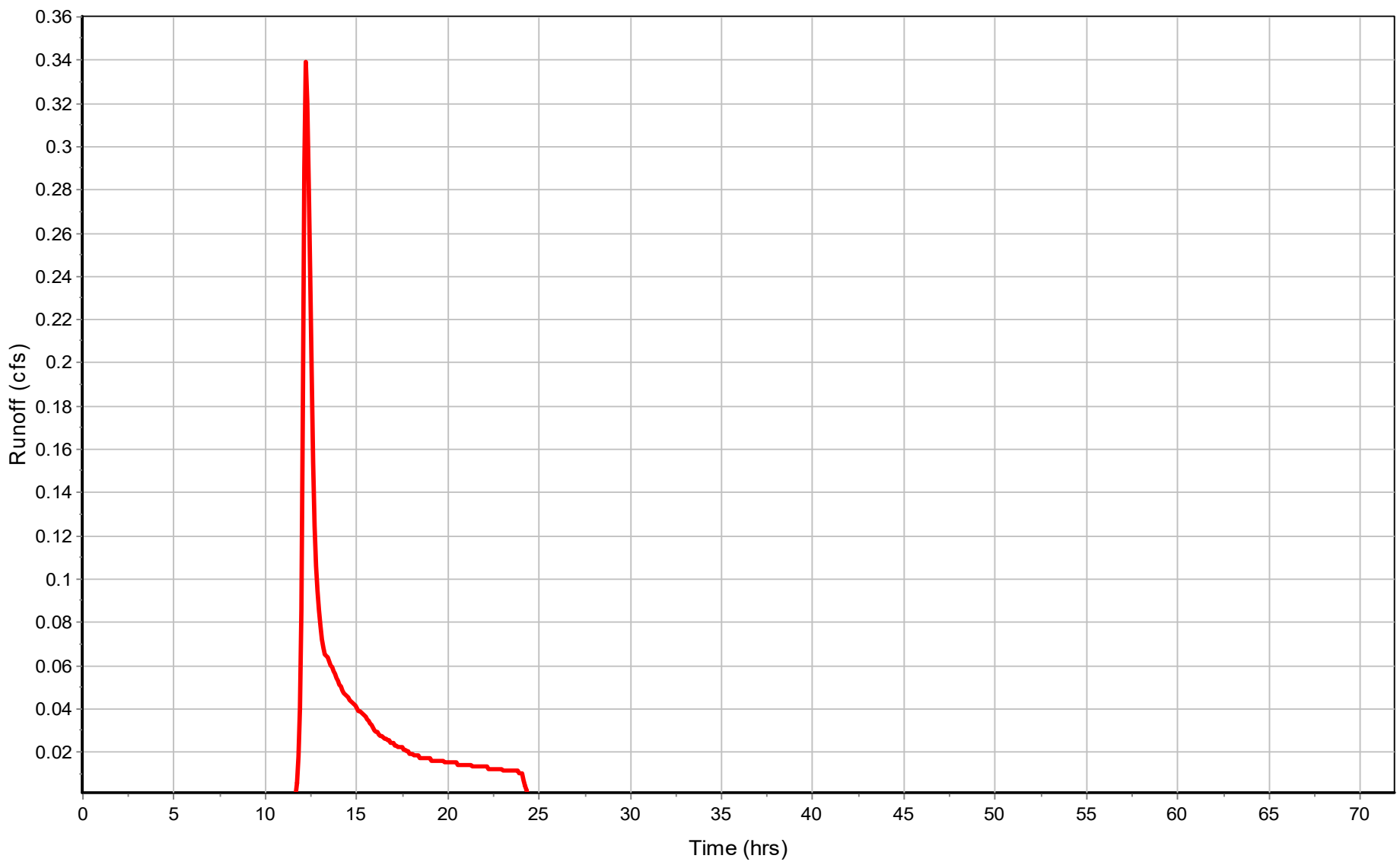
Total Rainfall (in) 8.8
Total Runoff (in) 1.95
Peak Runoff (cfs) 0.34
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:17:56

Subbasin : Sub-E01.1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E01_Ex

Input Data

Area (ac) 0.26
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.26	A	43
Composite Area & Weighted CN	0.26		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	106.59	0	0
Slope (%) :	14	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.1	0	0
Computed Flow Time (min) :	17.48	0	0

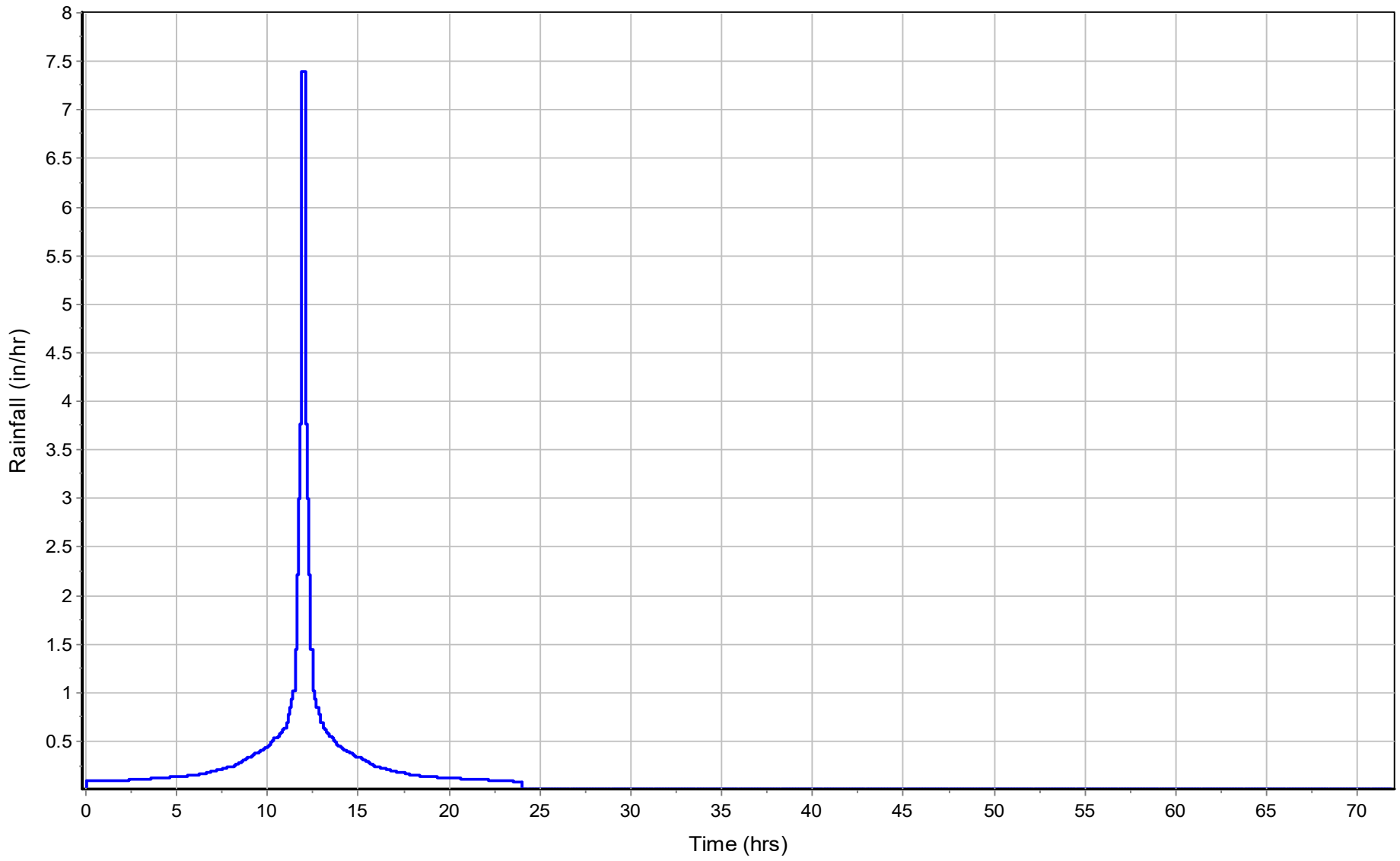
Total TOC (min) 17.48

Subbasin Runoff Results

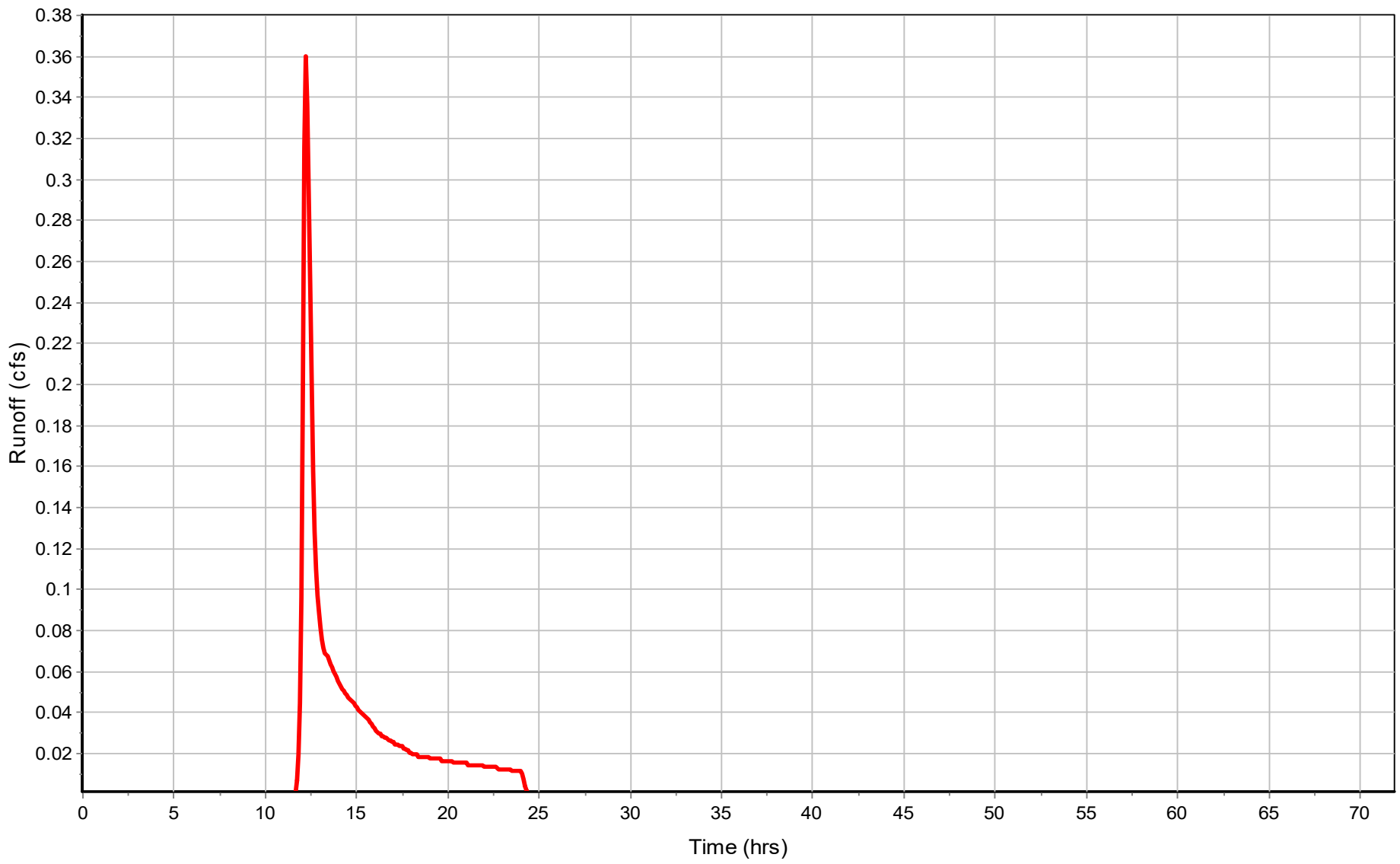
Total Rainfall (in) 8.8
Total Runoff (in) 1.95
Peak Runoff (cfs) 0.36
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:17:29

Subbasin : Sub-E01_Ex

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E03.1

Input Data

Area (ac) 0.1
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.1	A	43
Composite Area & Weighted CN	0.1		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	138.1	0	0
Slope (%) :	14	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.11	0	0
Computed Flow Time (min) :	21.5	0	0

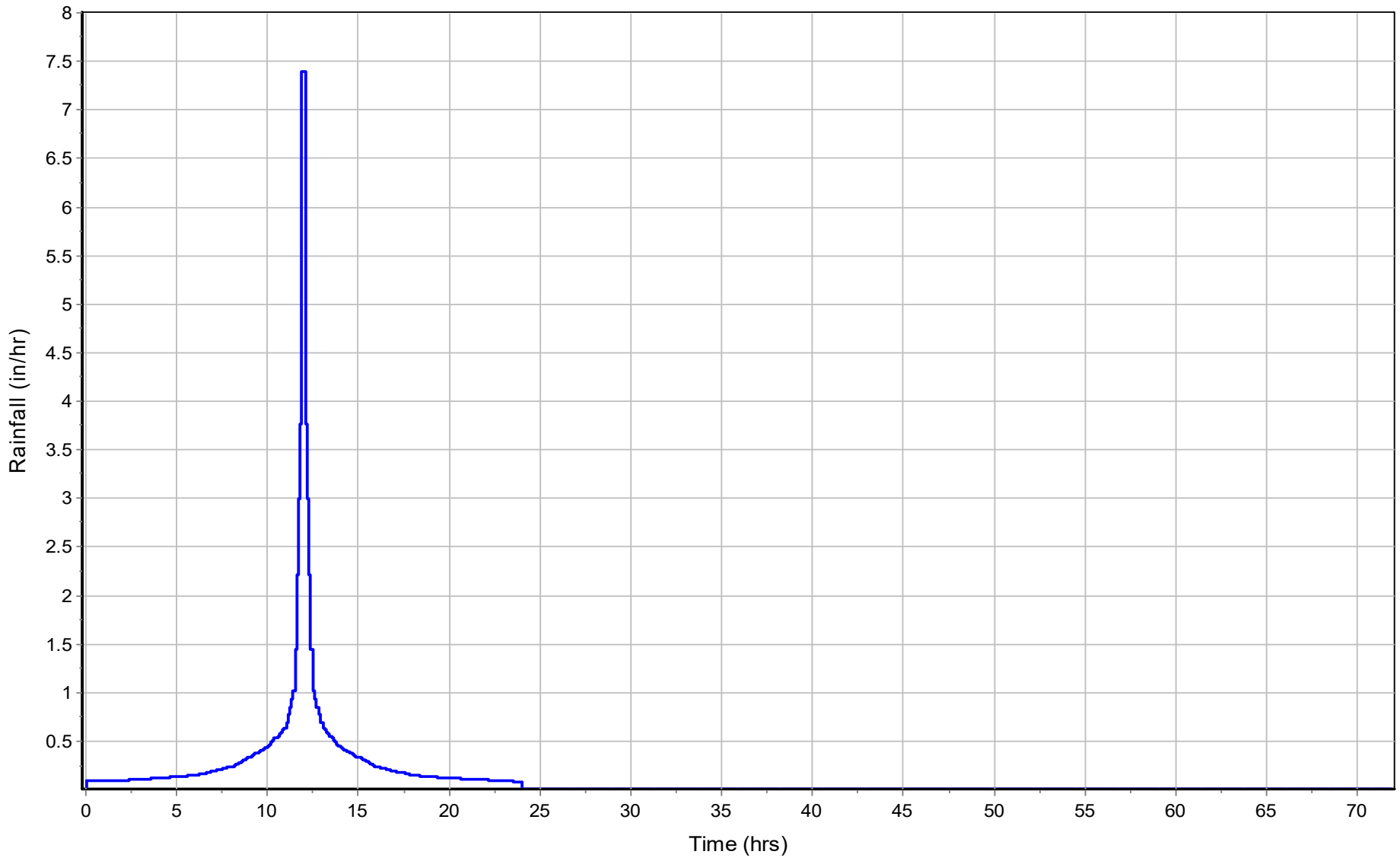
Total TOC (min) 21.50

Subbasin Runoff Results

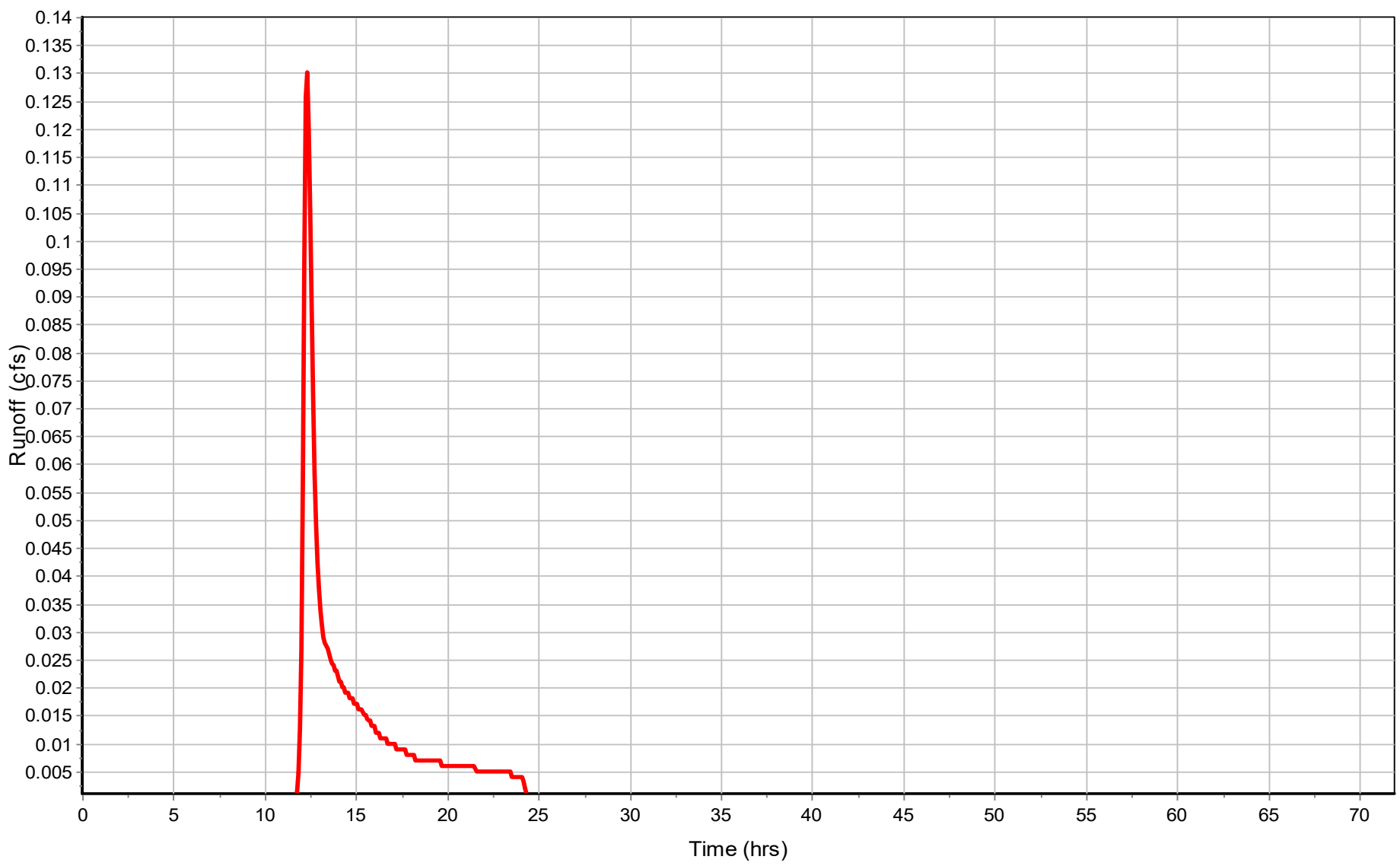
Total Rainfall (in) 8.8
Total Runoff (in) 1.95
Peak Runoff (cfs) 0.13
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:21:30

Subbasin : Sub-E03.1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E05.1

Input Data

Area (ac) 0.02
Peak Rate Factor 0
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.02	A	43
Composite Area & Weighted CN	0.02		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	43.1	0	0
Slope (%) :	12	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.08	0	0
Computed Flow Time (min) :	9.01	0	0

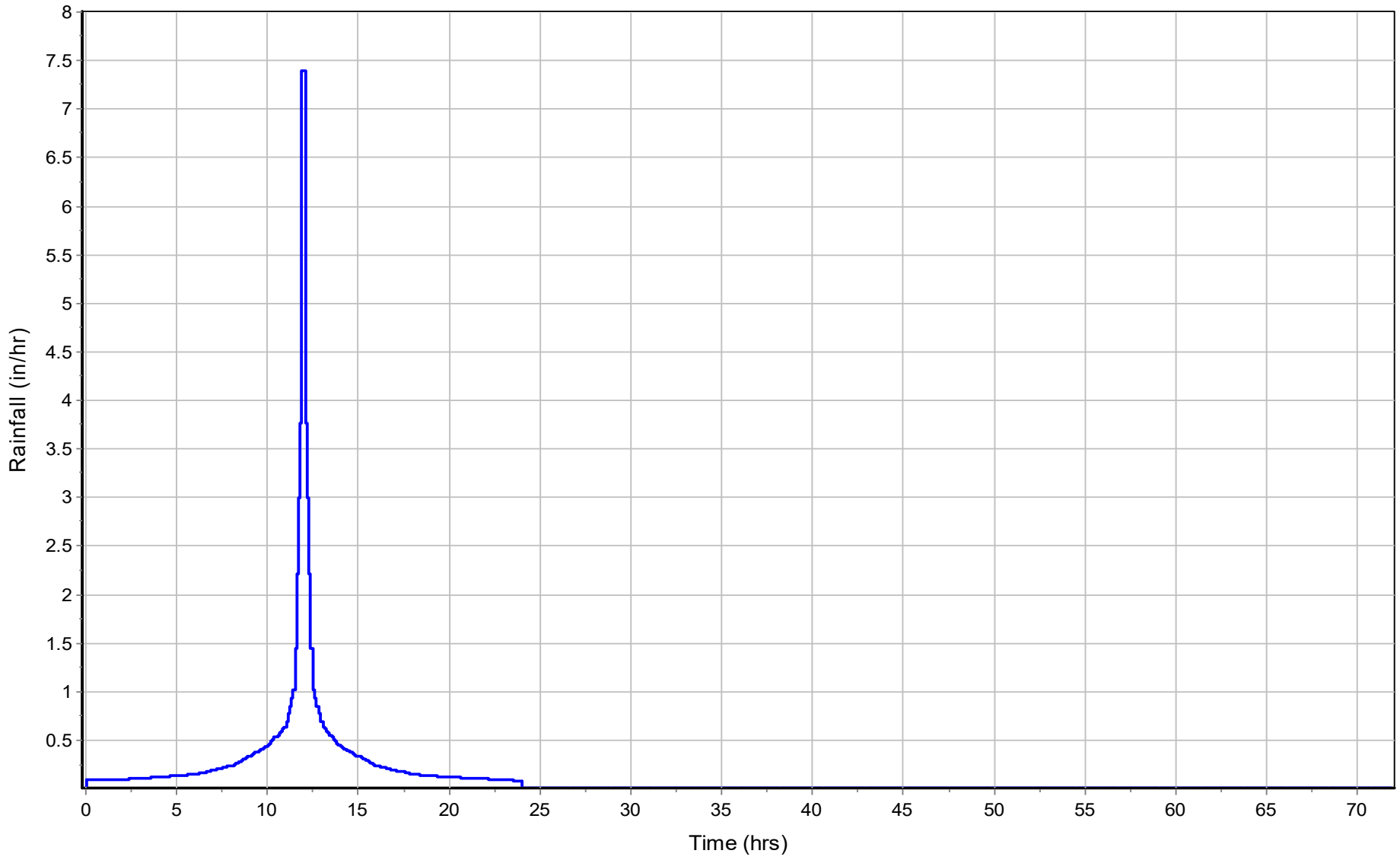
Total TOC (min) 9.01

Subbasin Runoff Results

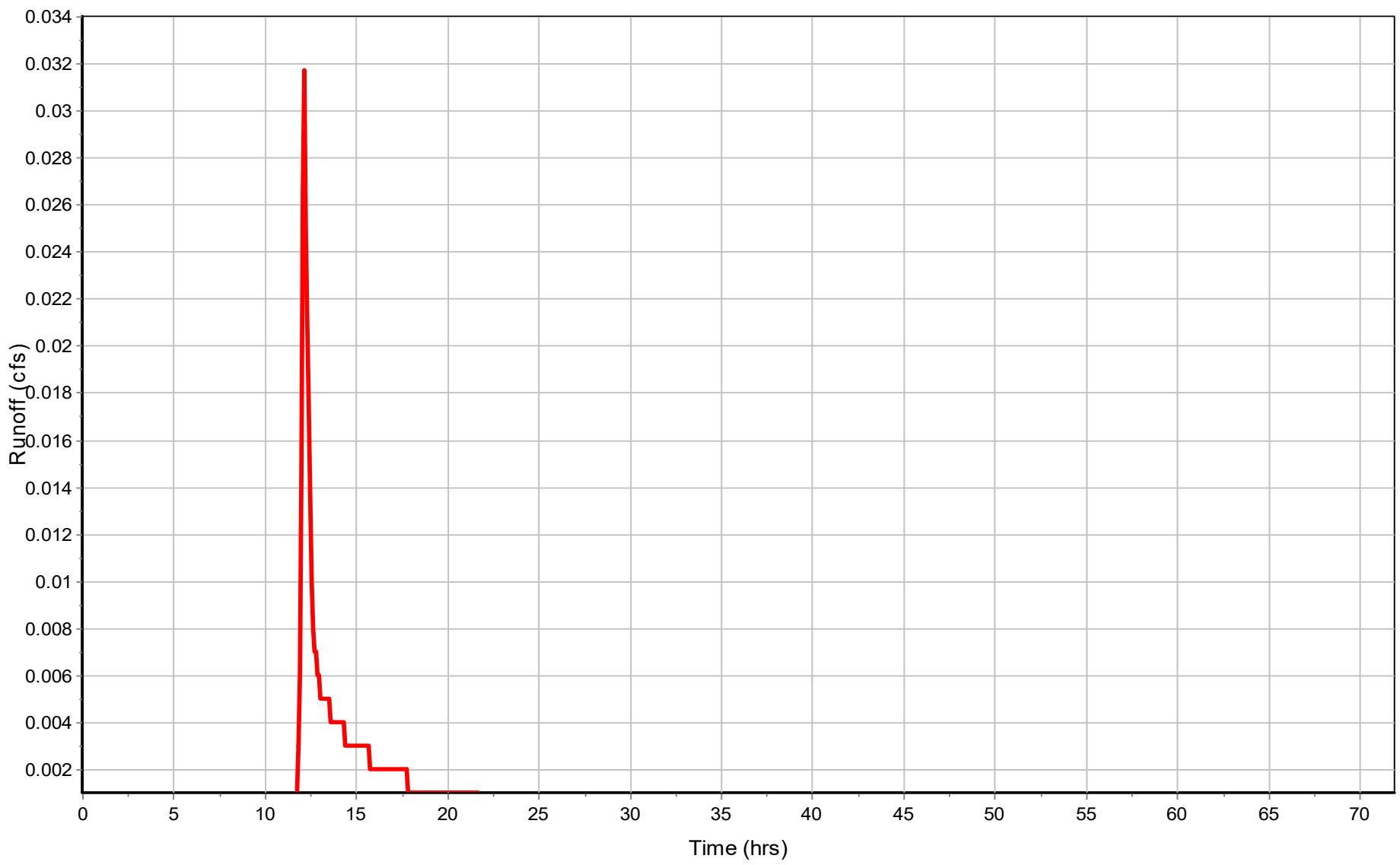
Total Rainfall (in) 8.8
Total Runoff (in) 1.84
Peak Runoff (cfs) 0.03
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:09:01

Subbasin : Sub-E05.1

Rainfall Intensity Graph



Runoff Hydrograph



Junction Input

SN	Element ID	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Ground/Rim (Max) Offset (ft)	Initial Water Elevation (ft)	Initial Water Depth (ft)	Surcharge Elevation (ft)	Surcharge Depth (ft)	Ponded Area (ft^2)	Minimum Pipe Cover (ft)
1	1-Jun	116.60	117.90	1.30	0.00	-116.60	0.00	-117.90	0.00	0.00

Junction Results

SN	Element ID	Peak Inflow (cfs)	Peak Lateral Inflow (cfs)	Max HGL Elevation Attained (ft)	Max HGL Depth Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Average HGL Elevation Attained (ft)	Average HGL Depth Attained (ft)	Time of Max HGL Occurrence (days hh:mm)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	1-Jun	0.72	0.13	117.57	0.97	0.00	4.13	117.28	0.68	0 13:31	0 00:00	0.00	0.00

Channel Input

SN	Element ID	Length (ft)	Inlet Invert Elevation (ft)	Inlet Invert Offset (ft)	Outlet Invert Elevation (ft)	Outlet Invert Offset (ft)	Total Drop (ft)	Average Slope (%)	Shape	Height (ft)	Width (ft)	Manning's Roughness	Entrance Losses	Exit/Bend Losses	Additional Losses	Initial Flow (cfs)	Flap Gate
1	Ditch-01	81.45	116.60	0.00	116.36	3.96	0.24	0.2900	Trapezoidal	1.300	6.200	0.0250	0.5000	0.5000	0.0000	0.00	No

Channel Results

SN	Element ID	Peak Flow (cfs)	Time of Peak Flow Occurrence (days hh:mm)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Travel Time (min)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Froude Number	Reported Condition
1	Ditch-01	0.65	0 12:43	11.76	0.06	0.82	1.66	1.08	0.83	0.00		

Storage Nodes

Storage Node : Basin-A1

Input Data

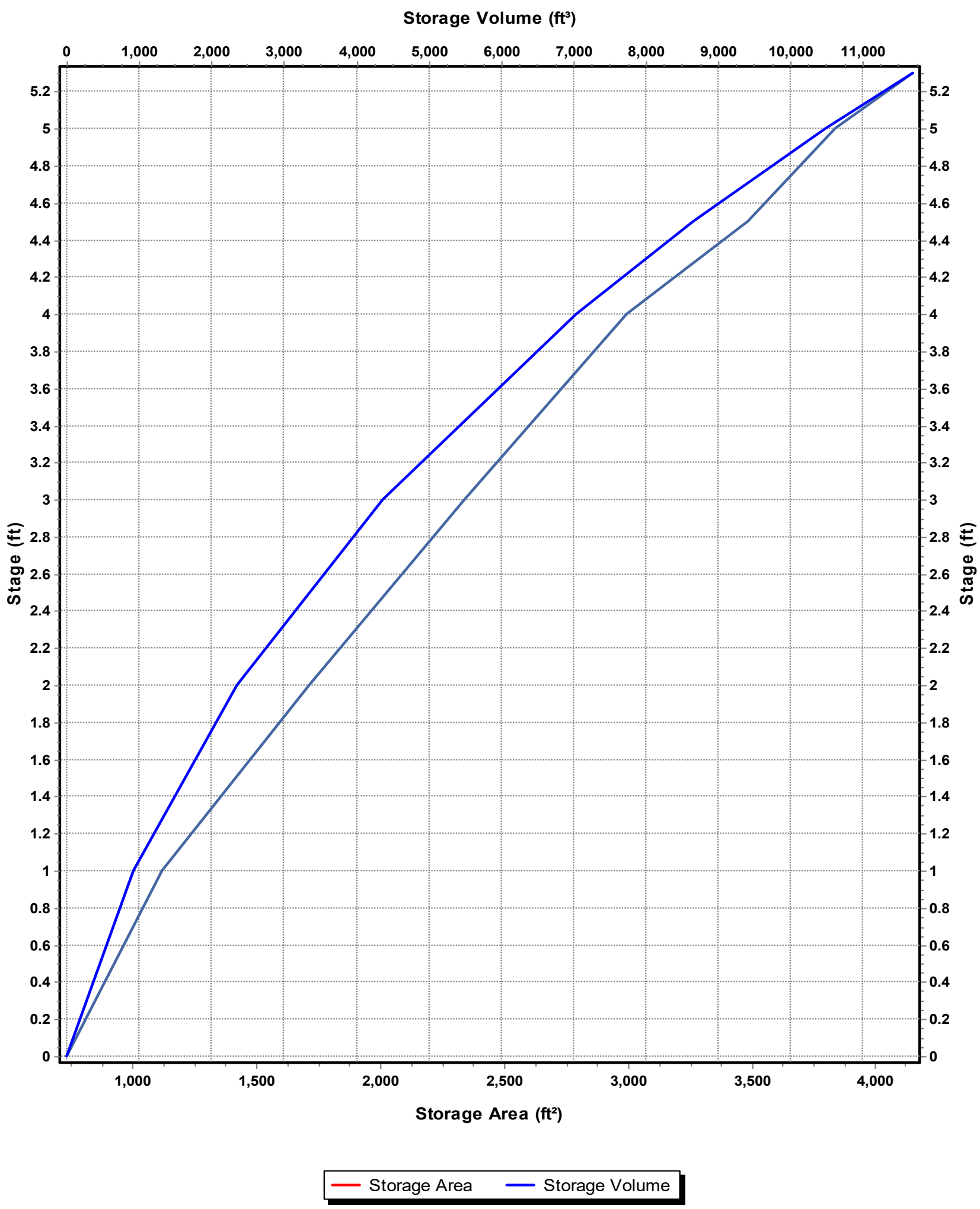
Invert Elevation (ft)	112.40
Max (Rim) Elevation (ft)	117.70
Max (Rim) Offset (ft)	5.30
Initial Water Elevation (ft)	112.40
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Basin-01

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	734.2	0
1	1121.14	927.67
2	1714.29	2345.39
3	2339.15	4372.11
4	2995.85	7039.61
4.5	3484.76	8659.76
5	3837.05	10490.21
5.3	4151.91	11688.55

Storage Area Volume Curves



Storage Node : Basin-A1 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-B-A1	Trapezoidal	No	117.40	5.00	4.00	0.30	3.33

Output Summary Results

Peak Inflow (cfs)	4.5
Peak Lateral Inflow (cfs)	0.34
Peak Outflow (cfs)	0.87
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	117.55
Max HGL Depth Attained (ft)	5.15
Average HGL Elevation Attained (ft)	116.58
Average HGL Depth Attained (ft)	4.18
Time of Max HGL Occurrence (days hh:mm)	0 13:30
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Basin-A2

Input Data

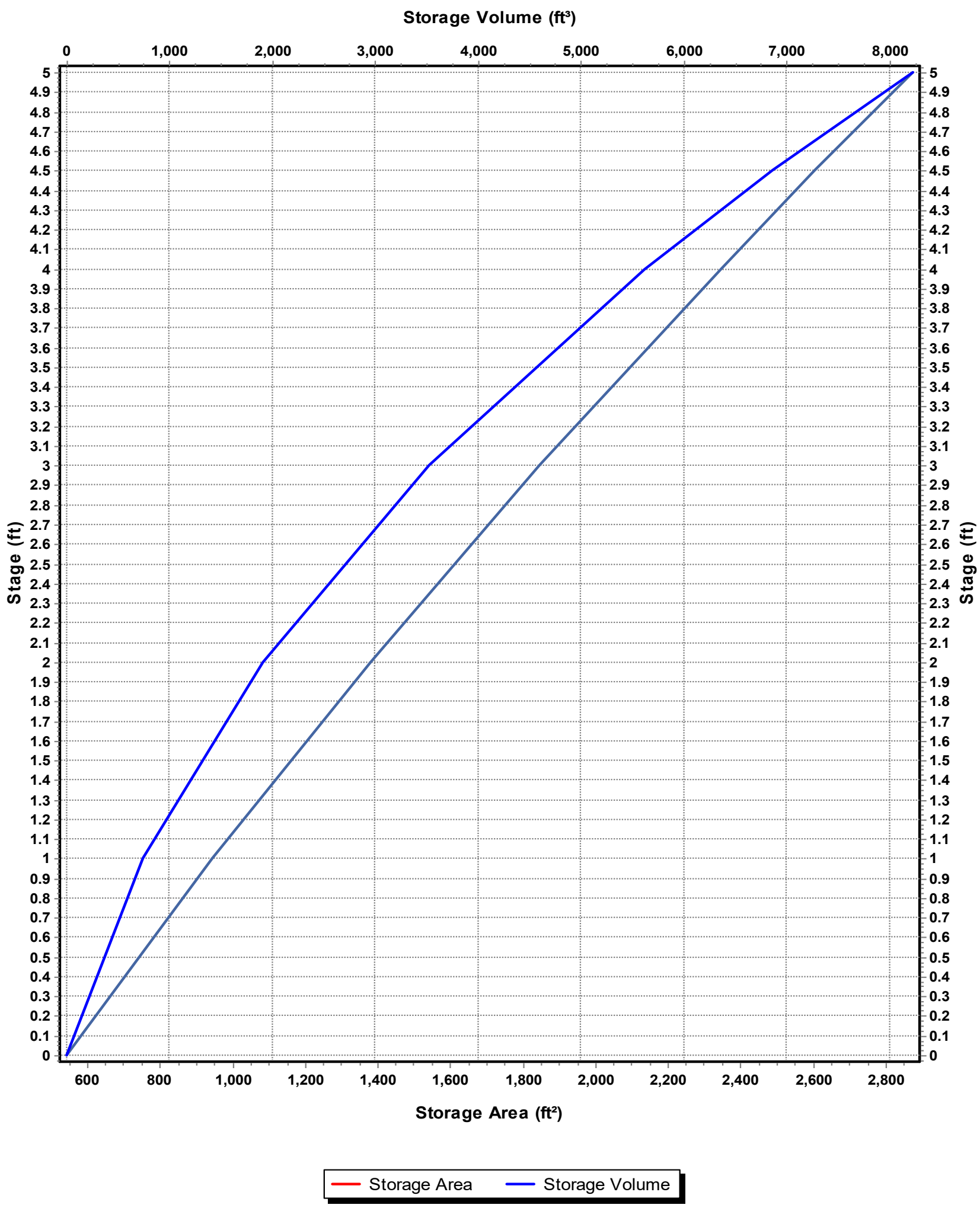
Invert Elevation (ft)	112.90
Max (Rim) Elevation (ft)	117.90
Max (Rim) Offset (ft)	5.00
Initial Water Elevation (ft)	112.90
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Basin-02

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	543.55	0
1	946	744.78
2	1380.46	1908.01
3	1846.91	3521.7
4	2345.37	5617.84
4.5	2606.6	6855.83
5	2875.82	8226.44

Storage Area Volume Curves



Storage Node : Basin-A2 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-B-A2	Trapezoidal	No	117.50	4.60	5.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	5.11
Peak Lateral Inflow (cfs)	0
Peak Outflow (cfs)	4.53
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	117.61
Max HGL Depth Attained (ft)	4.71
Average HGL Elevation Attained (ft)	116.75
Average HGL Depth Attained (ft)	3.85
Time of Max HGL Occurrence (days hh:mm)	0 12:47
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Forebay-A1

Input Data

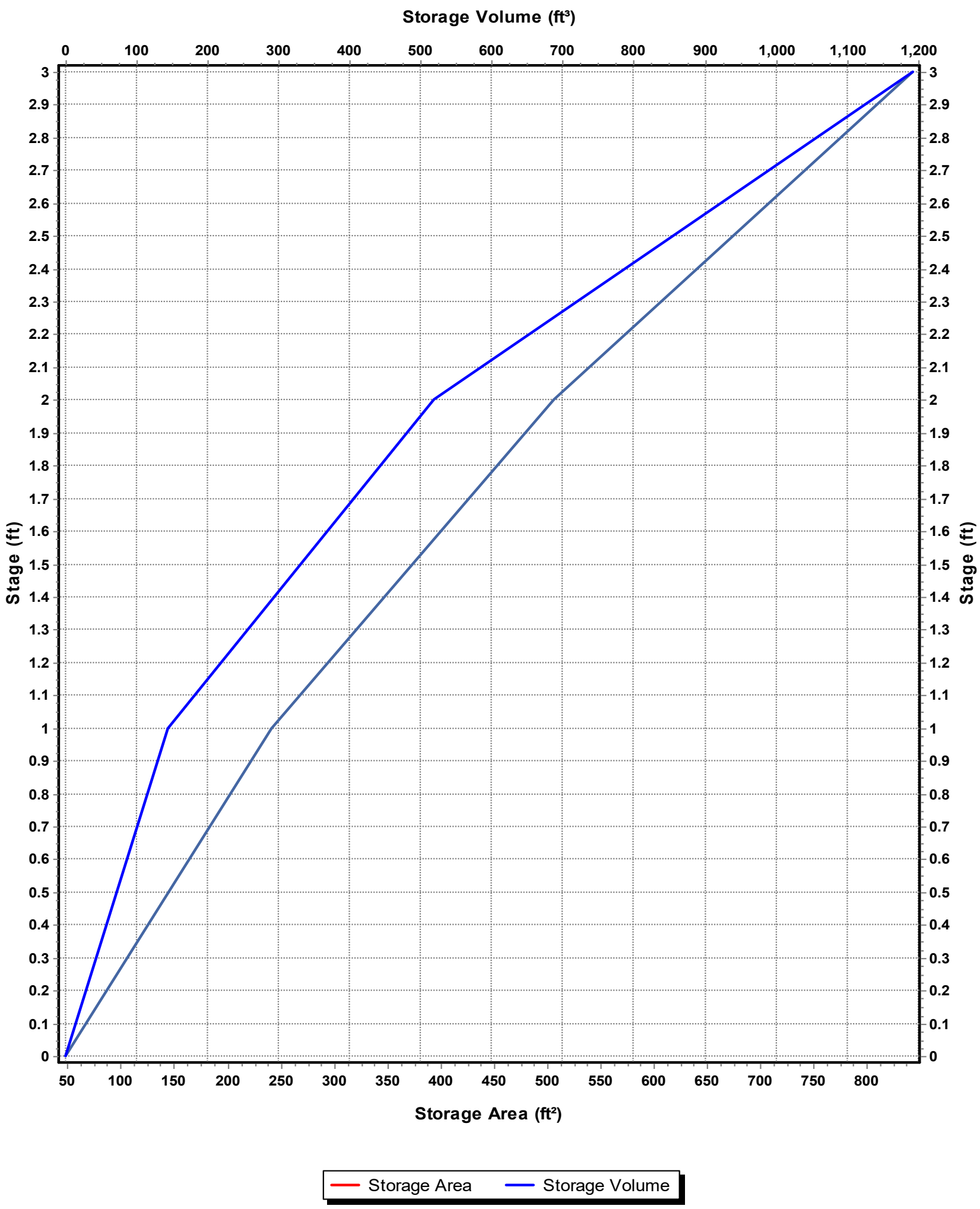
Invert Elevation (ft)	114.40
Max (Rim) Elevation (ft)	117.70
Max (Rim) Offset (ft)	3.30
Initial Water Elevation (ft)	114.40
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Forebay-01

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	48.29	0
1	241.18	144.74
2	506.06	518.36
3	842.94	1192.86

Storage Area Volume Curves



Storage Node : Forebay-A1 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-F-A1	Trapezoidal	No	117.30	2.90	8.00	2.00	3.33

Output Summary Results

Peak Inflow (cfs)	4.3
Peak Lateral Inflow (cfs)	4.3
Peak Outflow (cfs)	4.26
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	117.59
Max HGL Depth Attained (ft)	3.19
Average HGL Elevation Attained (ft)	117.04
Average HGL Depth Attained (ft)	2.64
Time of Max HGL Occurrence (days hh:mm)	0 12:10
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Forebay-A2

Input Data

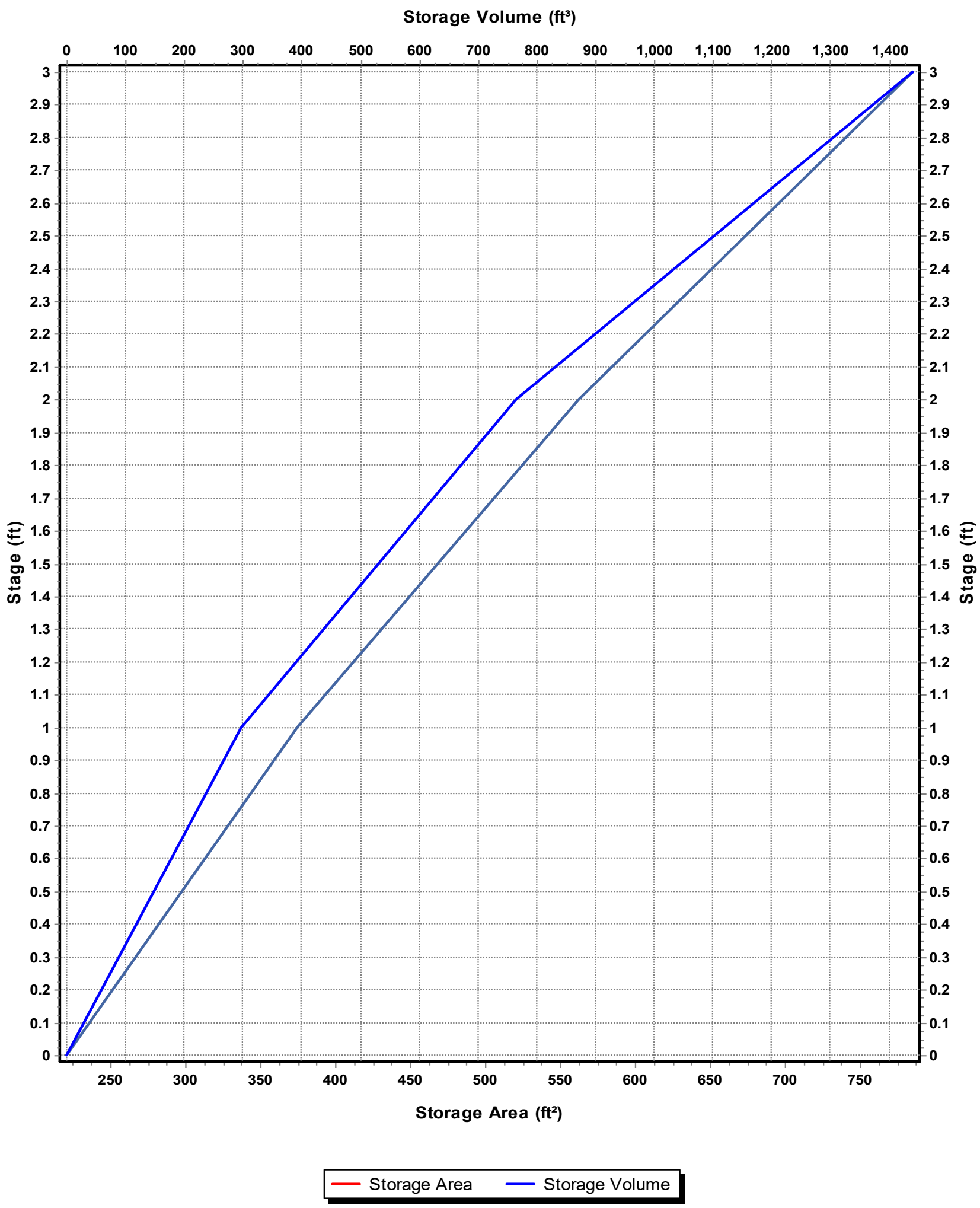
Invert Elevation (ft)	114.90
Max (Rim) Elevation (ft)	117.90
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.90
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Forebay-02

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	221.26	0
1	374.45	297.86
2	562.72	766.45
3	785.55	1440.59

Storage Area Volume Curves



Storage Node : Forebay-A2 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-F-A2	Trapezoidal	No	117.00	2.10	10.00	1.00	3.33

Output Summary Results

Peak Inflow (cfs)	4.43
Peak Lateral Inflow (cfs)	4
Peak Outflow (cfs)	5.11
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	117.66
Max HGL Depth Attained (ft)	2.76
Average HGL Elevation Attained (ft)	117.17
Average HGL Depth Attained (ft)	2.27
Time of Max HGL Occurrence (days hh:mm)	0 12:51
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Project Description

File Name ..... Pave.Paws_A1_A2.SPF

Project Options

Flow Units ..... CFS
Elevation Type ..... Elevation
Hydrology Method ..... SCS TR-20
Time of Concentration (TOC) Method ..... SCS TR-55
Link Routing Method ..... Hydrodynamic
Enable Overflow Ponding at Nodes ..... YES
Skip Steady State Analysis Time Periods .... NO

Analysis Options

Start Analysis On 00:00:00 0:00:00
End Analysis On 00:00:00 0:00:00
Start Reporting On 00:00:00 0:00:00
Antecedent Dry Days ..... 0 days
Runoff (Dry Weather) Time Step ..... 0 01:00:00 days hh:mm:ss
Runoff (Wet Weather) Time Step ..... 0 00:05:00 days hh:mm:ss
Reporting Time Step ..... 0 00:05:00 days hh:mm:ss
Routing Time Step ..... 30 seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	7
Nodes	7
Junctions	1
Outfalls	2
Flow Diversions	0
Inlets	0
Storage Nodes	4
Links	5
Channels	1
Pipes	0
Pumps	0
Orifices	0
Weirs	4
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	100 years	Intensity	inches	Massachusetts	None	100.00	7.48	SCS Type III 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Sub-A1	0.73	484.00	76.00	7.48	4.69	3.44	3.51	0 00:06:00
2	Sub-A2	0.69	484.00	76.00	7.48	4.69	3.22	3.27	0 00:06:00
3	Sub-E01	0.76	484.00	43.00	7.48	1.29	0.98	0.52	0 00:28:48
4	Sub-E01.1	0.25	484.00	43.00	7.48	1.29	0.32	0.20	0 00:17:56
5	Sub-E01_Ex	0.26	484.00	43.00	7.48	1.29	0.34	0.21	0 00:17:28
6	Sub-E03.1	0.10	484.00	43.00	7.48	1.29	0.13	0.08	0 00:21:30
7	Sub-E05.1	0.02	0.00	43.00	7.48	1.05	0.02	0.02	0 00:09:00

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	1-Jun	Junction	116.60	117.90	0.00	0.00	0.00	0.23	117.50	0.00	4.20	0 00:00	0.00	0.00
2	Out-E01	Outfall	116.00					0.52	116.00					
3	Out-Prop-A1	Outfall	116.00					0.33	116.00					
4	Basin-A1	Storage Node	112.40	117.70	112.40		0.00	3.51	117.48				0.00	0.00
5	Basin-A2	Storage Node	112.90	117.90	112.90		0.00	3.19	117.56				0.00	0.00
6	Forebay-A1	Storage Node	114.40	117.70	114.40		0.00	3.45	117.55				0.00	0.00
7	Forebay-A2	Storage Node	114.90	117.90	114.90		0.00	3.21	117.55				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length (ft)	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Average Slope (%)	Diameter or Height (ft)	Manning's Roughness	Peak Flow (cfs)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Reported Condition
1	Ditch-01	Channel	1-Jun	Basin-A1	81.45	116.60	116.36	0.2900	1.300	0.0250	0.37	11.76	0.03	0.67	1.00	0.78	0.00	
2	Weir-B-A1	Weir	Basin-A1	Out-Prop-A1		112.40	116.00				0.30							
3	Weir-B-A2	Weir	Basin-A2	1-Jun		112.90	116.60				0.21							
4	Weir-F-A1	Weir	Forebay-A1	Basin-A1		114.40	112.40				3.41							
5	Weir-F-A2	Weir	Forebay-A2	Basin-A2		114.90	112.90				3.19							

Subbasin Hydrology

Subbasin : Sub-A1

Input Data

Area (ac) 0.73
Peak Rate Factor 484
Weighted Curve Number 76
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	0.73	A	76
Composite Area & Weighted CN	0.73		76

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft^2)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	132.16	0	0
Slope (%) :	0.71	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.78	0	0
Computed Flow Time (min) :	2.84	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	257.27	0	0
Channel Slope (%) :	0.4	0	0
Cross Section Area (ft^2) :	2.067	0	0
Wetted Perimeter (ft) :	5.25	0	0
Velocity (ft/sec) :	1.69	0	0
Computed Flow Time (min) :	2.54	0	0

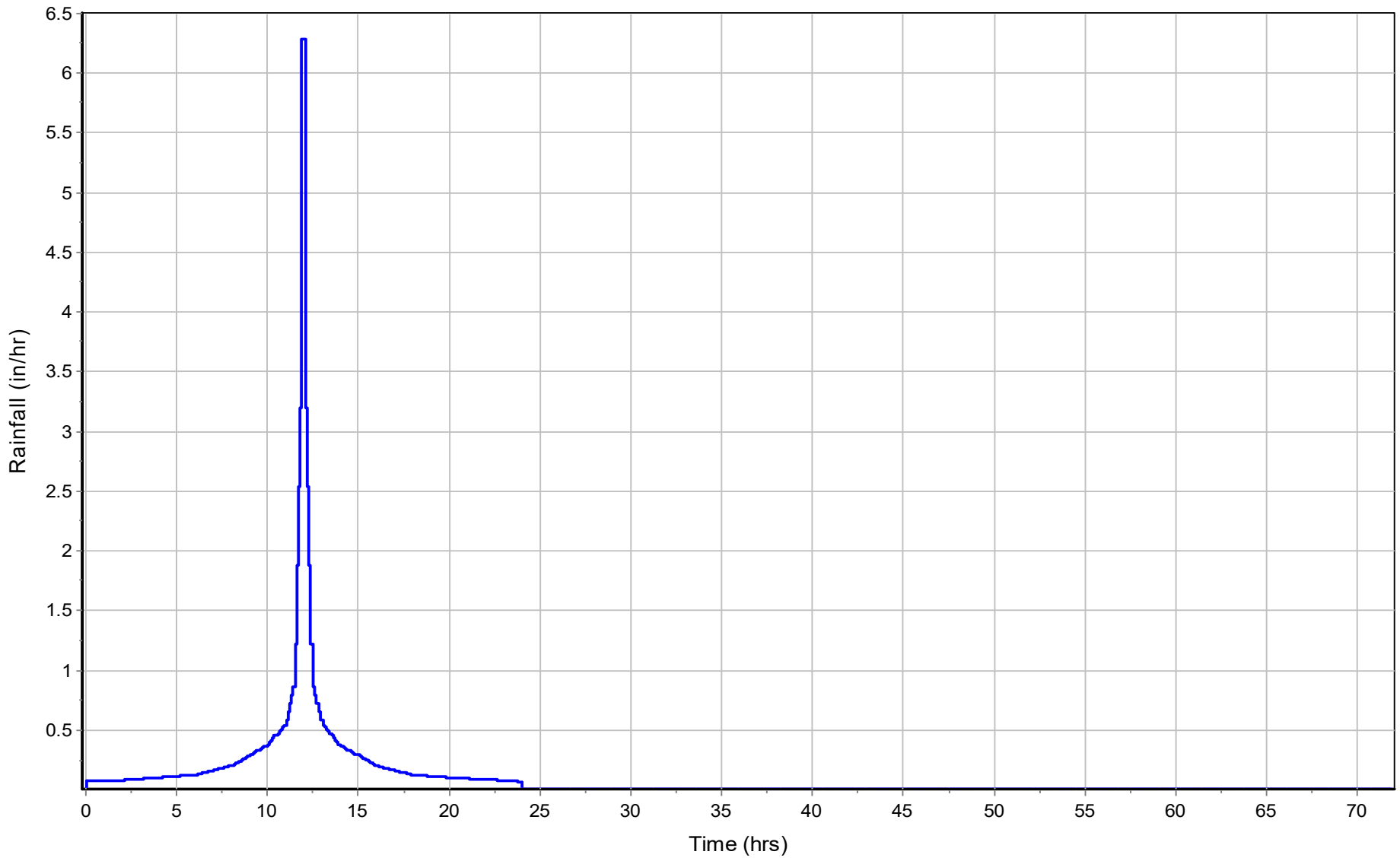
Total TOC (min) 5.38

Subbasin Runoff Results

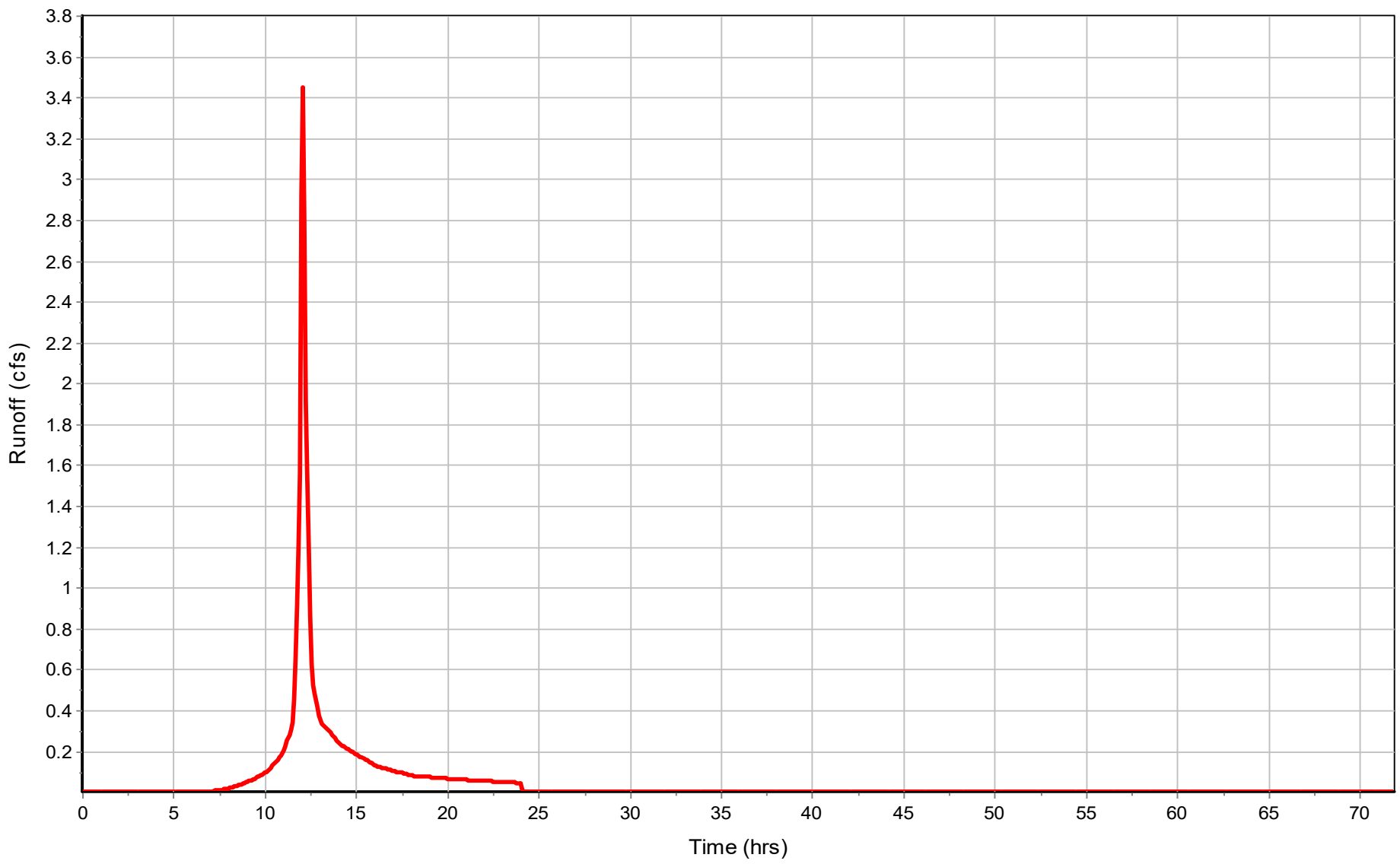
Total Rainfall (in)	7.48
Total Runoff (in)	4.69
Peak Runoff (cfs)	3.51
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:05:23

Subbasin : Sub-A1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-A2

Input Data

Area (ac) 0.69
Peak Rate Factor 484
Weighted Curve Number 76
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	0.69	A	76
Composite Area & Weighted CN	0.69		76

Time of Concentration

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	331.61	0	0
Channel Slope (%) :	5.4	0	0
Cross Section Area (ft^2) :	3	0	0
Wetted Perimeter (ft) :	6.32	0	0
Velocity (ft/sec) :	7.02	0	0
Computed Flow Time (min) :	0.79	0	0

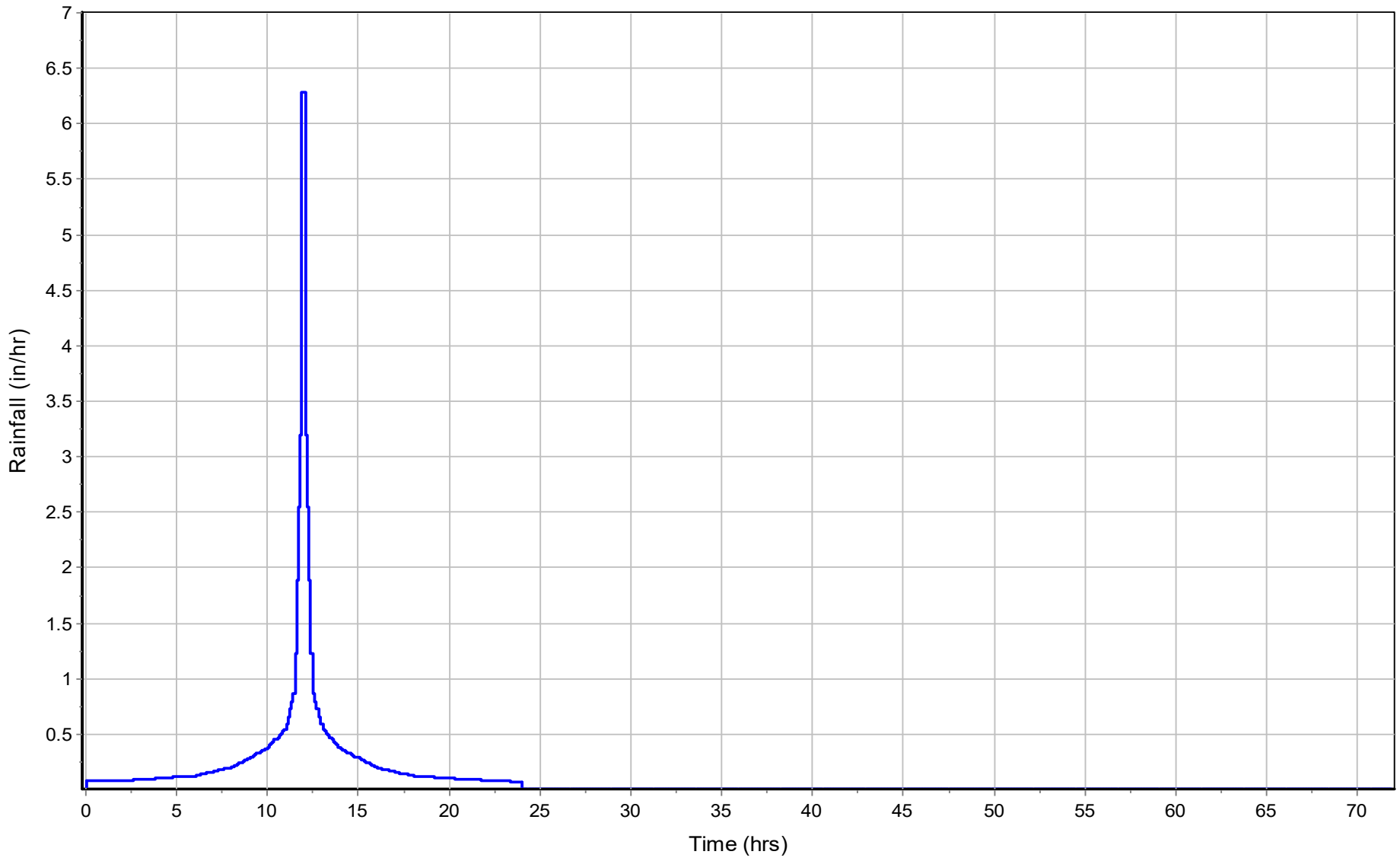
Total TOC (min) 0.79

Subbasin Runoff Results

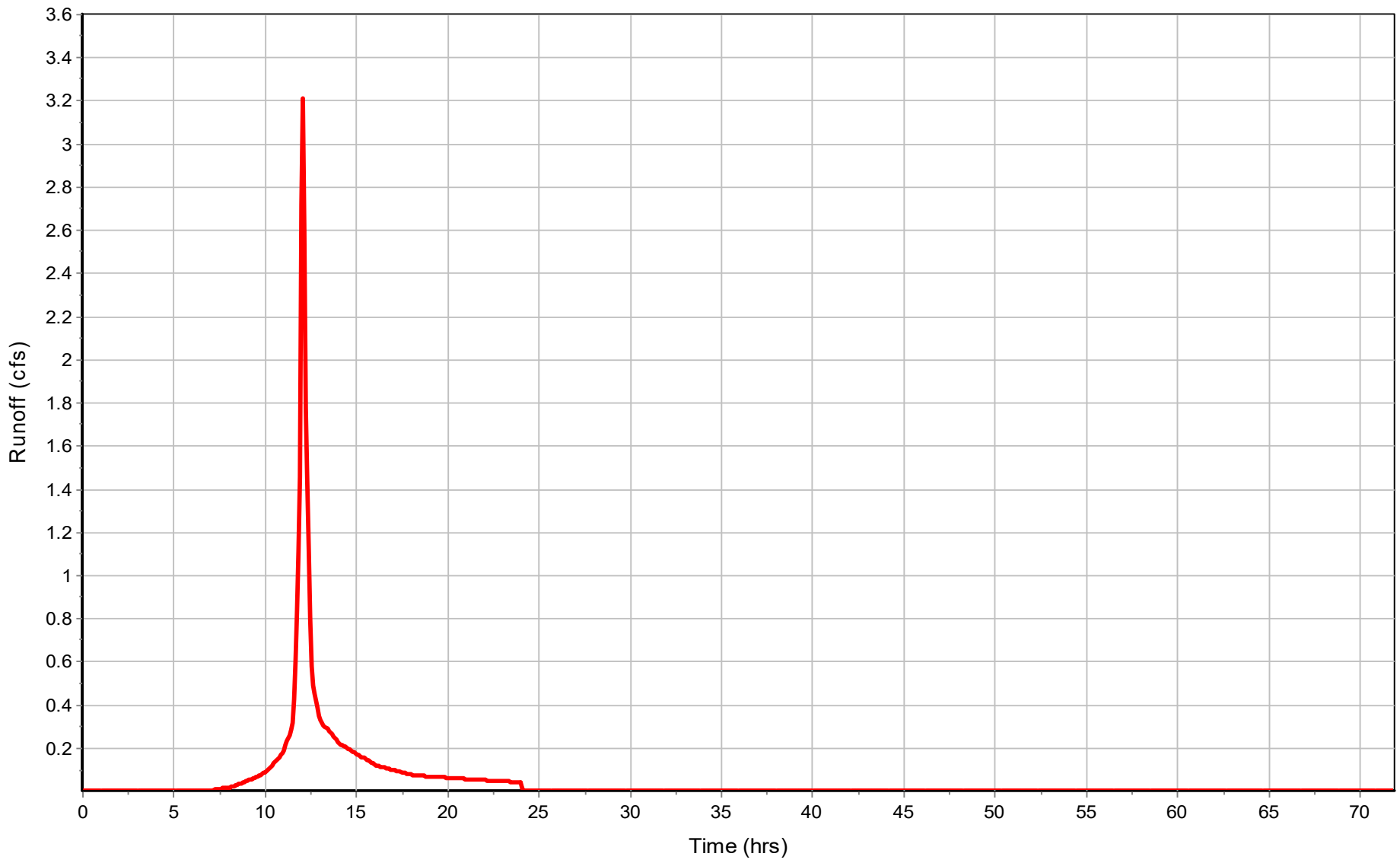
Total Rainfall (in) 7.48
Total Runoff (in) 4.69
Peak Runoff (cfs) 3.27
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:00:47

Subbasin : Sub-A2

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E01

Input Data

Area (ac) 0.76
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.76	A	43
Composite Area & Weighted CN	0.76		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	249.61	0	0
Slope (%) :	22	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.14	0	0
Computed Flow Time (min) :	28.81	0	0

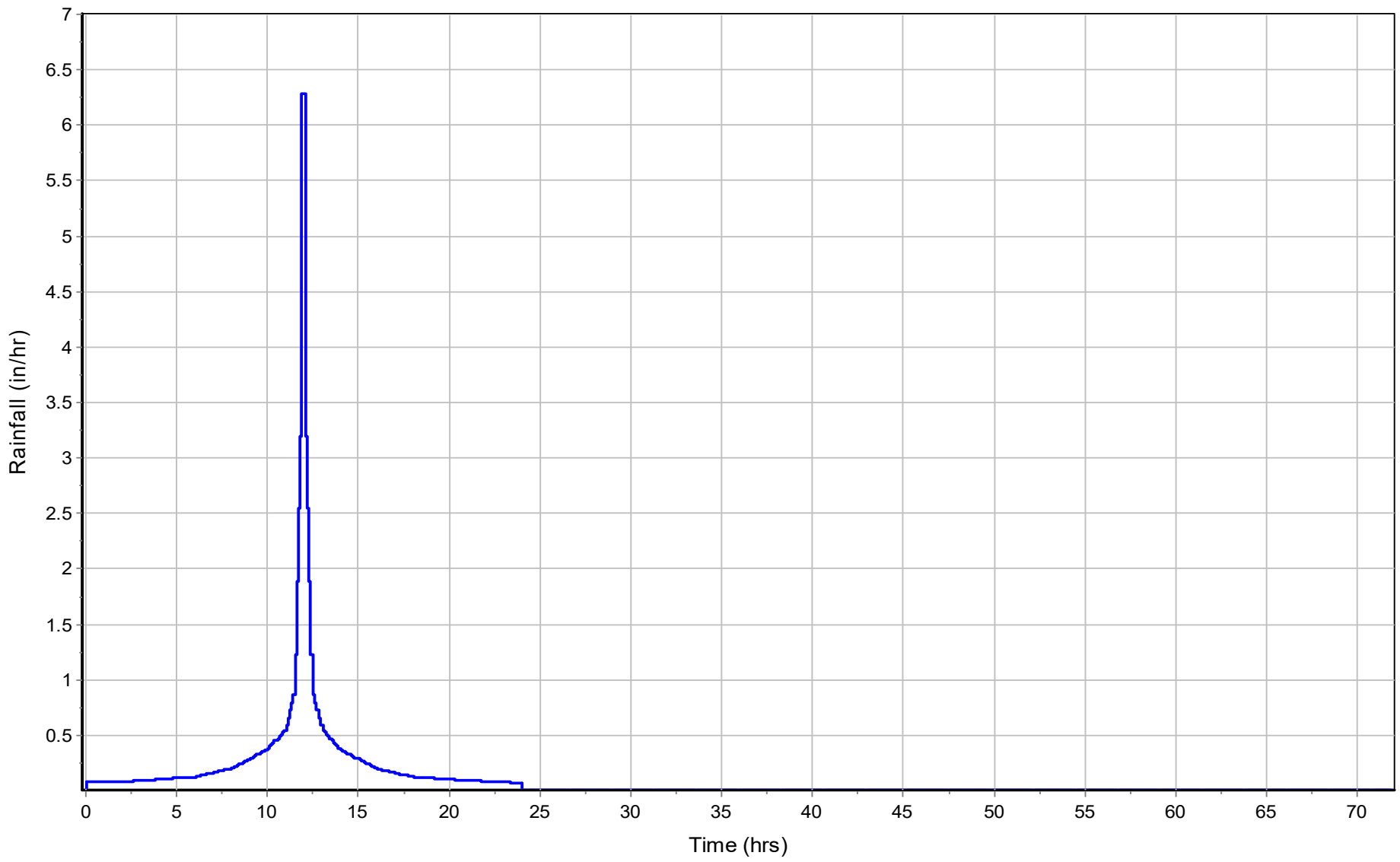
Total TOC (min) 28.81

Subbasin Runoff Results

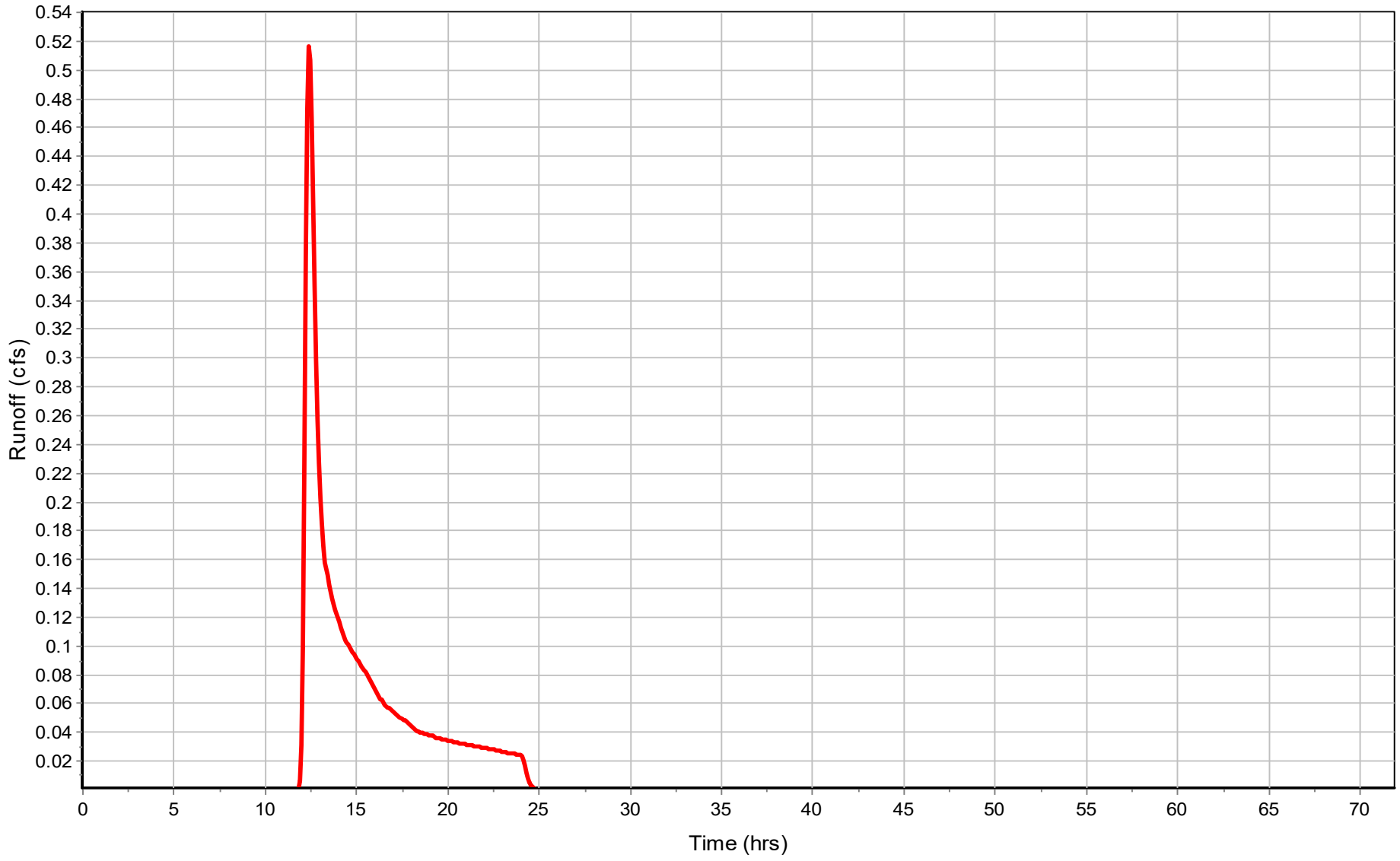
Total Rainfall (in) 7.48
Total Runoff (in) 1.29
Peak Runoff (cfs) 0.52
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:28:49

Subbasin : Sub-E01

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E01.1

Input Data

Area (ac) 0.25
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.25	A	43
Composite Area & Weighted CN	0.25		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	128.34	0	0
Slope (%) :	19	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.12	0	0
Computed Flow Time (min) :	17.94	0	0

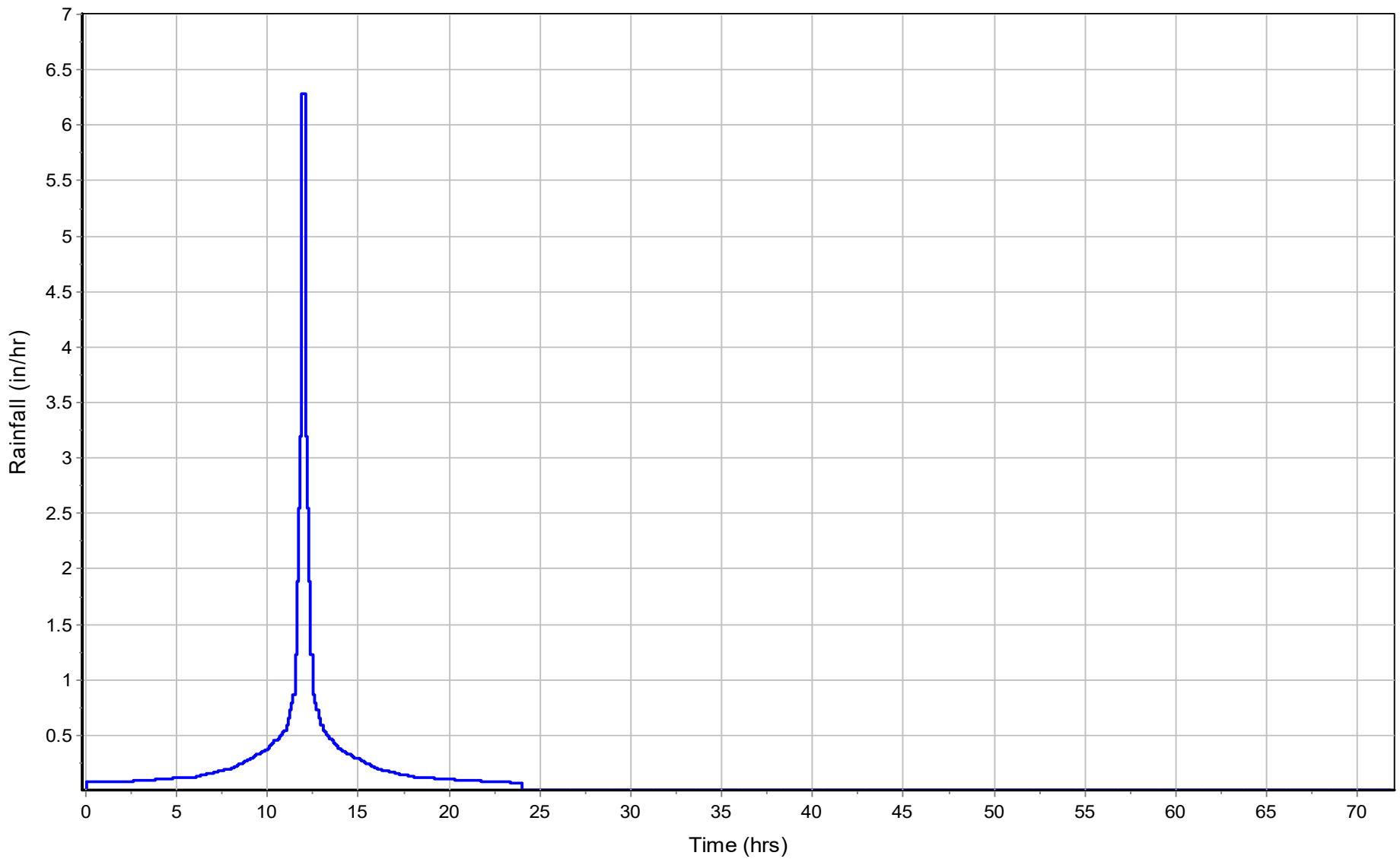
Total TOC (min) 17.94

Subbasin Runoff Results

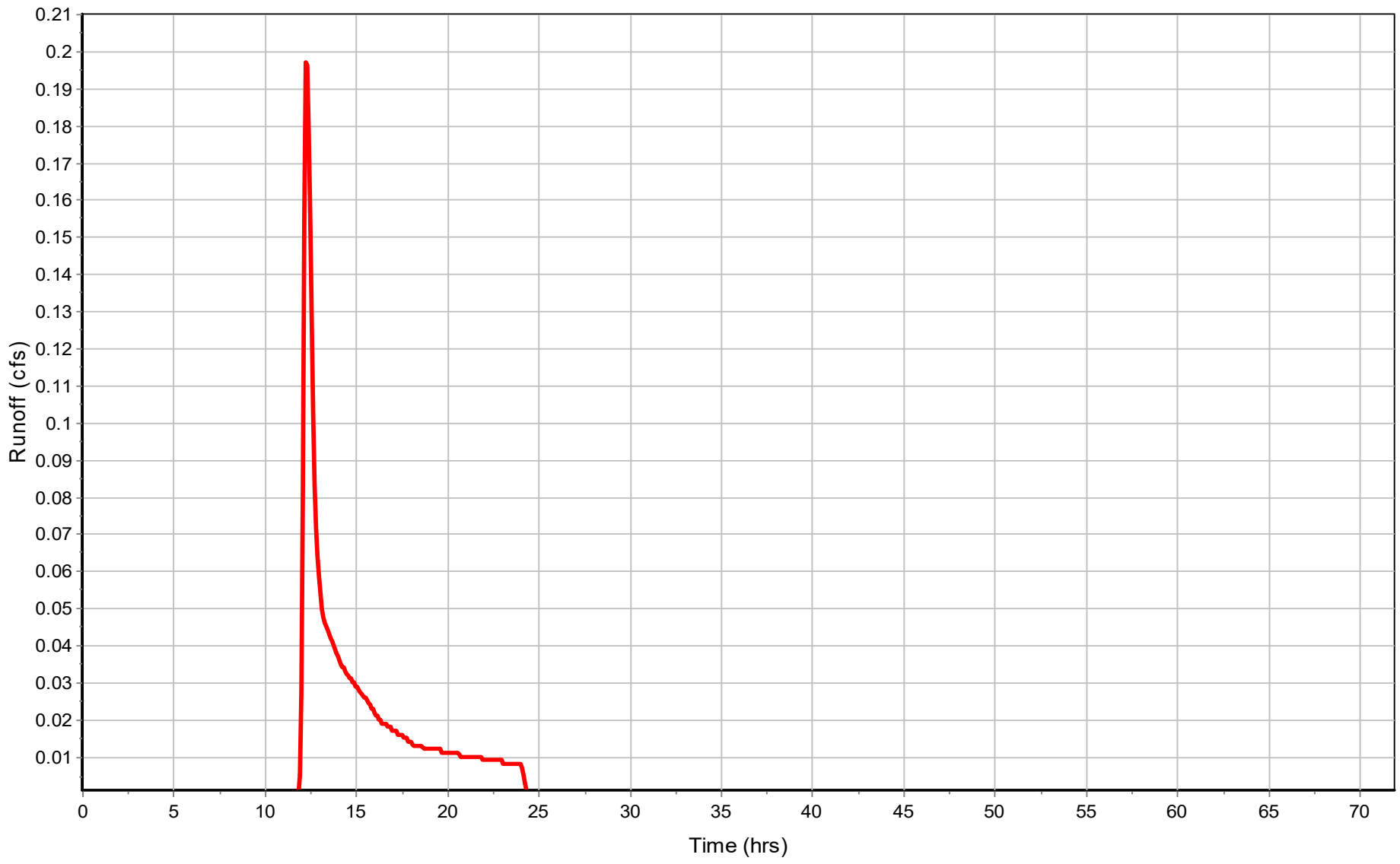
Total Rainfall (in) 7.48
Total Runoff (in) 1.29
Peak Runoff (cfs) 0.2
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:17:56

Subbasin : Sub-E01.1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E01_Ex

Input Data

Area (ac) 0.26
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.26	A	43
Composite Area & Weighted CN	0.26		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	106.59	0	0
Slope (%) :	14	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.1	0	0
Computed Flow Time (min) :	17.48	0	0

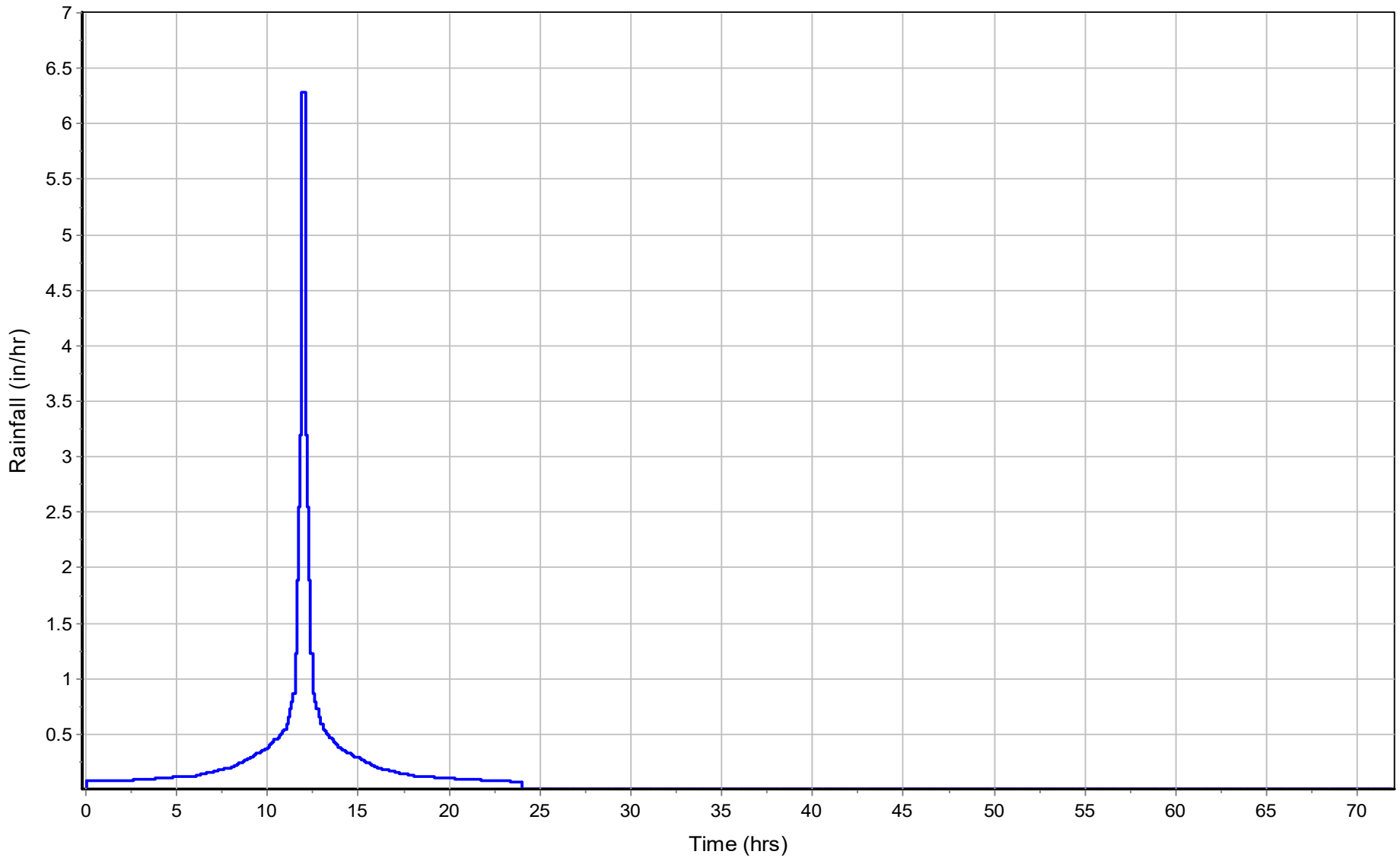
Total TOC (min) 17.48

Subbasin Runoff Results

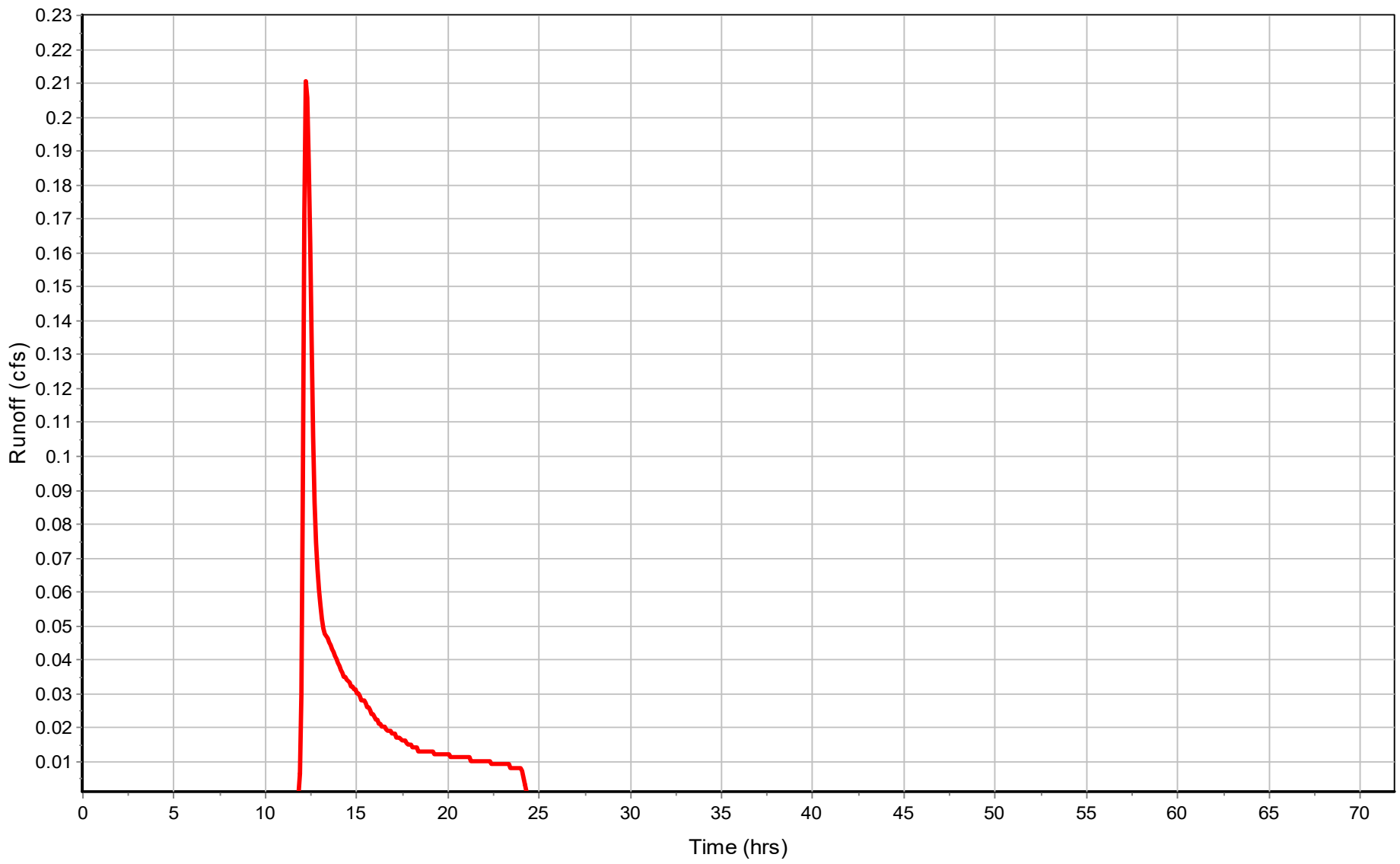
Total Rainfall (in) 7.48
Total Runoff (in) 1.29
Peak Runoff (cfs) 0.21
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:17:29

Subbasin : Sub-E01_Ex

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E03.1

Input Data

Area (ac) 0.1
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.1	A	43
Composite Area & Weighted CN	0.1		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	138.1	0	0
Slope (%) :	14	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.11	0	0
Computed Flow Time (min) :	21.5	0	0

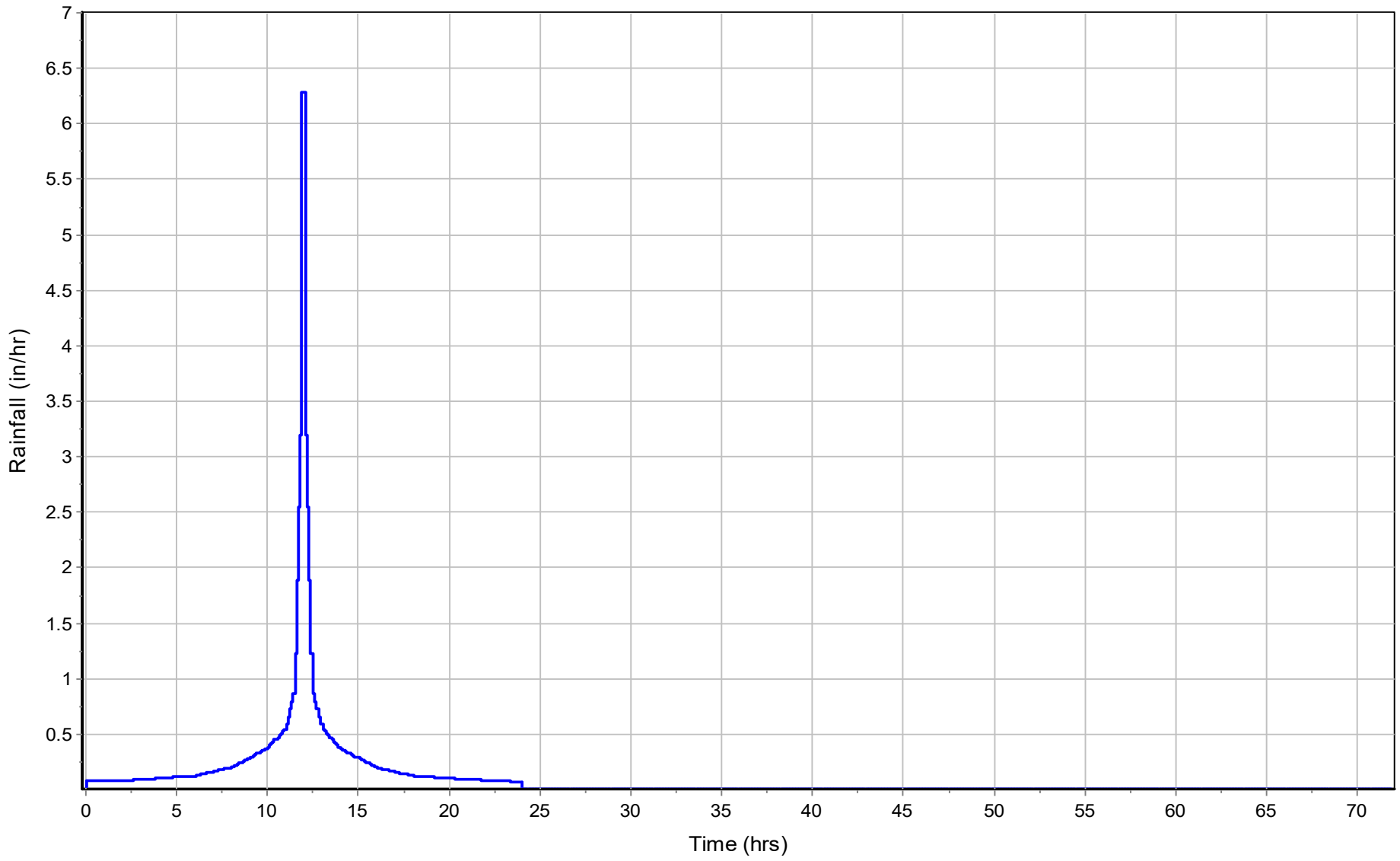
Total TOC (min) 21.50

Subbasin Runoff Results

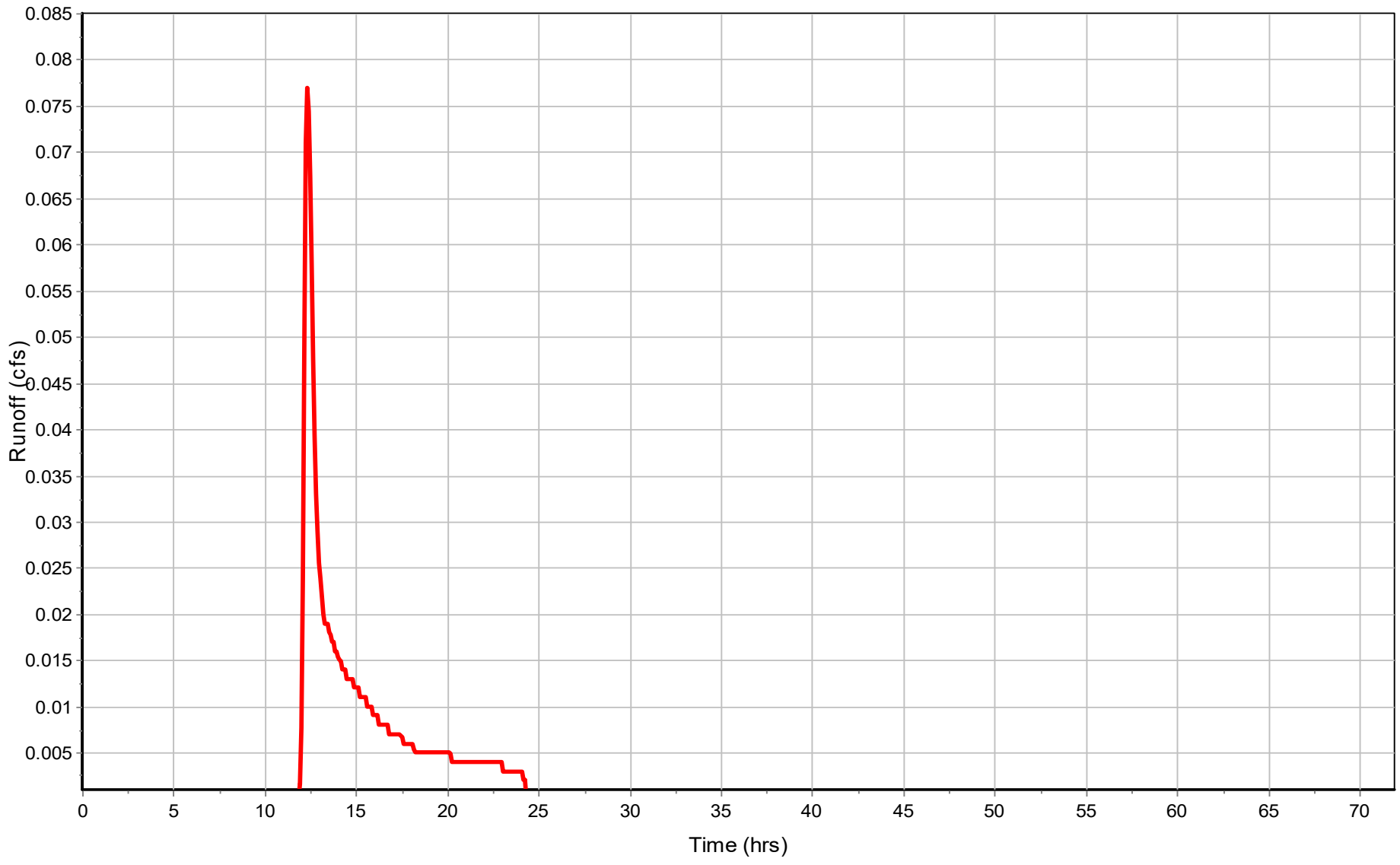
Total Rainfall (in) 7.48
Total Runoff (in) 1.29
Peak Runoff (cfs) 0.08
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:21:30

Subbasin : Sub-E03.1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E05.1

Input Data

Area (ac) 0.02
Peak Rate Factor 0
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.02	A	43
Composite Area & Weighted CN	0.02		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	43.1	0	0
Slope (%) :	12	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.08	0	0
Computed Flow Time (min) :	9.01	0	0

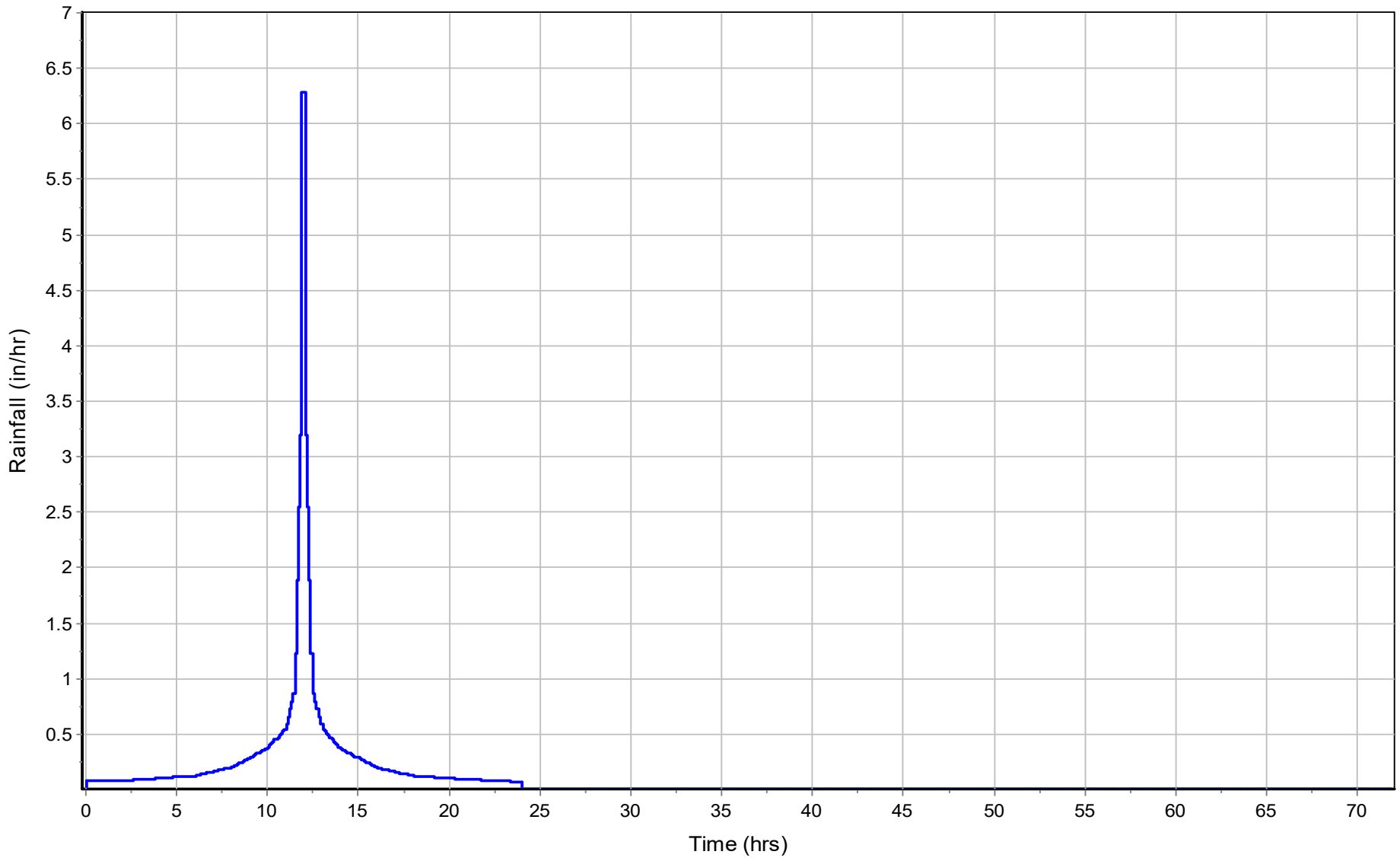
Total TOC (min) 9.01

Subbasin Runoff Results

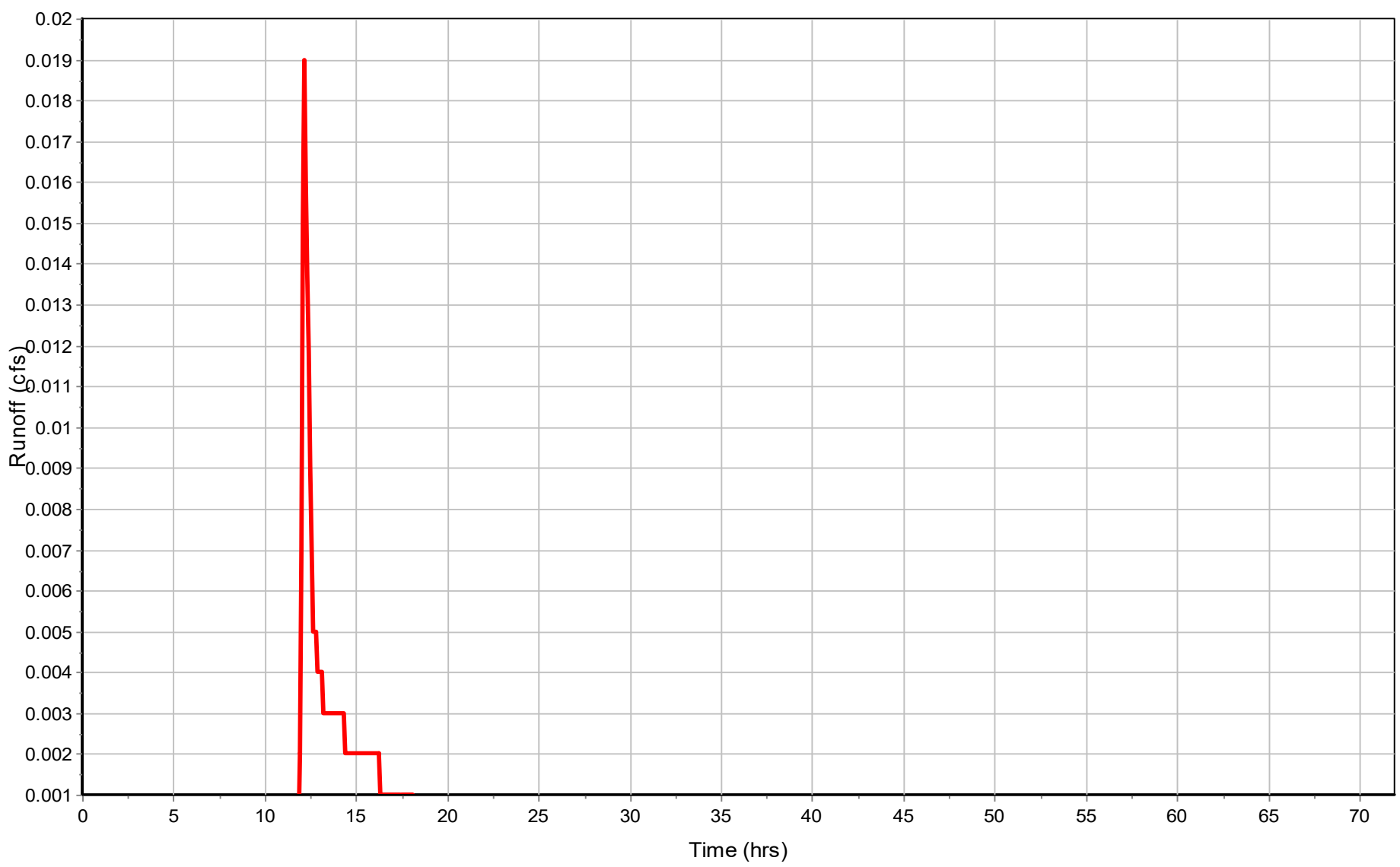
Total Rainfall (in) 7.48
Total Runoff (in) 1.05
Peak Runoff (cfs) 0.02
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:09:01

Subbasin : Sub-E05.1

Rainfall Intensity Graph



Runoff Hydrograph



Junction Input

SN	Element ID	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Ground/Rim (Max) Offset (ft)	Initial Water Elevation (ft)	Initial Water Depth (ft)	Surcharge Elevation (ft)	Surcharge Depth (ft)	Ponded Area (ft^2)	Minimum Pipe Cover (ft)
1	1-Jun	116.60	117.90	1.30	0.00	-116.60	0.00	-117.90	0.00	0.00

Junction Results

SN	Element ID	Peak Inflow (cfs)	Peak Lateral Inflow (cfs)	Max HGL Elevation Attained (ft)	Max HGL Depth Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Average HGL Elevation Attained (ft)	Average HGL Depth Attained (ft)	Time of Max HGL Occurrence (days hh:mm)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	1-Jun	0.23	0.08	117.50	0.90	0.00	4.20	117.26	0.66	0 16:01	0 00:00	0.00	0.00

Channel Input

SN	Element ID	Length (ft)	Inlet Invert Elevation (ft)	Inlet Invert Offset (ft)	Outlet Invert Elevation (ft)	Outlet Invert Offset (ft)	Total Drop (ft)	Average Slope (%)	Shape	Height (ft)	Width (ft)	Manning's Roughness	Entrance Losses	Exit/Bend Losses	Additional Losses	Initial Flow (cfs)	Flap Gate
1	Ditch-01	81.45	116.60	0.00	116.36	3.96	0.24	0.2900	Trapezoidal	1.300	6.200	0.0250	0.5000	0.5000	0.0000	0.00	No

Channel Results

SN	Element ID	Peak Flow (cfs)	Time of Peak Flow Occurrence (days hh:mm)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Travel Time (min)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Froude Number	Reported Condition
1	Ditch-01	0.37	0 16:02	11.76	0.03	0.67	2.03	1.00	0.78	0.00		

Storage Nodes

Storage Node : Basin-A1

Input Data

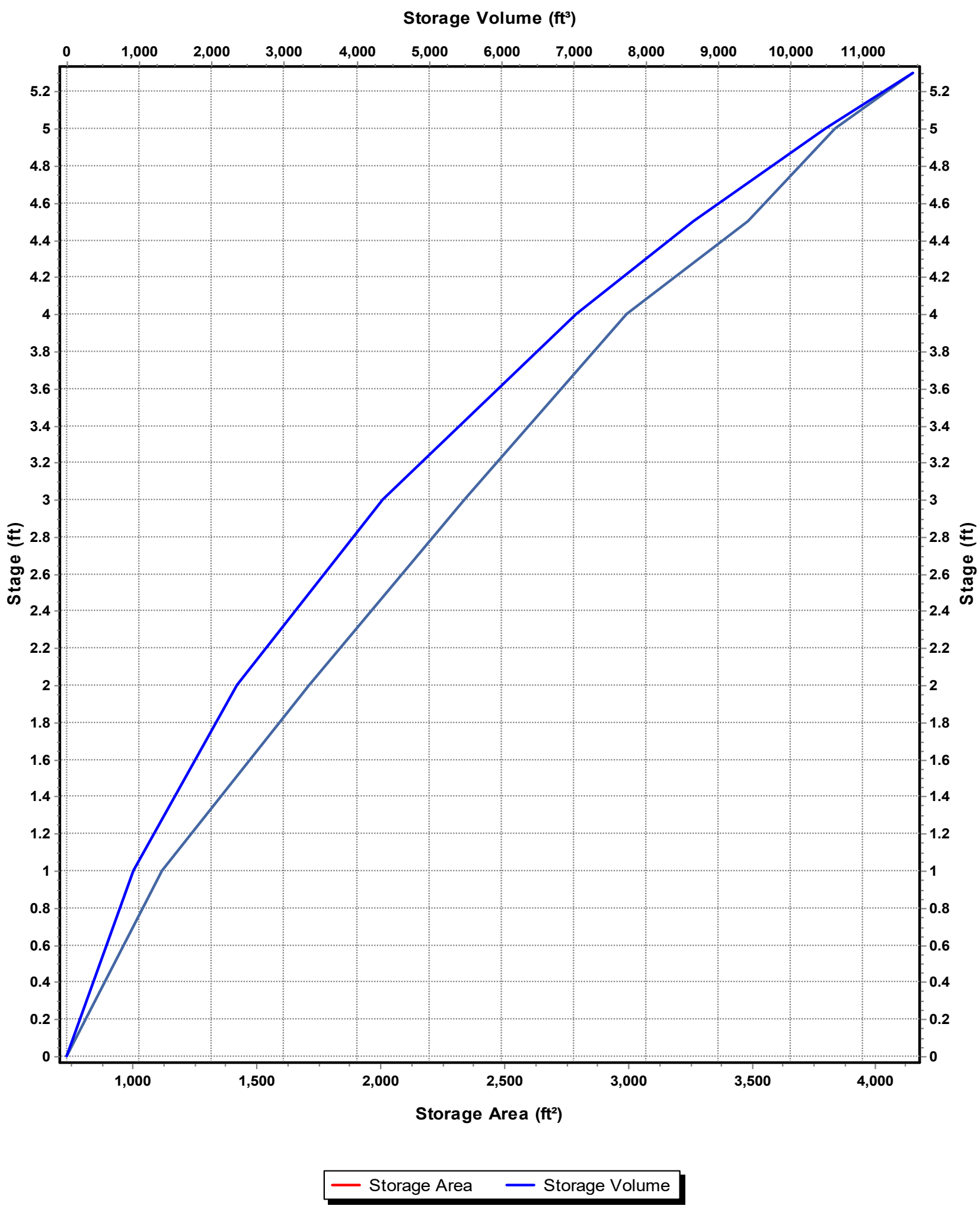
Invert Elevation (ft)	112.40
Max (Rim) Elevation (ft)	117.70
Max (Rim) Offset (ft)	5.30
Initial Water Elevation (ft)	112.40
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Basin-01

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	734.2	0
1	1121.14	927.67
2	1714.29	2345.39
3	2339.15	4372.11
4	2995.85	7039.61
4.5	3484.76	8659.76
5	3837.05	10490.21
5.3	4151.91	11688.55

Storage Area Volume Curves



Storage Node : Basin-A1 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-B-A1	Trapezoidal	No	117.40	5.00	4.00	0.30	3.33

Output Summary Results

Peak Inflow (cfs)	3.51
Peak Lateral Inflow (cfs)	0.2
Peak Outflow (cfs)	0.74
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	117.48
Max HGL Depth Attained (ft)	5.08
Average HGL Elevation Attained (ft)	116.54
Average HGL Depth Attained (ft)	4.14
Time of Max HGL Occurrence (days hh:mm)	0 16:05
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Basin-A2

Input Data

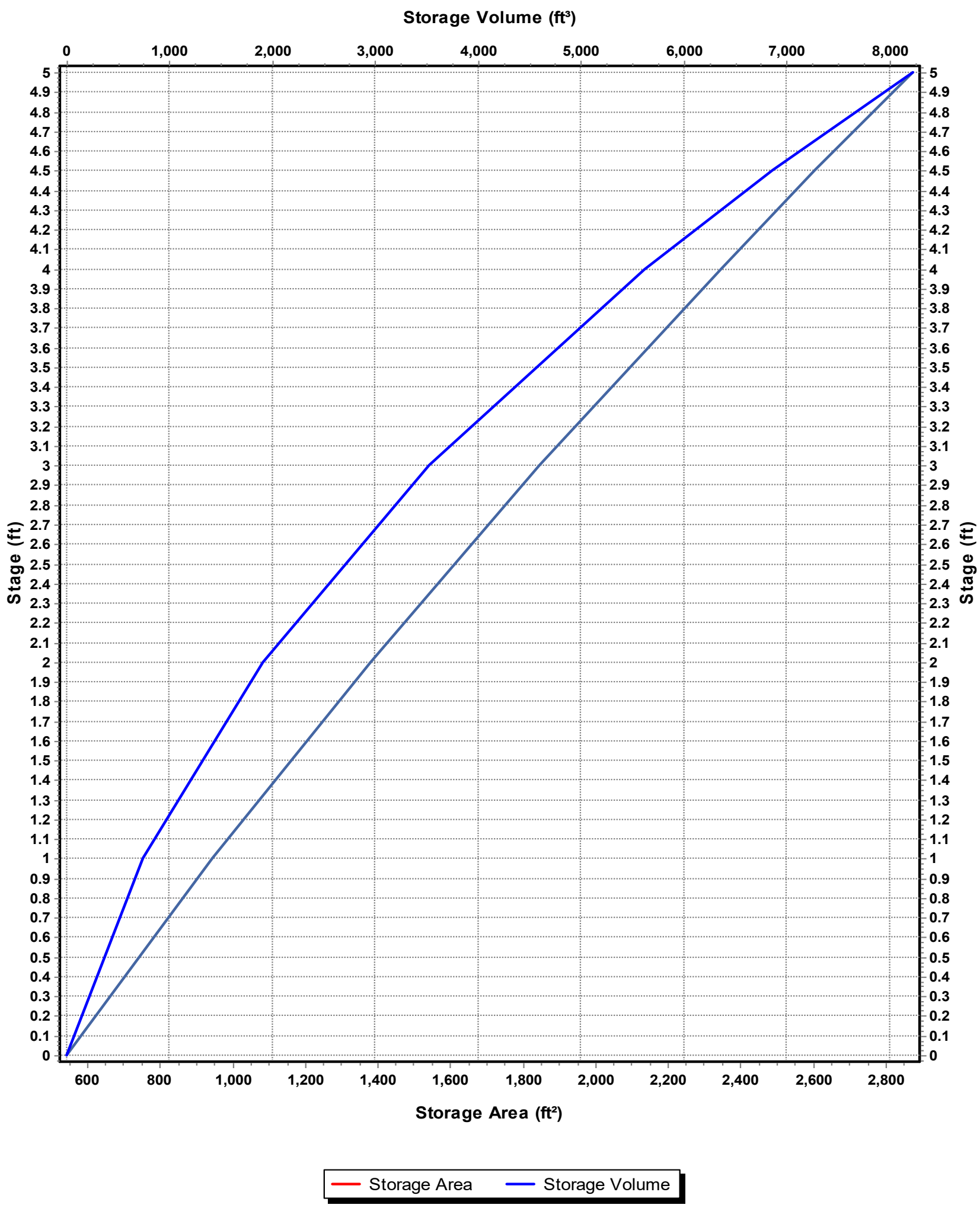
Invert Elevation (ft)	112.90
Max (Rim) Elevation (ft)	117.90
Max (Rim) Offset (ft)	5.00
Initial Water Elevation (ft)	112.90
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Basin-02

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	543.55	0
1	946	744.78
2	1380.46	1908.01
3	1846.91	3521.7
4	2345.37	5617.84
4.5	2606.6	6855.83
5	2875.82	8226.44

Storage Area Volume Curves



Storage Node : Basin-A2 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-B-A2	Trapezoidal	No	117.50	4.60	5.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	3.19
Peak Lateral Inflow (cfs)	0
Peak Outflow (cfs)	2.67
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	117.56
Max HGL Depth Attained (ft)	4.66
Average HGL Elevation Attained (ft)	116.72
Average HGL Depth Attained (ft)	3.82
Time of Max HGL Occurrence (days hh:mm)	0 14:29
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Forebay-A1

Input Data

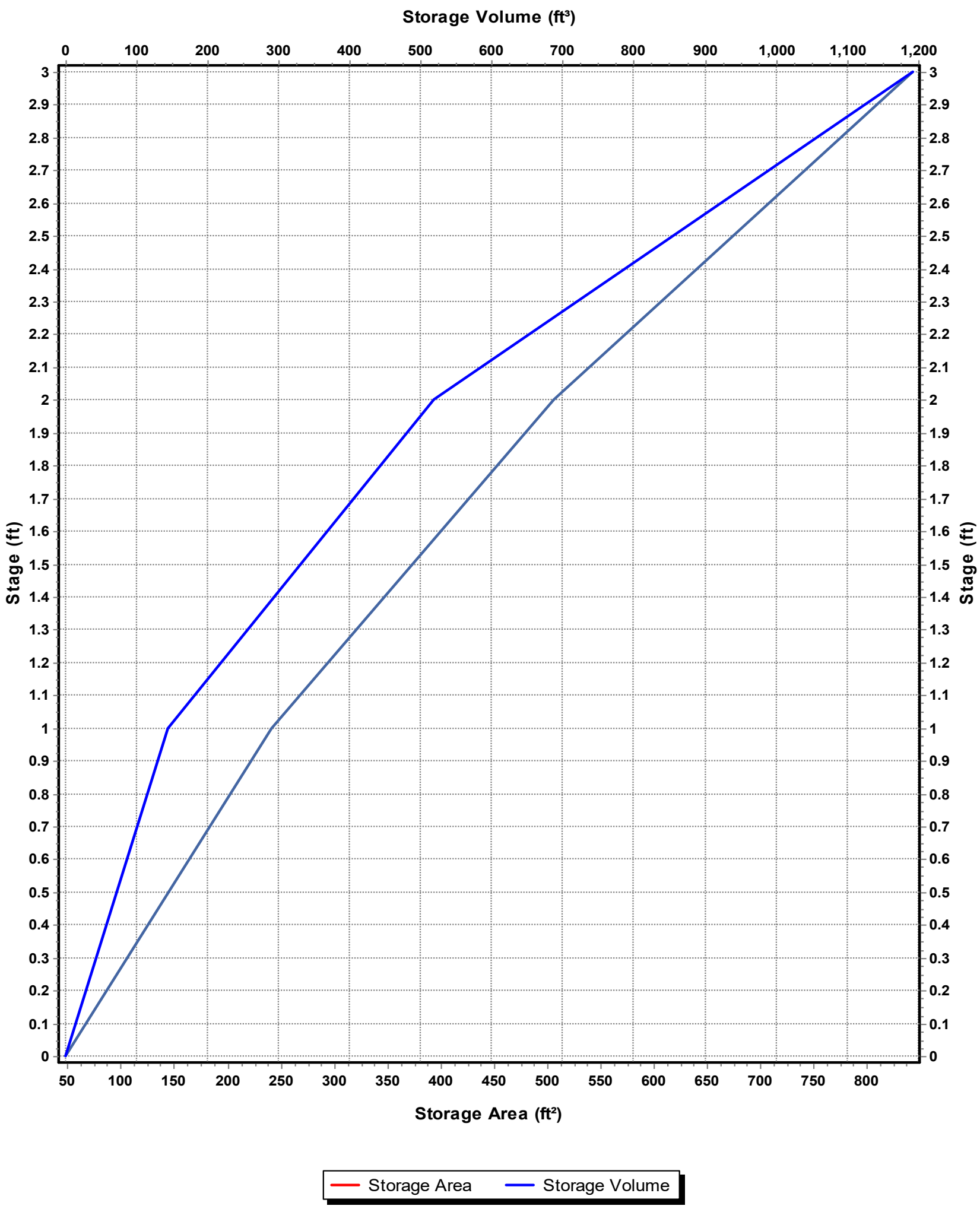
Invert Elevation (ft)	114.40
Max (Rim) Elevation (ft)	117.70
Max (Rim) Offset (ft)	3.30
Initial Water Elevation (ft)	114.40
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Forebay-01

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	48.29	0
1	241.18	144.74
2	506.06	518.36
3	842.94	1192.86

Storage Area Volume Curves



Storage Node : Forebay-A1 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-F-A1	Trapezoidal	No	117.30	2.90	8.00	2.00	3.33

Output Summary Results

Peak Inflow (cfs)	3.45
Peak Lateral Inflow (cfs)	3.45
Peak Outflow (cfs)	3.41
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	117.55
Max HGL Depth Attained (ft)	3.15
Average HGL Elevation Attained (ft)	117.01
Average HGL Depth Attained (ft)	2.61
Time of Max HGL Occurrence (days hh:mm)	0 12:10
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Forebay-A2

Input Data

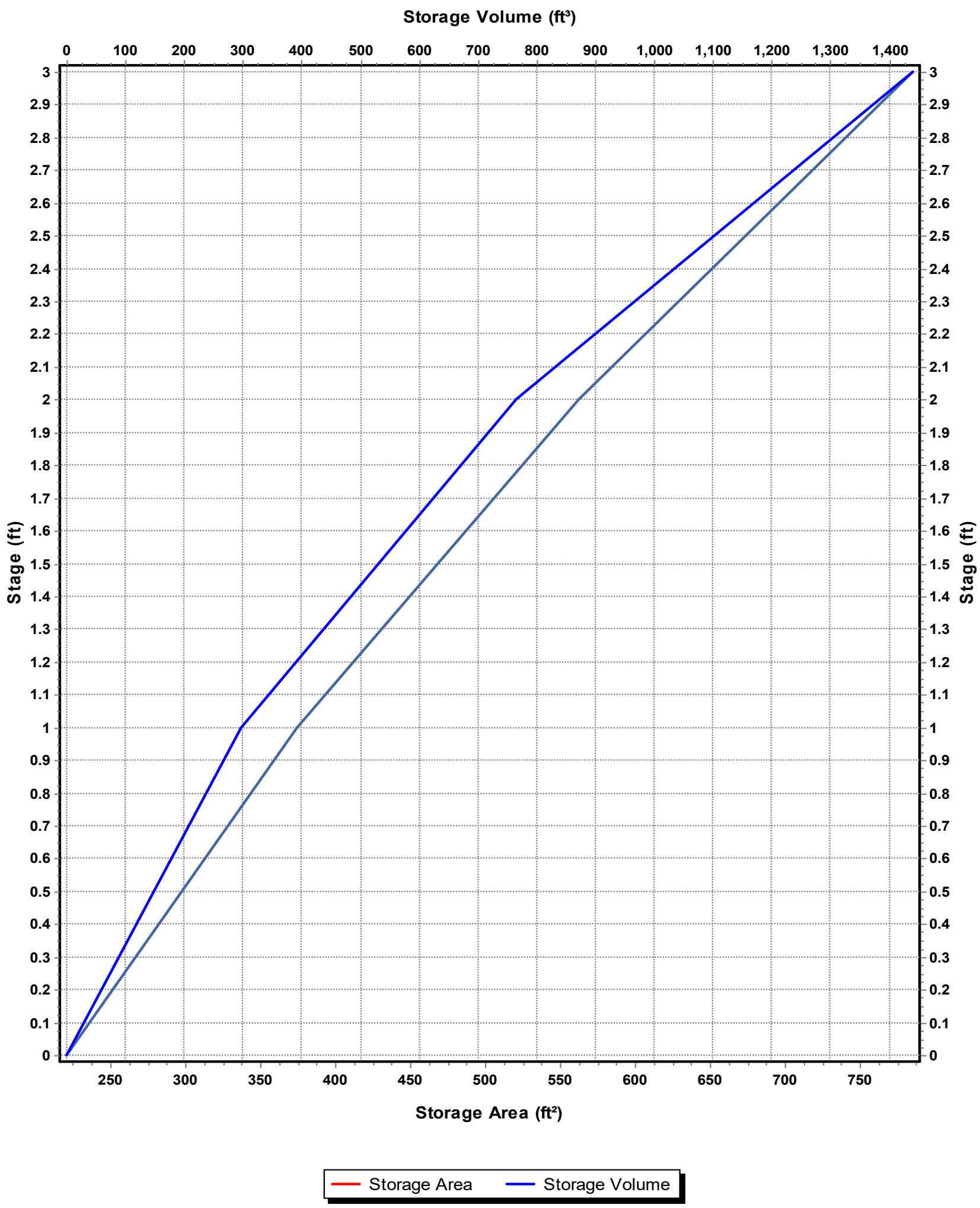
Invert Elevation (ft)	114.90
Max (Rim) Elevation (ft)	117.90
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.90
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Forebay-02

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	221.26	0
1	374.45	297.86
2	562.72	766.45
3	785.55	1440.59

Storage Area Volume Curves



Storage Node : Forebay-A2 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-F-A2	Trapezoidal	No	117.00	2.10	10.00	1.00	3.33

Output Summary Results

Peak Inflow (cfs)	3.21
Peak Lateral Inflow (cfs)	3.21
Peak Outflow (cfs)	3.19
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	117.55
Max HGL Depth Attained (ft)	2.65
Average HGL Elevation Attained (ft)	117.14
Average HGL Depth Attained (ft)	2.24
Time of Max HGL Occurrence (days hh:mm)	0 14:26
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

SSA Analysis – Drainage Area A3 – Existing and Proposed

Project Description

File Name	Pave.Paws_A3.SPF

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	SCS TR-20
Time of Concentration (TOC) Method	SCS TR-55
Link Routing Method	Hydrodynamic
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	NO

Analysis Options

Start Analysis On	00:00:00	0:00:00
End Analysis On	00:00:00	0:00:00
Start Reporting On	00:00:00	0:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	3
Nodes	4
Junctions	0
Outfalls	2
Flow Diversions	0
Inlets	0
Storage Nodes	2
Links	2
Channels	0
Pipes	0
Pumps	0
Orifices	0
Weirs	2
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	2 years	Intensity	inches	Massachusetts	None	2.00	3.02	SCS Type III 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	E03.3.1	0.16	484.00	43.00	3.42	0.00	0.00	0.00	0 00:19:16
2	Sub-A3	1.05	484.00	69.85	3.42	0.95	1.00	1.00	0 00:06:00
3	Sub-E03.3	0.35	484.00	43.00	3.42	0.04	0.01	0.00	0 00:21:06

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Out-A3	Outfall	114.00					0.00	114.00					
2	Out-E03.3	Outfall	50.00					0.00	50.00					
3	Basin-A3	Storage Node	113.50	117.50	113.50		0.00	0.88	115.07				0.00	0.00
4	Forebay-A3	Storage Node	114.50	117.50	114.50		0.00	0.92	117.06				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(ft)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
1	Weir-B-A3	Weir	Basin-A3	Out-A3		113.50	114.00				0.00							
2	Weir-F-A3	Weir	Forebay-A3	Basin-A3		114.50	113.50				0.88							

Subbasin Hydrology

Subbasin : E03.3.1

Input Data

Area (ac)	0.16
Peak Rate Factor	484
Weighted Curve Number	43
Rain Gage ID	Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.16	A	43
Composite Area & Weighted CN	0.16		43

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft^2)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	160.97	0	0
Slope (%) :	25	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.14	0	0
Computed Flow Time (min) :	19.27	0	0

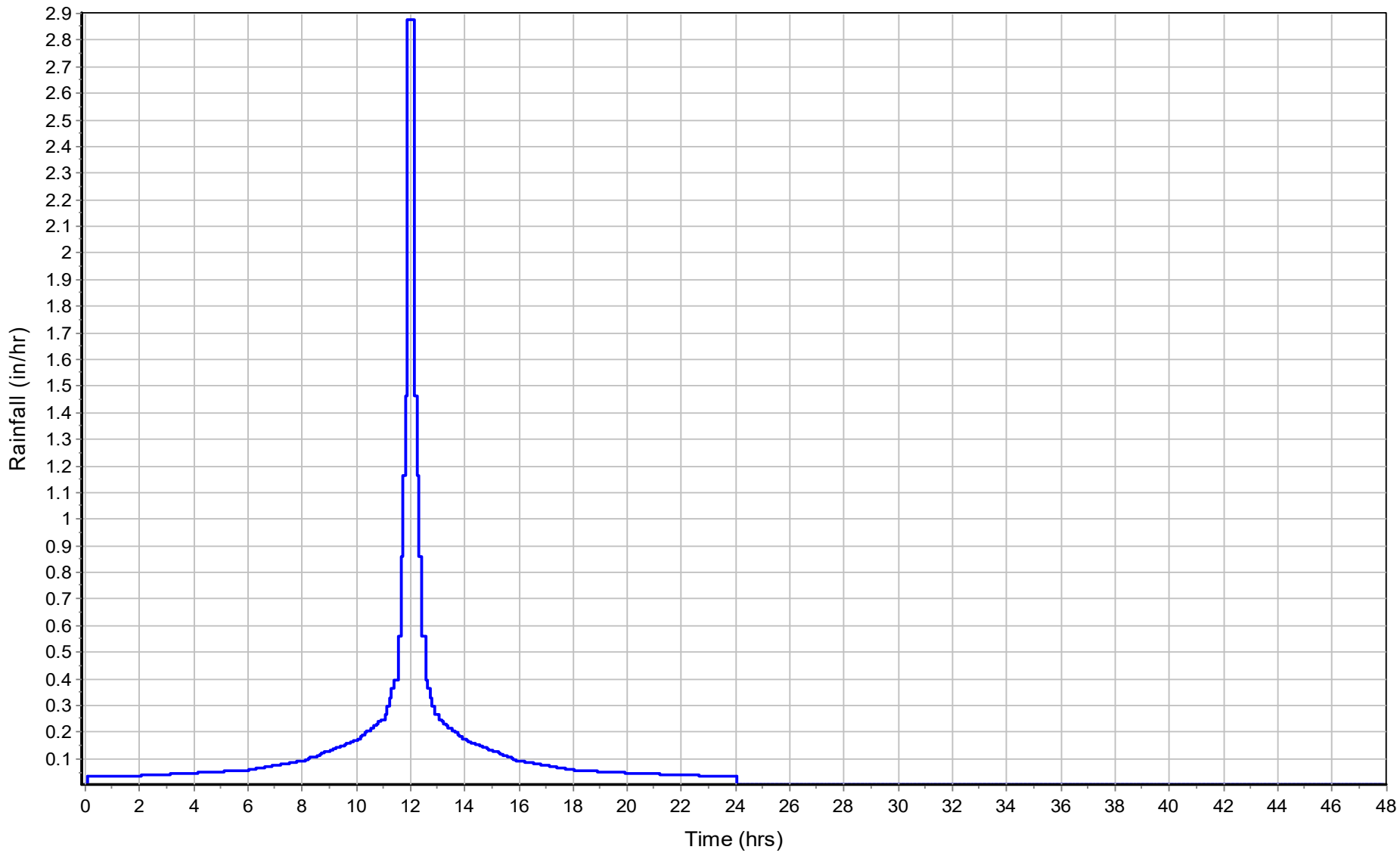
Total TOC (min) 19.27

Subbasin Runoff Results

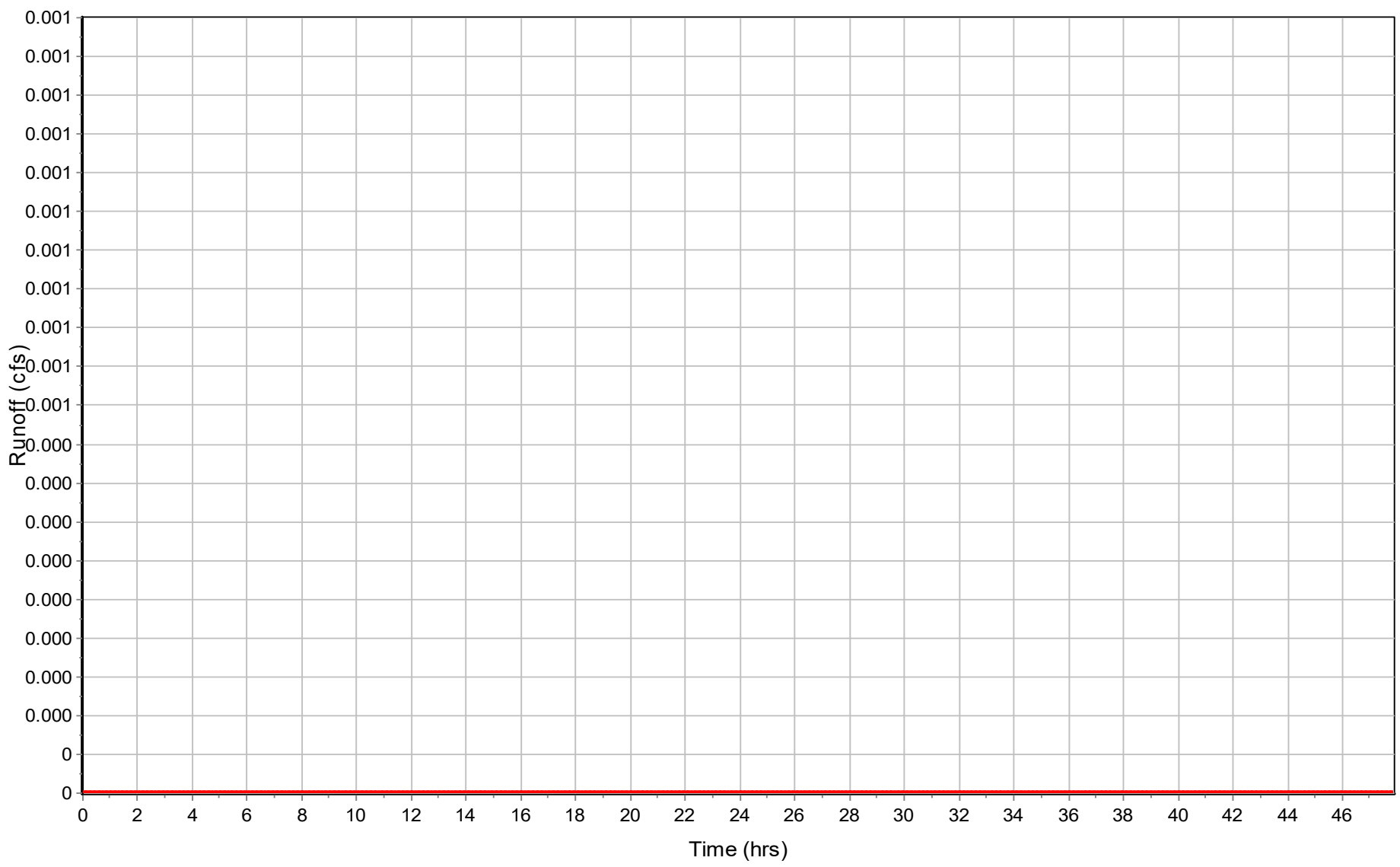
Total Rainfall (in)	3.42
Total Runoff (in)	0
Peak Runoff (cfs)	0
Weighted Curve Number	43
Time of Concentration (days hh:mm:ss)	0 00:19:16

Subbasin : E03.3.1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-A3

Input Data

Area (ac)	1.05
Peak Rate Factor	484
Weighted Curve Number	69.85
Rain Gage ID	Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	0.88	A	76
Woods & grass combination, Fair	0.2	A	43
Composite Area & Weighted CN	1.08		69.85

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	25.24	0	0
Slope (%) :	0.5	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.48	0	0
Computed Flow Time (min) :	0.87	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	238.39	0	0
Channel Slope (%) :	0.3	0	0
Cross Section Area (ft^2) :	3	0	0
Wetted Perimeter (ft) :	6.32	0	0
Velocity (ft/sec) :	1.66	0	0
Computed Flow Time (min) :	2.4	0	0

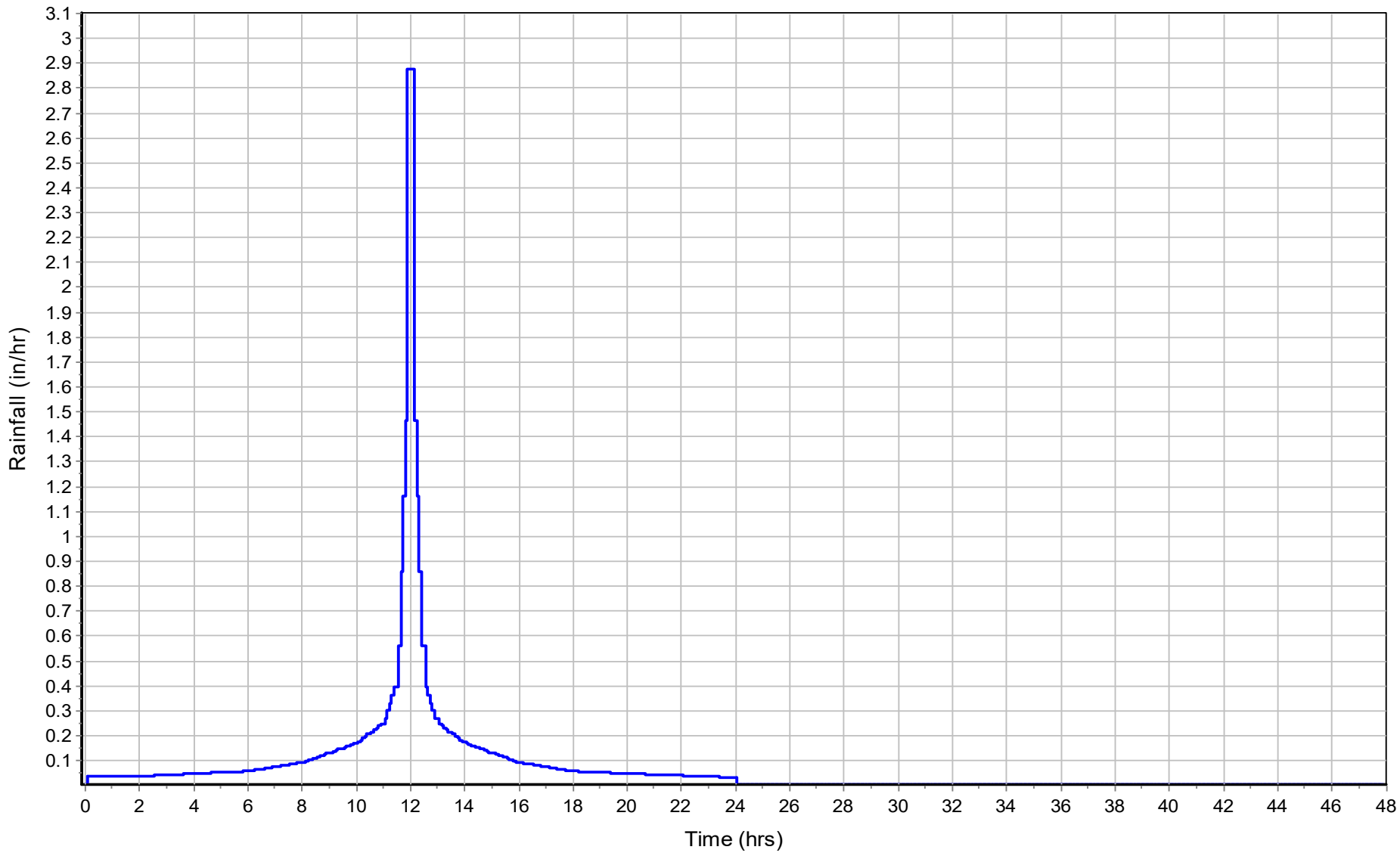
Total TOC (min) 3.27

Subbasin Runoff Results

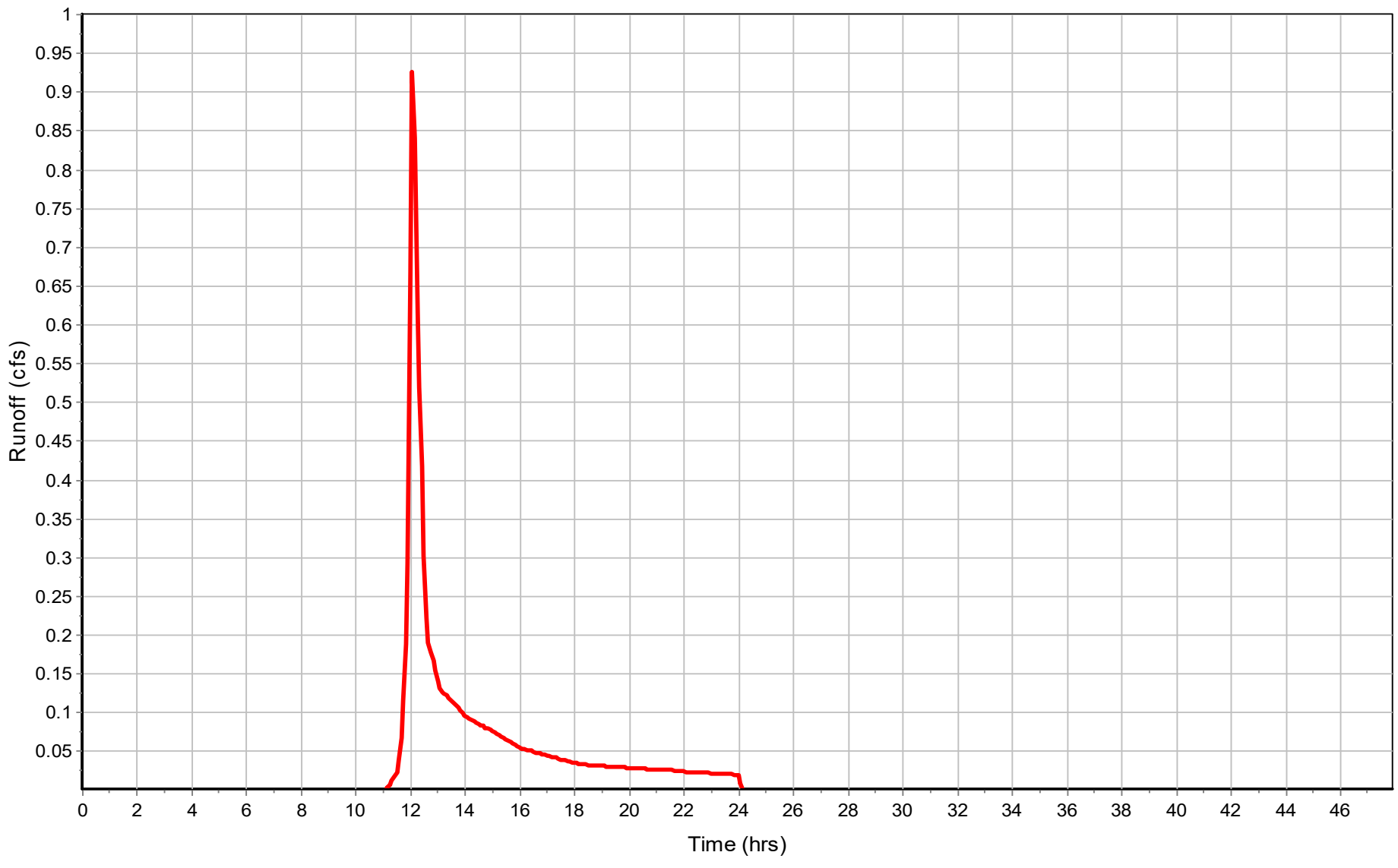
Total Rainfall (in)	3.42
Total Runoff (in)	0.95
Peak Runoff (cfs)	1
Weighted Curve Number	69.85
Time of Concentration (days hh:mm:ss)	0 00:03:16

Subbasin : Sub-A3

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E03.3

Input Data

Area (ac) 0.35
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.35	A	43
Composite Area & Weighted CN	0.35		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	180.27	0	0
Slope (%) :	25	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.14	0	0
Computed Flow Time (min) :	21.1	0	0

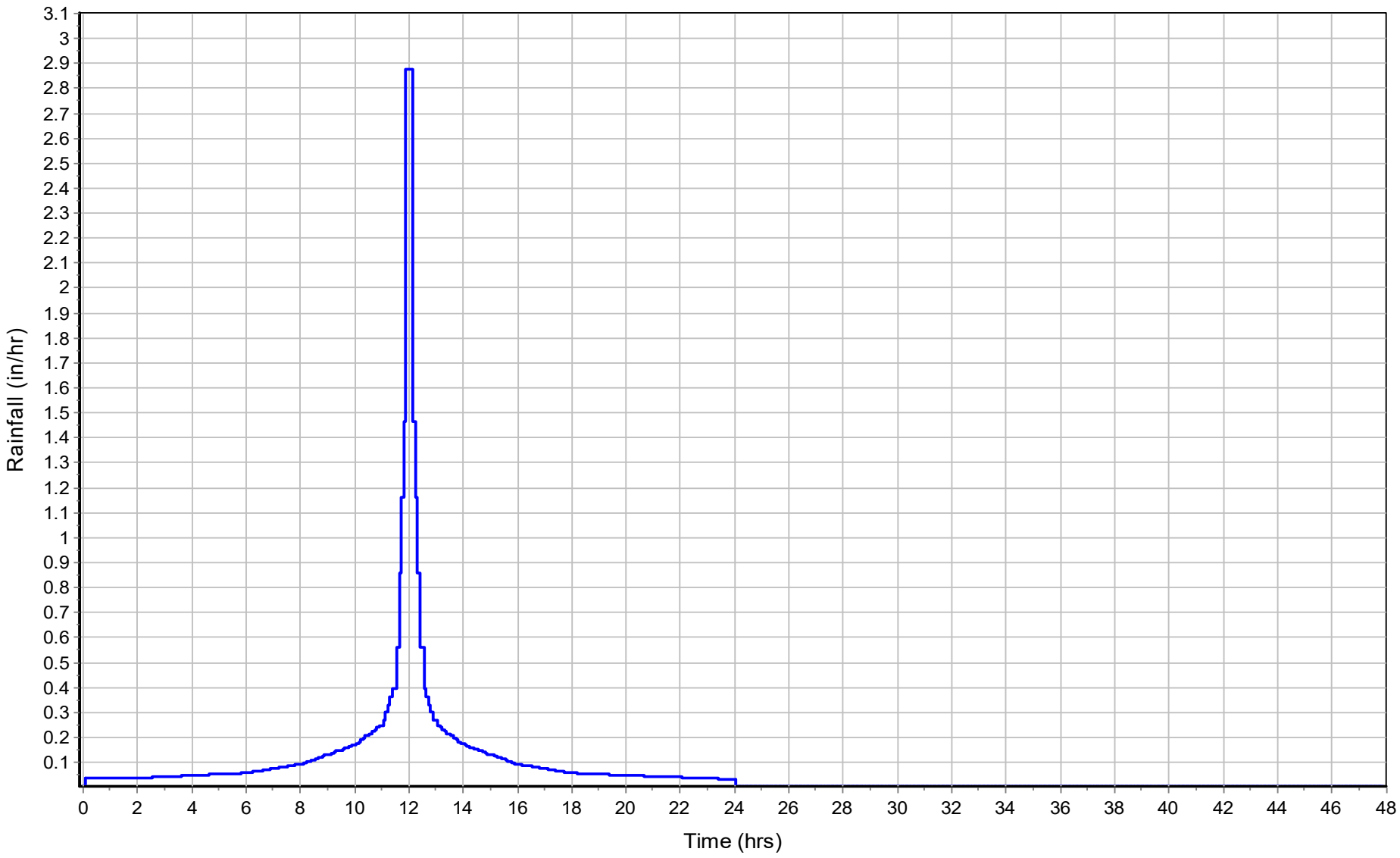
Total TOC (min) 21.10

Subbasin Runoff Results

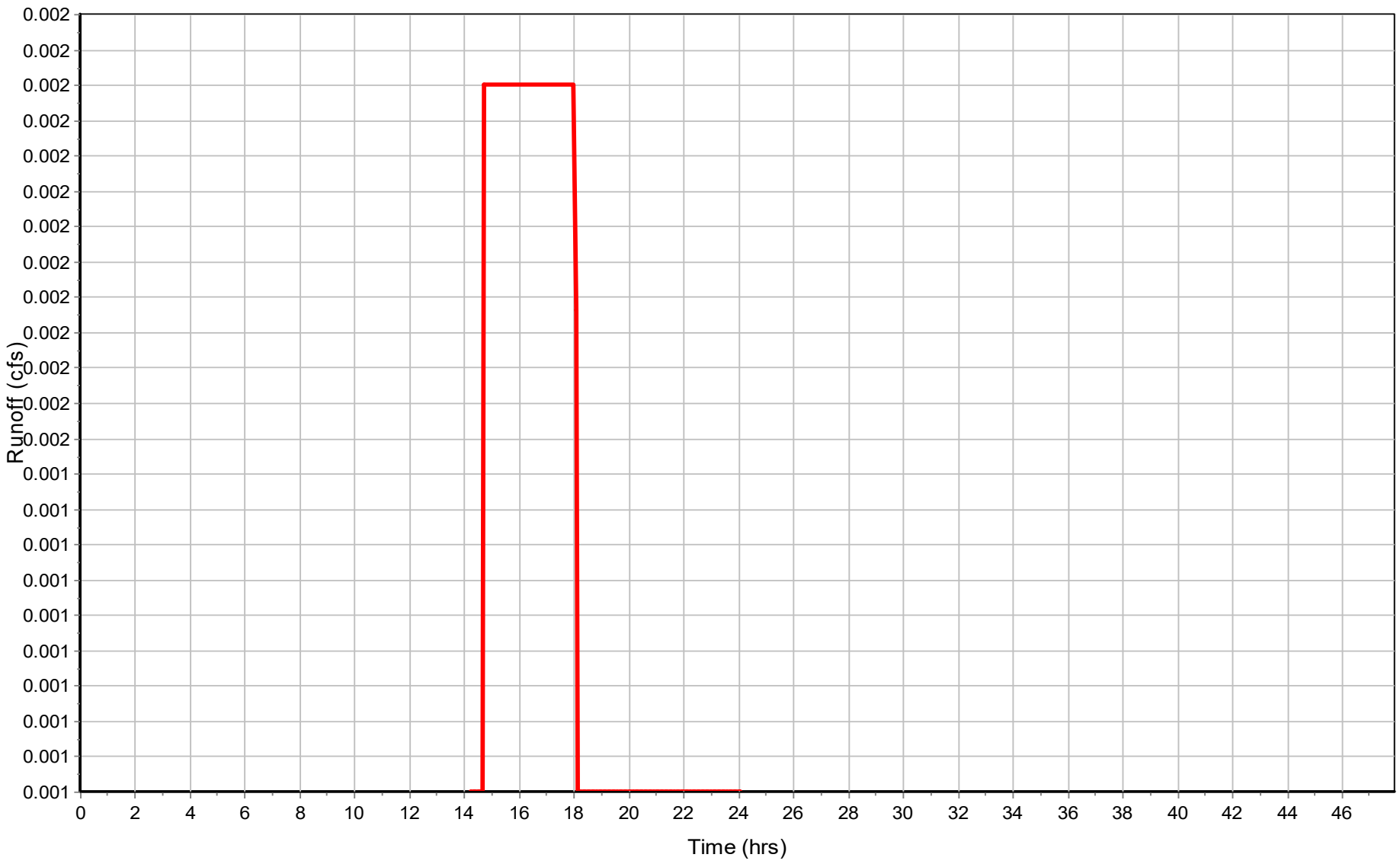
Total Rainfall (in) 3.42
Total Runoff (in) 0.04
Peak Runoff (cfs) 0
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:21:06

Subbasin : Sub-E03.3

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A3

Input Data

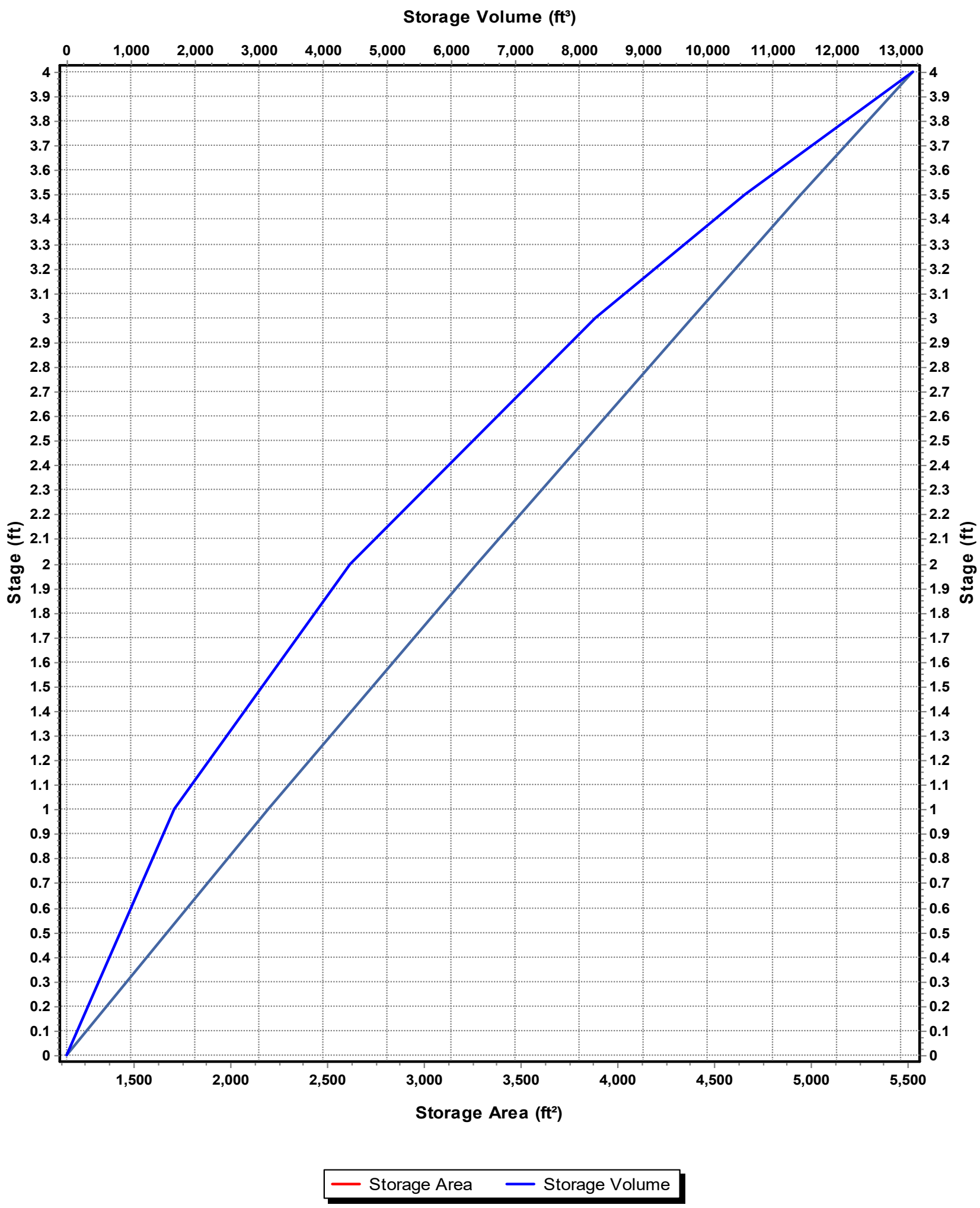
Invert Elevation (ft)	113.50
Max (Rim) Elevation (ft)	117.50
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	113.50
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Basin-03

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	1157.27	0
1	2197.59	1677.43
2	3275.77	4414.11
3	4385.72	8244.86
3.5	4952.65	10579.45
4	5527.59	13199.51

Storage Area Volume Curves



Storage Node : Basin-A3 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-B-A3	Trapezoidal	No	117.23	3.73	3.00	1.00	3.33

Output Summary Results

Peak Inflow (cfs)	0.88
Peak Lateral Inflow (cfs)	0
Peak Outflow (cfs)	0
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	115.07
Max HGL Depth Attained (ft)	1.57
Average HGL Elevation Attained (ft)	114.6
Average HGL Depth Attained (ft)	1.1
Time of Max HGL Occurrence (days hh:mm)	1 01:47
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Forebay-A3

Input Data

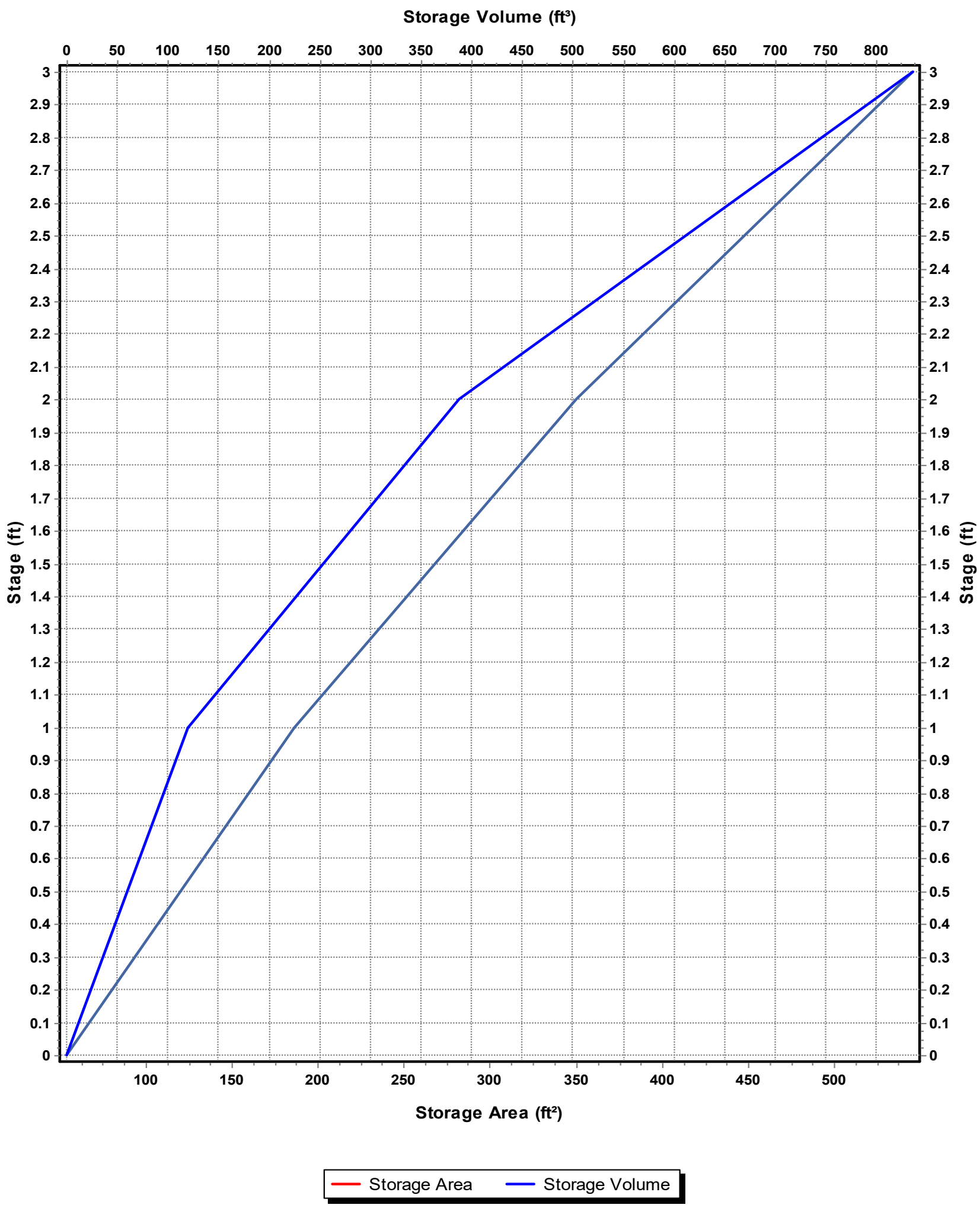
Invert Elevation (ft)	114.50
Max (Rim) Elevation (ft)	117.50
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.50
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Forebay-03

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	54	0
1	186	120
2	350	388
3	546	836

Storage Area Volume Curves



Storage Node : Forebay-A3 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-F-A3	Trapezoidal	No	116.90	2.40	4.00	2.00	3.33

Output Summary Results

Peak Inflow (cfs)	0.92
Peak Lateral Inflow (cfs)	0.92
Peak Outflow (cfs)	0.88
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	117.06
Max HGL Depth Attained (ft)	2.56
Average HGL Elevation Attained (ft)	116.31
Average HGL Depth Attained (ft)	1.81
Time of Max HGL Occurrence (days hh:mm)	0 12:12
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Project Description

File Name	Pave.Paws_A3.SPF

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	SCS TR-20
Time of Concentration (TOC) Method	SCS TR-55
Link Routing Method	Hydrodynamic
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	NO

Analysis Options

Start Analysis On	00:00:00	0:00:00
End Analysis On	00:00:00	0:00:00
Start Reporting On	00:00:00	0:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	3
Nodes	4
Junctions	0
Outfalls	2
Flow Diversions	0
Inlets	0
Storage Nodes	2
Links	2
Channels	0
Pipes	0
Pumps	0
Orifices	0
Weirs	2
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	10 years	Intensity	inches	Massachusetts	None	10.00	4.99	SCS Type III 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	E03.3.1	0.16	484.00	43.00	4.99	0.35	0.06	0.02	0 00:19:16
2	Sub-A3	1.05	484.00	69.85	4.99	2.02	2.13	2.20	0 00:06:00
3	Sub-E03.3	0.35	484.00	43.00	4.99	0.35	0.12	0.04	0 00:21:06

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Out-A3	Outfall	114.00					0.02	114.00					
2	Out-E03.3	Outfall	50.00					0.04	50.00					
3	Basin-A3	Storage Node	113.50	117.50	113.50		0.00	2.08	116.25				0.00	0.00
4	Forebay-A3	Storage Node	114.50	117.50	114.50		0.00	2.11	117.18				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(ft)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
1	Weir-B-A3	Weir	Basin-A3	Out-A3		113.50	114.00				0.00							
2	Weir-F-A3	Weir	Forebay-A3	Basin-A3		114.50	113.50				2.08							

Subbasin Hydrology

Subbasin : E03.3.1

Input Data

Area (ac)	0.16
Peak Rate Factor	484
Weighted Curve Number	43
Rain Gage ID	Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.16	A	43
Composite Area & Weighted CN	0.16		43

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft^2)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	160.97	0	0
Slope (%) :	25	0	0
2 yr, 24 hr Rainfall (in) :	3.42	0	0
Velocity (ft/sec) :	0.14	0	0
Computed Flow Time (min) :	19.27	0	0

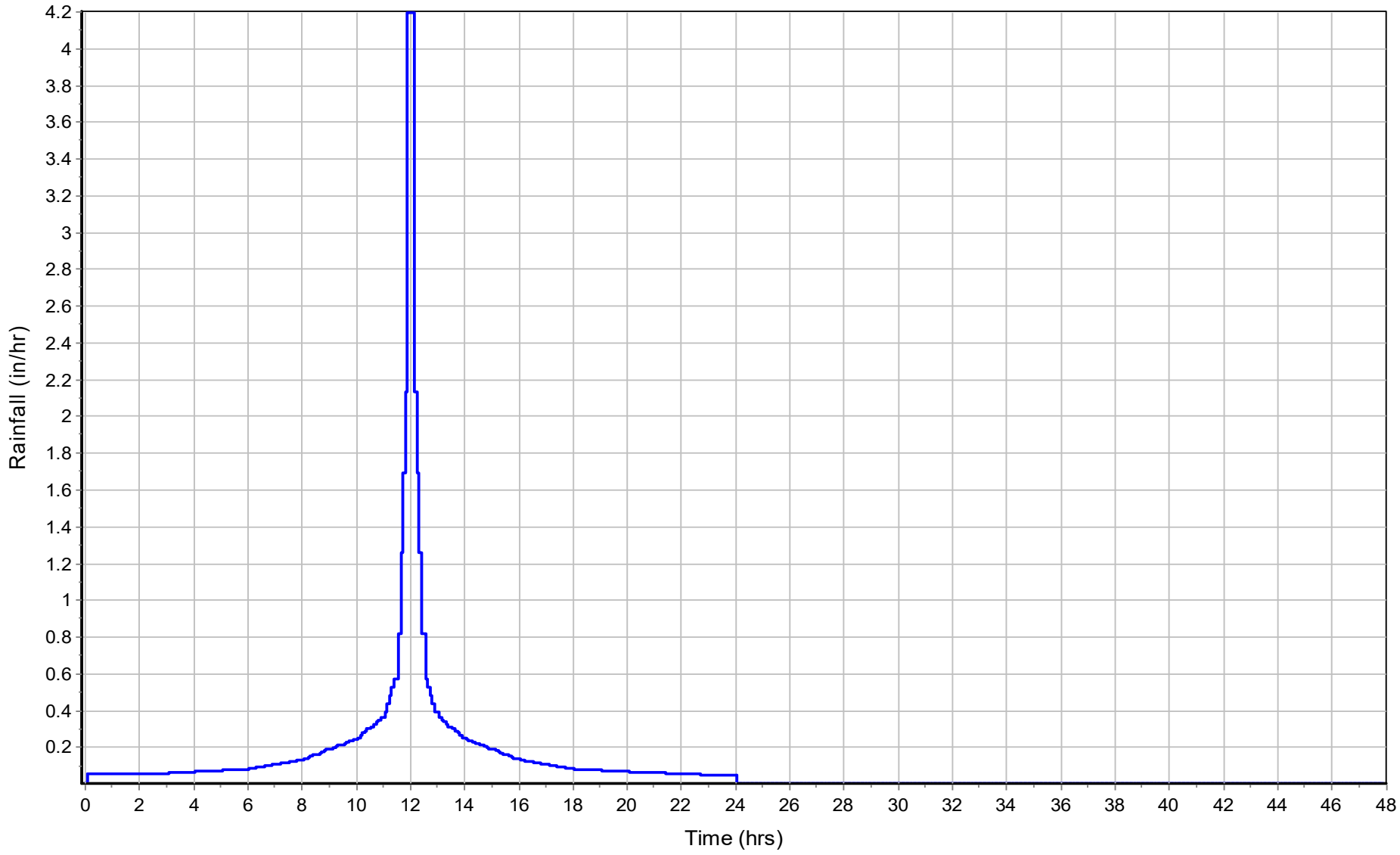
Total TOC (min) 19.27

Subbasin Runoff Results

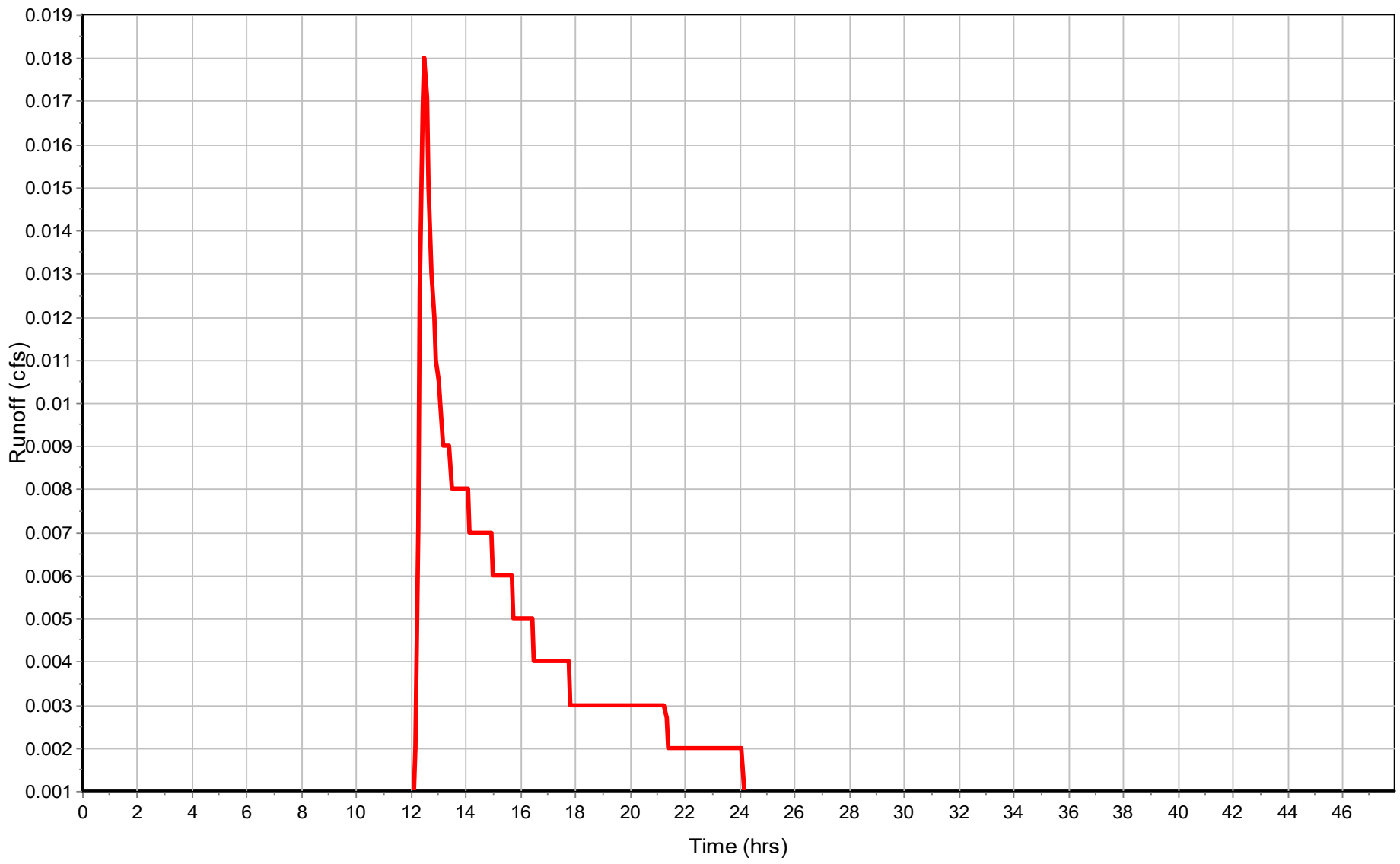
Total Rainfall (in)	4.99
Total Runoff (in)	0.35
Peak Runoff (cfs)	0.02
Weighted Curve Number	43
Time of Concentration (days hh:mm:ss)	0 00:19:16

Subbasin : E03.3.1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-A3

Input Data

Area (ac)	1.05
Peak Rate Factor	484
Weighted Curve Number	69.85
Rain Gage ID	Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	0.88	A	76
Woods & grass combination, Fair	0.2	A	43
Composite Area & Weighted CN	1.08		69.85

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	25.24	0	0
Slope (%) :	0.5	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.48	0	0
Computed Flow Time (min) :	0.87	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	238.39	0	0
Channel Slope (%) :	0.3	0	0
Cross Section Area (ft^2) :	3	0	0
Wetted Perimeter (ft) :	6.32	0	0
Velocity (ft/sec) :	1.66	0	0
Computed Flow Time (min) :	2.4	0	0

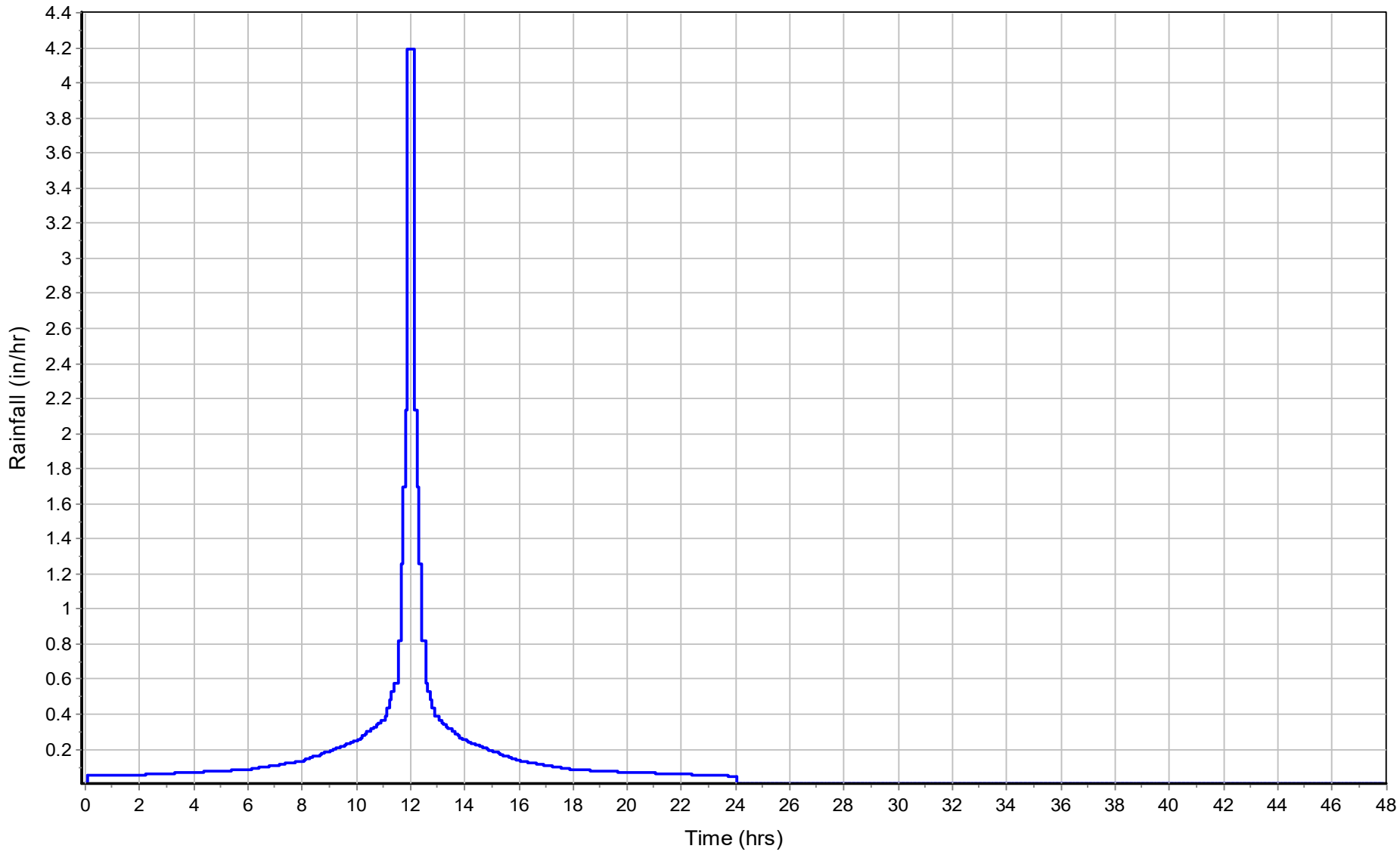
Total TOC (min) 3.27

Subbasin Runoff Results

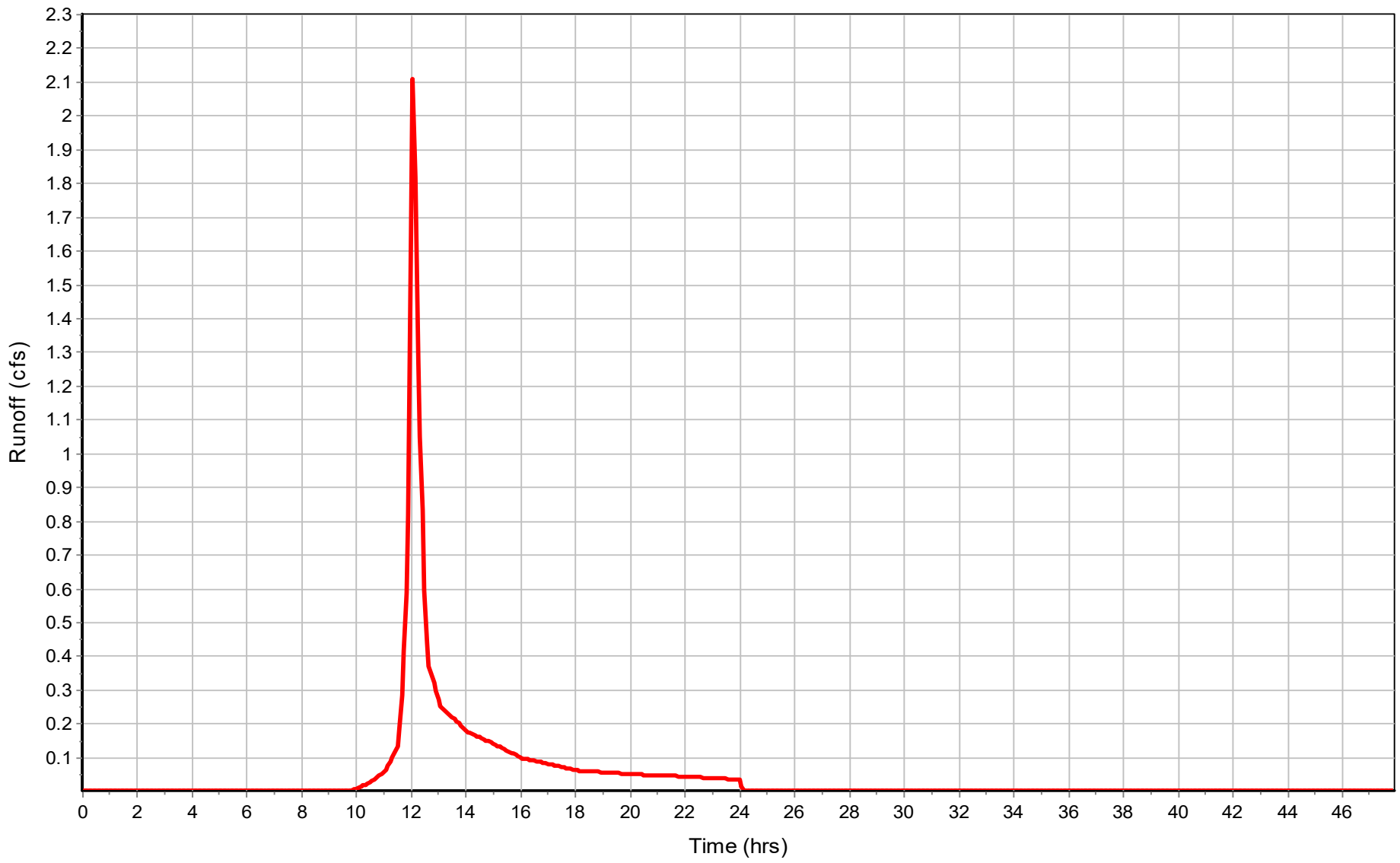
Total Rainfall (in)	4.99
Total Runoff (in)	2.02
Peak Runoff (cfs)	2.2
Weighted Curve Number	69.85
Time of Concentration (days hh:mm:ss)	0 00:03:16

Subbasin : Sub-A3

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E03.3

Input Data

Area (ac) 0.35
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.35	A	43
Composite Area & Weighted CN	0.35		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	180.27	0	0
Slope (%) :	25	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.14	0	0
Computed Flow Time (min) :	21.1	0	0

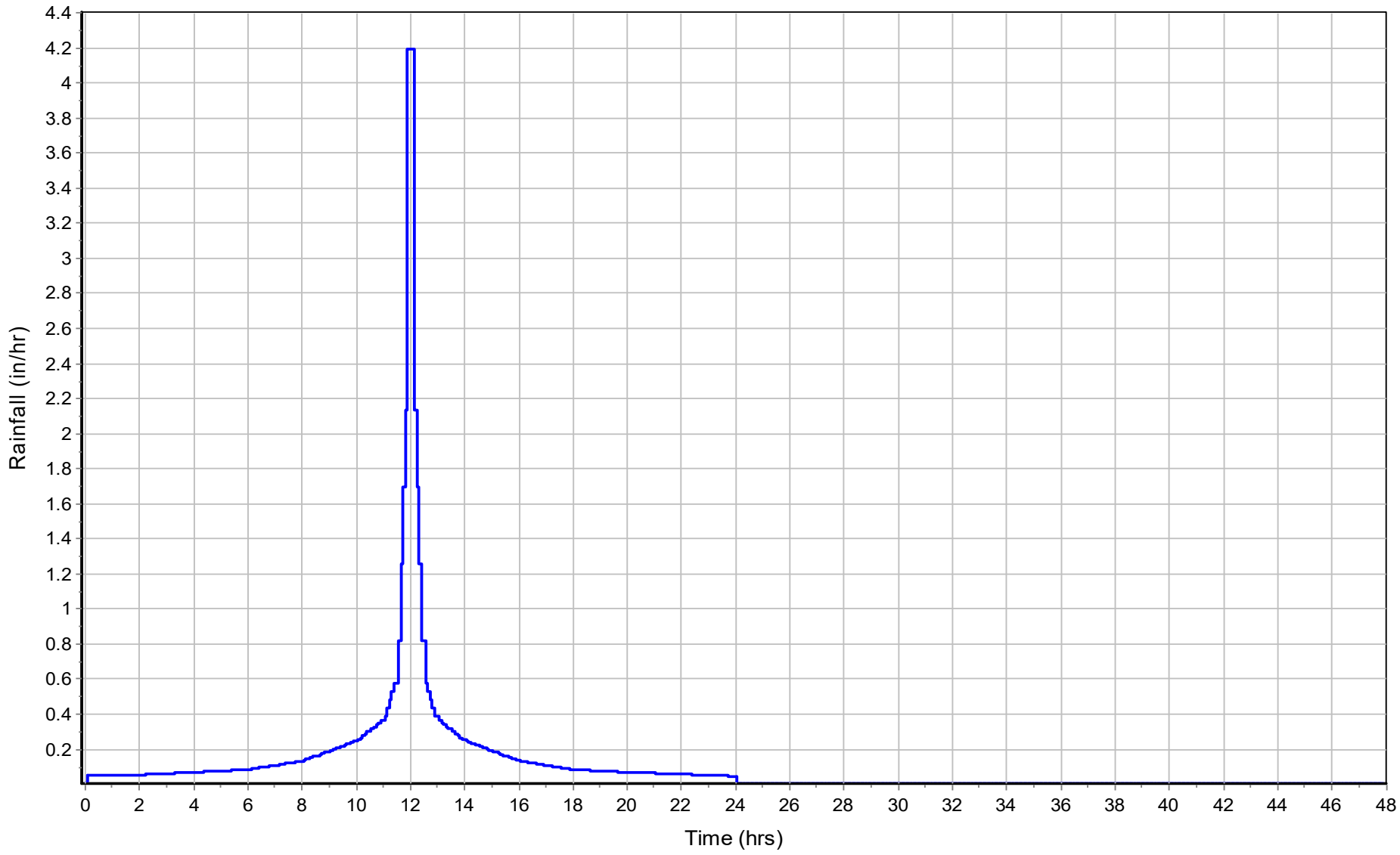
Total TOC (min) 21.10

Subbasin Runoff Results

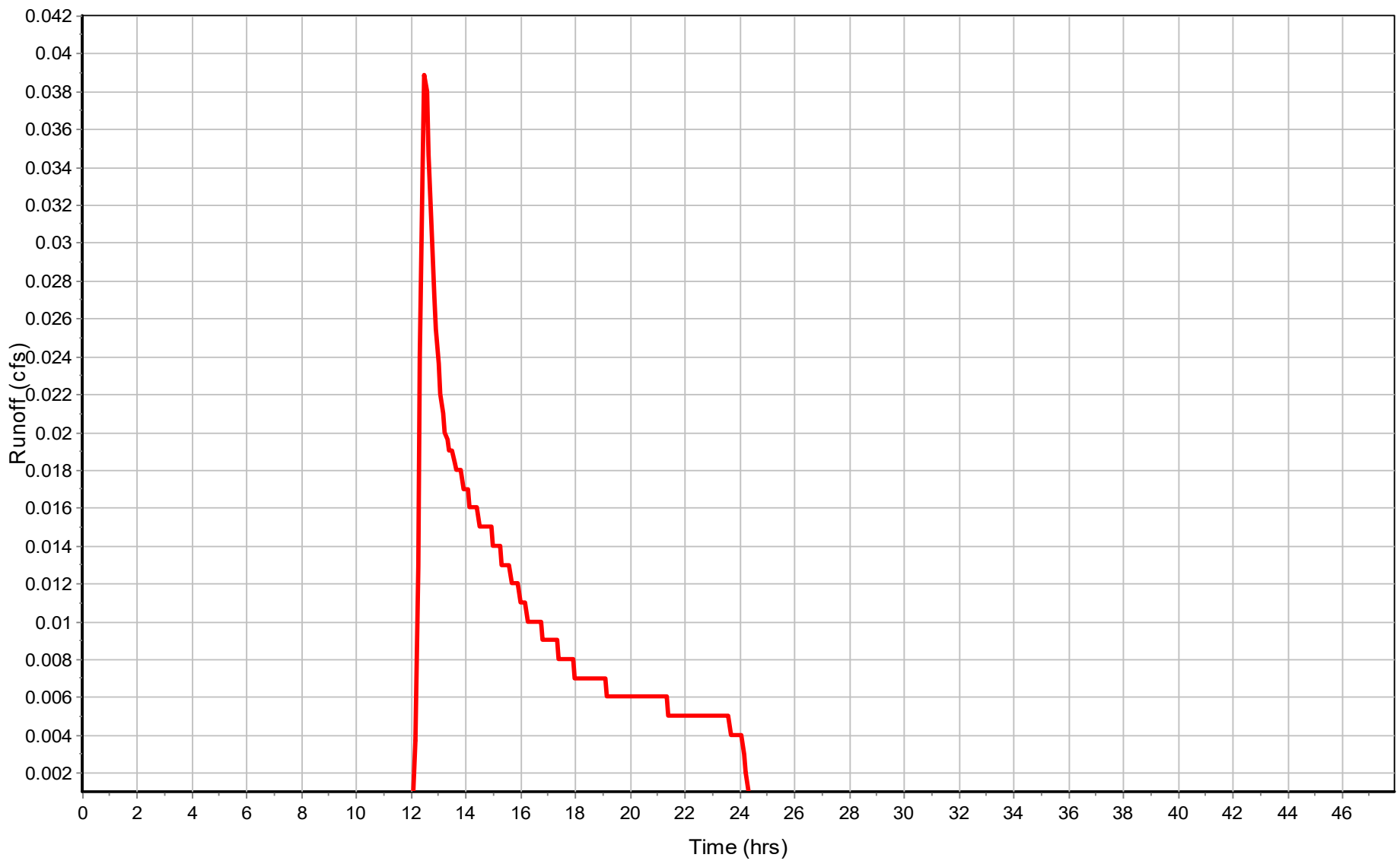
Total Rainfall (in) 4.99
Total Runoff (in) 0.35
Peak Runoff (cfs) 0.04
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:21:06

Subbasin : Sub-E03.3

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A3

Input Data

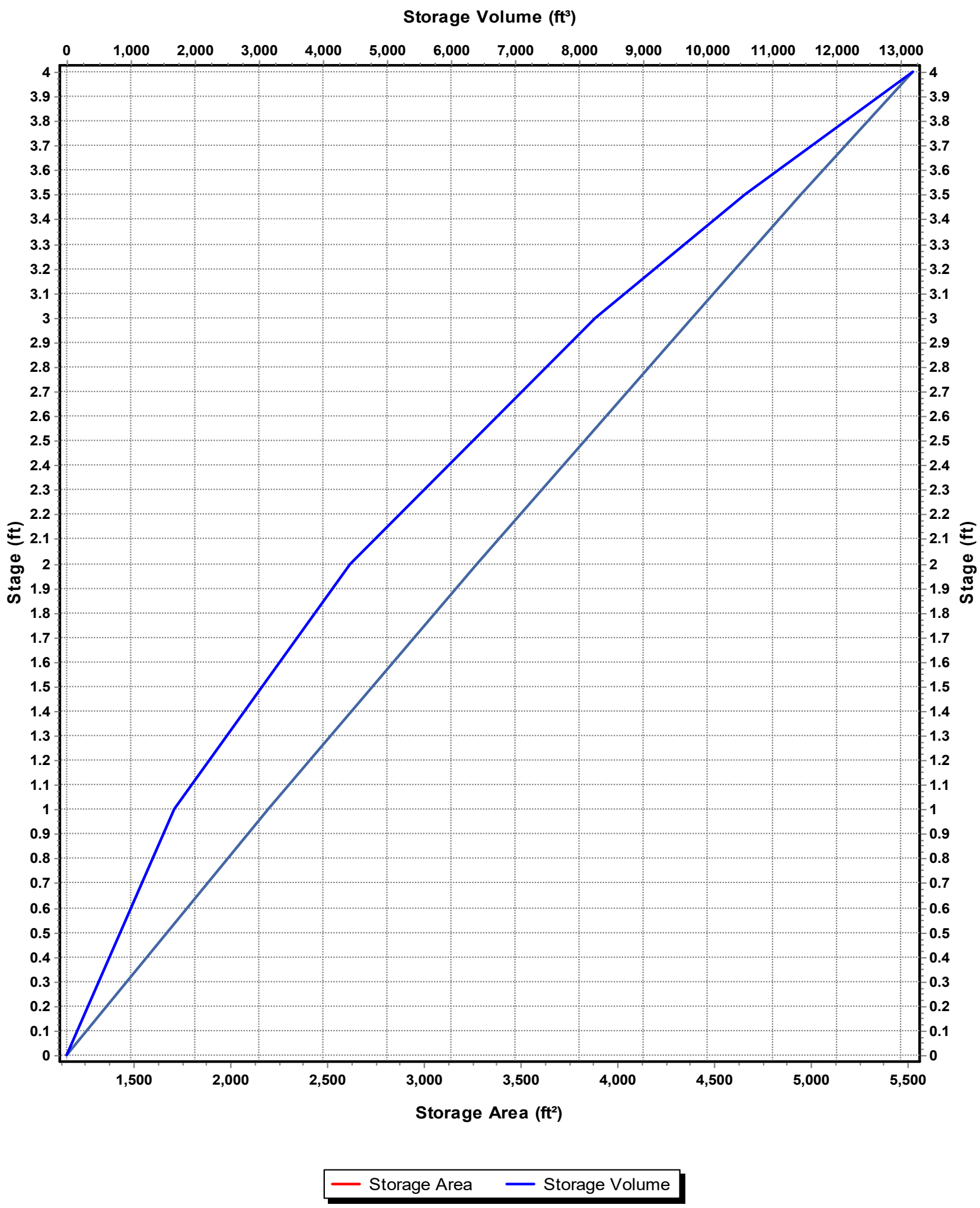
Invert Elevation (ft)	113.50
Max (Rim) Elevation (ft)	117.50
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	113.50
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Basin-03

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	1157.27	0
1	2197.59	1677.43
2	3275.77	4414.11
3	4385.72	8244.86
3.5	4952.65	10579.45
4	5527.59	13199.51

Storage Area Volume Curves



Storage Node : Basin-A3 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-B-A3	Trapezoidal	No	117.23	3.73	3.00	1.00	3.33

Output Summary Results

Peak Inflow (cfs)	2.08
Peak Lateral Inflow (cfs)	0
Peak Outflow (cfs)	0
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	116.25
Max HGL Depth Attained (ft)	2.75
Average HGL Elevation Attained (ft)	115.46
Average HGL Depth Attained (ft)	1.96
Time of Max HGL Occurrence (days hh:mm)	1 01:49
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Forebay-A3

Input Data

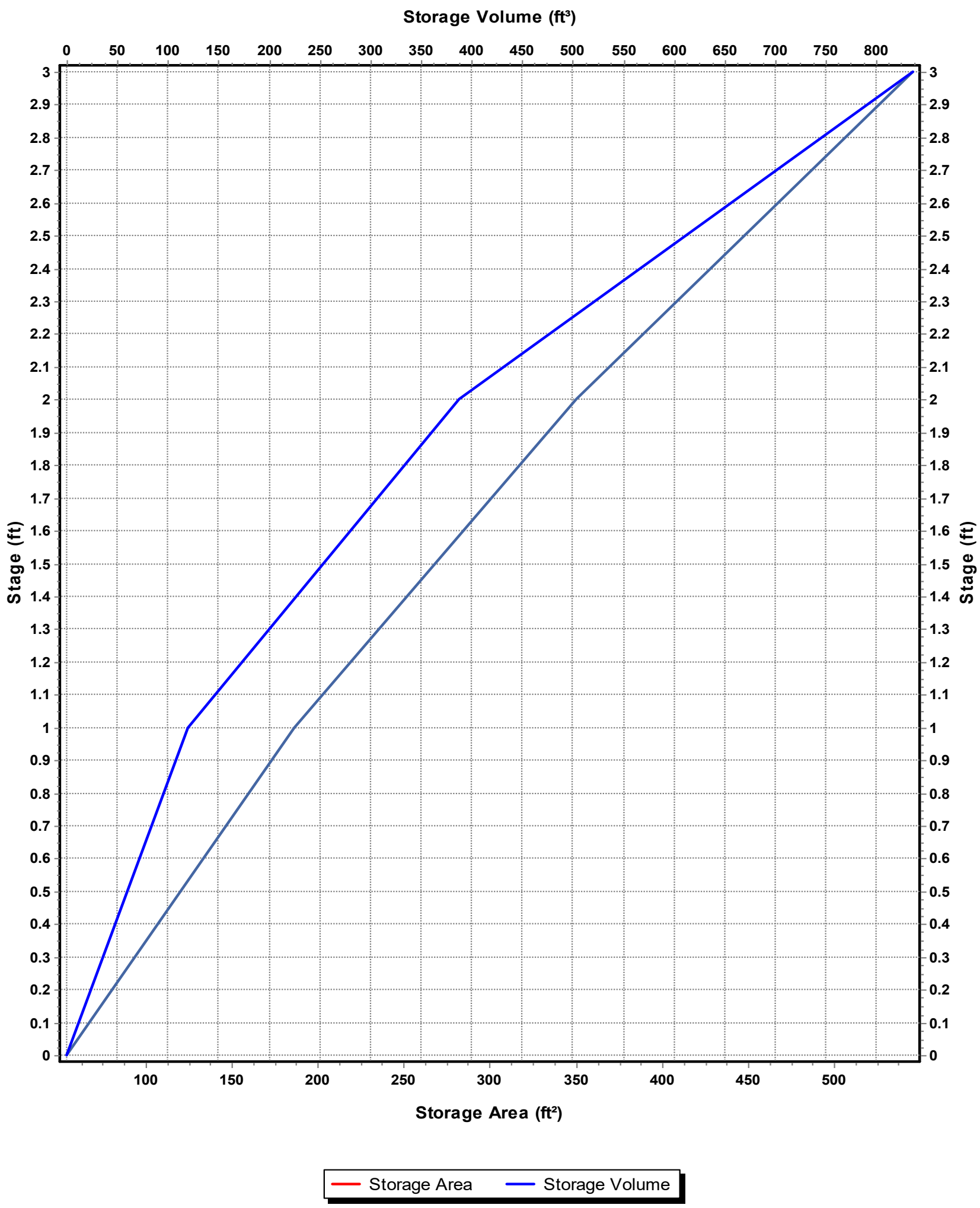
Invert Elevation (ft)	114.50
Max (Rim) Elevation (ft)	117.50
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.50
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Forebay-03

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	54	0
1	186	120
2	350	388
3	546	836

Storage Area Volume Curves



Storage Node : Forebay-A3 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-F-A3	Trapezoidal	No	116.90	2.40	4.00	2.00	3.33

Output Summary Results

Peak Inflow (cfs)	2.11
Peak Lateral Inflow (cfs)	2.11
Peak Outflow (cfs)	2.08
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	117.18
Max HGL Depth Attained (ft)	2.68
Average HGL Elevation Attained (ft)	116.35
Average HGL Depth Attained (ft)	1.85
Time of Max HGL Occurrence (days hh:mm)	0 12:10
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Project Description

File Name ..... Pave.Paws_A3.SPF

Project Options

Flow Units ..... CFS
Elevation Type ..... Elevation
Hydrology Method ..... SCS TR-20
Time of Concentration (TOC) Method ..... SCS TR-55
Link Routing Method ..... Hydrodynamic
Enable Overflow Ponding at Nodes ..... YES
Skip Steady State Analysis Time Periods .... NO

Analysis Options

Start Analysis On 00:00:00 0:00:00
End Analysis On 00:00:00 0:00:00
Start Reporting On 00:00:00 0:00:00
Antecedent Dry Days ..... 0 days
Runoff (Dry Weather) Time Step ..... 0 01:00:00 days hh:mm:ss
Runoff (Wet Weather) Time Step ..... 0 00:05:00 days hh:mm:ss
Reporting Time Step ..... 0 00:05:00 days hh:mm:ss
Routing Time Step ..... 30 seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	3
Nodes	4
Junctions	0
Outfalls	2
Flow Diversions	0
Inlets	0
Storage Nodes	2
Links	2
Channels	0
Pipes	0
Pumps	0
Orifices	0
Weirs	2
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	25 years	Intensity	inches	Massachusetts	None	25.00	5.97	SCS Type III 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	E03.3.1	0.16	484.00	43.00	5.97	0.66	0.11	0.05	0 00:19:16
2	Sub-A3	1.05	484.00	69.85	5.97	2.77	2.92	3.03	0 00:06:00
3	Sub-E03.3	0.35	484.00	43.00	5.97	0.66	0.23	0.11	0 00:21:06

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Out-A3	Outfall	114.00					0.05	114.00					
2	Out-E03.3	Outfall	50.00					0.11	50.00					
3	Basin-A3	Storage Node	113.50	117.50	113.50		0.00	2.90	116.89				0.00	0.00
4	Forebay-A3	Storage Node	114.50	117.50	114.50		0.00	2.92	117.25				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(ft)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
1	Weir-B-A3	Weir	Basin-A3	Out-A3		113.50	114.00				0.00							
2	Weir-F-A3	Weir	Forebay-A3	Basin-A3		114.50	113.50				2.90							

Subbasin Hydrology

Subbasin : E03.3.1

Input Data

Area (ac)	0.16
Peak Rate Factor	484
Weighted Curve Number	43
Rain Gage ID	Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.16	A	43
Composite Area & Weighted CN	0.16		43

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft^2)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	160.97	0	0
Slope (%) :	25	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.14	0	0
Computed Flow Time (min) :	19.27	0	0

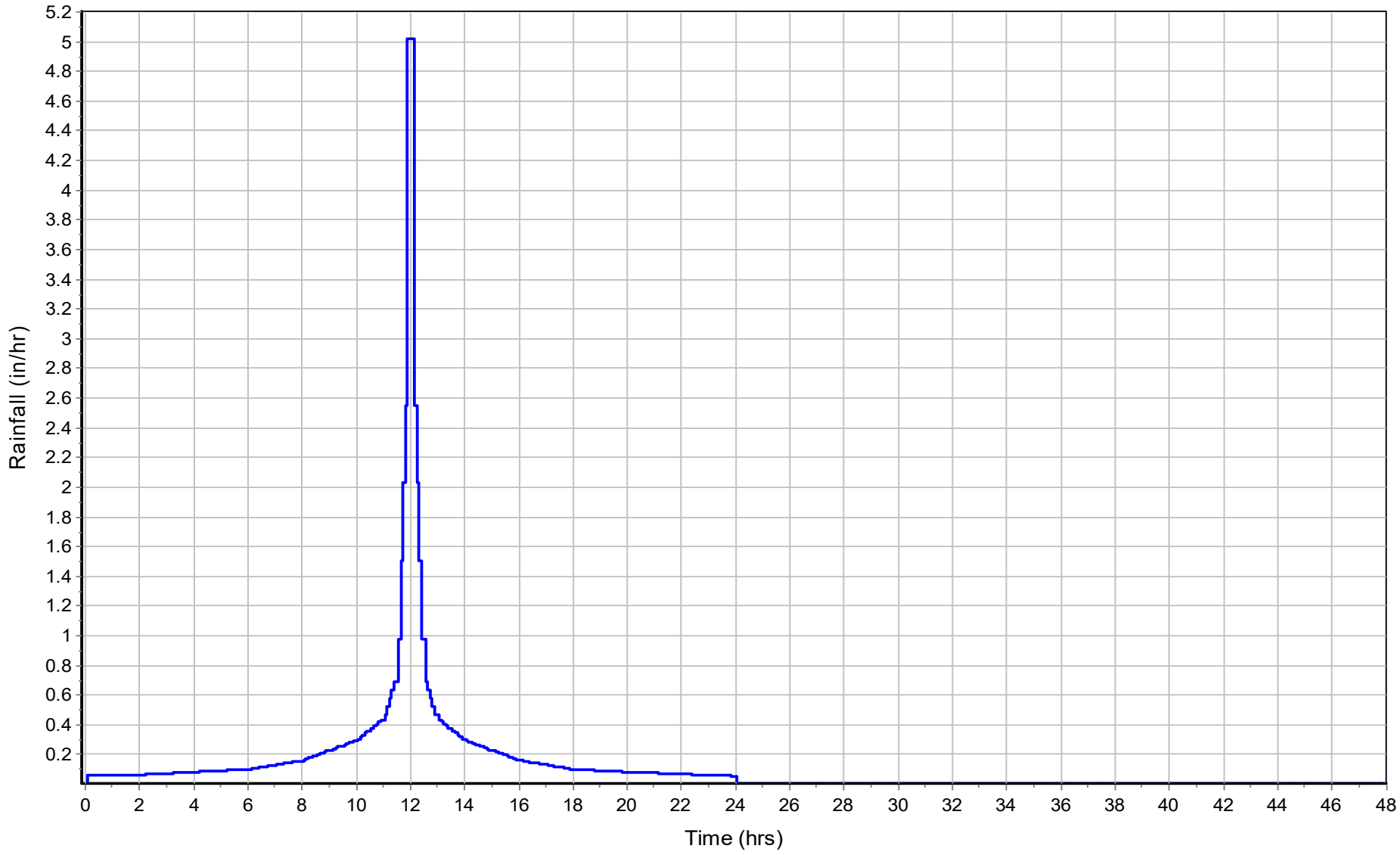
Total TOC (min) 19.27

Subbasin Runoff Results

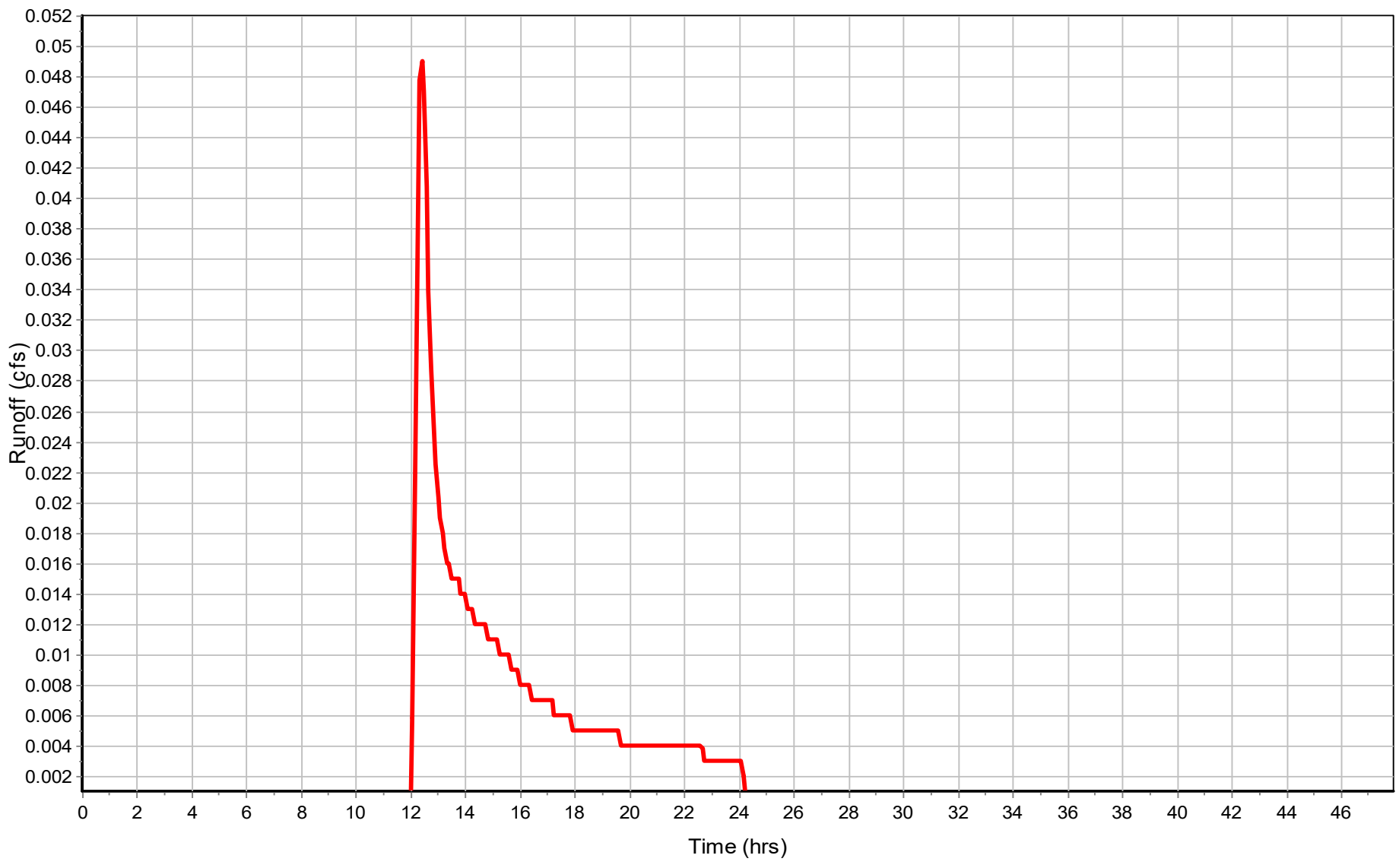
Total Rainfall (in)	5.97
Total Runoff (in)	0.66
Peak Runoff (cfs)	0.05
Weighted Curve Number	43
Time of Concentration (days hh:mm:ss)	0 00:19:16

Subbasin : E03.3.1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-A3

Input Data

Area (ac)	1.05
Peak Rate Factor	484
Weighted Curve Number	69.85
Rain Gage ID	Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	0.88	A	76
Woods & grass combination, Fair	0.2	A	43
Composite Area & Weighted CN	1.08		69.85

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	25.24	0	0
Slope (%) :	0.5	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.48	0	0
Computed Flow Time (min) :	0.87	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	238.39	0	0
Channel Slope (%) :	0.3	0	0
Cross Section Area (ft^2) :	3	0	0
Wetted Perimeter (ft) :	6.32	0	0
Velocity (ft/sec) :	1.66	0	0
Computed Flow Time (min) :	2.4	0	0

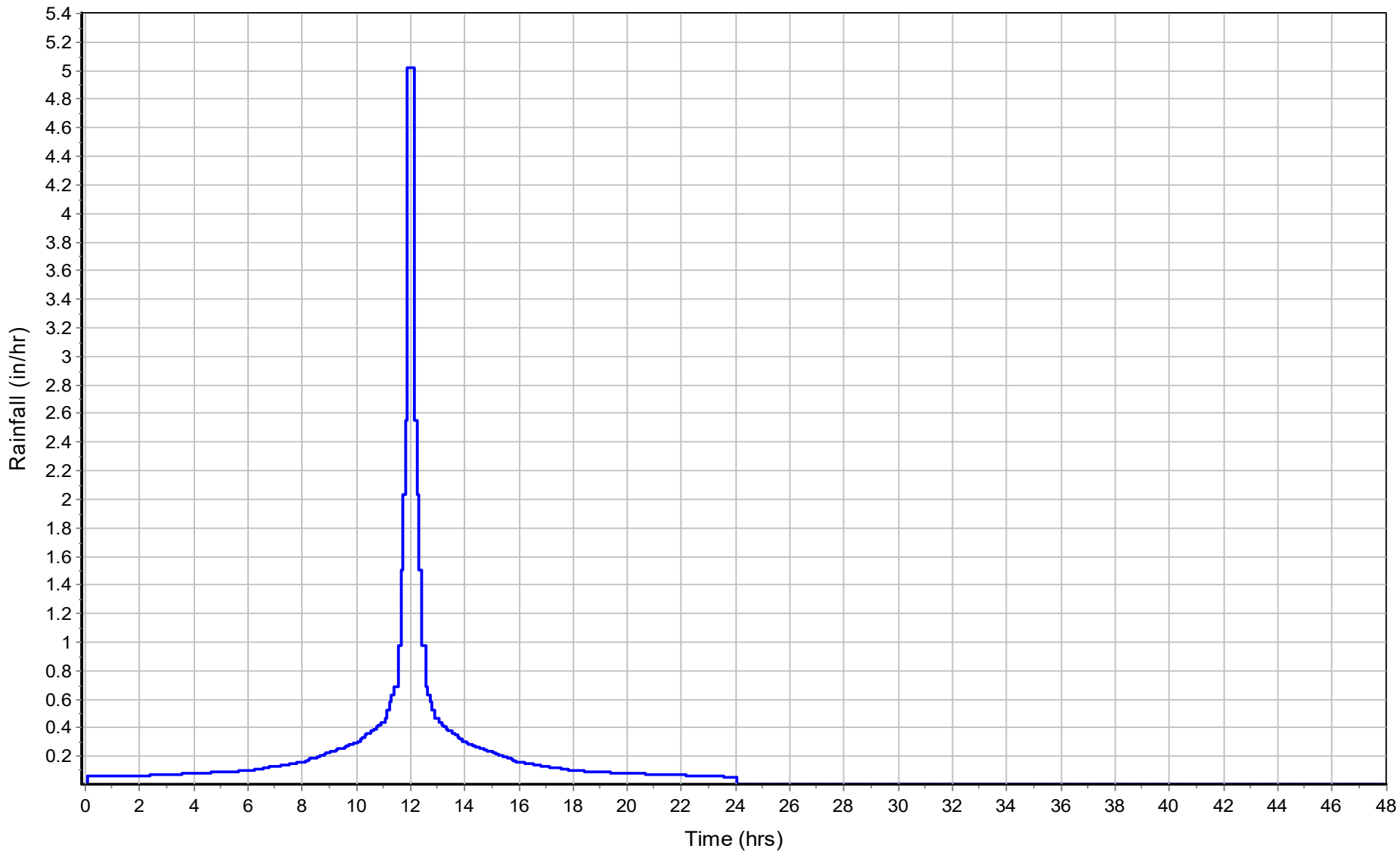
Total TOC (min) 3.27

Subbasin Runoff Results

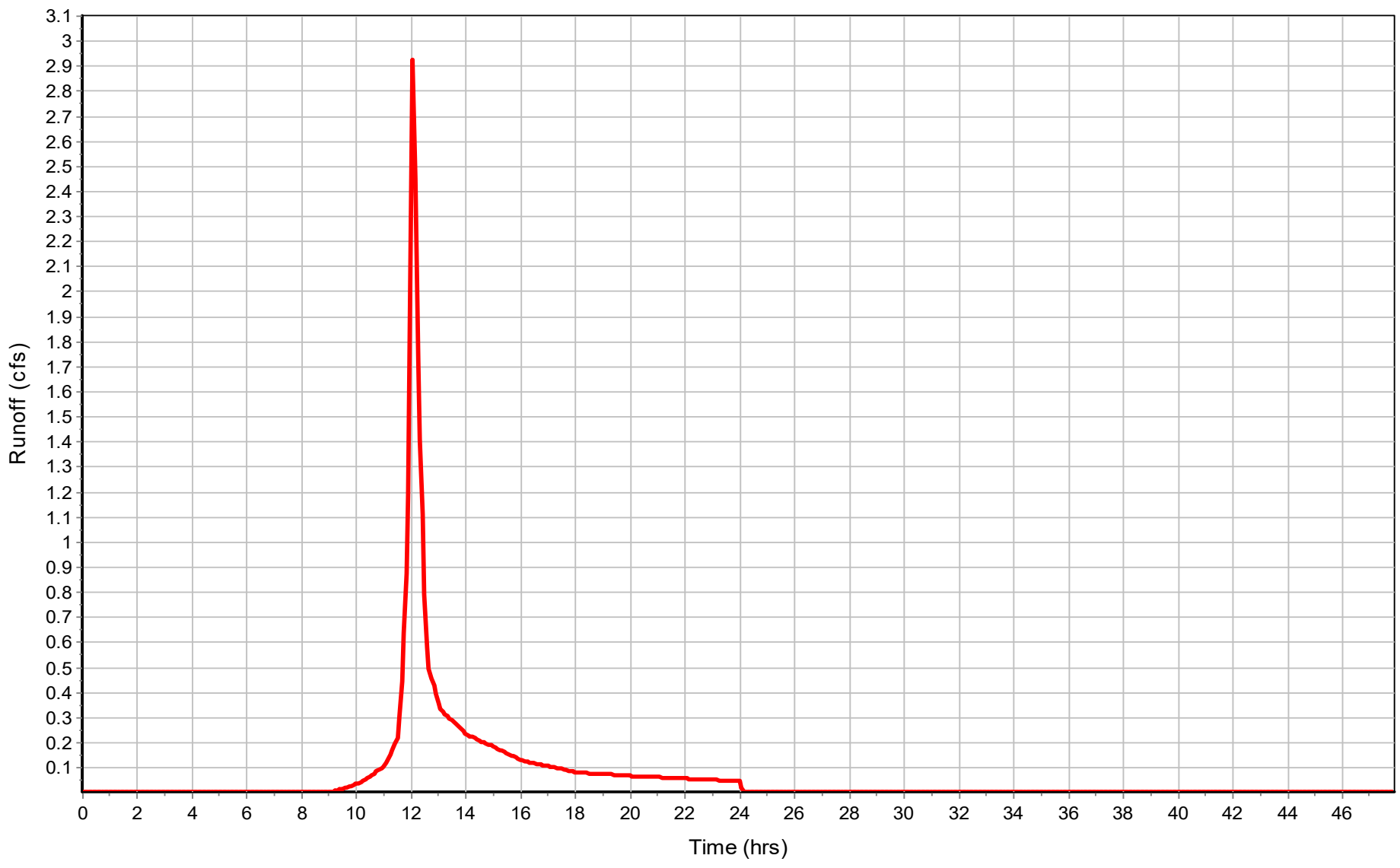
Total Rainfall (in)	5.97
Total Runoff (in)	2.77
Peak Runoff (cfs)	3.03
Weighted Curve Number	69.85
Time of Concentration (days hh:mm:ss)	0 00:03:16

Subbasin : Sub-A3

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E03.3

Input Data

Area (ac) 0.35
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.35	A	43
Composite Area & Weighted CN	0.35		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	180.27	0	0
Slope (%) :	25	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.14	0	0
Computed Flow Time (min) :	21.1	0	0

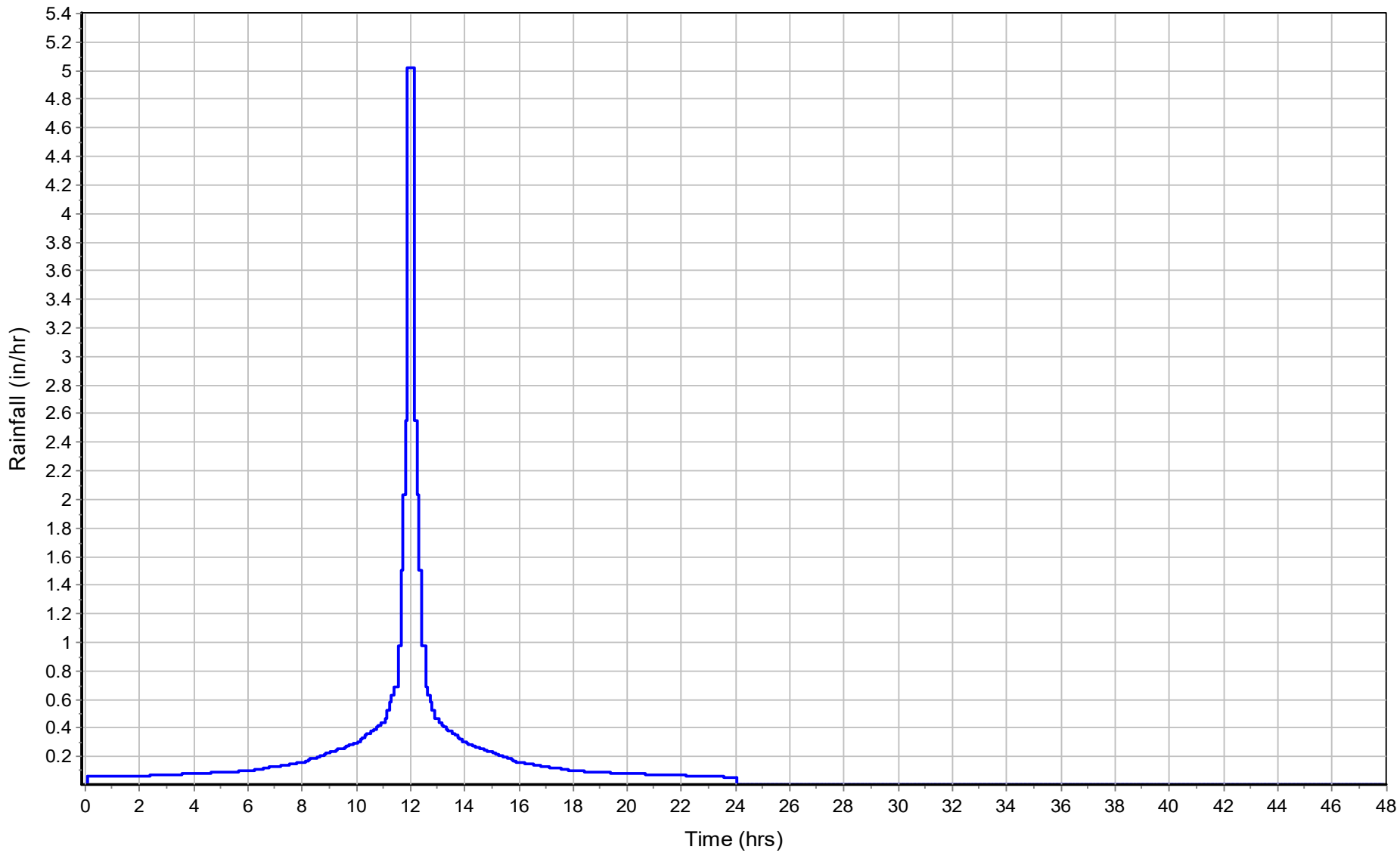
Total TOC (min) 21.10

Subbasin Runoff Results

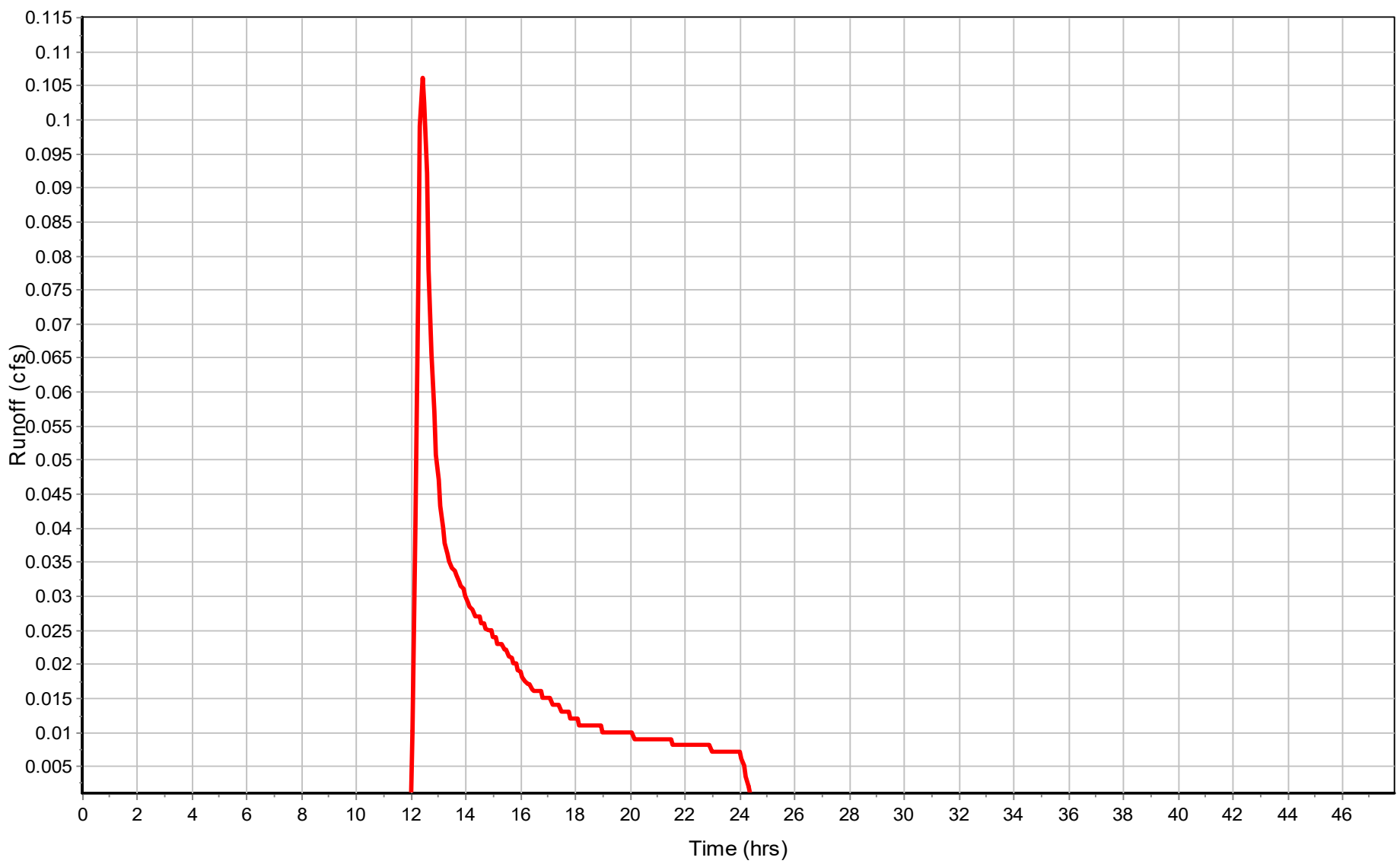
Total Rainfall (in) 5.97
Total Runoff (in) 0.66
Peak Runoff (cfs) 0.11
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:21:06

Subbasin : Sub-E03.3

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A3

Input Data

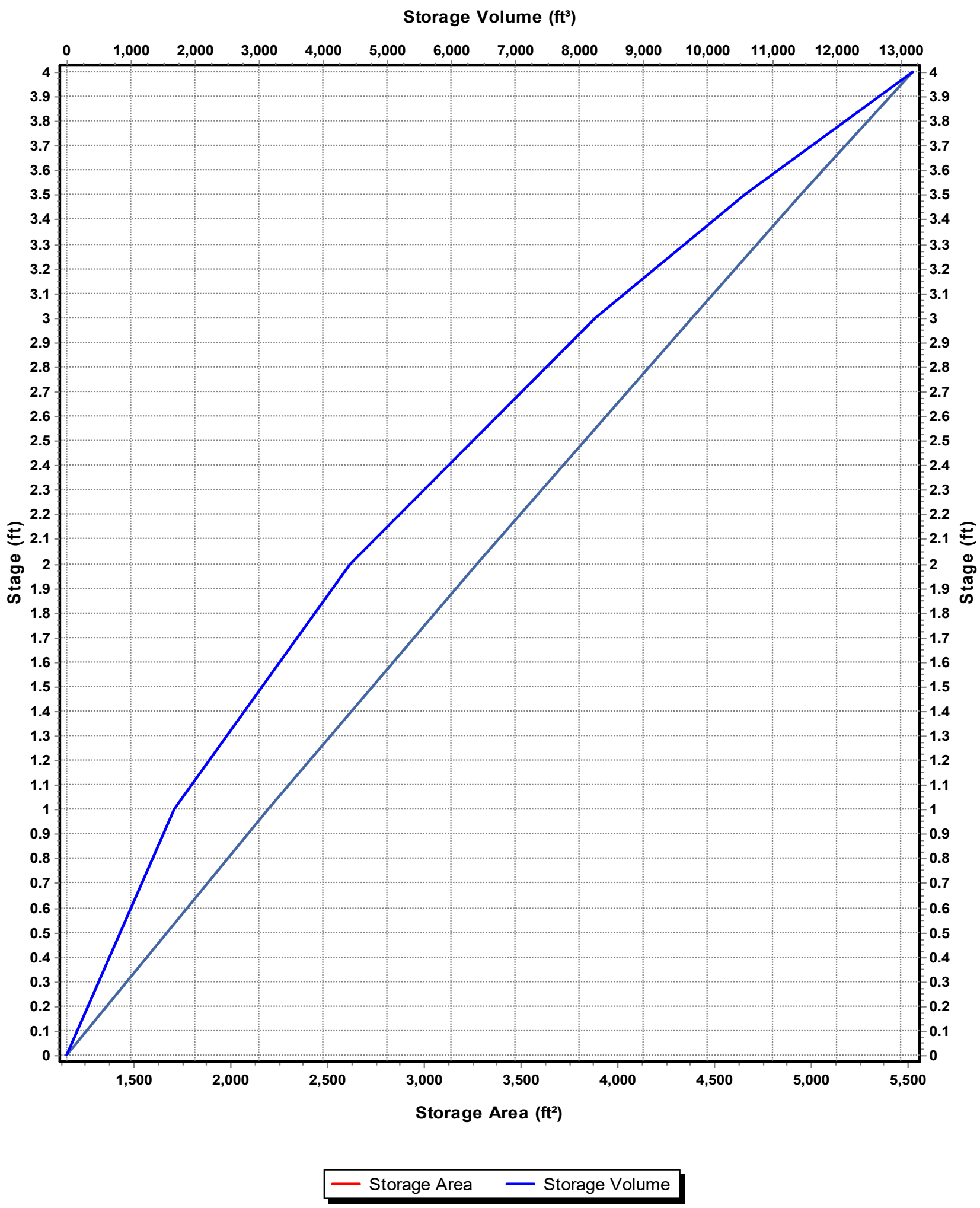
Invert Elevation (ft)	113.50
Max (Rim) Elevation (ft)	117.50
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	113.50
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Basin-03

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	1157.27	0
1	2197.59	1677.43
2	3275.77	4414.11
3	4385.72	8244.86
3.5	4952.65	10579.45
4	5527.59	13199.51

Storage Area Volume Curves



Storage Node : Basin-A3 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-B-A3	Trapezoidal	No	117.23	3.73	3.00	1.00	3.33

Output Summary Results

Peak Inflow (cfs)	2.9
Peak Lateral Inflow (cfs)	0
Peak Outflow (cfs)	0
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	116.89
Max HGL Depth Attained (ft)	3.39
Average HGL Elevation Attained (ft)	115.94
Average HGL Depth Attained (ft)	2.44
Time of Max HGL Occurrence (days hh:mm)	1 01:50
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Forebay-A3

Input Data

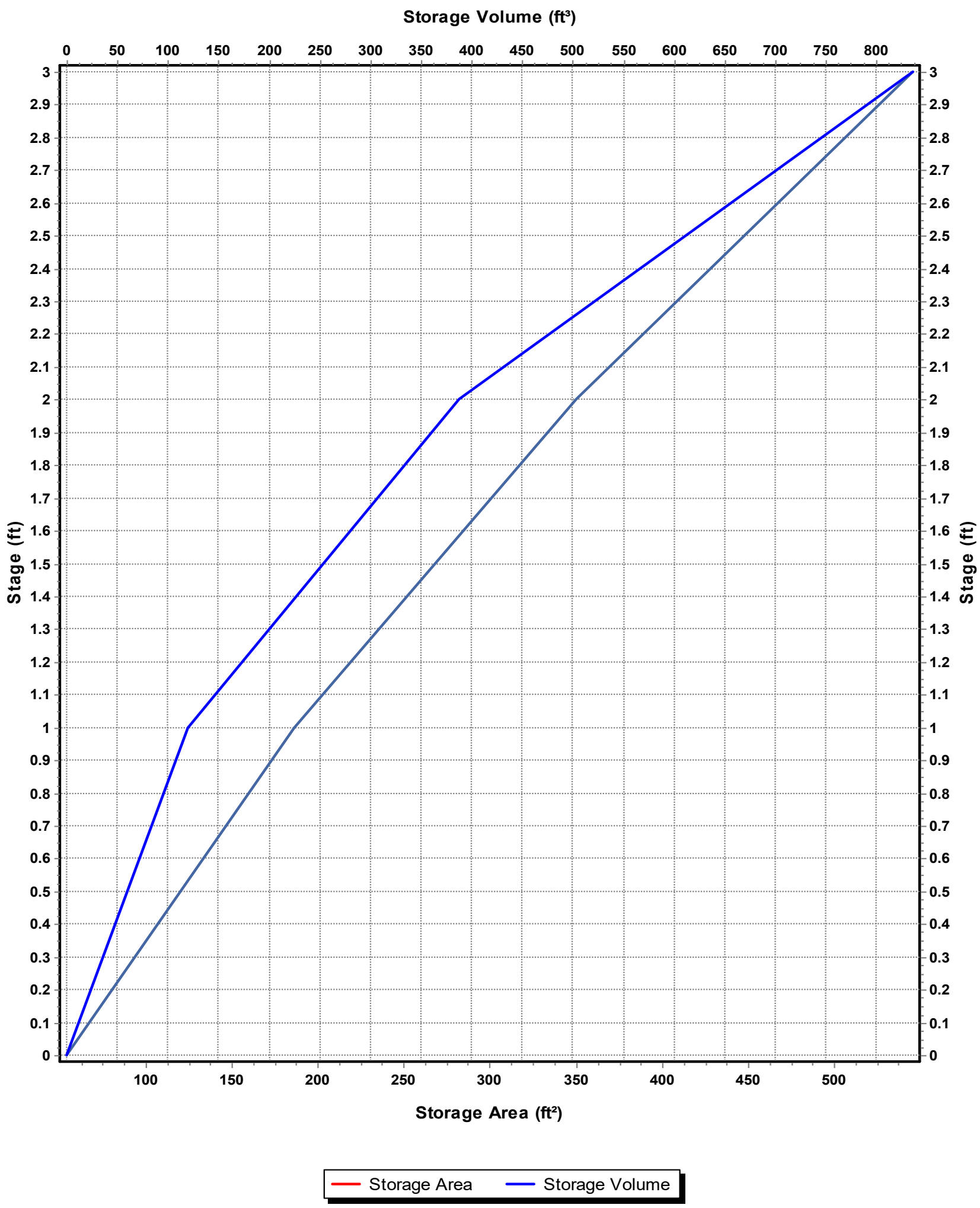
Invert Elevation (ft)	114.50
Max (Rim) Elevation (ft)	117.50
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.50
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Forebay-03

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	54	0
1	186	120
2	350	388
3	546	836

Storage Area Volume Curves



Storage Node : Forebay-A3 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-F-A3	Trapezoidal	No	116.90	2.40	4.00	2.00	3.33

Output Summary Results

Peak Inflow (cfs)	2.92
Peak Lateral Inflow (cfs)	2.92
Peak Outflow (cfs)	2.9
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	117.25
Max HGL Depth Attained (ft)	2.75
Average HGL Elevation Attained (ft)	116.38
Average HGL Depth Attained (ft)	1.88
Time of Max HGL Occurrence (days hh:mm)	0 12:10
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Project Description

File Name ..... Pave.Paws_A3.SPF

Project Options

Flow Units ..... CFS
Elevation Type ..... Elevation
Hydrology Method ..... SCS TR-20
Time of Concentration (TOC) Method ..... SCS TR-55
Link Routing Method ..... Hydrodynamic
Enable Overflow Ponding at Nodes ..... YES
Skip Steady State Analysis Time Periods .... NO

Analysis Options

Start Analysis On 00:00:00 0:00:00
End Analysis On 00:00:00 0:00:00
Start Reporting On 00:00:00 0:00:00
Antecedent Dry Days ..... 0 days
Runoff (Dry Weather) Time Step ..... 0 01:00:00 days hh:mm:ss
Runoff (Wet Weather) Time Step ..... 0 00:05:00 days hh:mm:ss
Reporting Time Step ..... 0 00:05:00 days hh:mm:ss
Routing Time Step ..... 30 seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	3
Nodes	4
Junctions	0
Outfalls	2
Flow Diversions	0
Inlets	0
Storage Nodes	2
Links	2
Channels	0
Pipes	0
Pumps	0
Orifices	0
Weirs	2
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	50 years	Intensity	inches	Massachusetts	None	50.00	6.71	SCS Type III 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	E03.3.1	0.16	484.00	43.00	6.71	0.95	0.15	0.08	0 00:19:16
2	Sub-A3	1.05	484.00	69.85	6.71	3.36	3.54	3.68	0 00:06:00
3	Sub-E03.3	0.35	484.00	43.00	6.71	0.95	0.34	0.18	0 00:21:06

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Out-A3	Outfall	114.00					0.08	114.00					
2	Out-E03.3	Outfall	50.00					0.18	50.00					
3	Basin-A3	Storage Node	113.50	117.50	113.50		0.00	3.54	117.26				0.00	0.00
4	Forebay-A3	Storage Node	114.50	117.50	114.50		0.00	3.56	117.29				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(ft)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
1	Weir-B-A3	Weir	Basin-A3	Out-A3		113.50	114.00				0.05							
2	Weir-F-A3	Weir	Forebay-A3	Basin-A3		114.50	113.50				3.54							

Subbasin Hydrology

Subbasin : E03.3.1

Input Data

Area (ac)	0.16
Peak Rate Factor	484
Weighted Curve Number	43
Rain Gage ID	Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.16	A	43
Composite Area & Weighted CN	0.16		43

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft^2)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	160.97	0	0
Slope (%) :	25	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.14	0	0
Computed Flow Time (min) :	19.27	0	0

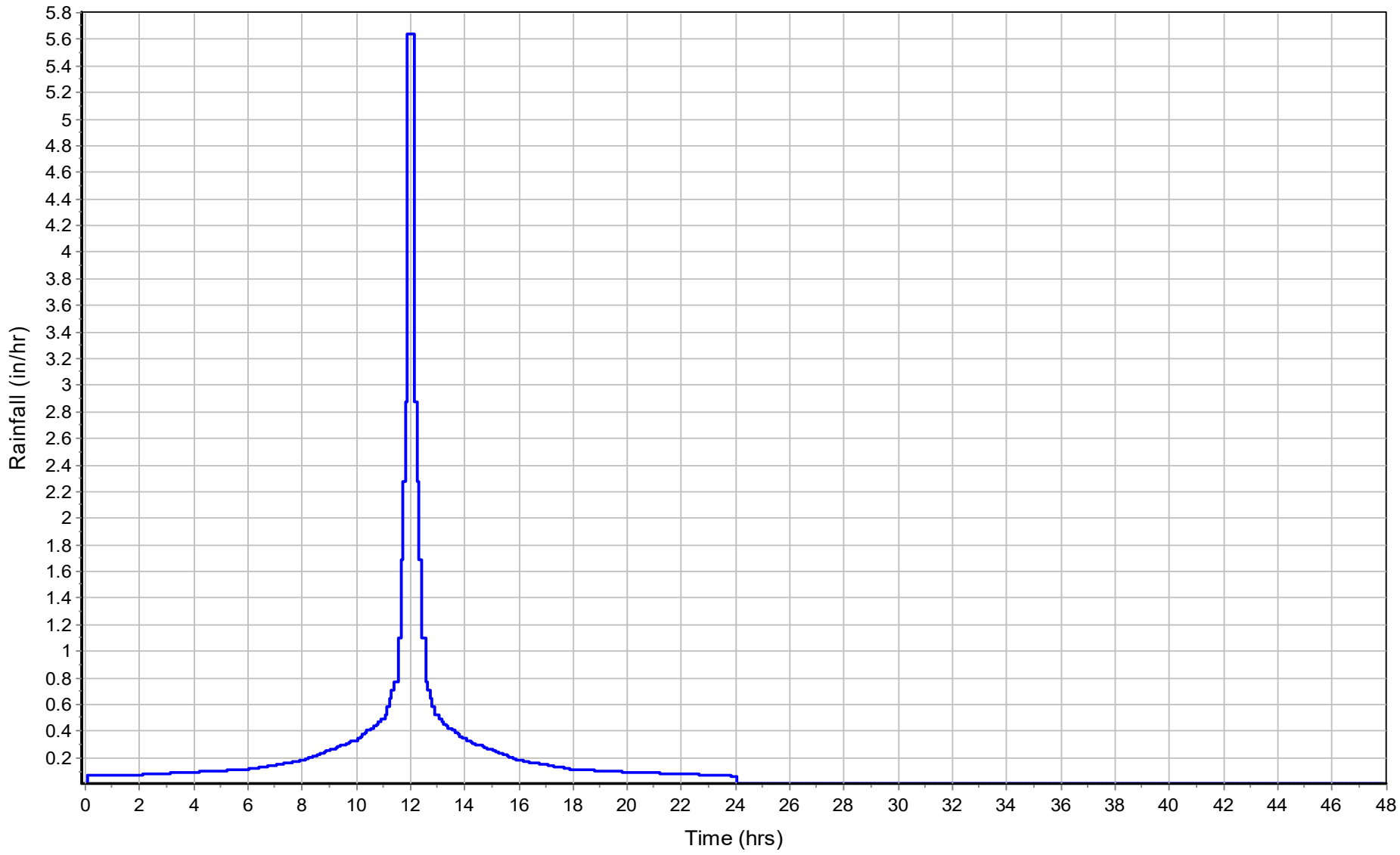
Total TOC (min) 19.27

Subbasin Runoff Results

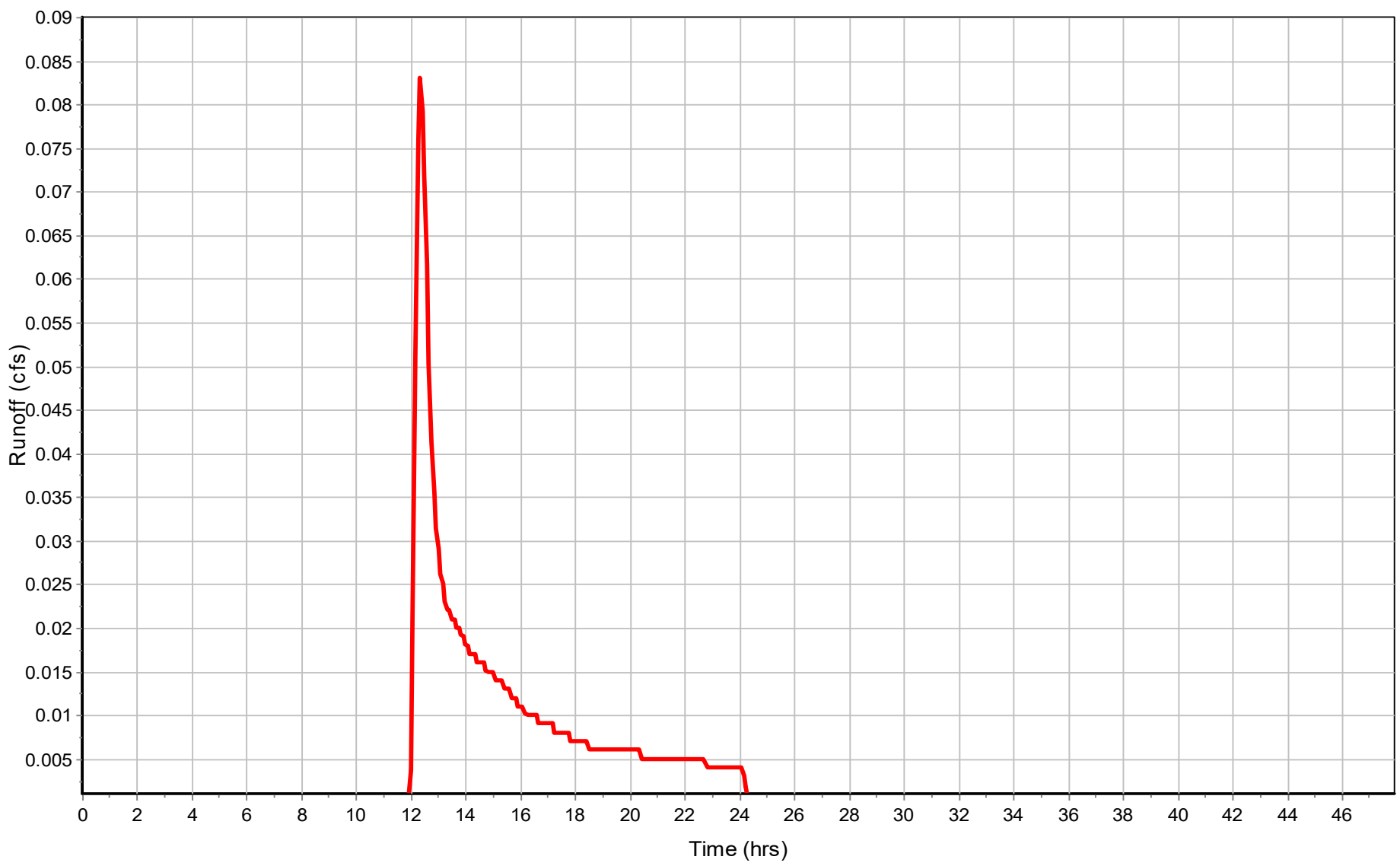
Total Rainfall (in)	6.71
Total Runoff (in)	0.95
Peak Runoff (cfs)	0.08
Weighted Curve Number	43
Time of Concentration (days hh:mm:ss)	0 00:19:16

Subbasin : E03.3.1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-A3

Input Data

Area (ac)	1.05
Peak Rate Factor	484
Weighted Curve Number	69.85
Rain Gage ID	Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	0.88	A	76
Woods & grass combination, Fair	0.2	A	43
Composite Area & Weighted CN	1.08		69.85

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	25.24	0	0
Slope (%) :	0.5	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.48	0	0
Computed Flow Time (min) :	0.87	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	238.39	0	0
Channel Slope (%) :	0.3	0	0
Cross Section Area (ft^2) :	3	0	0
Wetted Perimeter (ft) :	6.32	0	0
Velocity (ft/sec) :	1.66	0	0
Computed Flow Time (min) :	2.4	0	0

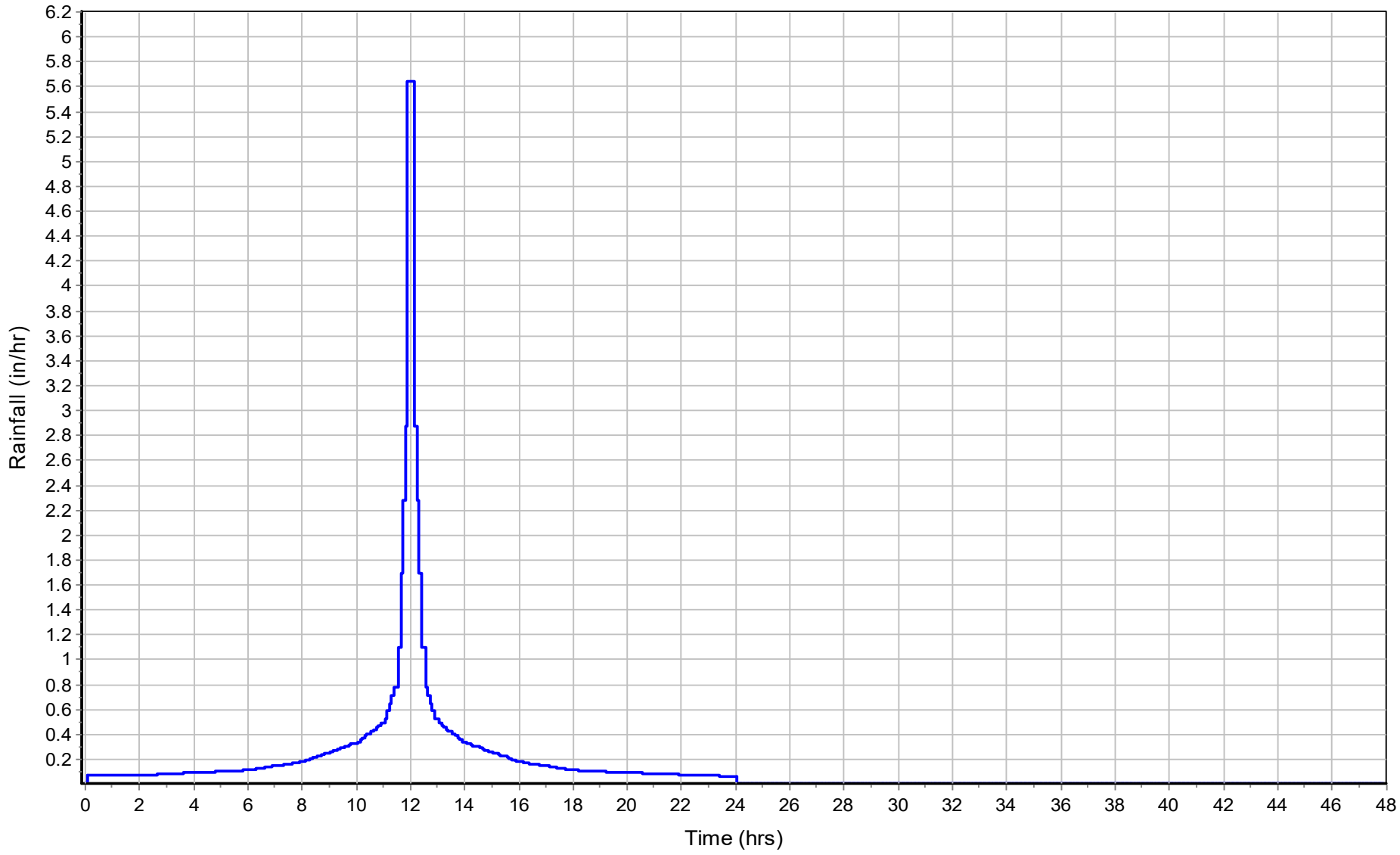
Total TOC (min) 3.27

Subbasin Runoff Results

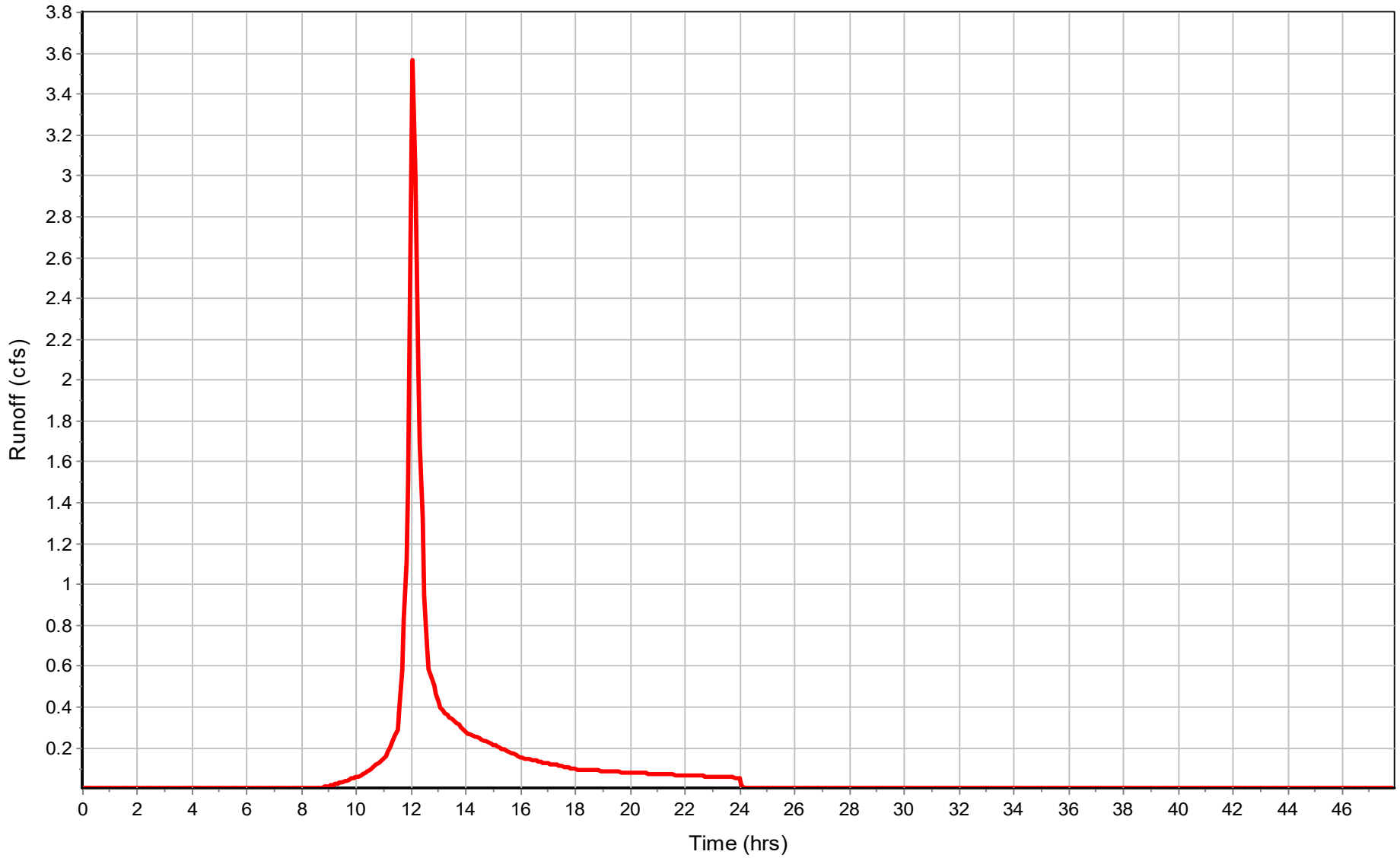
Total Rainfall (in)	6.71
Total Runoff (in)	3.36
Peak Runoff (cfs)	3.68
Weighted Curve Number	69.85
Time of Concentration (days hh:mm:ss)	0 00:03:16

Subbasin : Sub-A3

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E03.3

Input Data

Area (ac) 0.35
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.35	A	43
Composite Area & Weighted CN	0.35		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	180.27	0	0
Slope (%) :	25	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.14	0	0
Computed Flow Time (min) :	21.1	0	0

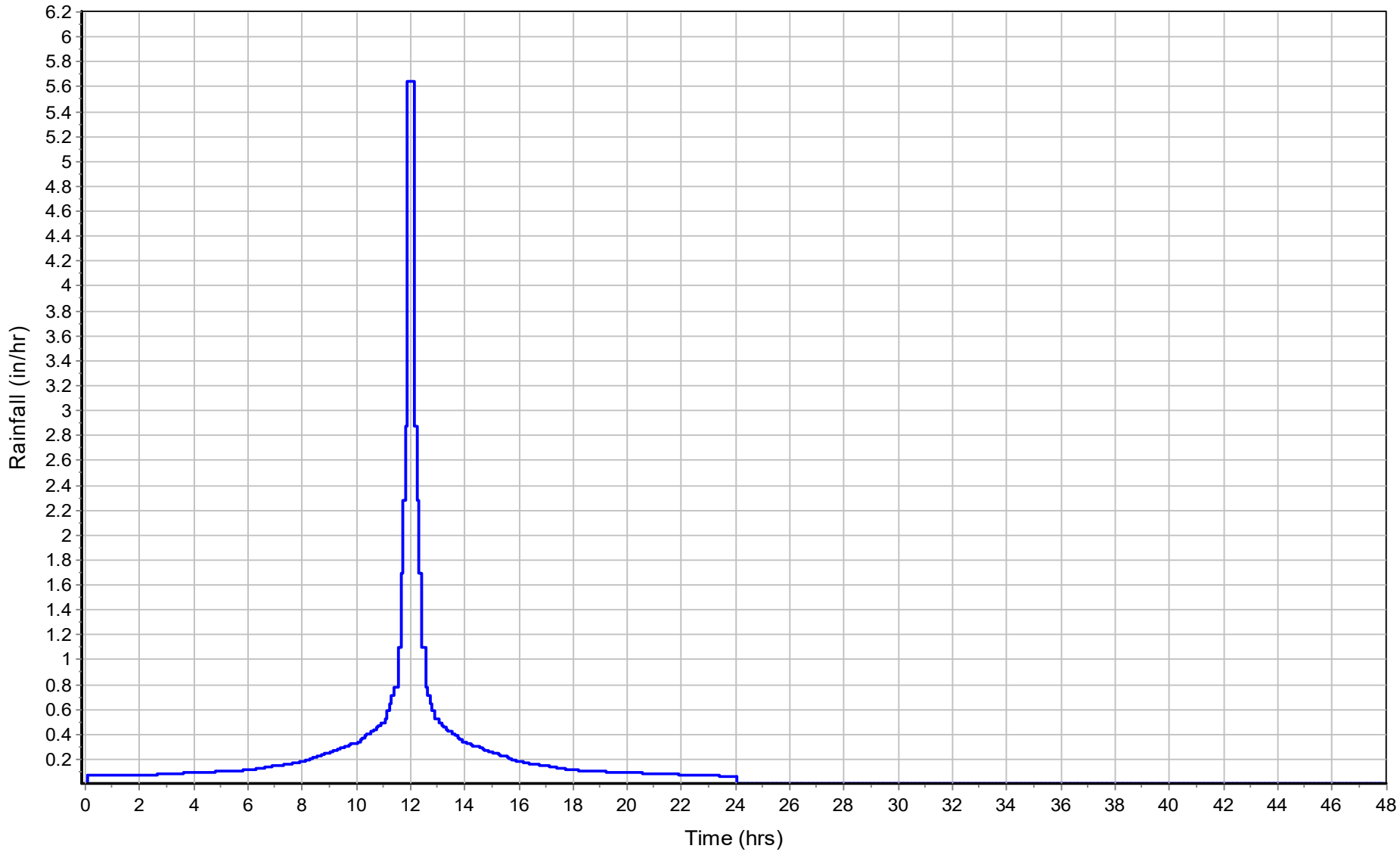
Total TOC (min) 21.10

Subbasin Runoff Results

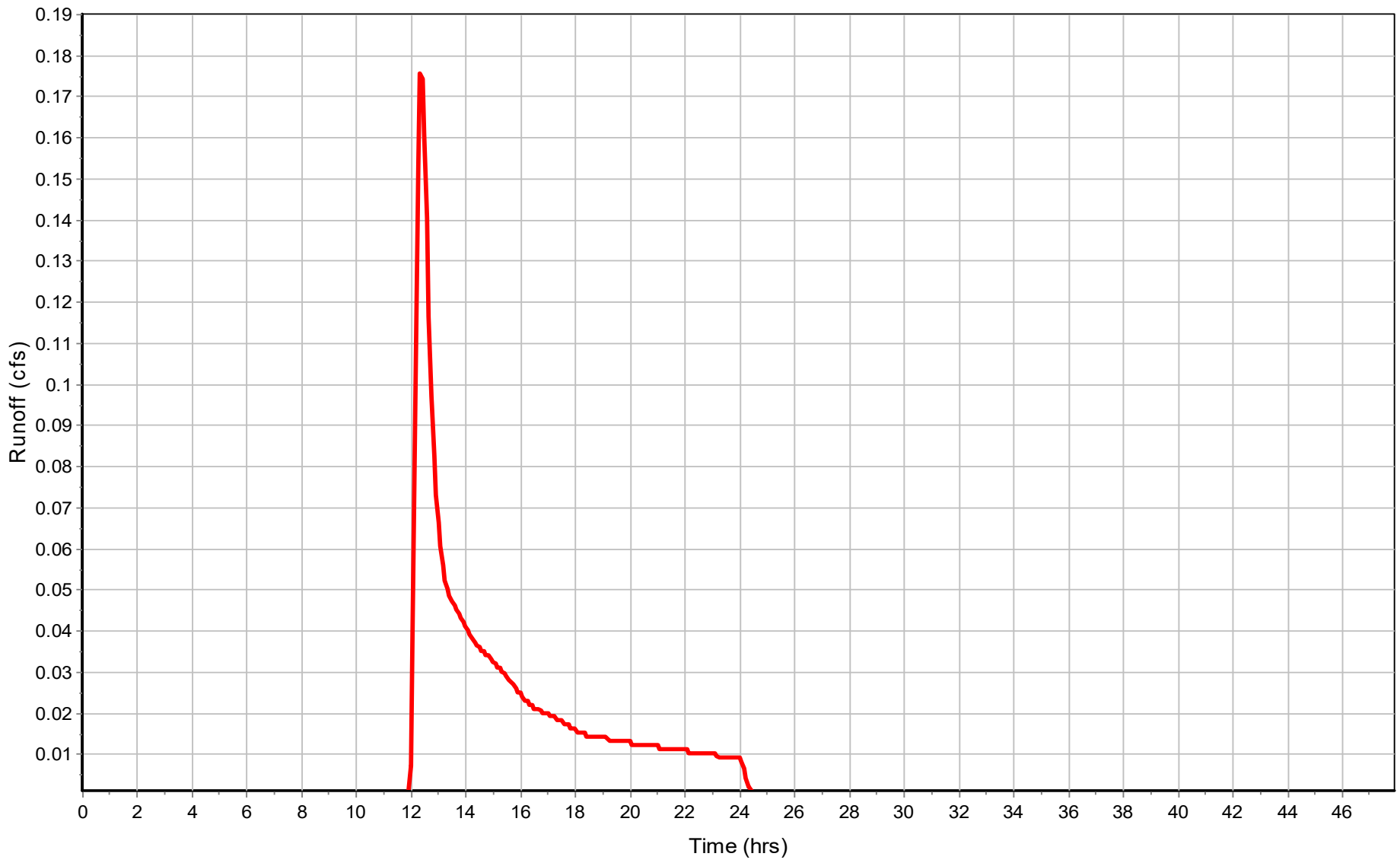
Total Rainfall (in) 6.71
Total Runoff (in) 0.95
Peak Runoff (cfs) 0.18
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:21:06

Subbasin : Sub-E03.3

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A3

Input Data

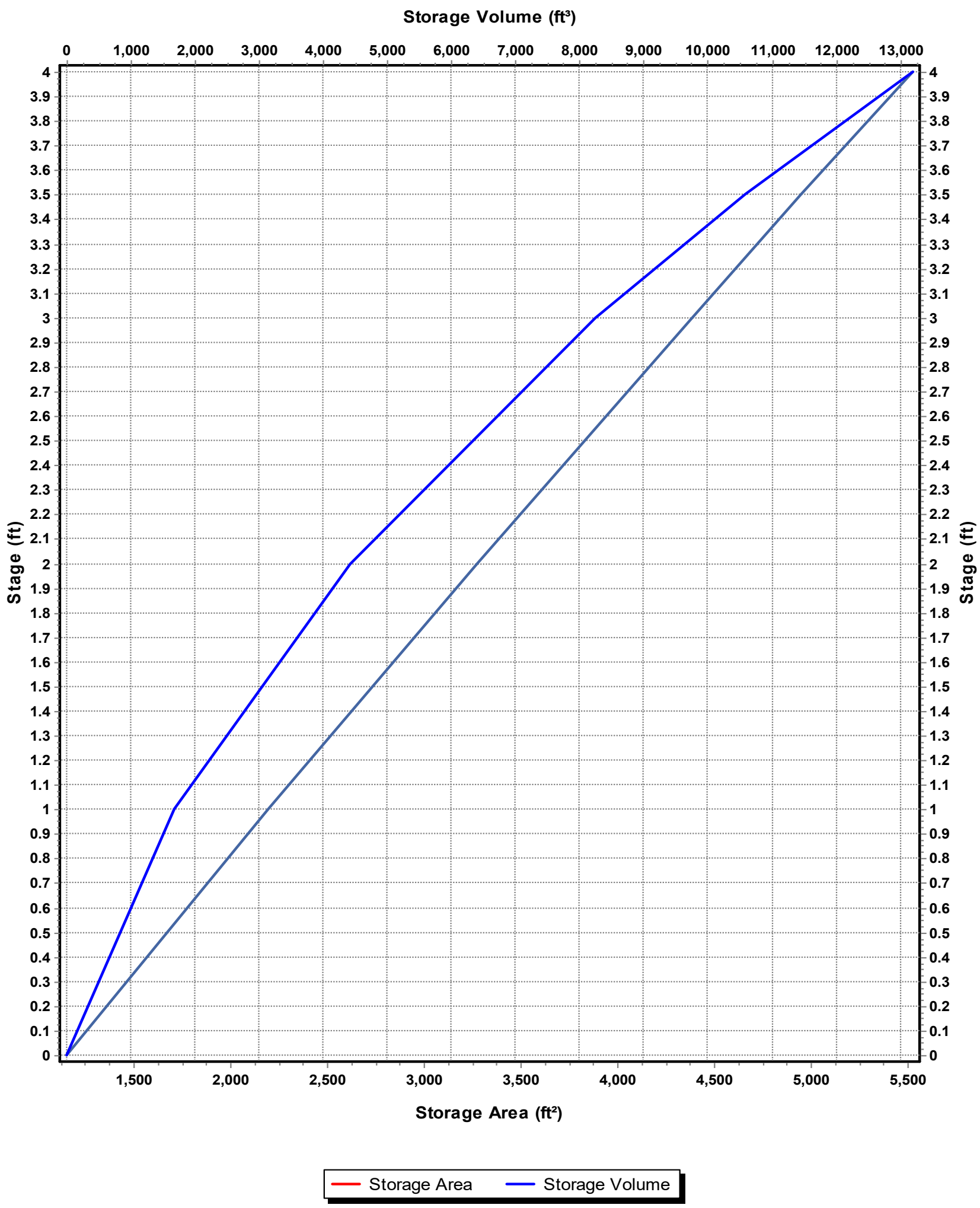
Invert Elevation (ft)	113.50
Max (Rim) Elevation (ft)	117.50
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	113.50
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Basin-03

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	1157.27	0
1	2197.59	1677.43
2	3275.77	4414.11
3	4385.72	8244.86
3.5	4952.65	10579.45
4	5527.59	13199.51

Storage Area Volume Curves



Storage Node : Basin-A3 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-B-A3	Trapezoidal	No	117.23	3.73	3.00	1.00	3.33

Output Summary Results

Peak Inflow (cfs)	3.54
Peak Lateral Inflow (cfs)	0
Peak Outflow (cfs)	0.4
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	117.26
Max HGL Depth Attained (ft)	3.76
Average HGL Elevation Attained (ft)	116.21
Average HGL Depth Attained (ft)	2.71
Time of Max HGL Occurrence (days hh:mm)	1 00:02
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Forebay-A3

Input Data

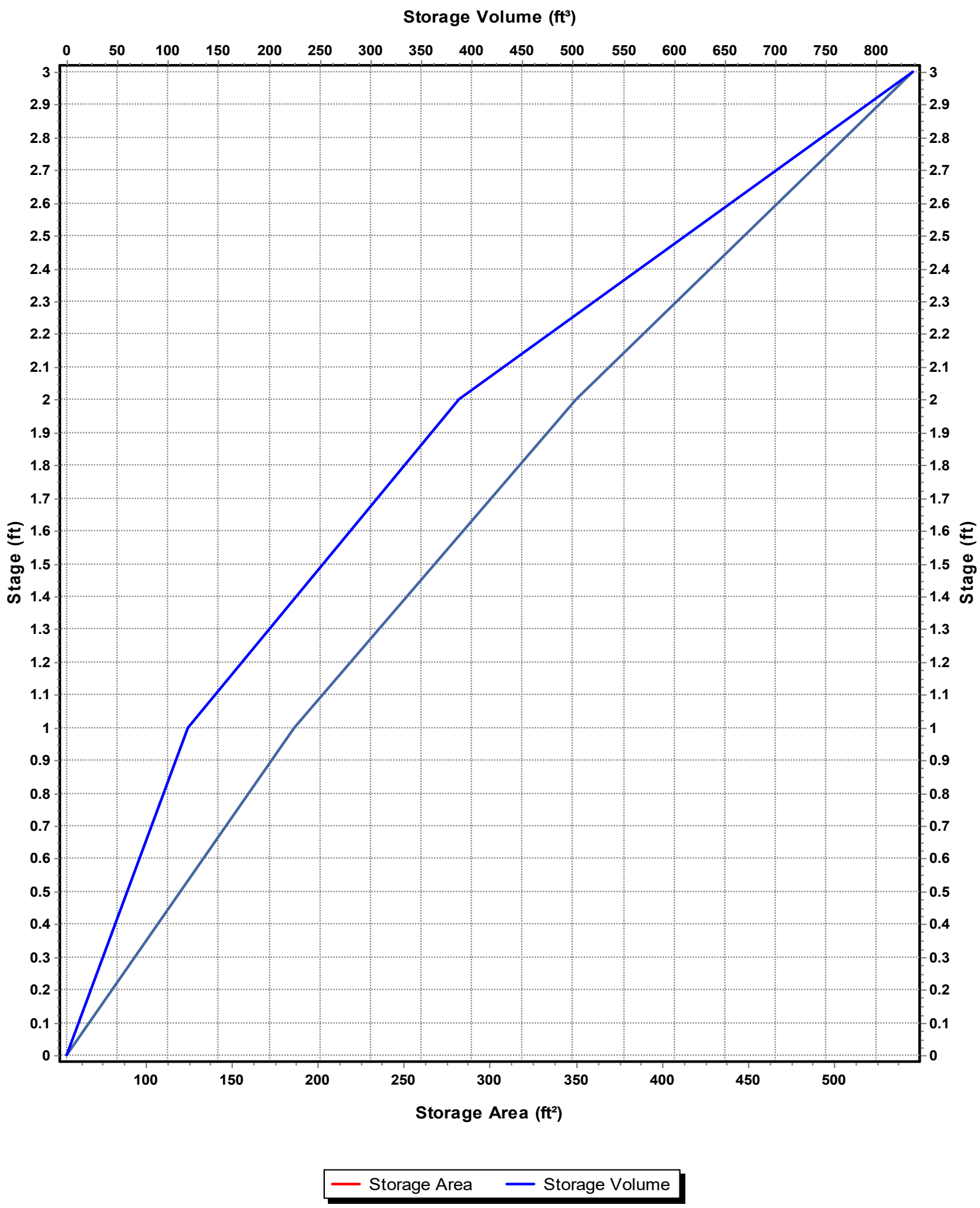
Invert Elevation (ft)	114.50
Max (Rim) Elevation (ft)	117.50
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.50
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Forebay-03

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	54	0
1	186	120
2	350	388
3	546	836

Storage Area Volume Curves



Storage Node : Forebay-A3 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-F-A3	Trapezoidal	No	116.90	2.40	4.00	2.00	3.33

Output Summary Results

Peak Inflow (cfs)	3.56
Peak Lateral Inflow (cfs)	3.56
Peak Outflow (cfs)	3.54
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	117.29
Max HGL Depth Attained (ft)	2.79
Average HGL Elevation Attained (ft)	116.61
Average HGL Depth Attained (ft)	2.11
Time of Max HGL Occurrence (days hh:mm)	0 12:10
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Project Description

File Name ..... Pave.Paws_A3.SPF

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	SCS TR-20
Time of Concentration (TOC) Method	SCS TR-55
Link Routing Method	Hydrodynamic
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	NO

Analysis Options

Start Analysis On	00:00:00	0:00:00
End Analysis On	00:00:00	0:00:00
Start Reporting On	00:00:00	0:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	3
Nodes	4
Junctions	0
Outfalls	2
Flow Diversions	0
Inlets	0
Storage Nodes	2
Links	2
Channels	0
Pipes	0
Pumps	0
Orifices	0
Weirs	2
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	50 years (2070)	Intensity	inches	Massachusetts	None	50.00	8.80	SCS Type III 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	E03.3.1	0.16	484.00	43.00	8.80	1.95	0.31	0.21	0 00:19:16
2	Sub-A3	1.05	484.00	69.85	8.80	5.14	5.42	5.57	0 00:06:00
3	Sub-E03.3	0.35	484.00	43.00	8.80	1.95	0.69	0.45	0 00:21:06

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Out-A3	Outfall	114.00					0.45	114.00					
2	Out-E03.3	Outfall	50.00					0.45	50.00					
3	Basin-A3	Storage Node	113.50	117.50	113.50		0.00	5.41	117.35				0.00	0.00
4	Forebay-A3	Storage Node	114.50	117.50	114.50		0.00	5.45	117.41				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(ft)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
1	Weir-B-A3	Weir	Basin-A3	Out-A3		113.50	114.00				0.42							
2	Weir-F-A3	Weir	Forebay-A3	Basin-A3		114.50	113.50				5.41							

Subbasin Hydrology

Subbasin : E03.3.1

Input Data

Area (ac)	0.16
Peak Rate Factor	484
Weighted Curve Number	43
Rain Gage ID	Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.16	A	43
Composite Area & Weighted CN	0.16		43

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft^2)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	160.97	0	0
Slope (%) :	25	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.14	0	0
Computed Flow Time (min) :	19.27	0	0

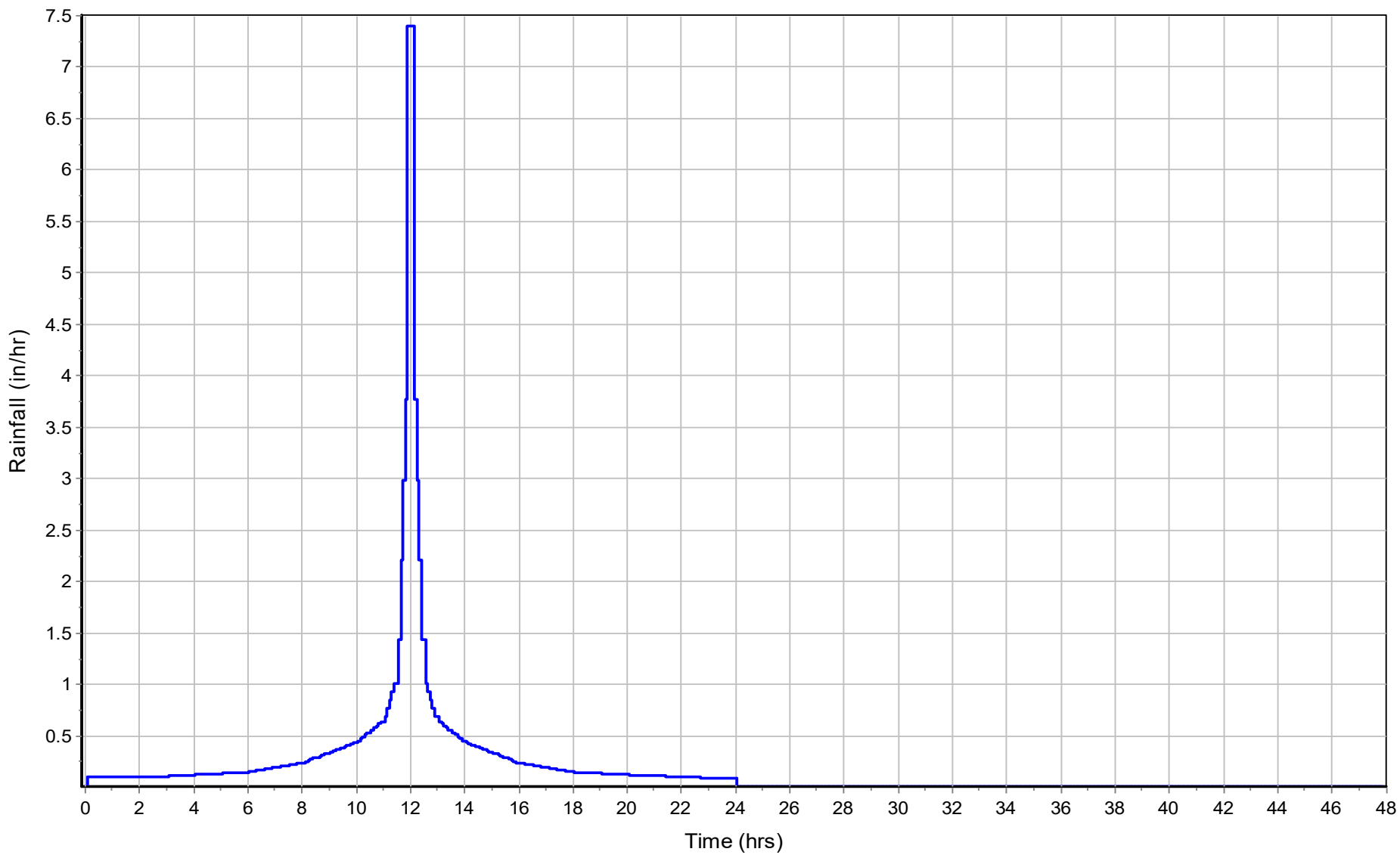
Total TOC (min) 19.27

Subbasin Runoff Results

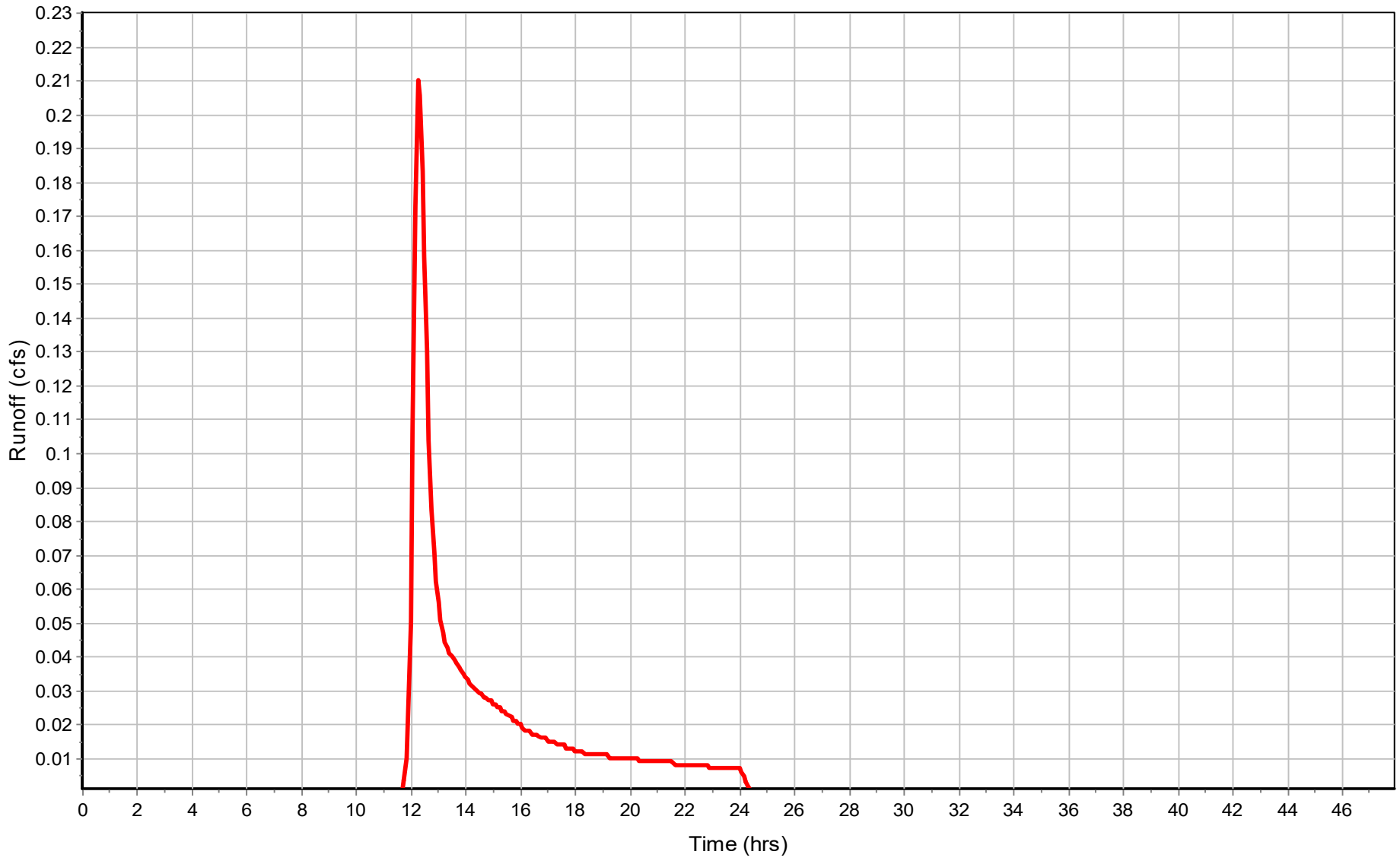
Total Rainfall (in)	8.8
Total Runoff (in)	1.95
Peak Runoff (cfs)	0.21
Weighted Curve Number	43
Time of Concentration (days hh:mm:ss)	0 00:19:16

Subbasin : E03.3.1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-A3

Input Data

Area (ac)	1.05
Peak Rate Factor	484
Weighted Curve Number	69.85
Rain Gage ID	Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	0.88	A	76
Woods & grass combination, Fair	0.2	A	43
Composite Area & Weighted CN	1.08		69.85

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	25.24	0	0
Slope (%) :	0.5	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.48	0	0
Computed Flow Time (min) :	0.87	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	238.39	0	0
Channel Slope (%) :	0.3	0	0
Cross Section Area (ft^2) :	3	0	0
Wetted Perimeter (ft) :	6.32	0	0
Velocity (ft/sec) :	1.66	0	0
Computed Flow Time (min) :	2.4	0	0

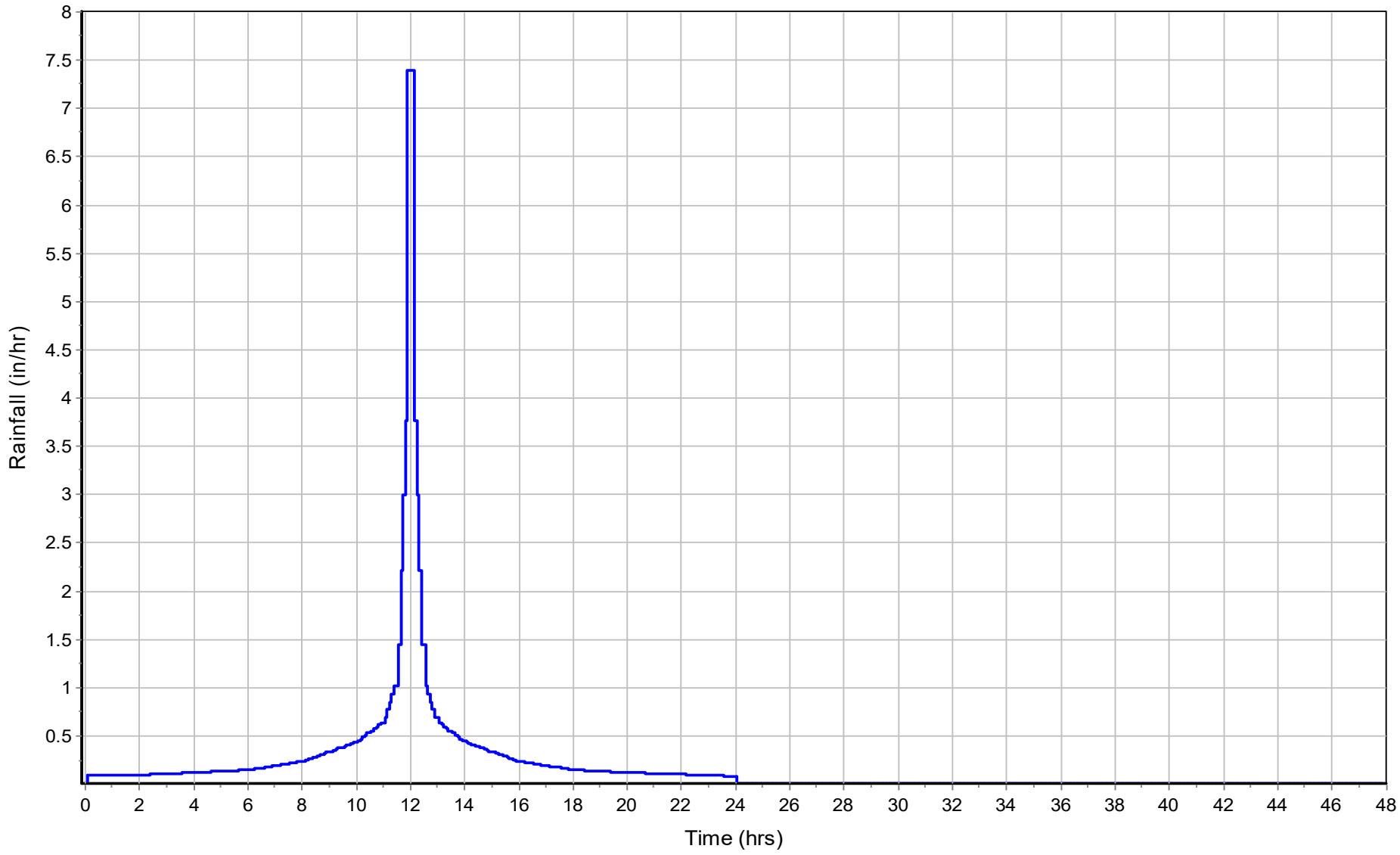
Total TOC (min) 3.27

Subbasin Runoff Results

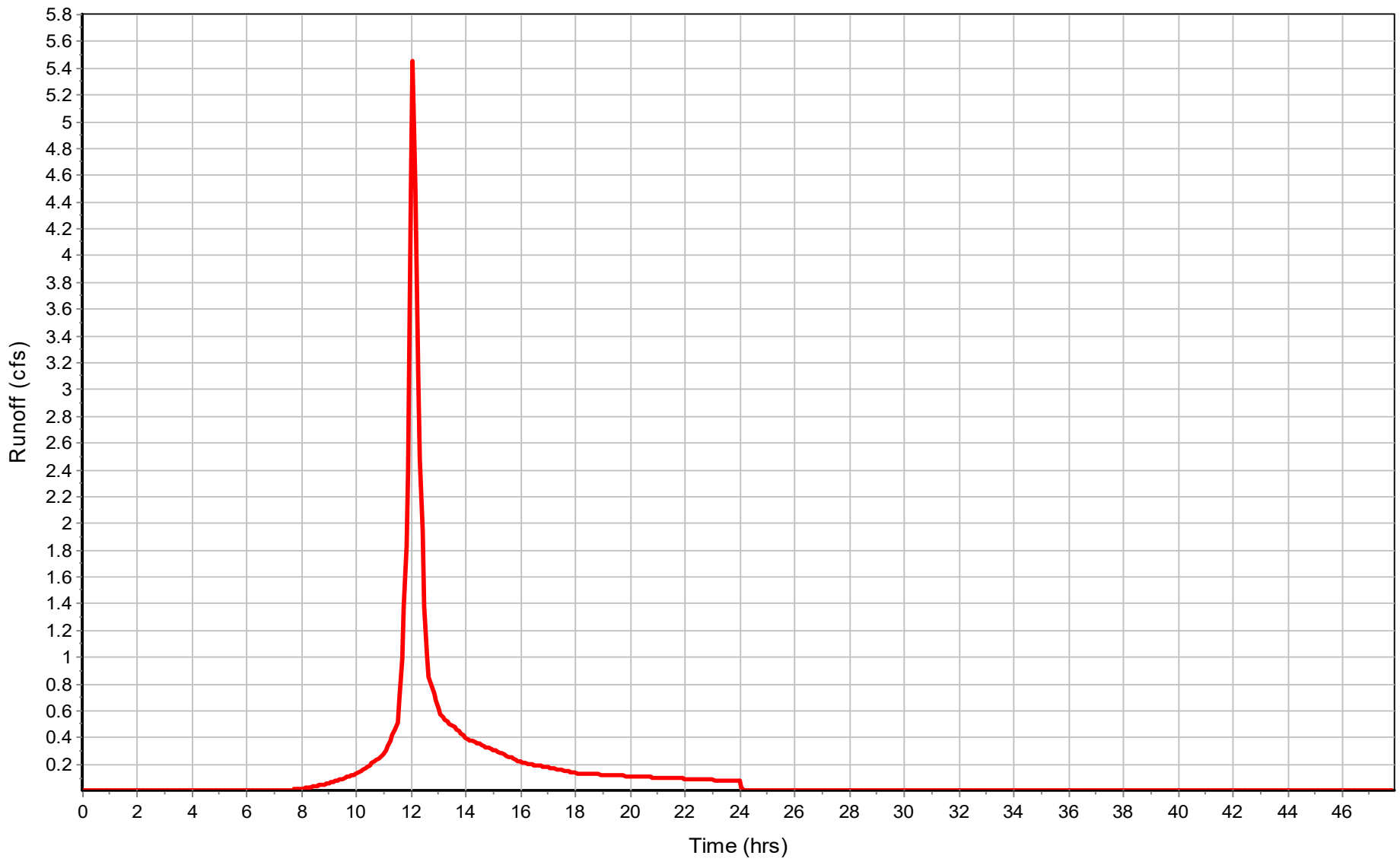
Total Rainfall (in)	8.8
Total Runoff (in)	5.14
Peak Runoff (cfs)	5.57
Weighted Curve Number	69.85
Time of Concentration (days hh:mm:ss)	0 00:03:16

Subbasin : Sub-A3

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E03.3

Input Data

Area (ac) 0.35
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.35	A	43
Composite Area & Weighted CN	0.35		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	180.27	0	0
Slope (%) :	25	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.14	0	0
Computed Flow Time (min) :	21.1	0	0

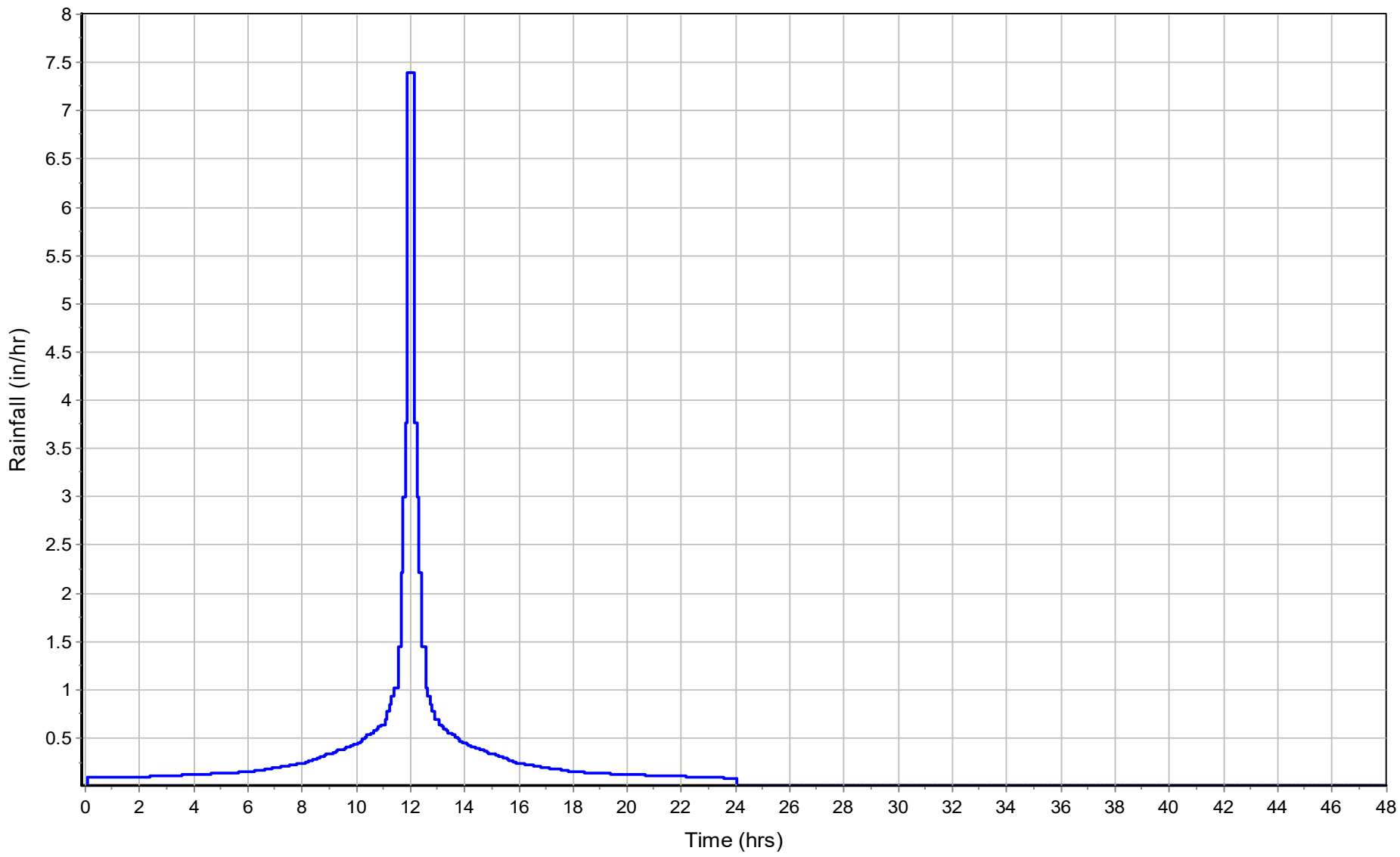
Total TOC (min) 21.10

Subbasin Runoff Results

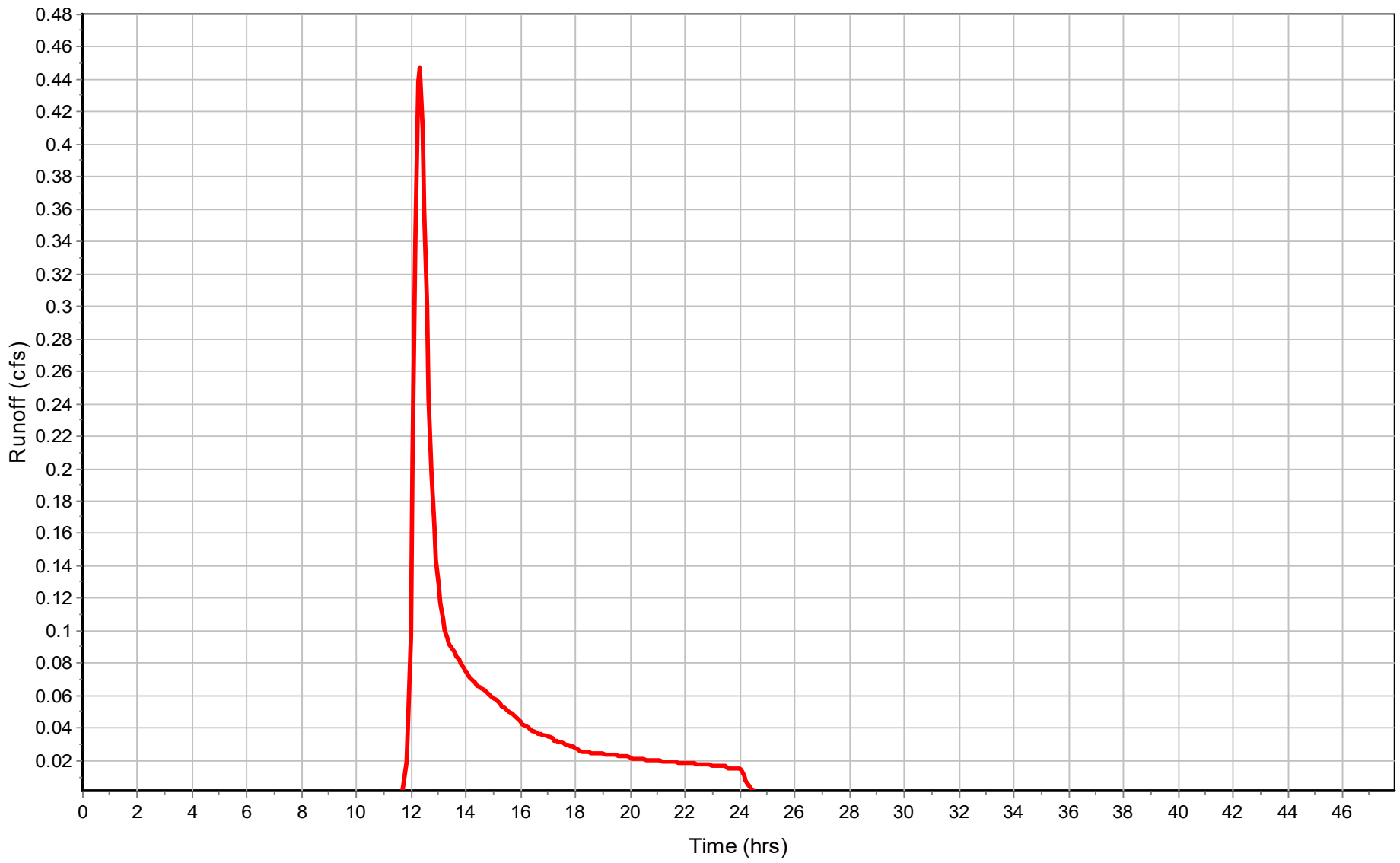
Total Rainfall (in) 8.8
Total Runoff (in) 1.95
Peak Runoff (cfs) 0.45
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:21:06

Subbasin : Sub-E03.3

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A3

Input Data

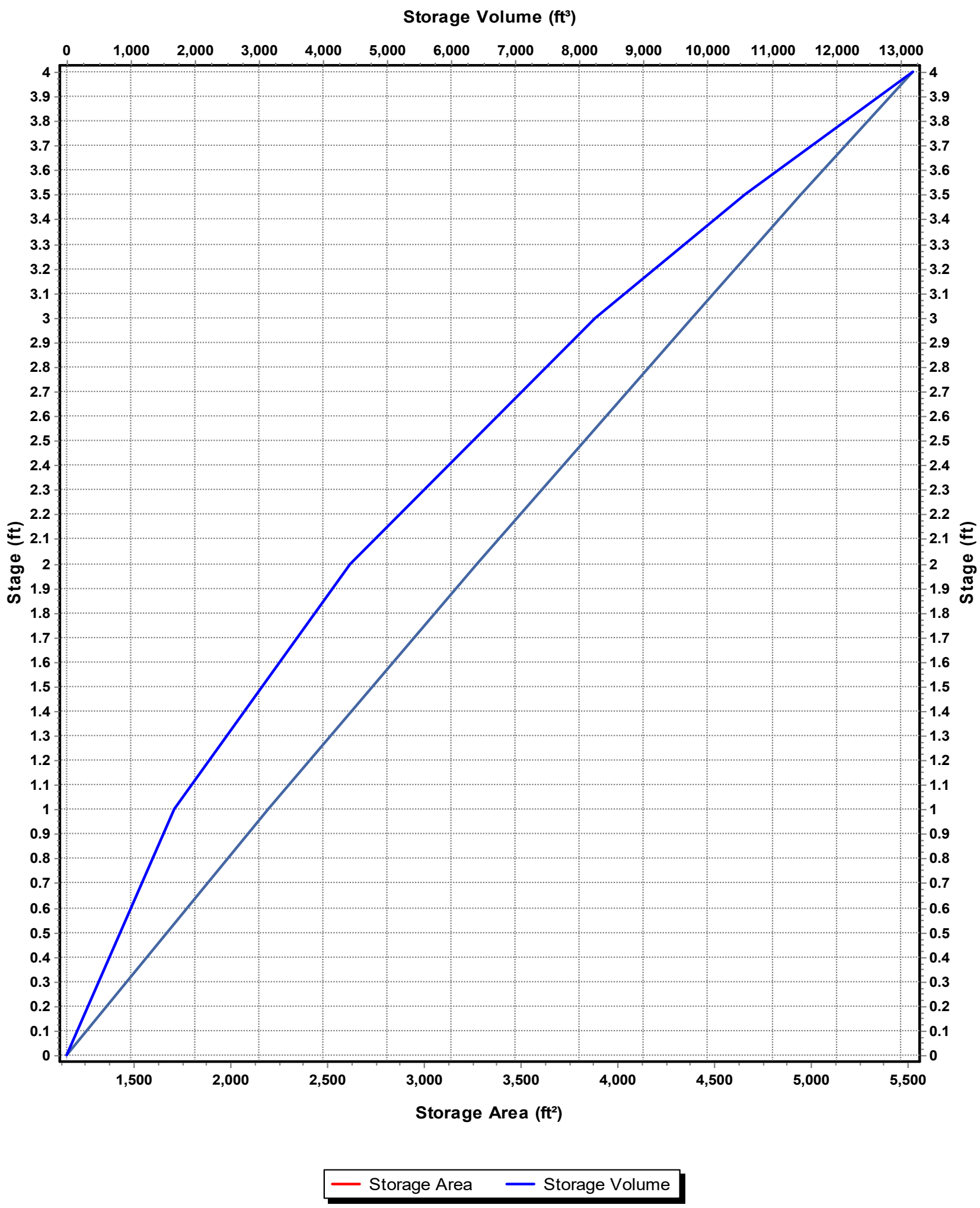
Invert Elevation (ft)	113.50
Max (Rim) Elevation (ft)	117.50
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	113.50
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Basin-03

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	1157.27	0
1	2197.59	1677.43
2	3275.77	4414.11
3	4385.72	8244.86
3.5	4952.65	10579.45
4	5527.59	13199.51

Storage Area Volume Curves



Storage Node : Basin-A3 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-B-A3	Trapezoidal	No	117.23	3.73	3.00	1.00	3.33

Output Summary Results

Peak Inflow (cfs)	5.41
Peak Lateral Inflow (cfs)	0
Peak Outflow (cfs)	0.84
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	117.35
Max HGL Depth Attained (ft)	3.85
Average HGL Elevation Attained (ft)	116.32
Average HGL Depth Attained (ft)	2.82
Time of Max HGL Occurrence (days hh:mm)	0 14:00
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Forebay-A3

Input Data

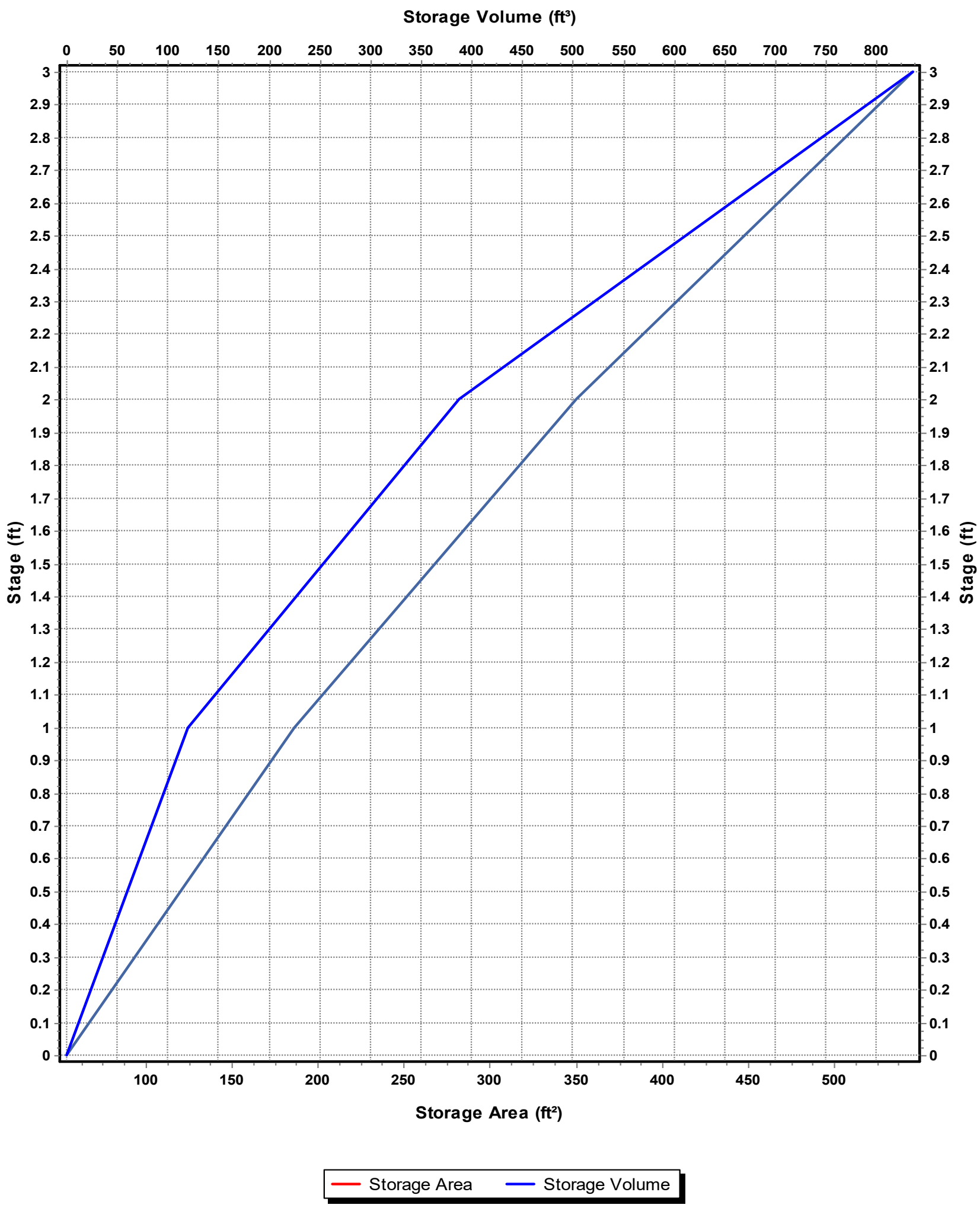
Invert Elevation (ft)	114.50
Max (Rim) Elevation (ft)	117.50
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.50
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Forebay-03

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	54	0
1	186	120
2	350	388
3	546	836

Storage Area Volume Curves



Storage Node : Forebay-A3 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-F-A3	Trapezoidal	No	116.90	2.40	4.00	2.00	3.33

Output Summary Results

Peak Inflow (cfs)	5.45
Peak Lateral Inflow (cfs)	5.45
Peak Outflow (cfs)	5.41
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	117.41
Max HGL Depth Attained (ft)	2.91
Average HGL Elevation Attained (ft)	116.71
Average HGL Depth Attained (ft)	2.21
Time of Max HGL Occurrence (days hh:mm)	0 12:10
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Project Description

File Name	Pave.Paws_A3.SPF

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	SCS TR-20
Time of Concentration (TOC) Method	SCS TR-55
Link Routing Method	Hydrodynamic
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	NO

Analysis Options

Start Analysis On	00:00:00	0:00:00
End Analysis On	00:00:00	0:00:00
Start Reporting On	00:00:00	0:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	3
Nodes	4
Junctions	0
Outfalls	2
Flow Diversions	0
Inlets	0
Storage Nodes	2
Links	2
Channels	0
Pipes	0
Pumps	0
Orifices	0
Weirs	2
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	100 years	Intensity	inches	Massachusetts	None	100.00	7.48	SCS Type III 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	E03.3.1	0.16	484.00	43.00	7.48	1.29	0.20	0.13	0 00:19:16
2	Sub-A3	1.05	484.00	69.85	7.48	4.00	4.22	4.37	0 00:06:00
3	Sub-E03.3	0.35	484.00	43.00	7.48	1.29	0.46	0.27	0 00:21:06

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Out-A3	Outfall	114.00					0.15	114.00					
2	Out-E03.3	Outfall	50.00					0.27	50.00					
3	Basin-A3	Storage Node	113.50	117.50	113.50		0.00	4.22	117.29				0.00	0.00
4	Forebay-A3	Storage Node	114.50	117.50	114.50		0.00	4.25	117.34				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(ft)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
1	Weir-B-A3	Weir	Basin-A3	Out-A3		113.50	114.00				0.14							
2	Weir-F-A3	Weir	Forebay-A3	Basin-A3		114.50	113.50				4.22							

Subbasin Hydrology

Subbasin : E03.3.1

Input Data

Area (ac)	0.16
Peak Rate Factor	484
Weighted Curve Number	43
Rain Gage ID	Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.16	A	43
Composite Area & Weighted CN	0.16		43

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft^2)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	160.97	0	0
Slope (%) :	25	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.14	0	0
Computed Flow Time (min) :	19.27	0	0

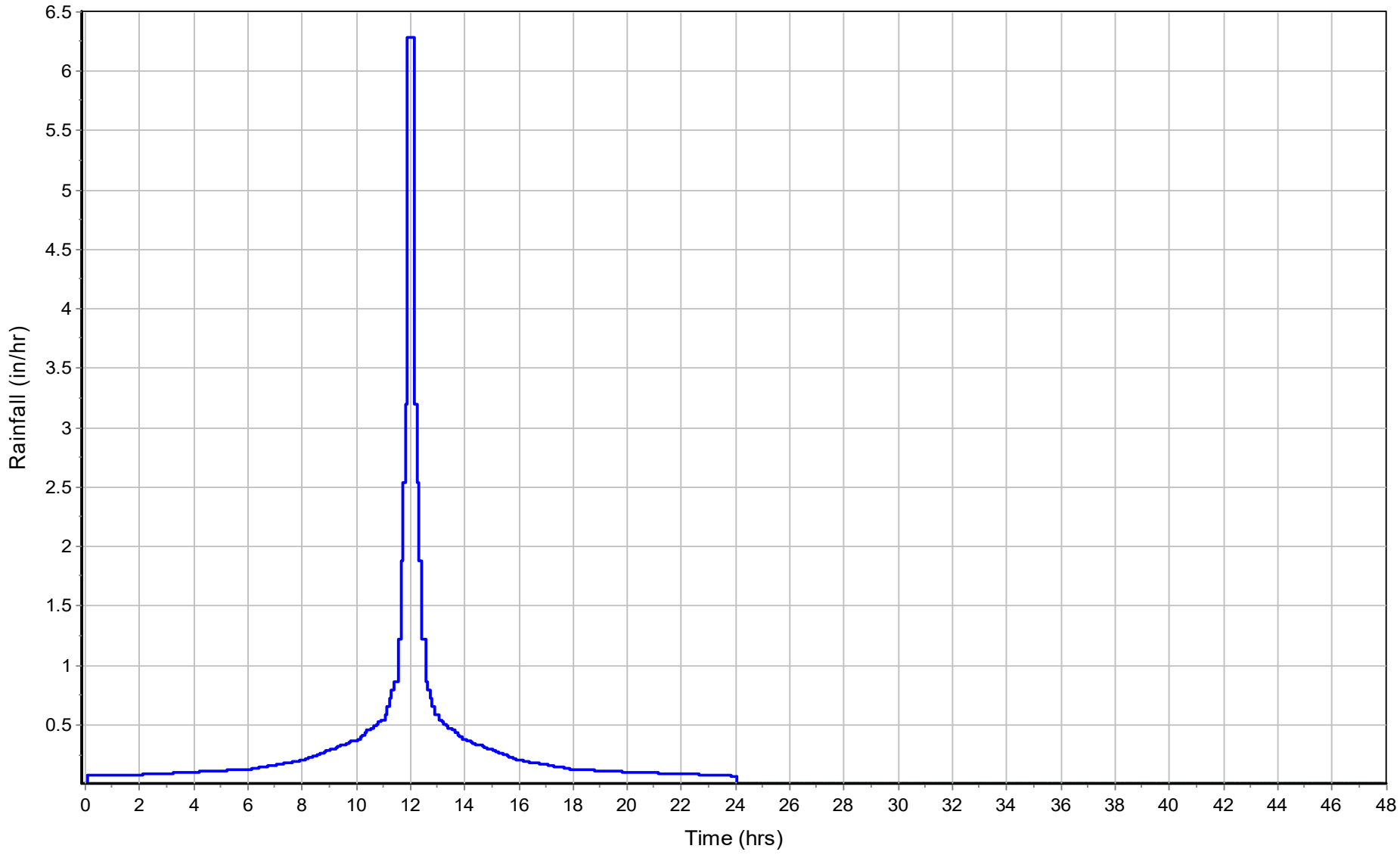
Total TOC (min) 19.27

Subbasin Runoff Results

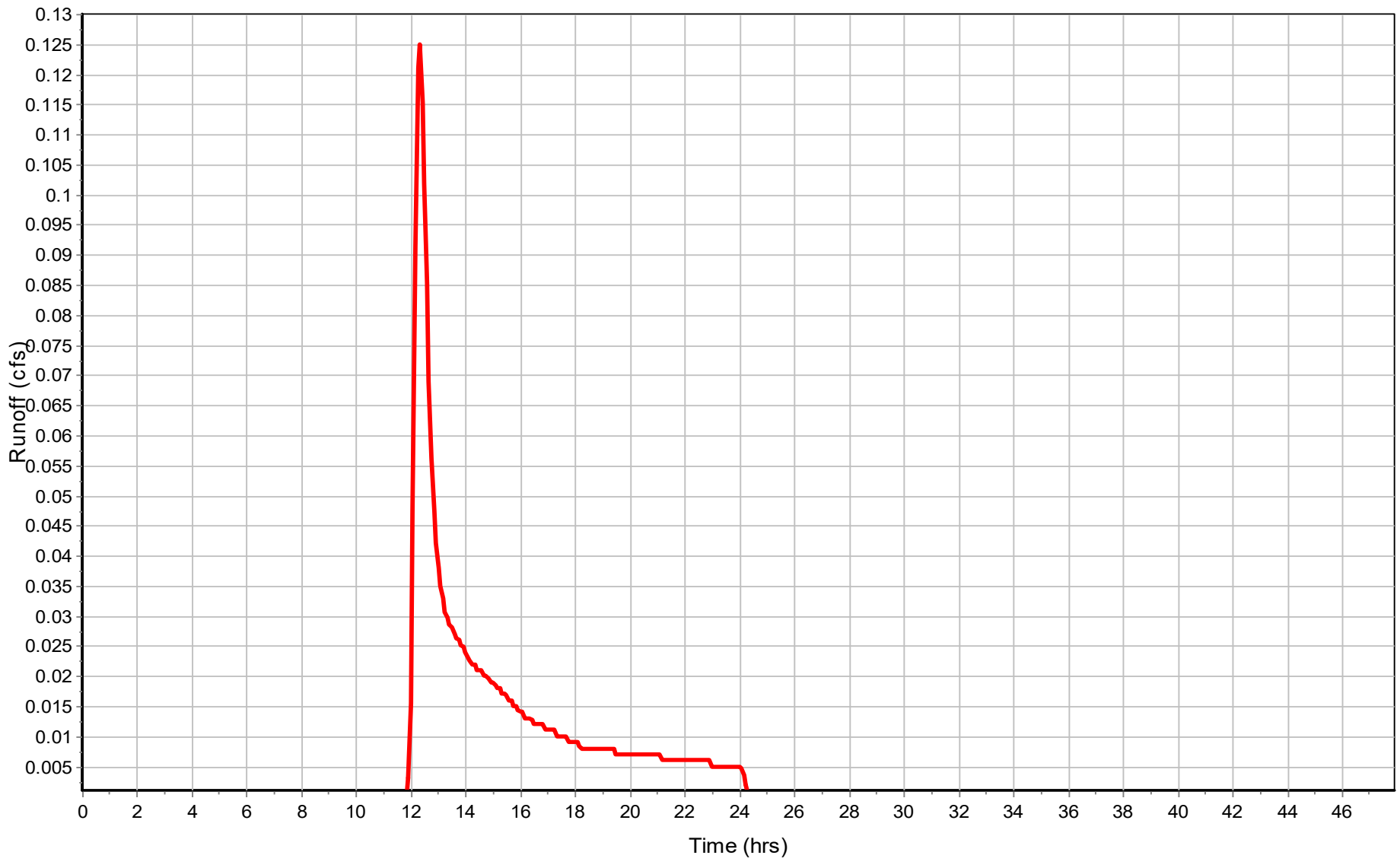
Total Rainfall (in)	7.48
Total Runoff (in)	1.29
Peak Runoff (cfs)	0.13
Weighted Curve Number	43
Time of Concentration (days hh:mm:ss)	0 00:19:16

Subbasin : E03.3.1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-A3

Input Data

Area (ac)	1.05
Peak Rate Factor	484
Weighted Curve Number	69.85
Rain Gage ID	Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	0.88	A	76
Woods & grass combination, Fair	0.2	A	43
Composite Area & Weighted CN	1.08		69.85

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	25.24	0	0
Slope (%) :	0.5	0	0
2 yr, 24 hr Rainfall (in) :	3002	0	0
Velocity (ft/sec) :	0.48	0	0
Computed Flow Time (min) :	0.87	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	238.39	0	0
Channel Slope (%) :	0.3	0	0
Cross Section Area (ft^2) :	3	0	0
Wetted Perimeter (ft) :	6.32	0	0
Velocity (ft/sec) :	1.66	0	0
Computed Flow Time (min) :	2.4	0	0

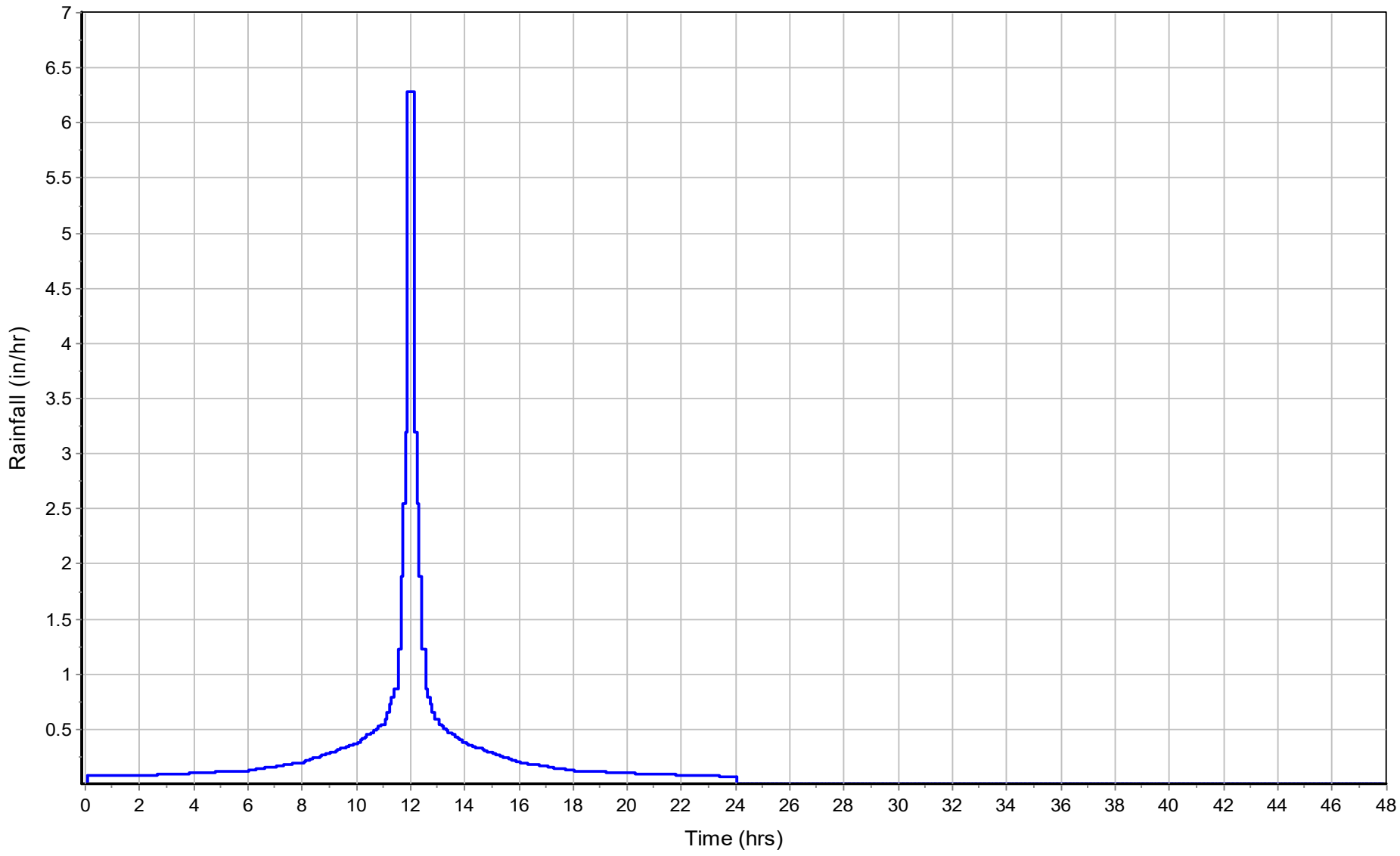
Total TOC (min) 3.27

Subbasin Runoff Results

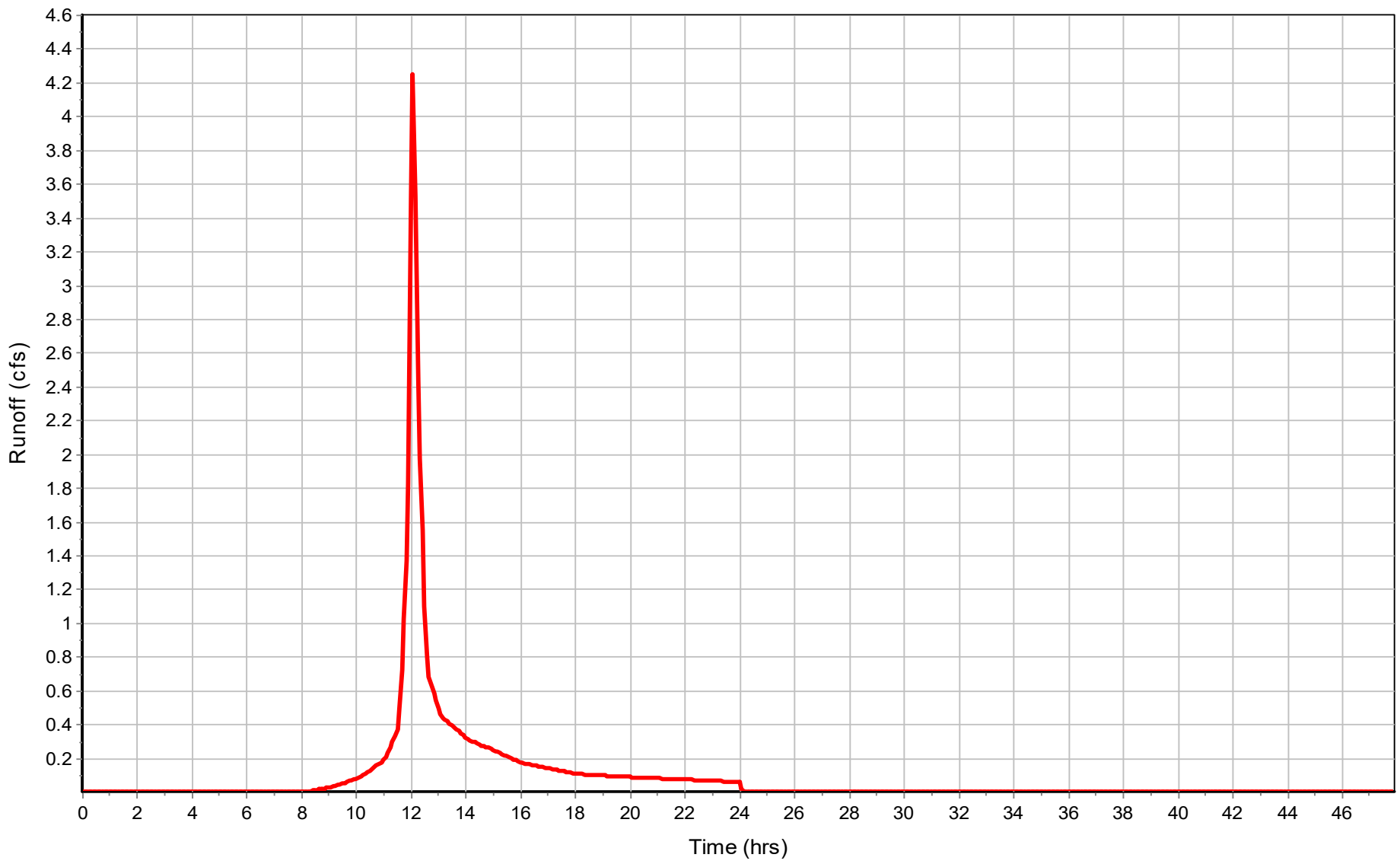
Total Rainfall (in)	7.48
Total Runoff (in)	4
Peak Runoff (cfs)	4.37
Weighted Curve Number	69.85
Time of Concentration (days hh:mm:ss)	0 00:03:16

Subbasin : Sub-A3

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E03.3

Input Data

Area (ac) 0.35
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.35	A	43
Composite Area & Weighted CN	0.35		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	180.27	0	0
Slope (%) :	25	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.14	0	0
Computed Flow Time (min) :	21.1	0	0

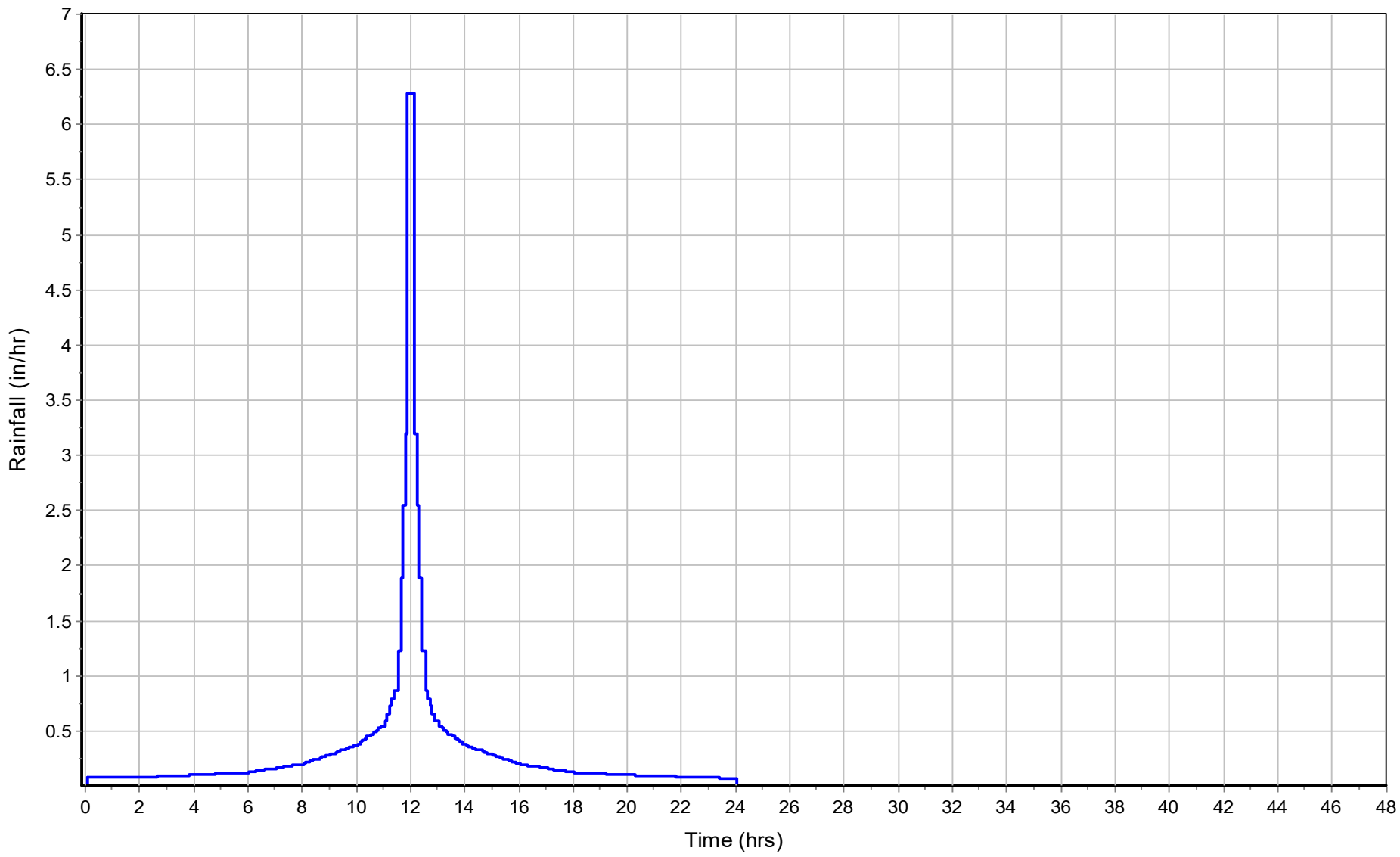
Total TOC (min) 21.10

Subbasin Runoff Results

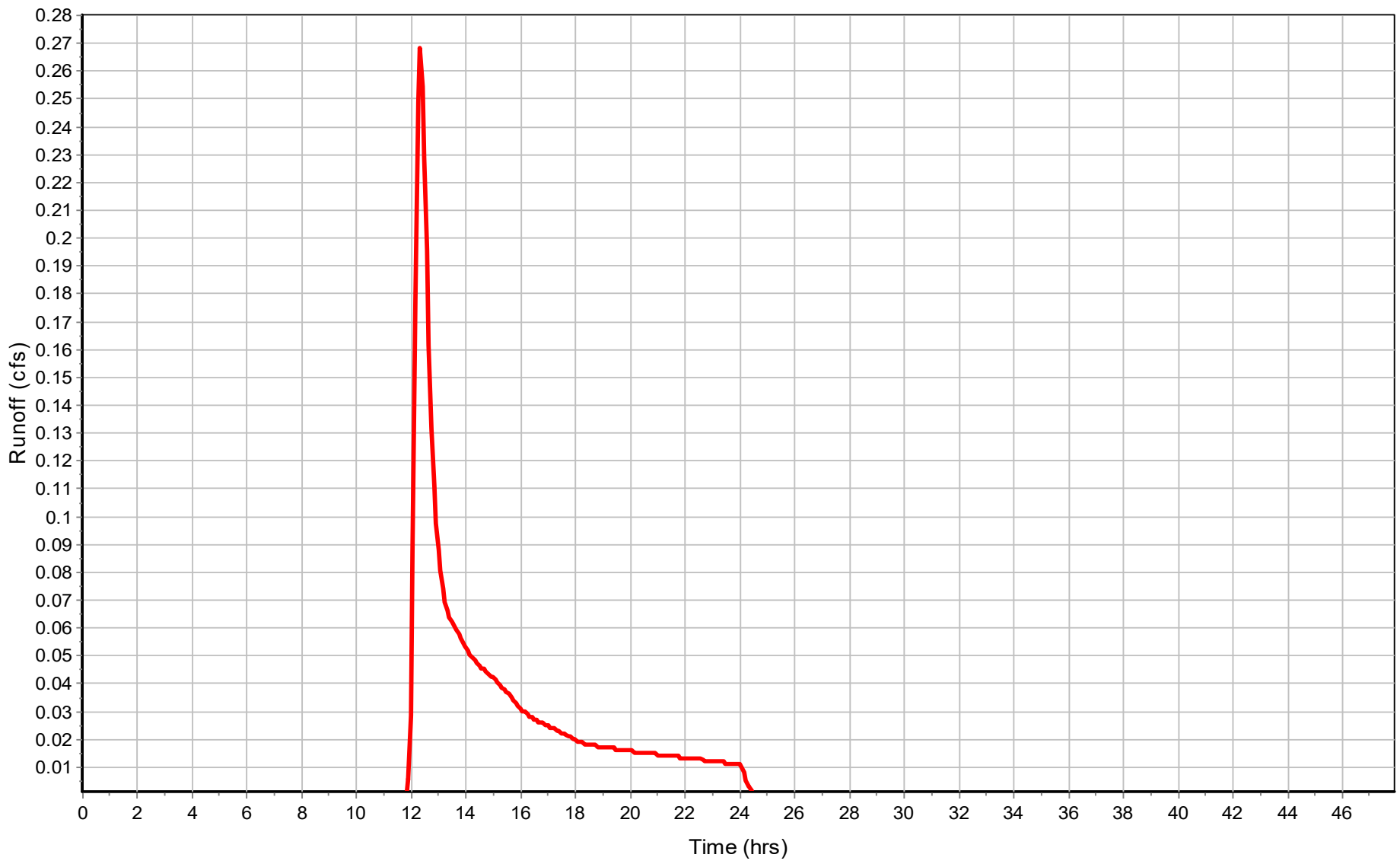
Total Rainfall (in) 7.48
Total Runoff (in) 1.29
Peak Runoff (cfs) 0.27
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:21:06

Subbasin : Sub-E03.3

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A3

Input Data

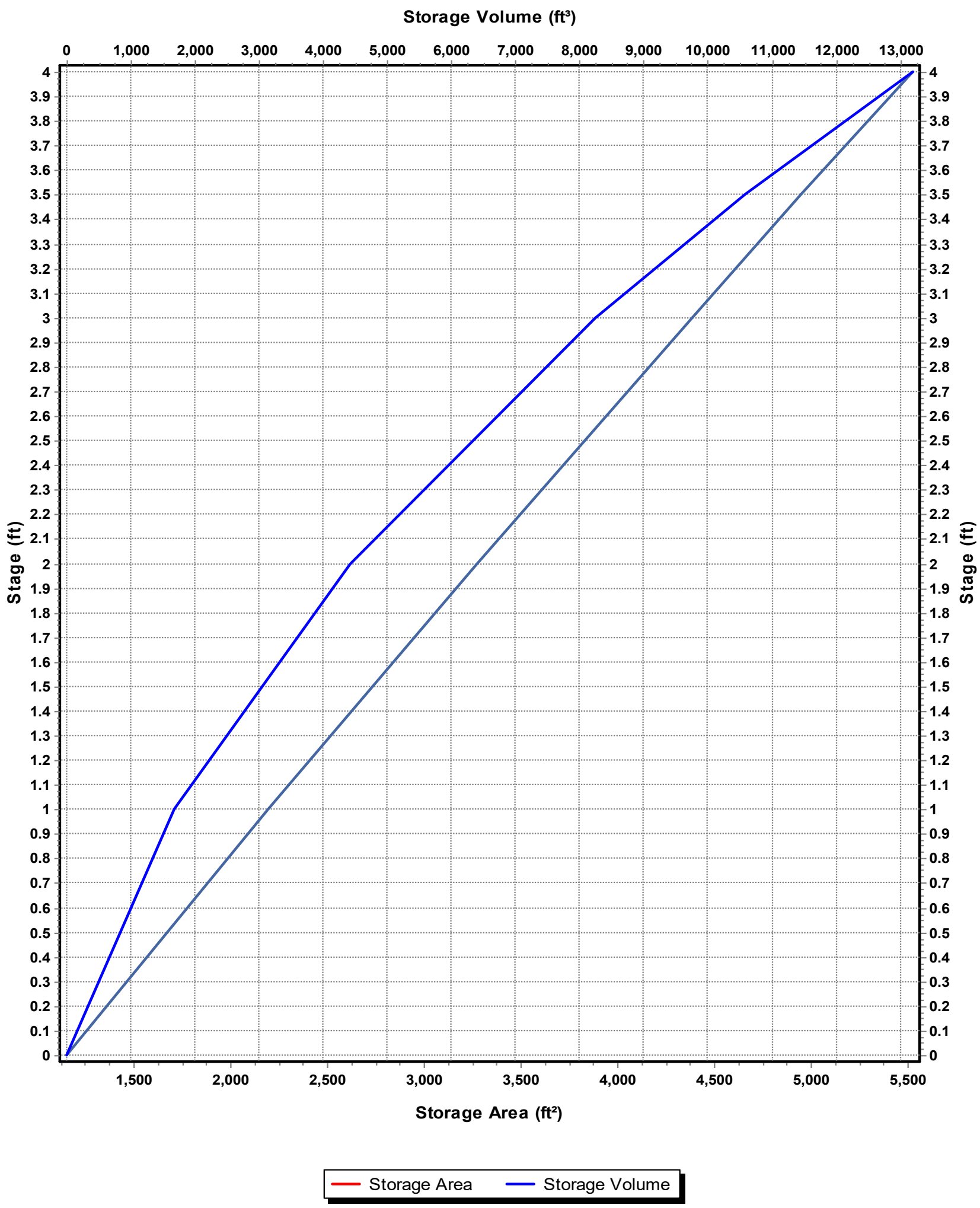
Invert Elevation (ft)	113.50
Max (Rim) Elevation (ft)	117.50
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	113.50
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Basin-03

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	1157.27	0
1	2197.59	1677.43
2	3275.77	4414.11
3	4385.72	8244.86
3.5	4952.65	10579.45
4	5527.59	13199.51

Storage Area Volume Curves



Storage Node : Basin-A3 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-B-A3	Trapezoidal	No	117.23	3.73	3.00	1.00	3.33

Output Summary Results

Peak Inflow (cfs)	4.22
Peak Lateral Inflow (cfs)	0
Peak Outflow (cfs)	0.55
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	117.29
Max HGL Depth Attained (ft)	3.79
Average HGL Elevation Attained (ft)	116.27
Average HGL Depth Attained (ft)	2.77
Time of Max HGL Occurrence (days hh:mm)	0 17:22
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Forebay-A3

Input Data

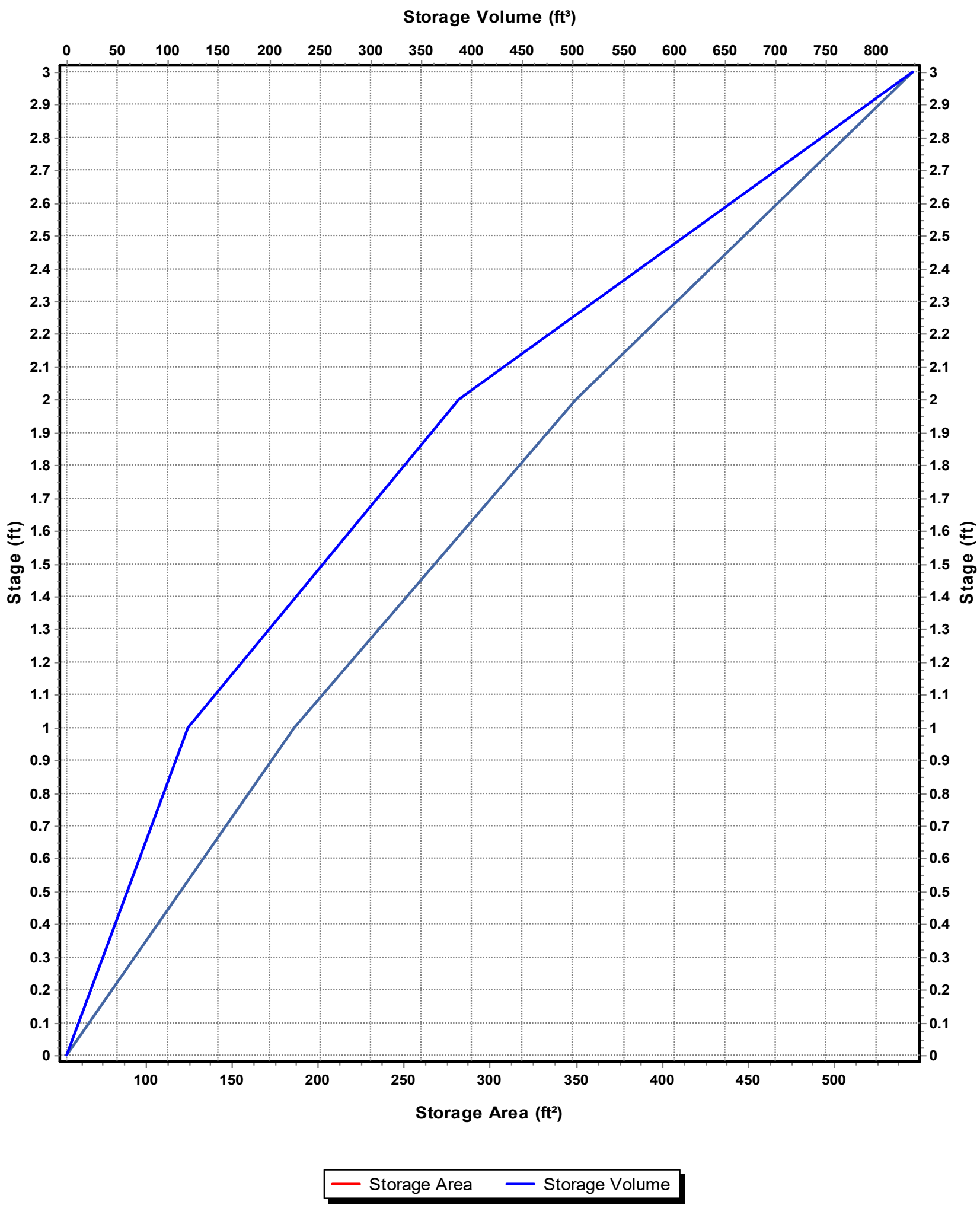
Invert Elevation (ft)	114.50
Max (Rim) Elevation (ft)	117.50
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.50
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Forebay-03

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	54	0
1	186	120
2	350	388
3	546	836

Storage Area Volume Curves



Storage Node : Forebay-A3 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-F-A3	Trapezoidal	No	116.90	2.40	4.00	2.00	3.33

Output Summary Results

Peak Inflow (cfs)	4.25
Peak Lateral Inflow (cfs)	4.25
Peak Outflow (cfs)	4.22
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	117.34
Max HGL Depth Attained (ft)	2.84
Average HGL Elevation Attained (ft)	116.66
Average HGL Depth Attained (ft)	2.16
Time of Max HGL Occurrence (days hh:mm)	0 12:10
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

SSA Analysis – Drainage Area A4 – Existing and Proposed

Project Description

File Name	Pave.Paws_A4.SPF

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	SCS TR-20
Time of Concentration (TOC) Method	SCS TR-55
Link Routing Method	Hydrodynamic
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	NO

Analysis Options

Start Analysis On	00:00:00	0:00:00
End Analysis On	00:00:00	0:00:00
Start Reporting On	00:00:00	0:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	4
Nodes	4
Junctions	0
Outfalls	2
Flow Diversions	0
Inlets	0
Storage Nodes	2
Links	2
Channels	0
Pipes	0
Pumps	0
Orifices	0
Weirs	2
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	2 years	Intensity	inches	Massachusetts	None	2.00	3.02	SCS Type III 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Sub-A4	0.22	484.00	76.00	3.42	1.31	0.29	0.30	0 00:06:00
2	Sub-E03.2	0.51	484.00	43.00	3.42	0.04	0.02	0.00	0 00:22:12
3	Sub-E03.2.1	0.38	484.00	43.00	3.42	0.04	0.02	0.00	0 00:18:17
4	Sub-E04	0.19	484.00	43.00	3.42	0.00	0.00	0.00	0 00:15:05

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Out-A4	Outfall	106.00					0.00	106.00					
2	Out-E03.2	Outfall	0.00					0.00	0.00					
3	Basin-A4	Storage Node	114.00	117.00	114.00		0.00	0.01	114.51				0.00	0.00
4	Forebay-A4	Storage Node	114.00	117.00	114.00		0.00	0.29	116.50				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(ft)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
1	Weir-B-A4	Weir	Basin-A4	Out-A4		114.00	106.00				0.00							
2	Weir-F-04	Weir	Forebay-A4	Basin-A4		114.00	114.00				0.01							

Subbasin Hydrology

Subbasin : Sub-A4

Input Data

Area (ac) 0.22
Peak Rate Factor 484
Weighted Curve Number 76
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	0.22	A	76
Composite Area & Weighted CN	0.22		76

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft^2)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	110.17	0	0
Slope (%) :	1	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.86	0	0
Computed Flow Time (min) :	2.14	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	76.5	0	0
Channel Slope (%) :	1.13	0	0
Cross Section Area (ft^2) :	2.43	0	0
Wetted Perimeter (ft) :	5.69	0	0
Velocity (ft/sec) :	2.99	0	0
Computed Flow Time (min) :	0.43	0	0

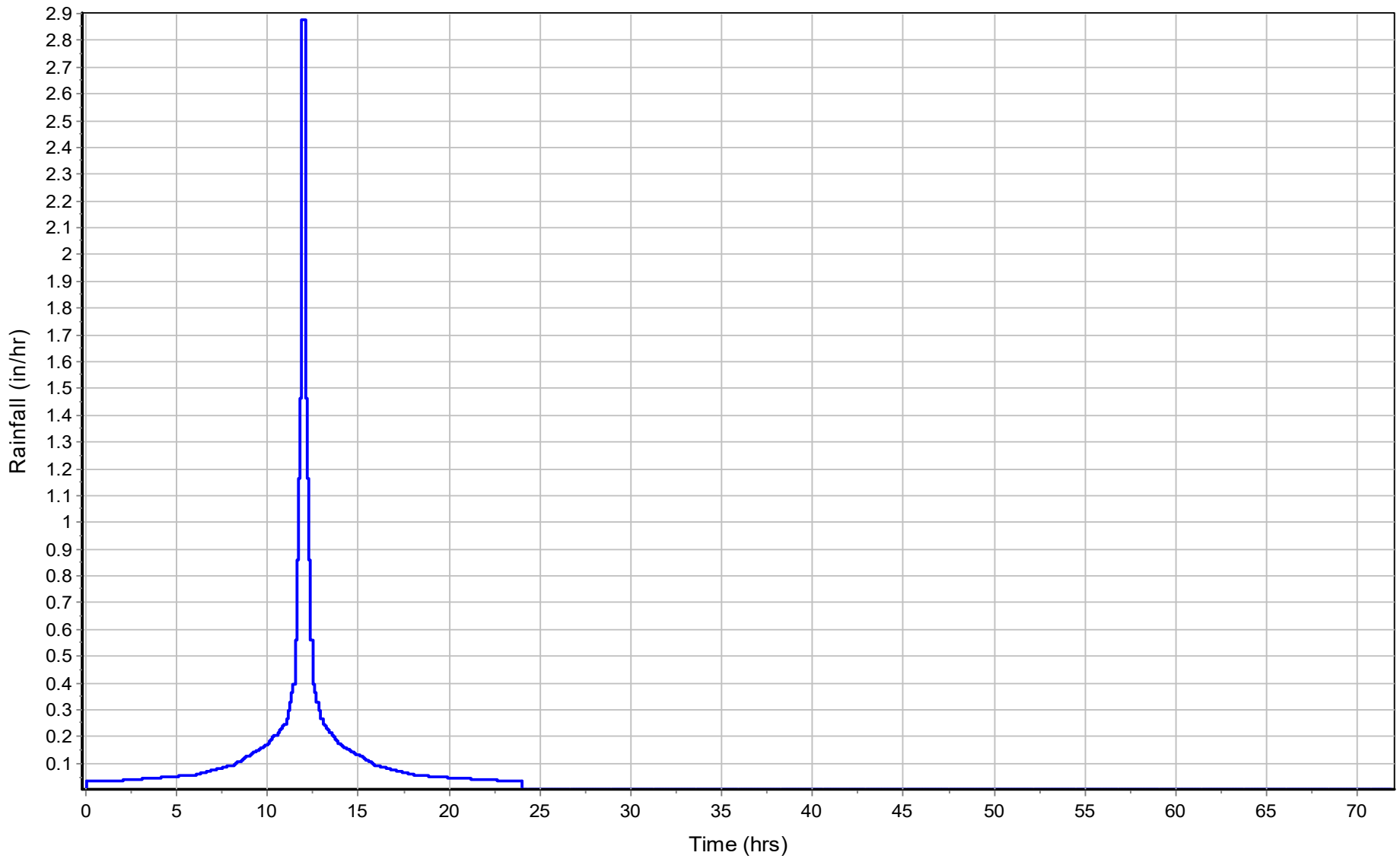
Total TOC (min) 2.57

Subbasin Runoff Results

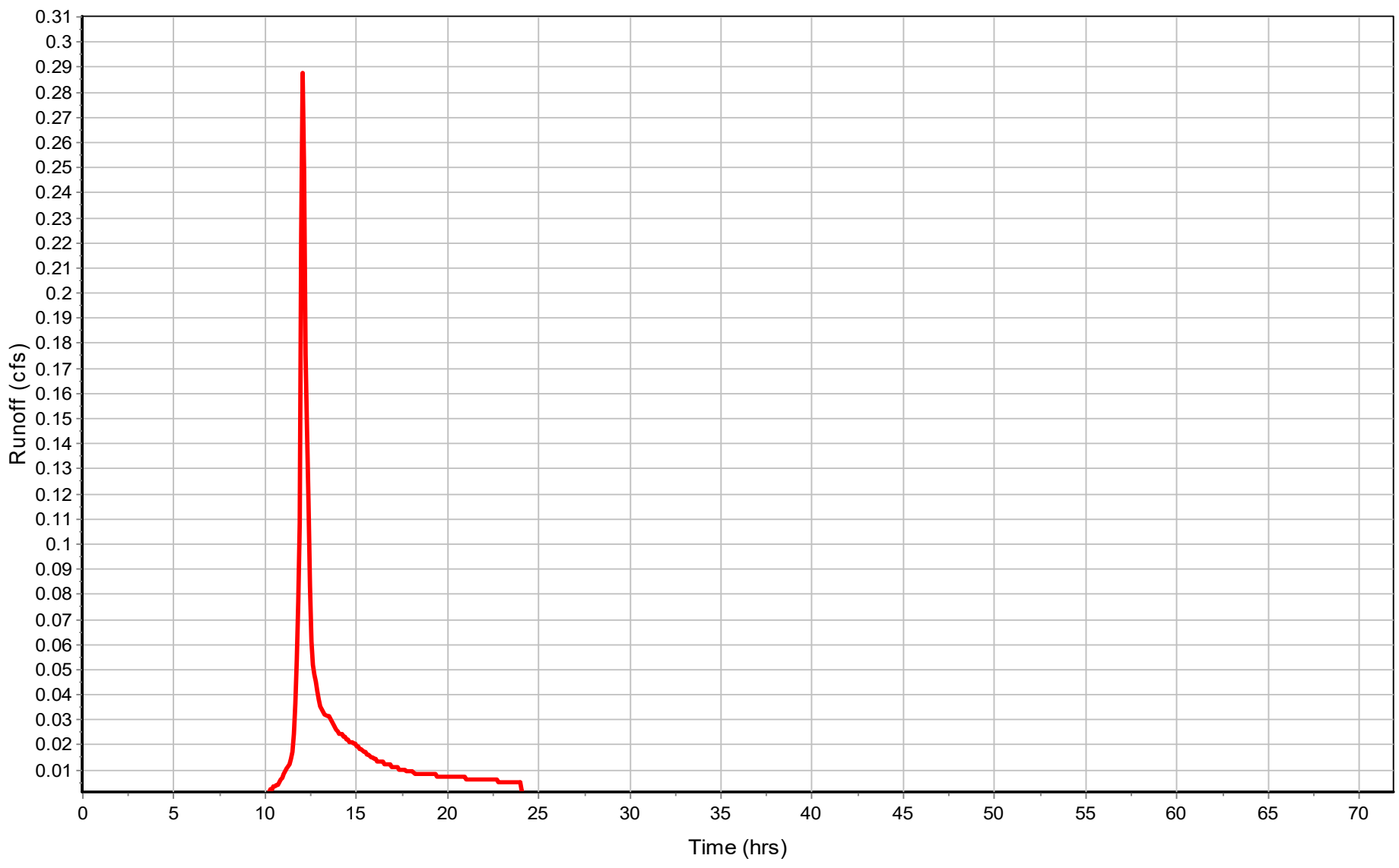
Total Rainfall (in)	3.42
Total Runoff (in)	1.31
Peak Runoff (cfs)	0.3
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:02:34

Subbasin : Sub-A4

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E03.2

Input Data

Area (ac) 0.51
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.51	A	43
Composite Area & Weighted CN	0.51		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	143.83	0	0
Slope (%) :	14	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.11	0	0
Computed Flow Time (min) :	22.21	0	0

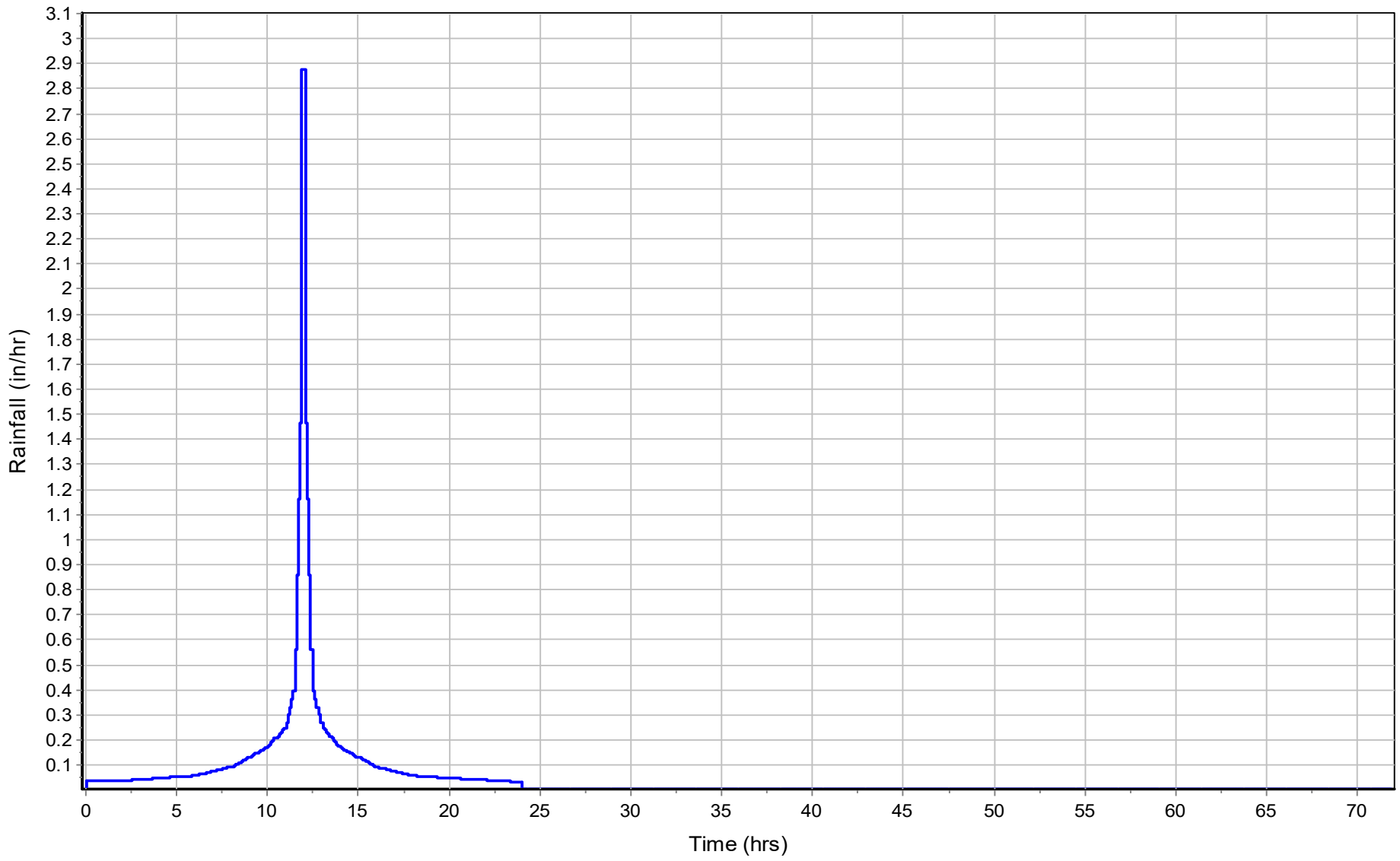
Total TOC (min) 22.21

Subbasin Runoff Results

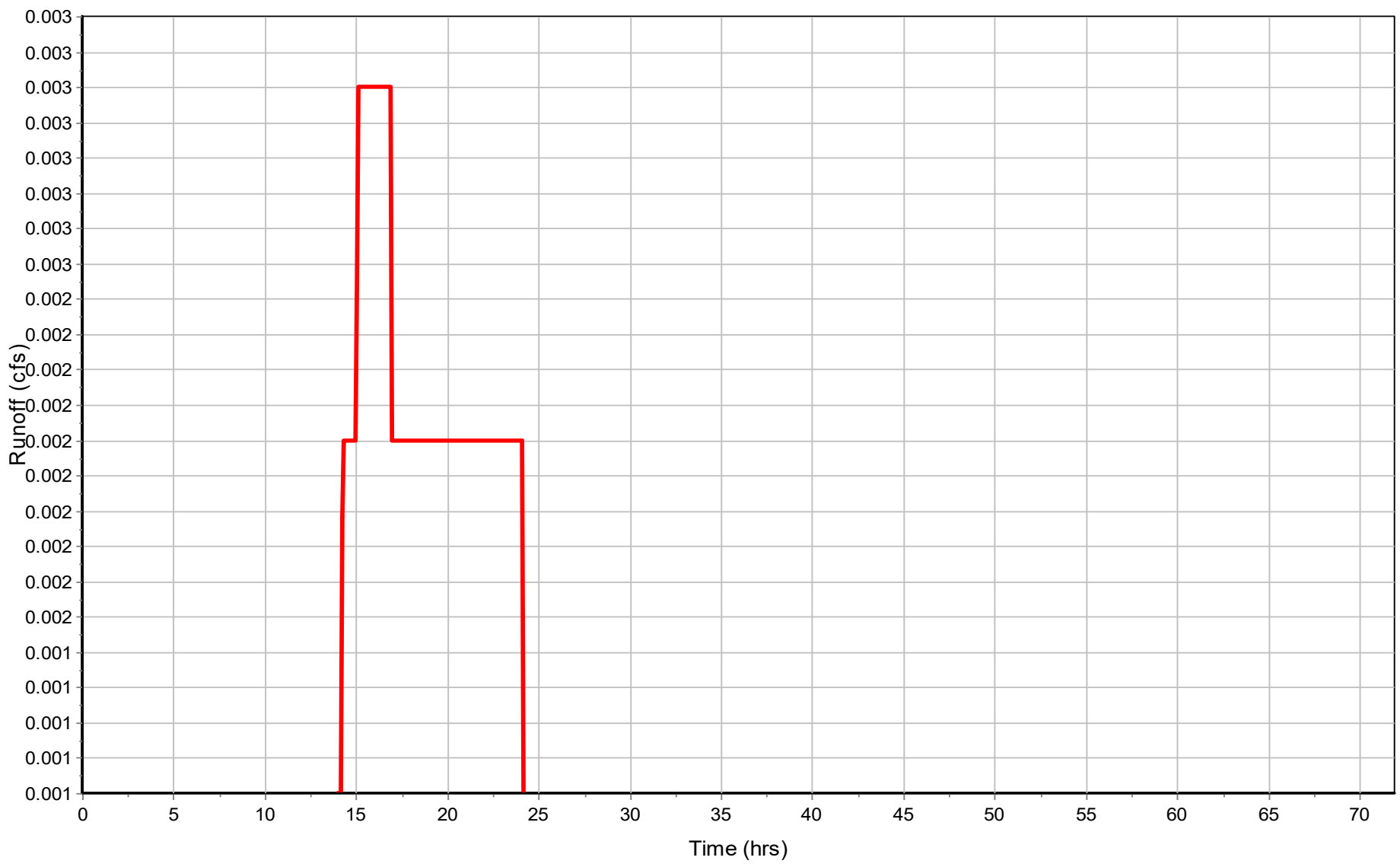
Total Rainfall (in) 3.42
Total Runoff (in) 0.04
Peak Runoff (cfs) 0
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:22:13

Subbasin : Sub-E03.2

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E03.2.1

Input Data

Area (ac) 0.38
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.38	A	43
Composite Area & Weighted CN	0.38		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	116.8	0	0
Slope (%) :	15	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.11	0	0
Computed Flow Time (min) :	18.29	0	0

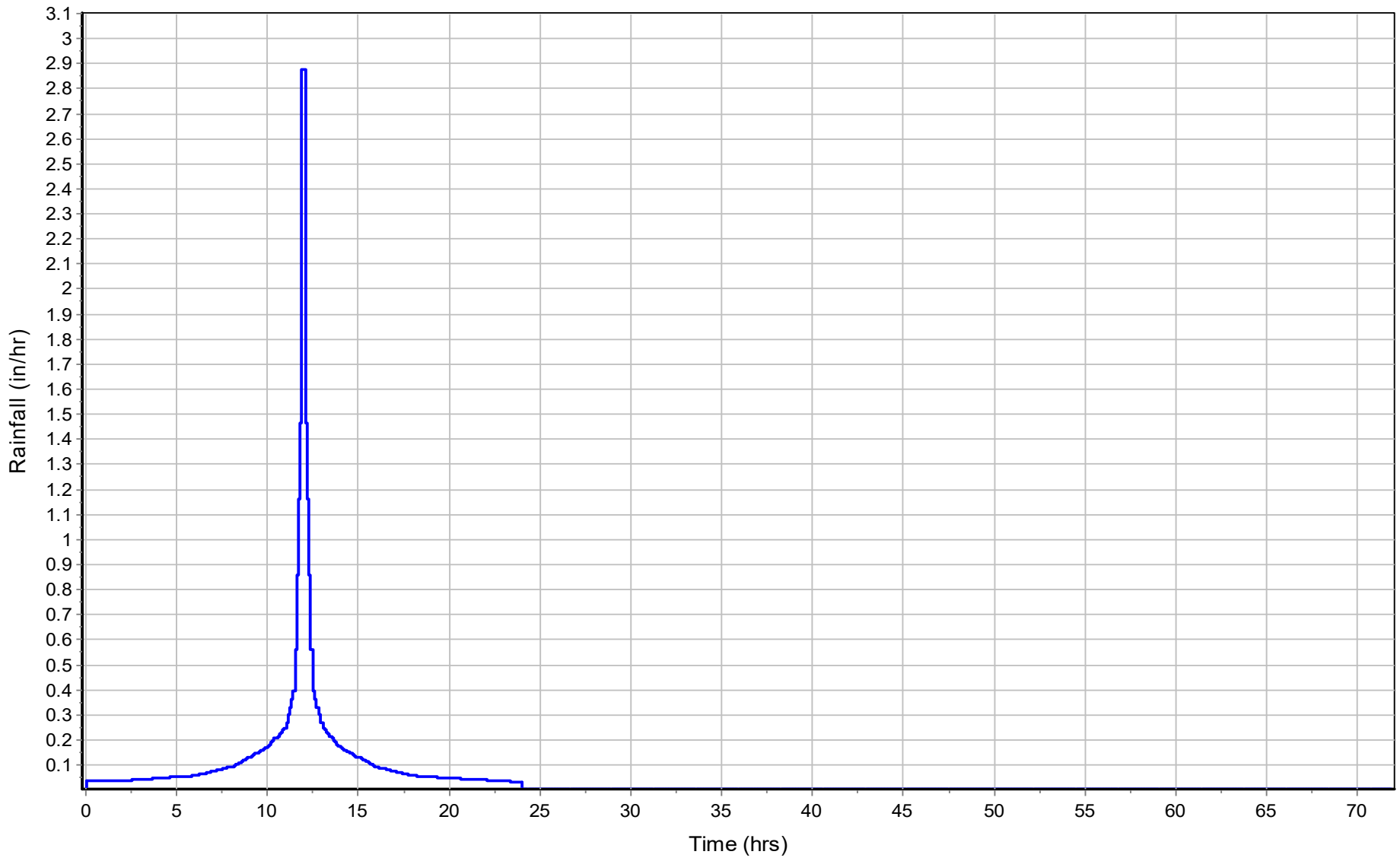
Total TOC (min) 18.29

Subbasin Runoff Results

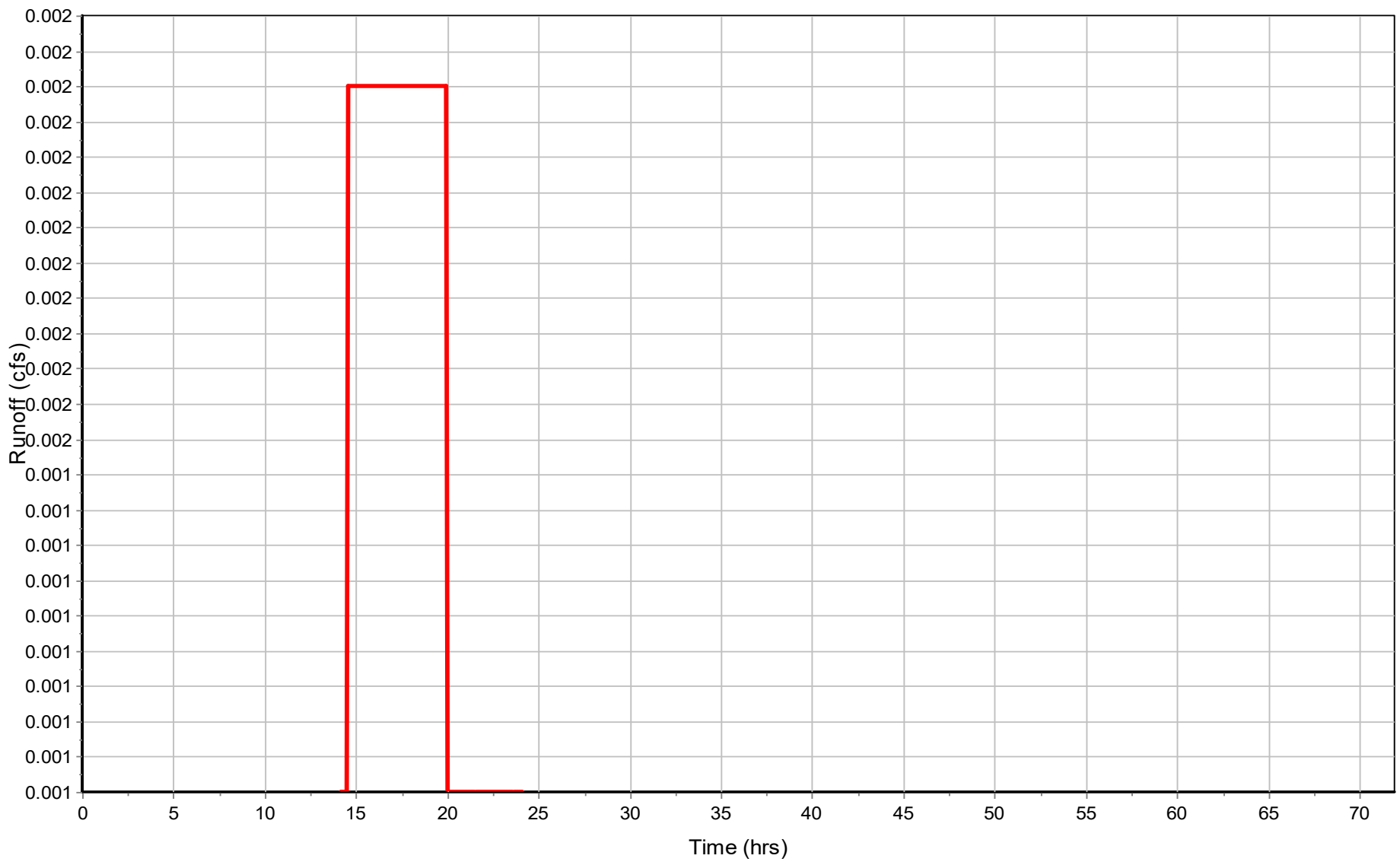
Total Rainfall (in) 3.42
Total Runoff (in) 0.04
Peak Runoff (cfs) 0
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:18:17

Subbasin : Sub-E03.2.1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E04

Input Data

Area (ac) 0.19
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.19	A	43
Composite Area & Weighted CN	0.19		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	88.76	0	0
Slope (%) :	14	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.1	0	0
Computed Flow Time (min) :	15.09	0	0

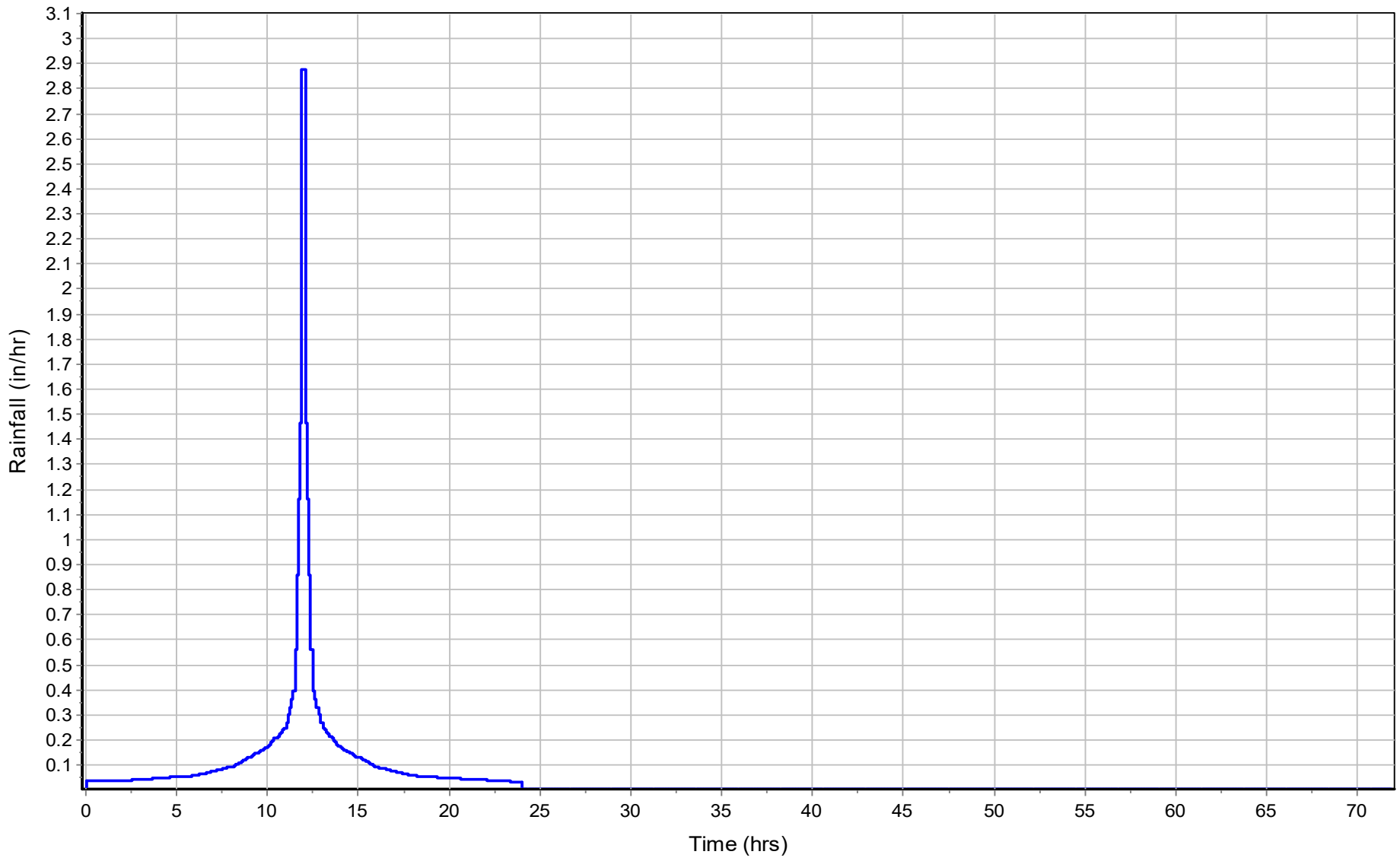
Total TOC (min) 15.09

Subbasin Runoff Results

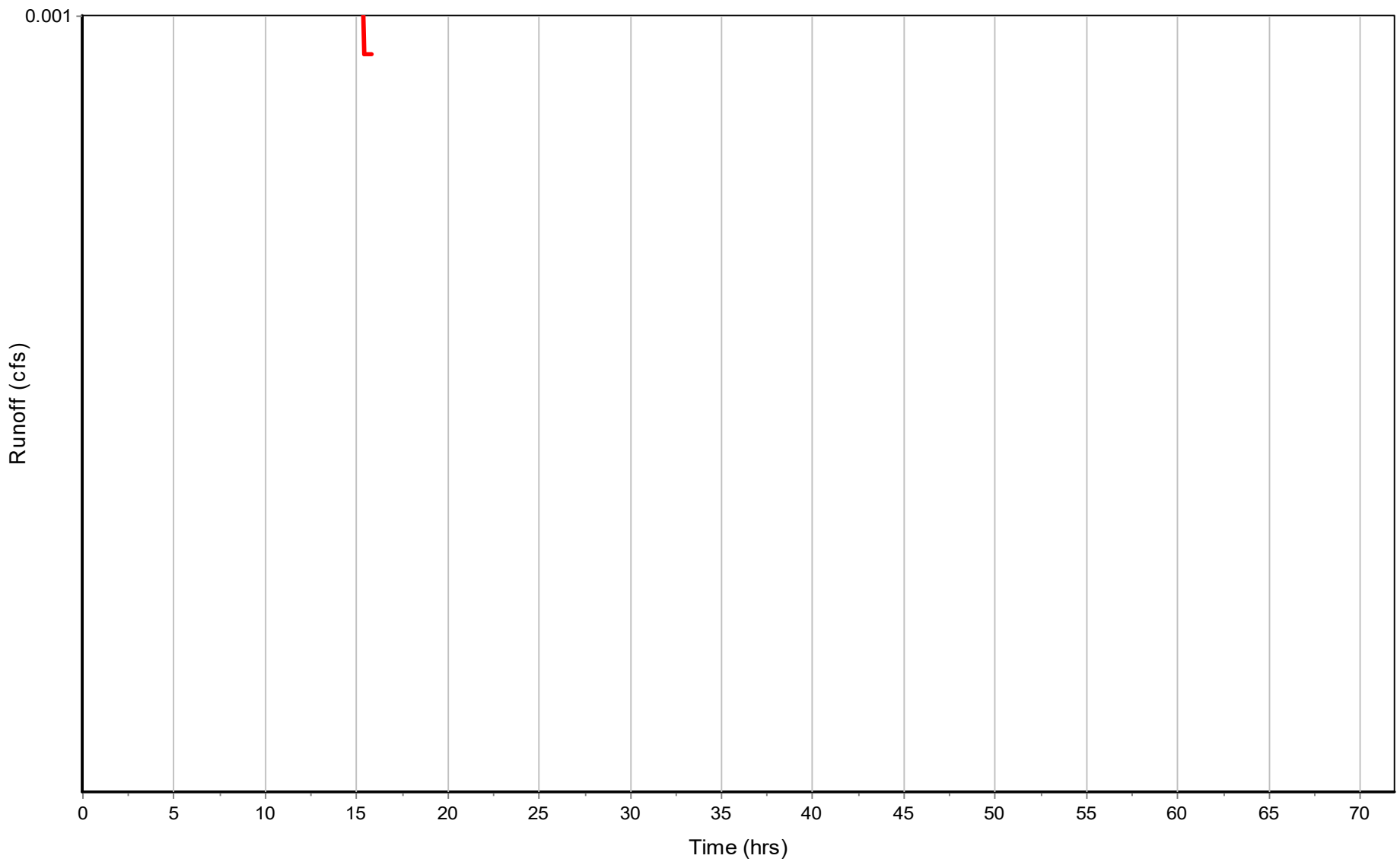
Total Rainfall (in) 3.42
Total Runoff (in) 0
Peak Runoff (cfs) 0
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:15:05

Subbasin : Sub-E04

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A4

Input Data

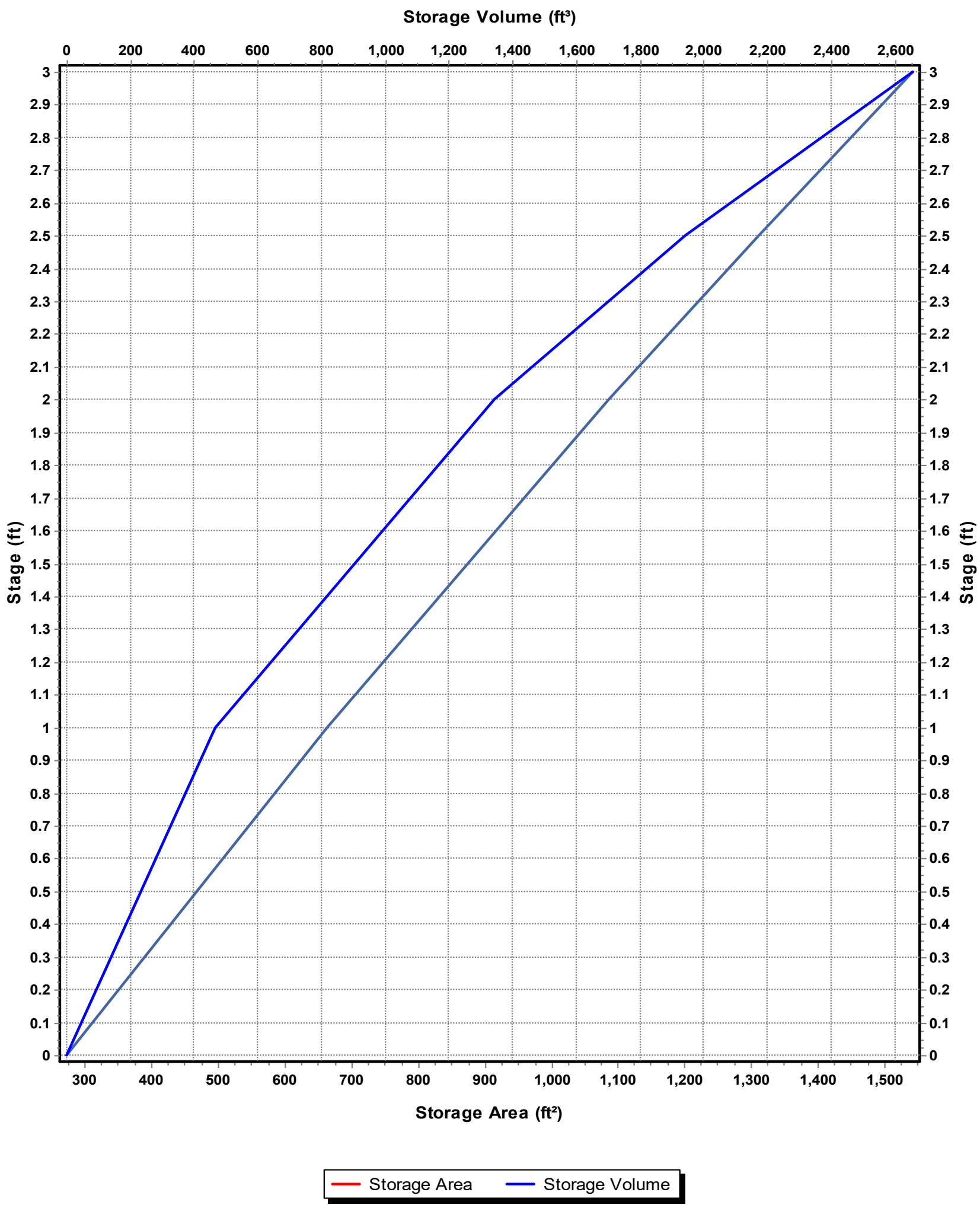
Invert Elevation (ft)	114.00
Max (Rim) Elevation (ft)	117.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.00
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Basin-04

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	272.59	0
1	664.04	468.32
2	1087.5	1344.09
2.5	1311.22	1943.77
3	1542.95	2657.31

Storage Area Volume Curves



Storage Node : Basin-A4 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-B-A4	Trapezoidal	No	116.80	2.80	10.00	0.20	3.33

Output Summary Results

Peak Inflow (cfs)	0.01
Peak Lateral Inflow (cfs)	0
Peak Outflow (cfs)	0
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	114.51
Max HGL Depth Attained (ft)	0.51
Average HGL Elevation Attained (ft)	114.37
Average HGL Depth Attained (ft)	0.37
Time of Max HGL Occurrence (days hh:mm)	1 00:55
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Forebay-A4

Input Data

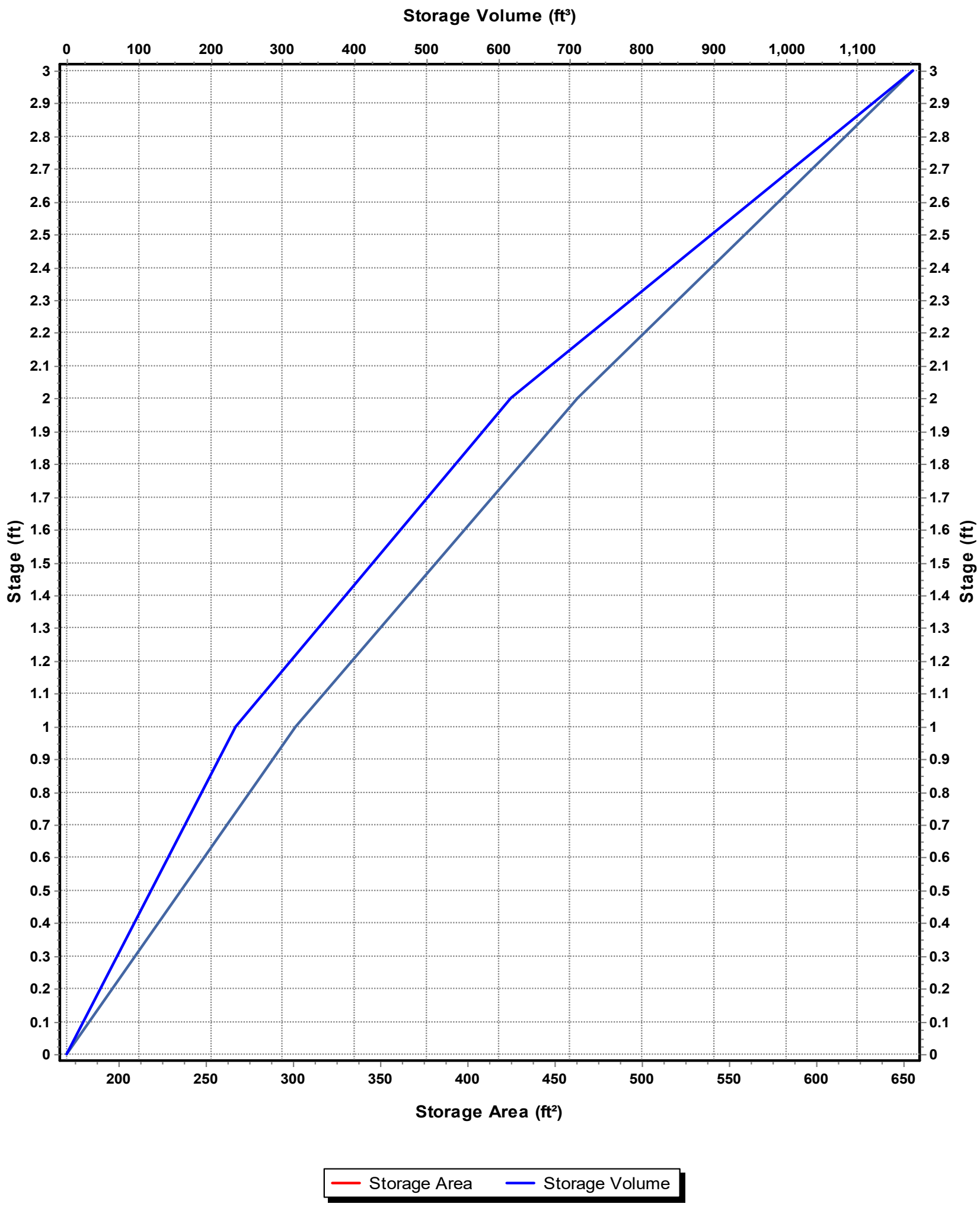
Invert Elevation (ft)	114.00
Max (Rim) Elevation (ft)	117.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.00
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Forebay-04

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	170.46	0
1	301.38	235.92
2	462.94	618.08
3	655.13	1177.12

Storage Area Volume Curves



Storage Node : Forebay-A4 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-F-04	Trapezoidal	No	116.50	2.50	10.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	0.29
Peak Lateral Inflow (cfs)	0.29
Peak Outflow (cfs)	0.01
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	116.5
Max HGL Depth Attained (ft)	2.5
Average HGL Elevation Attained (ft)	116.06
Average HGL Depth Attained (ft)	2.06
Time of Max HGL Occurrence (days hh:mm)	0 17:04
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Project Description

File Name	Pave.Paws_A4.SPF

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	SCS TR-20
Time of Concentration (TOC) Method	SCS TR-55
Link Routing Method	Hydrodynamic
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	NO

Analysis Options

Start Analysis On	00:00:00	0:00:00
End Analysis On	00:00:00	0:00:00
Start Reporting On	00:00:00	0:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	4
Nodes	4
Junctions	0
Outfalls	2
Flow Diversions	0
Inlets	0
Storage Nodes	2
Links	2
Channels	0
Pipes	0
Pumps	0
Orifices	0
Weirs	2
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	10 years	Intensity	inches	Massachusetts	None	10.00	4.99	SCS Type III 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Sub-A4	0.22	484.00	76.00	4.99	2.53	0.57	0.59	0 00:06:00
2	Sub-E03.2	0.51	484.00	43.00	4.99	0.35	0.18	0.06	0 00:22:12
3	Sub-E03.2.1	0.38	484.00	43.00	4.99	0.35	0.13	0.04	0 00:18:17
4	Sub-E04	0.19	484.00	43.00	4.99	0.35	0.07	0.02	0 00:15:05

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Out-A4	Outfall	106.00					0.04	106.00					
2	Out-E03.2	Outfall	0.00					0.05	0.00					
3	Basin-A4	Storage Node	114.00	117.00	114.00		0.00	0.30	116.07				0.00	0.00
4	Forebay-A4	Storage Node	114.00	117.00	114.00		0.00	0.57	116.54				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(ft)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
1	Weir-B-A4	Weir	Basin-A4	Out-A4		114.00	106.00				0.00							
2	Weir-F-04	Weir	Forebay-A4	Basin-A4		114.00	114.00				0.28							

Subbasin Hydrology

Subbasin : Sub-A4

Input Data

Area (ac) 0.22
Peak Rate Factor 484
Weighted Curve Number 76
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	0.22	A	76
Composite Area & Weighted CN	0.22		76

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft^2)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	110.17	0	0
Slope (%) :	1	0	0
2 yr, 24 hr Rainfall (in) :	3.42	0	0
Velocity (ft/sec) :	0.86	0	0
Computed Flow Time (min) :	2.14	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	76.5	0	0
Channel Slope (%) :	1.13	0	0
Cross Section Area (ft^2) :	2.43	0	0
Wetted Perimeter (ft) :	5.69	0	0
Velocity (ft/sec) :	2.99	0	0
Computed Flow Time (min) :	0.43	0	0

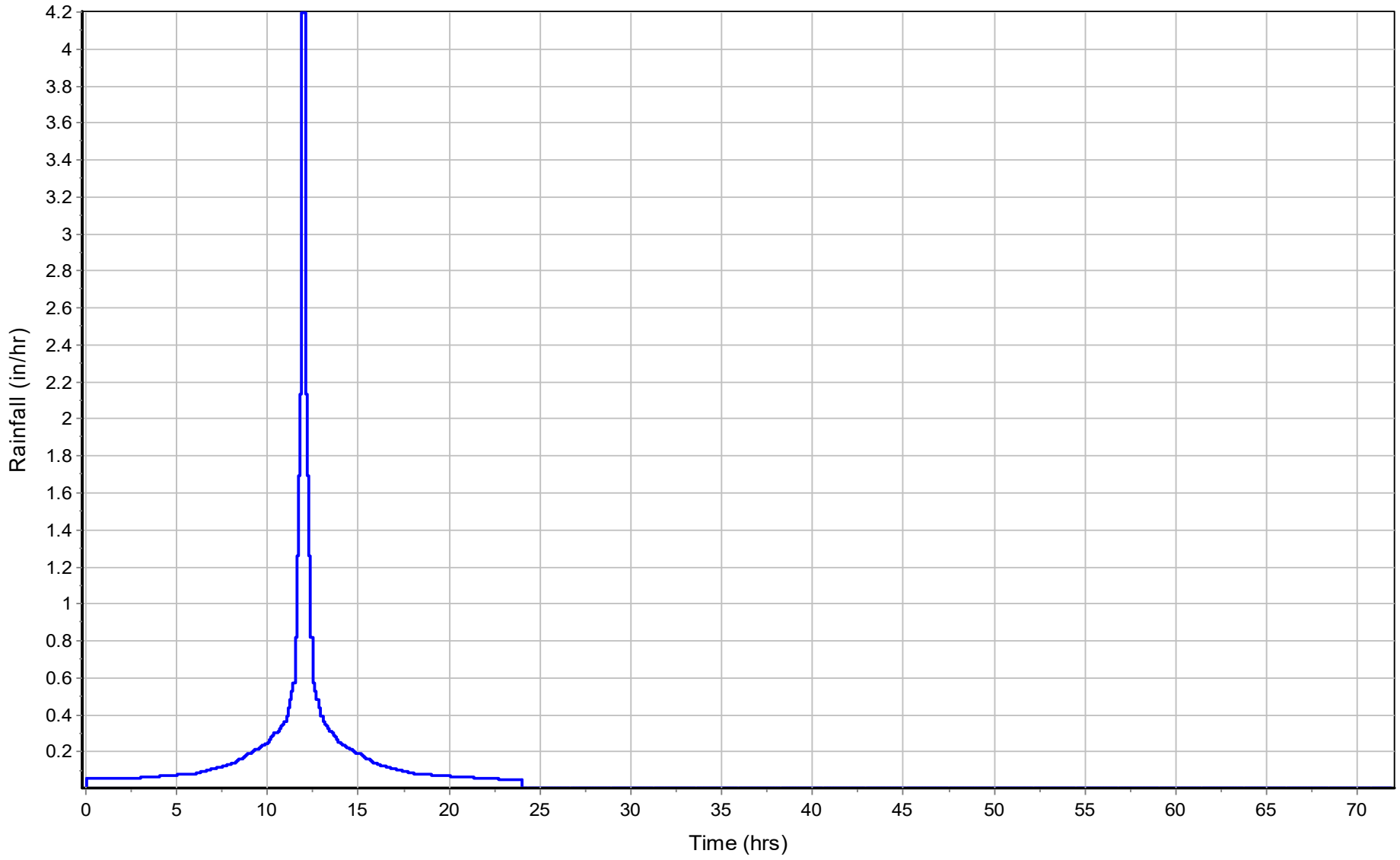
Total TOC (min) 2.57

Subbasin Runoff Results

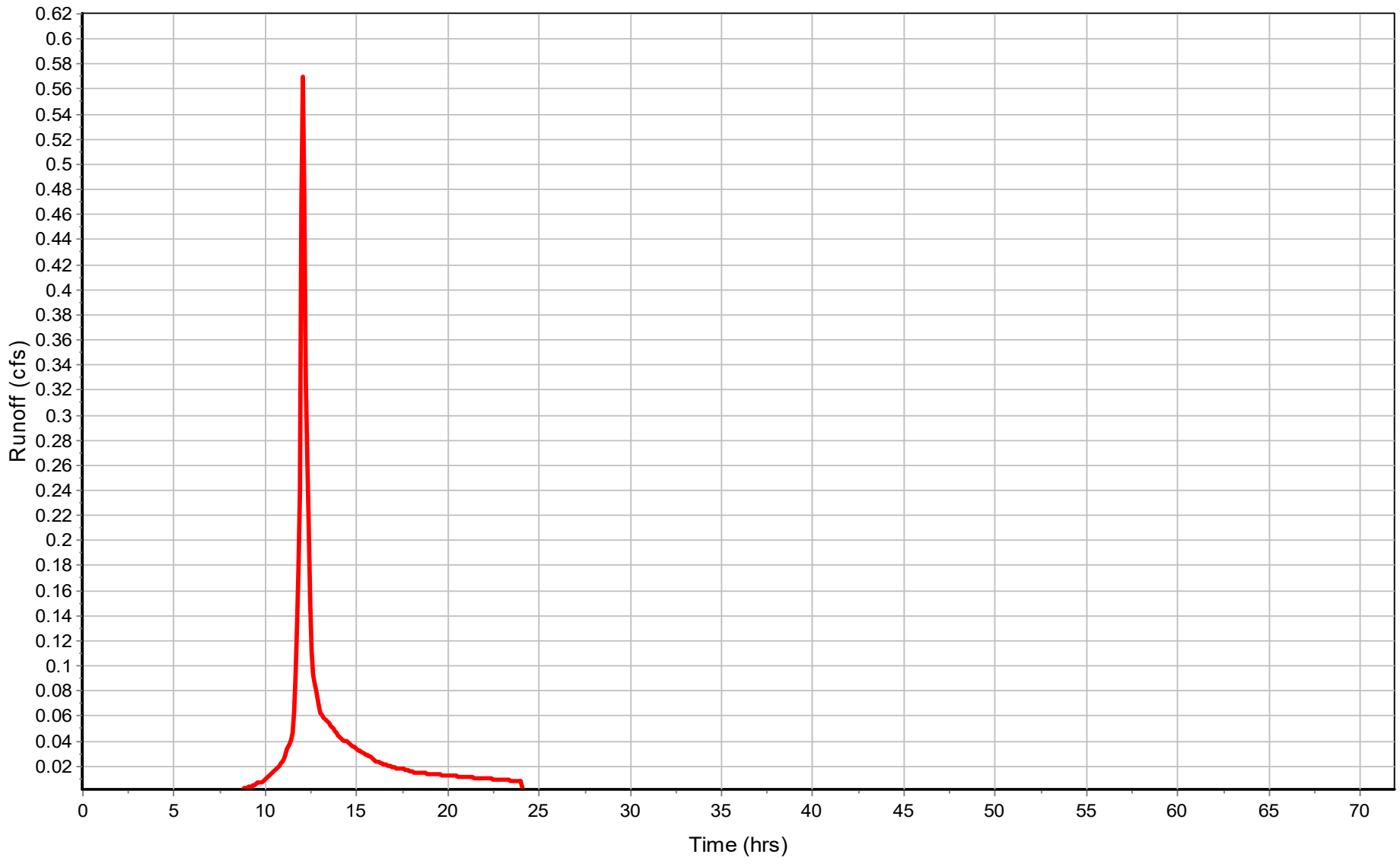
Total Rainfall (in)	4.99
Total Runoff (in)	2.53
Peak Runoff (cfs)	0.59
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:02:34

Subbasin : Sub-A4

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E03.2

Input Data

Area (ac) 0.51
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.51	A	43
Composite Area & Weighted CN	0.51		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	143.83	0	0
Slope (%) :	14	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.11	0	0
Computed Flow Time (min) :	22.21	0	0

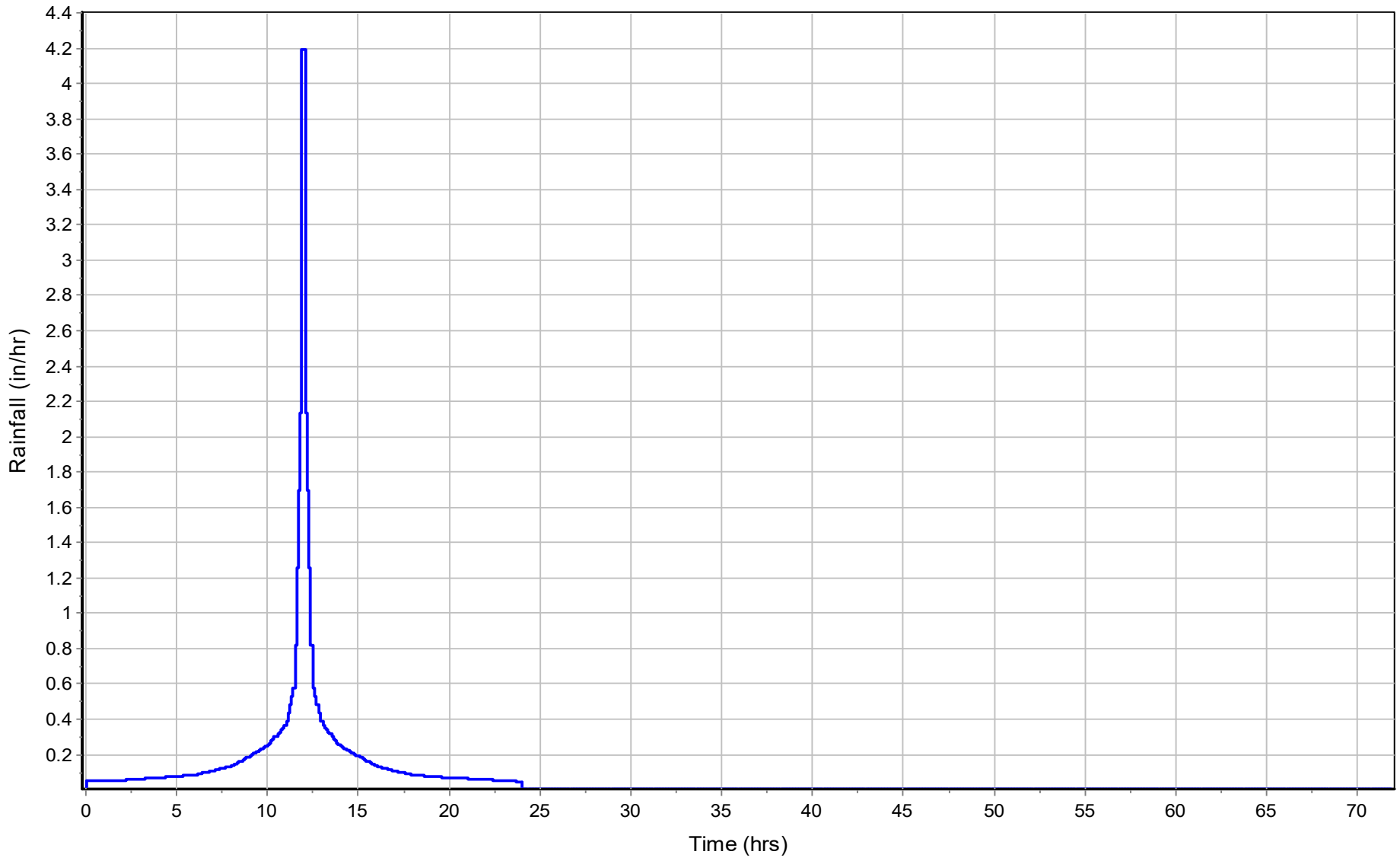
Total TOC (min) 22.21

Subbasin Runoff Results

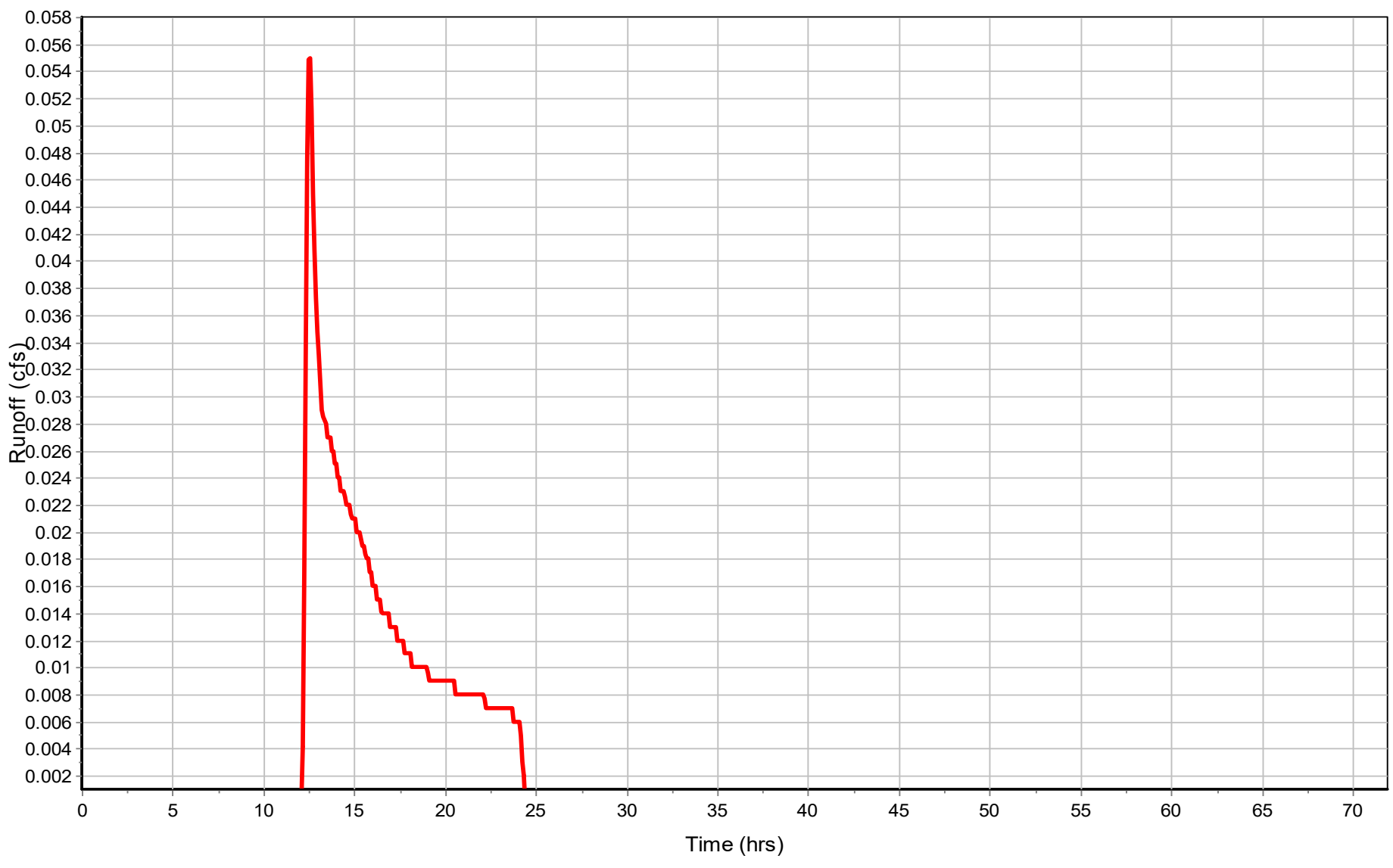
Total Rainfall (in) 4.99
Total Runoff (in) 0.35
Peak Runoff (cfs) 0.06
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:22:13

Subbasin : Sub-E03.2

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E03.2.1

Input Data

Area (ac) 0.38
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.38	A	43
Composite Area & Weighted CN	0.38		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	116.8	0	0
Slope (%) :	15	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.11	0	0
Computed Flow Time (min) :	18.29	0	0

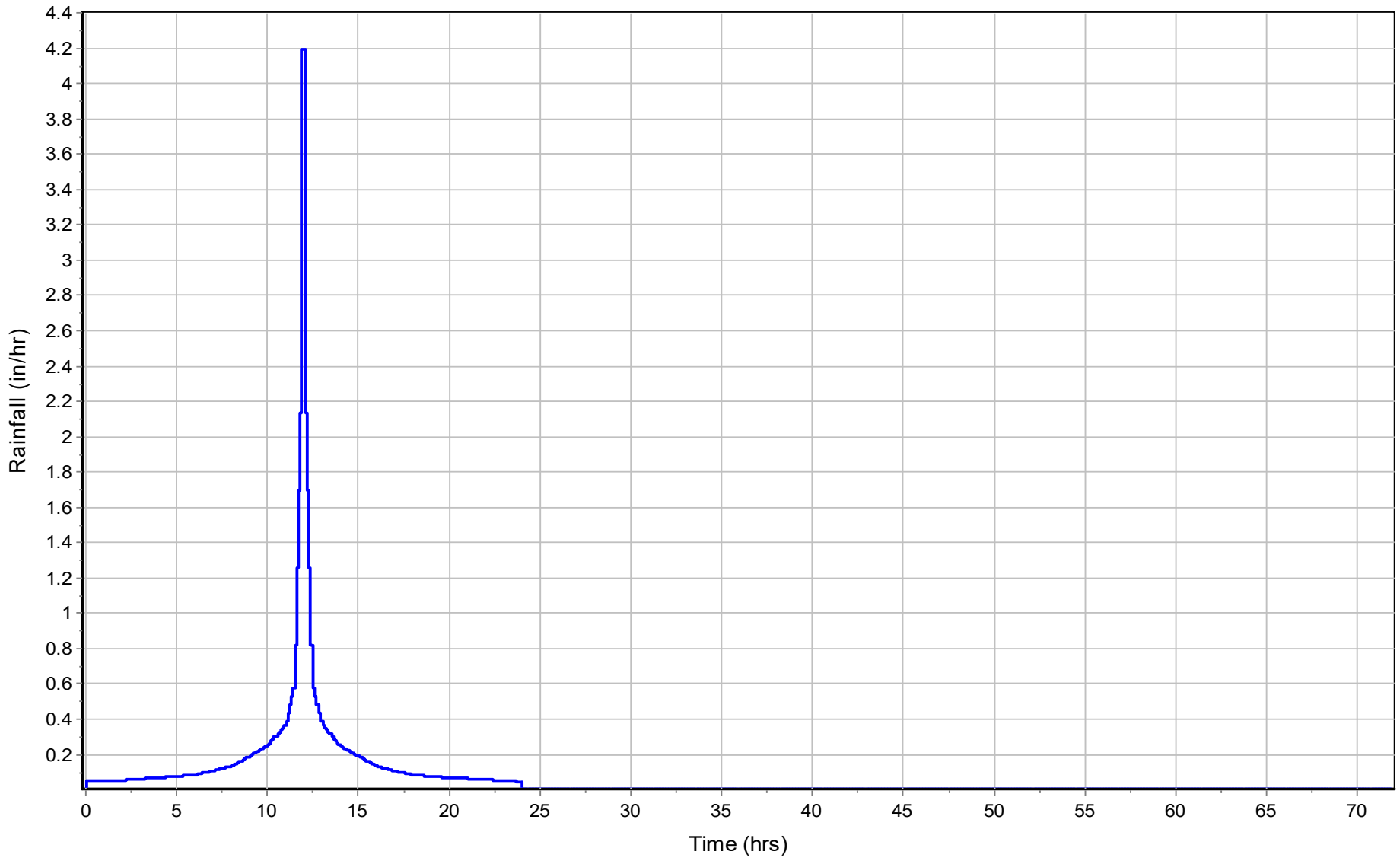
Total TOC (min) 18.29

Subbasin Runoff Results

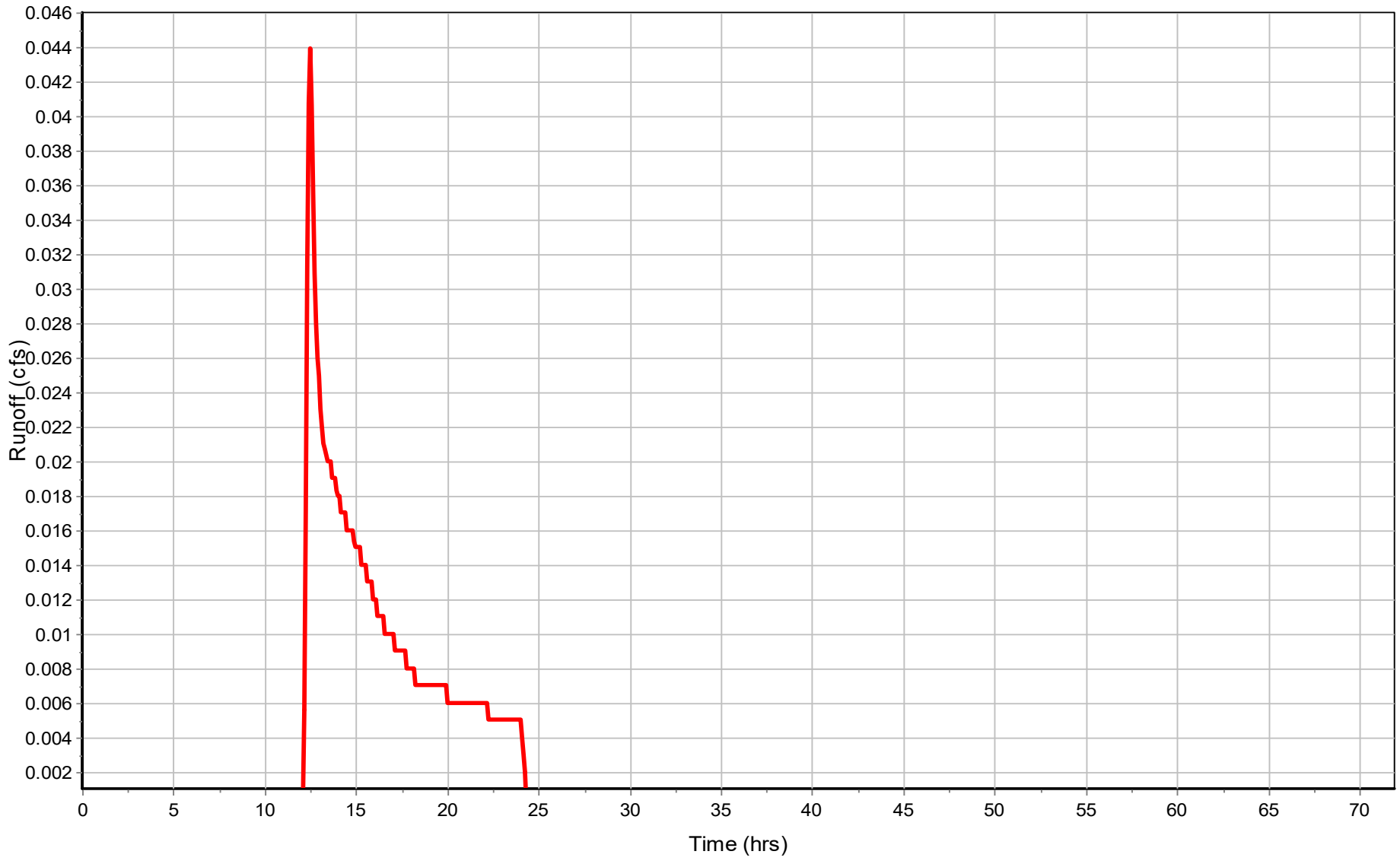
Total Rainfall (in) 4.99
Total Runoff (in) 0.35
Peak Runoff (cfs) 0.04
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:18:17

Subbasin : Sub-E03.2.1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E04

Input Data

Area (ac) 0.19
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.19	A	43
Composite Area & Weighted CN	0.19		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	88.76	0	0
Slope (%) :	14	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.1	0	0
Computed Flow Time (min) :	15.09	0	0

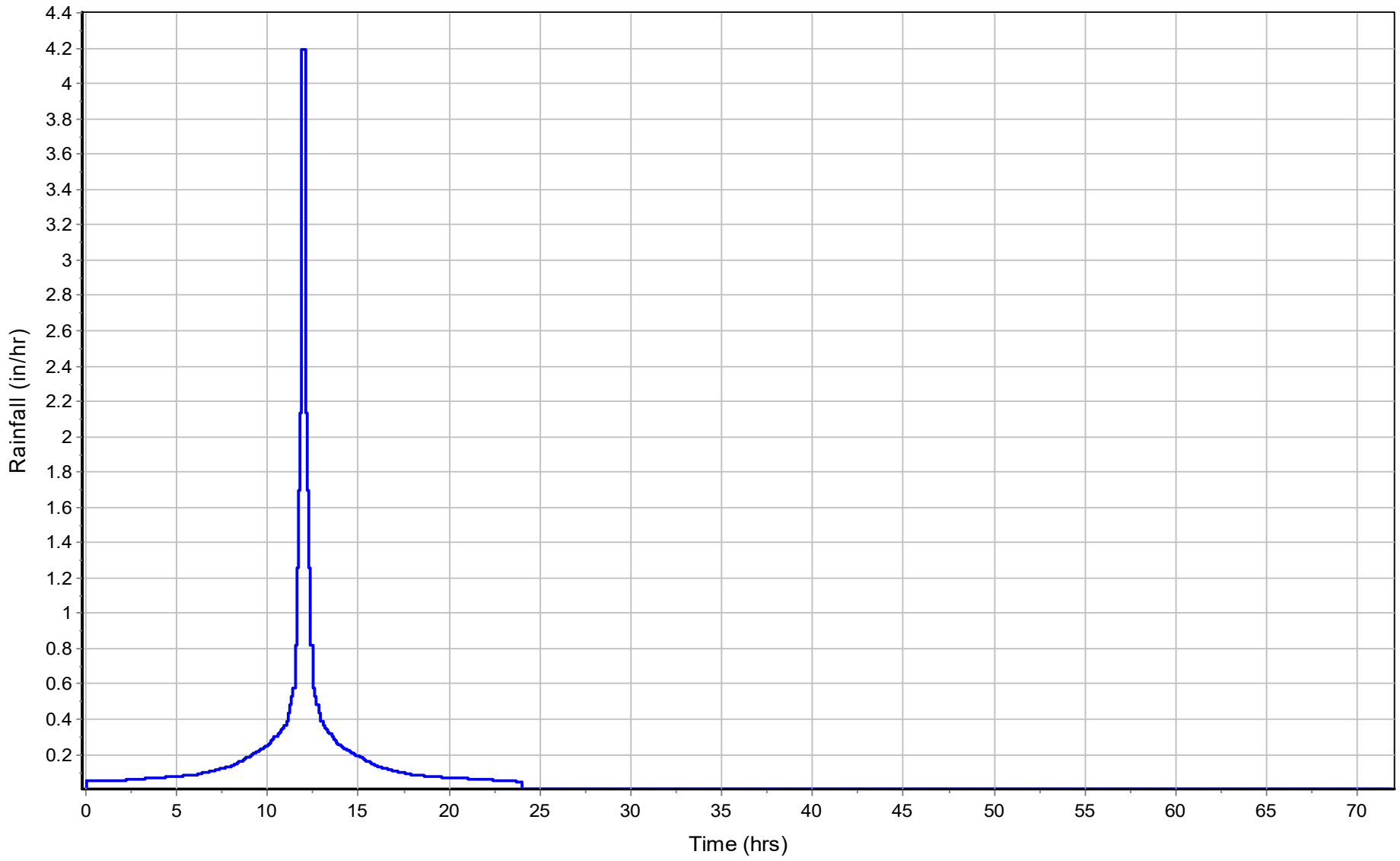
Total TOC (min) 15.09

Subbasin Runoff Results

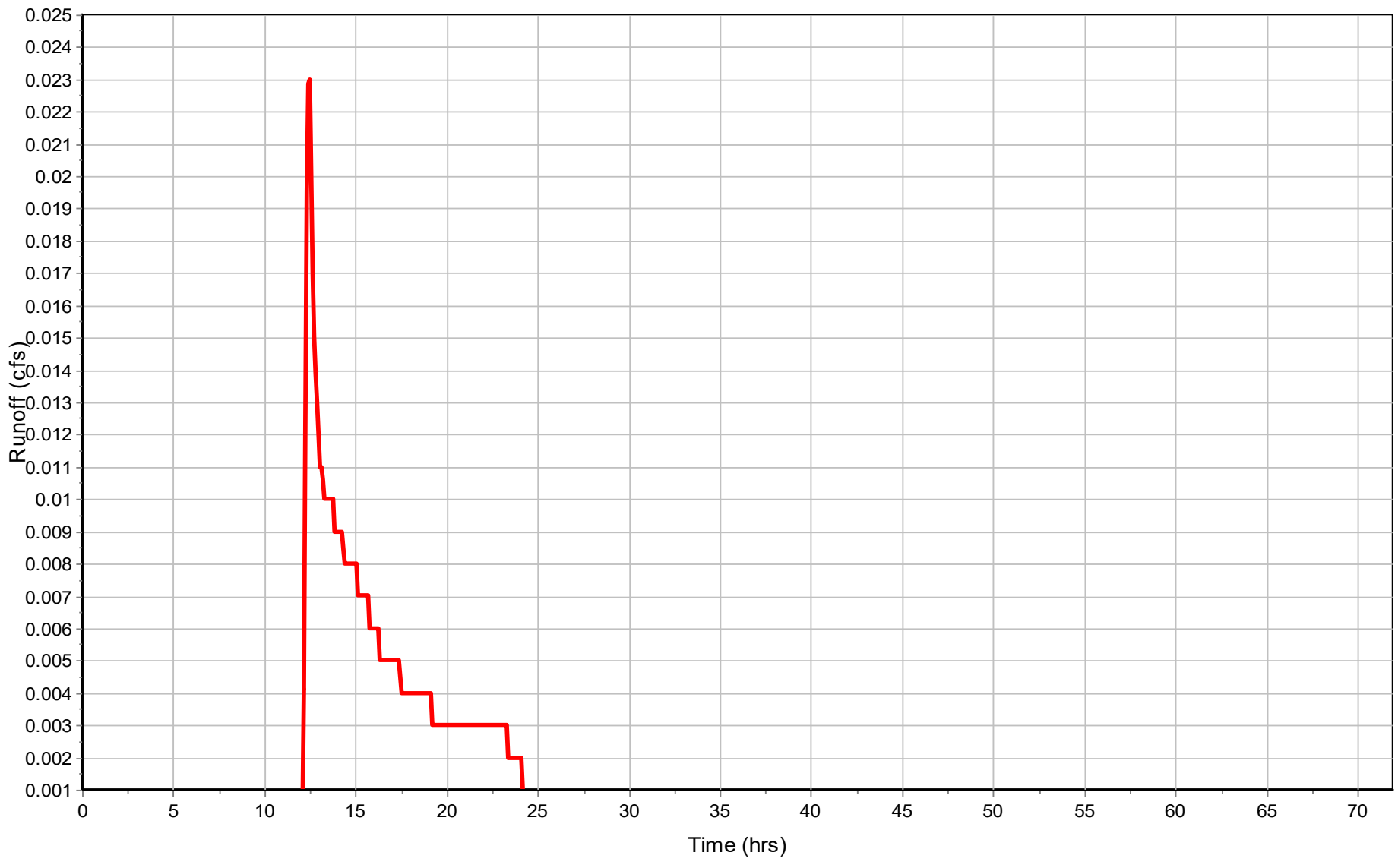
Total Rainfall (in) 4.99
Total Runoff (in) 0.35
Peak Runoff (cfs) 0.02
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:15:05

Subbasin : Sub-E04

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A4

Input Data

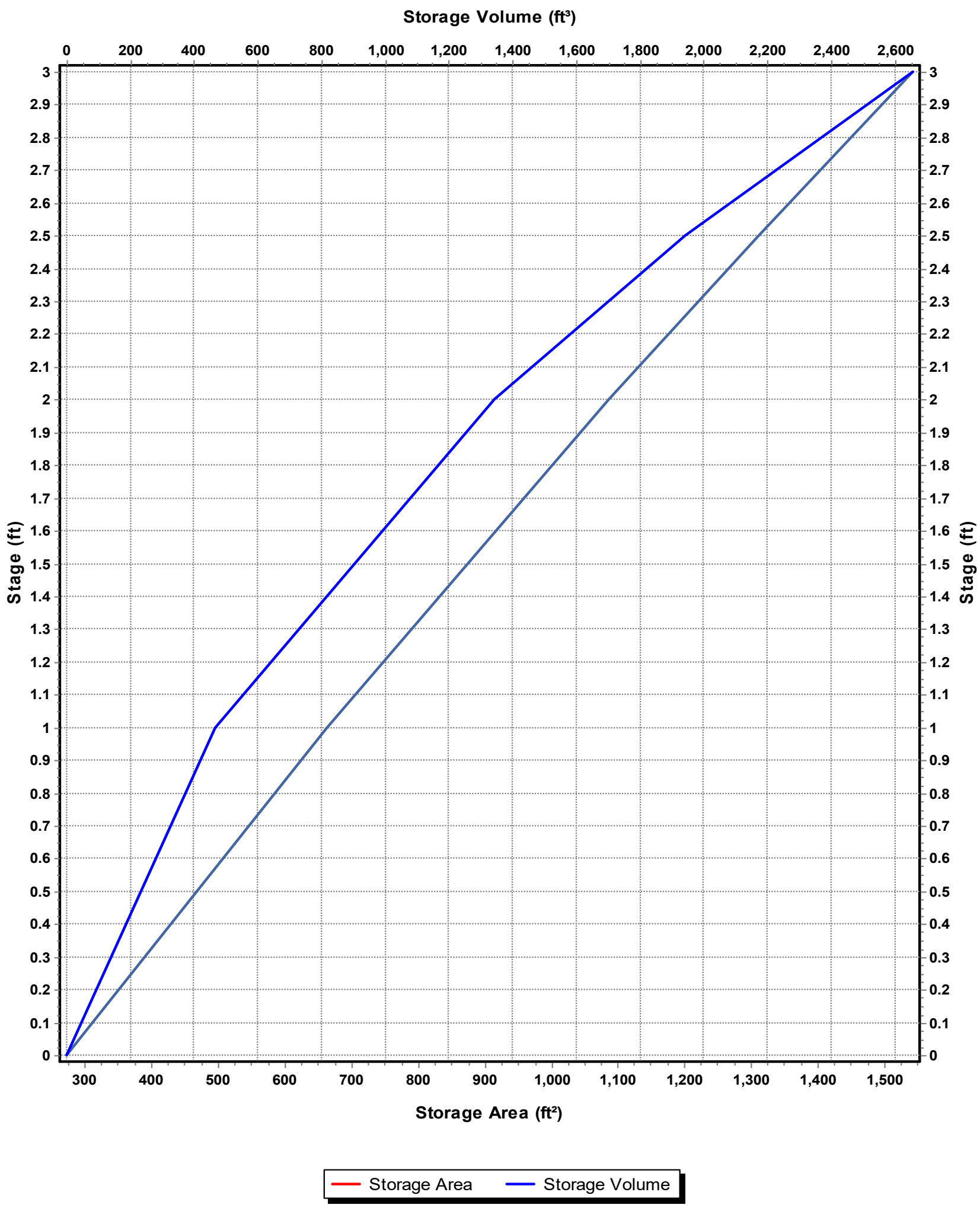
Invert Elevation (ft)	114.00
Max (Rim) Elevation (ft)	117.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.00
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Basin-04

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	272.59	0
1	664.04	468.32
2	1087.5	1344.09
2.5	1311.22	1943.77
3	1542.95	2657.31

Storage Area Volume Curves



Storage Node : Basin-A4 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-B-A4	Trapezoidal	No	116.80	2.80	10.00	0.20	3.33

Output Summary Results

Peak Inflow (cfs)	0.3
Peak Lateral Inflow (cfs)	0.02
Peak Outflow (cfs)	0
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	116.07
Max HGL Depth Attained (ft)	2.07
Average HGL Elevation Attained (ft)	115.65
Average HGL Depth Attained (ft)	1.65
Time of Max HGL Occurrence (days hh:mm)	1 00:56
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Forebay-A4

Input Data

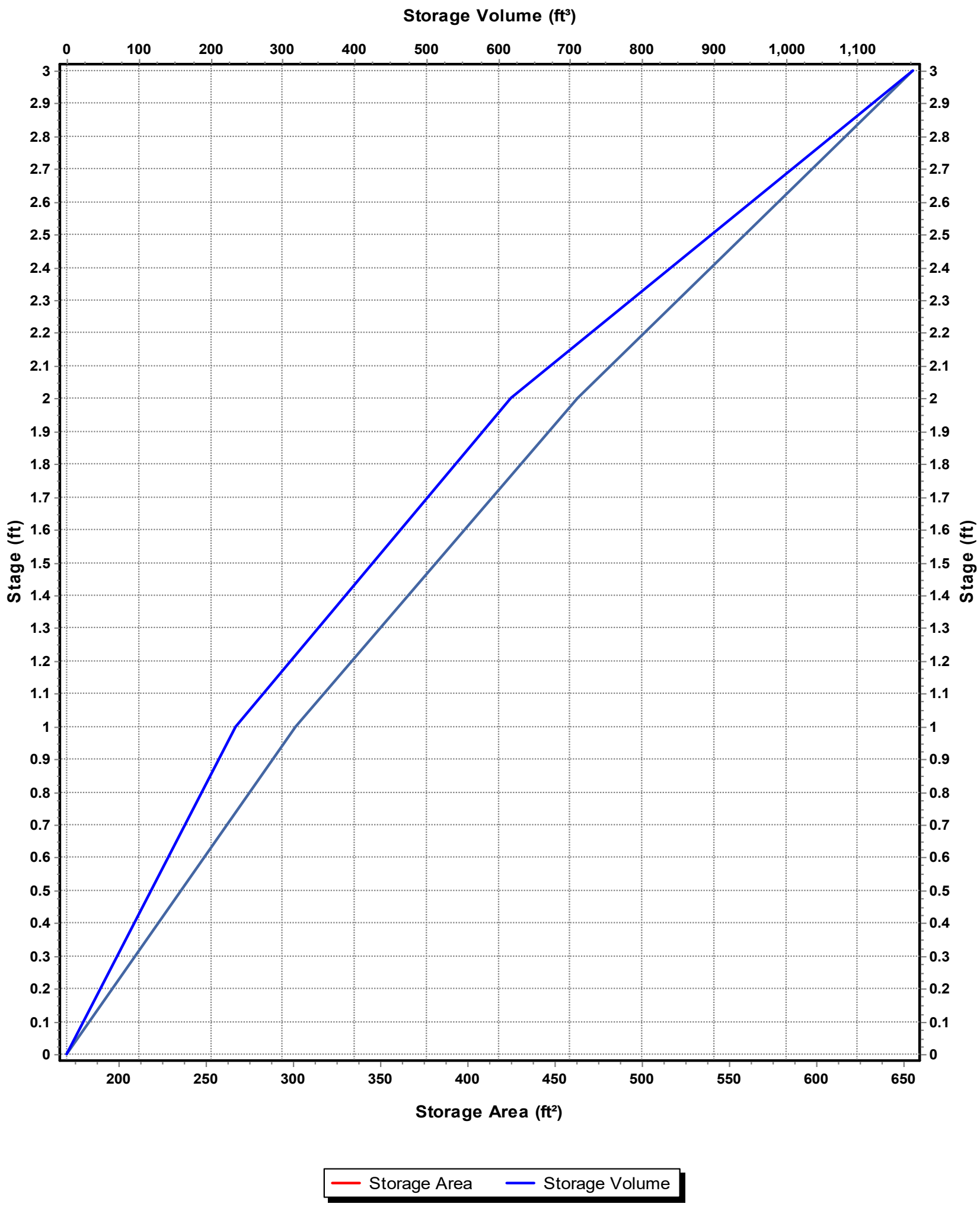
Invert Elevation (ft)	114.00
Max (Rim) Elevation (ft)	117.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.00
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Forebay-04

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	170.46	0
1	301.38	235.92
2	462.94	618.08
3	655.13	1177.12

Storage Area Volume Curves



Storage Node : Forebay-A4 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-F-04	Trapezoidal	No	116.50	2.50	10.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	0.57
Peak Lateral Inflow (cfs)	0.57
Peak Outflow (cfs)	0.28
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	116.54
Max HGL Depth Attained (ft)	2.54
Average HGL Elevation Attained (ft)	116.09
Average HGL Depth Attained (ft)	2.09
Time of Max HGL Occurrence (days hh:mm)	0 12:24
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Project Description

File Name	Pave.Paws_A4.SPF

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	SCS TR-20
Time of Concentration (TOC) Method	SCS TR-55
Link Routing Method	Hydrodynamic
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	NO

Analysis Options

Start Analysis On	00:00:00	0:00:00
End Analysis On	00:00:00	0:00:00
Start Reporting On	00:00:00	0:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	4
Nodes	4
Junctions	0
Outfalls	2
Flow Diversions	0
Inlets	0
Storage Nodes	2
Links	2
Channels	0
Pipes	0
Pumps	0
Orifices	0
Weirs	2
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	25 years	Intensity	inches	Massachusetts	None	25.00	5.97	SCS Type III 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Sub-A4	0.22	484.00	76.00	5.97	3.35	0.75	0.77	0 00:06:00
2	Sub-E03.2	0.51	484.00	43.00	5.97	0.66	0.34	0.15	0 00:22:12
3	Sub-E03.2.1	0.38	484.00	43.00	5.97	0.66	0.25	0.12	0 00:18:17
4	Sub-E04	0.19	484.00	43.00	5.97	0.66	0.13	0.06	0 00:15:05

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Out-A4	Outfall	106.00					0.12	106.00					
2	Out-E03.2	Outfall	0.00					0.15	0.00					
3	Basin-A4	Storage Node	114.00	117.00	114.00		0.00	0.73	116.74				0.00	0.00
4	Forebay-A4	Storage Node	114.00	117.00	114.00		0.00	0.75	116.76				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(ft)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
1	Weir-B-A4	Weir	Basin-A4	Out-A4		114.00	106.00				0.00							
2	Weir-F-04	Weir	Forebay-A4	Basin-A4		114.00	114.00				0.70							

Subbasin Hydrology

Subbasin : Sub-A4

Input Data

Area (ac) 0.22
Peak Rate Factor 484
Weighted Curve Number 76
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	0.22	A	76
Composite Area & Weighted CN	0.22		76

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft^2)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	110.17	0	0
Slope (%) :	1	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.86	0	0
Computed Flow Time (min) :	2.14	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	76.5	0	0
Channel Slope (%) :	1.13	0	0
Cross Section Area (ft^2) :	2.43	0	0
Wetted Perimeter (ft) :	5.69	0	0
Velocity (ft/sec) :	2.99	0	0
Computed Flow Time (min) :	0.43	0	0

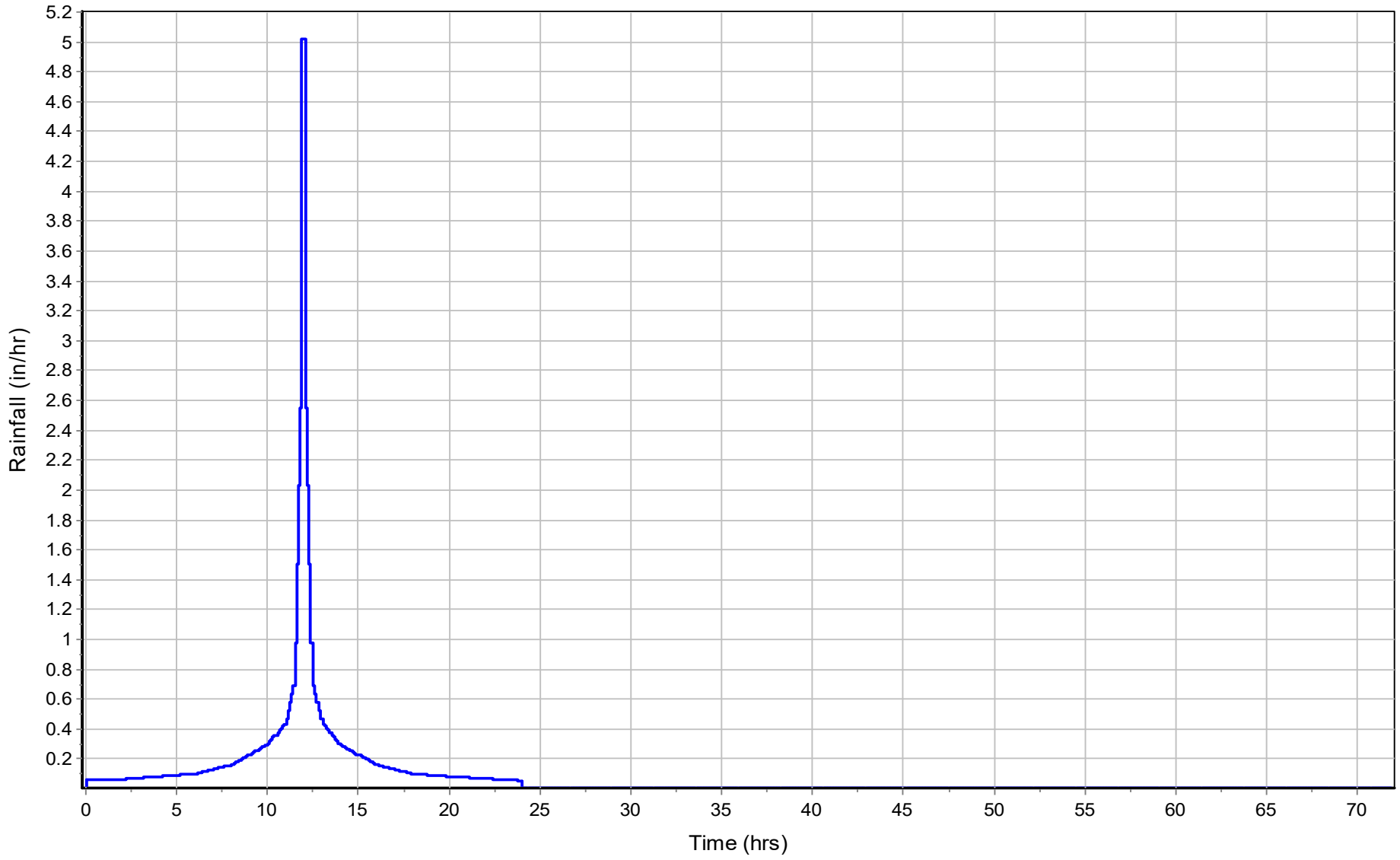
Total TOC (min) 2.57

Subbasin Runoff Results

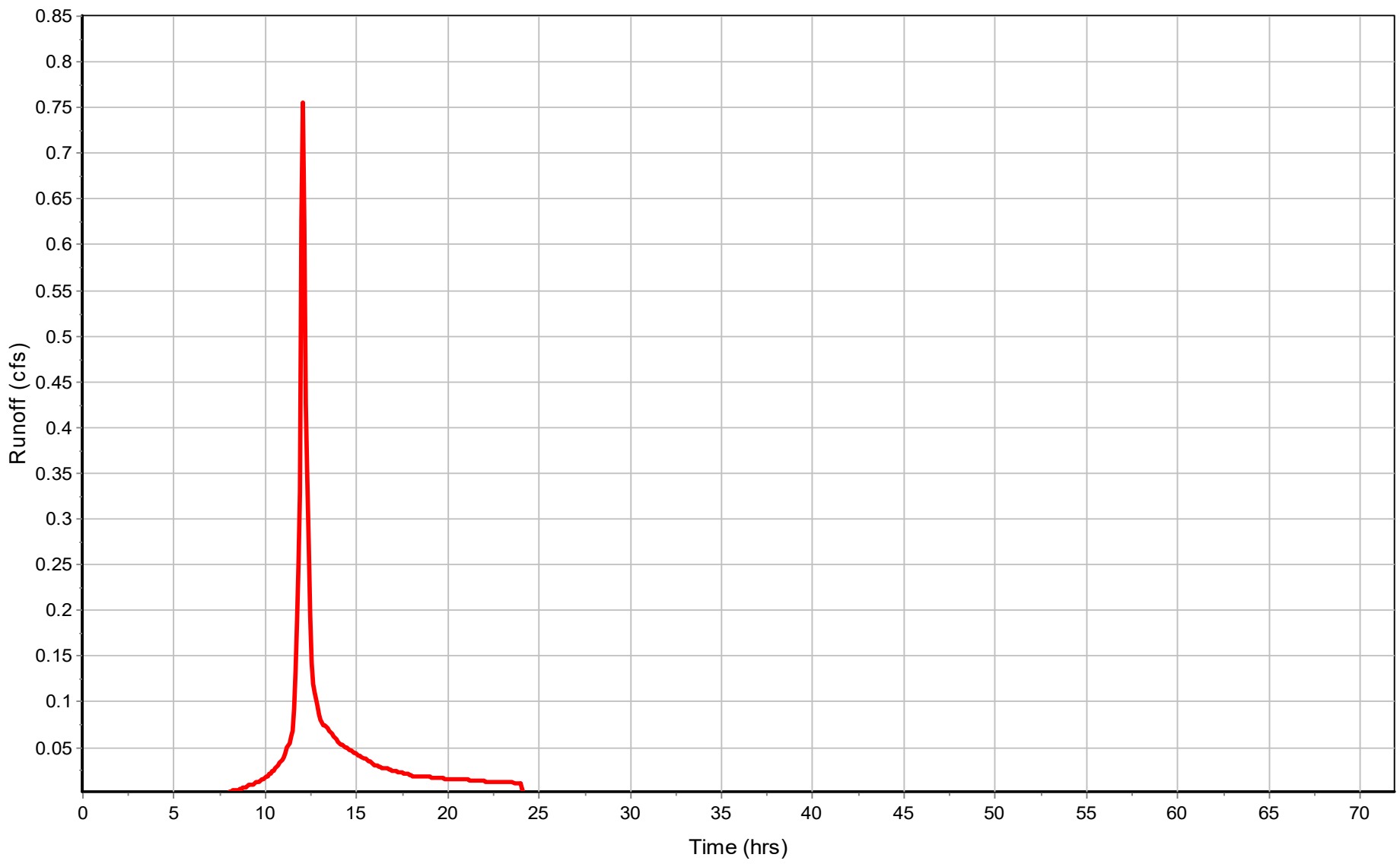
Total Rainfall (in)	5.97
Total Runoff (in)	3.35
Peak Runoff (cfs)	0.77
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:02:34

Subbasin : Sub-A4

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E03.2

Input Data

Area (ac) 0.51
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.51	A	43
Composite Area & Weighted CN	0.51		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	143.83	0	0
Slope (%) :	14	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.11	0	0
Computed Flow Time (min) :	22.21	0	0

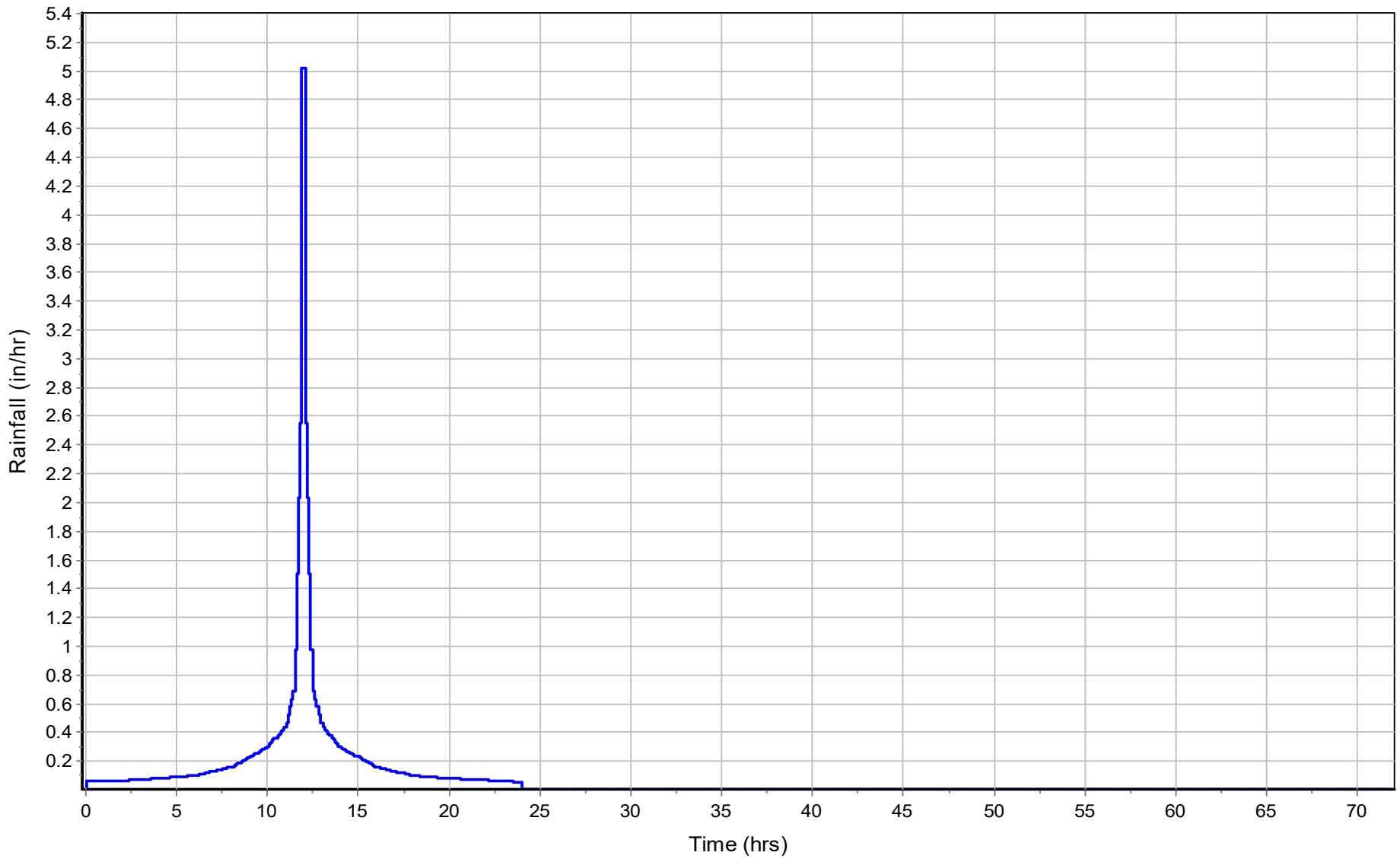
Total TOC (min) 22.21

Subbasin Runoff Results

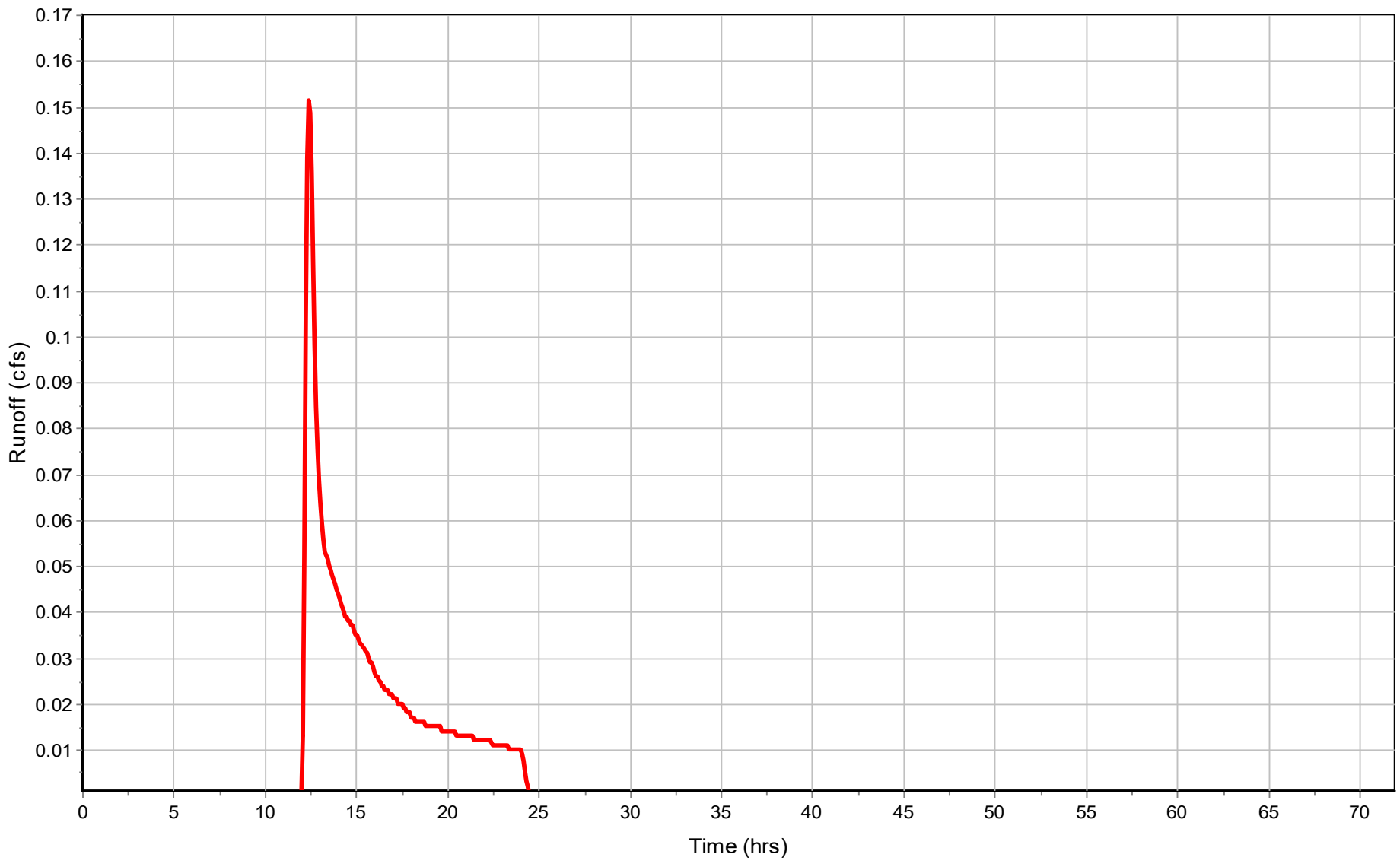
Total Rainfall (in) 5.97
Total Runoff (in) 0.66
Peak Runoff (cfs) 0.15
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:22:13

Subbasin : Sub-E03.2

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E03.2.1

Input Data

Area (ac) 0.38
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.38	A	43
Composite Area & Weighted CN	0.38		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	116.8	0	0
Slope (%) :	15	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.11	0	0
Computed Flow Time (min) :	18.29	0	0

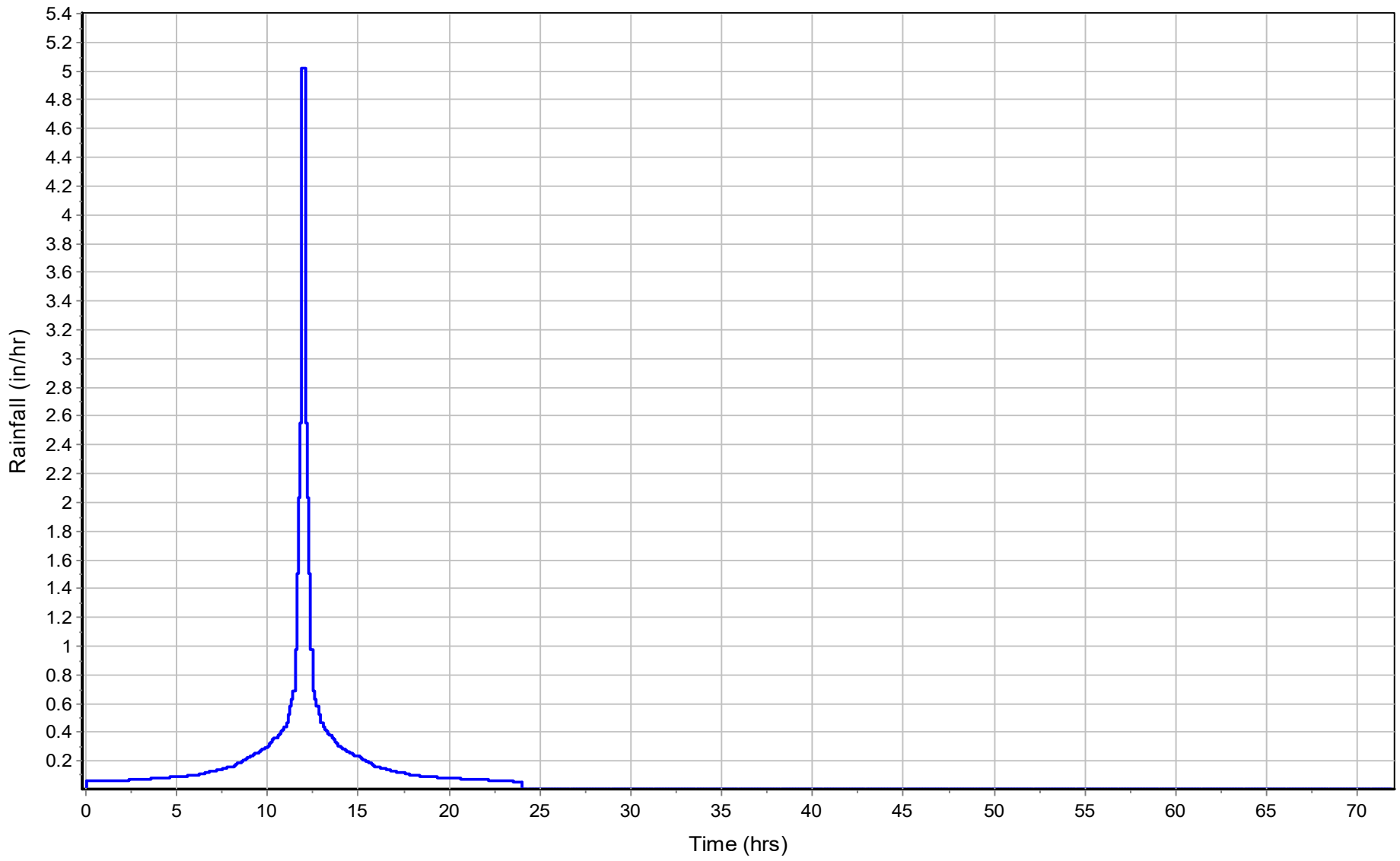
Total TOC (min) 18.29

Subbasin Runoff Results

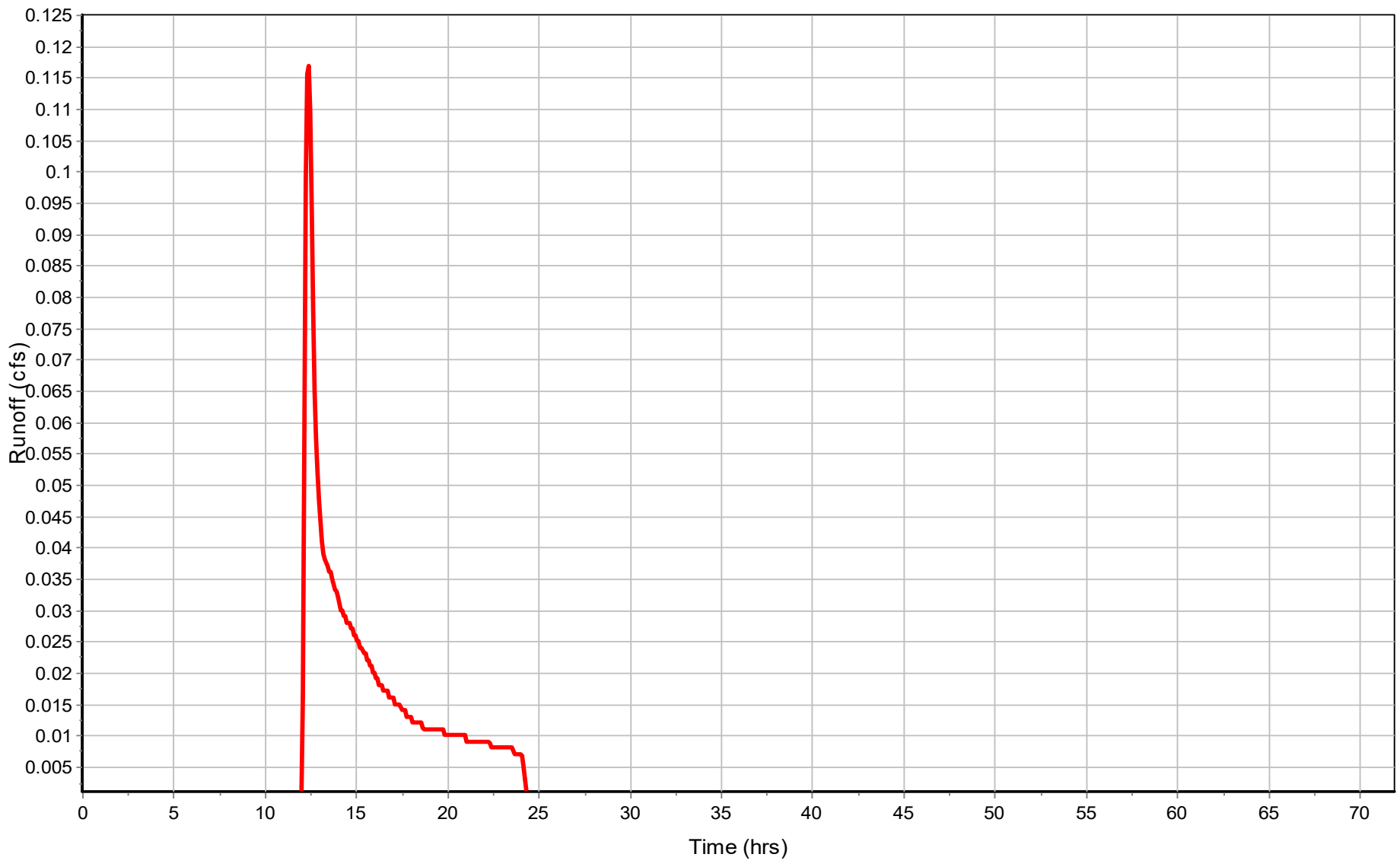
Total Rainfall (in) 5.97
Total Runoff (in) 0.66
Peak Runoff (cfs) 0.12
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:18:17

Subbasin : Sub-E03.2.1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E04

Input Data

Area (ac) 0.19
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.19	A	43
Composite Area & Weighted CN	0.19		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	88.76	0	0
Slope (%) :	14	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.1	0	0
Computed Flow Time (min) :	15.09	0	0

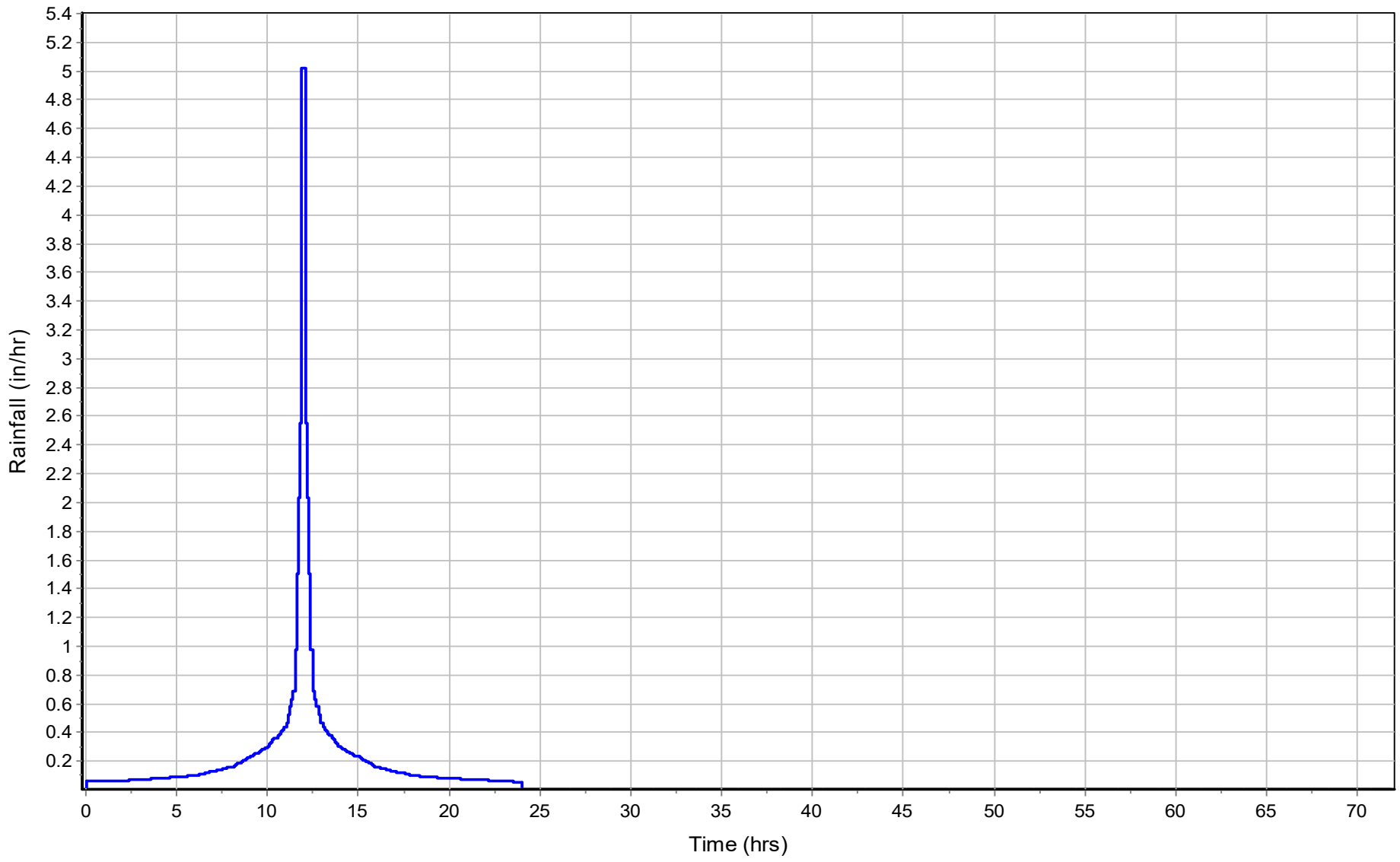
Total TOC (min) 15.09

Subbasin Runoff Results

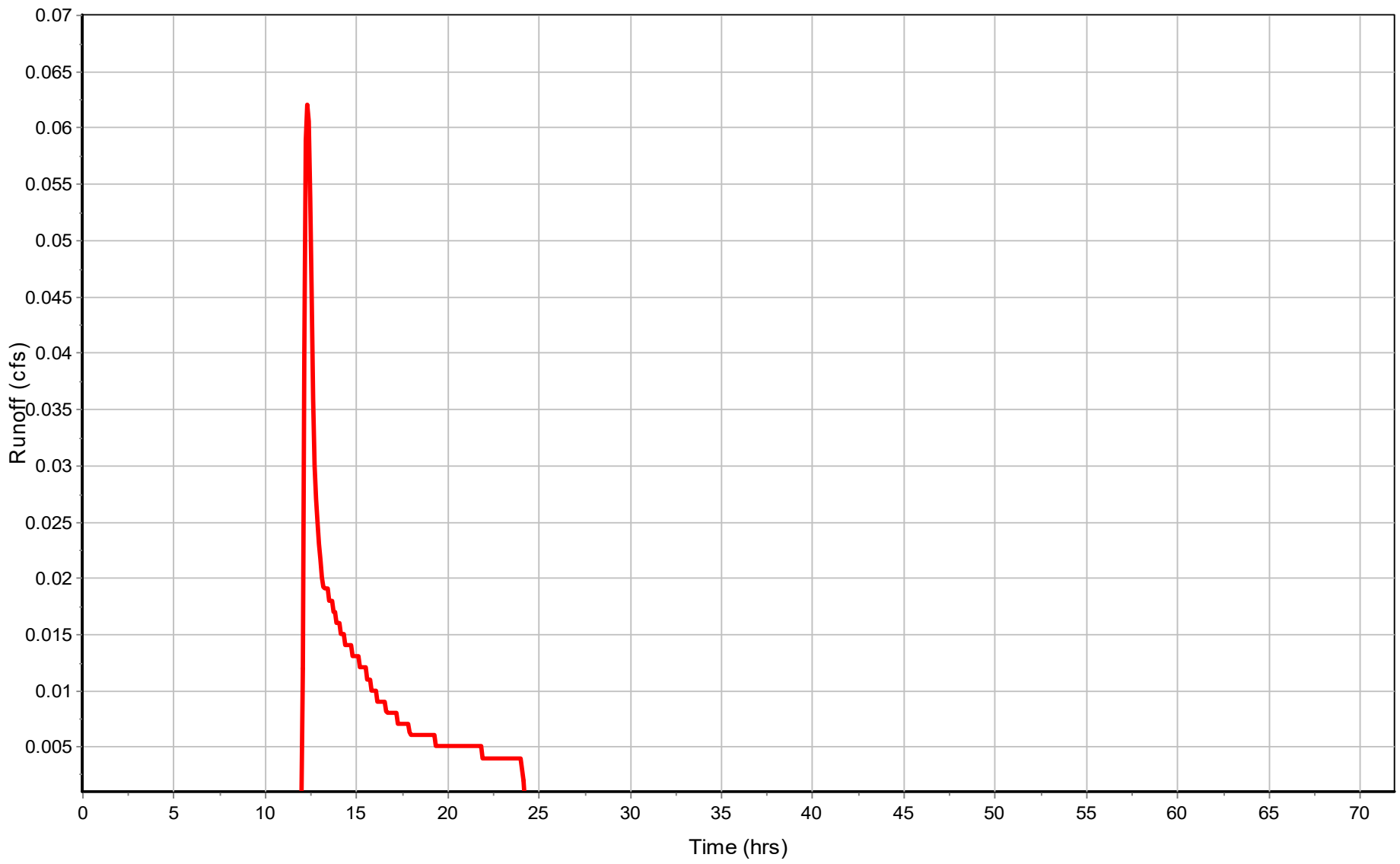
Total Rainfall (in) 5.97
Total Runoff (in) 0.66
Peak Runoff (cfs) 0.06
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:15:05

Subbasin : Sub-E04

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A4

Input Data

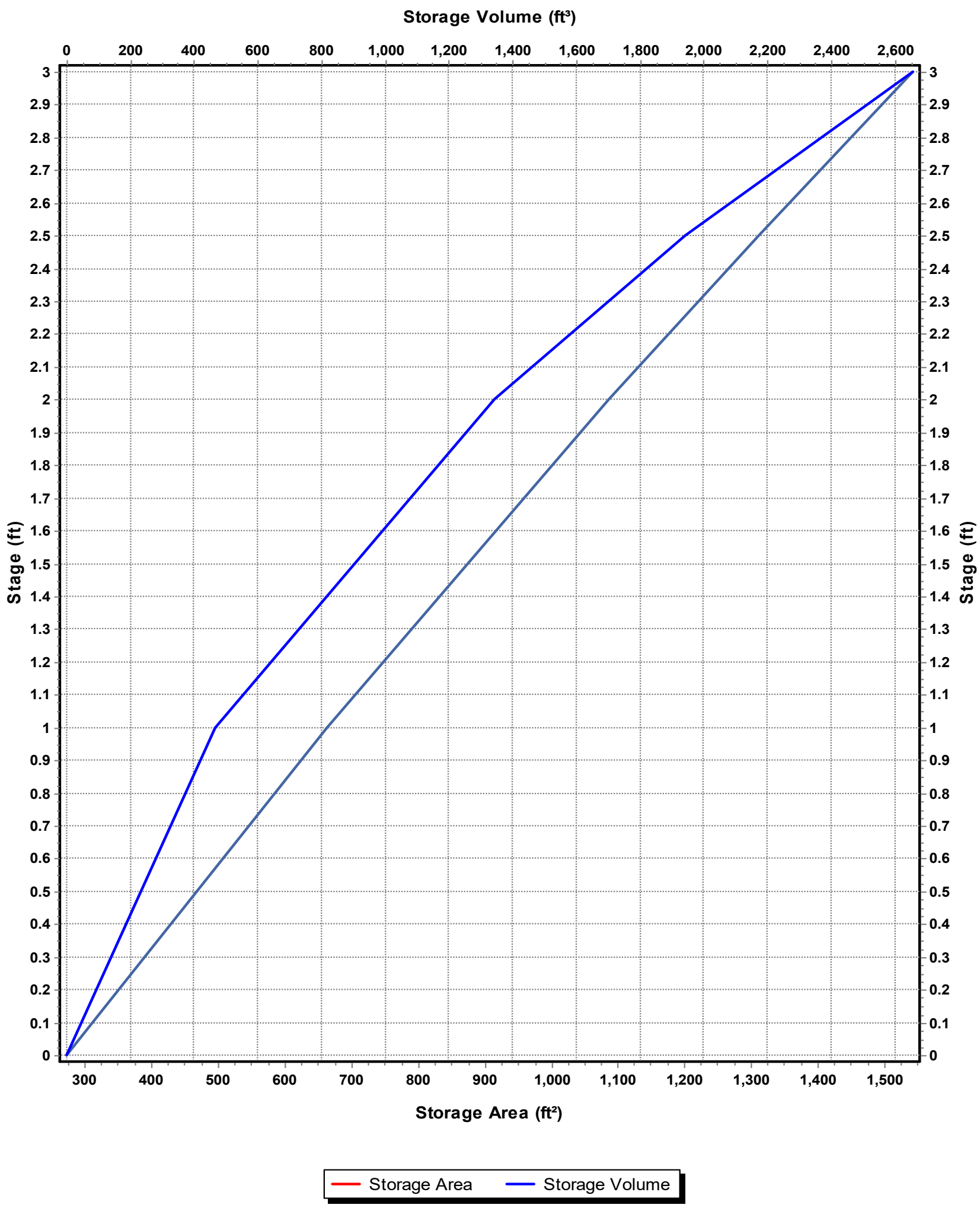
Invert Elevation (ft)	114.00
Max (Rim) Elevation (ft)	117.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.00
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Basin-04

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	272.59	0
1	664.04	468.32
2	1087.5	1344.09
2.5	1311.22	1943.77
3	1542.95	2657.31

Storage Area Volume Curves



Storage Node : Basin-A4 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-B-A4	Trapezoidal	No	116.80	2.80	10.00	0.20	3.33

Output Summary Results

Peak Inflow (cfs)	0.73
Peak Lateral Inflow (cfs)	0.06
Peak Outflow (cfs)	0.27
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	116.74
Max HGL Depth Attained (ft)	2.74
Average HGL Elevation Attained (ft)	116.19
Average HGL Depth Attained (ft)	2.19
Time of Max HGL Occurrence (days hh:mm)	3 00:00
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Forebay-A4

Input Data

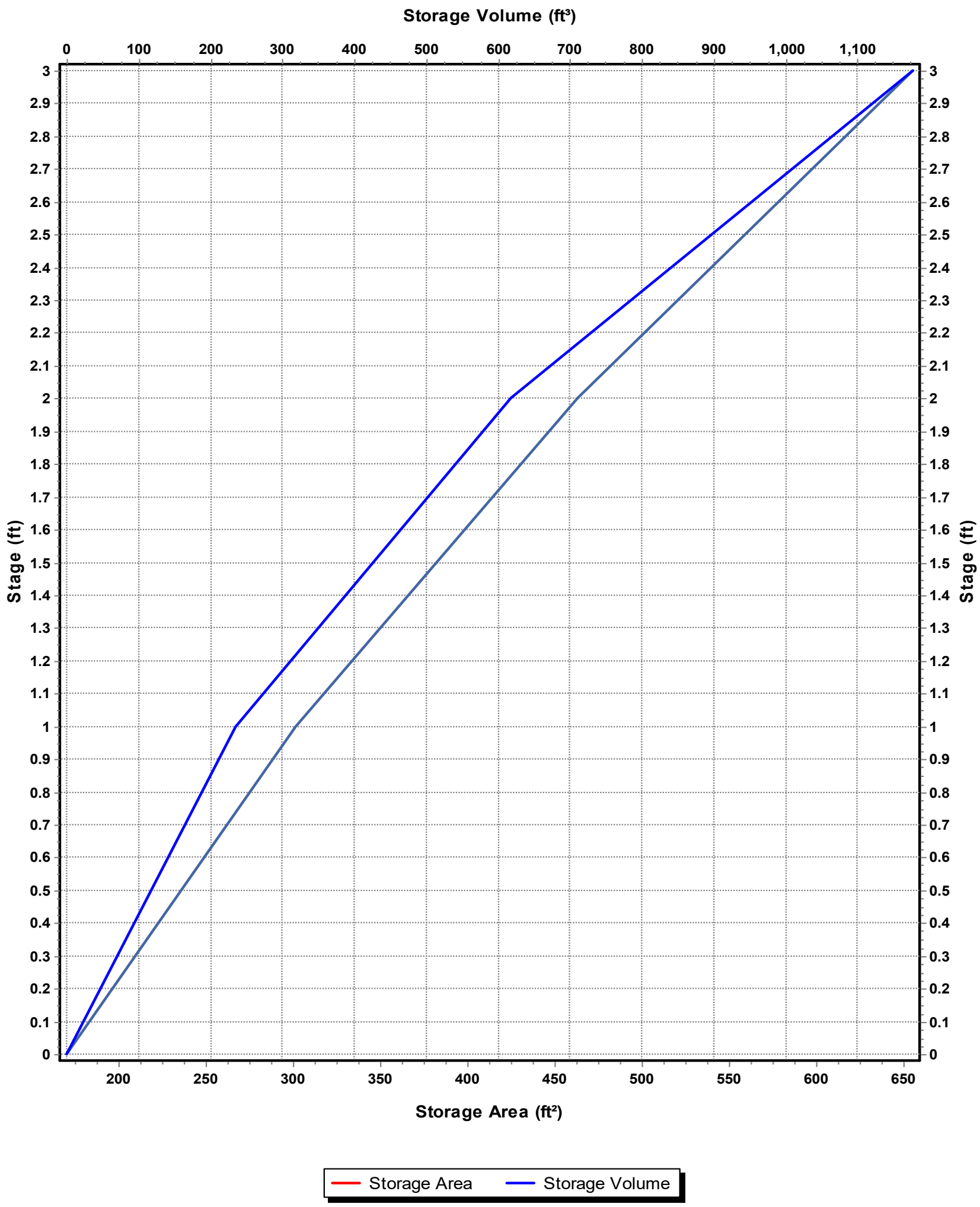
Invert Elevation (ft)	114.00
Max (Rim) Elevation (ft)	117.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.00
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Forebay-04

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	170.46	0
1	301.38	235.92
2	462.94	618.08
3	655.13	1177.12

Storage Area Volume Curves



Storage Node : Forebay-A4 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-F-04	Trapezoidal	No	116.50	2.50	10.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	0.75
Peak Lateral Inflow (cfs)	0.75
Peak Outflow (cfs)	0.7
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	116.76
Max HGL Depth Attained (ft)	2.76
Average HGL Elevation Attained (ft)	116.26
Average HGL Depth Attained (ft)	2.26
Time of Max HGL Occurrence (days hh:mm)	3 00:00
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Project Description

File Name	Pave.Paws_A4.SPF

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	SCS TR-20
Time of Concentration (TOC) Method	SCS TR-55
Link Routing Method	Hydrodynamic
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	NO

Analysis Options

Start Analysis On	00:00:00	0:00:00
End Analysis On	00:00:00	0:00:00
Start Reporting On	00:00:00	0:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	4
Nodes	4
Junctions	0
Outfalls	2
Flow Diversions	0
Inlets	0
Storage Nodes	2
Links	2
Channels	0
Pipes	0
Pumps	0
Orifices	0
Weirs	2
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	50 years	Intensity	inches	Massachusetts	None	50.00	6.71	SCS Type III 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Sub-A4	0.22	484.00	76.00	6.71	4.00	0.90	0.92	0 00:06:00
2	Sub-E03.2	0.51	484.00	43.00	6.71	0.95	0.49	0.25	0 00:22:12
3	Sub-E03.2.1	0.38	484.00	43.00	6.71	0.95	0.36	0.20	0 00:18:17
4	Sub-E04	0.19	484.00	43.00	6.71	0.95	0.18	0.11	0 00:15:05

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Out-A4	Outfall	106.00					0.20	106.00					
2	Out-E03.2	Outfall	0.00					0.25	0.00					
3	Basin-A4	Storage Node	114.00	117.00	114.00		0.00	0.94	116.80				0.00	0.00
4	Forebay-A4	Storage Node	114.00	117.00	114.00		0.00	0.90	116.82				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length (ft)	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Average Slope (%)	Diameter or Height (ft)	Manning's Roughness	Peak Flow (cfs)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Reported Condition
1	Weir-B-A4	Weir	Basin-A4	Out-A4		114.00	106.00				0.03							
2	Weir-F-04	Weir	Forebay-A4	Basin-A4		114.00	114.00				0.89							

Subbasin Hydrology

Subbasin : Sub-A4

Input Data

Area (ac) 0.22
Peak Rate Factor 484
Weighted Curve Number 76
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	0.22	A	76
Composite Area & Weighted CN	0.22		76

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft^2)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	110.17	0	0
Slope (%) :	1	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.86	0	0
Computed Flow Time (min) :	2.14	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	76.5	0	0
Channel Slope (%) :	1.13	0	0
Cross Section Area (ft^2) :	2.43	0	0
Wetted Perimeter (ft) :	5.69	0	0
Velocity (ft/sec) :	2.99	0	0
Computed Flow Time (min) :	0.43	0	0

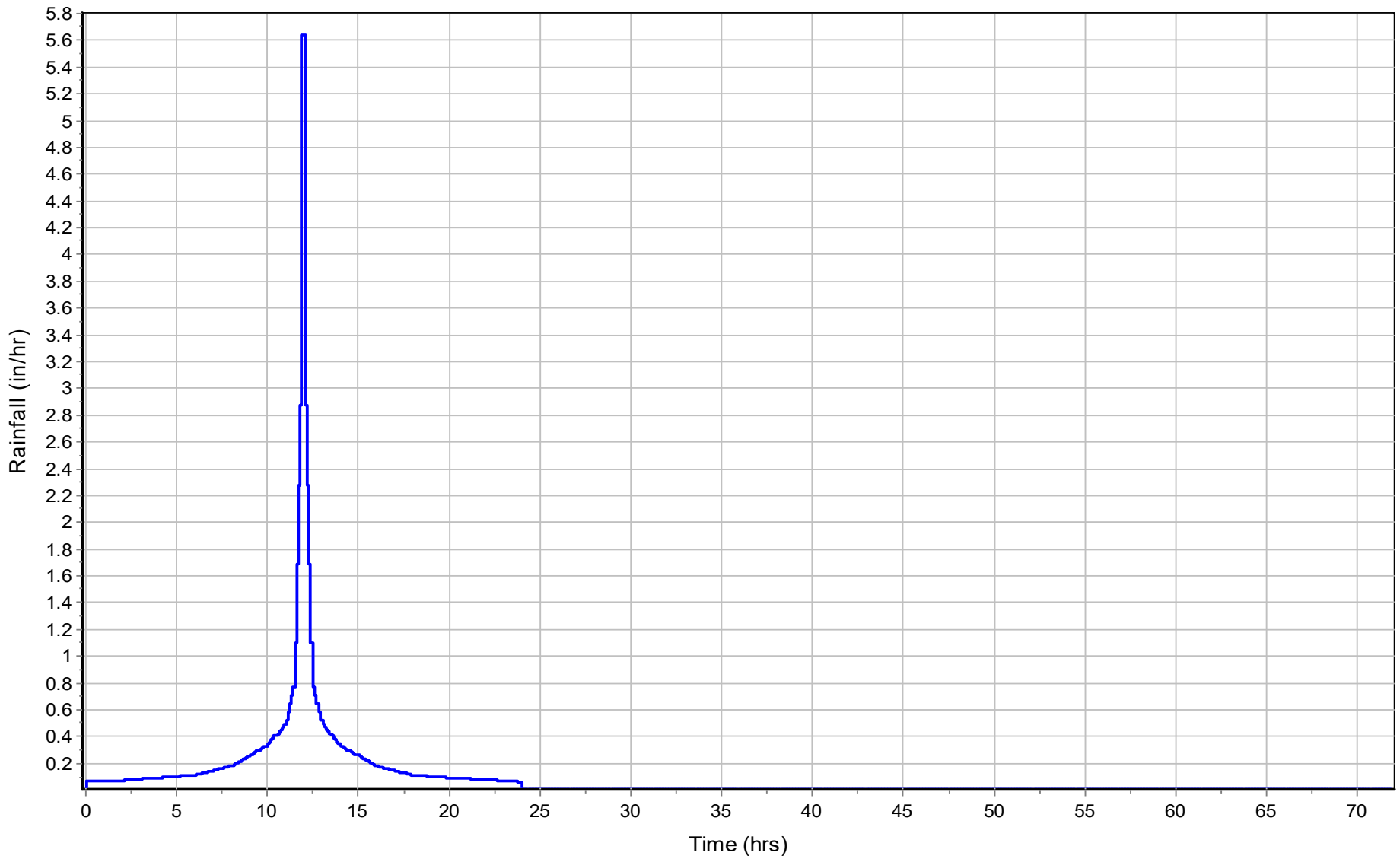
Total TOC (min) 2.57

Subbasin Runoff Results

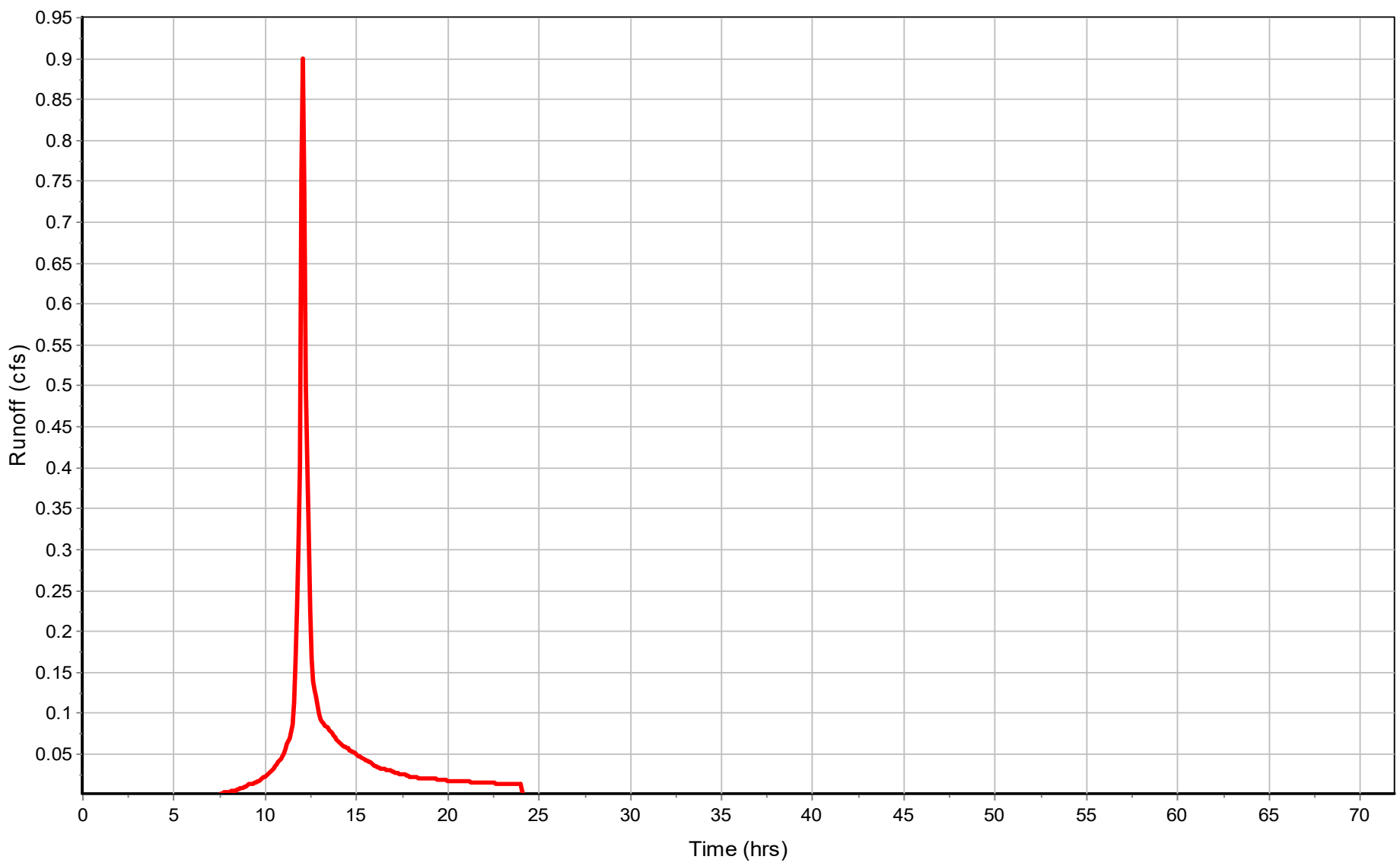
Total Rainfall (in)	6.71
Total Runoff (in)	4
Peak Runoff (cfs)	0.92
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:02:34

Subbasin : Sub-A4

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E03.2

Input Data

Area (ac) 0.51
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.51	A	43
Composite Area & Weighted CN	0.51		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	143.83	0	0
Slope (%) :	14	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.11	0	0
Computed Flow Time (min) :	22.21	0	0

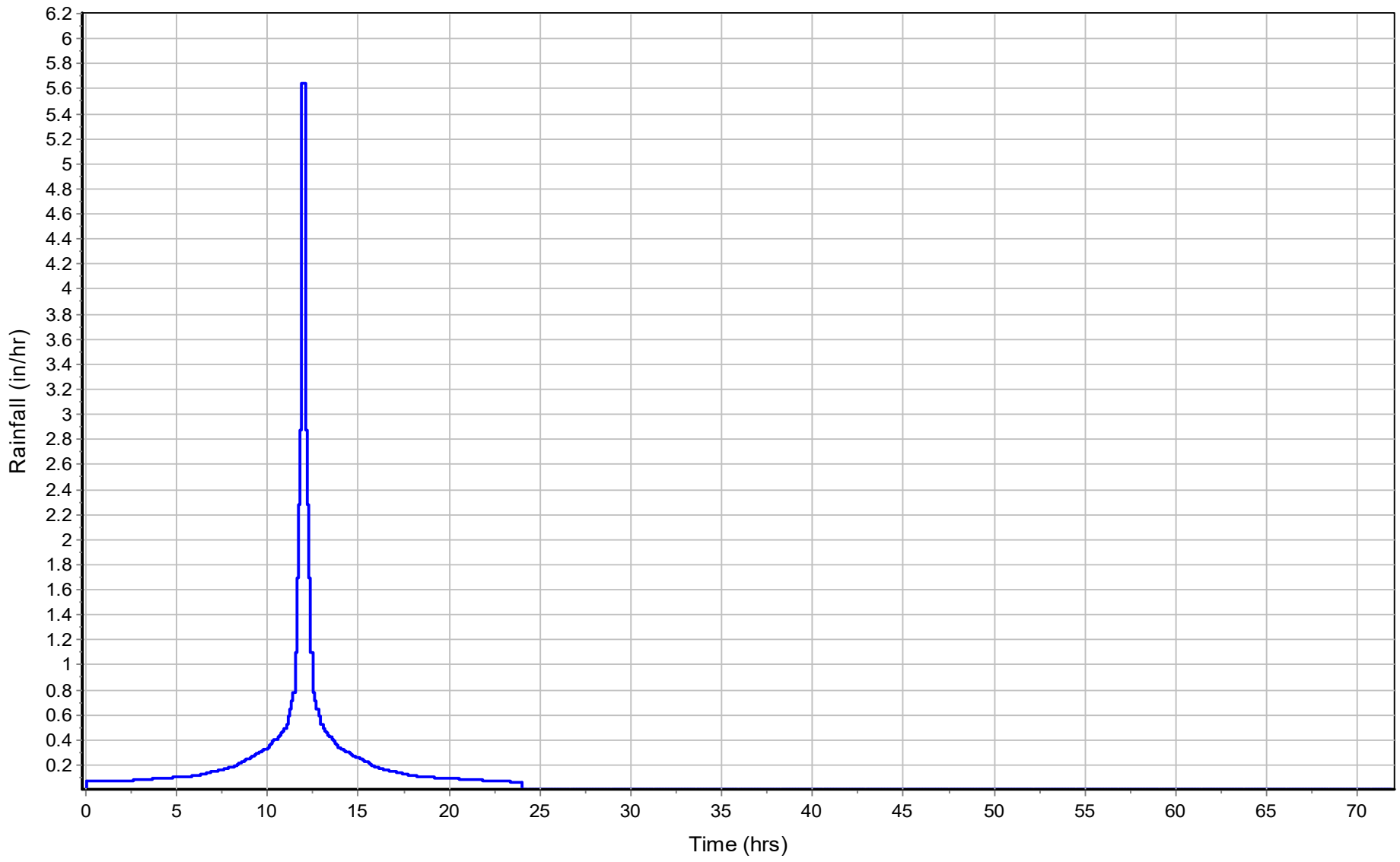
Total TOC (min) 22.21

Subbasin Runoff Results

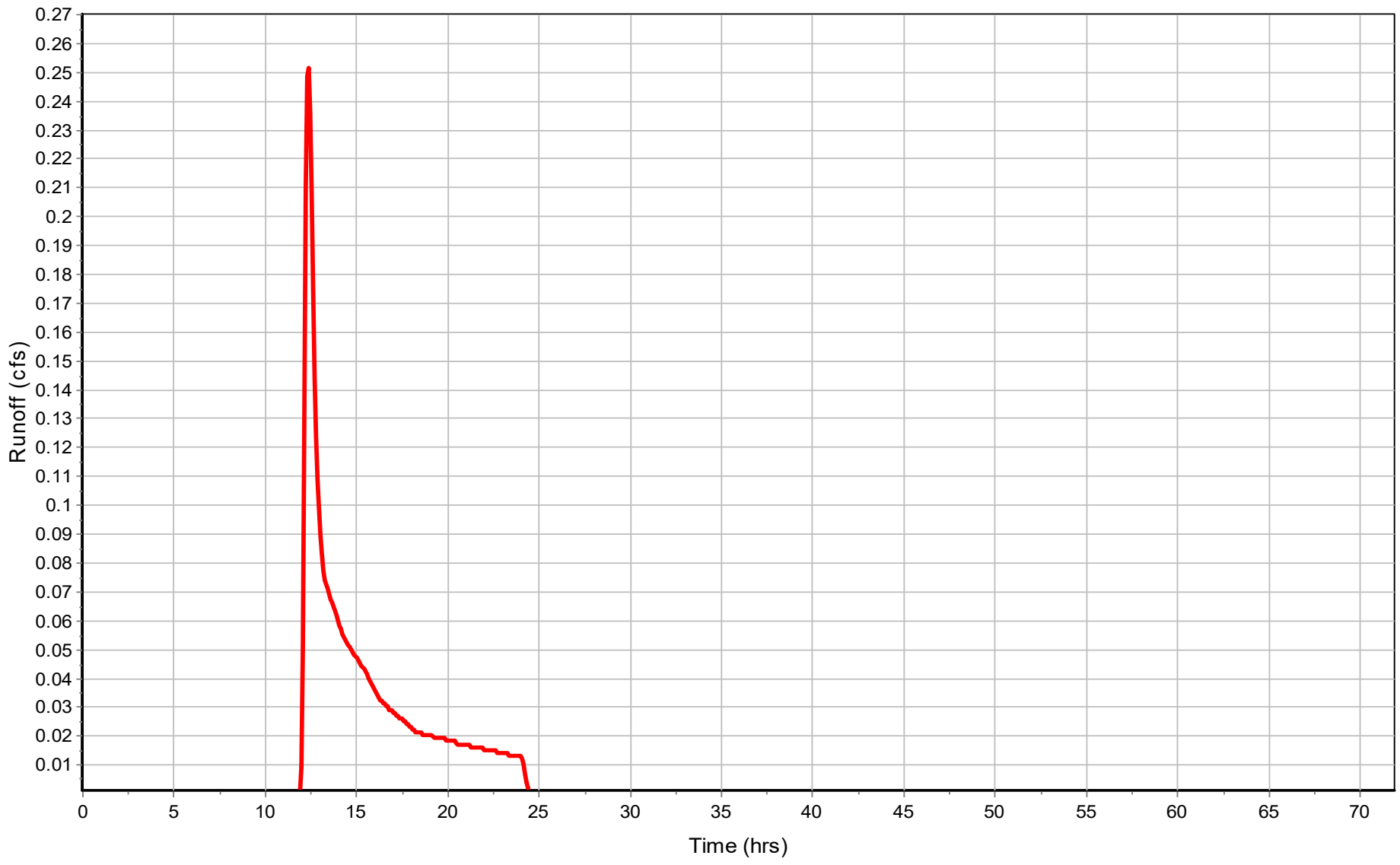
Total Rainfall (in) 6.71
Total Runoff (in) 0.95
Peak Runoff (cfs) 0.25
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:22:13

Subbasin : Sub-E03.2

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E03.2.1

Input Data

Area (ac) 0.38
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.38	A	43
Composite Area & Weighted CN	0.38		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	116.8	0	0
Slope (%) :	15	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.11	0	0
Computed Flow Time (min) :	18.29	0	0

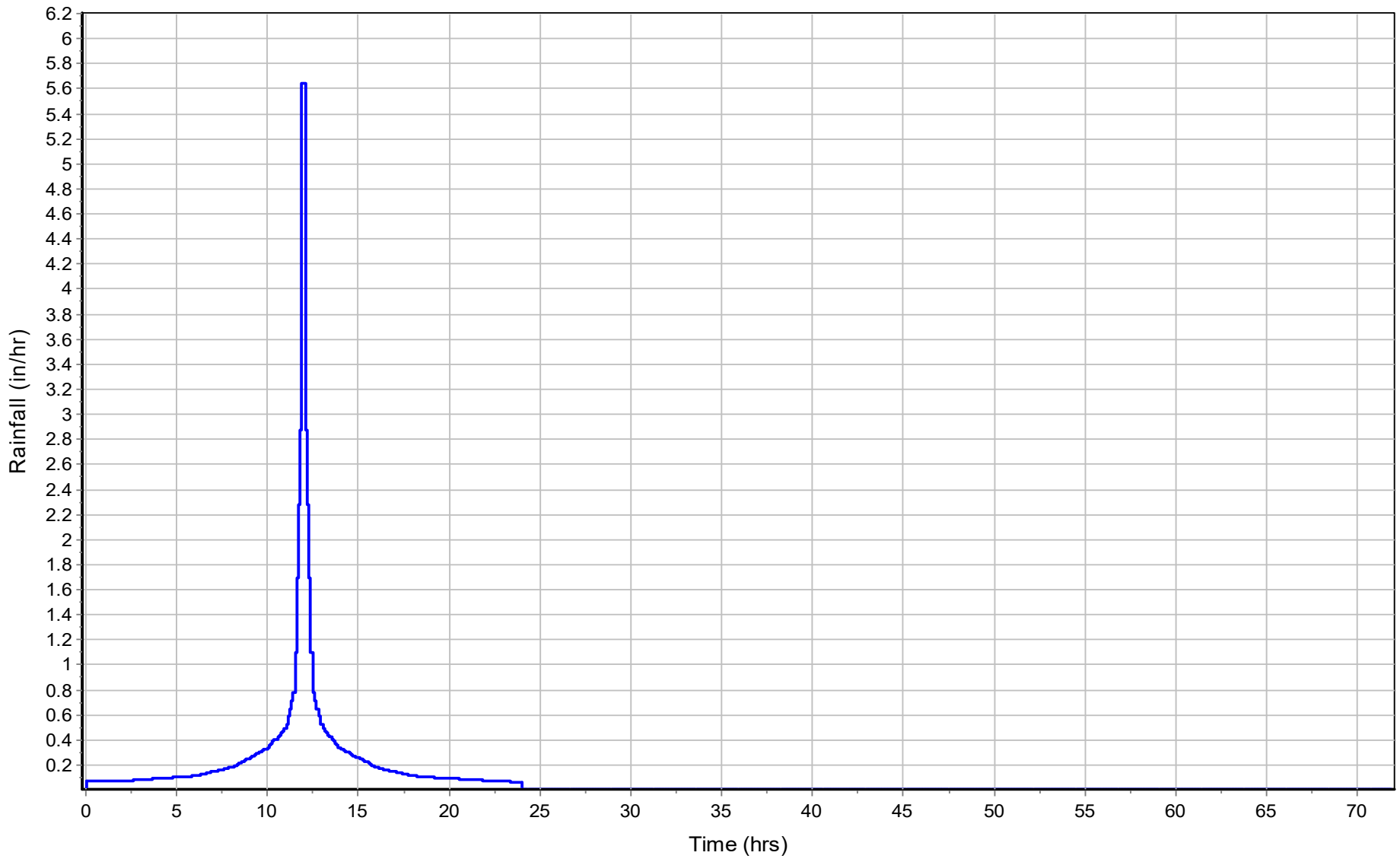
Total TOC (min) 18.29

Subbasin Runoff Results

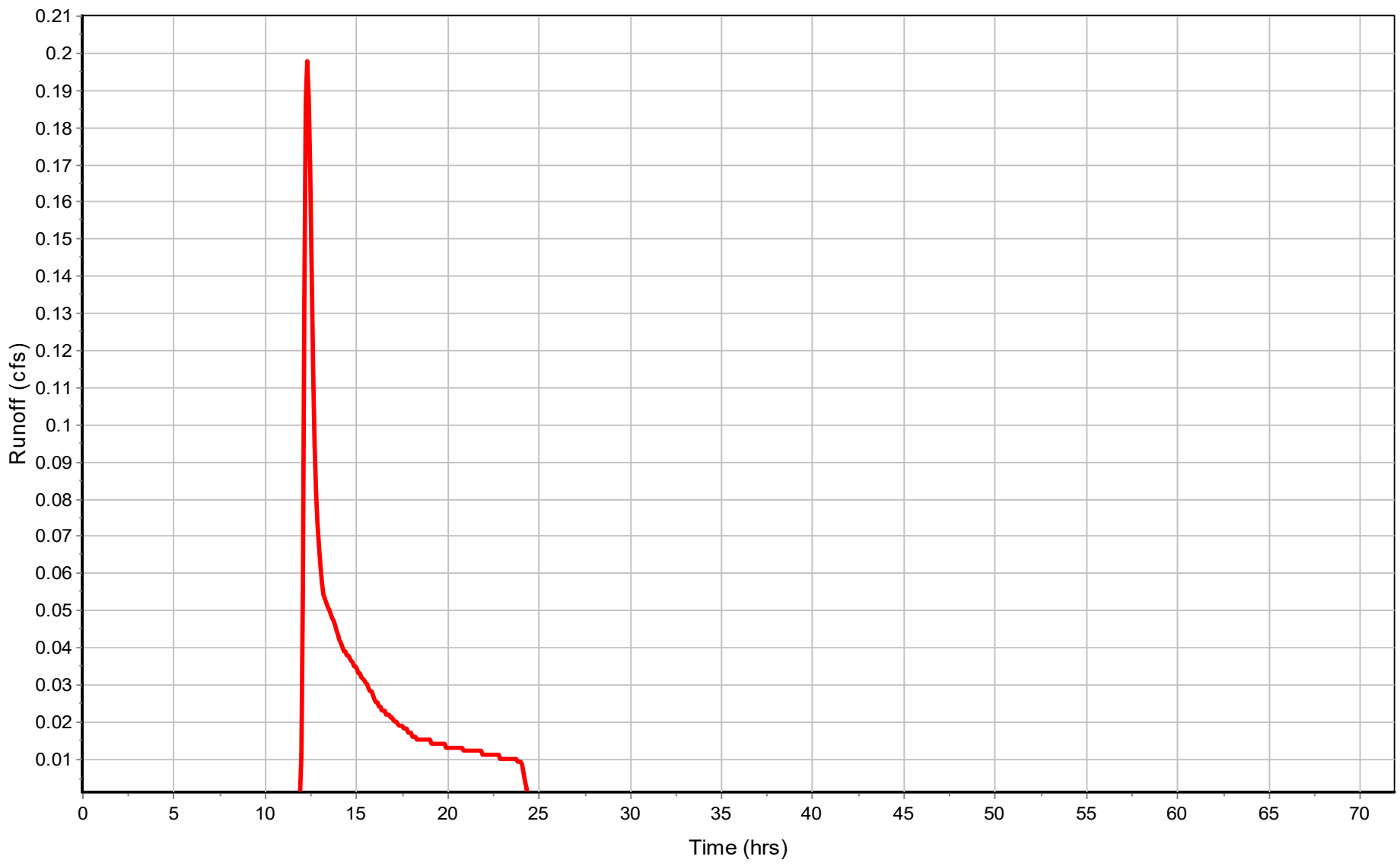
Total Rainfall (in) 6.71
Total Runoff (in) 0.95
Peak Runoff (cfs) 0.2
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:18:17

Subbasin : Sub-E03.2.1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E04

Input Data

Area (ac) 0.19
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.19	A	43
Composite Area & Weighted CN	0.19		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	88.76	0	0
Slope (%) :	14	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.1	0	0
Computed Flow Time (min) :	15.09	0	0

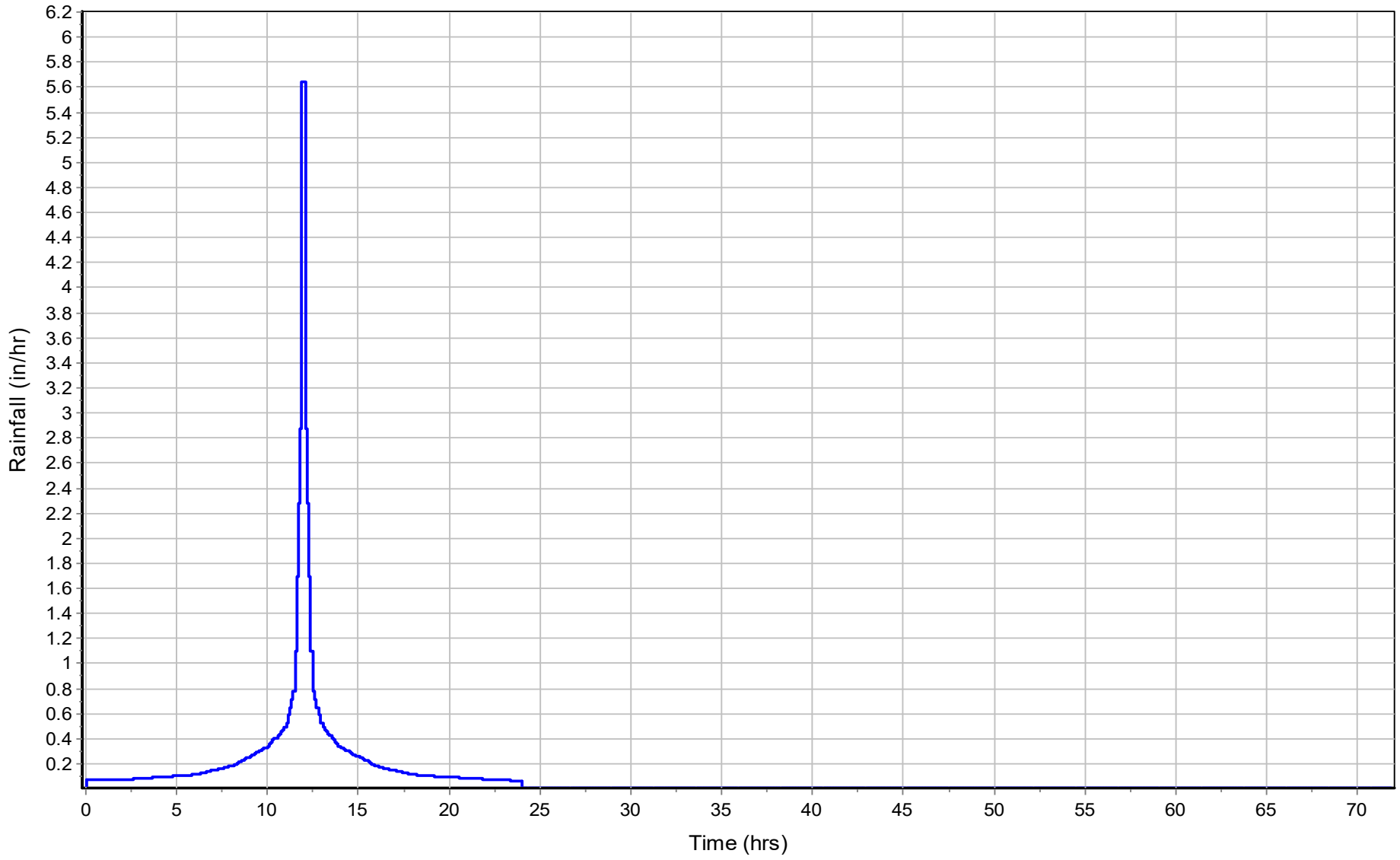
Total TOC (min) 15.09

Subbasin Runoff Results

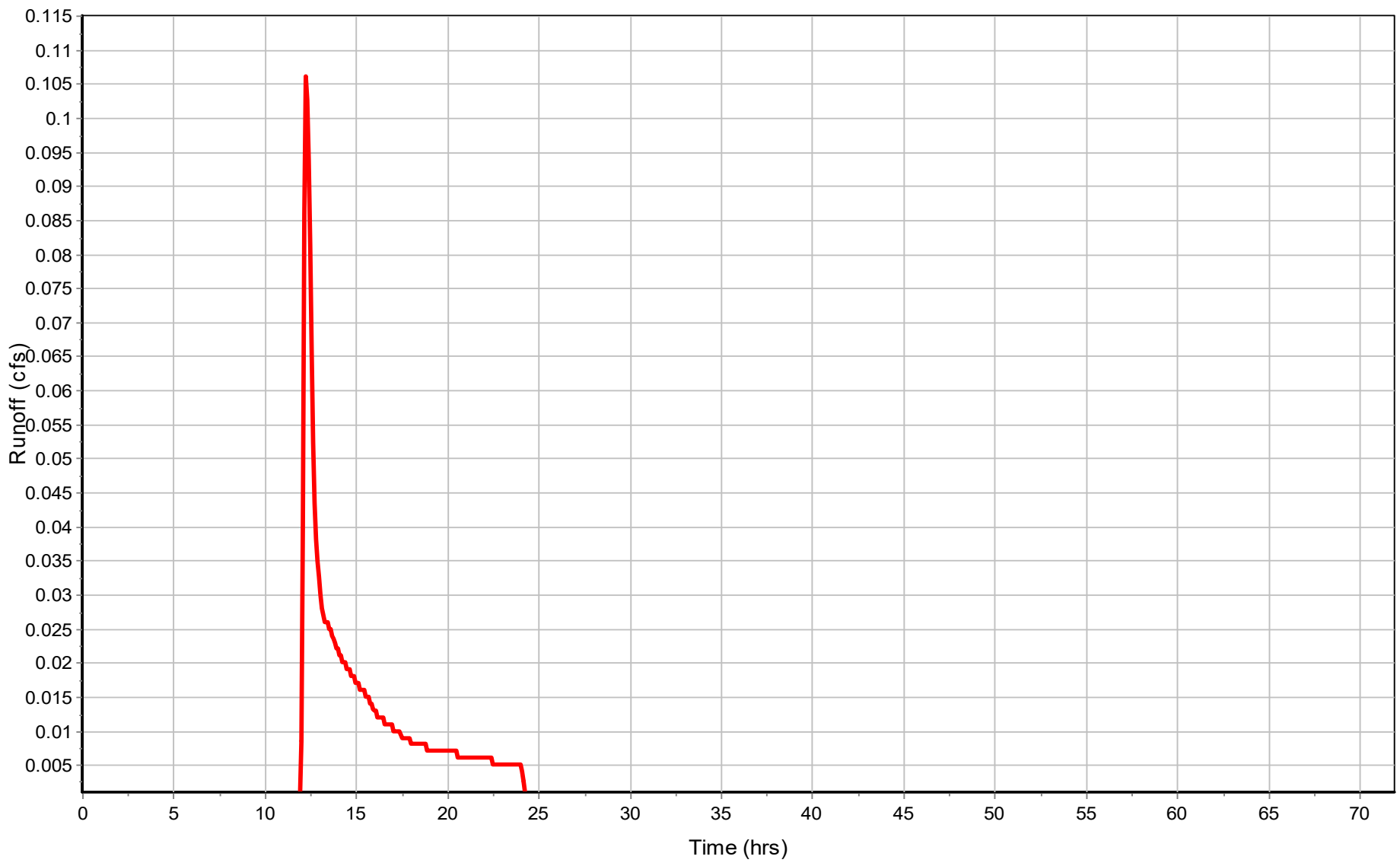
Total Rainfall (in) 6.71
Total Runoff (in) 0.95
Peak Runoff (cfs) 0.11
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:15:05

Subbasin : Sub-E04

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A4

Input Data

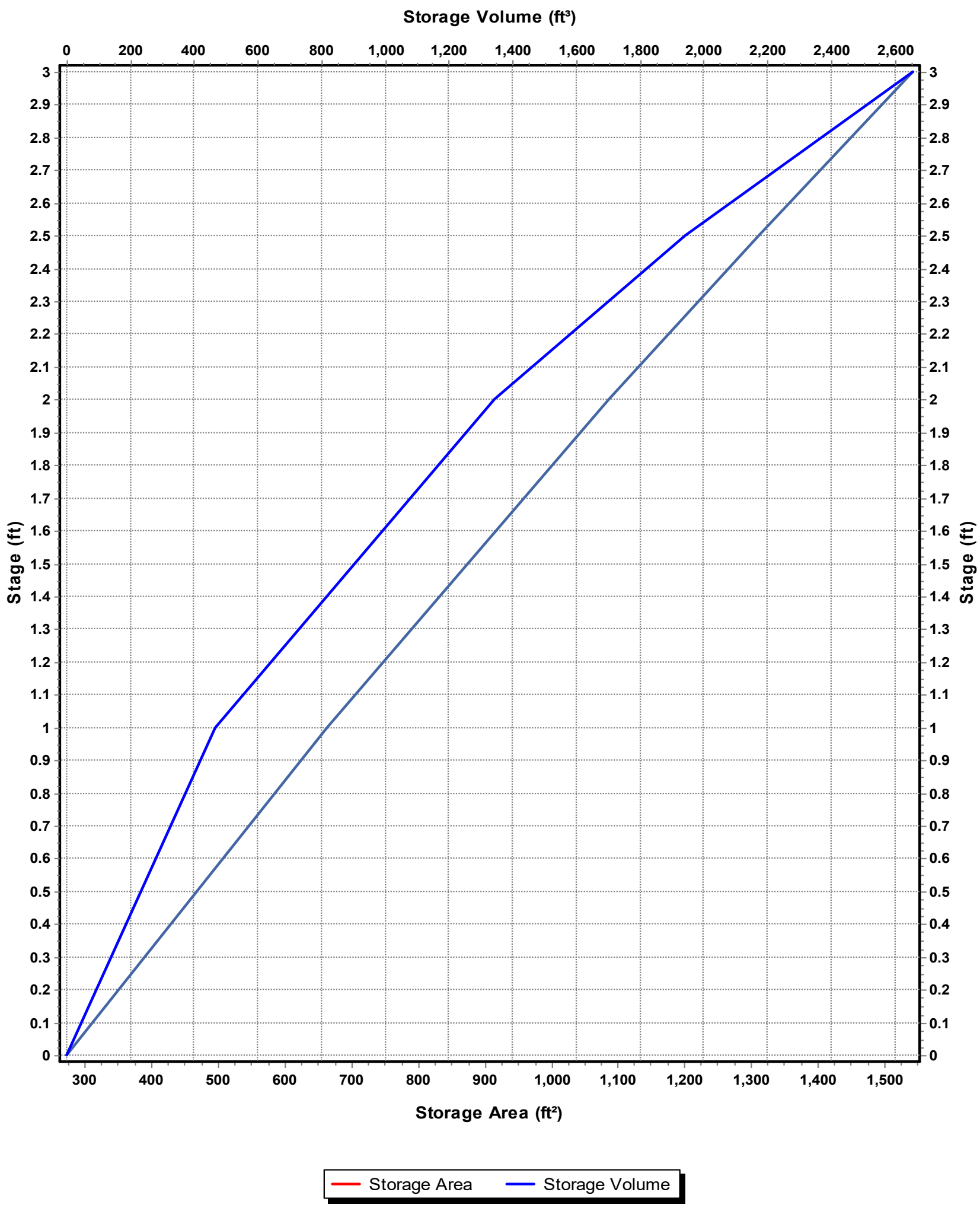
Invert Elevation (ft)	114.00
Max (Rim) Elevation (ft)	117.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.00
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Basin-04

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	272.59	0
1	664.04	468.32
2	1087.5	1344.09
2.5	1311.22	1943.77
3	1542.95	2657.31

Storage Area Volume Curves



Storage Node : Basin-A4 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-B-A4	Trapezoidal	No	116.80	2.80	10.00	0.20	3.33

Output Summary Results

Peak Inflow (cfs)	0.94
Peak Lateral Inflow (cfs)	0.11
Peak Outflow (cfs)	0.13
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	116.8
Max HGL Depth Attained (ft)	2.8
Average HGL Elevation Attained (ft)	116.28
Average HGL Depth Attained (ft)	2.28
Time of Max HGL Occurrence (days hh:mm)	0 18:55
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Forebay-A4

Input Data

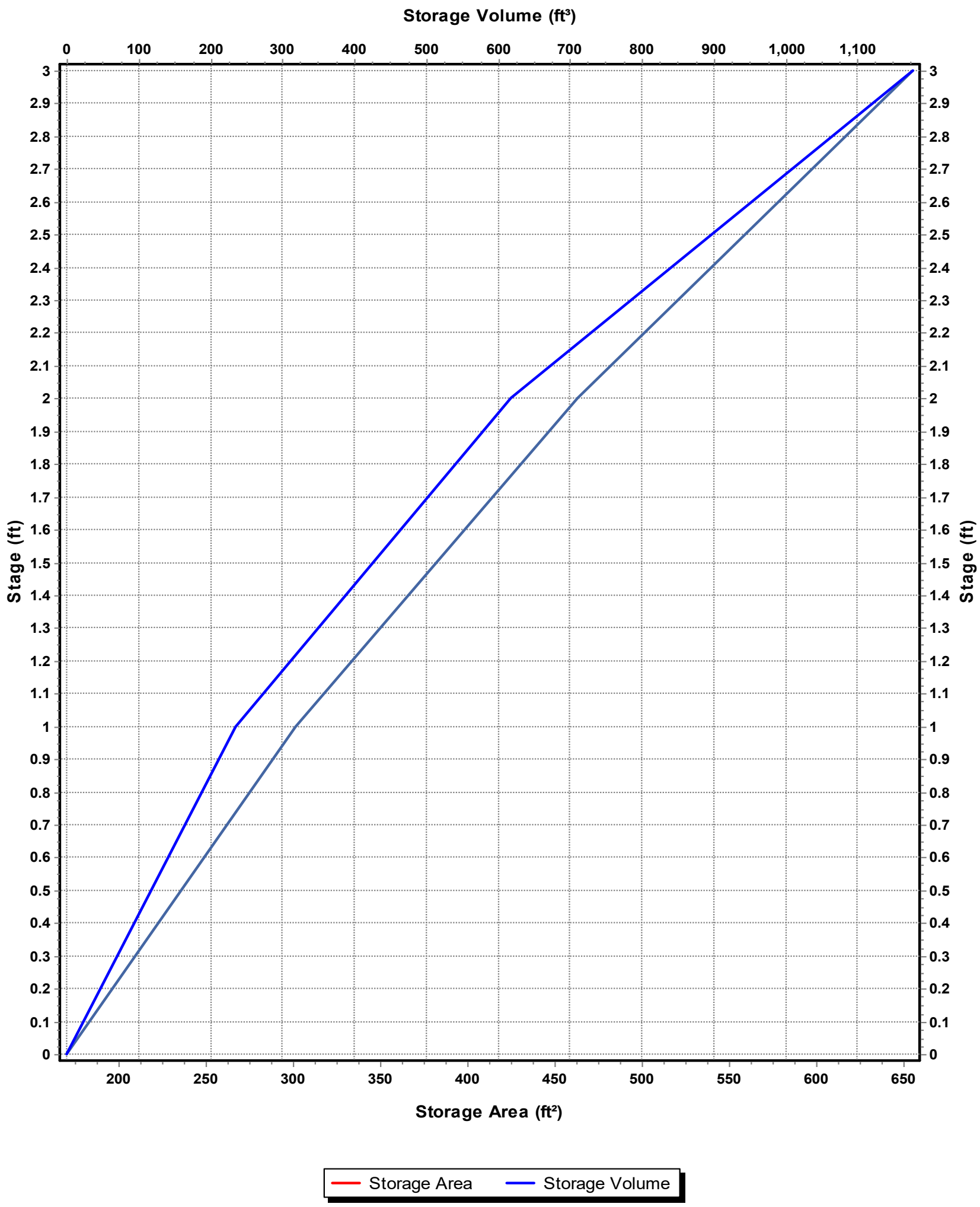
Invert Elevation (ft)	114.00
Max (Rim) Elevation (ft)	117.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.00
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Forebay-04

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	170.46	0
1	301.38	235.92
2	462.94	618.08
3	655.13	1177.12

Storage Area Volume Curves



Storage Node : Forebay-A4 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-F-04	Trapezoidal	No	116.50	2.50	10.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	0.9
Peak Lateral Inflow (cfs)	0.9
Peak Outflow (cfs)	0.89
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	116.82
Max HGL Depth Attained (ft)	2.82
Average HGL Elevation Attained (ft)	116.35
Average HGL Depth Attained (ft)	2.35
Time of Max HGL Occurrence (days hh:mm)	0 18:55
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Project Description

File Name ..... Pave.Paws_A4.SPF

Project Options

Flow Units ..... CFS
Elevation Type ..... Elevation
Hydrology Method ..... SCS TR-20
Time of Concentration (TOC) Method ..... SCS TR-55
Link Routing Method ..... Hydrodynamic
Enable Overflow Ponding at Nodes ..... YES
Skip Steady State Analysis Time Periods ..... NO

Analysis Options

Start Analysis On	00:00:00	0:00:00
End Analysis On	00:00:00	0:00:00
Start Reporting On	00:00:00	0:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins.....	4
Nodes.....	4
Junctions	0
Outfalls	2
Flow Diversions	0
Inlets	0
Storage Nodes	2
Links.....	2
Channels	0
Pipes	0
Pumps	0
Orifices	0
Weirs	2
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	50 years (2070)	Intensity	inches	Massachusetts	None	50.00	8.80	SCS Type III 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Sub-A4	0.22	484.00	76.00	8.80	5.89	1.32	1.33	0 00:06:00
2	Sub-E03.2	0.51	484.00	43.00	8.80	1.95	1.00	0.65	0 00:22:12
3	Sub-E03.2.1	0.38	484.00	43.00	8.80	1.95	0.74	0.51	0 00:18:17
4	Sub-E04	0.19	484.00	43.00	8.80	1.95	0.37	0.28	0 00:15:05

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Out-A4	Outfall	106.00					0.51	106.00					
2	Out-E03.2	Outfall	0.00					0.64	0.00					
3	Basin-A4	Storage Node	114.00	117.00	114.00		0.00	1.94	116.84				0.00	0.00
4	Forebay-A4	Storage Node	114.00	117.00	114.00		0.00	1.60	116.87				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(ft)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
1	Weir-B-A4	Weir	Basin-A4	Out-A4		114.00	106.00				0.28							
2	Weir-F-04	Weir	Forebay-A4	Basin-A4		114.00	114.00				1.89							

Subbasin Hydrology

Subbasin : Sub-A4

Input Data

Area (ac) 0.22
Peak Rate Factor 484
Weighted Curve Number 76
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	0.22	A	76
Composite Area & Weighted CN	0.22		76

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft^2)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	110.17	0	0
Slope (%) :	1	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.86	0	0
Computed Flow Time (min) :	2.14	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	76.5	0	0
Channel Slope (%) :	1.13	0	0
Cross Section Area (ft^2) :	2.43	0	0
Wetted Perimeter (ft) :	5.69	0	0
Velocity (ft/sec) :	2.99	0	0
Computed Flow Time (min) :	0.43	0	0

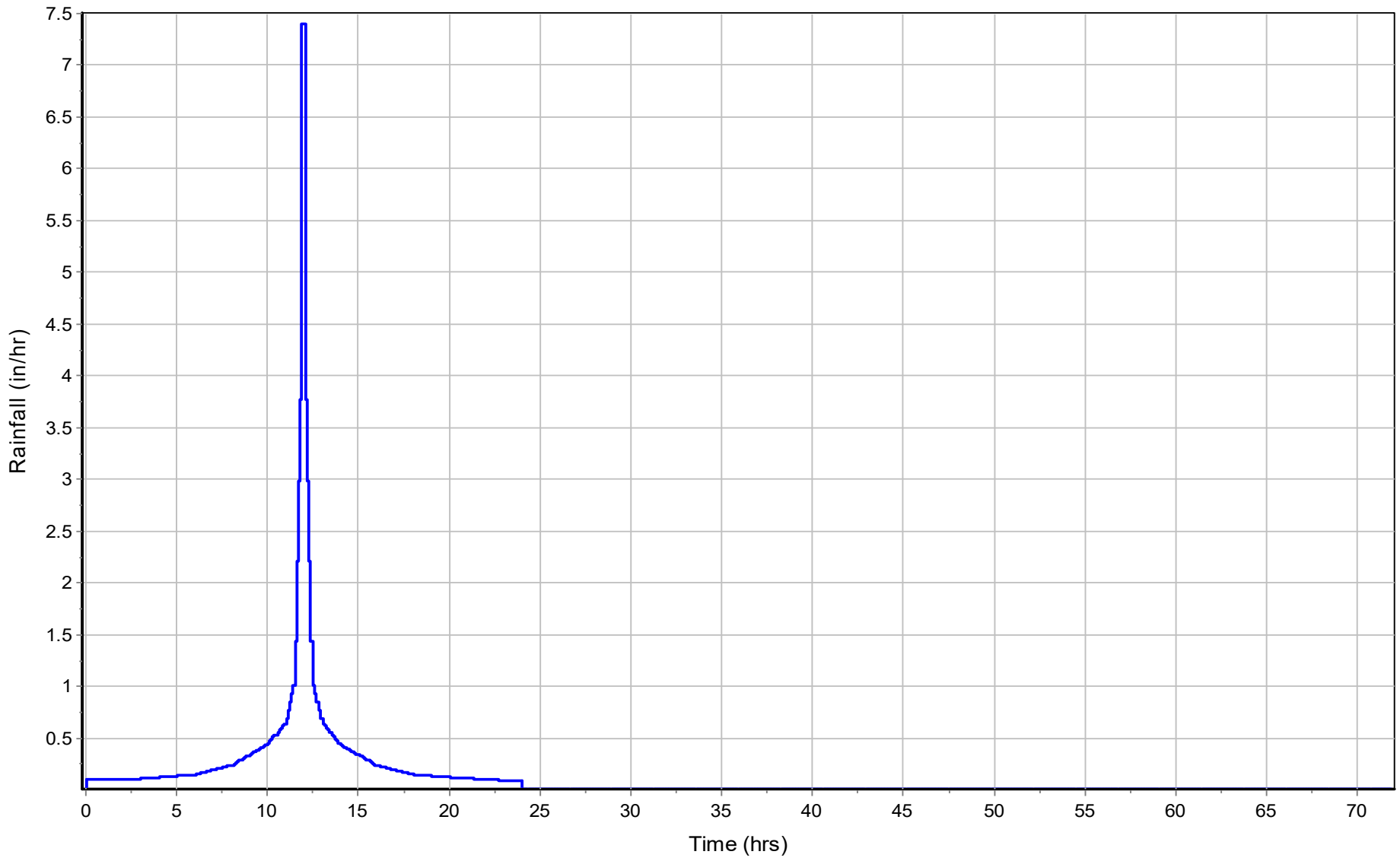
Total TOC (min) 2.57

Subbasin Runoff Results

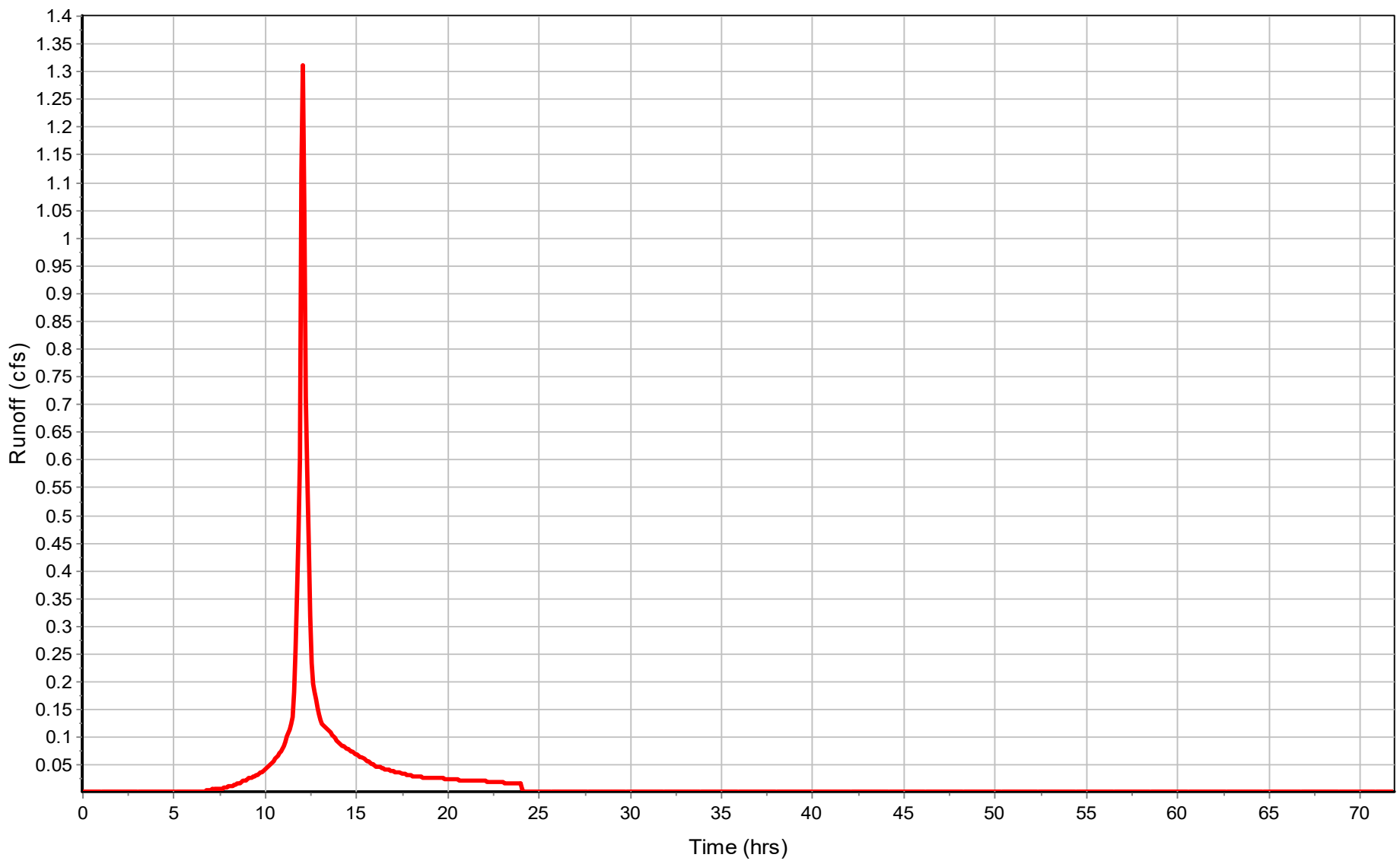
Total Rainfall (in)	8.8
Total Runoff (in)	5.89
Peak Runoff (cfs)	1.33
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:02:34

Subbasin : Sub-A4

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E03.2

Input Data

Area (ac) 0.51
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.51	A	43
Composite Area & Weighted CN	0.51		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	143.83	0	0
Slope (%) :	14	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.11	0	0
Computed Flow Time (min) :	22.21	0	0

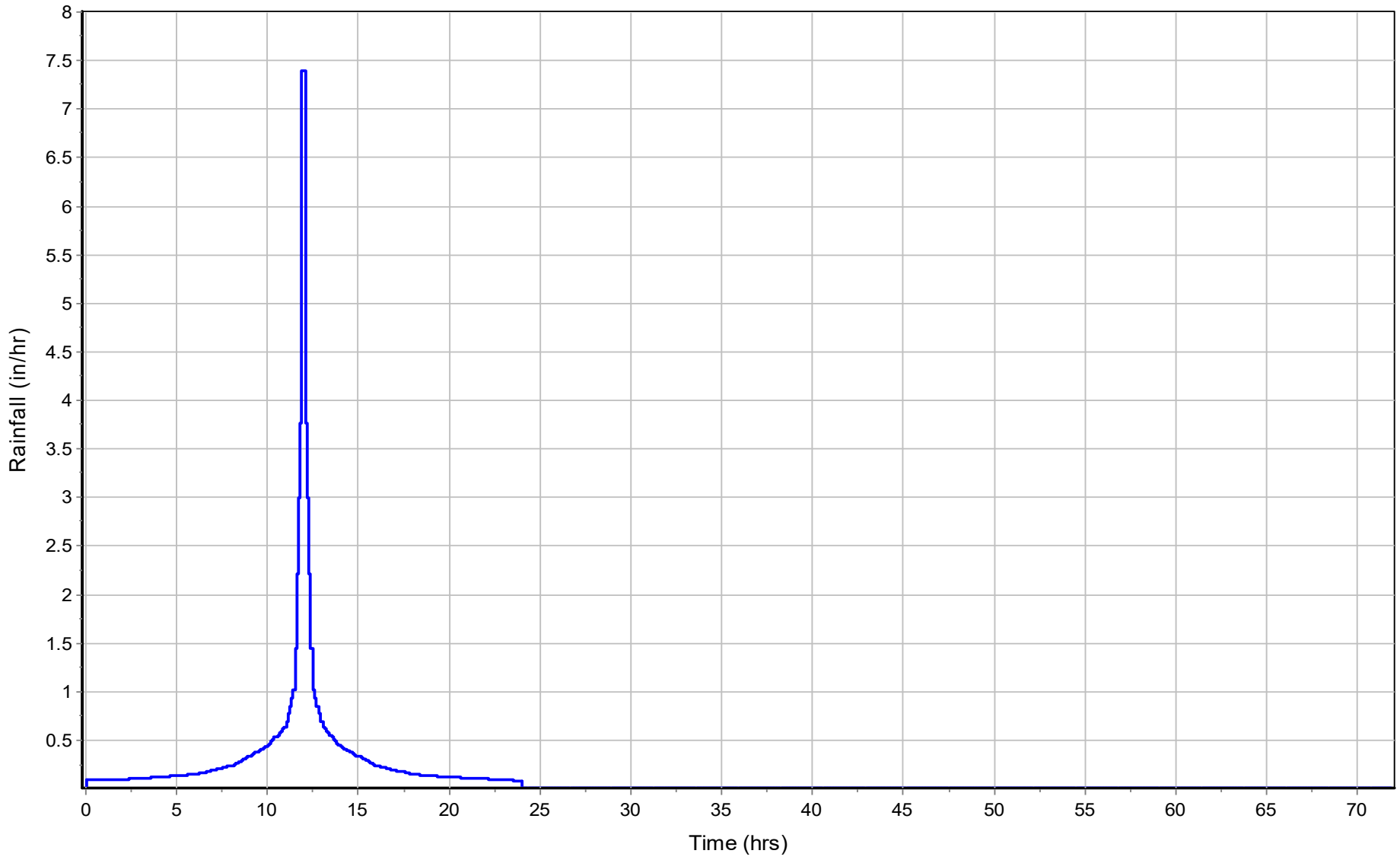
Total TOC (min) 22.21

Subbasin Runoff Results

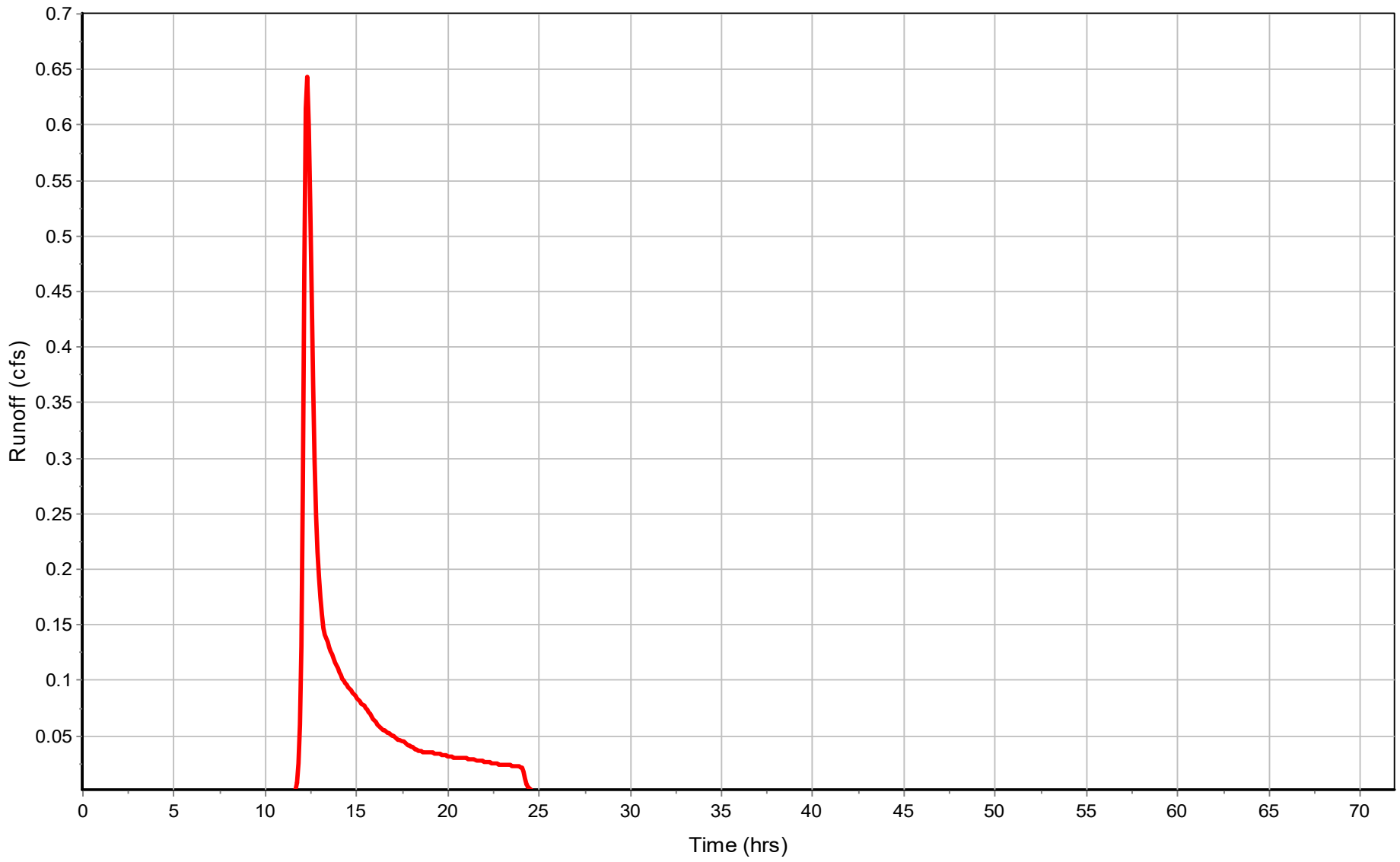
Total Rainfall (in) 8.8
Total Runoff (in) 1.95
Peak Runoff (cfs) 0.65
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:22:13

Subbasin : Sub-E03.2

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E03.2.1

Input Data

Area (ac) 0.38
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.38	A	43
Composite Area & Weighted CN	0.38		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	116.8	0	0
Slope (%) :	15	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.11	0	0
Computed Flow Time (min) :	18.29	0	0

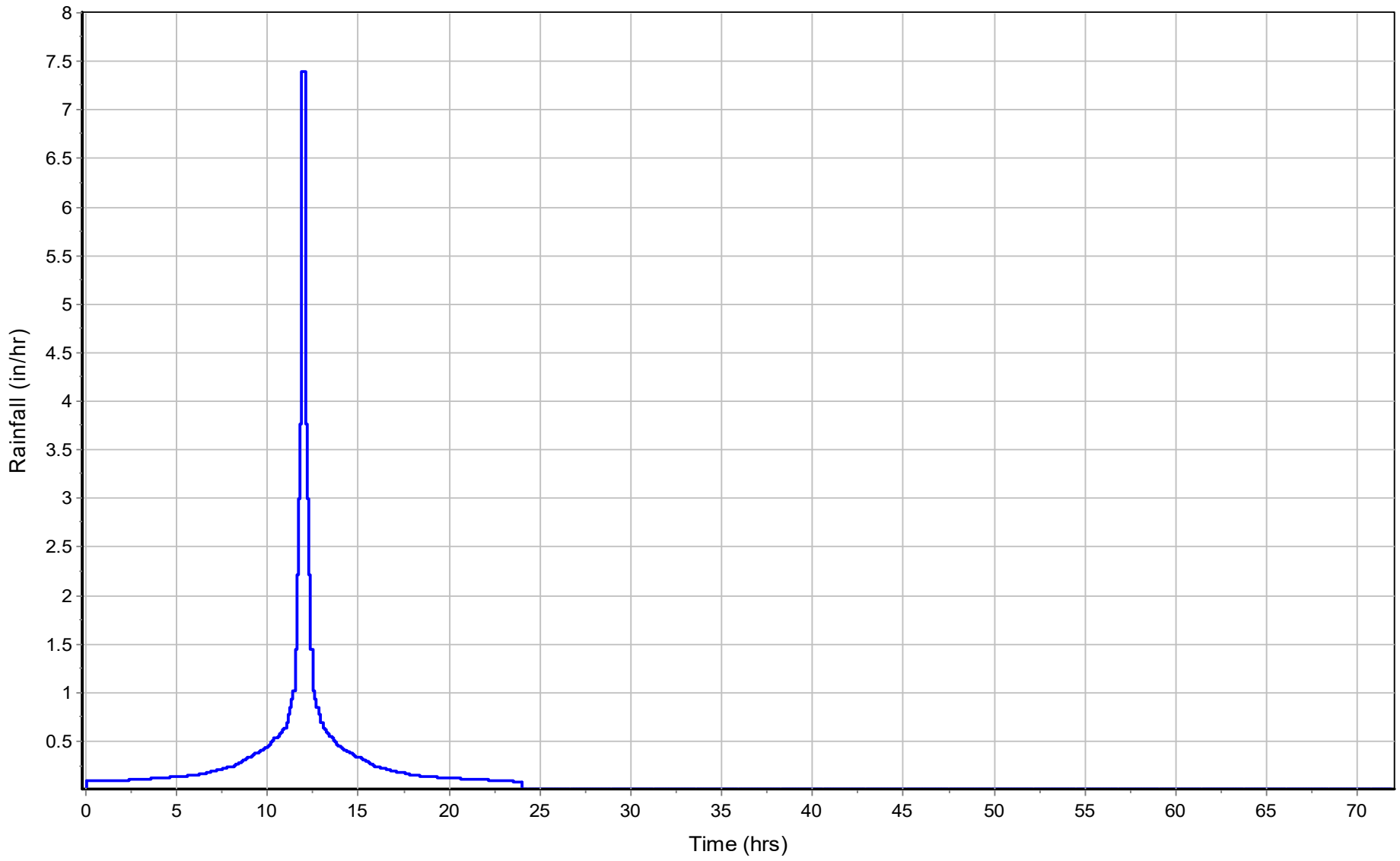
Total TOC (min) 18.29

Subbasin Runoff Results

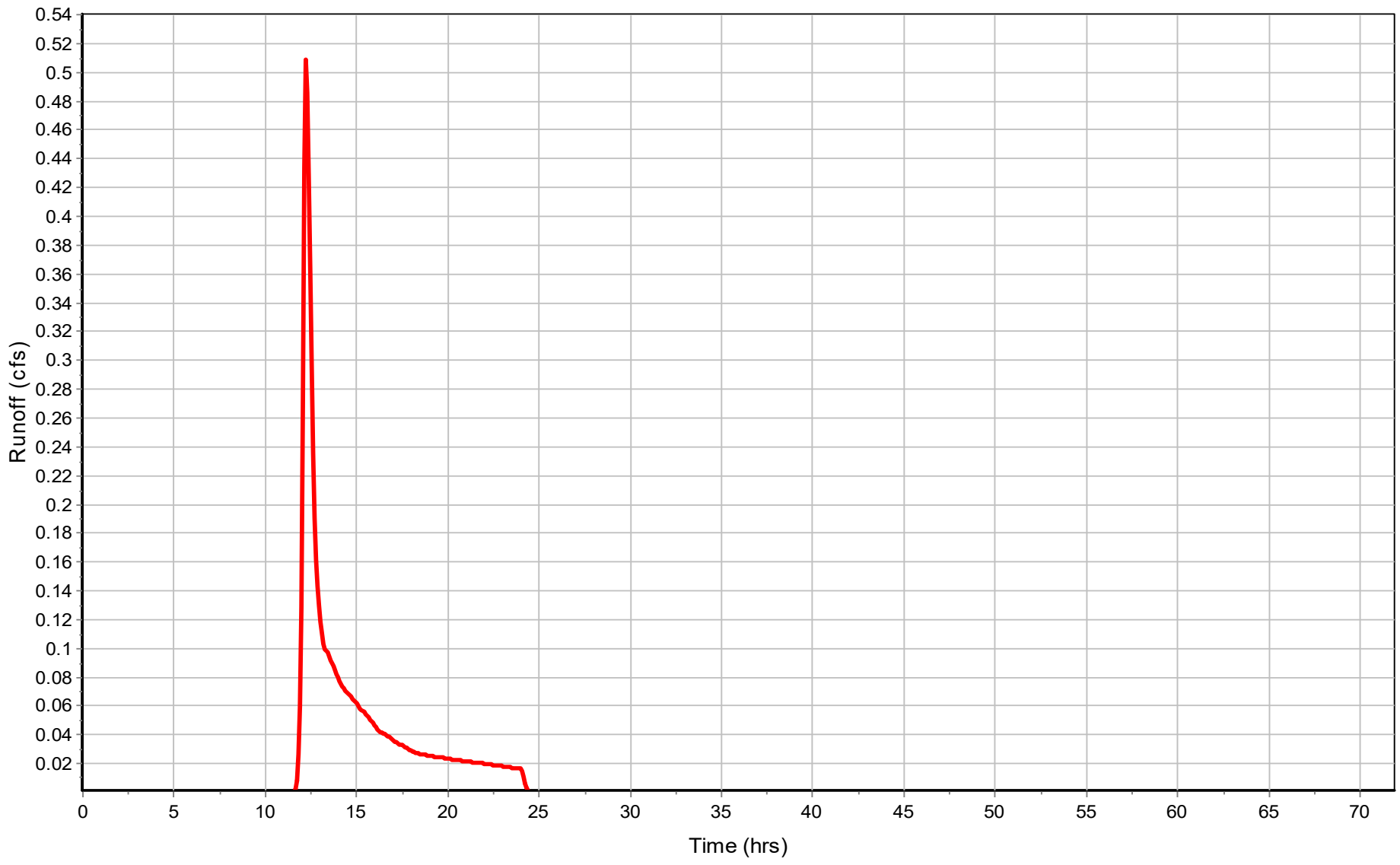
Total Rainfall (in) 8.8
Total Runoff (in) 1.95
Peak Runoff (cfs) 0.51
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:18:17

Subbasin : Sub-E03.2.1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E04

Input Data

Area (ac) 0.19
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.19	A	43
Composite Area & Weighted CN	0.19		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	88.76	0	0
Slope (%) :	14	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.1	0	0
Computed Flow Time (min) :	15.09	0	0

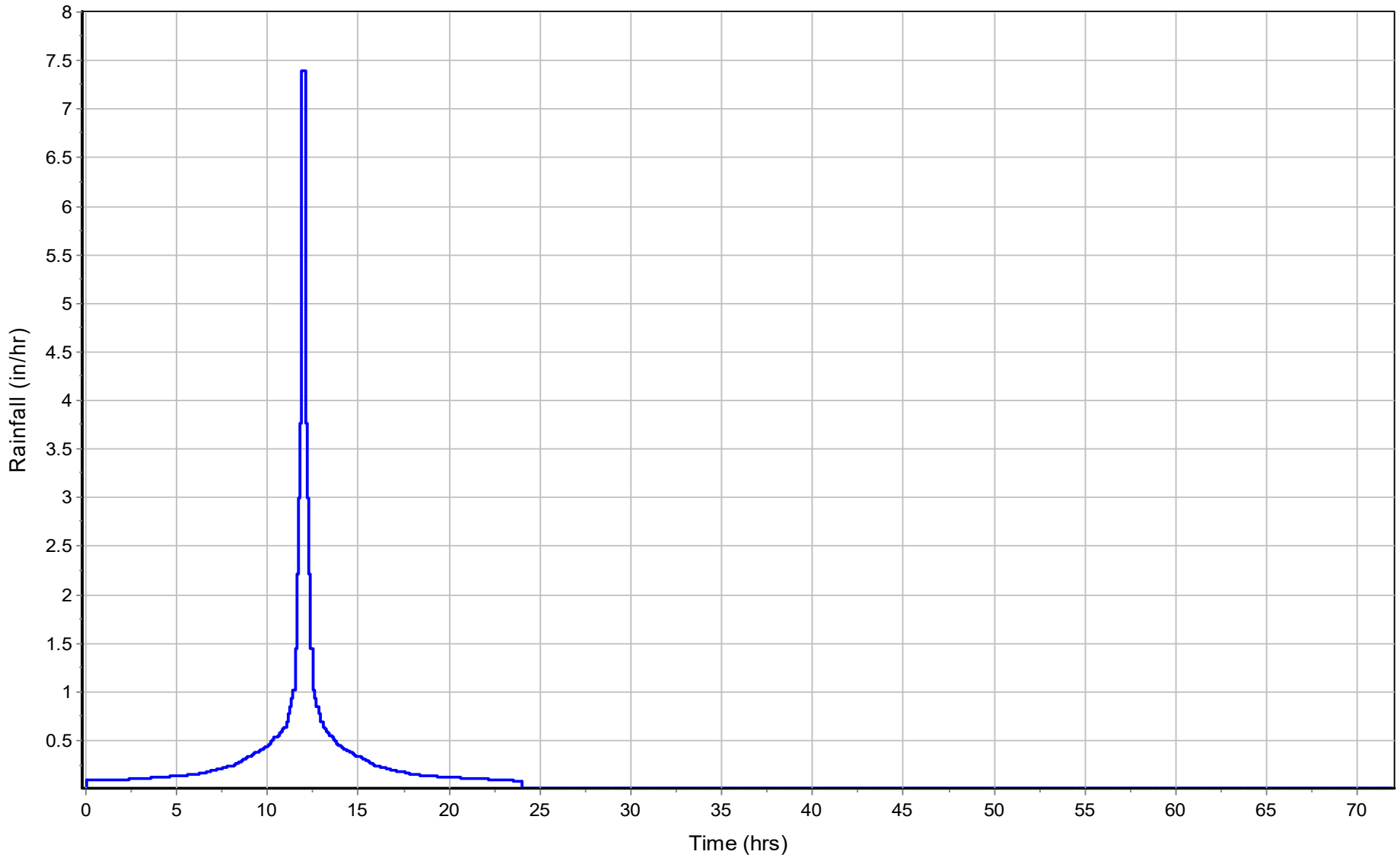
Total TOC (min) 15.09

Subbasin Runoff Results

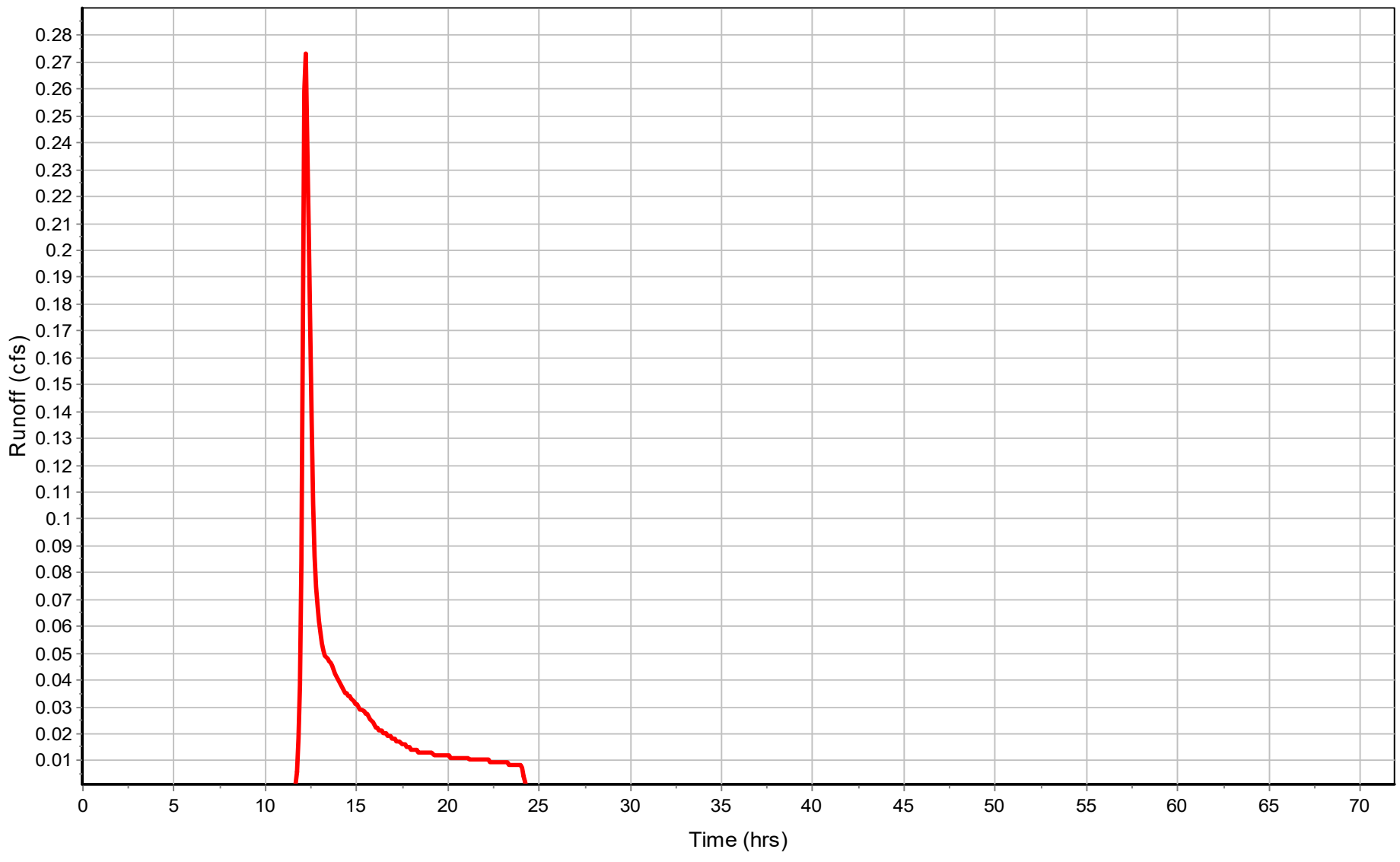
Total Rainfall (in) 8.8
Total Runoff (in) 1.95
Peak Runoff (cfs) 0.28
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:15:05

Subbasin : Sub-E04

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A4

Input Data

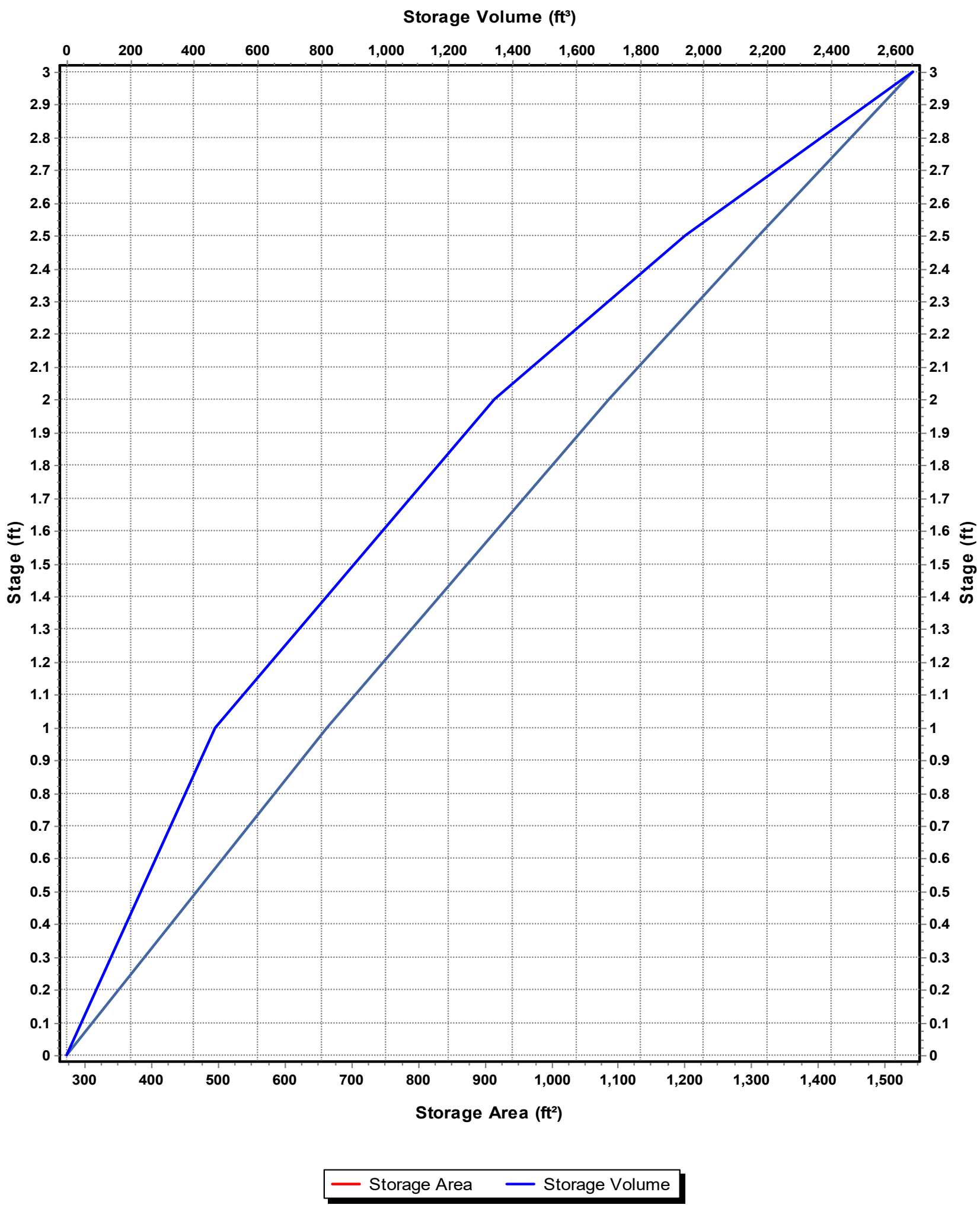
Invert Elevation (ft)	114.00
Max (Rim) Elevation (ft)	117.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.00
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Basin-04

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	272.59	0
1	664.04	468.32
2	1087.5	1344.09
2.5	1311.22	1943.77
3	1542.95	2657.31

Storage Area Volume Curves



Storage Node : Basin-A4 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-B-A4	Trapezoidal	No	116.80	2.80	10.00	0.20	3.33

Output Summary Results

Peak Inflow (cfs)	1.94
Peak Lateral Inflow (cfs)	0.27
Peak Outflow (cfs)	1.69
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	116.84
Max HGL Depth Attained (ft)	2.84
Average HGL Elevation Attained (ft)	116.31
Average HGL Depth Attained (ft)	2.31
Time of Max HGL Occurrence (days hh:mm)	0 12:55
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Forebay-A4

Input Data

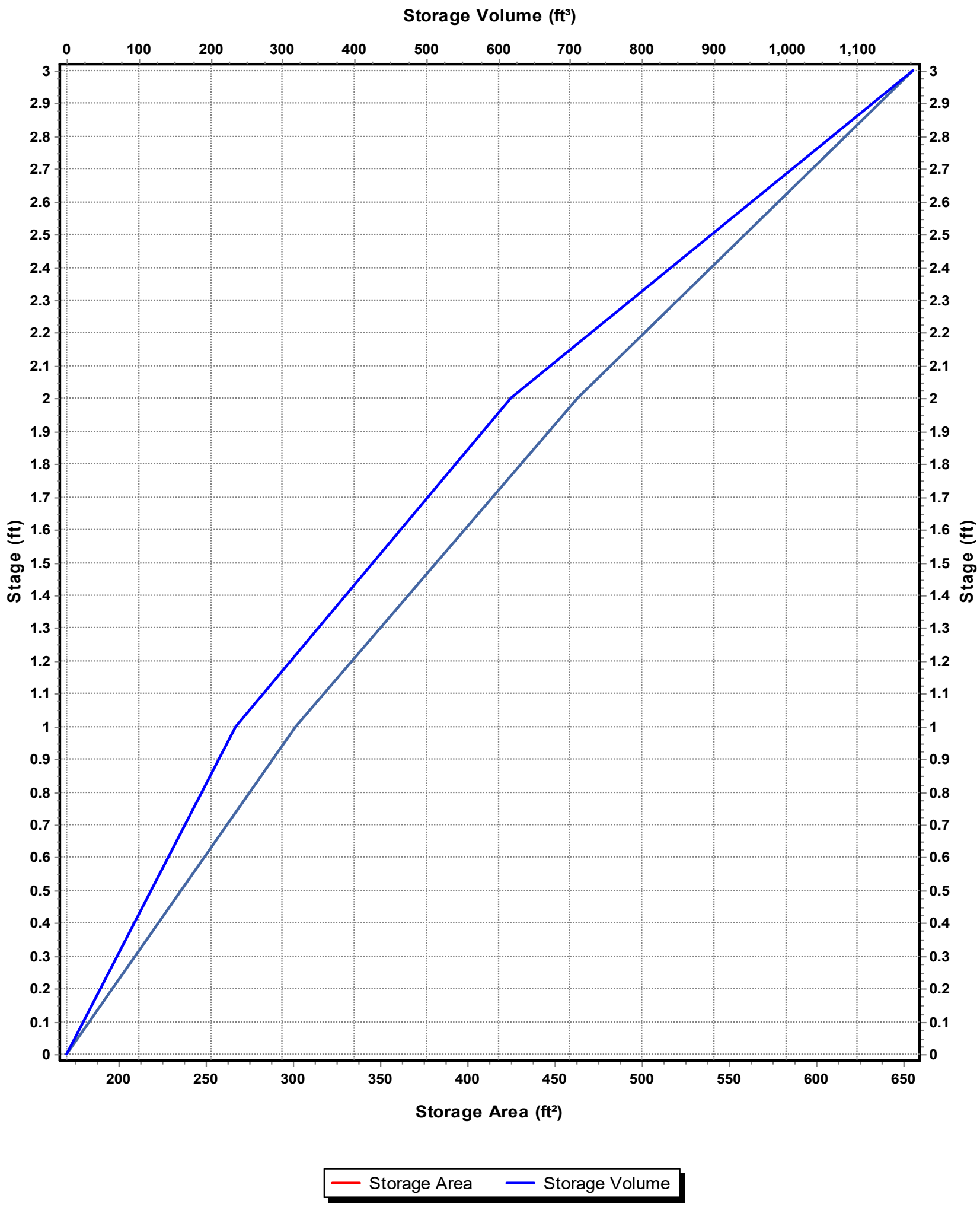
Invert Elevation (ft)	114.00
Max (Rim) Elevation (ft)	117.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.00
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Forebay-04

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	170.46	0
1	301.38	235.92
2	462.94	618.08
3	655.13	1177.12

Storage Area Volume Curves



Storage Node : Forebay-A4 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-F-04	Trapezoidal	No	116.50	2.50	10.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	1.6
Peak Lateral Inflow (cfs)	1.31
Peak Outflow (cfs)	1.89
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	116.87
Max HGL Depth Attained (ft)	2.87
Average HGL Elevation Attained (ft)	116.39
Average HGL Depth Attained (ft)	2.39
Time of Max HGL Occurrence (days hh:mm)	0 12:58
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Project Description

File Name	Pave.Paws_A4.SPF

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	SCS TR-20
Time of Concentration (TOC) Method	SCS TR-55
Link Routing Method	Hydrodynamic
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	NO

Analysis Options

Start Analysis On	00:00:00	0:00:00
End Analysis On	00:00:00	0:00:00
Start Reporting On	00:00:00	0:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	4
Nodes	4
Junctions	0
Outfalls	2
Flow Diversions	0
Inlets	0
Storage Nodes	2
Links	2
Channels	0
Pipes	0
Pumps	0
Orifices	0
Weirs	2
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	100 years	Intensity	inches	Massachusetts	None	100.00	7.48	SCS Type III 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Sub-A4	0.22	484.00	76.00	7.48	4.69	1.05	1.07	0 00:06:00
2	Sub-E03.2	0.51	484.00	43.00	7.48	1.29	0.66	0.38	0 00:22:12
3	Sub-E03.2.1	0.38	484.00	43.00	7.48	1.29	0.49	0.30	0 00:18:17
4	Sub-E04	0.19	484.00	43.00	7.48	1.29	0.24	0.16	0 00:15:05

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Out-A4	Outfall	106.00					0.30	106.00					
2	Out-E03.2	Outfall	0.00					0.38	0.00					
3	Basin-A4	Storage Node	114.00	117.00	114.00		0.00	1.13	116.81				0.00	0.00
4	Forebay-A4	Storage Node	114.00	117.00	114.00		0.00	1.05	116.84				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(ft)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
1	Weir-B-A4	Weir	Basin-A4	Out-A4		114.00	106.00				0.08							
2	Weir-F-04	Weir	Forebay-A4	Basin-A4		114.00	114.00				1.04							

Subbasin Hydrology

Subbasin : Sub-A4

Input Data

Area (ac) 0.22
Peak Rate Factor 484
Weighted Curve Number 76
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	0.22	A	76
Composite Area & Weighted CN	0.22		76

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft^2)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	110.17	0	0
Slope (%) :	1	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.86	0	0
Computed Flow Time (min) :	2.14	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	76.5	0	0
Channel Slope (%) :	1.13	0	0
Cross Section Area (ft^2) :	2.43	0	0
Wetted Perimeter (ft) :	5.69	0	0
Velocity (ft/sec) :	2.99	0	0
Computed Flow Time (min) :	0.43	0	0

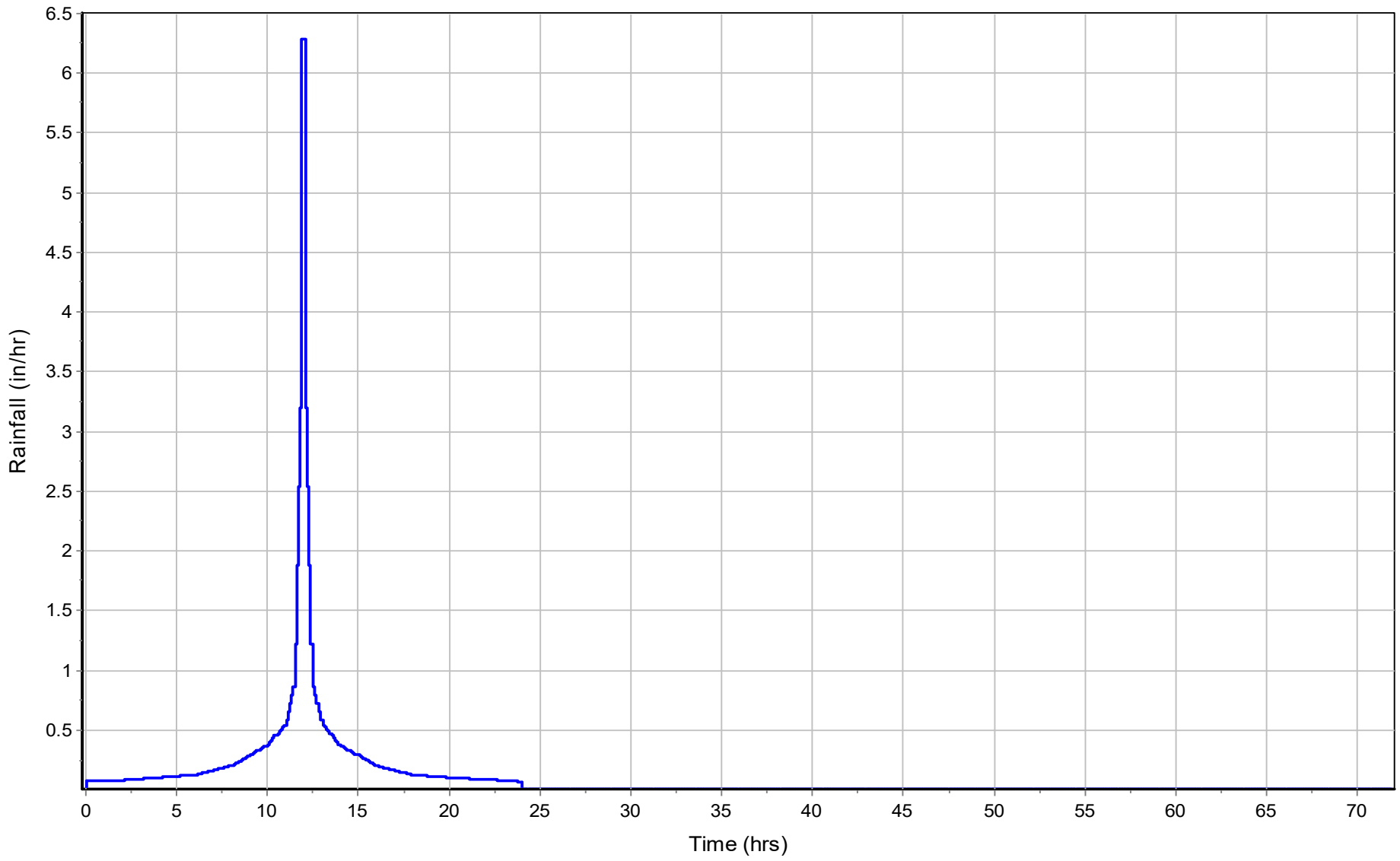
Total TOC (min) 2.57

Subbasin Runoff Results

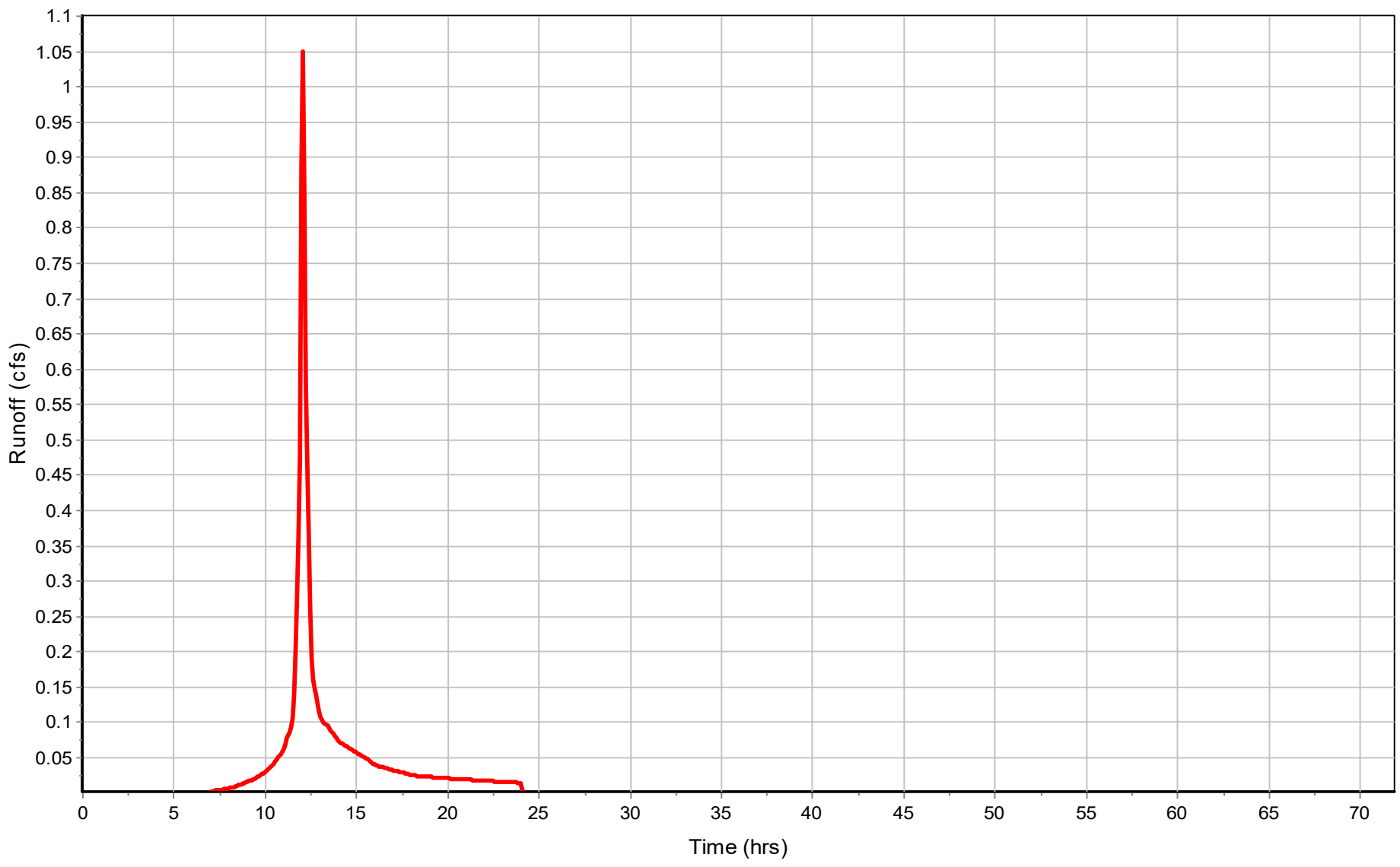
Total Rainfall (in)	7.48
Total Runoff (in)	4.69
Peak Runoff (cfs)	1.07
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:02:34

Subbasin : Sub-A4

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E03.2

Input Data

Area (ac) 0.51
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.51	A	43
Composite Area & Weighted CN	0.51		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	143.83	0	0
Slope (%) :	14	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.11	0	0
Computed Flow Time (min) :	22.21	0	0

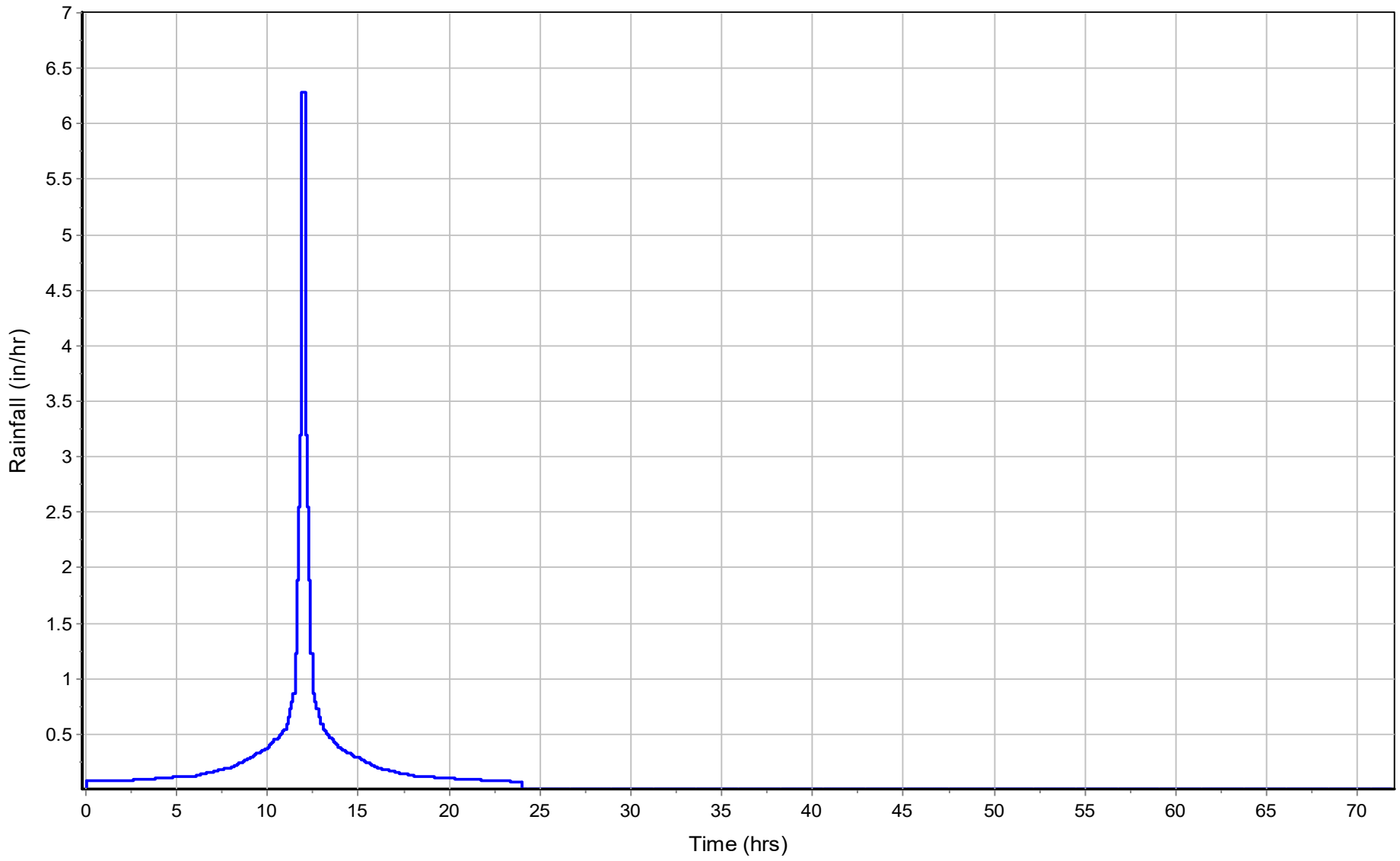
Total TOC (min) 22.21

Subbasin Runoff Results

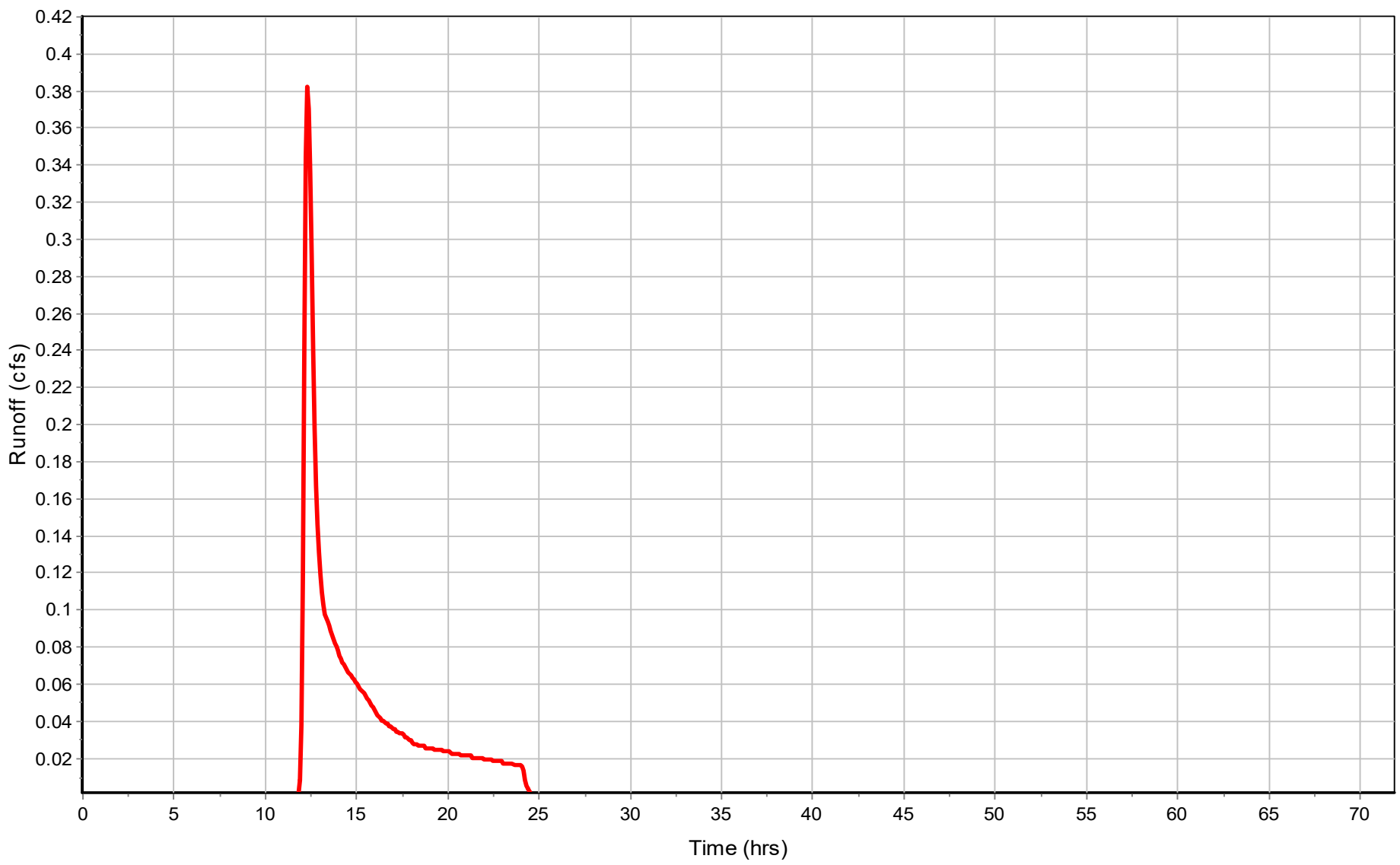
Total Rainfall (in) 7.48
Total Runoff (in) 1.29
Peak Runoff (cfs) 0.38
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:22:13

Subbasin : Sub-E03.2

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E03.2.1

Input Data

Area (ac) 0.38
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.38	A	43
Composite Area & Weighted CN	0.38		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	116.8	0	0
Slope (%) :	15	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.11	0	0
Computed Flow Time (min) :	18.29	0	0

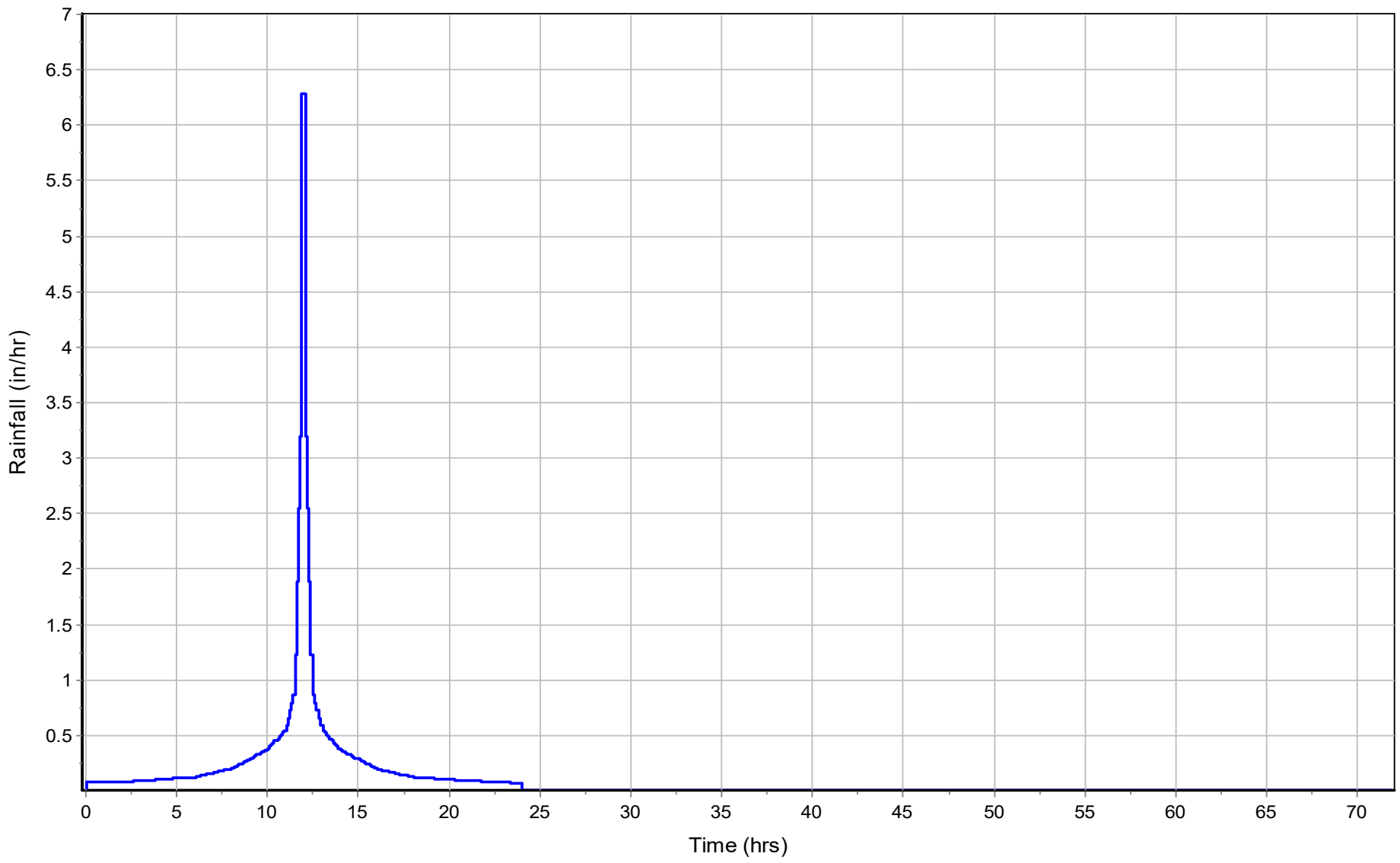
Total TOC (min) 18.29

Subbasin Runoff Results

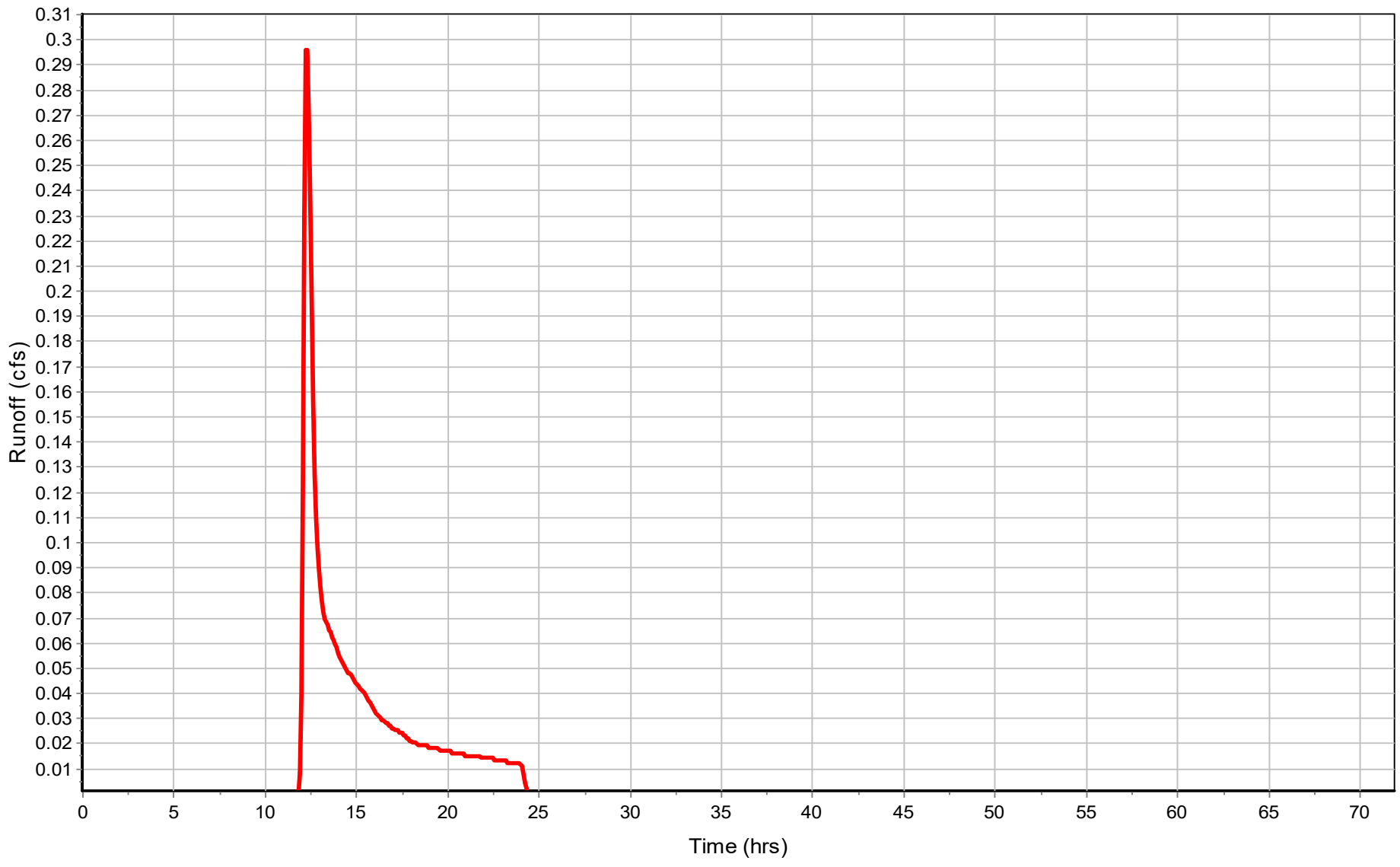
Total Rainfall (in) 7.48
Total Runoff (in) 1.29
Peak Runoff (cfs) 0.3
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:18:17

Subbasin : Sub-E03.2.1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E04

Input Data

Area (ac) 0.19
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.19	A	43
Composite Area & Weighted CN	0.19		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	88.76	0	0
Slope (%) :	14	0	0
2 yr, 24 hr Rainfall (in) :	3.02	0	0
Velocity (ft/sec) :	0.1	0	0
Computed Flow Time (min) :	15.09	0	0

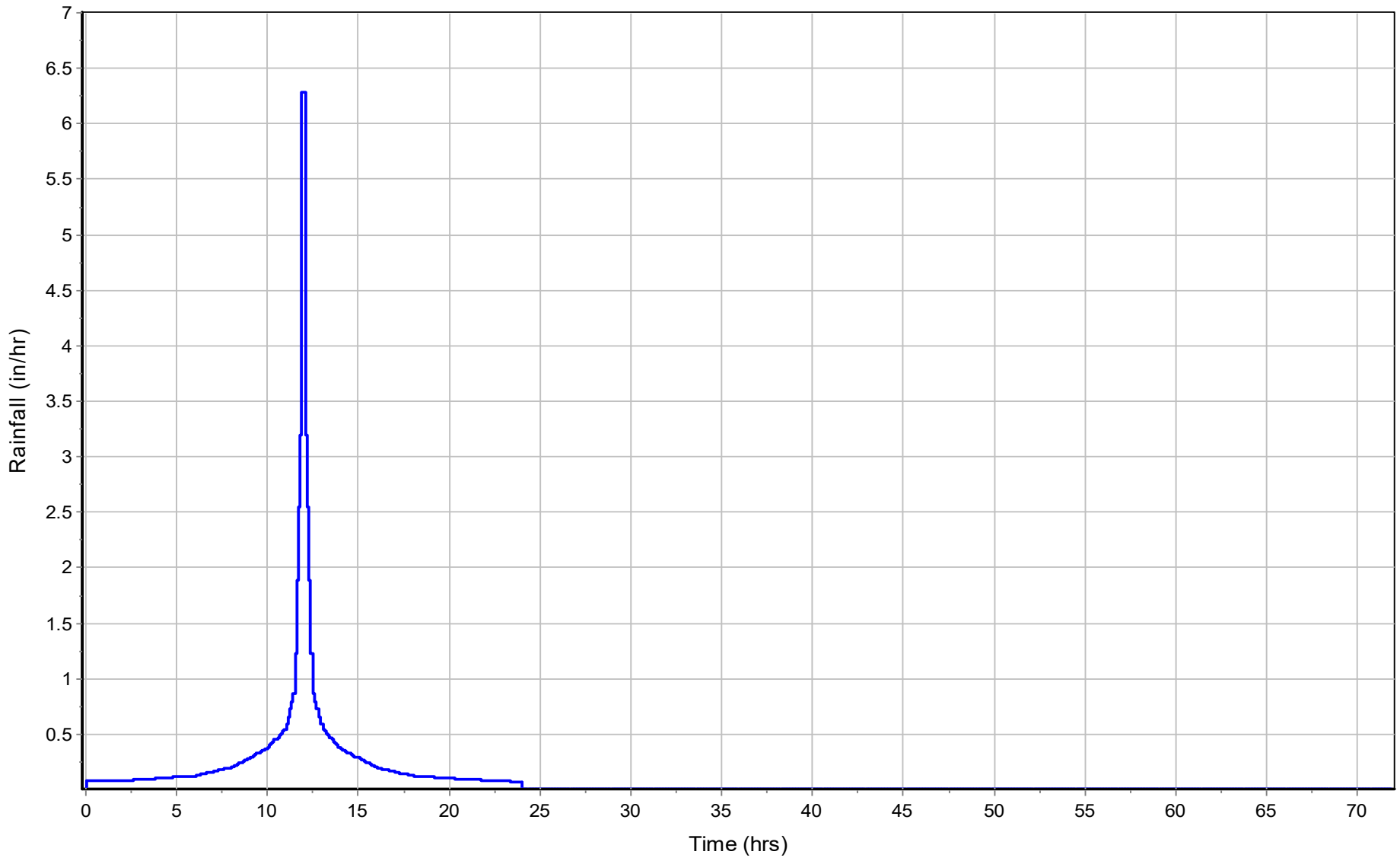
Total TOC (min) 15.09

Subbasin Runoff Results

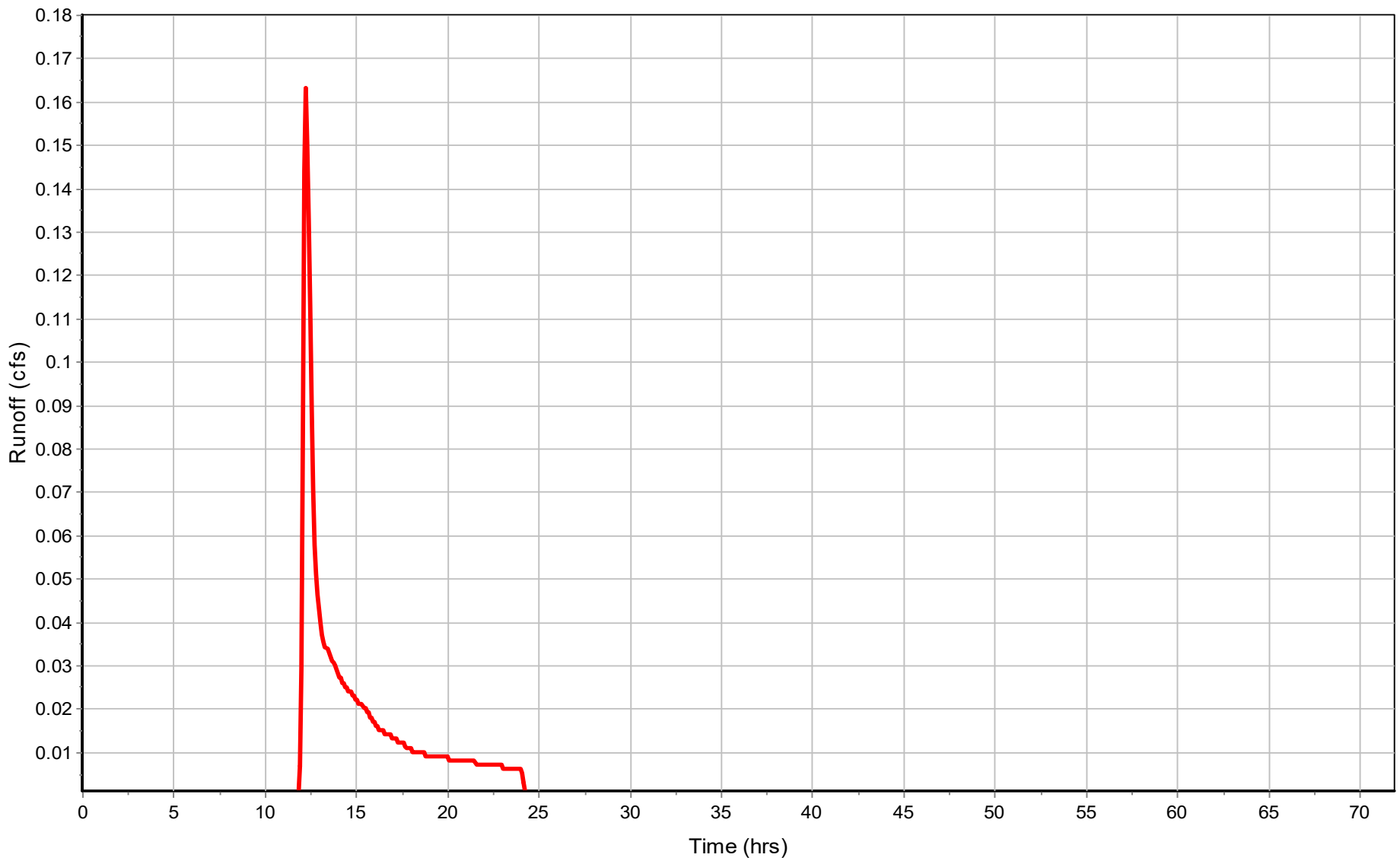
Total Rainfall (in) 7.48
Total Runoff (in) 1.29
Peak Runoff (cfs) 0.16
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:15:05

Subbasin : Sub-E04

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A4

Input Data

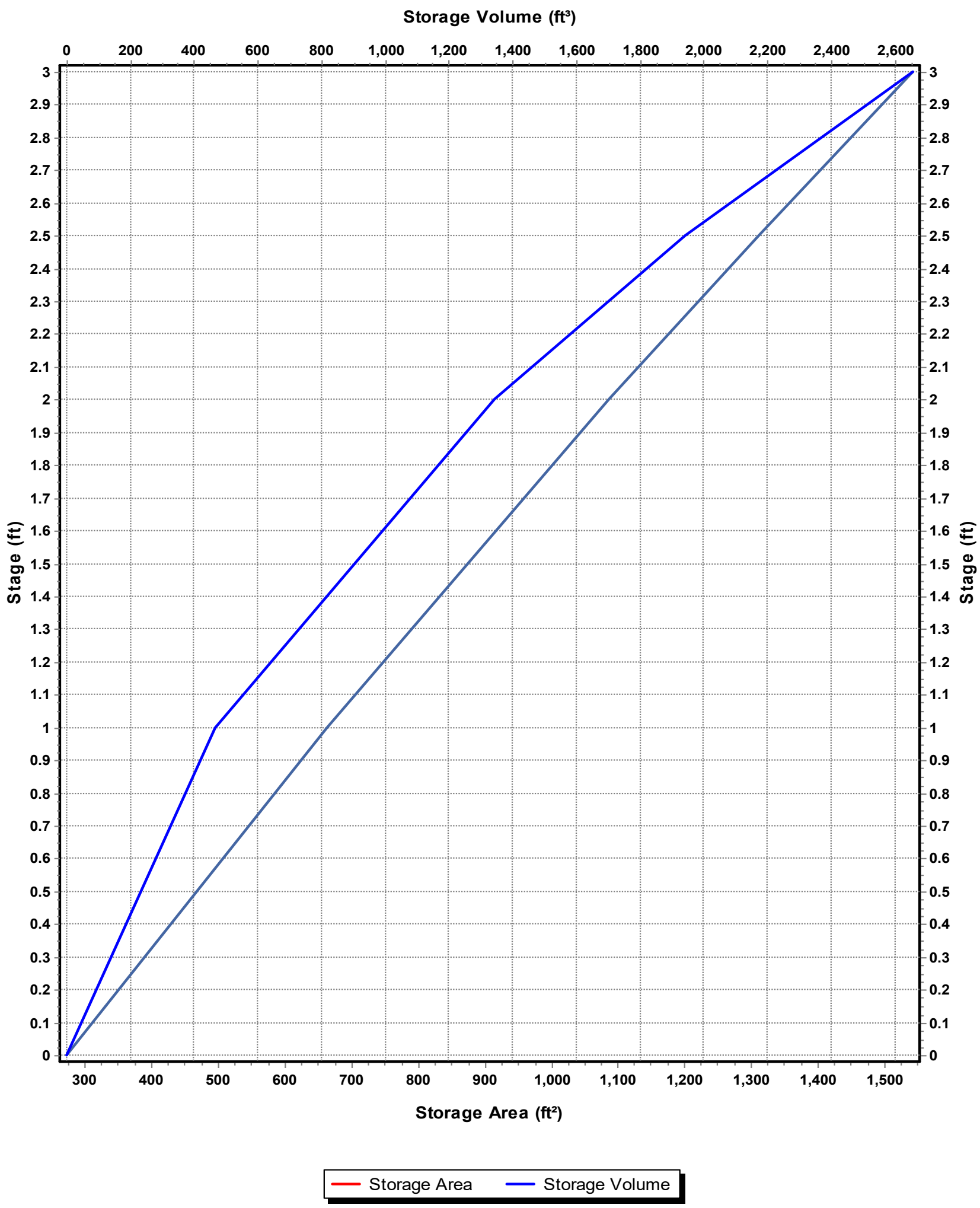
Invert Elevation (ft)	114.00
Max (Rim) Elevation (ft)	117.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.00
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Basin-04

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	272.59	0
1	664.04	468.32
2	1087.5	1344.09
2.5	1311.22	1943.77
3	1542.95	2657.31

Storage Area Volume Curves



Storage Node : Basin-A4 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-B-A4	Trapezoidal	No	116.80	2.80	10.00	0.20	3.33

Output Summary Results

Peak Inflow (cfs)	1.13
Peak Lateral Inflow (cfs)	0.16
Peak Outflow (cfs)	0.08
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	116.81
Max HGL Depth Attained (ft)	2.81
Average HGL Elevation Attained (ft)	116.3
Average HGL Depth Attained (ft)	2.3
Time of Max HGL Occurrence (days hh:mm)	0 15:00
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Forebay-A4

Input Data

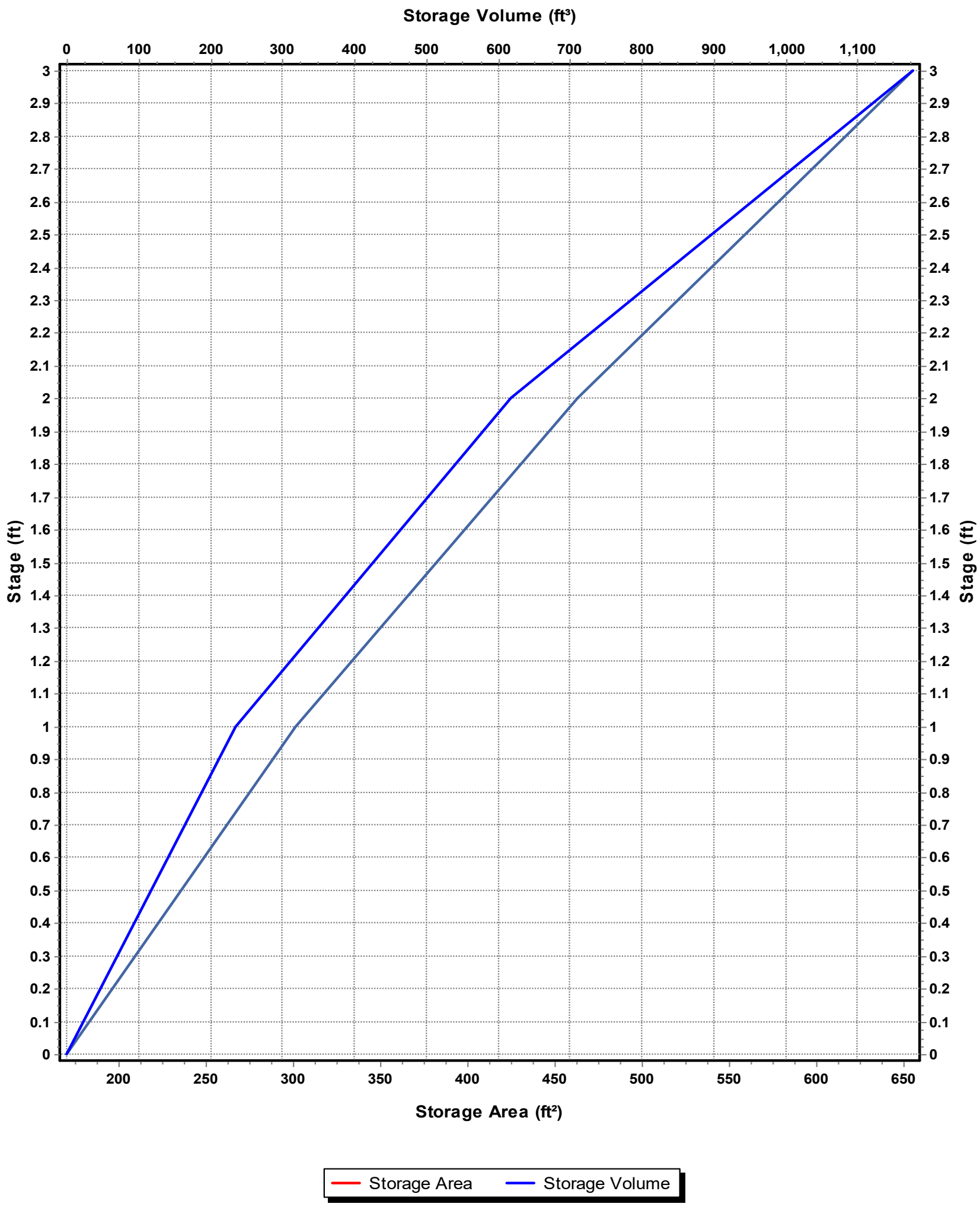
Invert Elevation (ft)	114.00
Max (Rim) Elevation (ft)	117.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.00
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Forebay-04

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	170.46	0
1	301.38	235.92
2	462.94	618.08
3	655.13	1177.12

Storage Area Volume Curves



Storage Node : Forebay-A4 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-F-04	Trapezoidal	No	116.50	2.50	10.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	1.05
Peak Lateral Inflow (cfs)	1.05
Peak Outflow (cfs)	1.04
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	116.84
Max HGL Depth Attained (ft)	2.84
Average HGL Elevation Attained (ft)	116.37
Average HGL Depth Attained (ft)	2.37
Time of Max HGL Occurrence (days hh:mm)	0 14:58
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Attachment D - Standard 3 Supporting Information

NRCS Soil Report

Site Specific Geotechnical Engineering Report

Drawdown Analysis

Recharge Volume

NRCS Soils Report

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Barnstable County, Massachusetts



April 20, 2026

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require

alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

Contents

Preface.....2
How Soil Surveys Are Made.....5
Soil Map.....8
Soil Map.....9
Legend.....10
Map Unit Legend.....11
Map Unit Descriptions.....11
Barnstable County, Massachusetts.....13
483C—Plymouth-Barnstable complex, rolling, very bouldery.....13
484C—Plymouth-Barnstable complex, rolling, extremely bouldery.....15
484D—Plymouth-Barnstable complex, hilly, extremely bouldery.....17
References.....20

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map



Map Scale: 1:1,200 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 15 30 60 90

Feet: 0 50 100 200 300

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 19N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:25,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Barnstable County, Massachusetts
Survey Area Data: Version 24, Sep 5, 2025

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jun 10, 2022—Jun 30, 2022

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
483C	Plymouth-Barnstable complex, rolling, very bouldery	0.9	31.0%
484C	Plymouth-Barnstable complex, rolling, extremely bouldery	1.9	62.8%
484D	Plymouth-Barnstable complex, hilly, extremely bouldery	0.2	6.3%
Totals for Area of Interest		**3.0**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or

landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Barnstable County, Massachusetts

483C—Plymouth-Barnstable complex, rolling, very bouldery

Map Unit Setting

National map unit symbol: 98rz
Elevation: 0 to 1,000 feet
Mean annual precipitation: 40 to 50 inches
Mean annual air temperature: 45 to 55 degrees F
Frost-free period: 140 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Plymouth and similar soils: 55 percent
Barnstable and similar soils: 20 percent
Minor components: 25 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Plymouth

Setting

Landform: Moraines
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loose sandy glaciofluvial deposits and/or loose sandy ablation till; loose sandy glaciofluvial deposits and/or loose sandy ablation till

Typical profile

H1 - 0 to 3 inches: loamy coarse sand
H2 - 3 to 29 inches: gravelly loamy coarse sand
H3 - 29 to 64 inches: gravelly coarse sand

Properties and qualities

Slope: 8 to 15 percent
Surface area covered with cobbles, stones or boulders: 2.0 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Excessively drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): High to very high (6.00 to 20.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 3.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: A
Ecological site: F149BY005MA - Dry Outwash
Hydric soil rating: No

Description of Barnstable

Setting

Landform: Moraines
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Friable loamy ablation till over reworked sandy glaciofluvial deposits; loamy ablation till over reworked sandy outwash

Typical profile

H1 - 0 to 1 inches: sandy loam
H2 - 1 to 23 inches: sandy loam
H3 - 23 to 64 inches: coarse sand

Properties and qualities

Slope: 8 to 15 percent
Surface area covered with cobbles, stones or boulders: 1.6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 4.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: A
Ecological site: F149BY011MA - Well Drained Till Uplands
Hydric soil rating: No

Minor Components

Hinckley

Percent of map unit: 10 percent
Hydric soil rating: No

Carver

Percent of map unit: 10 percent
Hydric soil rating: No

Nantucket

Percent of map unit: 5 percent
Hydric soil rating: No

484C—Plymouth-Barnstable complex, rolling, extremely bouldery

Map Unit Setting

National map unit symbol: 98s1
Elevation: 0 to 1,000 feet
Mean annual precipitation: 40 to 50 inches
Mean annual air temperature: 45 to 55 degrees F
Frost-free period: 140 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Plymouth and similar soils: 55 percent
Barnstable and similar soils: 20 percent
Minor components: 25 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Plymouth

Setting

Landform: Moraines
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loose sandy glaciofluvial deposits and/or loose sandy ablation till; loose sandy glaciofluvial deposits and/or loose sandy ablation till

Typical profile

H1 - 0 to 3 inches: loamy coarse sand
H2 - 3 to 29 inches: gravelly loamy coarse sand
H3 - 29 to 64 inches: gravelly coarse sand

Properties and qualities

Slope: 8 to 15 percent
Surface area covered with cobbles, stones or boulders: 9.0 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Excessively drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): High to very high (6.00 to 20.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 3.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: A

Ecological site: F149BY005MA - Dry Outwash
Hydric soil rating: No

Description of Barnstable

Setting

Landform: Moraines
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Friable loamy ablation till over reworked sandy glaciofluvial deposits; loamy ablation till over reworked sandy outwash

Typical profile

H1 - 0 to 1 inches: sandy loam
H2 - 1 to 23 inches: sandy loam
H3 - 23 to 64 inches: coarse sand

Properties and qualities

Slope: 8 to 15 percent
Surface area covered with cobbles, stones or boulders: 9.0 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 4.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: A
Ecological site: F149BY011MA - Well Drained Till Uplands
Hydric soil rating: No

Minor Components

Carver

Percent of map unit: 10 percent
Hydric soil rating: No

Hinckley

Percent of map unit: 10 percent
Hydric soil rating: No

Nantucket

Percent of map unit: 5 percent
Hydric soil rating: No

484D—Plymouth-Barnstable complex, hilly, extremely bouldery

Map Unit Setting

National map unit symbol: 98s2
Elevation: 0 to 1,000 feet
Mean annual precipitation: 40 to 50 inches
Mean annual air temperature: 45 to 55 degrees F
Frost-free period: 140 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Plymouth and similar soils: 55 percent
Barnstable and similar soils: 20 percent
Minor components: 25 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Plymouth

Setting

Landform: Moraines
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Loose sandy glaciofluvial deposits and/or loose sandy ablation till; loose sandy glaciofluvial deposits and/or loose sandy ablation till

Typical profile

H1 - 0 to 3 inches: loamy coarse sand
H2 - 3 to 29 inches: gravelly loamy coarse sand
H3 - 29 to 64 inches: gravelly coarse sand

Properties and qualities

Slope: 15 to 25 percent
Surface area covered with cobbles, stones or boulders: 9.0 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Excessively drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): High to very high (6.00 to 20.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 3.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: A

Ecological site: F149BY005MA - Dry Outwash
Hydric soil rating: No

Description of Barnstable

Setting

Landform: Moraines
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Friable loamy ablation till over reworked sandy glaciofluvial deposits; loamy ablation till over reworked sandy outwash

Typical profile

H1 - 0 to 1 inches: sandy loam
H2 - 1 to 23 inches: sandy loam
H3 - 23 to 64 inches: coarse sand

Properties and qualities

Slope: 15 to 25 percent
Surface area covered with cobbles, stones or boulders: 9.0 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 4.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: A
Ecological site: F149BY011MA - Well Drained Till Uplands
Hydric soil rating: No

Minor Components

Nantucket

Percent of map unit: 10 percent
Hydric soil rating: No

Carver

Percent of map unit: 5 percent
Hydric soil rating: No

Hinckley

Percent of map unit: 5 percent
Hydric soil rating: No

Merrimac

Percent of map unit: 5 percent
Hydric soil rating: No

References

American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deep-water habitats of the United States. U.S. Fish and Wildlife Service FWS/OBS-79/31.

Federal Register. July 13, 1994. Changes in hydric soils of the United States.

Federal Register. September 18, 2002. Hydric soils of the United States.

Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.

National Research Council. 1995. Wetlands: Characteristics and boundaries.

Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_054262

Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service, U.S. Department of Agriculture Handbook 436. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053577

Soil Survey Staff. 2010. Keys to soil taxonomy. 11th edition. U.S. Department of Agriculture, Natural Resources Conservation Service. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053580

Tiner, R.W., Jr. 1985. Wetlands of Delaware. U.S. Fish and Wildlife Service and Delaware Department of Natural Resources and Environmental Control, Wetlands Section.

United States Army Corps of Engineers, Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Waterways Experiment Station Technical Report Y-87-1.

United States Department of Agriculture, Natural Resources Conservation Service. National forestry manual. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2_053374

United States Department of Agriculture, Natural Resources Conservation Service. National range and pasture handbook. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/landuse/rangepasture/?cid=stelprdb1043084

United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053624

United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf

Boring Logs

GeoEngineers performed a geotechnical subsurface exploration program on March 13, 2025. The exploration program consisted of three (3) borings (designated MR-01, MR-02, and MR-02A) advanced to depths between 17 and 32 feet below the ground surface (bgs) by Geologic Earth Exploration, Inc. (Geologic) of Norfolk, Massachusetts. The borings were advanced using hollow-stem auger drilling methods with a track mounted Acker Rebel drill rig. The borings were continuously monitored by a representative from our firm who logged and classified the soils encountered, obtained representative soil samples, observed groundwater conditions, and prepared logs for the explorations.

Soils encountered in the borings were visually classified in general accordance with the classification system described in Figure A-1. A key to the boring log symbols is also presented in Figure A-1. The logs of the borings are presented in Figures A-2 through A-4 within Appendix A. The boring logs are based on our interpretation of the field and laboratory data and indicate the various types of soils and groundwater conditions encountered. The logs also indicate the depths at which these soils or their characteristics change, although the change may be gradual. If the change occurred between samples, it was interpreted. The densities noted in the boring logs are based on the blow count data obtained in the borings and judgment based on the conditions encountered.

The soils encountered within the borings were generally sampled at the surface continuously until 10 feet bgs, then at 5-foot vertical intervals thereafter with a 2-inch outside-diameter split-barrel standard penetration test (SPT) sampler. The disturbed samples were obtained by driving the sampler 24 inches into the soil with a 140-pound automatic hammer free-falling 30 inches. The number of blows required for each 6 inches of penetration was recorded. The blow count (“N-value”) of the soil was calculated as the number of blows required for the middle 12 inches of penetration. This resistance, or N-value, provides a measure of the relative density of granular soils and the relative consistency of cohesive soils. Where very dense soil conditions precluded driving the full 24 inches, the penetration resistance for the partial penetration was entered on the logs. The blow counts are shown in the boring logs at the respective sample depths. Auger refusal was encountered at 17 feet bgs while drilling boring MR-02. An offset boring, MR-02A, was augured without sampling to 20 feet, at which depth sampling continued.

Observations of groundwater conditions were made during drilling. The groundwater conditions encountered during drilling are presented in the boring logs. Groundwater conditions observed during drilling represent a short-term condition and may or may not be representative of the long-term groundwater conditions at the Site. Groundwater conditions observed during drilling should be considered approximate.

Logs of the test borings are provided in Appendix A, Subsurface Exploration and Laboratory Testing.

Site Specific Geotechnical Report

Geotechnical Engineering Report

Cape Canal Bridge Relocation Project
Cape Sagamore Metering & Regulating Station
Barnstable County, Massachusetts

for
Enbridge, Inc.

April 25, 2025

239 Causeway Street, Suite 400
Boston, Massachusetts 02114
617.749.9220

GeoEngineers USA

Geotechnical Engineering Report

Cape Canal Bridge Relocation Project
Cape Sagamore Metering & Regulating Station
Barnstable County, Massachusetts

File No. 15556-039-00
April 25, 2025

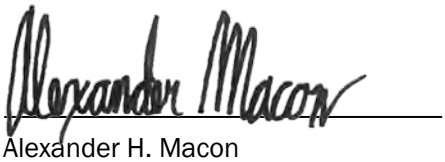
Prepared for:

Enbridge, Inc.
915 North Eldridge Parkway, Suite 1100
Houston, Texas 77079

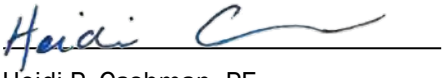
Attention: Cindy Dilber

Prepared by:

GeoEngineers USA, PC
239 Causeway Street, Suite 400
Boston, Massachusetts 02114
617.749.9220



Alexander H. Macon
Staff Geotechnical Engineer 2



Heidi P. Cashman, PE
Associate Geotechnical Engineer

AHM:HPC:dt

Disclaimer: Any electronic form, facsimile, or hard copy of the original document (email, text, table, and/or figure), if provided, and any attachments are only a copy of the original document. The original document is stored by GeoEngineers USA, PC and will serve as the official document of record.

Table of Contents

Executive Summary 1
1.0 Introduction 1
2.0 Site Location and Project Understanding 1
3.0 Subsurface Exploration Program 1
3.1. Subsurface Exploration 1
3.2. Laboratory Testing 2
4.0 Site Conditions 3
4.1. Surface Conditions 3
4.2. Available Subsurface Information 3
4.2.1. Surficial Material 3
4.2.2. Bedrock Geology 3
4.3. Subsurface Conditions 3
4.3.1. Soil Conditions 3
4.3.2. Groundwater Conditions 4
5.0 Geotechnical Recommendations 4
5.1. Seismic Design Parameters 5
5.1.1. Seismic Site Class and Design Parameters 5
5.1.2. Liquefaction Potential 5
5.2. Foundation Design recommendations 5
5.2.1. Allowable Bearing Pressure 6
5.2.2. Foundation Dimensions 6
5.2.3. Settlement 6
5.3. Slab-on-Grade 6
5.4. Earthwork and Subgrade Preparation 6
5.4.1. Boulder Removal 7
5.4.2. Structural Fill 8
5.4.3. Structural Fill Placement and Compaction Criteria 8
5.4.4. Weather Conditions 9
5.5. Material Reuse and Management 9
5.5.1. Onsite Soil Reuse 9
5.6. Temporary Construction Dewatering 10
6.0 Limitations 10
7.0 References 10

List of Figures

Figure 1. Vicinity Map
Figure 2. Boring Location Map

Appendices

Appendix A. Subsurface Explorations and Laboratory Testing
Figure A-1. Key to Exploration Logs
Figures A-2 through A-4. Logs of Borings
Laboratory Test Results
Appendix B. Report Limitations and Guidelines for Use

Executive Summary

The proposed Site development involves the construction of a Metering and Regulation (M&R) facility on the cape side of the Sagamore Bridge to facilitate a new horizontal directional drilling (HDD) gas line crossing the Cape Cod Canal. The Site is currently unimproved woodland located on the Joint Base Cape Cod military compound with an overhead power utility easement along the southern edge of the Site.

Based on our understanding of the Site concepts and our review of the subsurface conditions, we recommend that the M&R station be supported by conventional shallow spread footings and slab-on-grade bearing on natural inorganic soils (i.e. natural sand deposits).

Boulders were encountered during our exploration program and should be anticipated to be encountered during construction. Localized boulder removal should be anticipated to facilitate foundation and slab construction.

Additional design considerations and recommendations are provided in Section 5.0 of this report.

1.0 Introduction

This report presents the results of GeoEngineers USA, PC (GeoEngineers) geotechnical engineering services for the proposed Metering and Regulating (M&R) Station development at the cape side of the Sagamore Bridge along the west side of Pave Paws Road on the Joint Base Cape Cod military compound in Bourne, Massachusetts (the Site). The Site is shown relative to surrounding physical features in Figure 1, Vicinity Map, and Figure 2, Boring Location Map.

The purpose of this report is to provide geotechnical engineering recommendations for the design and construction of the planned M&R station development on the cape side of the Sagamore Bridge. Our services have been completed in general accordance with our signed agreement dated October 31, 2023, and revised April 4, 2025. This report is subject to the attached limitations.

2.0 Site Location and Project Understanding

The Site consists of undeveloped woodland, and it is completely bound by undeveloped woodland. Pave Paws Road runs to the east of the Site and an overhead power utility easement with dirt road is located south of the Site. Existing noteworthy features beyond the Site boundaries include the Space Force branch military base of the Joint Base Cape Cod which is generally further southeast, the Cape Cod Canal which is generally further north of the Site, and the existing Sagamore Bridge which is generally further northeast of the Site.

Project concepts are still in development; however we understand Site improvements will consist of removal of woodland, and construction of a single-story at grade M&R facility and associated equipment.

Building loads are unavailable at this time, however based on discussions with the project team, and experience with similar structures of this type, we anticipate individual column loads of less than 50 kips and wall loads of less than 4 kips/linear-foot. Building loads once available should be provided to GeoEngineers to confirm our recommendations herein.

3.0 Subsurface Exploration Program

3.1. SUBSURFACE EXPLORATION

GeoEngineers performed a geotechnical subsurface exploration program on March 13, 2025. The exploration program consisted of three (3) borings (designated MR-01, MR-02, and MR-02A) advanced to depths between 17 and 32 feet below the ground surface (bgs) by Geologic Earth Exploration, Inc. (Geologic) of Norfolk, Massachusetts. The borings were advanced using hollow-stem auger drilling methods with a track mounted Acker Rebel drill rig. The borings were continuously monitored by a representative from our firm who logged and classified the soils encountered, obtained representative soil samples, observed groundwater conditions, and prepared logs for the explorations.

Soils encountered in the borings were visually classified in general accordance with the classification system described in Figure A-1. A key to the boring log symbols is also presented in Figure A-1. The logs of the borings are presented in Figures A-2 through A-4 within Appendix A. The boring logs are based on our

interpretation of the field and laboratory data and indicate the various types of soils and groundwater conditions encountered. The logs also indicate the depths at which these soils or their characteristics change, although the change may be gradual. If the change occurred between samples, it was interpreted. The densities noted in the boring logs are based on the blow count data obtained in the borings and judgment based on the conditions encountered.

The soils encountered within the borings were generally sampled at the surface continuously until 10 feet bgs, then at 5-foot vertical intervals thereafter with a 2-inch outside-diameter split-barrel standard penetration test (SPT) sampler. The disturbed samples were obtained by driving the sampler 24 inches into the soil with a 140-pound automatic hammer free-falling 30 inches. The number of blows required for each 6 inches of penetration was recorded. The blow count ("N-value") of the soil was calculated as the number of blows required for the middle 12 inches of penetration. This resistance, or N-value, provides a measure of the relative density of granular soils and the relative consistency of cohesive soils. Where very dense soil conditions precluded driving the full 24 inches, the penetration resistance for the partial penetration was entered on the logs. The blow counts are shown in the boring logs at the respective sample depths. Auger refusal was encountered at 17 feet bgs while drilling boring MR-02. An offset boring, MR-02A, was augured without sampling to 20 feet, at which depth sampling continued.

Observations of groundwater conditions were made during drilling. The groundwater conditions encountered during drilling are presented in the boring logs. Groundwater conditions observed during drilling represent a short-term condition and may or may not be representative of the long-term groundwater conditions at the Site. Groundwater conditions observed during drilling should be considered approximate.

Logs of the test borings are provided in Appendix A, Subsurface Exploration and Laboratory Testing.

3.2. LABORATORY TESTING

Six (6) soil samples were submitted to Geotesting Express of Acton, Massachusetts for geotechnical laboratory testing in accordance with the standards provided in ASTM International (ASTM) and American Association of State Highway and Transportation Officials (AASHTO) procedures. One (1) representative composite sample was created of representative soil samples from MR-02/MR-2A and the following laboratory tests were conducted.

- One (1) Standard Classification, per ASTM D2488
- One (1) grain-size analysis (sieve only), per ASTM D6913.
- One (1) moisture content determinations, per ASTM D2216.
- One (1) unit weight determination, per ASTM D7263.
- One (1) soil electric resistivity test on the composite sample, per AASHTO T288.
- One (1) sulfate determination on the composite sample, per ASTM D516.
- One (1) chloride determination on the composite sample, per ASTM D512.
- One (1) pH determination on the composite sample, per ASTM D4972.

Laboratory test results are provided in Appendix A, Subsurface Exploration and Laboratory Testing.

4.0 Site Conditions

4.1. SURFACE CONDITIONS

Site survey information is unavailable at this time. The site is generally flat and slopes up steeply in the east at the Pave Paws Road soil embankment. An overhead power utility easement corridor runs along the southern edge of the Site. An existing dirt road is present within the overhead power utility easement along the south edge of the Site connecting Pave Paws Road to Jarvis Road. Surficial glacial erratic boulders, 3- to 5-foot wide, were observed across the Site.

4.2. AVAILABLE SUBSURFACE INFORMATION

4.2.1. Surficial Material

Surficial geologic mapping indicates that early to late Wisconsin Age (75,000 to 11,000 years ago) end moraine deposits are the predominant surficial materials present at the Site. The end moraine deposits are typically composed predominantly of boulders and ablation-facies, looser coarse grain sandy upper till; with lenses of stratified sand and gravel occurring locally within the till. Within the larger deposits the surface ablation till is as much as 30 ft thick and overlies sand, gravel, and silty sand meltwater deposits. Some of the end moraine deposits include thrusted sheets of glacial meltwater deposits resulting from readvance of the ice margin. The stratification of the underlying sediments may also be deformed as the result of post-depositional collapse caused by melting of buried ice. Surface boulders on end moraine deposits are generally more numerous than on adjacent till surfaces with dense concentrations of boulders present in some places. Deposits occur as freestanding hummocky landforms, commonly in ridges that trend east-northeast to west-southwest, and range in height from 10 to 100 feet. The thickness of the end moraine deposits is expected to be over 100 feet, overlying the bedrock described below (Stone, et al, 2019), (Hartshorn, et al, 1991).

4.2.2. Bedrock Geology

Geologic mapping indicates the primary bedrock present at the Site is Proterozoic Age (2,500 to 542 million years ago) plutonic and metamorphic rocks consisting primarily of granite, gneiss, and schist (undivided) (Zen, et al, 1983).

4.3. SUBSURFACE CONDITIONS

4.3.1. Soil Conditions

In general, the soil conditions observed at the Site consist of topsoil, underlain by subsoil, and natural sand deposits. Surficial glacial erratic boulders, 3- to 5-foot wide were observed across the Site. Details of the subsurface strata from the explorations by GeoEngineers are summarized below from the ground surface down:

- **Topsoil:** A topsoil layer was encountered at all boring locations and was observed at ground surface across the Site. The topsoil was observed to be approximately 3- to 5-inches thick. The topsoil layer primarily consists of silty fine-grained sand with trace amounts of gravel and organic matter (roots). The N-values in the topsoil material generally indicated a very loose condition.
- **Subsoil:** A layer of subsoil was observed beneath the topsoil layer at all boring locations. The bottom of subsoil was observed approximately 2 feet bgs at all boring locations. The subsoil layer primarily

consists of silty fine to medium-grained sand with trace amounts of gravel and organic matter (roots). The N-values in the subsoil material generally indicated a very loose condition.

- **Natural Sand Deposits:** Natural sand deposits were observed underlying the subsoil, within all borings, and extended to the depths explored. Borings were terminated within the natural sand deposits, therefore the natural sand deposits depths are likely deeper than reported herein.

  The natural sand deposits primarily consist of fine to medium-grained sand with varying amounts of gravel and silt. The N-values in the natural sand material indicate a condition ranging from loose to very dense but are generally medium dense to dense. The gravel content in the natural sand sample selected for grain-size analysis was about 13 percent. The fines content in the natural sand sample selected for grain-size analysis was about 3 percent. The moisture content in the natural sand sample selected for analysis was about 3 percent. The unit weight of the natural sand sample selected for analysis was about 104 pounds per cubic foot (pcf). Auger refusal was encountered at 17 feet bgs within boring MR-02, which likely indicates the presence of cobbles and/or boulders within the natural sand deposits. Drill rig chatter was noted while drilling throughout the natural sand deposits, another potential indication of the presence of gravel, cobbles, and/or boulders this layer.

4.3.2. Groundwater Conditions

Groundwater was not observed during drilling of the test borings. However, it should be noted that groundwater levels will vary depending on tidal action, seasonal variations in temperature, precipitation, and can also be influenced by subsurface utilities, construction activities, and other factors.

5.0 Geotechnical Recommendations

Below is a summary of the geotechnical considerations associated with design and development of the Site. Additional details are provided in subsequent sections of this report.

- The proposed structures can be supported by conventional shallow spread footings and a slab-on-grade following removal of topsoil and subsoil containing roots. Foundations should bear directly on the natural sand deposits or compacted structural fill placed over the natural sand deposits. Foundations should not bear on topsoil or subsoil.
- The subsoil (both organic and inorganic) is not suitable for foundation support; however, the existing inorganic subsoil (i.e. subsoil free of roots) can remain in place below the slab provided the subgrade is prepared as specified herein.
- Localized boulders are anticipated within the natural sand deposits, as evidenced from drilling action and auger refusal during our field exploration program. Localized boulder removal should be anticipated at the proposed foundation, slab, and utility areas. We anticipate that boulders could be removed using large excavators or by mechanical means (i.e. hoe-ramming). We recommend that boulders (if encountered) should be removed to at least 12 inches below footings and sub-slab utilities.
- Inorganic granular soils (i.e., inorganic subsoil and natural sand deposits) from cut/fill activities can be re-used as backfill provided it is placed and compacted as specified herein.

5.1. SEISMIC DESIGN PARAMETERS

5.1.1. Seismic Site Class and Design Parameters

The Massachusetts State Building Code 10th edition (MSBC10) incorporates the 2021 International Building Code (2021 IBC) by reference with state specific amendments. We have considered the soil conditions encountered in the borings to be consistent and representative of the soil conditions in the top 100 feet of soil at the Site. Given this, it is GeoEngineers' opinion that the Site is best characterized as Site Class D. The 2021 IBC seismic design parameters are presented in Table 1.

TABLE 1. 2021 IBC SEISMIC DESIGN PARAMETERS

2021 IBC PARAMETER	RECOMMENDED VALUE
Mapped Spectral Acceleration for short periods, (SS):	0.180
Mapped Spectral Acceleration for 1-sec period, (S1):	0.052
Site Class:	D
Site Coefficient, (Fa):	1.6
Site Coefficient, (Fv):	2.4
5% damped design spectral response acceleration at short periods, (SDS):	0.192
5% damped design spectral response acceleration at 1-sec periods, (SD1):	0.083
Anticipated Risk Category:	IV
Seismic Design Category:	C

Note:

The anticipated risk category is based on the assumption that the M&R stations are critical to national defense and would be part of the gas line supplying the military base Joint Base Cape Cod. Should a lower anticipated risk category of III be permitted, a seismic design category of B can be justified.

5.1.2. Liquefaction Potential

The soils encountered at the Site are not considered susceptible to liquefaction based on the criteria set forth in section 1806.4 of MSBC10.

5.2. FOUNDATION DESIGN RECOMMENDATIONS

We recommend the proposed structures be supported on conventional shallow spread footings. Footings should bear directly on inorganic, natural, granular soil (i.e. natural sand deposits), or structural fill placed over the natural sand deposits.

Foundations should not bear directly on topsoil, subsoil, or boulders. Some over-excavation of the existing topsoil and subsoil may be necessary to expose the top of the natural sand deposits suitable for footing bearing. The existing topsoil and subsoil material (both organic and inorganic), where present, should be excavated from within the zone of influence (ZOI) of the footings. The ZOI is defined as a one (1) horizontal to one (1) vertical (1H:1V) line projecting outward and downward from the outside edge of the foundation element. Additional construction recommendations for subgrade preparation are provided in Section 5.4 Earthwork and Subgrade Preparation.

Where boulder removal is required to achieve the bottom of footing elevation, the boulder should be removed to allow placement of 12 inches of Gravel Fill to provide a soil cushion between the bottom of footing and boulder surface to minimize the potential for hard spots below the footing and the potential for differential settlement.

5.2.1. Allowable Bearing Pressure

For foundations constructed as recommended in this report, we recommend using a net allowable bearing pressure of 4 kips per square foot (ksf). The allowable soil bearing pressure applies to the total of dead and long-term live loads. Building loads are unavailable at this time and the allowable soil bearing pressure is based upon assumed building loads. Based on our experience with similar structures of this type we assume that individual column loads will likely be less than 50 kips and wall loads will likely be less than 4 kips/linear-foot. Building loads once available should be provided to GeoEngineers to confirm our recommendations herein.

5.2.2. Foundation Dimensions

The minimum recommended lateral dimension for isolated spread footings is 36 inches, while continuous wall footings should be at least 18 inches wide. Footings in areas exposed to freezing temperatures should be founded at least 4 feet below exterior finished grade for frost protection. Interior footings, in areas not exposed to freezing temperatures, should be at least 24 inches below finished floor grade, or a depth that provides at least 12 inches between the top of the footing and finished floor elevation, whichever is deeper. A minimum 12-inch soil cushion should be provided between the bottom of the footing and top of boulders.

5.2.3. Settlement

Provided that topsoil and subsoil (both organic and inorganic) are removed, and that the subgrade is prepared as recommended herein, we estimate that the total post-construction settlement, based on assumed building loads, will be less than 1 inch. Post-construction, differential settlements are estimated to be less than 0.5 inches between adjacent columns but will vary based on live load distribution and column spacing.

5.3. SLAB-ON-GRADE

The slab-on-grade should bear on a minimum of 12 inches of base course (Gravel Fill). For slabs designed as a beam on an elastic foundation, a modulus of subgrade reaction of 150 pounds per cubic inch (pci) may be used for subgrade soils prepared as recommended herein.

5.4. EARTHWORK AND SUBGRADE PREPARATION

The following paragraphs describe the recommended earthwork procedures for preparation of the building areas.

- Unsuitable materials (topsoil and subsoil containing roots) should be removed in their entirety from the proposed building/structures footprint and at least 5 feet beyond.
- The existing topsoil and subsoil (both organic and inorganic) should be over-excavated below proposed footings and perimeter foundation walls, down to a subgrade consisting of inorganic, granular, natural soil (i.e. natural sand deposits). Over-excavation should extend to the ZOI of the footings as previously

defined herein. Footings should not bear on subsoil; however, subsoil free of roots may remain below the proposed slab-on-grade.

- Following removal of the unsuitable materials noted above and prior to placing raise-in-grade fill, the exposed subgrade within the building footprint, and 5 feet beyond the exterior walls, should be proof-compacted with at least eight (8) passes of a 20-ton smooth-drum, vibratory roller until visibly firm and stable as observed by the Geotechnical Engineer or their qualified representative. Any soft or loose areas identified during proof-compaction should be over-excavated and replaced with Gravel Fill as specified herein.
- Footing subgrades should be excavated with a smooth-edge bucket to limit disturbance to the underlying subgrade. If footings are excavated with a toothed bucket, the subgrade should be compacted with at least six (6) passes of a 1,000-pound vibratory plate compactor, or equivalent effort, until the subgrade is visibly firm and stable as observed by the Geotechnical Engineer or his/her qualified representative. Footings should bear directly on the natural, inorganic, granular soil (i.e. natural sand deposits) or Gravel Fill placed directly over the natural sand deposits.
- Localized areas of boulders are anticipated below within the proposed building and structures, and should be removed using large excavators or mechanical means (i.e. hoe-ramming) to at least 12 inches below the base course for slabs and 12 inches below the bottom of footing in the building areas.
- Where boulders are present at the footing subgrade, the boulders should be removed 12 inches below the bottom of footing and replaced with a soil cushion of compacted Gravel Fill. Footings should bear directly on soil, to avoid the potential for differential settlement due to hard spots below the footing.
- Raise-in-grade fill placed within the building pad to achieve Site grades should consist of Structural Fill, as specified herein. Structural Fill should be placed in 12-inch-thick, loose lifts and compacted to at least 95 percent of its maximum dry density as determined by ASTM D1557, Method C (modified proctor).
- For the slab-on-grade, the exposed subgrade (for base course) should be proof-compacted with at least eight (8) passes of a 20-ton smooth-drum, vibratory roller until visibly firm and stable as observed by the Geotechnical Engineer or their qualified representative. The final 12 inches of soil directly below the slab-on-grade should consist of Gravel Fill as defined herein and compacted to at least 95 percent of its maximum dry density as determined by ASTM D1557 Method C (Modified Proctor).
- The excavated on-site soils may be re-used as raise-in-grade fill, provided it meets the requirements for Structural Fill provided herein. Raise-in-grade fill and backfill should be placed and compacted in maximum 12-inch-thick loose lifts and compacted as specified herein.
- Temporary cut slopes of natural material below proposed footings for building foundations should be conducted at a 1.5H:1V slope angle (or shallower) to maintain a safe excavation.

5.4.1. Boulder Removal

Boulders were encountered within the natural sand deposits during drilling, as such localized boulders are expected to be present at subgrade elevations. It is recommended that boulders, if encountered, be removed to at least 12 inches below the bottom of utility corridors, foundations, and slabs so that they are supported by a cushion of compacted soil to limit the potential for differential settlement due to hard spots. If boulders are encountered in areas where there are building/structures, boulders should be removed to allow construction of the base course layer below the slabs.

5.4.2. Structural Fill

Raise-in-grade fill placed within the building pad and site areas should consist of Structural Fill as described below:

- Gravel Fill to serve as the base course for the building slab should consist of hard, inert, durable gravel and sand. The material should be free from organics, clay, loam, sticks, snow/ice, debris and other deleterious materials. Gravel Fill should be processed to meet the gradation requirements for MassDOT Item M2.01.7-1, dense-graded crushed stone.
- Soil material generated from on-site cut areas, free of organics and other deleterious material, may be used as raise-in-grade fill below the base course layer. On-site fill should have a maximum particle size of 6 inches. On-site fill meeting the gradation requirements below and free from roots and organics, may be used as general raise-in-grade fill below building and Site areas.

SIEVE SIZE	PERCENT PASSING BY WEIGHT
6-inch	100
1-inch	85-100
No. 4	20-90
No. 40	10-75
No. 200	0-40*

Notes:

Silt content of the subsoil may vary. The on-site inorganic material is intended to be re-used as backfill below the base course layer provided it is placed and compacted as specified herein.

- Structural Fill imported from off-site sources and used as backfill within the building areas, and as general raise in grade fill in non-building areas (below base course), should consist of the following:

SIEVE SIZE	PERCENT PASSING BY WEIGHT
4-inch	100
1-inch	70-100
No. 40	30-60
No. 200	0-10

- Structural Fill placed within irregularly shaped utility trenches or trenches not accessible to compaction equipment should consist of Controlled Density Fill (CDF) consisting of high slump Portland Cement Concrete (PCC) with a compressive strength less than 150 pci at 28 days; otherwise, the trench should be backfilled in accordance with the project specifications.

5.4.3. Structural Fill Placement and Compaction Criteria

Structural Fill should be mechanically compacted to a firm, non-yielding (stable) condition. Structural Fill should be placed in loose lifts approximately 12 inches thick. Each lift should be conditioned to the proper moisture content and compacted as specified herein before placing subsequent lifts. Structural Fill should be compacted to the following criteria:

- Structural Fill should be compacted to at least 95 percent of its maximum dry density as determined by ASTM D1557 Method C, Modified Proctor.

5.4.4. Weather Conditions

The subsoil contains a sufficient percentage of fines and should be considered sensitive to moisture and frost susceptible. When the moisture content of these soils is more than a few percent above the optimum moisture content, these soils become unstable, and operation of equipment on these soils and compaction of these soils is difficult. Additionally, disturbance of near-surface soils should be expected if earthwork is completed during periods of wet weather. During wet weather, we recommend the following:

- The ground surface in and around the work area should be graded so that surface water is directed away from the work area. The ground surface should be graded such that areas of ponded water do not develop. The contractor should take measures to prevent surface water from collecting in excavations and trenches. Measures should be implemented to remove surface water from the work area, and it should not be directed towards downslope structures, unless properly collected and conveyed to appropriate catch basins.
- Earthwork activities should not take place during periods of moderate to heavy precipitation.
- Slopes with exposed soils should be covered with plastic sheeting or similar means.
- The contractor should take necessary measures to prevent on-site soils, and soils to be used as fill, from becoming wet or unstable. These measures may include temporary construction dewatering, the use of plastic sheeting, sumps with pumps, and grading. The Site soils should not be left uncompacted and exposed to moisture. Sealing the surficial soils by rolling with a smooth-drum roller prior to periods of precipitation will reduce the extent to which these soils become wet or unstable.
- The contractor should cover all soil stockpiles that will be used as structural fill with plastic sheeting.
- Construction traffic should be restricted to specific areas of the Site, preferably areas that are surfaced with materials not susceptible to wet weather disturbance.
- Construction activities should be scheduled so that the length of time that soils are left exposed to moisture is reduced to the extent practicable.
- Footings and backfill should not be placed over a subgrade with standing water or that is frozen.

In the event that standing water is present on the subgrade, the water should be removed from the surface and any soft and yielding soils should be removed or allowed to dry prior to the placement of backfill. In the event that the subgrade is frozen, the soil that is frozen should be removed, or thawed, and re compacted prior to placement of backfill.

5.5. MATERIAL REUSE AND MANAGEMENT

5.5.1. Onsite Soil Reuse

Based on available data, we anticipate that the natural soils (inorganic subsoil and natural sand deposits, free of organics and other deleterious materials) may be suitable for reuse below building and Site areas provided they can be placed and compacted in accordance with the project specifications and recommendations herein. Subsoil may be sensitive to excess moisture as described herein.

Subsoil containing organics could be screened of organics and reused on Site. Natural on-site soil (i.e., subsoil or natural sand deposits) containing organics are suitable for re-use in landscaped areas. Stripped

on-site topsoil can be reused as topsoil within landscaped areas provided it meets project environmental and landscape architecture requirements.

5.6. TEMPORARY CONSTRUCTION DEWATERING

Groundwater, while generally not encountered at the Site, may still impact Site construction activities during the wet seasons due to surficial runoff and ponding. As such localized dewatering may be necessary for deep construction activities (i.e., deep excavations). We anticipate that dewatering can be achieved by installing sumps at low points in the excavation. Sumps should be constructed with crushed stone wrapped in a geotextile fabric. Groundwater is anticipated to be recharged on Site to the ground surface, and should be performed in accordance with local, State, and Federal regulations.

6.0 Limitations

We have prepared this report for Enbridge, Inc., who may distribute copies of this report to their authorized agents and regulatory agencies, as may be required for the project.

Within the limitations of scope, schedule, and budget, our services have been executed in accordance with generally accepted practices in the field of geotechnical engineering in this area at the time this report was prepared. The conclusions, recommendations, and opinions presented in this report are based on our professional knowledge, judgment, and experience. No warranty or other conditions, express or implied, should be understood.

Any electronic form, facsimile, or hard copy of the original document (email, text, table and/or figure), if provided, and any attachments should be considered a copy of the original document. The original document is stored by GeoEngineers USA, PC and will serve as the official document of record.

Please refer to Appendix B entitled “Report Limitations and Guidelines for Use” for additional information pertaining to use of this report.

7.0 References

ASCE 7-16, 2017. “Minimum Design Loads for Buildings and Other Structures,” American Society of Civil Engineers.

ASTM D-1557, 2012. “Standard Testing Method for Laboratory Compaction Characteristics of Soil Using Modified Effort,” ASTM International.

Commonwealth of Massachusetts Department of Transportation (MassDOT), 2022, “Standard Specifications for Highways and Bridges.”

Hartshorn, J.H., Thompson, W.B., Chapman, W.F., Black, R.F., Richmond, G.M., Grant, D.R., And Fullerton, D.S., 1991, Quaternary Geologic Map of The Boston 4 Degrees X 6 Degrees Quadrangle, United States and Canada, U.S. Geological Survey, Miscellaneous Investigations Series Map I-1420 (Nk-19), Scale 1:1,000,000.

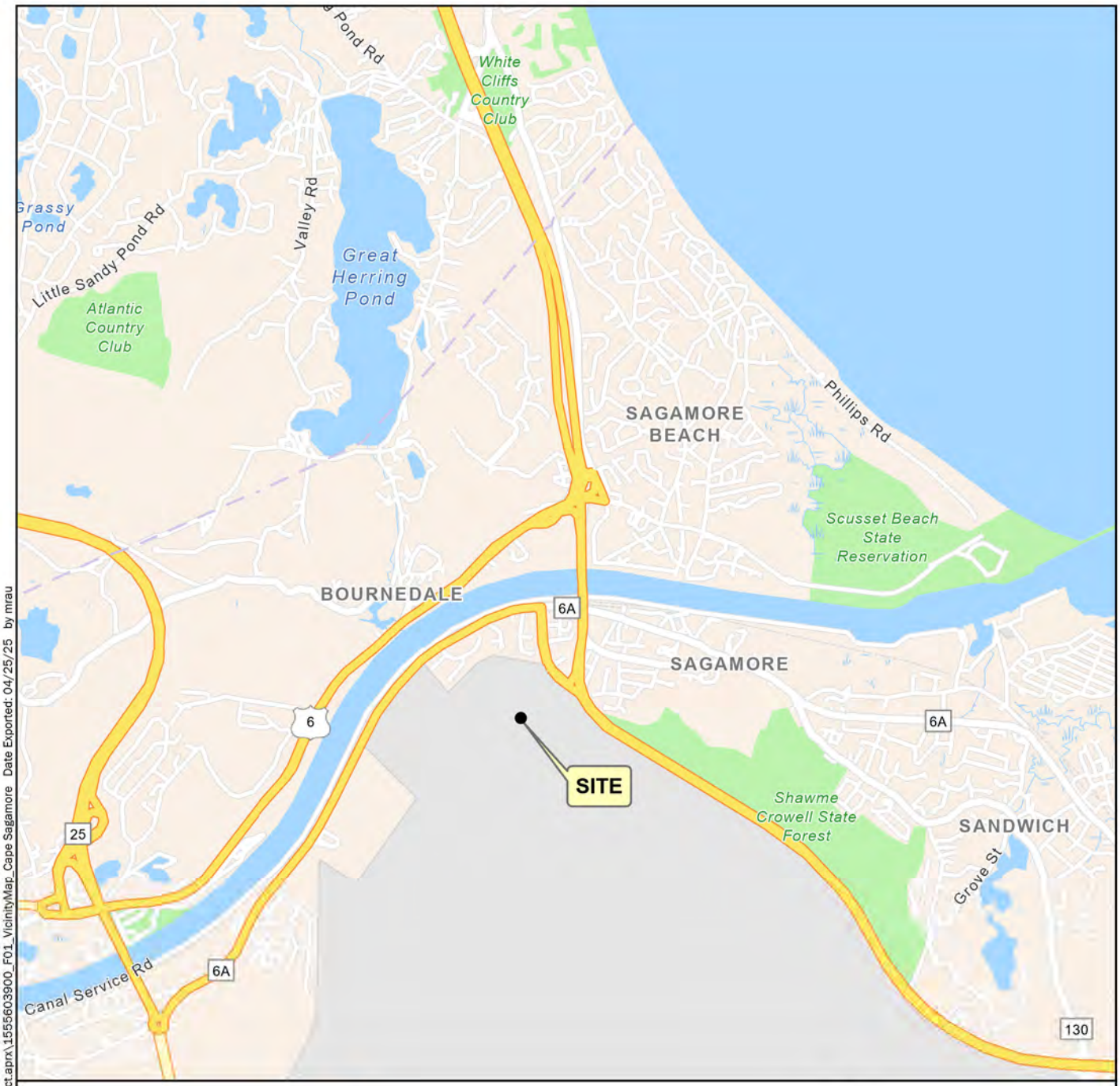
International Code Council, 2021, “International Building Code.”

Massachusetts State Building Code, 2021, “780 CMR Tenth Edition.”

Stone, J.R., Stone, B.D., Digiacomo-Cohen, M.L., And Mabee, S.B., 2019, Surficial Materials of Massachusetts—A 1:24,000-Scale Geologic Map Database, U.S. Geological Survey, Scientific Investigations Map Sim-3402, Scale 1: 24,000.

Zen, E-An, Goldsmith, Richard, Ratcliffe, N.M., Robinson, Peter, Stanley, R.S., Hatch, N.L., Shride, A.F., Weed, E.G.A., and Wones, D.R., 1983, Bedrock Geologic Map of Massachusetts, U.S. Geological Survey, Scale 1:250,000.

Figures





N

0 2,000

Feet

Source(s):
- ESRI

Coordinate System: NAD 1983 StatePlane Massachusetts Mainland FIPS 2001 Feet

Disclaimer: This figure was created for a specific purpose and project. Any use of this figure for any other project or purpose shall be at the user's sole risk and without liability to GeoEngineers. The locations of features shown may be approximate. GeoEngineers makes no warranty or representation as to the accuracy, completeness, or suitability of the figure, or data contained therein. The file containing this figure is a copy of a master document, the original of which is retained by GeoEngineers and is the official document of record.

Vicinity Map

Cape Canal Bridge Replacement Project
Cape Sagamore - M&R Station
Barnstable County, Massachusetts

GeoEngineers USA

Figure 1

P:\15\15556039\GIS\15556039_Project\15556039_Project\15556039_Project.aprx\1555603900_F01_VicinityMap_Cape Sagamore Date Exported: 04/25/25 by mrau



Note(s):
1. GeoEngineers, USA, P.C. has not verified the field location of the existing utilities.

Source(s):
- Aerial from Google Earth Pro, dated 05/27/23.

Coordinate System: MA State Plane, Mainland Zone, NAD83, US Foot

Disclaimer: This figure was created for a specific purpose and project. Any use of this figure for any other project or purpose shall be at the user's sole risk and without liability to GeoEngineers USA, P.C. The locations of features shown may be approximate. GeoEngineers, USA, P.C makes no warranty or representation as to the accuracy, completeness, or suitability of the figure, or data contained therein. The file containing this figure is a copy of a master document, the original of which is retained by GeoEngineers and is the official document of record.

Legend
- Boring Location
- Site Boundary

N
0 250
Feet

Boring Location Map

Cape Canal Bridge Replacement Project
Cape Sagamore - M&R Station
Barnstable County, Massachusetts

GeoEngineers USA

Figure 2

TJP : BTL
P:\15\15556039\CAD\00\HDD\Sagamore\BLM\Dwg\1555603900_F2 BLM.dwg\TAB:FIGURE 2 (2) modified on Apr 25, 2025 - 8:49am MRAU

Appendices

Appendix A
Subsurface Exploration and Laboratory Testing

Appendix A
Field Explorations and Laboratory Testing

FIELD EXPLORATIONS

We explored subsurface conditions at the site on March 13, 2025 by drilling three (3) geotechnical borings (MR-01, MR-02, and MR-02A). The geotechnical borings were drilled to depths of up to approximately 17 and 32 feet below ground surface (bgs) by means of a track-mounted drill rig. The locations of the borings are shown in the attached Boring Location Map, Figure 2. The Massachusetts DigSafe utility locating agency was contacted to locate utilities in the project area prior to the start of the exploratory borings.

A GeoEngineers representative observed field activities, classified the soil encountered, obtained representative samples, and prepared a log of each exploration. The soils encountered were classified visually in general accordance with American Society for Testing and Materials (ASTM) D2487, which is described in Figure A-1.

In general, soil samples were obtained from the borings continuously to a depth of 10-feet and then at 5-foot-depth intervals using 2-inch I.D. split-spoon samplers. The split-spoon samplers were driven 24 inches during Standard Penetration Tests (SPT), using a 140-pound automatic hammer with a 30-inch drop. The number of hammer blows required to drive the sampler the middle 12-inches was recorded on field logs. Each boring was backfilled upon completion with drilled cuttings.

The relative density of the SPT samples recovered at each interval was evaluated based on correlations with lab and field observations in general accordance with the values outlined in Table A-1 below.

TABLE A-1 CORRELATION BETWEEN BLOW COUNTS AND RELATIVE DENSITY[1]

COHESIVE SOILS (CLAY/SILT)						
Parameter	Very Soft	Soft	Medium Stiff	Stiff	Very Stiff	Hard
Blows, N	< 2	2 – 4	4 – 8	8 – 16	16 – 32	> 32
COHESIONLESS SOILS (GRAVEL/SAND/SILTY SAND)[2]						
Parameter	Very Loose	Loose	Medium Dense		Dense	Very Dense
Blows, N	0 – 4	4 – 10	10 – 30		30 – 50	> 50

Notes:

[1]After Terzaghi, K and Peck, R.B., "Soil Mechanics in Engineering Practice," John Wiley & Sons, Inc., 1962.

[2]Classification applies to soils containing additional constituents; that is, organic clay, silty or clayey sand, etc.

The exploration logs are presented in Figures A-2 through A-4. The logs are based on our interpretation of the field data and indicate the various types of soil encountered while indicating the approximate depths at which the subsurface conditions change. Unless noted on the boring logs, the lines between soil units represent approximate boundaries. The transition between materials may be gradual or may occur between recovered samples. Additionally, the boring logs represent conditions observed at the time of drilling and have been edited to incorporate results of the laboratory tests performed as appropriate.

LABORATORY TESTING

General

Soil samples obtained from the borings were transported to Geocomp Corporation's GeoTesting Express' laboratory in Acton, Massachusetts and examined to confirm or modify field classifications. Representative soil samples were selected for laboratory testing consisting of standard classification, grain-size analyses, moisture content determination, unit weight determination, resistivity testing, sulfate determination, chloride determination, and pH determination. The laboratory testing procedures are discussed in more detail below. A summary of the lab results is shown in the attached Laboratory Test Results.

Standard Classification of Soils

Standard classification of soils was performed on selected coarse-grained samples in general accordance with ASTM D2488. The results of the classification are in general accordance with the Unified Soil Classification System (USCS) and are presented in the attached Laboratory Test Results.

Grain-size Analysis

Grain-size analyses were performed on selected coarse-grained samples in general accordance with ASTM D6913. The results of the sieve analyses were plotted and classified in general accordance with the Unified Soil Classification System (USCS) and are presented in the attached Laboratory Test Results. The percentage passing the U.S. No. 200 sieve is shown on the boring logs at the respective sample depths.

Moisture Content

Moisture content determinations were performed on selected coarse-grained samples in general accordance with ASTM D2216. The results of the moisture content determinations are shown on the boring logs at the respective sample depths and presented in the attached Laboratory Test Results.

Unit Weight Determination

Unit weight determinations were performed on selected coarse-grained samples in general accordance with ASTM D7263. The results of the unit weight determinations are presented in the attached Laboratory Test Results.

Soil Resistivity

Laboratory measurements of soil resistivity in general accordance with AASHTO T288 were performed on selected samples. The results of the soil resistivity testing are shown are presented in the attached Laboratory Test Results.

Sulfate Determination

Sulfate determinations were performed on selected coarse-grained samples in general accordance with ASTM D516. The results of the sulfate content determinations are presented in the attached Laboratory Test Results.

Chloride Determination

Chloride determinations were performed on selected coarse-grained samples in general accordance with ASTM D512. The results of the chloride content determinations are presented in the attached Laboratory Test Results.

pH Determination

pH determinations were performed on selected coarse-grained samples in general accordance with ASTM D4972. The results of the pH determinations are presented in the attached Laboratory Test Results.

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES
	MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
MORE THAN 50% RETAINED ON NO. 200 SIEVE	SAND AND SANDY SOILS	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS
				SP	POORLY-GRADED SANDS, GRAVELLY SAND
	MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS, ROCK FLOUR, CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
MORE THAN 50% PASSING NO. 200 SIEVE	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS AND SILTS OF MEDIUM TO HIGH PLASTICITY
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: Multiple symbols are used to indicate borderline or dual soil classifications

ADDITIONAL MATERIAL SYMBOLS

SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
	AC	Asphalt Concrete
	CC	Cement Concrete
	CR	Crushed Rock/ Quarry Spalls
	SOD	Sod/Forest Duff
	TS	Topsoil

Groundwater Contact

Measured groundwater level in exploration, well, or piezometer

Measured free product in well or piezometer

Graphic Log Contact

Distinct contact between soil strata

Approximate contact between soil strata

Material Description Contact

Contact between geologic units

Contact between soil of the same geologic unit

Sampler Symbol Descriptions

Modified California Sampler (6-inch sleeve) or Dames & Moore

Standard Penetration Test (SPT)

Shelby tube

Piston

Direct-Push

Bulk or grab

Continuous Coring

Blowcount is recorded for driven samplers as the number of blows required to advance sampler 12 inches (or distance noted). See exploration log for hammer weight and drop.

"P" indicates sampler pushed using the weight of the drill rig.

"WOH" indicates sampler pushed using the weight of the hammer.

Laboratory / Field Tests

%F	Percent fines
%G	Percent gravel
AL	Atterberg limits
CA	Chemical analysis
CP	Laboratory compaction test
CS	Consolidation test
DD	Dry density
DS	Direct shear
HA	Hydrometer analysis
MC	Moisture content
MD	Moisture content and dry density
Mohs	Mohs hardness scale
OC	Organic content
PM	Permeability or hydraulic conductivity
PI	Plasticity index
PL	Point load test
PP	Pocket penetrometer
SA	Sieve analysis
TX	Triaxial compression
UC	Unconfined compression
UU	Unconsolidated undrained triaxial compression
VS	Vane shear

Sheen Classification

NS	No Visible Sheen
SS	Slight Sheen
MS	Moderate Sheen
HS	Heavy Sheen

NOTE: The reader must refer to the discussion in the report text and the logs of explorations for a proper understanding of subsurface conditions. Descriptions on the logs apply only at the specific exploration locations and at the time the explorations were made; they are not warranted to be representative of subsurface conditions at other locations or times.

Key to Exploration Logs

GeoEngineers USA

Figure A-1

Drilled Start 3/13/2025 End 3/13/2025	Total Depth (ft) 32	Logged By AM Checked By HPC	Driller Geologic Earth Exploration, Inc.	Drilling Method Hollow-stem Auger	
Surface Elevation (ft) 114.887 Vertical Datum NAVD88		Hammer Data Autohammer 140 (lbs) / 30 (in) Drop		Drilling Equipment Acker Rebel	
Easting (X) 915372.629 Northing (Y) 2741463.538		System Datum Mass State Plane Mainland NAD83 (feet)		Groundwater not observed at time of exploration	

Notes:

Elevation (feet)	Depth (feet)	Interval	Recovered (in)	Blows/foot	Sample Name Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
	0		7	1-1-2-5 (3)	S-1		TS	Approximately 3 inches of dark brown silty fine sand with trace roots (very loose, moist) (topsoil)			Moderate rig chatter from 0 to 4 feet
							SM	Orange brown silty fine to medium sand with trace roots (very loose, moist) (subsoil)			
			13	3-4-3-5 (7)	S-2		SP	Light brown fine to medium sand with fine gravel and trace silt (loose, moist)			
110	5		15	6-5-6-14 (11)	S-3			Becomes medium dense			Moderate rig chatter from 4 to 8 feet
			14	8-6-7-9 (13)	S-4						
105	10		0	32-39-40-50/5" (79)	S-5			No recovery (very dense)			Light rig chatter from 8 to 15 feet
100	15		14	47-17-13-15 (30)	S-6			Becomes dense			Light rig chatter from 15 to 20 feet
95	20		19	9-12-14-14 (26)	S-7			Becomes medium dense			Light rig chatter from 20 to 25 feet
90	25		17	7-7-9-14 (16)	S-8						Light rig chatter from 25 to 30 feet
85	30		20	9-9-12-19 (21)	S-8						

Boring terminated at 32 feet below ground surface.
Backfilled to grade with drilling cuttings.

Note: See Figure A-1 for explanation of symbols.
Coordinates Data Source: Horizontal approximated based on survey data completed by Enbridge. Vertical approximated based on survey data completed by Enbridge.

Date:4/24/25 Path:P:\15\15556039\GINT\15556039000.GPJ DBLibrary/Library:GEOUSA_DF_STD_US.GLB/GEI8_GEOTECH_STANDARD_%F_NO_GW_4BC

Log of Boring MR-01

GeoEngineers USA

Project: Cape Canal Bridge Relocation - M&R Stations
Project Location: Barnstable County, Massachusetts
Project Number: 15556-039-00

Figure A-2
Sheet 1 of 1

Drilled: Start 3/13/2025 End 3/13/2025	Total Depth (ft): 17	Logged By: AM Checked By: HPC	Driller: Geologic Earth Exploration, Inc.	Drilling Method: Hollow-stem Auger	
Surface Elevation (ft): 112.913 Vertical Datum: NAVD88		Hammer Data: Autohammer 140 (lbs) / 30 (in) Drop		Drilling Equipment: Acker Rebel	
Easting (X): 915298.832 Northing (Y): 2741524.963		System Datum: Mass State Plane Mainland NAD83 (feet)		Groundwater not observed at time of exploration	

Notes:

Elevation (feet)	Depth (feet)	FIELD DATA: Interval	Recovered (in)	Blows/foot	Sample Name Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
	0		13	1-1-1-6 (2)	S-1		TS	Approximately 5 inches of dark brown silty fine sand with trace roots (very loose, moist) (topsoil)			Moderate rig chatter from 0 to 4 feet
							SM				
110			7	4-8-8-8 (16)	S-2		SP-SM	Orange brown silty fine to medium sand with trace roots (very loose, moist) (subsoil)			
								Light brown fine to medium sand with silt and trace fine gravel (medium dense, moist)			
			4	4-5-11-16 (16)	S-3		SP	Light brown fine to medium sand with fine gravel and trace silt (medium dense, moist)			Moderate rig chatter from 4 to 8 feet
	5		10	16-8-7-18 (15)	S-4						
105			13	10-5-6-8 (11)	S-5 MC, SA, DD				2.5	3.2	Moderate rig chatter from 8 to 15 feet % Gravel = 12.8; Dry density = 104.0
	10										
100											
	15		16	7-22-12-15 (34)	S-6						Moderate rig chatter from 15 to 17 feet. Auger refusal at 17 feet below ground surface, offset boring.

Boring terminated at 17 feet below ground surface due to auger refusal. Backfilled to grade with drilling cuttings.

Note: See Figure A-1 for explanation of symbols.
Coordinates Data Source: Horizontal approximated based on survey data completed by Enbridge. Vertical approximated based on survey data completed by Enbridge.

Log of Boring MR-02

GeoEngineers USA

Project: Cape Canal Bridge Relocation - M&R Stations
Project Location: Barnstable County, Massachusetts
Project Number: 15556-039-00

Figure A-3
Sheet 1 of 1

Date:4/24/25 Path:P:\15\15556039\GINT\15556039OO.GPJ DBLibrary/Library:GEOUSA_DF_STD_US.GLB/GEI8_GEOTECH_STANDARD_%F_NO_GW_4BC

Drilled	Start 3/13/2025	End 3/13/2025	Total Depth (ft) 32	Logged By AM / Checked By HPC	Driller Geologic Earth Exploration, Inc.	Drilling Method Hollow-stem Auger
Surface Elevation (ft) / Vertical Datum	112.43 NAVD88		Hammer Data	Autohammer 140 (lbs) / 30 (in) Drop	Drilling Equipment	Acker Rebel
Easting (X) / Northing (Y)	915290.213 2741519.153		System Datum	Mass State Plane Mainland NAD83 (feet)	Groundwater not observed at time of exploration	

Notes:

Elevation (feet)	Depth (feet)	FIELD DATA: Interval Recovered (in)	FIELD DATA: Blows/foot	FIELD DATA: Sample Name Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
110	0									Boring offset from MR-02 and drilled down to 20 feet below ground surface to continue sampling. Moderate rig chatter from 0 to 5 feet
	5									Heavy rig chatter from 5 to 6½ feet. Inferred boulders from 5 to 6½ feet. Light rig chatter from 6½ to 10 feet
105	10									Light rig chatter from 10 to 12 feet. Inferred cobbles from 12½ to 13 feet
100	15									Moderate rig chatter from 15 to 16½ feet. Inferred cobbles from 15 to 16½ feet. Light rig chatter from 16½ to 20 feet
95	20	8	9-10-13-27 (23)	S-1		SP	Light brown fine to medium sand with trace fine gravel and trace silt (medium dense, moist)			Light rig chatter from 20 to 25 feet
90	25	15	7-9-15-12 (24)	S-2						Light rig chatter from 25 to 30 feet
85	30	18	10-11-11-28 (22)	S-3			Becomes gravelly			

Boring terminated at 32 feet below ground surface.
Backfilled to grade with drilling cuttings.

Note: See Figure A-1 for explanation of symbols.
Coordinates Data Source: Horizontal approximated based on survey data completed by Enbridge. Vertical approximated based on survey data completed by Enbridge.

Log of Boring MR-02A

GeoEngineers USA

Project: Cape Canal Bridge Relocation - M&R Stations
Project Location: Barnstable County, Massachusetts
Project Number: 15556-039-00

Figure A-4
Sheet 1 of 1

Date:4/24/25 Path:P:\15\15556039\GINT\1555603900.GPJ DBLibrary/Library:GEOUSA_DF_STD_US.GLB/GEI8_GEOTECH_STANDARD_%F_NO_GW_4BC

Client:	GeoEngineers, Inc.				
Project:	Cape Cod - En bridge				
Location:	MA			Project No:	GTX-320749
Boring ID:	---	Sample Type:	---	Tested By:	ajl
Sample ID:	---	Test Date:	03/26/25	Checked By:	ank
Depth :	---	Test Id:	808033		

Moisture Content of Soil and Rock - ASTM D2216

Boring ID	Sample ID	Depth	Description	Moisture Content, %
MR-02	S- 5	8-10	Moist, yellowish brown sand	2.5
[redacted]				
[redacted]				
[redacted]				
[redacted]				
[redacted]				
[redacted]				
[redacted]				
[redacted]				
[redacted]				

Notes: Temperature of Drying : 110° Celsius

Client:	GeoEngineers, Inc.				
Project:	Cape Cod - En bridge				
Location:	MA			Project No:	GTX-320749
Boring ID:	---	Sample Type:	---	Tested By:	ajl
Sample ID:	---	Test Date:	03/31/25	Checked By:	ank
Depth :	---	Test Id:	808070		

pH of Soil by ASTM D4972

Boring ID	Sample ID	Depth	Visual Description	pH of Soil in Distilled Water	pH of Soil in Calcium Chloride
MR-02/02A	S-4, S-5, S-6/S-1, S-2, S-3	Composite	Moist, yellowish brown sand	7.4	6.0
[redacted]					
[redacted]					
[redacted]					

Notes: Sample Preparation: screened through #10 sieve

Method A, pH meter used

Client:	GeoEngineers, Inc.				
Project:	Cape Cod - En bridge				
Location:	MA			Project No:	GTX-320749
Boring ID:	---	Sample Type:	---	Tested By:	ajl
Sample ID:	---	Test Date:	03/24/25	Checked By:	ank
Depth :	---	Test Id:	808068		

Laboratory Determination of Density (Unit Weight) of Soil Specimens by ASTM D7263

Boring ID	Sample ID	Depth	Visual Description	Bulk Density pcf	Moisture Content %	Dry Density pcf	*
MR-02	S- 5	8-10	Moist, yellowish brown sand	106.6	2.480	104.0	(1)
[redacted]							
[redacted]							
[redacted]							
[redacted]							

* Sample Comments

(1): Method B-Volumetric, Reconstituted (compacted)

(2): Method B-Volumetric, Reconstituted (compacted)

(3): Method B-Volumetric, Reconstituted (compacted)

(4): Method B-Volumetric, Reconstituted (compacted)

(5): Method B-Volumetric, Reconstituted (compacted)

Notes: Moisture Content determined by ASTM D2216.

Client:	Geo Engineer, Inc.
Project:	Cape Cod-En Bridge
Location:	MA
GTX#:	320749
Test Date:	04/01/25
Due Date:	04/03/25
Tested By:	NMK
Checked By:	ank

Minimum Laboratory Soil Resistivity by AASHTO T 288

Boring ID	Sample ID	Depth, ft.	Sample Description	Electrical Resistivity, ohm-cm	Electrical Conductivity, $(ohm\text{-}cm)^{-1}$
MR-02/02A	S-4, S-5, S-6/S-1, S-2, S-3	Composite	Moist, yellowish brown sand	84,675	1.18E-05
[redacted]					
[redacted]					
[redacted]					

Notes: Test Equipment: Nilsson Model 400 Soil Resistance Meter, MC Miller Soil Box

Water added to sample to create a thick slurry prior to testing (saturated condition).

Electrical Conductivity is calculated as inverse of Electrical Resistivity (per ASTM G57)

Test conducted in standard laboratory atmosphere: 68-73 F

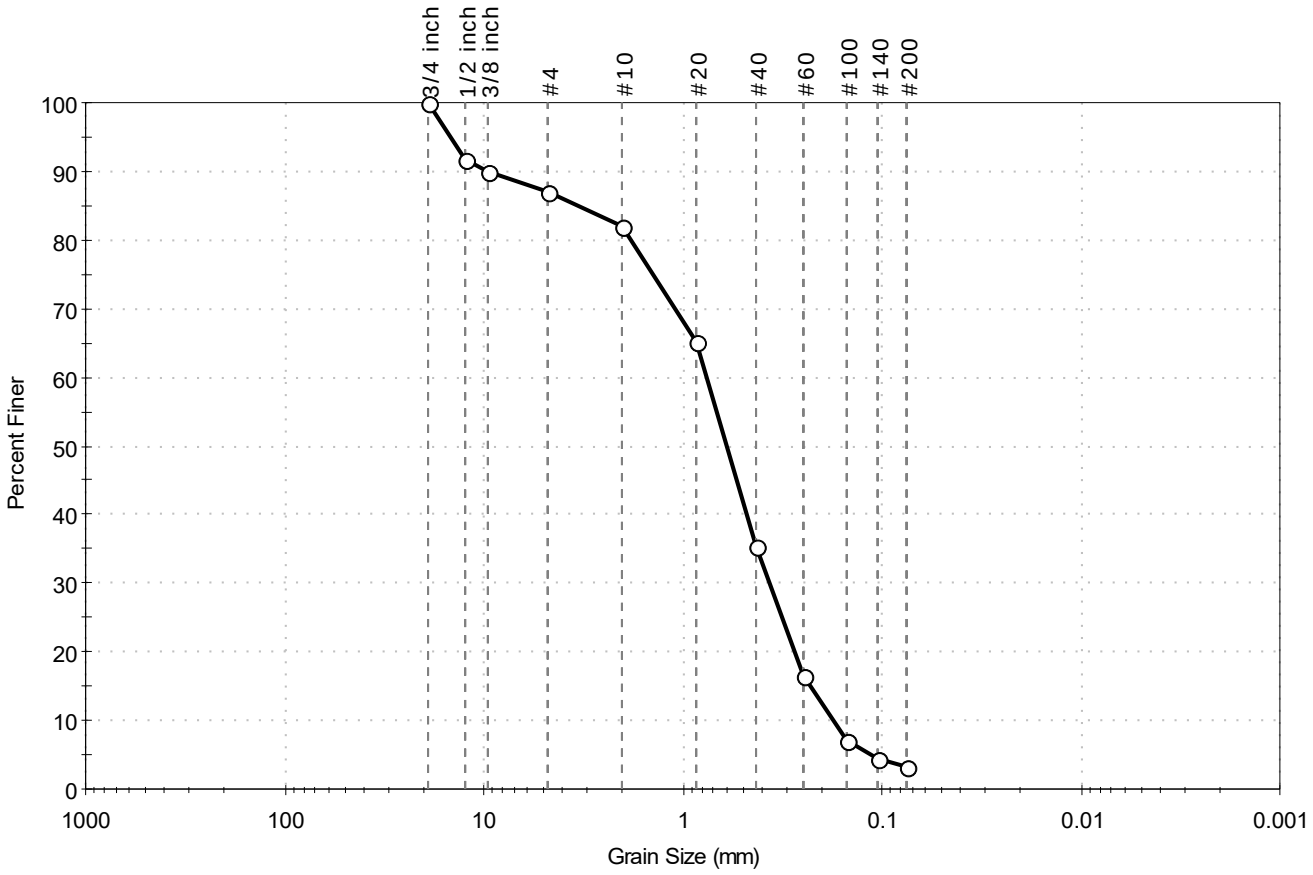
Client:	GeoEngineers, Inc.				
Project:	Cape Cod - En bridge				
Location:	MA			Project No:	GTX-320749
Boring ID:	MR-02	Sample Type:	Jar	Tested By:	ajl
Sample ID:	S-5	Test Date:	03/27/25	Checked By:	ank
Depth :	8-10	Test Id:	808039		
Test Comment:	---				
Visual Description:	Moist, yellowish brown sand				
Sample Comment:	---				

Description and Classification of Soils (Visual-Manual) - ASTM D2488

Parameter	Result
Group Name	Sand
Group Symbol	SP
% Cobbles/Boulders	0
% Gravel	13
% Sand	84
% Fines	3
Angularity (coarse grained)	SUBANGULAR
Shape (coarse grained)	N/A
Maximum Particle Size (mm)	12.5
Hardness (coarse grained)	HARD
Plasticity (fine grained)	NONPLASTIC
Dry Strength (fine grained)	NONE
Dilatancy (fine grained)	RAPID
Toughness (fine grained)	---
Color	Yellowish brown
Odor	NONE
Moisture	MOIST
Reaction with HCL	NONE
Consistency (intact,fine grained)	---
Structure (intact)	---
Cementation (intact, coarse grained)	---

Client:	GeoEngineers, Inc.				
Project:	Cape Cod - En bridge				
Location:	MA			Project No:	GTX-320749
Boring ID:	MR-02	Sample Type:	Jar	Tested By:	ajl
Sample ID:	S-5	Test Date:	03/26/25	Checked By:	ank
Depth :	8-10	Test Id:	808025		
Test Comment:	---				
Visual Description:	Moist, yellowish brown sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D6913



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	12.8	84.0	3.2

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
3/4 inch	19.00	100		
1/2 inch	12.50	92		
3/8 inch	9.50	90		
#4	4.75	87		
#10	2.00	82		
#20	0.85	65		
#40	0.42	35		
#60	0.25	17		
#100	0.15	7		
#140	0.11	4		
#200	0.075	3.2		

Coefficients

D_{85} = 3.3147 mm	D_{30} = 0.3660 mm
D_{60} = 0.7543 mm	D_{15} = 0.2293 mm
D_{50} = 0.5982 mm	D_{10} = 0.1753 mm
C_u = 4.303	C_c = 1.013

Classification

ASTM — Poorly graded SAND (SP)

AASHTO — Stone Fragments, Gravel and Sand (A-1-b (1))

Sample / Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

PO Box 572455 / Salt Lake City UT 84157-2455 / USA
TEL +1 801 262 2448 · FAX +1 801 262 9870 · www.TEi-TS.com

GEOTESTING EXPRESS INCORPORATED
125 NAGOG PARK
ACTON MA 01720-3451
USA

Analysis No.	TS-A2512584
Report Date	31 March 2025
Date Sampled	24 March 2025
Date Received	27 March 2025
Where Sampled	Acton, MA USA
Sampled By	Client

This is to attest that we have examined: Soil: Project: Cape Cod – En Bridge; Site Location: - — -; Job Number: GTX-320749

When examined to the applicable requirements of:

ASTM D 512-12*	“Standard Test Methods for Chloride Ion in Water” Method B
ASTM D 516-22	“Standard Test Method for Sulfate Ion in Water”

Results:

ASTM D 512 - Chloride Method B

Sample		Results		Minimum Detection Limit
		ppm (mg/kg)	%[1]	
MR-02/02A		< 10.	< 0.0010	10.
S-4, S-5, S-6/S-1, S-2, S-3	Composite			
[redacted]				
[redacted]				
[redacted]				

NOTE: [1]Percent by weight after drying and prepared as per the Standard. *Withdrawn 2021 without Replacement

Testing Services analytical Laboratory
3455 South 500 West
Salt Lake City, UT 84115-4234 USA
TEL: +1 801 262 2448
FAX: +1 801 262 9870

ASTM D 516 - Sulfates (Soluble)

Sample		Results		Minimum Detection Limit
		ppm (mg/kg)	%[1]	
MR-02/02A		10.	0.0010	10.
S-4, S-5, S-6/S-1, S-2, S-3	Composite			
[redacted]				
[redacted]				
[redacted]				

NOTE: [1]Percent by weight after drying and prepared as per the Standard.

END OF ANALYSIS

USEPA Laboratory ID UT00930

Merrill Gee P.E. – Engineer in Charge

© 2025 by Testing Engineers International, Inc. CAVEAT: This certificate may not be reproduced except in full, without the expressed written consent of TEi-Testing Services, LLC. Note: The values in this certificate are the values obtained under standard test conditions as reported in the appropriate Report of Test and thus may be used for purposes of demonstrating compliance or for comparison with other units tested under the same standard. The results do not indicate the function of the sample(s) under nonstandard or field conditions. Statement of Risk: Client understands and agrees that declarations of conformity are made by directly comparing the measurement results against the test limits given in the standard without consideration to factors that may contribute to measurement uncertainty and accepts the shared risk that arises from this approach. This certificate gives the characteristics of the sample(s) submitted for testing only. It does not and may not be used to certify the characteristics of the product, nor to imply that the product in general meets the requirements of any standard, nor its acceptability in the marketplace. TEi stylized lettering and logo are registered trademarks, and use is by contract and/or written permission only. USEPA Laboratory ID UT00930 TEi-Testing Services is a wholly owned LLC of Testing Engineers International, Inc.

Appendix B
Report Limitations and Guidelines for Use

Appendix B
Report Limitations and Guidelines For Use[1]

This appendix provides information to help you manage your risks with respect to the use of this report.

READ THESE PROVISIONS CLOSELY

It is important to recognize that the geoscience practices (geotechnical engineering, geology, and environmental science) rely on professional judgment and opinion to a greater extent than other engineering and natural science disciplines, where more precise and/or readily observable data may exist. To help clients better understand how this difference pertains to our services, GeoEngineers includes the following explanatory "limitations" provisions in its reports. Please confer with GeoEngineers if you need to know more how these "Report Limitations and Guidelines for Use" apply to your project or site.

GEOTECHNICAL SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES, PERSONS, AND PROJECTS

This report has been prepared for Enbridge, Inc. and for the Project specifically identified in the report. The information contained herein is not applicable to other sites or projects.

GeoEngineers structures its services to meet the specific needs of its clients. No party other than the party to whom this report is addressed may rely on the product of our services unless we agree to such reliance in advance and in writing. Within the limitations of the agreed scope of services for the Project, and its schedule and budget, our services have been executed in accordance with our Agreement with Enbridge, Inc. dated October 31, 2023, and revised April 4, 2025 and generally accepted geotechnical practices in this area at the time this report was prepared. We do not authorize, and will not be responsible for, the use of this report for any purposes or projects other than those identified in the report.

A GEOTECHNICAL ENGINEERING OR GEOLOGIC REPORT IS BASED ON A UNIQUE SET OF PROJECT-SPECIFIC FACTORS

This report has been prepared for Enbridge Inc. for the proposed Cape Sagamore M&R Station Site, in Bourne, Massachusetts. GeoEngineers considered a number of unique, project-specific factors when establishing the scope of services for this project and report. Unless GeoEngineers specifically indicates otherwise, it is important not to rely on this report if it was:

- Not prepared for you,
- Not prepared for your project,
- Not prepared for the specific site explored, or
- Completed before important project changes were made.

1 Developed based on material provided by GBA, GeoProfessional Business Association; www.geoprofessional.org.

For example, changes that can affect the applicability of this report include those that affect:

- The function of the proposed structure;
- Elevation, configuration, location, orientation, or weight of the proposed structure;
- Composition of the design team; or
- Project ownership.

If changes occur after the date of this report, GeoEngineers cannot be responsible for any consequences of such changes in relation to this report unless we have been given the opportunity to review our interpretations and recommendations. Based on that review, we can provide written modifications or confirmation, as appropriate.

ENVIRONMENTAL CONCERNS ARE NOT COVERED

Unless environmental services were specifically included in our scope of services, this report does not provide any environmental findings, conclusions, or recommendations, including but not limited to, the likelihood of encountering underground storage tanks or regulated contaminants.

SUBSURFACE CONDITIONS CAN CHANGE

This geotechnical or geologic report is based on conditions that existed at the time the study was performed. The findings and conclusions of this report may be affected by the passage of time, by man-made events such as construction on or adjacent to the site, new information or technology that becomes available subsequent to the report date, or by natural events such as floods, earthquakes, slope instability or groundwater fluctuations. If more than a few months have passed since issuance of our report or work product, or if any of the described events may have occurred, please contact GeoEngineers before applying this report for its intended purpose so that we may evaluate whether changed conditions affect the continued reliability or applicability of our conclusions and recommendations.

TOPSOIL

For the purposes of this report, we consider topsoil to consist of generally fine-grained soil with an appreciable amount of organic matter based on visual examination and to be unsuitable for direct support of the proposed improvements. However, the organic content and other mineralogical and gradational characteristics used to evaluate the suitability of soil for use in landscaping and agricultural purposes was not determined, nor considered in our analyses. Therefore, the information and recommendations in this report and our logs and descriptions should not be used as a basis for estimating the volume of topsoil available for such purposes.

GEOTECHNICAL AND GEOLOGIC FINDINGS ARE PROFESSIONAL OPINIONS

Our interpretations of subsurface conditions are based on field observations from widely spaced sampling locations at the site. Site exploration identifies the specific subsurface conditions only at those points where subsurface tests are conducted or samples are taken. GeoEngineers reviewed field and laboratory data and then applied its professional judgment to render an informed opinion about subsurface conditions at other locations. Actual subsurface conditions may differ, sometimes significantly, from the opinions

presented in this report. Our report, conclusions and interpretations are not a warranty of the actual subsurface conditions.

GEOTECHNICAL ENGINEERING REPORT RECOMMENDATIONS ARE NOT FINAL

We have developed the following recommendations based on data gathered from subsurface investigation(s). These investigations sample just a small percentage of a site to create a snapshot of the subsurface conditions elsewhere on the site. Such sampling on its own cannot provide a complete and accurate view of subsurface conditions for the entire site. Therefore, the recommendations included in this report are preliminary and should not be considered final. GeoEngineers' recommendations can be finalized only by observing actual subsurface conditions revealed during construction. GeoEngineers cannot assume responsibility or liability for the recommendations in this report if we do not perform construction observation.

We recommend that you allow sufficient monitoring, testing and consultation during construction by GeoEngineers to confirm that the conditions encountered are consistent with those indicated by the explorations, to provide recommendations for design changes if the conditions revealed during the work differ from those anticipated, and to evaluate whether earthwork activities are completed in accordance with our recommendations. Retaining GeoEngineers for construction observation for this project is the most effective means of managing the risks associated with unanticipated conditions. If another party performs field observation and confirms our expectations, the other party must take full responsibility for both the observations and recommendations. Please note, however, that another party would lack our project-specific knowledge and resources.

A GEOTECHNICAL ENGINEERING OR GEOLOGIC REPORT COULD BE SUBJECT TO MISINTERPRETATION

Misinterpretation of this report by members of the design team or by contractors can result in costly problems. GeoEngineers can help reduce the risks of misinterpretation by conferring with appropriate members of the design team after submitting the report, reviewing pertinent elements of the design team's plans and specifications, participating in pre-bid and preconstruction conferences, and providing construction observation.

DO NOT REDRAW THE EXPLORATION LOGS

Geotechnical engineers and geologists prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. The logs included in a geotechnical engineering or geologic report should never be redrawn for inclusion in architectural or other design drawings. Photographic or electronic reproduction is acceptable, but separating logs from the report can create a risk of misinterpretation.

GIVE CONTRACTORS A COMPLETE REPORT AND GUIDANCE

To help reduce the risk of problems associated with unanticipated subsurface conditions, GeoEngineers recommends giving contractors the complete geotechnical engineering or geologic report, including these "Report Limitations and Guidelines for Use." When providing the report, you should preface it with a clearly written letter of transmittal that:

- Advises contractors that the report was not prepared for purposes of bid development and that its accuracy is limited; and
- Encourages contractors to conduct additional study to obtain the specific types of information they need or prefer.

CONTRACTORS ARE RESPONSIBLE FOR SITE SAFETY ON THEIR OWN CONSTRUCTION PROJECTS

Our geotechnical recommendations are not intended to direct the contractor's procedures, methods, schedule, or management of the work site. The contractor is solely responsible for job site safety and for managing construction operations to minimize risks to on-site personnel and adjacent properties.

BIOLOGICAL POLLUTANTS

GeoEngineers' Scope of Work specifically excludes the investigation, detection, prevention, or assessment of the presence of Biological Pollutants. Accordingly, this report does not include any interpretations, recommendations, findings, or conclusions regarding the detecting, assessing, preventing or abating of Biological Pollutants, and no conclusions or inferences should be drawn regarding Biological Pollutants as they may relate to this project. The term "Biological Pollutants" includes, but is not limited to, molds, fungi, spores, bacteria, and viruses, and/or any of their byproducts.

A Client that desires these specialized services is advised to obtain them from a consultant who offers services in this specialized field.

INFORMATION PROVIDED BY OTHERS

GeoEngineers has relied upon certain data or information provided or compiled by others in the performance of our services. Although we use sources that we reasonably believe to be trustworthy, GeoEngineers cannot warrant or guarantee the accuracy or completeness of information provided or compiled by others.

Drawdown Analysis

Drawdown Analysis

Required Drawdown Time

Infiltration Basin	Bottom Area (sf)	100-Year Storage (cf)	Infiltration Rate (in/hr)	Drawdown Time (hr)
1	734.20	10490.20	6.880	24.9
2	543.55	7280.13	6.880	23.4
3	1157.27	12063.93	6.880	18.2
4	272.59	2372.37	6.880	15.2

NRCS Web Soil Infiltration Data

NRCS Web Soil Map Symbol and Soil Name	Ksat rv (micro m/sec)	Ksat rv (in/hr)	Safety Factor (0.5)	Design Infiltration Rate
Plymouth-Barnstable complex, rolling, very bouldery				
483C	106.6054	15.11	0.5	7.553
Plymouth-Barnstable complex, rolling, extremely bouldery				
484C	106.6054	15.11	0.5	7.553
Plymouth-Barnstable complex, hilly, extremely bouldery				
484D	97.101	13.76	0.5	6.880

Design Infiltration Rate = 6.88 in/hr

Recharge Volume

Attachment E - Standard 4 Supporting Information

Long-Term Pollution Prevention Plan

Water Quality Volume Calculations

TSS Removal Work Sheet

Nitrogen Loading Calculations

Long – Term Pollution Prevention Plan

This Long-Term Pollution Prevention Plan has been developed to establish site management practices that improve the quality of stormwater discharges from the Project.

Pollutant Control Approach

Maintenance of Impervious Areas

Standard Gravel Areas

Gravel area maintenance involves regular raking to redistribute stones, removing debris with a leaf blower, and replenishing aggregate every 2–4 years to fix sinking or bare spots. For longevity, ensure proper drainage with a crown, clean debris from edges, and remove sediment to prevent clogging. Maintain Proper Grading on roads with a 3% grade to shed water and reduce erosion and sediment runoff.

Key Maintenance Activities:

- **Raking & Leveling:** Regularly rake in ruts and maintain a level surface, especially in high-traffic areas.
- **Debris Removal:** Use a leaf blower or rake to remove leaves and debris, preventing decomposition that creates soil for weeds.
- **Replenishing:** Top off gravel every 2-4 years as it settles or sinks into the ground.
- **Weed Management:** Pull weeds regularly and apply mulch glue or similar products to help keep gravel in place and reduce weed growth.
- **Drainage & Erosion Control:** Ensure the area has a slight slope (crown) to prevent standing water. Inspect for erosion and fill in low spots with clean, washed stone.
- **Edge Maintenance:** Clean edges to maintain a clear boundary.

O&M for Specific Gravel Uses:

- **Gravel Driveways:** Use a rake or land plane to keep the surface level and remove potholes. Maintain 3% grade to promote sheet flow and avoid erosion and sedimentation.
- **Pervious Gravel Areas:** Remove sediment that clogs voids to maintain infiltration. If clogged, remove the top layer of rock to wash or replace it.

Maintenance of Vegetated Areas

Proper maintenance of vegetated areas can prevent the pollution of stormwater runoff by controlling the source of pollutants such as suspended sediments, excess nutrients, and chemicals from landscape care products. Practices that should be followed under the regular maintenance of the vegetated landscape include:

- Inspect vegetated areas on a semi-annual basis and remove any litter.

- Maintain vegetated areas adjacent to pavement to prevent soil washout.
- Immediately clean any soil deposited on pavement.
- Re-seed bare areas; install appropriate erosion control measures when native soil is exposed or erosion channels are forming.

Management of Snow and Ice

Storage and Disposal

Snow shall be stockpiled on standard pavement surfaces so sand and salt may be swept in the spring or removed as snow melts and drains through the stormwater management system. Key practices for the safe storage and disposal of snow include:

- Under no circumstances shall snow be disposed or stored in wetland resource areas.
- Under no circumstances shall snow be disposed or stored in stormwater basins, ponds, rain gardens, swales, channels, or trenches.

Salt and Deicing Chemicals

The amount of salt and deicing chemicals to be used on the site shall be reduced to the minimum amount needed to provide safe pedestrian and vehicle travel. The following practices should be followed to control the amount of salt and deicing

materials that come into contact with stormwater runoff:

- Devices used for spreading salt and deicing chemicals should be capable of varying the rate of application based on the site specific conditions.
- Sand and salt should be stockpiled under covered storage facilities that prevent precipitation and adjacent runoff from coming in contact with the deicing materials

Spill Prevention and Response Plan

Initial Notification

In the event of a spill the facility and/or construction manager or supervisor will be notified immediately.

Facility Manager: Joseph Bruno (Jpseph.Bruno@enbridge.com)

Construction Manager: Williams Rogers (William.Rodger@enbridge.com)

The supervisor will first contact the Fire Department and then notify the Police Department, the Public Health Commission and the Conservation Commission. The Fire Department is ultimately responsible for matters of public health and safety and should be notified immediately.

Further Notification

Based on the nature, size, and potential environmental impact of the spill or release, additional notifications may be made to appropriate local, state, and federal agencies, as well as qualified cleanup contractors and emergency response personnel.

Applicable regulatory notifications may include the Massachusetts Department of Environmental Protection (MassDEP), the National Response Center (NRC), and other agencies as required by law or permit conditions. Emergency response personnel and the designated Site Representative shall coordinate response actions and determine appropriate cleanup and reporting measures based on site conditions and regulatory requirements.

Emergency contact information shall be maintained at the site office and made readily accessible to project personnel during construction and facility operations. Spill incidents and corrective actions shall be documented and maintained as part of the project records, and spill reporting forms shall be completed as necessary.

Emergency Notification Phone Numbers

1. FACILITY MANAGER NAME: Joseph Bruno ALERNATE CONTACT: William Rogers	 PHONE: 508-938-7710 CELL: 617-281-3984 PHONE: 508-699-5471 CELL: 781-844-2725
2. FIRE AND POLICE DEPARTMENT	EMERGENCY: 911
3. CLEANUP CONTRACTOR: ADDRESS: _____ _____	PHONE: _____
4. STATE DEPARTMENT OF ENVIRONMENTAL PROTECTION (DEP)/ DEPARTMENT OF ENVIRONMENTAL SERVICES (DES)	EMERGENCY PHONE: 508-946-2700
5. NATIONAL RESPONSE CENTER U.S ENVIORNMENTAL PROTECTION AGENCY	PHONE: (800) 424-8802 PHONE: 1-888-372-7341
6. BARNSTABLE HEATH DEPARTMENT CAPE COD CONSERVATION COMISSION:	PHONE: 508-862-4644 PHONE: 508-362-3828

Hazardous Waste / Oil Spill Report

Date: ____/____/_____ Time: _____ AM / PM

Exact location _____

Type of equipment:_____ Make:_____ Size:_____

License or S/N:_____ Weather Conditions:_____

On or near water ☐ Yes If yes, name of body of water:_____

☐ No

Type of chemical / oil spilled: _____

Amount of chemical / oil spilled: _____

Cause of spill: _____

_____

_____

Measures taken to contain or clean up spill: _____

_____

_____

Amount of chemical / oil recovered: _____ Method:_____

Material collected as a result of clean up

_____ drums containing: _____

_____ drums containing: _____

_____ drums containing: _____

Location and method of debris disposal:_____

Name and address of any person, firm, or corporation suffering damages:_____

_____

Procedures, method, and precautions instituted to prevent a similar occurrence from recurring: :_____

_____

Spill reported to General Office by:_____Time: _____AM / PM

Spill reported to DEP / National Response Center by:_____

DEP Date: ____/____/_____ Time:_____AM / PM Inspector:_____

NRC Date: ____/____/_____ Time:_____AM / PM Inspector: _____

Additional comments: _____

_____

Assessment – Initial Containment

- The supervisor or manager will assess the incident and initiate containment
- control measures with the appropriate spill containment equipment included in the spill kit kept on-site. A list of recommended spill equipment to be kept on site is included on the following page.
- Fire / Police Department: 911
- Municipality Health Department: (508) 862-4644
- Municipality Conservation Commission: (508) 362-3828

Stormwater Operation and Maintenance Plan

Project Information

Cape Cod Canal Bridge Replacement Project

Site

Bourne Rotary M&R Station

Owner

Algonquin Gas Transmission, LLC

Site Supervisor

Name: Joseph Bruno

PHONE: 508-938-7710

CELL: 617-281-3984

Name: William Rogers

PHONE: 508-699-5471

CELL: 781-844-2725

Description of Stormwater Maintenance Measures

The following Operation and Maintenance (O&M) program is proposed to ensure the continued effectiveness of the stormwater management system. Attached to this plan are a Stormwater Best Management Practices Checklist and Maintenance Figure for use during the long term operation and maintenance of the stormwater management system.

The long term O&M of the stormwater management system is estimated to cost approximately $20,000 annually.

Grass Swales

Grass swales shall be inspected semi-annually and after storm events exceeding 1 inch of rainfall. Swales shall be maintained to ensure proper flow conveyance without erosion or standing water. Sediment and debris shall be removed as needed to maintain design capacity. Vegetation shall be mowed and maintained to promote uniform flow and infiltration. Eroded areas shall be repaired and stabilized.

Sediment Forebays

Sediment forebays shall be inspected semi-annually and after major storm events. Accumulated sediment shall be removed when it reaches 50% of the design storage capacity or as needed to maintain function. Inlet and outlet structures shall be checked for blockages or damage. Removed sediment shall be disposed of in accordance with applicable regulations.

Infiltration Basin

The infiltration basin shall be inspected semi-annually and after storm events exceeding 1 inch of rainfall. The basin shall be maintained to ensure proper infiltration, including removal of accumulated sediment, trash, and debris. Sediment shall be removed when accumulation exceeds 3 inches. The basin shall be evaluated if standing water persists longer than 72 hours, and corrective actions shall be implemented as needed. Vegetation shall be maintained to ensure proper function.

Inspections and Cleaning

A routine inspection and maintenance program shall be implemented in accordance with the Massachusetts Stormwater Management Standards (310 CMR 10.00). Inspection records shall include the date, inspector name, observations, and corrective actions taken. Maintenance activities, including sediment removal and repairs, shall be documented and retained on-site or made available upon request. Any deficiencies identified during inspections shall be corrected in a timely manner to ensure continued compliance.

Long Term Best Management Practices – Maintenance / Evaluation Checklist

Best Management Practices	Inspection Frequency	Date	Inspector	Minimum Maintenance and Key items to check	Cleaning/Repair needed	Date of Cleaning/ Repair	Preformed by:

Stormwater Control Manager: _____

Water Quality Volume Calculations

Water Quality Volume Calculations

Storage Volume Summary

Forebay	Treatment Depth (in)	Impervious Area (Acres)	Required Volume (cf)	Provided Volume (cf)
1	0.10	0.52	187.23	982.51
2	0.10	0.17	61.11	823.76
3	0.10	0.40	145.02	542.91
4	0.10	0.16	59.47	1127.15

Min. Storage Volume = 0.1-inch per impervious acre tributary to BMP (per Volume 2, Chapter 2, p.13 of the 2008 MA DEP Stormwater Management Handbook)

Basin	Treatment Depth (in)	Impervious Area (Acres)	Required Volume (cf)	Provided Volume (cf)
1	1.00	0.52	1872.32	10490.20
2	1.00	0.17	611.14	7119.15
3	1.00	0.40	1450.21	11746.88
4	1.00	0.16	594.68	2357.85

Provided Storage Volumes

	Depth (ft)	Area (sf)	Cumulative Volume (cf)
Forebay 1	0.00	48.29	0.00
	1.00	241.18	144.74
	2.00	506.06	518.36
	2.80	654.31	982.51
	3.20	923.70	1298.11

	Depth (ft)	Area (sf)	Cumulative Volume (cf)
Forebay 2	0.00	221.26	0.00
	1.00	374.45	297.86
	2.00	562.72	766.45
	2.10	583.45	823.76
	3.00	785.55	1439.81

	Depth (ft)	Area (sf)	Cumulative Volume (cf)
Forebay 3	0.00	54.00	0.00
	1.00	186.00	120.00
	2.00	350.00	388.00
	2.40	424.56	542.91
	3.00	546.00	834.08

	Depth (ft)	Area (sf)	Cumulative Volume (cf)
Forebay 4	0.00	170.46	0.00
	1.00	301.38	235.92
	2.00	462.94	618.08
	3.00	555.20	1127.15
	3.50	655.13	1429.73

	Depth (ft)	Area (sf)	Cumulative Volume (cf)
Infiltration Basin 1	0.00	734.20	0.00
	1.00	1121.14	927.67
	2.00	1714.29	2345.38
	3.00	2339.15	4372.10
	4.00	2995.85	7039.60
	4.50	3484.76	8659.75
	5.00	3837.05	10490.20
	5.30	4151.91	11688.54

	Depth (ft)	Area (sf)	Cumulative Volume (cf)
Infiltration Basin 2	0.00	543.55	0.00
	1.00	946.00	744.78
	2.00	1380.46	1908.01
	3.00	1846.91	3521.70
	4.00	2345.37	5617.84
	4.60	2705.28	7119.15
	5.00	2875.82	8226.44

	Depth (ft)	Area (sf)	Cumulative Volume (cf)
Infiltration Basin 3	0.00	1157.27	0.00
	1.00	2197.59	1677.43
	2.00	3275.77	4414.11
	3.00	4385.72	8244.86
	3.73	5344.83	11746.88
	4.00	5527.59	13199.51

	Depth (ft)	Area (sf)	Cumulative Volume (cf)
Infiltration Basin 4	0.00	272.59	0.00
	1.00	664.04	468.32
	2.00	1087.50	1344.09
	2.80	1473.66	1943.77
	3.00	1542.95	2657.31

TSS Removal Worksheets

INSTRUCTIONS:
1. In BMP Column, click on Blue Cell to Activate Drop Down Menu
2. Select BMP from Drop Down Menu
3. After BMP is selected, TSS Removal and other Columns are automatically completed.

Version 1, Automated: Mar. 4, 2008

Location: Barnstable County - Drainage Area 1

TSS Removal Calculation Worksheet

B BMP[1]	C TSS Removal Rate[1]	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
Grass Channel	0.50	1.00	0.50	0.50
Sediment Forebay	0.25	0.50	0.13	0.38
Infiltration Basin	0.80	0.38	0.30	0.08
	0.00	0.08	0.00	0.08
	0.00	0.08	0.00	0.08

Total TSS Removal = 93%

Separate Form Needs to be Completed for Each Outlet or BMP Train

Project: MASS DOT Canal Bridges Relocation
Prepared By: Drake Trawhon
Date: 5/5/2026

*Equals remaining load from previous BMP (E) which enters the BMP

Non-automated TSS Calculation Sheet must be used if Proprietary BMP Proposed
1. From MassDEP Stormwater Handbook Vol. 1

INSTRUCTIONS:
1. In BMP Column, click on Blue Cell to Activate Drop Down Menu
2. Select BMP from Drop Down Menu
3. After BMP is selected, TSS Removal and other Columns are automatically completed.

Version 1, Automated: Mar. 4, 2008

Location: Barnstable County - Drainage Area 2

TSS Removal Calculation Worksheet

B BMP[1]	C TSS Removal Rate[1]	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
Grass Channel	0.50	1.00	0.50	0.50
Sediment Forebay	0.25	0.50	0.13	0.38
Infiltration Basin	0.80	0.38	0.30	0.08
	0.00	0.08	0.00	0.08
	0.00	0.08	0.00	0.08

Total TSS Removal = 93%

Separate Form Needs to be Completed for Each Outlet or BMP Train

Project: MASS DOT Canal Bridges Relocation
Prepared By: Drake Trawhon
Date: 5/5/2026

*Equals remaining load from previous BMP (E) which enters the BMP

Non-automated TSS Calculation Sheet must be used if Proprietary BMP Proposed
1. From MassDEP Stormwater Handbook Vol. 1

INSTRUCTIONS:
1. In BMP Column, click on Blue Cell to Activate Drop Down Menu
2. Select BMP from Drop Down Menu
3. After BMP is selected, TSS Removal and other Columns are automatically completed.

Version 1, Automated: Mar. 4, 2008

Location: Barnstable County - Drainage Area 3

TSS Removal Calculation Worksheet

B BMP[1]	C TSS Removal Rate[1]	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
Grass Channel	0.50	1.00	0.50	0.50
Sediment Forebay	0.25	0.50	0.13	0.38
Infiltration Basin	0.80	0.38	0.30	0.08
	0.00	0.08	0.00	0.08
	0.00	0.08	0.00	0.08

Total TSS Removal = 93%

Separate Form Needs to be Completed for Each Outlet or BMP Train

Project: MASS DOT Canal Bridges Relocation
Prepared By: Drake Trawhon
Date: 5/5/2026

*Equals remaining load from previous BMP (E) which enters the BMP

Non-automated TSS Calculation Sheet must be used if Proprietary BMP Proposed
1. From MassDEP Stormwater Handbook Vol. 1

INSTRUCTIONS:
1. In BMP Column, click on Blue Cell to Activate Drop Down Menu
2. Select BMP from Drop Down Menu
3. After BMP is selected, TSS Removal and other Columns are automatically completed.

Version 1, Automated: Mar. 4, 2008

Location: Barnstable County - Drainage Area 4

TSS Removal Calculation Worksheet

B BMP[1]	C TSS Removal Rate[1]	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
Grass Channel	0.50	1.00	0.50	0.50
Sediment Forebay	0.25	0.50	0.13	0.38
Infiltration Basin	0.80	0.38	0.30	0.08
	0.00	0.08	0.00	0.08
	0.00	0.08	0.00	0.08

Total TSS Removal = 93%

Separate Form Needs to be Completed for Each Outlet or BMP Train

Project: MASS DOT Canal Bridges Relocation
Prepared By: Drake Trawhon
Date: 5/5/2026

*Equals remaining load from previous BMP (E) which enters the BMP

Non-automated TSS Calculation Sheet must be used if Proprietary BMP Proposed
1. From MassDEP Stormwater Handbook Vol. 1

Nitrogen Loading Calculations

NITROGEN LOADING CALCULATION

Based on Cape Cod Commission Technical Bulletin 91-001 (April 1992)

SECTION 1 — INPUT DATA

Property Information

Parameter	Description	Value	Units		Source / Notes	
Property Name	Project ID	Pave Paws	—		Source: Project data	
Town / Municipality	Cape Cod Commission town	Bourne	—		TB 91-001 Table 1	
Target NO_3-N Conc.	Max allowable concentration	5	ppm		TB 91-001, Section B.1	

Site Areas (Editable Inputs — Blue)

Surface Type	Description	Area (ft²)	Area (acres)		Notes	
Gravel Area	Impervious — site runoff	51,552	1.183		Source: Site plan	
Paved Area	Impervious — road runoff	0	0.000		Source: Site plan	
Pervious Area	Natural — recharge only	52,558	1.207		Source: Site plan	
Roof Area	Impervious — roof runoff	2,788	0.064		Enter if applicable	
Lawn Area	Fertilized turf	0	0.000		Enter if applicable	
TOTAL SITE AREA		**106,898**	**2.454**		**ft²**	

CCC Standard Parameters (per Technical Bulletin 91-001)

Parameter	Value	Units			Source	
Recharge — Impervious surfaces	40	in/yr			TB 91-001, Section B.5	
Recharge — Natural (Bourne)	21	in/yr			TB 91-001, Table 1	
NO_3-N conc. — Road/Gravel runoff	1.5	ppm			TB 91-001, Section B.5	
NO_3-N conc. — Roof runoff	0.75	ppm			TB 91-001, Section B.5	
NO_3-N conc. — Wastewater	35	ppm			TB 91-001, Section B.2	
Fertilizer application rate	3	lbs N/1000 ft²/yr			TB 91-001, Section B.4	
Fertilizer leaching rate	0.25	%			TB 91-001, Section B.4	
Unit conversion — L per ft³	28.32	L/ft³			Standard conversion	
Unit conversion — days per year	365	d/yr			Standard	
Unit conversion — ft per inch	0.083333333	ft/in			Standard	
mg per lb	454000	mg/lb			Standard	

SECTION 2 — MASS BALANCE CALCULATIONS

Surface / Source	Area or Flow	Units	Flow (L/d)	Conc. (mg/L)	Load (mg/d)	Notes
A. Impervious Surfaces						
Gravel Area	51552	ft²	13,332.90	1.50	19,999.35	Road runoff @ 1.5 ppm
Paved Area	0	ft²	0.00	1.50	0.00	Road runoff @ 1.5 ppm
Roof Area	2788	ft²	721.06	0.75	540.80	Roof runoff @ 0.75 ppm
Subtotal — Impervious			**14,053.96**	**—**	**20,540.15**	
B. Natural / Pervious Area (contributes to denominator only — N load = 0)						
Natural Area	52558	ft²	7,136.37	0.00	0.00	N load ignored per TB 91-001 B.5
C. Lawn Areas						
Lawn Area	0	ft²	0.00	N/A	0.00	3 lbs/1000ft²/yr × 25% leaching
D. Wastewater						
Wastewater Flow	0	L/d	0.00	35.00	0.00	Enter Title 5 flow (L/d) in col B

SECTION 3 — SUMMARY & RESULT

Component		Flow (L/d)		Load (mg/d)		
Impervious Surfaces (Gravel + Paved + Roof)		14,053.96		20,540.15		
Natural / Pervious Areas		7,136.37		0.00		
Lawn Areas		0.00		0.00		
Wastewater		0.00		0.00		
TOTAL		**21,190.33**		**20,540.15**		

Calculated NO_3-N Concentration	**0.969 ppm**	**ppm NO_3-N**
Target Concentration	**5.0 ppm**	**ppm NO_3-N (max)**
COMPLIANCE STATUS		**✓ COMPLIES — Below Target**

Note: Per TB 91-001, natural recharge nitrogen load is negligible and excluded from numerator. Gravel treated as road runoff (1.5 ppm). Lawn N load adds to numerator only (no dilution volume).

Attachment F - Standard 8 Supporting Information

Site Specific Erosion and Sediment Control Plan Narrative

Site Specific Erosion and Sediment Control Plan

Site Specific Erosion and Sediment Control Plan Narrative

Construction of the Mainland Sagamore Meter Station will be conducted in a manner that minimizes erosion, sedimentation, and off-site transport of disturbed soils. Erosion and sediment control measures will be installed prior to the commencement of earth disturbing activities and will be maintained throughout construction until final stabilization is achieved.

Construction activities will be sequenced to limit the extent and duration of exposed soils to the maximum extent practicable. Clearing, grading, excavation, and fill operations will be performed in a controlled manner, and disturbed areas will be stabilized as soon as practicable following completion of construction activities.

Temporary erosion and sediment control measures will be implemented to intercept, contain, and manage stormwater runoff from disturbed areas during construction. These measures will be installed and maintained in accordance with the project plans, applicable permit requirements, and Algonquin Gas Transmission, LLC and Enbridge environmental construction procedures.

Routine inspections will be conducted during active construction to verify that erosion and sediment control measures remain functional and effective. Damaged, displaced, or ineffective controls will be repaired, replaced, or supplemented as necessary. Accumulated sediment will be removed from control measures when required to maintain their intended performance.

Temporary construction-related stormwater management practices, material storage areas, equipment staging areas, and concrete washout facilities will be managed to prevent sediment discharge and minimize impacts to adjacent properties, drainage features, wetlands, and other environmentally sensitive resources.

Upon completion of construction, all disturbed areas not required for permanent operations will be restored and stabilized through establishment of permanent vegetative cover or other approved stabilization methods. Temporary erosion and sediment control measures will remain in place until final stabilization has been achieved and the potential for erosion and sediment transport has been minimized.

The project will be constructed in accordance with the approved Erosion and Sediment Control Plan, applicable federal, state, and local requirements, and the environmental commitments applicable to the Cape Cod Canal Bridge Replacement Project.

Erosion and Sedimentation Control Measures

The following erosion and sedimentation controls were selected based on existing and proposed site conditions for use during the earthwork and construction phases of the project. In addition to those outlined below, additional practices are included in Algonquin’s Standard Erosion and Sediment Control Manual.

Silt Fence/Fiber Rolls

Sediment barriers will be placed to trap sediment transported by runoff before it reaches the drainage system or leaves the construction site. In areas where high runoff velocities or high sediment loads are expected, fiber rolls will be backed up with silt fencing. This semi-permeable

barrier made of a synthetic porous fabric will provide additional protection. The silt fence and fiber roll barrier will be replaced as determined by periodic field inspections.

Catch Basin Protection

Newly constructed and existing nearby catch basins will be protected with silt sacks throughout construction.

Concrete Wash Area

The best management practice objectives for concrete washout are to (a) collect and retain all the concrete washout water and solids in leak proof containers, so that this caustic material does not reach the soil surface and then migrate to surface waters or into the ground water, and (b) recycle 100 percent of the collected concrete washout water and solids. Another objective is to support the diversion of recyclable materials from landfills.

Concrete washout facilities should be inspected daily and after heavy rains to check for leaks, identify any plastic linings and sidewalls have been damaged by construction activities, and determine whether they have been filled to over 75 percent capacity. When the washout container is filled to over 75 percent of its capacity, the washwater should be vacuumed off or allowed to evaporate to avoid overflows. Then when the remaining cementitious solids have hardened, they should be removed and recycled. Damages to the container should be repaired promptly. Before heavy rains, the washout container's liquid level should be lowered or the container should be covered to avoid an overflow during the rain storm.

Temporary Diversion Channels

Diversion channels will be used to collect runoff from construction areas and discharge to either sedimentation basins or protected catch basin inlets.

Vegetative Slope Stabilization

Stabilization of open soil surfaces will be implemented within 14 days after grading or construction activities have temporarily or permanently ceased, unless there is sufficient snow cover to prohibit implementation. Vegetative slope stabilization will be used to minimize erosion on slopes of 3:1 or flatter. Annual grasses, such as annual rye, will be used to ensure rapid germination and production of root mass. Permanent stabilization will be completed with the planting of perennial grasses or legumes. Establishment of temporary and permanent vegetative cover may be established by hydro-seeding or sodding. A suitable topsoil, good seedbed preparation, and adequate lime, fertilizer and water will be provided for effective establishment of these vegetative stabilization methods. Mulch will also be used after permanent seeding to protect soil from the impact of falling rain and to increase the capacity of the soil

Maintenance

- The contractor or subcontractor will be responsible for implementing each control shown on the Sedimentation and Erosion Control Plan. In accordance with EPA regulations, the contractor must sign a copy of a certification to verify that a plan has been prepared and that permit regulations are understood.

- The on-site contractor will inspect all sediment and erosion control structures periodically and after each rainfall event. Records of the inspections will be prepared and maintained on-site by the contractor.
- Silt shall be removed from behind barriers if greater than 6-inches deep or as needed.
- Damaged or deteriorated items will be repaired immediately after
- identification.
- The underside of straw wattles should be kept in close contact with the earth and reset as necessary.
- Sediment that is collected in structures shall be disposed of properly and covered if stored on-site.
- Erosion control structures shall remain in place until all disturbed earth has been securely stabilized. After removal of structures, disturbed areas shall be regraded and stabilized as necessary.

Construction Best Management Practices - Maintenance/Evaluation Checklist

Best Management Practice	Inspection Frequency	Date Inspected	Inspector	Minimum Maintenance and Key Items to Check	Cleaning/Repair Needed ☐ yes ☐ no	Date of Cleaning/Repair	Performed by:
					☐ yes ☐ no		
					☐ yes ☐ no		
					☐ yes ☐ no		
					☐ yes ☐ no		
					☐ yes ☐ no		
					☐ yes ☐ no		
					☐ yes ☐ no		

Stormwater Control Manager _____

CAPE COD CANAL PIPELINE RELOCATION PROJECT
PAVE PAWS ROAD METER STATION
M&R 00845
BARNSTABLE COUNTY, MASSACHUSETTS
2026

DATE		ISSUE	LEAD DFRS.	SECT. SUPV.	APPROVALS PROJ. ENG./ DESIGN ENG.	PROJ. MGR./ DESIGN MGR.	PROJECT DIRECTOR
06/24/26	☒	ISSUED FOR PERMIT	CR	DT	PB	AC	
05/15/26	☒	ISSUED FOR BID	JA	DT	PB	AC	

DWG. NO.	DRAWING TITLE
	CIVIL DRAWINGS
00845-C.015-0002	EROSION & SEDIMENT COVER SHEET
00845-C.020-0001	EROSION & SEDIMENT CONTROL GENERAL NOTES
00845-C.320-0001	EXISTING CONDITIONS PLAN
00845-C.320-0002	EXISTING SUBCATCHMENT AREAS PLAN
00845-C.320-0003	PROPOSED SITE LAYOUT PLAN
00845-C.301-0001	GRADING PLAN
00845-C.301-0002	GRADING CROSS SECTIONS
00845-C.320-0004	CONSTRUCTION EROSION AND SEDIMENT CONTROL PLAN
00845-C.320-0005	PROPOSED SUBCATCHMENT AREAS PLAN
00845-C.320-0006	DETAILS
00845-C.320-0007	DETAILS



VICINITY MAP

EXHIBIT A

SRO NO. XXXX

PLANT W.O. NO.

PIPELINE W.B.S. NO. 30002835

YEAR 2026

ENBRIDGE®

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
No. 58957
PROFESSIONAL ENGINEER
07/08/26

Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

ISSUED FOR PERMIT
06/24/2026

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		C	06/24/26	JA	DT	ISSUED FOR PERMIT
		B	05/15/26	JA	DT	ISSUED FOR BID
		A	05/15/26	JA	DT	ISSUED FOR PERMIT

audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

TITLE	INITIALS	DATE
DRAWN BY:	JA	05/15/26
DESIGN CHECKER:	DT	06/24/26
DESIGN ENGINEER:	PB	06/24/26
PROJECT MANAGER:	AC	06/24/26

CAPE COD CANAL PIPELINE RELOCATION PROJECT
PAVE PAWS ROAD METER STATION
M&R 00845

TITLE: EROSION AND SEDIMENT CONTROL COVER SHEET

LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

YEAR: 2026 | W.O.: | SCALE: NTS

ENBRIDGE

Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

DWG.: 00845-C.015-0002 | REV.: C

S:\AE\Projects\Enbridge\Mass\026356-001\200_Civil_Structural\170_Drawings\E&S Plans\Pave Paws Road M&R\00845-C.015-0002.dwg - PLOT TIME: 6/24/2026 9:41 AM

SEDIMENTATION AND EROSION CONTROL NOTES

IT IS THE INTENT OF THE CONTRACT PLANS AND DETAILS TO CONTROL EROSION AND SEDIMENTATION IN ALL PORTIONS OF THE SITE. THE CONTRACTOR IS TO IMPLEMENT THE EROSION AND SEDIMENTATION CONTROLS INDICATED ON THE PLANS, IN ACCORDANCE WITH THE FOLLOWING NOTES, BUT IS ALERTED TO THE FACT THAT ADDITIONAL MEASURES MAY BE REQUIRED TO COMPLY WITH THIS INTENT, AS FIELD CONDITIONS MAY WARRANT. SHOULD SUCH MEASURES BE DETERMINED TO BE REQUIRED OR ORDERED BY THE ENGINEER, THEY ARE TO BE IMPLEMENTED IMMEDIATELY. IN ADDITION, THE CONTRACTOR SHALL PREPARE AND SUBMIT FOR ENGINEER'S REVIEW A STORMWATER POLLUTION PREVENTION PLAN (SWPPP) AND FILE A NOTICE OF INTENT WITH THE U.S. EPA AS REQUIRED UNDER THE NPDES CONSTRUCTION GENERAL PERMIT PROGRAM. A COPY OF THE SWPPP SHALL BE KEPT ON-SITE AT ALL TIMES AND UPDATED AS REQUIRED.

1. THE CONTRACTOR SHALL BE RESPONSIBLE FOR IMPLEMENTING EROSION CONTROL MEASURES IN ORDER TO PREVENT THE OFF-SITE TRACKING OF EARTH, SEDIMENT, AND DEBRIS; AND FOR GENERALLY CONTROLLING THE EROSION AND SEDIMENT TRANSPORT DURING THE CONSTRUCTION PROCESS. SITE SPECIFIC CONDITIONS MAY REQUIRE MODIFICATIONS IN THE FIELD, BUT THE CONTRACTOR MUST ENSURE THAT THAT MEASURES IMPLEMENTED IN THE FIELD MEET THE MINIMUM REQUIREMENTS OF THESE PLANS.

2. ALL WORK SHALL BE IN ACCORDANCE WITH THE CONTRACT DOCUMENTS, THE PROVISIONS OF ALL APPLICABLE PERMITS AND APPROVALS ISSUED BY LOCAL, STATE, AND FEDERAL REGULATION FOR ACTIVITIES INVOLVING WETLANDS, WATERCOURSES AND/OR EROSION CONTROLS. ALL EROSION AND SEDIMENTATION CONTROL MEASURES SHALL BE CONSTRUCTED IN ACCORDANCE WITH THE MASSACHUSETTS EROSION AND SEDIMENT CONTROL GUIDELINES FOR URBAN AND SUBURBAN AREAS, FEBRUARY 2008 AND THE MASSACHUSETTS STORMWATER HANDBOOK VOLUME 1, AS AMENDED.

3. THE CONTRACTOR IS RESPONSIBLE FOR THE INSTALLATION OF SILT FENCES, CHECK DAMS AND TEMPORARY SEDIMENT BASINS. SUCH PRACTICES DIVERT FLOWS FROM EXPOSED SOILS, LIMIT RUNOFF AND THE DISCHARGE OF POLLUTANTS FROM EXPOSED AREAS OF THE SITE TO THE DEGREE ATTAINABLE. TEMPORARY EROSION AND SEDIMENTATION CONTROL MEASURES SHALL BE INSTALLED PRIOR TO THE COMMENCEMENT OF ANY SITE WORK, SHALL BE MAINTAINED DURING CONSTRUCTION, AND SHALL REMAIN IN PLACE UNTIL ALL SITE WORK IS COMPLETED AND GROUND COVER IS ESTABLISHED BY NEW SEEDLINGS). (AT LEAST 751 UNIFORM COVERAGE BY NEW SEEDLINGS).

4. IN GENERAL, WORK REQUIRING EROSION CONTROL INCLUDES EXCAVATIONS, FILLS, RETAINING WALLS, DRAINAGE, ROUGH AND FINISH GRADING, AND STOCKPILING OF EARTH.

5. AREAS SUBJECT TO EROSION SHALL BE MINIMIZED IN TERMS OF TIME AND AREA. DO NOT DISTURB VEGETATION AND TOPSOIL BEYOND THE PROPOSED LIMIT OF SILT FENCE ACTIVITIES.

6. A STABILIZED CONSTRUCTION ENTRANCE SHALL BE INSTALLED AT ALL POINTS OF ACCESS TO THE SITE TO MINIMIZE TRACKING OF SEDIMENT ONTO PUBLIC ROADWAY.

7. EROSION CONTROL MEASURE SHALL BE INCORPORATED IN THE SEQUENCE OF CONSTRUCTION TO PREVENT SEDIMENT LADEN WATER FROM LEAVING THE SITE.

8. EARTHWORK ACTIVITY SHALL BE PERFORMED IN A MANNER SUCH THAT RUNOFF IS DIRECTED TO PERIMETER CONTROLS. IN NO CASE SHALL RUNOFF FROM ROADWAYS OR OTHER AREAS, UPGRADIENT FROM EMBANKMENTS, BE ALLOWED TO RUN DOWN ANY CUT OR FILL SLOPE, WITHOUT THE APPROVAL OF THE ENGINEER.

9. THE CONTRACTOR SHALL, AT ALL TIMES, HAVE A STOCKPILE OF HAY BALES, SILT FENCE, CRUSHED STONE, AND CATCH BASIN FILTER BAGS ADEQUATE TO REINFORCE/REPLACE EROSION AND SEDIMENT CONTROLS AS NEEDED.

10. ALL EROSION AND SEDIMENTATION CONTROL MEASURES SHALL BE MAINTAINED IN EFFECTIVE CONDITION THROUGHOUT THE CONSTRUCTION PERIOD SO THAT ALL AREAS ARE STABILIZED TO PREVENT THE MOVEMENT OF SOIL, SILT, SEDIMENT AND DEBRIS INTO DRAINAGE SYSTEMS OR WATERWAYS ON AND NEAR CONSTRUCTION ACTIVITY. THE CONTRACTOR SHALL INSPECT THE EROSION CONTROLS DAILY AND CLEAN ACCUMULATED MATERIALS FROM BEHIND THEM, AS NECESSARY. ALL EROSION AND SEDIMENTATION CONTROL MEASURES FOUND TO BE IN NEED OF REPAIR OR REPLACEMENT SHALL BE IMMEDIATELY CORRECTED, SO AS TO MAINTAIN THE INTEGRITY OF THE EROSION AND SEDIMENTATION CONTROL SYSTEM.

11. IN ORDER TO MINIMIZE EROSION AND SEDIMENT RUNOFF FROM THE SITE, THE CONTRACTOR SHOULD MAINTAIN EXISTING VEGETATION WHERE POSSIBLE AND STABILIZE THE DISTURBED PORTIONS OF THE SITE AS QUICKLY AS POSSIBLE. THE CONTRACTOR SHALL PHASE CONSTRUCTION TO MINIMIZE THE AREA OF DISTURBED EARTH OPEN TO THE ELEMENTS AT ANY GIVEN TIME. THIS SHALL BE ACHIEVED BY THE FOLLOWING METHODS OR OTHER BEST MANAGEMENT PRACTICES (BMP's):

    A. LOAMING AND SEEDING CUT SLOPES IMMEDIATELY UPON COMPLETION OF SUBGRADE PREPARATION, AND SECURING SUCH NEWLY ESTABLISHED SLOPES WITH EROSION CONTROL NETTING AND/OR MULCH.
    B. PLACING AND COMPACTING PAVEMENT GRAVEL BASE AND SUB- BASE IMMEDIATELY UPON COMPLETION OF SUBGRADE PREPARATION.
    C. LIMITING STRIPPING AND STOCKPILING OF LOAM TO AREAS SLATED FOR IMMEDIATE CONSTRUCTION AND STABILIZATION (I.E. PLACEMENT OF GRAVELS, LOAM AND SEED, EROSION CONTROL MATTING).

12. THE CONTRACTOR MUST ALSO ANTICIPATE INCREASED RUNOFF FROM STEEPER SLOPES AND DURING HIGH GROUNDWATER CONDITIONS.THIS MAY OCCUR DURING THE WET SEASON (TYPICALLY MARCH THROUGH APRIL) OR AFTER SIGNIFICANT PRECIPITATION EVENTS.

13. SEDIMENT REMOVED FROM CONTROL STRUCTURES SHALL BE DISPOSED OF LEGALLY OFF SITE. NO EQUIPMENT OR MATERIAL OF ANY KIND SHALL BE STOCKPILED OR DEPOSITED IN ANY REGULATED AREA, UNLESS SPECIFICALLY SHOWN ON THE CONTRACT PLANS OR AUTHORIZED BY PROJECT PERMITS/APPROVALS.

14. STOCKPILED SOIL SHALL BE SURROUNDED WITH SILTATION FENCES TO PREVENT AND CONTROL SILTATION AND EROSION. STOCKPILES THAT WILL REMAIN EXPOSED FOR MORE THAN 30 DAYS, SHALL BE STABILIZED WITH MULCH OR SEEDED FOR TEMPORARY VEGETATIVE COVER.

15. TEMPORARY STORAGE OF MATERIALS ON-SITE SHALL BE LOCATED GREATER THAN 1OO-FEET FROM WETLAND AREAS, AND AS APPROVED BY THE ENGINEER. EROSION CONTROLS INSTALLED ALONG WETLAND RESOURCE AREAS SHALL DEFINE THE LIMIT OF WORK AND SHALL NOT BE CROSSED. THERE SHALL BE NO LONG-TERM STORAGE OF MATERIAL ON-SITE OR ON -ROUTE. MATERIAL NOT USED ON-SITE OR ON-ROUTE SHALL BE TRUCKED TO AN ACCEPTABLE OFF-SITE DISPOSAL LOCATION.

16. ALL DISTURBED SURFACES SHALL BE STABILIZED WITHIN 14 DAYS AFTER CONSTRUCTION IN ANY PORTION OF THE SITE THAT HAS BEEN COMPLETED OR WHERE CONSTRUCTION HAS TEMPORARILY CEASED.

17. ALL AREAS OF DISTURBANCE MUST HAVE TEMPORARY OR FINAL STABILIZATION WITH MULCH OR MULCH NETTING, OR SEEDED FOR TEMPORARY VEGETATIVE COVER, WITHIN 14 DAYS OF THE INITIAL DISTURBANCE. AFTER THIS TIME, ANY DISTURBANCE IN THE AREA MUST BE STABILIZED AT THE END OF EACH WORK DAY. THE FOLLOWING EXCEPTIONS APPLY:

    A. STABILIZATION IS NOT REQUIRED IF WORK IS TO CONTINUE IN THE AREA WITHIN THE NEXT 24 HOURS AND THERE IS NO PRECIPITATION FORECAST FOR THE NEXT 24 HOURS.
    B. STABILIZATION IS NOT REQUIRED IF THE WORK IS OCCURRING IN A SELF-CONTAINED EXCAVATION WITH A DEPTH OF 2 FEET OR GREATER.

18. THERE SHALL BE NO DIRECT DISCHARGE FROM ANY REQUIRED DEWATERING OPERATIONS INTO ANY WETLAND, WATERCOURSE, OR DRAINAGE SYSTEM AND THEN ONLY AS ALLOWED BY REGULATORY PERMITS. ANY DEWATERING DISCHARGE CONTAINING SETTLEABLE SOLIDS (SEDIMENTS) SHALL BE PASSED THROUGH A SEDIMENTATION CONTROL BASIN, FRACTIONATION TANK OR SIMILAR TREATMENT, APPROVED BY THE ENGINEER, TO REMOVE THESE SOLIDS. CONTRACTOR SHALL MAINTAIN SAID SEDIMENT CONTROL DEVICES THROUGHOUT THE ENTIRE DEWATERING OPERATION AND SHALL CEASE DEWATERING, IF DEFICIENCIES ARE NOTED, UNTIL THE DEFICIENCIES ARE CORRECTED.

19. THE CONTRACTOR SHALL INSPECT ALL PORTIONS OF THE SITE IN ANTICIPATION OF RAINFALL EVENTS TO DETERMINE IF SITE GRADING IS SUFFICIENT TO PREVENT EROSION OF SLOPES AND/OR THE TRANSPORTATION OF SEDIMENTS TO WETLANDS OR WATERCOURSES, WITHIN THE PROJECT LIMITS. SHOULD ADDITIONAL MEASURES BE REQUIRED, THEY ARE TO BE IMPLEMENTED IMMEDIATELY. IN NO CASE SHALL THE INSTALLATION OF ADDITIONAL MEASURES, NECESSARY TO PROTECT SLOPES WITHIN THE PROJECT LIMITS, BE DELAYED BEYOND THE COMMENCEMENT OF PRECIPITATION.

20. EROSION CONTROL MEASURES SHALL BE INSPECTED EVERY WEEK, AND WITHIN 24-HOUR OF AN EVENT GREATER THAN 0.25 INCHES. ANY NECESSARY REPLACEMENT OF REPAIR SHALL BE PERFORMED PROMPTLY BY THE CONTRACTOR

21. ALL DISTURBED EARTH SLOPES SHALL BE STABILIZED WITH PERMANENT VEGETATIVE COVER AS SOON AS POSSIBLE. DISTURBED AREAS, THAT ARE NOT SUBJECT TO CONSTRUCTION TRAFFIC, SHALL RECEIVE A PERMANENT OR TEMPORARY VEGETATIVE COVER AS SOON AS FINAL CONTOURS ARE ESTABLISHED. IF THE SEASON PREVENTS THE ESTABLISHMENT OF A VEGETATIVE COVER, DISTURBED AREAS SHALL BE THOROUGHLY MULCHED. MULCHED AREAS SHALL BE SEEDED AS SOON AS WEATHER CONDITIONS ALLOW.

22. ALL SLOPES STEEPER THAN 2H:1V SHALL BE COVERED WITH MODIFIED ROCKFILL AND AN APPROVED EROSION CONTROL MATTING.

23. CONTRACTOR SHALL REMOVE ALL SEDIMENTATION CONTROL SYSTEMS, REMOVE ALL ACCUMULATED SEDIMENTS, AND SEED THE DISTURBED AREAS, WHEN THE CONTROL SYSTEMS ARE NO LONGER REQUIRED. CONTRACTOR SHALL REQUEST AND RECEIVE PERMISSION FROM THE ENGINEER PRIOR TO REMOVING ANY CONTROL SYSTEM.

24. THE CONTRACTOR SHALL REMOVE AND DISPOSE OF ALL SILT AND DEBRIS RESULTING FROM CONSTRUCTION OPERATIONS FROM EACH DRAINAGE STRUCTURE UPON COMPLETION OF THE PROJECT.

25. OBJECTS AND/OR AREAS DAMAGED BY THE CONTRACTOR'S OPERATIONS SHALL BE RESTORED TO THEIR ORIGINAL CONDITION AND ELEVATION.

26. ALL DISTURBED AREAS NOT OCCUPIED BY PAVEMENT, SIDEWALK OR RIPRAP SHALL BE COVERED WITH 4" (MIN.) OF LOAM AND SEED.

27. PERMANENT SEEDING SHALL OCCUR BETWEEN MARCH 1 AND JUNE 15, OR BETWEEN AUGUST 15 AND OCTOBER 15.

28. THE CONTRACTOR SHALL MODIFY, REPAIR, OR INSTALL ADDITIONAL EROSION AND SEDIMENTATION CONTROL MEASURES AS NECESSARY TO PREVENT SEDIMENT FROM LEAVING THE SITE AT NO ADDITIONAL COST.

A. GENERAL CONSTRUCTION NOTES

1. SITE PREPARATION, GRADING AND DRAINAGE SHALL BE IN ACCORDANCE WITH THESE GENERAL NOTES, APPROVED CONSTRUCTION DRAWINGS AND PROJECT SPECIFICATIONS. FOR EARTHWORK REQUIREMENTS AND THE CONSTRUCTION OF STRUCTURAL SUBGRADES, IF IN CONFLICT WITH THESE GENERAL NOTES, THE GEOTECHNICAL REPORT SHALL GOVERN IN DETAILS.
2. CONTRACTOR SHALL COMPLY WITH OSHA REGULATIONS, STATE SPECIFIC LAWS AND COMPANY SAFETY STANDARDS AT ALL TIMES.
3. CONTRACTOR SHALL OBTAIN ALL REQUIRED PERMITS PRIOR TO STARTING CONSTRUCTION. CONTRACTOR SHALL HAVE A COPY OF ALL DRIVEWAY PERMITS ON SITE AT ALL TIMES DURING CONSTRUCTION OF DRIVES AND DRIVEWAY CULVERTS.
4. CONTRACTOR TO PROVIDE ALL MATERIAL NECESSARY FOR INSTALLATION.
5. ALL PROJECT MATERIALS OR FOR THE REPAIR OF EXISTING ELEMENTS SHALL BE NEW PRODUCTS AND FREE FROM DEFECTS PER PROJECT SPECIFICATIONS.
6. PRIOR TO BACKFILLING PONDS, CREEKS, DITCHES, OR OTHER RUNOFF CHANNELS, ALL ACCUMULATED SEDIMENT, ORGANIC MATERIAL, AND DEBRIS SHALL BE REMOVED AND DISPOSED OF AS DIRECTED BY THE COMPANY.
7. WASTE MATERIALS INCLUDING PAVEMENT REMOVED DURING CONSTRUCTION, WASTE PIPING AND SUPPLIES AND CONSTRUCTION DEBRIS SHALL BECOME THE PROPERTY OF THE CONTRACTOR AND SHALL BE REMOVED FROM THE PROJECT SITE AND DISPOSED OF PROPERLY BY THE CONTRACTOR.
8. EARTHWORK QUANTITIES SHOWN ARE APPROXIMATE AND ARE PROVIDED FOR INFORMATION PURPOSES ONLY. QUANTITIES DO NOT ACCOUNT FOR SHRINKAGE, SWELL (BULK) FACTORS, LOSS OF MATERIAL, OR REMOVAL/REPLACEMENT OF UNSUITABLE MATERIALS ENCOUNTERED IN THE FIELD. FOUNDATION AREAS WERE NOT ACCOUNTED FOR IN THE EARTHWORK ANALYSIS CALCULATION. THE CONTRACTOR SHALL VERIFY ALL QUANTITIES AND CONDITIONS PRIOR TO CONSTRUCTION.

B. UTILITIES, RIGHT-OF-WAY AND EASEMENTS

1. THE CONTRACTOR SHALL VERIFY THE LOCATIONS, ELEVATIONS AND DIMENSIONS OF ALL EXISTING UTILITIES, STRUCTURES, ETC. AFFECTING HIS WORK PRIOR TO CONSTRUCTION.
2. CONTRACTOR SHALL NOTIFY THE LOCAL JURISDICTIONAL AUTHORITY BEFORE ANY WORK IS WITHIN THE STREET RIGHT-OF-WAY OR EASEMENTS.
3. CONTRACTOR SHALL GIVE NOTICE TO ALL AUTHORIZED INSPECTORS, SUPERINTENDENTS AND PERSONS IN CHARGE OF PUBLIC AND PRIVATE UTILITIES AFFECTED BY HIS OPERATIONS PRIOR TO STARTING WORK.
4. CONTRACTOR SHALL VERIFY THE LOCATIONS OF EXISTING UNDERGROUND UTILITIES PRIOR TO COMMENCING CONSTRUCTION AND SHALL REPORT DISCREPANCIES TO THE COMPANY REPRESENTATIVE IMMEDIATELY.
5. CONTRACTOR TO PROTECT ACTIVE UTILITY LINES OR ELECTRICAL CONDUITS SHOWN ON THE DRAWINGS OR OTHERWISE MADE KNOWN TO THE CONSTRUCTION MANAGEMENT PRIOR TO COMMENCING WORK.
6. ALL UTILITIES SHALL BE KEPT IN OPERATION EXCEPT WITH THE EXPRESS WRITTEN CONSENT OF THE UTILITY OWNER. IT SHALL BE THE CONTRACTOR'S RESPONSIBILITY TO PRESERVE EXISTING UTILITIES.
7. CONTRACTOR SHALL LOCATE ALL UNDERGROUND PIPELINES AND PROTECT THEM DURING CONSTRUCTION FROM IMPOSING HEAVY LOADS FROM SITE PREPARATION ACTIVITIES, MACHINERY AND ANY OTHER EQUIPMENT THAT MAY DAMAGE EXISTING FACILITIES. CONTRACTOR SHALL BE FULLY RESPONSIBLE FOR ANY DAMAGES DURING CONTRUCTION AND REPAIR IN ACCORDANCE WITH THE OWNING AUTHORITIES WITH NO COST TO THE OWNER.
8. ALL GRADING EXCAVATION WORK TO BE PERFORMED WITHIN PIPELINE RIGHT-OF-WAY OR EASEMENTS OR WITHIN 25 FT, MEASURED AT RIGHT ANGLES, OF PIPELINES, SHALL BE IN THE PRESENCE OF COMPANY REPRESENTATIVE.
9. WORK SHALL BE STOPPED IF ANY UNDERGROUND UTILITIES ARE ENCOUNTERED DURING EARTHWORK OPERATIONS AND THE COMPANY REPRESENTATIVE SHALL BE NOTIFIED FOR SPECIFIC DIRECTION.
10. CONTRACTOR SHALL LOCATE ALL OVERHEAD ELECTRICAL POWER LINES IN THE PROPERTY PRIOR TO BEGINNING ANY CONSTRUCTION. FEDERAL AND STATE REGULATIONS RELATED TO HEALTH AND SAFETY SHALL BE FOLLOWED FOR ANY WORK RELATED TO OVERHEAD ELECTRICAL POWER LINES.
11. CONTRACTOR SHALL BE FULLY RESPONSIBLE FOR ANY AND ALL DAMAGE TO FACILITIES, PROPERTY, UNDERGROUND UTILITIES AND TO EXISTING PUBLIC OR PRIVATE UTILITY LINES, INCLUDING BUT NOT LIMITED TO PIPELINES, WATER LINES, WASTEWATER COLLECTION SYSTEMS AND STORM SEWERS, DURING CONSTRUCTION. ALL DAMAGE SHALL BE REPAIRED IN ACCORDANCE WITH THE OWNING AUTHORITY, WITH NO COST TO THE OWNER.
12. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ANY REPAIR OR REPLACEMENT TO MEET THE STANDARDS OF THE APPROPRIATE REGULATORY AGENCY FOR ANY PAVEMENT, DRIVEWAYS, SIDEWALKS, CURBS AND OTHER EXISTING STRUCTURE THAT SUBJECTED TO MODIFICATION OR DAMAGED DURING OR AS A RESULT OF CONSTRUCTION.
13. THE CONTRACTOR SHALL BE RESPONSIBLE FOR CONTACTING THE APPROPRIATE UTILITY COMPANY OR OWNER AS APPLICABLE TO STABILIZE UTILITY POLES AND REMOVE AND REPLACE EXISTING GUY WIRES AS NECESSARY FOR CONSTRUCTION. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ALL COST ASSOCIATED WITH THE WORK.

C. CLEARING AND GRUBBING

1. CONTRACTOR SHALL BE RESPONSIBLE FOR CLEARING AND GRUBBING TO THE GRADING AREA LIMITS SHOWN ON THE CONSTRUCTION DRAWINGS AND FURTHER DESCRIBED BELOW. CONTRACTOR TO SPREAD ORGANIC SOILS FROM VEGETATION STRIP IN AREAS DESIGNATED BY THE OWNER REPRESENTATIVE.
2. UNLESS NOTED IN THE GEOTECHNICAL REPORT, STRIPPING OF TOP SOIL SHALL BE AT A MINIMUM DEPTH OF 12 IN. OR AS DIRECTED BY THE GEOTECHNICAL ENGINEER OR HIS DIRECT REPRESENTATIVE.
3. IN AREAS WHERE TREES, SHRUBS, GROWTH OR OTHER ITEMS ARE DESIGNATED TO REMAIN BY CONSTRUCTION MANAGEMENT, SELECTED CLEARING SHALL BE DONE AND ADEQUATELY PROTECTED FROM CONSTRUCTION EQUIPMENT WITHIN THE SURROUNDING AREAS.
4. CONTRACTOR SHALL STRIP ALL TREES, SHRUBS, VEGETATION, ORGANICS, LOOSE TOPSOIL AND OTHER DEBRIS FROM GRADING AREA. CLEAN OUT ROOTS 0.5 IN. IN DIAMETER AND LARGER TO A DEPTH OF 12 IN. BELOW EXISTING GROUND SURFACE OR SUBGRADE OF NEWLY GRADED SURFACE, WHICHEVER IS LOWER.
5. CONTRACTOR TO CLEAR UNDERGROWTH & DEAD WOOD MATERIALS WITHOUT DISTURBING THE SUBSOIL.
6. APPLY HERBICIDE TO REMAINING STUMPS INHIBITING GROWTH AS REQUIRED.
7. CONTRACTOR TO DISPOSE OF TOP SOIL, RUBBISH, DEBRIS, AND OTHER OBJECTIONABLE MATERIAL TO DESIGNATED DISPOSAL AREAS AS DIRECTED BY THE COMPANY.
8. UPON COMPLETION OF WORK, NO MATERIAL RESULTING FROM CLEARING AND GRUBBING OPERATIONS SHALL REMAIN WITHIN THE LIMITS OF THE SITE, EXCEPT IN THE DESIGNATED AREA.

D. SITE PREPARATION, EXCAVATION, SUBGRADE AND BACKFILL

1. CONTRACTOR SHALL EXCAVATE AND GRADE THE SITE AS DETAILED IN THE CONSTRUCTION DRAWINGS AND FOLLOW SPECIFICATIONS PER GEOTECHNICAL REPORT RECOMMENDATIONS.
2. EXPOSED SUBGRADE SHALL BE PROOF ROLLED IN ACCORDANCE WITH MASSACHUSETTS ITEM 170. WEAK OR SOFT ZONE MATERIALS SHALL BE REMOVED AND REPLACED/COMPACTED WITH APPROVED FILL MATERIAL.
3. UNLESS NOTED IN THE GEOTECHNICAL REPORT, ALL FILL MATERIAL SHALL:

    - BE COMPACTED IN LOOSE LIFTS 6 IN. OR LESS.
    - NOT EXCEED A SLOPE OF 1:10 BETWEEN DIFFERING TRANSITION FILL DEPTHS.
    - BE COMPACTED TO A MINIMUM OF 95% BUT NOT GREATER THAN 98% OF THE MAXIMUM DRY DENSITY AS DETERMINED BY THE STANDARD PROCTOR TEST (ASTM D-698).
    - HAVE MOISTURE CONTENT CONTROLLED AT THE TIME OF COMPACTION BETWEEN OPTIMUM AND 4% ABOVE OPTIMUM MOISTURE CONTENT.
    - THE CONTRACTOR SHALL IMPORT ALL FILL MATERIAL FROM AN APPROVED BORROW SITE, AND THIS MATERIAL SHALL MEET THE REQUIREMENTS OF THE PROJECT GEOTECHNICAL REPORT PREPARED BY GEOENGINEERS USA, PC. IMPORT MATERIAL SHALL BE APPROVED BY THE GEOTECHNICAL ENGINEER OF RECORD AND MEET THE REQUIREMENTS FOR LIQUID LIMIT (LL), PLASTIC LIMIT (PL) AND GRADATION.

4. PRIOR TO FILL PLACEMENT, THE TOP 12 IN. OF THE GROUND SURFACE IN FILL AREAS SHALL BE SCARIFIED, MOISTURE CONDITIONED AND RECOMPACTED PER GEOTECH RECOMMENDATIONS.
5. BACKFILL SHALL BE FREE FROM ORGANIC MATERIAL OR ANY OTHER DELETERIOUS MATTER.
6. PRIOR TO PERFORMING SOIL COMPACTION, MOISTURE CONDITION OR AERATE EACH LIFT AS NECESSARY TO PROVIDE THE REQUIRED MOISTURE CONTENT.
7. DO NOT PLACE BACKFILL OR FILL MATERIAL ON SURFACES THAT ARE MUDDY, FROZEN, OR CONTAIN FROST OR ICE.
8. MECHANICAL TAMPING OF BACKFILL AND FILL SHALL BE DONE WITH SUITABLE SIZED TAMPING FOOT SO AS TO PROVIDE UNIFORM COMPACTION.
9. INSPECTION AND FREQUENT TESTING BY QUALIFIED PERSONNEL DURING FILL COMPACTION IS NECESSARY TO ENSURE PROPER MOISTURE CONTENT AND DEGREE OF COMPACTION. CERTIFICATION SHALL BE OBTAINED FROM THE INSPECTING AGENCY THAT ALL FILL, BACKFILL AND SUBGRADE MATERIALS ARE IN COMPLIANCE WITH THE MOISTURE CONTENT AND COMPACTION RECOMMENDATIONS.
10. THE GEOTECHNICAL ENGINEER OR HIS DIRECT REPRESENTATIVE WILL MONITOR THE FILL OPERATION, IDENTIFY SOIL TYPES, AND MAKE RECOMMENDATIONS CONCERNING SELECTION AND PLACEMENT OF SOILS.
11. EXCESS EXCAVATION SHALL BE DISPOSED TO DESIGNATED DISPOSAL AREAS AS DIRECTED BY THE COMPANY.

E. WATER MANAGEMENT AND CONTROL

1. ADEQUATE DRAINAGE SHALL BE MAINTAINED AT ALL TIMES DURING CONSTRUCTION ACTIVITY. EARTHWORK SHALL BE ACCOMPLISHED IN SUCH A WAY TO ELIMINATE ACCUMULATION OF RAINWATER AND GROUNDWATER. THE CONTRACTOR SHALL INSTALL TEMPORARY MEASURES FOR MANAGING STORMWATER RUN-OFF FROM THE CUT OR FILL AREAS AS REQUIRED, MINIMIZING EROSION TO MEET NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) REQUIREMENTS.
2. CONTRACTOR SHALL PREVENT WATER FROM PONDING ON SITE AND SHALL NOT BLOCK DRAINAGE FROM OR DIRECT EXCESS DRAINAGE ONTO ADJACENT PROPERTY.
3. CONTRACTOR SHALL PROVIDE TEMPORARY PUMPING FACILITIES TO DRAIN THE WATER DURING CONSTRUCTION.
4. DEWATERING OF GROUNDWATER FOR EXCAVATIONS SHALL BE ACCOMPLISHED BY DEWATERING AT LEAST 3 FT BELOW THE BOTTOM OF THE EXCAVATION.
5. REMOVE ALL WATER, INCLUDING GROUNDWATER AND RAINWATER, TO A DESIGNATED LOCATION USING PUMPS, DRAINS OR OTHER APPROVED METHODS.
6. CONTRACTOR SHALL KEEP ALL EXCAVATIONS AND SITE CONSTRUCTION FREE FROM WATER. MAINTAIN TRENCH DRY AT ALL TIMES AND PROVIDE AUTOMATIC OR CONTINUOUS TRENCH PUMPS, AND WELL POINTS IF NECESSARY, TO OBTAIN DRY BEDDING CONDITIONS.

F. SURVEY BEARINGS & ELEVATION DATUM

1. ALL COORDINATES AND ELEVATIONS ARE REFERENCED TO NAD83 MASSACHUSETTS STATE PLANE COORDINATES, MAINLAND ZONE, US FOOT.

G. GEOTECHNICAL REPORT

1. THE GEOTECHNICAL ENGINEERING REPORT ENTITLED "CAPE CANAL BRIDGE RELOCATION PROJECT CAPE SAGAMORE METERING & REGULATING STATION" PREPARED BY GEOENGINEERS USA, PC. PROJECT NO. 15556-039-00, DATED APRIL 25, 2025.

H. SOIL TYPES

ID #	DESCRIPTION
483C	PLYMOUTH - BARNSTABLE COMPLEX, ROLLING, VERY BOULDERY
484C	PLYMOUTH-BARNSTABLE COMPLEX, ROLLING, EXTREMELY BOULDERY
484D	PLYMOUTH-BARNSTABLE COMPLEX, HILLY, EXTREMELY BOULDERY

THE ABOVE INFORMATION WAS OBTAINED FROM THE SOIL SURVEY GEOGRAPHIC (SSURGO) DATABASE FOR BARNSTABLE COUNTY, MASSACHUSETTS.

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
No. 58957
PROFESSIONAL ENGINEER

07/08/26

ISSUED FOR PERMIT
06/24/2026

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		C	06/24/26	JA	DT	ISSUED FOR PERMIT
		B	06/24/26	CR	DT	ISSUE FOR BID
		A	06/24/26	VN	DT	ISSUED FOR PERMIT

audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N, SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

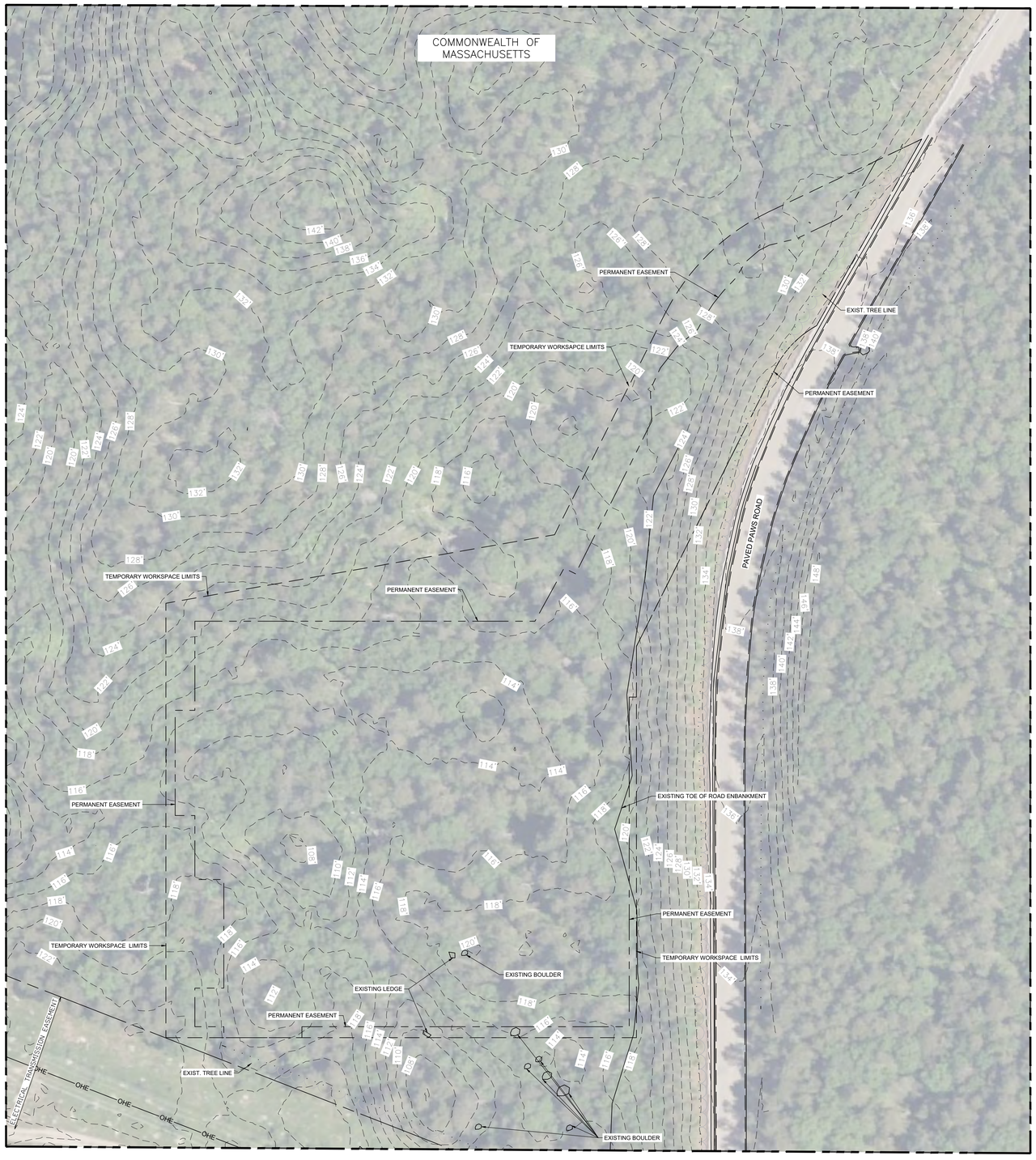
TITLE	INITIALS	DATE
DRAWN BY:	VN	05/15/26
DESIGN CHECKER:	DT	06/24/26
DESIGN ENGINEER:	PB	06/24/26
PROJECT MANAGER:	AC	06/24/26

CAPE COD CANAL PIPELINE RELOCATION PROJECT
PAVE PAWS ROAD METER STATION
M&R 00845
TITLE: EROSION AND SEDIMENT CONTROL GENERAL NOTES
LOC.: BARNSTABLE COUNTY, MASSACHUSETTS
YEAR: 2026 | W.O.: | SCALE: NO SCALE

ENBRIDGE
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

DWG.: 00845-C.020-0001 | REV.: C

S:\AE\Projects\Enbridge\Mass\026356-001\200_Civil_Structural\170_Drawings\E&S Plans\Pave Paws Road M&R\00845-C.020-0001.dwg — PLOT TIME: 6/24/2026 4:08 PM



PAVE PAWS ROAD METER STATION

EXISTING CONDITIONS PLAN

SCALE: 1" = 40'

0 40' 80'

Scale: 1" = 40'

NN 6.757°

STATION NORTH

NOTES:

1. ALL CONTOUR LABELS AND ELEVATION CALLOUTS ARE IN FEET.
2. PROPOSED SITE BOUNDARY WAS PROVIDED BY ALGONQUIN 3RD PARTY CONSULTANT.
3. SUPPLEMENTAL TAX PARCEL DATA IS SHOWN FOR REFERENCE ONLY AND WAS OBTAINED FROM THE CAPE COD COMMISSION OPEN GIS DATA HUB WEBSITE. PROJECT AREA IS WITHIN THE COMMONWEALTH OF MASSACHUSETTS PROPERTY.
4. PROPERTY CONVEYED TO ALGONQUIN GAS TRANSMISSION, LLC.
5. TOPOGRAPHIC SURVEY INFORMATION WAS PROVIDED BY ALGONQUIN GAS TRANSMISSION, LLC. ALL COORDINATES AND DISTANCES SHOWN HEREON ARE REFERENCED TO THE MASSACHUSETTS STATE PLANE COORDINATE SYSTEM, US FEET.ELEVATIONS ARE REFERENCED TO NAVD 88.
6. ADDITIONAL CONTOUR DATA WAS OBTAINED FROM 2022 USGS LIDAR POINT CLOUD DATA SETS.
7. THIS PROPERTY IS LOCATED IN ZONE X (AREA OF MINIMAL FLOOD HAZARD) AS DEPICTED ON FLOOD INSURANCE RATE MAP 25001C0318K DATED JULY 6, 2021.
8. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT NATURAL RESOURCE STUDY THE SITE IS WITHIN THE NATURAL HERITAGE AND ENDANGERED SPECIES PROGRAM (NHESP), PRIORITY HABITATS OF RARE WILDLIFE, OR THE NHESP ESTIMATED HABITATS OF RARE WILDLIFE.
9. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THE SITE THERE IS NOT A WETLAND WITHIN 100 FEET OF THE PROJECT LIMITS.
10. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THE SITE IS NOT LOCATED WITHIN AN AREA OF CRITICAL ENVIRONMENTAL CONCERN.
11. THIS PLAN SET IS PRELIMINARY. FOR PERMITTING PURPOSES ONLY. THIS PLAN IS NOT INTENDED FOR CONSTRUCTION PURPOSES.

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
No. 58957
PROFESSIONAL ENGINEER

07/08/26

ISSUED FOR PERMIT
06/24/2026

LEGEND

EXISTING OVERHEAD ELECTRIC —OHE—OHE—

EXISTING CONTOUR LINE 115'

WORKSPACE LIMITS

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		C	06/24/26	JA	DT	ISSUED FOR PERMIT
		B	05/15/26	JA	DT	ISSUED FOR BID
		A	05/15/26	JA	DT	ISSUED FOR PERMIT

audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

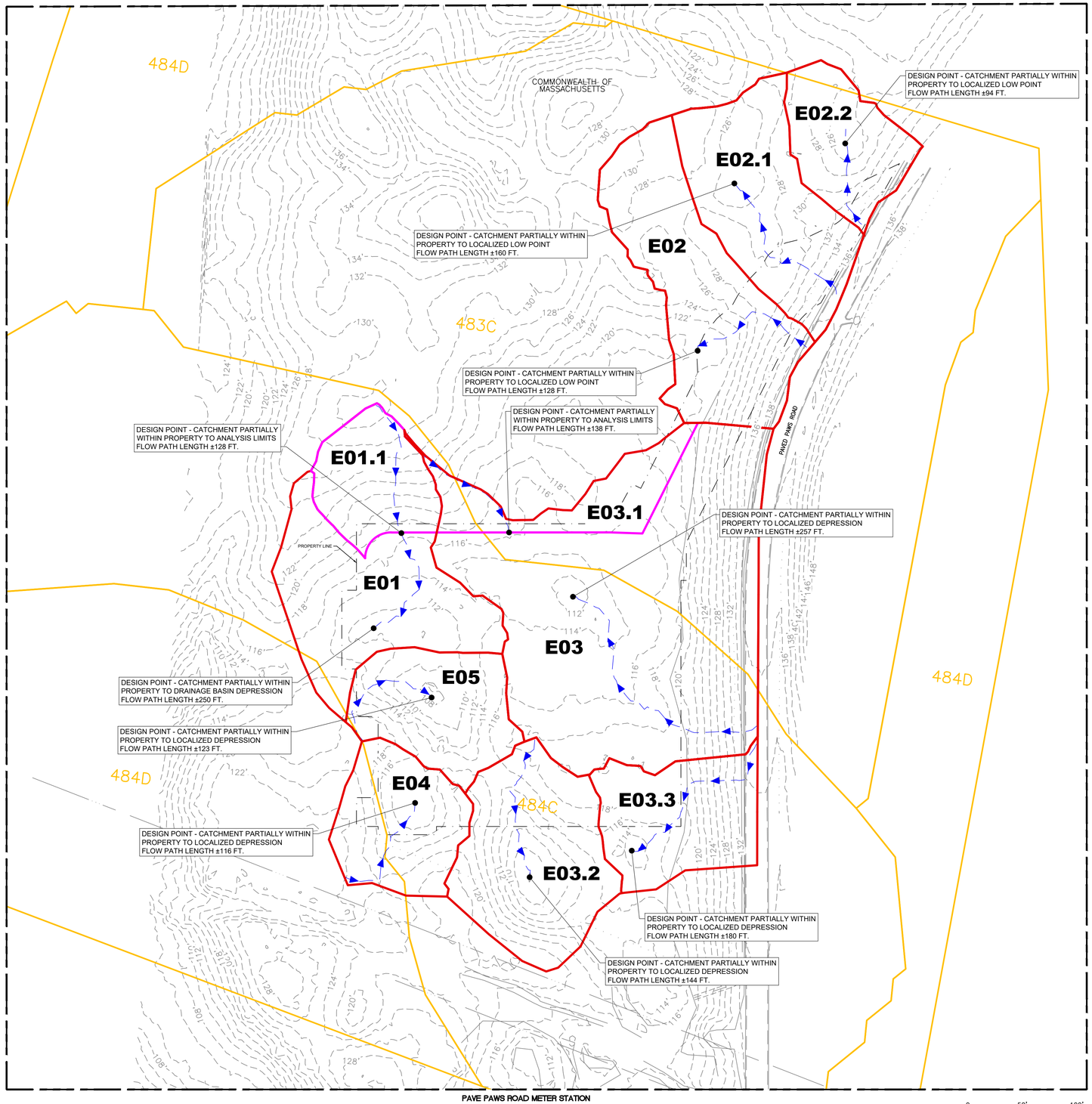
DRAWN BY:	JA	05/15/26	CAPE COD CANAL PIPELINE RELOCATION PROJECT
DESIGN CHECKER:	DT	06/24/26	PAVE PAWS ROAD METER STATION
DESIGN ENGINEER:	PB	06/24/26	M&R 00845
PROJECT MANAGER:	AC	06/24/26	TITLE: EXISTING CONDITIONS PLAN
TITLE	INITIALS	DATE	LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

YEAR: 2026 | W.O.: | SCALE: 1"=40' | DWG.: 00845-C.320-0001 | REV.: C

ENBRIDGE

Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

S:\AE\Projects\Enbridge\Mass\026356-001\200_Civil_Structural\170_Drawings\E&S Plans\Pave Paws Road M&R\00845-C.320-0001.dwg — PLOT TIME: 6/24/2026 2:40 PM



PAVE PAWS ROAD METER STATION

EXISTING SUBCATCHMENT AREAS PLAN

SCALE: 1" = 50'

0 50' 100'

Scale: 1" = 50'

NN 6.757°

STATION NORTH

NOTES:

1. ALL CONTOUR LABELS AND ELEVATION CALLOUTS ARE IN FEET.
2. PROPOSED SITE BOUNDARY WAS PROVIDED BY ALGONQUIN 3RD PARTY CONSULTANT.
3. SUPPLEMENTAL TAX PARCEL DATA IS SHOWN FOR REFERENCE ONLY AND WAS OBTAINED FROM THE CAPE COD COMMISSION OPEN GIS DATA HUB WEBSITE. PROJECT AREA IS WITHIN THE COMMONWEALTH OF MASSACHUSETTS PROPERTY.
4. PROPERTY CONVEYED TO ALGONQUIN GAS TRANSMISSION, LLC.
5. TOPOGRAPHIC SURVEY INFORMATION WAS PROVIDED BY ALGONQUIN GAS TRANSMISSION, LLC. ALL COORDINATES AND DISTANCES SHOWN HEREON ARE REFERENCED TO THE MASSACHUSETTS STATE PLANE COORDINATE SYSTEM, US FEET.ELEVATIONS ARE REFERENCED TO NAVD 88.
6. ADDITIONAL CONTOUR DATA WAS OBTAINED FROM 2022 USGS LIDAR POINT CLOUD DATA SETS.
7. THIS PROPERTY IS LOCATED IN ZONE X (AREA OF MINIMAL FLOOD HAZARD) AS DEPICTED ON FLOOD INSURANCE RATE MAP 25001C0318K DATED JULY 6, 2021.
8. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT NATURAL RESOURCE STUDY THE SITE IS WITHIN THE NATURAL HERITAGE AND ENDANGERED SPECIES PROGRAM (NHESP), PRIORITY HABITATS OF RARE WILDLIFE, OR THE NHESP ESTIMATED HABITATS OF RARE WILDLIFE.
9. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THE SITE THERE IS NOT A WETLAND WITHIN 100 FEET OF THE PROJECT LIMITS.
10. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THE SITE IS NOT LOCATED WITHIN AN AREA OF CRITICAL ENVIRONMENTAL CONCERN.
11. THIS PLAN SET IS PRELIMINARY. FOR PERMITTING PURPOSES ONLY. THIS PLAN IS NOT INTENDED FOR CONSTRUCTION PURPOSES.
12. REFER TO THE "EROSION & SEDIMENT GENERAL NOTES" (DWG. 00845-C.020-0001) FOR SOIL TYPES INFORMATION.

LEGEND

- EXISTING MAJOR CONTOUR 70'
- EXISTING MINOR CONTOUR 72'
- PROPERTY LINE
- GIS TAX PARCELS
- SUBCATCHMENT AREA BOUNDARY
- ANALYSIS LIMITS BOUNDARY
- NRCS SOIL BOUNDARY
- TIME OR CONCENTRATION LINE

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
No. 58957
PROFESSIONAL ENGINEER

07/08/26

ISSUED FOR PERMIT
06/24/2026

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		C	06/24/26	JA	DT	ISSUED FOR PERMIT
		B	05/15/26	JA	DT	ISSUE FOR BID
		A	05/15/26	JA	DT	ISSUED FOR PERMIT

audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

DRAWN BY:	JA	05/15/26	CAPE COD CANAL PIPELINE RELOCATION PROJECT
DESIGN CHECKER:	DT	06/24/26	PAVE PAWS ROAD METER STATION
DESIGN ENGINEER:	PB	06/24/26	M&R 00845
PROJECT MANAGER:	AC	06/24/26	TITLE: EXISTING SUBCATCHMENT AREAS PLAN
			LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

TITLE	INITIALS	DATE	YEAR: 2026	W.O.:	SCALE: 1"=50'	DWG.: 00845-C.320-0002	REV.: C

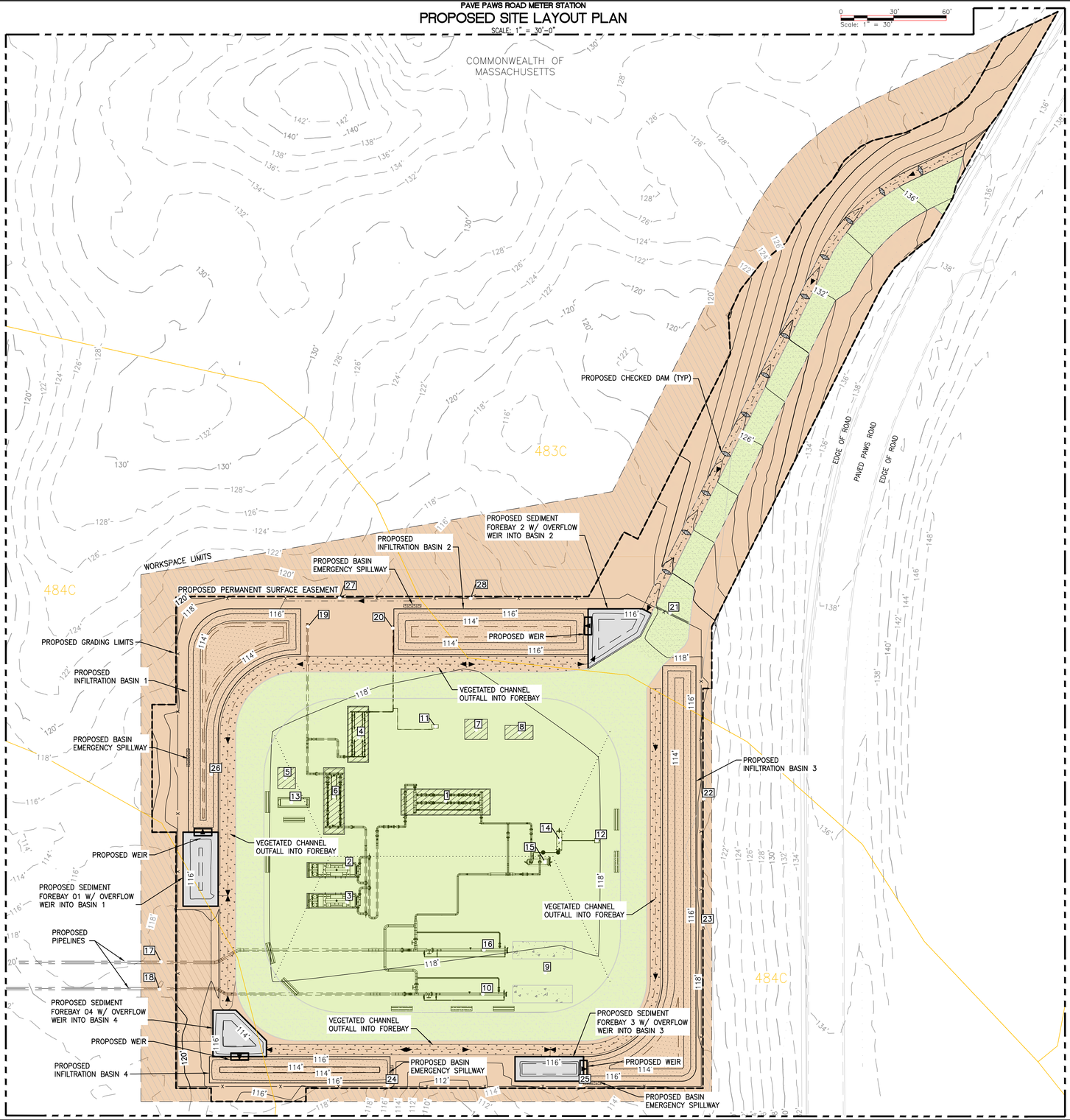
ENBRIDGE
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

S:\AE\Projects\Enbridge\Mass\026356-001\200_Civil_Structural\170_Drawings\E&S Plans\Pave Paws Road M&R\00845-C.320-0002.dwg — PLOT TIME: 6/24/2026 2:28 PM

PAVE PAWS ROAD METER STATION

PROPOSED SITE LAYOUT PLAN

SCALE: 1" = 30'-0"



NN 6.757°

STATION NORTH

NOTES:

1. ALL CONTOUR LABELS AND ELEVATION CALLOUTS ARE IN FEET.
2. PROPOSED SITE BOUNDARY WAS PROVIDED BY ALGONQUIN GAS TRANSMISSION, LLC 3RD PARTY CONSULTANT.
3. SUPPLEMENTAL TAX PARCEL DATA IS SHOWN FOR REFERENCE ONLY AND WAS OBTAINED FROM THE CAPE COD COMMISSION OPEN GIS DATA HUB WEBSITE. PROJECT AREA IS WITHIN THE COMMONWEALTH OF MASSACHUSETTS PROPERTY.
4. PROPERTY CONVEYED TO ALGONQUIN GAS TRANSMISSION, LLC.
5. TOPOGRAPHIC SURVEY INFORMATION WAS PROVIDED BY ALGONQUIN GAS TRANSMISSION, LLC. ALL COORDINATES AND DISTANCES SHOWN HEREON ARE REFERENCED TO THE MASSACHUSETTS STATE PLANE COORDINATE SYSTEM, US FEET. ELEVATIONS ARE REFERENCED TO NAVD 88.
6. ADDITIONAL CONTOUR DATA WAS OBTAINED FROM 2022 USGS LIDAR POINT CLOUD DATA SETS.
7. THIS PROPERTY IS LOCATED IN ZONE X (AREA OF MINIMAL FLOOD HAZARD) AS DEPICTED ON FLOOD INSURANCE RATE MAP 25001C0318K DATED JULY 6, 2021.
8. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT NATURAL RESOURCE STUDY THE SITE IS WITHIN THE NATURAL HERITAGE AND ENDANGERED SPECIES PROGRAM (NHESP), PRIORITY HABITATS OF RARE WILDLIFE, OR THE NHESP ESTIMATED HABITATS OF RARE WILDLIFE.
9. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THERE IS NOT A WETLAND WITHIN 100 FEET OF THE PROJECT LIMITS.
10. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THE SITE IS NOT LOCATED WITHIN AN AREA OF CRITICAL ENVIRONMENTAL CONCERN.
11. THIS PLAN SET IS PRELIMINARY. FOR PERMITTING PURPOSES ONLY. THIS PLAN IS NOT INTENDED FOR CONSTRUCTION PURPOSES.
11. SEE GRADING PLAN DRAWING 00845-C.301-0001 FOR DETAILS ON SITE GRADING AND STORM WATER MANAGEMENT.

KEY NOTE ID	
POINT #	DESCRIPTION
1	30'x50' METER BUILDING
2	HEATER
3	HEATER
4	32'x12' REGULATOR BUILDING
5	12'x10' ODORIZIER BUILDING
6	32'x12' REGULATOR BUILDING
7	10'x12' N.G. EGM BUILDING
8	8'x8' ENBRIDGE EGM BUILDING
9	34'x10' MAINTANANCE SLABS
10	PIPELINE TRAP
11	GENERATOR
12	TRUCK BOX
13	TANK
14	FILTER SEPERATOR
15	AUX SUMP

KEY NOTE ID	
POINT #	DESCRIPTION
16	PIPELINE TRAP
17	PIPELINE (BY OTHERS)
18	PIPELINE (BY OTHERS)
19	PIPELINE CONNECTION POINT
20	PIPELINE CONNECTION POINT
21	SLIDE GATE
22	ACCESS GATE
23	ACCESS GATE
24	ACCESS GATE
25	ACCESS GATE
26	ACCESS GATE
27	ACCESS GATE
28	ACCESS GATE

LEGEND

- PROPOSED ACCESS ROAD
- PROPOSED CONCRETE
- PROPOSED STRUCTURE
- PROPOSED ROCK (FACILITY)
- PROPOSED VEGETATED
- PROPOSED INFILTRATION BASIN
- PROPOSED SEDIMENT FOREBAY
- WORKSPACE
- INFILTRATION >2.4"/HR
- INFILTRATION <2.4"/HR
- EMERGENCY SPILL WAY
- PROPOSED DRAINAGE AREAS
- PROPOSED FENCE
- PROPOSED UG PIPING
- PERMANENT EASEMENT
- GIS TAX PARCELS
- NRCS SOIL BOUNDARY
- WORKSPACE LIMITS
- PROPOSED GRADE LIMITS
- EDGE OF ROAD
- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- PROPOSED FLOW LINE
- PROPOSED WIER
- PROPOSED ROCK CHECK DAM

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
No. 58957
PROFESSIONAL ENGINEER

07/08/26

ISSUED FOR PERMIT
06/24/2026

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		C	06/24/26	JA	DT	ISSUED FOR PERMIT
		B	05/15/26	JA	DT	ISSUED FOR BID
		A	05/15/26	JA	DT	ISSUED FOR PERMIT

audubon Engineering
3505 W. SAM HOUSTON PKWY. N., SUITE 100
HOUSTON, TX 77043
PHONE: (281) 669-0590

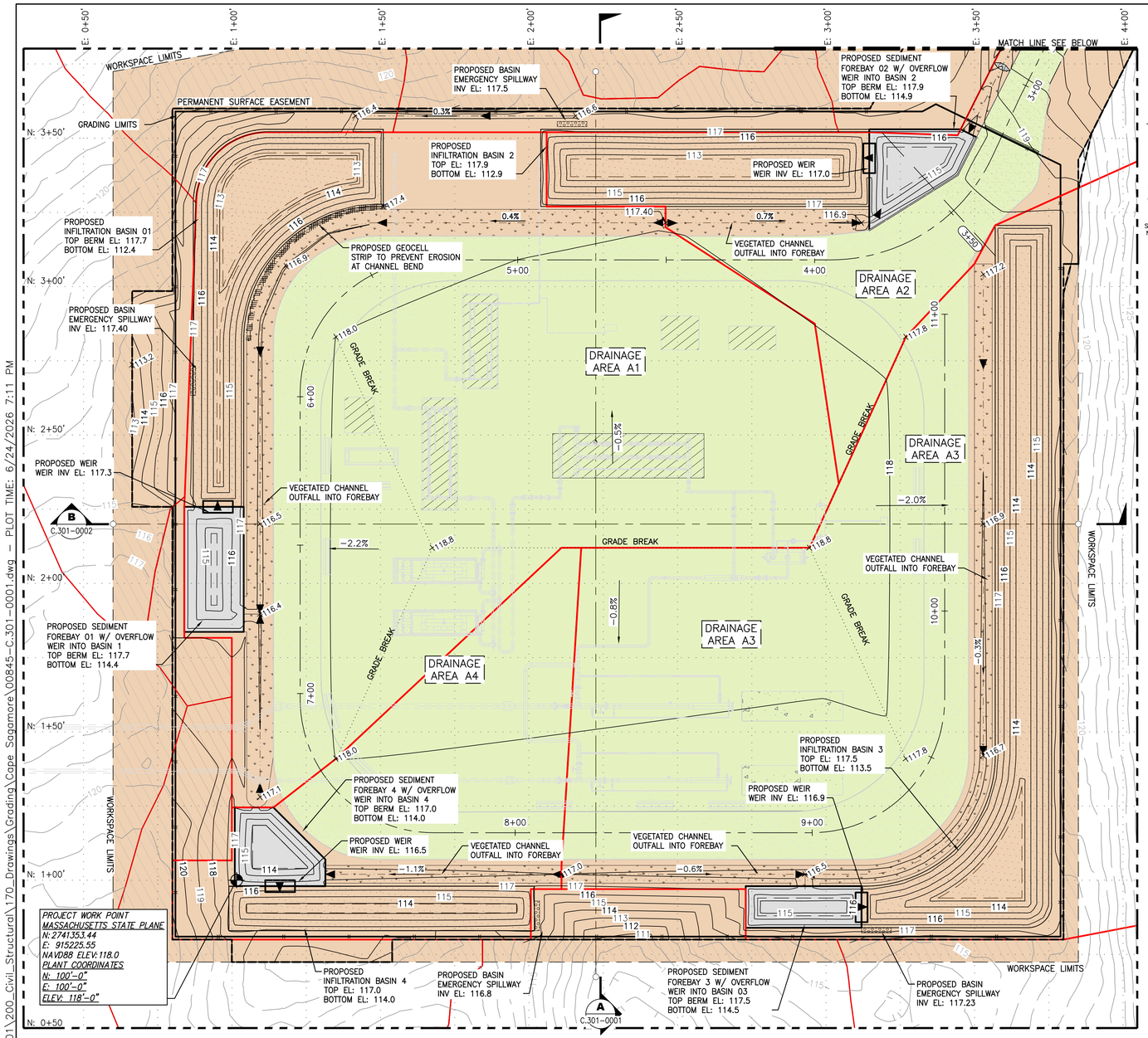
DRAWN BY:	JA	05/15/26
DESIGN CHECKER:	DT	06/24/26
DESIGN ENGINEER:	PB	06/24/26
PROJECT MANAGER:	AC	06/24/26

CAPE COD CANAL PIPELINE RELOCATION PROJECT
PAVE PAWS ROAD METER STATION
M&R 00845
TITLE: PROPOSED SITE LAYOUT PLAN
LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

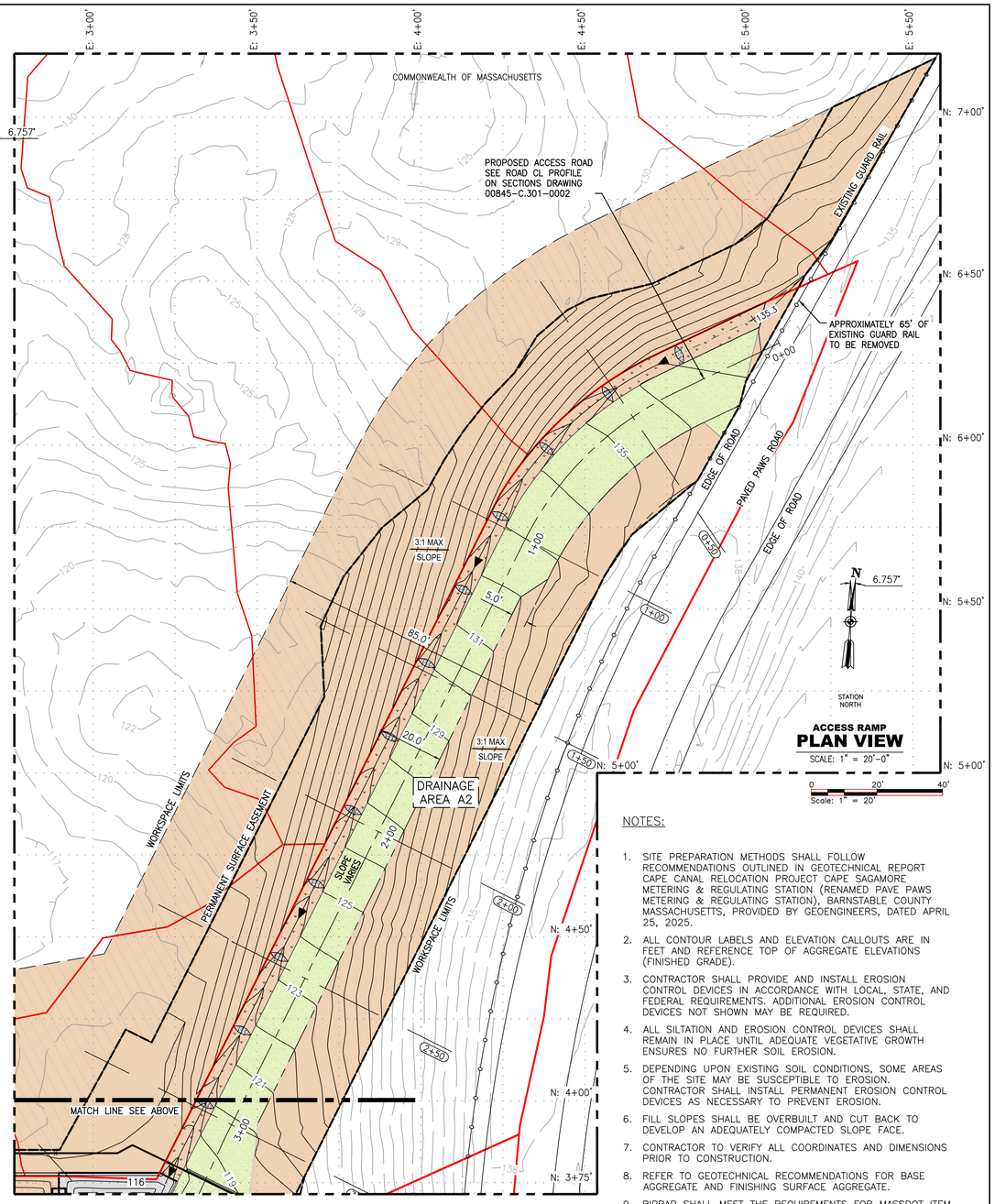
ENBRIDGE
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

TITLE	INITIALS	DATE	YEAR: 2026	W.O.:	SCALE: 1"=30'	DWG.: 00845-C.320-0003	REV.: C

S:\AE_Projects\Enbridge\Mass_026356-001\200_Civil_Structural\170_Drawings\E&S Plans\Pave Paws Road M&R\00845-C.320-0003.dwg - PLOT TIME: 6/24/2026 4:36 PM



METER STATION
PLAN VIEW
SCALE: 1" = 20'-0"



ACCESS RAMP
PLAN VIEW
SCALE: 1" = 20'-0"

0 20' 40'
Scale: 1" = 20'

NOTES:

1. SITE PREPARATION METHODS SHALL FOLLOW RECOMMENDATIONS OUTLINED IN GEOTECHNICAL REPORT CAPE CANAL RELOCATION PROJECT CAPE SAGAMORE METERING & REGULATING STATION (RENAMED PAVE PAWS METERING & REGULATING STATION), BARNSTABLE COUNTY MASSACHUSETTS, PROVIDED BY GEOENGINEERS, DATED APRIL 25, 2025.
2. ALL CONTOUR LABELS AND ELEVATION CALLOUTS ARE IN FEET AND REFERENCE TOP OF AGGREGATE ELEVATIONS (FINISHED GRADE).
3. CONTRACTOR SHALL PROVIDE AND INSTALL EROSION CONTROL DEVICES IN ACCORDANCE WITH LOCAL, STATE, AND FEDERAL REQUIREMENTS. ADDITIONAL EROSION CONTROL DEVICES NOT SHOWN MAY BE REQUIRED.
4. ALL SILTATION AND EROSION CONTROL DEVICES SHALL REMAIN IN PLACE UNTIL ADEQUATE VEGETATIVE GROWTH ENSURES NO FURTHER SOIL EROSION.
5. DEPENDING UPON EXISTING SOIL CONDITIONS, SOME AREAS OF THE SITE MAY BE SUSCEPTIBLE TO EROSION. CONTRACTOR SHALL INSTALL PERMANENT EROSION CONTROL DEVICES AS NECESSARY TO PREVENT EROSION.
6. FILL SLOPES SHALL BE OVERBUILT AND CUT BACK TO DEVELOP AN ADEQUATELY COMPACTED SLOPE FACE.
7. CONTRACTOR TO VERIFY ALL COORDINATES AND DIMENSIONS PRIOR TO CONSTRUCTION.
8. REFER TO GEOTECHNICAL RECOMMENDATIONS FOR BASE AGGREGATE AND FINISHING SURFACE AGGREGATE.
9. RIPRAP SHALL MEET THE REQUIREMENTS FOR MASSDOT ITEM M2.02.0 RIPRAP.
10. MIRAFI 140N, OR EQUIVALENT AND OVERLAIN WITH MIN. 18-INCHES OF RIPRAP SHALL BE PLACED IN FILL SLOPES 3.0H:1V TO 2.0H:V AND STEEPER.
11. CONTRACTOR TO PROVIDE ENGINEER OF RECORD GEOGRID AND GEOTEXTILE FABRIC SAMPLES, SPECIFICATIONS, AND INSTALLATION PROCEDURE PRIOR TO CONSTRUCTION.
12. ALL GEOGRID AND GEOTEXTILE FABRIC SHALL BE INSTALLED ACCORDING TO MANUFACTURER'S REQUIREMENTS AND RECOMMENDATIONS.
13. PROVIDE ENGINEER OF RECORD EQUIVALENT GEOTEXTILE FABRIC DATA SHEET AND SPECIFICATIONS.

EARTHWORK QUANTITIES:

CUT:	1452	CUBIC YARDS
FILL:	9592	CUBIC YARDS
NET (FILL):	8140	CUBIC YARDS

EARTHWORK QUANTITIES WERE DETERMINED BY COMPARING EXISTING GRADE WITH PROPOSED FINISH GRADE. PROPOSED CUT/FILL QUANTITIES ARE APPROXIMATE AND DO NOT ACCOUNT FOR STONE COVERAGE, STRIPPING TOPSOIL, SHRINKAGE FACTORS, BULK FACTORS, FINAL GRAVEL SURFACE LAYER, OR UNSUITABLE MATERIALS ENCOUNTERED.

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
No. 58957
PROFESSIONAL ENGINEER
07/08/26

ISSUED FOR PERMIT
06/24/2026

SURVEY NOTES:

1. BACKGROUND INFORMATION IS BASED ON THE FOLLOWING:
   1.1. TOPOGRAPHIC SURVEY INFORMATION WAS PROVIDED BY ENBRIDGE.
   1.2. ALL COORDINATES AND DISTANCES SHOWN HEREON ARE REFERENCED TO THE MAINE STATE PLANE COORDINATE SYSTEM, US FEET. ELEVATIONS ARE REFERENCED TO NAVD 88.

LEGEND

PROPOSED ACCESS ROAD
PROPOSED CONCRETE
PROPOSED STRUCTURE
PROPOSED ROCK (FACILITY)
PROPOSED FENCE
EXISTING CONTOUR LINE
FINISH CONTOUR LINE
DRAINAGE AREA BOUNDARY
WORKSPACE LIMITS
LIMITS OF GRADING
PROPOSED VEGETATED
PROPOSED INFILTRATION BASIN
PROPOSED SEDIMENT FOREBAY
GRADE BREAK
INFILTRATION >2.4"/HR
PROPOSED FLOW LLINE
PROPOSED EMERGENCY SPILLWAY
PROPOSED WEIR
PROPOSED ROCK CHECK DAM
INFILTRATION <2.4"/HR

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		E	06/24/26	JA	DT	ISSUED FOR PERMIT
		D	05/15/26	JA	DT	ISSUED FOR BID
		C	05/15/26	CR	DT	ISSUED FOR PERMIT
		B	02/17/26	CR	PB	ISSUED FOR REVIEW – 90% REVIEW
00845-C.301-0001	CIVIL GRADING SECTIONS	A	06/24/26	CR	PB	ISSUED FOR REVIEW – 60% REVIEW

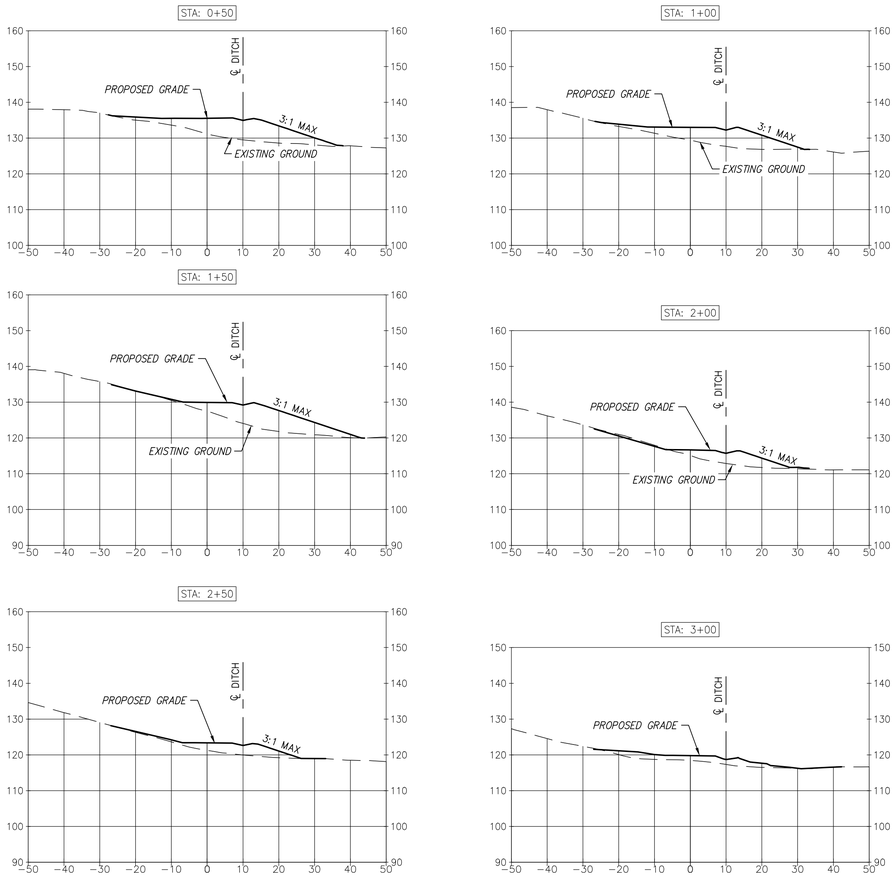
audubon Engineering
3505 W. SAM HOUSTON PKWY. N., SUITE 100
HOUSTON, TX 77043
PHONE: (281) 669-0590

DRAWN BY:	CR	01/08/25	CAPE COD CANAL PIPELINE RELOCATION PROJECT
DESIGN CHECKER:	AE	06/24/26	PAVE PAWS ROAD METER STATION
DESIGN ENGINEER:	PB	06/24/26	GRADING PLAN
PROJECT MANAGER:	AC	06/24/26	TITLE:

ENBRIDGE
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

TITLE	INITIALS	DATE	YEAR:	W.O.:	SCALE:	DWG.:	REV.:
			2026		AS NOTED	00845-C.301-0001	E

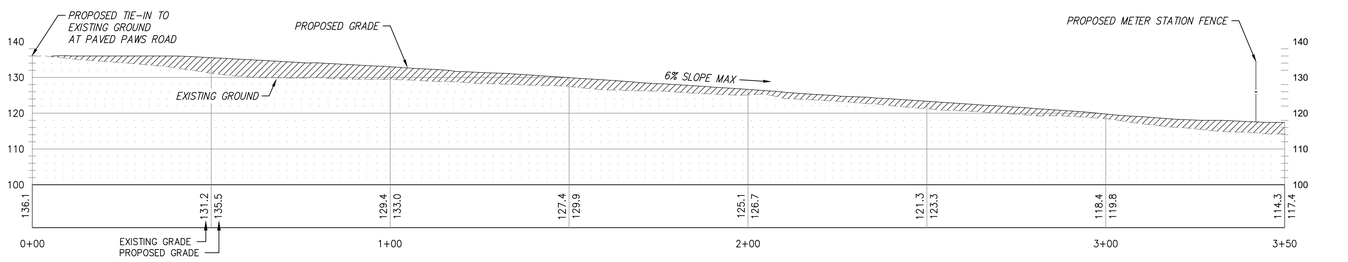
S:\AE\Projects\Enbridge\Mass\026356-001\200_Civil_Structural\170_Drawings\Grading\Cape Sagamore\00845-C.301-0001.dwg – PLOT TIME: 6/24/2026 7:11 PM



REFER TO GRADING PLAN 00845-C.301-0001

ACCESS ROAD RAMP CROSS SECTIONS

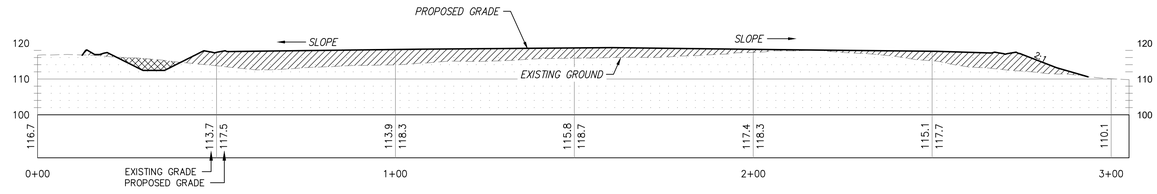
HORZ. & VERT. SCALE: 1" = 20'-0"



REFER TO GRADING PLAN 00845-C.301-0001

ACCESS ROAD RAMP C/L PROFILE

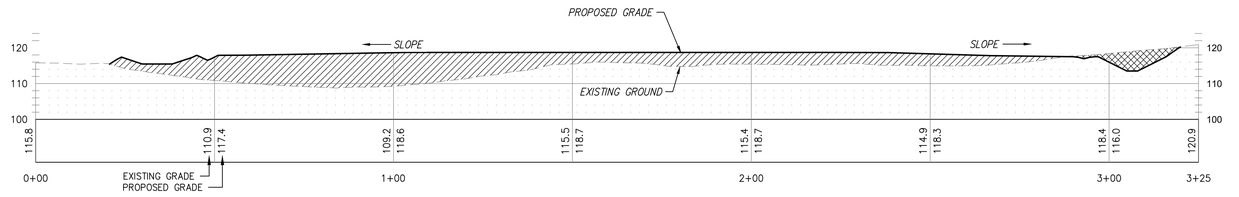
SCALE: 1" = 20'-0"



REFER TO GRADING PLAN 00845-C.301-0001

SECTION A

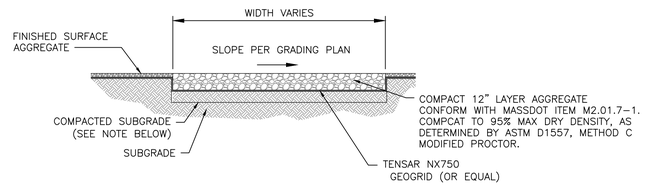
SCALE: 1" = 20'-0"



REFER TO GRADING PLAN 00845-C.301-0001

SECTION B

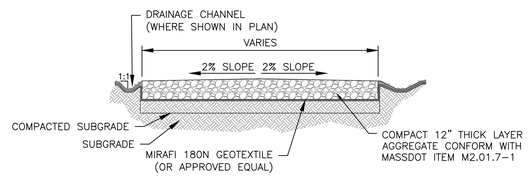
SCALE: 1" = 20'-0"



DETAIL B – TYPICAL AGGREGATE DRIVE AISLE

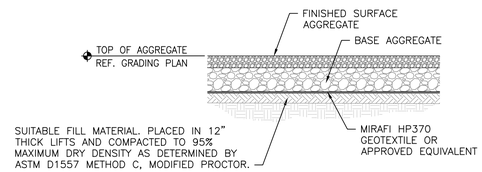
SCALE: NOT TO SCALE

NOTE: SITE PREPARATION SHALL CONFORM TO THE RECOMMENDATIONS OF THE GEOTECHNICAL REPORT REFERENCED.



DETAIL C – TYPICAL AGGREGATE ACCESS ROAD

SCALE: NOT TO SCALE



TYPICAL AGGREGATE YARD SURFACE SECTION

SCALE: NOT TO SCALE

SURVEY NOTES:

1. BACKGROUND INFORMATION IS BASED ON THE FOLLOWING:
   - 1.1. TOPOGRAPHIC SURVEY INFORMATION WAS PROVIDED BY ENBRIDGE.
   - 1.2. ALL COORDINATES AND DISTANCES SHOWN HEREON ARE REFERENCED TO THE MASSACHUSETTS STATE PLANE COORDINATE SYSTEM, US FEET. ELEVATIONS ARE REFERENCED TO NAVD 88.

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
No. 58957
PROFESSIONAL ENGINEER

07/08/26

ISSUED FOR PERMIT
06/24/26

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		E	06/24/26	JA	DT	ISSUED FOR PERMIT
		D	05/15/26	JA	DT	ISSUED FOR BID
		C	05/15/26	CR	DT	ISSUED FOR PERMIT
		B	02/17/26	CR	PB	ISSUED FOR REVIEW – 90% REVIEW
00845-C.301-0001	GRADING PLAN	A	05/09/25	CR	PB	ISSUED FOR REVIEW – 60% REVIEW

audubon Engineering
3505 W. SAM HOUSTON PKWY. N., SUITE 100
HOUSTON, TX 77043
PHONE: (281) 669-0590

TITLE	INITIALS	DATE
DRAWN BY:	JA	05/15/26
DESIGN CHECKER:	DT	06/24/26
DESIGN ENGINEER:	PB	06/24/26
PROJECT MANAGER:	AC	06/24/26

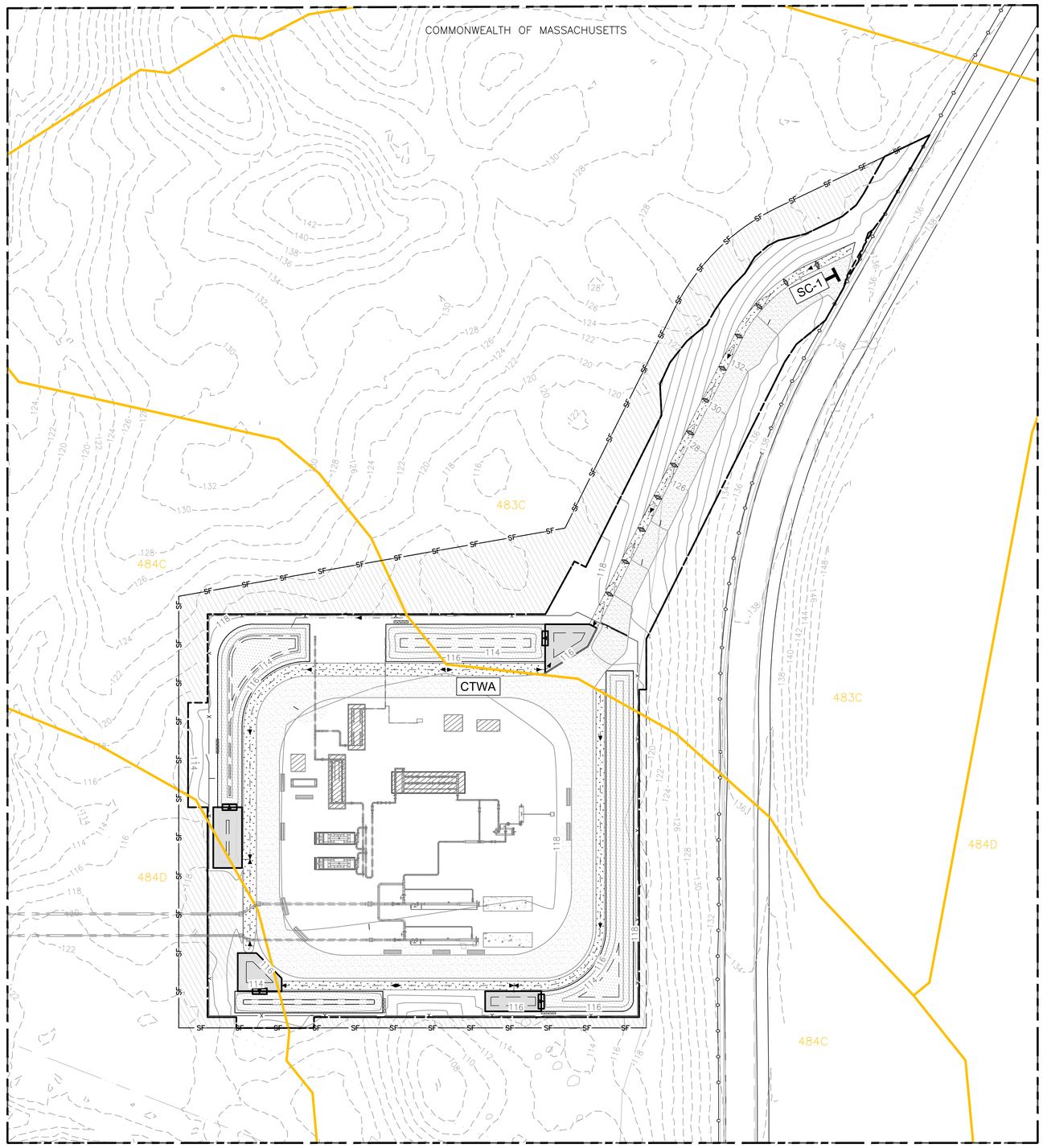
CAPE COD CANAL PIPELINE RELOCATION PROJECT
PAVE PAWS ROAD METER STATION
M&R 0845
TITLE: GRADING CROSS SECTIONS

LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

YEAR: 2026 | W.O.: | SCALE: AS NOTED | DWG.: 00845-C.301-0002 | REV.: E

ENBRIDGE
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

S:\AE\Projects\Enbridge\Mass\026356-001\200_Civil_Structural\170_Drawings\Grading\Cape Sagamore\00845-C.301-0002.dwg – PLOT TIME: 6/24/2026 12:09 PM



PAVE PAWS ROAD METER STATION

CONSTRUCTION EROSION AND SEDIMENT CONTROL PLAN

SCALE: 1" = 40'

0 40' 80'

Scale: 1" = 40'

NW 6.757"

STATION NORTH

NOTES:

1. ALL CONTOUR LABELS AND ELEVATION CALLOUTS ARE IN FEET.
2. PROPOSED SITE BOUNDARY WAS PROVIDED BY ALGONQUIN 3RD PARTY CONSULTANT.
3. SUPPLEMENTAL TAX PARCEL DATA IS SHOWN FOR REFERENCE ONLY AND WAS OBTAINED FROM THE CAPE COD COMMISSION OPEN GIS DATA HUB WEBSITE. PROJECT AREA IS WITHIN THE COMMONWEALTH OF MASSACHUSETTS PROPERTY.
4. PROPERTY CONVEYED TO ALGONQUIN GAS TRANSMISSION, LLC.
5. TOPOGRAPHIC SURVEY INFORMATION WAS PROVIDED BY ALGONQUIN GAS TRANSMISSION, LLC. ALL COORDINATES AND DISTANCES SHOWN HEREON ARE REFERENCED TO THE MASSACHUSETTS STATE PLANE COORDINATE SYSTEM, US FEET. ELEVATIONS ARE REFERENCED TO NAVD 88.
6. CONTOUR DATA SHOWN IS BASED ON THE TOPOGRAPHIC SURVEY REFERENCED ABOVE. ADDITIONAL CONTOUR DATA WAS OBTAINED FROM 2022 USGS LIDAR POINT CLOUD DATA SETS.
7. THIS PROPERTY IS LOCATED IN ZONE X (AREA OF MINIMAL FLOOD HAZARD) AS DEPICTED ON FLOOD INSURANCE RATE MAP 25001C0318K DATED JULY 6, 2021.
8. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT NATURAL RESOURCE STUDY THE SITE IS WITHIN THE NATURAL HERITAGE AND ENDANGERED SPECIES PROGRAM (NHESP), PRIORITY HABITATS OF RARE WILDLIFE, OR THE NHESP ESTIMATED HABITATS OF RARE WILDLIFE.
9. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THE SITE THERE IS NOT A WETLAND WITHIN 100 FEET OF THE PROJECT LIMITS.
10. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THE SITE IS NOT LOCATED WITHIN AN AREA OF CRITICAL ENVIRONMENTAL CONCERN.
11. THIS PLAN SET IS PRELIMINARY. FOR PERMITTING PURPOSES ONLY. PROPOSED GRADING MAY BE FURTHER OPTIMIZED TO ENSURE PROPER SHEET FLOW AROUND ASSUMED BUILDING LOCATIONS, FOUNDATIONS, AND MECHANICAL EQUIPMENT. THIS PLAN IS NOT INTENDED FOR CONSTRUCTION PURPOSES.
12. REFER TO DRAWINGS 00844-C.320-0006 THRU 0007 FOR BMP DETAILS.
13. REFER TO DRAWING 00844-C.020-0001 FOR CONSTRUCTION EROSION AND SEDIMENT CONTROL NOTES.
14. PROPOSED TEMPORARY WORKSPACE ACERAGE: 3.026 (131,819.31 SQFT)
15. CONTRACTOR TO ENSURE AL WORK TO BE CONDUCTED WITHIN THE WORK LIMITS SPECIFIED. WORK LIMITS SHALL BE CLEARLY MARKED.
16. REFER TO THE "EROSION & SEDIMENT GENERAL NOTES" (DWG. 00845-C.020-0001) FOR SOIL TYPES INFORMATION.

LEGEND

- PROPOSED ACCESS ROAD
- PROPOSED CONCRETE
- PROPOSED STRUCTURE
- PROPOSED ROCK (FACILITY)
- PROPOSED VEGETATED
- PROPOSED INFILTRATION BASIN
- PROPOSED SEDIMENT FOREBAY
- PROPOSED ROCK
- EXISTING PAVED AREA
- WETLAND
- CONSTRUCTION TRUCK WASH AREA (TO BE FIELD LOCATED) — CTWA
- STABLIZED CONSTRUCTION ACCESS (TO BE FIELD LOCATED) — SC-1
- PROPOSED FENCE
- PERMANENT EASEMENT
- GIS TAX PARCELS
- NRCS SOIL BOUNDARY
- WORKSPACE LIMITS
- PROPOSED GRADE LIMITS
- EDGE OF ROAD
- EDGE OF WATER
- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- PROPOSED SILT FENCE — SF
- PROPOSED SILT SOCK — SSS
- PROPOSED WIER
- PROPOSED EMERGENCY SPILLWAY
- TEMPORARY WORK SPACE
- PROPOSED ROCK CHECK DAM

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
No. 58957
PROFESSIONAL ENGINEER

07/08/26

ISSUED FOR PERMIT
06/24/2026

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		C	06/24/26	JA	DT	ISSUED FOR PERMIT
		B	05/15/26	JA	DT	ISSUED FOR BID
		A	05/15/26	JA	DT	ISSUED FOR PERMIT

audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

DRAWN BY:	JA	05/15/26
DESIGN CHECKER:	DT	06/24/26
DESIGN ENGINEER:	PB	06/24/26
PROJECT MANAGER:	AC	06/24/26

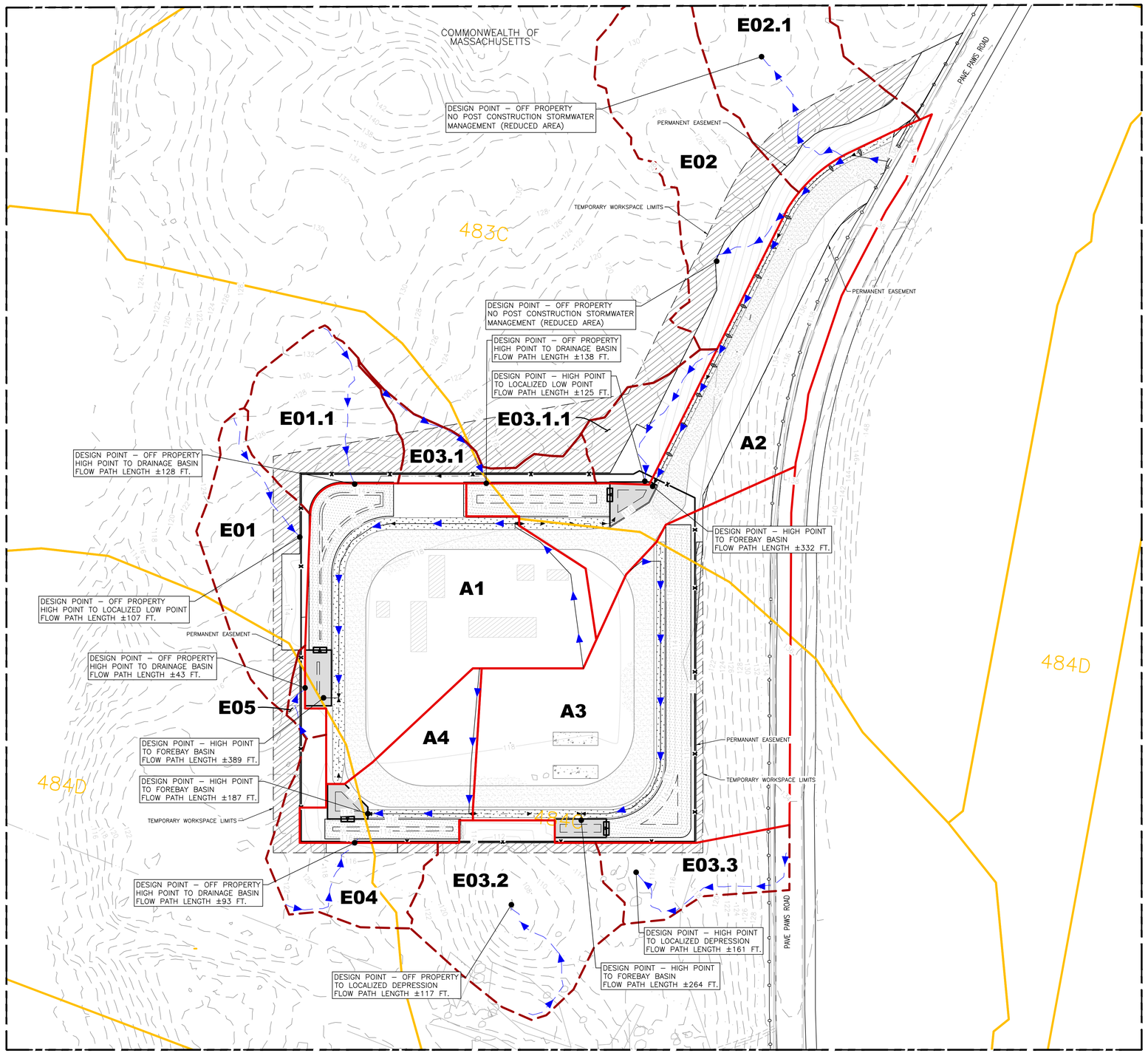
CAPE COD CANAL PIPELINE RELOCATION PROJECT
PAVE PAWS ROAD METER STATION
M&R 00845
CONSTRUCTION EROSION AND SEDIMENT CONTROL PLAN

LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

TITLE	INITIALS	DATE	YEAR:	W.O.:	SCALE:	DWG.:	REV.:
			2026		1"=40'	00845-C.320-0004	C

ENBRIDGE
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

S:\AE\Projects\Enbridge\Mass\026356-001\200_Civil_Structural\170_Drawings\E&S Plans\Pave Paws Road M&R\00845-C.320-0004.dwg - PLOT TIME: 6/24/2026 4:28 PM



PAVE PAWS ROAD METER STATION

PROPOSED SUBCATCHMENT AREAS PLAN

SCALE: 1" = 40'

N

6.757°

STATION NORTH

0 40' 80'

Scale: 1" = 40'

NOTES:

1. ALL CONTOUR LABELS AND ELEVATION CALLOUTS ARE IN FEET.
2. PROPOSED SITE BOUNDARY WAS PROVIDED BY ALGONQUIN 3RD PARTY CONSULTANT.
3. SUPPLEMENTAL TAX PARCEL DATA IS SHOWN FOR REFERENCE ONLY AND WAS OBTAINED FROM THE CAPE COD COMMISSION OPEN GIS DATA HUB WEBSITE. PROJECT AREA IS WITHIN THE COMMONWEALTH OF MASSACHUSETTS PROPERTY.
4. PROPERTY CONVEYED TO ALGONQUIN GAS TRANSMISSION, LLC.
5. TOPOGRAPHIC SURVEY INFORMATION WAS PROVIDED BY ALGONQUIN GAS TRANSMISSION, LLC. ALL COORDINATES AND DISTANCES SHOWN HEREON ARE REFERENCED TO THE MASSACHUSETTS STATE PLANE COORDINATE SYSTEM, US FEET. ELEVATIONS ARE REFERENCED TO NAVD 88.
6. ADDITIONAL CONTOUR DATA SHOWN IS BASED ON THE TOPOGRAPHIC SURVEY REFERENCED ABOVE. ADDITIONAL CONTOUR DATA WAS OBTAINED FROM 2022 USGS LIDAR POINT CLOUD DATA SETS.
7. THIS PROPERTY IS LOCATED IN ZONE X (AREA OF MINIMAL FLOOD HAZARD) AS DEPICTED ON FLOOD INSURANCE RATE MAP 25001C0318K DATED JULY 6, 2021.
8. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT NATURAL RESOURCE STUDY THE SITE IS WITHIN THE NATURAL HERITAGE AND ENDANGERED SPECIES PROGRAM (NHESP), PRIORITY HABITATS OF RARE WILDLIFE, OR THE NHESP ESTIMATED HABITATS OF RARE WILDLIFE.
9. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THE SITE THERE IS NOT A WETLAND WITHIN 100 FEET OF THE PROJECT LIMITS.
10. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THE SITE IS NOT LOCATED WITHIN AN AREA OF CRITICAL ENVIRONMENTAL CONCERN.
11. THIS PLAN SET IS PRELIMINARY. FOR PERMITTING PURPOSES ONLY. PROPOSED GRADING MAY BE FURTHER OPTIMIZED TO ENSURE PROPER SHEET FLOW AROUND ASSUMED BUILDING LOCATIONS, FOUNDATIONS, AND MECHANICAL EQUIPMENT. THIS PLAN IS NOT INTENDED FOR CONSTRUCTION PURPOSES.
12. REFER TO THE "EROSION & SEDIMENT GENERAL NOTES" (DWG. 00845-C.020-0001) FOR SOIL TYPES INFORMATION.

LEGEND

- PROPOSED ACCESS ROAD
- PROPOSED CONCRETE
- PROPOSED STRUCTURE
- PROPOSED ROCK (FACILITY)
- PROPOSED VEGETATED
- PROPOSED INFILTRATION BASIN
- PROPOSED SEDIMENT FOREBAY
- PROPOSED ROCK
- PROPOSED DRAINAGE AREAS
- EXISTING DRAINAGE AREAS
- PROPOSED FENCE
- PERMANENT EASEMENT LINE
- GIS TAX PARCELS
- NRCS SOIL BOUNDARY
- WORKSPACE LIMITS
- PROPOSED GRADE LIMITS
- EDGE OF ROAD
- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- TIME OF CONCENTRATION LINE
- PROPOSED SWALE FLOW LLINE

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
No. 58957
PROFESSIONAL ENGINEER

07/08/26

ISSUED FOR PERMIT
06/24/2026

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		C	06/24/26	JA	DT	ISSUED FOR PERMIT
		B	05/15/26	JA	DT	ISSUED FOR BID
		A	05/15/26	JA	DT	ISSUED FOR PERMIT

audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

DRAWN BY:	JA	05/15/26	CAPE COD CANAL PIPELINE RELOCATION PROJECT
DESIGN CHECKER:	DT	06/24/26	PAVE PAWS ROAD METER STATION
DESIGN ENGINEER:	PB	06/24/26	M&R 00845
PROJECT MANAGER:	AC	06/24/26	TITLE: PROPOSED SUBCATCHMENT AREAS PLAN
TITLE	INITIALS	DATE	LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

YEAR: 2026 | W.O.: | SCALE: 1"=40' | DWG.: 00845-C.320-0005 | REV.: C

ENBRIDGE
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

S:\AE\Projects\Enbridge\Mass\026356-001\200_Civil_Structural\170_Drawings\E&S Plans\Pave Paws Road M&R\00845-C.320-0005.dwg — PLOT TIME: 6/24/2026 6:25 PM

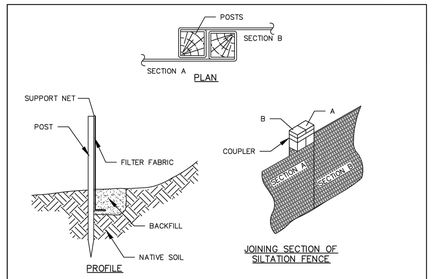
E&S CONSTRUCTION SEQUENCE AND MAINTENANCE

THE FOLLOWING CONSTRUCTION SEQUENCING AND EROSION AND SEDIMENTATION CONTROL MEASURES HAVE BEEN DEVELOPED TO MINIMIZE EROSION, SEDIMENT TRANSPORT, AND IMPACTS TO ADJACENT DRAINAGE SYSTEMS AND RESOURCE AREAS DURING ALL PHASES OF CONSTRUCTION. THE CONTRACTOR SHALL BE RESPONSIBLE FOR MAINTAINING ALL EROSION AND SEDIMENTATION CONTROLS THROUGHOUT CONSTRUCTION AND IMPLEMENTING ADDITIONAL MEASURES AS NECESSARY TO PREVENT OFF-SITE SEDIMENT TRANSPORT. THE SEQUENCE OF WORK SHALL GENERALLY PROCEED AS FOLLOWS:

- INSTALL CONSTRUCTION LIMIT SILT FENCING AND STABILIZED CONSTRUCTION ENTRANCES PRIOR TO THE COMMENCEMENT OF CLEARING OR EARTHWORK ACTIVITIES. CRUSHED STONE CONSTRUCTION ENTRANCE APRONS SHALL BE MAINTAINED TO MINIMIZE SEDIMENT TRACKING ONTO ADJACENT ROADWAYS.
- INSTALL PERIMETER EROSION AND SEDIMENTATION CONTROLS INCLUDING FIBER ROLLS AND SILT FENCE BARRIERS AT THE DOWNGRADIENT LIMITS OF DISTURBANCE AND AROUND SENSITIVE RESOURCE AREAS. IN AREAS SUBJECT TO CONCENTRATED RUNOFF OR HIGHER SEDIMENT LOADING, FIBER ROLLS SHALL BE SUPPLEMENTED WITH SILT FENCING FOR ADDITIONAL PROTECTION.
- INSTALL CATCH BASIN PROTECTION MEASURES, INCLUDING SILT SACKS WITHIN EXISTING AND NEWLY CONSTRUCTED CATCH BASINS, PRIOR TO NEARBY EARTH DISTURBANCE ACTIVITIES, IF APPLICABLE.
- ESTABLISH DESIGNATED CONCRETE WASHOUT AREAS IN APPROPRIATE UPLAND LOCATIONS TO CONTAIN CONCRETE WASH WATER AND SOLIDS GENERATED DURING CONSTRUCTION ACTIVITIES. CONCRETE WASHOUT FACILITIES SHALL BE LEAK PROOF AND MAINTAINED THROUGHOUT THE DURATION OF THE PROJECT.
- CONDUCT CLEARING AND GRUBBING OPERATIONS ONLY WITHIN APPROVED LIMITS OF DISTURBANCE. EXISTING VEGETATION OUTSIDE THE WORK LIMITS SHALL REMAIN PROTECTED TO THE MAXIMUM EXTENT PRACTICABLE.
- STRIP AND STOCKPILE TOPSOIL IN STABILIZED AREAS UNTIL HAULED OFF. ANY STOCKPILED SOILS REMAINING INACTIVE SHALL BE COVERED OR TEMPORARILY STABILIZED TO MINIMIZE EROSION AND FUGITIVE DUST.
- TEMPORARY CHANNELS TO BE REMOVED ONCE PERMANENT VEGETATED CHANNELS ARE INSTALLED.
- PERFORM EXCAVATION, GRADING, AND UTILITY INSTALLATION ACTIVITIES IN PHASES TO MINIMIZE THE EXTENT OF EXPOSED SOILS AT ANY ONE TIME.
- UTILIZE WATER TRUCKS OR OTHER DUST SUPPRESSION METHODS AS NECESSARY DURING EXCAVATION, GRADING, AND CONSTRUCTION OPERATIONS TO MINIMIZE DUST.
- INSTALL UNDERGROUND DRAINAGE INFRASTRUCTURE, STORMWATER MANAGEMENT SYSTEMS, AND ASSOCIATED DRAINAGE APPURTENANCES AS GRADING PROGRESSES.
- STABILIZE DISTURBED SOIL AREAS WITHIN FOURTEEN (14) DAYS AFTER CONSTRUCTION ACTIVITIES HAVE TEMPORARILY OR PERMANENTLY CEASED, UNLESS WEATHER CONDITIONS PROHIBIT STABILIZATION ACTIVITIES. TEMPORARY VEGETATIVE STABILIZATION SHALL INCLUDE HYDROSEEDING, TEMPORARY SEEDING, MULCH, OR EROSION CONTROL BLANKET APPLICATIONS AS APPROPRIATE.
- IMPLEMENT VEGETATIVE SLOPE STABILIZATION MEASURES ON SLOPES 2:1 OR FLATTER USING TEMPORARY ANNUAL GRASSES AND PERMANENT PERENNIAL SEED MIXES TO MINIMIZE EROSION AND PROMOTE LONG-TERM STABILIZATION.
- COMPLETE FINAL GRADING ACTIVITIES AND ESTABLISH PERMANENT STABILIZATION MEASURES INCLUDING PERMANENT SEEDING, LANDSCAPING, MULCH, EROSION CONTROL BLANKETS, AND OTHER APPROVED STABILIZATION METHODS.
- REMOVE ACCUMULATED SEDIMENT FROM TEMPORARY CONTROLS AND DRAINAGE STRUCTURES AS NECESSARY THROUGHOUT CONSTRUCTION.
- REMOVE TEMPORARY EROSION AND SEDIMENTATION CONTROLS ONLY AFTER ALL DISTURBED AREAS HAVE ACHIEVED PERMANENT STABILIZATION. DISTURBED AREAS RESULTING FROM REMOVAL ACTIVITIES SHALL BE REGRADED AND STABILIZED AS NECESSARY.

THE CONTRACTOR SHALL PERFORM ROUTINE INSPECTION AND MAINTENANCE OF ALL EROSION AND SEDIMENTATION CONTROL MEASURES THROUGHOUT CONSTRUCTION, INCLUDING BUT NOT LIMITED TO THE FOLLOWING:

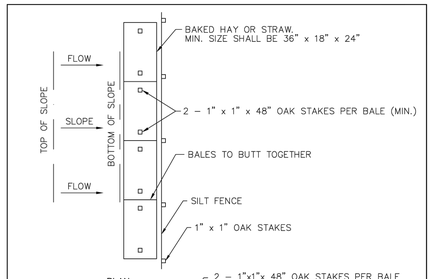
- INSPECT ALL EROSION AND SEDIMENTATION CONTROL MEASURES PERIODICALLY AND AFTER EACH RAINFALL EVENT. INSPECTION RECORDS SHALL BE MAINTAINED ONSITE BY THE CONTRACTOR.
- REPAIR OR REPLACE DAMAGED OR DETERIORATED EROSION CONTROL MEASURES IMMEDIATELY UPON IDENTIFICATION.
- REMOVE ACCUMULATED SEDIMENT FROM BEHIND SILT FENCE BARRIERS, STRAW WATTLES, AND OTHER SEDIMENT CONTROLS WHEN SEDIMENT REACHES APPROXIMATELY SIX INCHES IN DEPTH OR AS NECESSARY TO MAINTAIN FUNCTIONALITY.
- MAINTAIN FIBER ROLLS IN CONTINUOUS CONTACT WITH THE GROUND SURFACE AND RESET OR REPLACE AS NECESSARY.
- INSPECT AND MAINTAIN CATCH BASIN PROTECTION MEASURES REGULARLY AND REMOVE ACCUMULATED SEDIMENT AS REQUIRED.
- MAINTAIN STABILIZED CONSTRUCTION ENTRANCES AND REPLACE CRUSHED STONE AS SEDIMENT ACCUMULATES.
- INSPECT CONCRETE WASHOUT FACILITIES DAILY AND AFTER STORM EVENTS TO ENSURE ADEQUATE CONTAINMENT CAPACITY AND PREVENT LEAKAGE OR OVERFLOW. CONCRETE WASHOUT MATERIALS SHALL BE PROPERLY REMOVED AND RECYCLED OR DISPOSED OF IN ACCORDANCE WITH APPLICABLE REGULATIONS.
- MAINTAIN TEMPORARY AND PERMANENT VEGETATIVE STABILIZATION MEASURES, INCLUDING RESEEDING AND REPAIR OF ERODED AREAS AS NECESSARY.
- PROPERLY DISPOSE OF SEDIMENT AND DEBRIS REMOVED FROM EROSION CONTROL STRUCTURES AND COVER MATERIALS IF TEMPORARILY STORED ONSITE.
- MAINTAIN ALL EROSION AND SEDIMENTATION CONTROL MEASURES UNTIL FINAL SITE STABILIZATION HAS BEEN ACHIEVED.



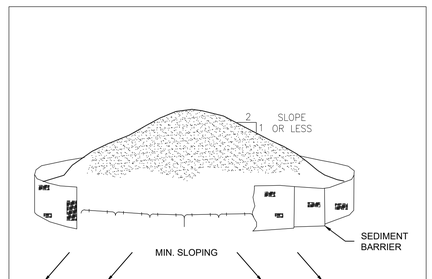
CONSTRUCTION NOTES

1. WOVEN WIRE FENCE TO BE FASTENED SECURELY TO FENCE POST WITH WIRE TIES OR STAPLES.
2. FILTER FABRIC TO BE FASTENED SECURELY TO WOVEN WIRE FENCE WITH TIES SPACED EVERY 24" AT TOP AND MID SECTION.
3. WHEN TWO SECTIONS OF FILTER FABRIC ADJOIN EACH OTHER, THEY SHALL BE OVERLAPPED BY 6 INCHES AND FOLDED.
4. MAINTENANCE SHALL BE PERFORMED AS NEEDED AND MATERIAL REMOVED WHEN "BULGES" DEVELOP IN THE SILT FENCE.
5. INSPECTION SHALL BE FREQUENT AND REPAIR REPLACEMENT SHALL BE MADE PROMPTLY AS NEEDED.
6. FENCES SHALL BE REMOVED WHEN THEY HAVE SERVED THEIR USEFULNESS SO AS NOT TO BLOCK OR IMPEDE STORM FLOW OR DRAINAGE.

SILTATION FENCE



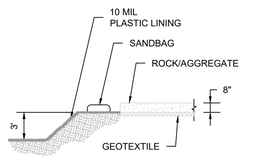
HAYBALES AND SILT FENCE

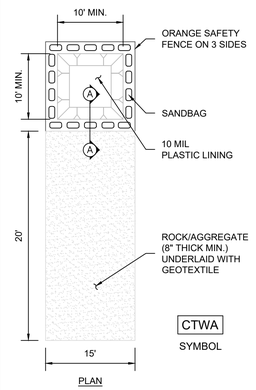


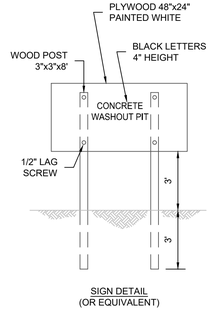
INSTALLATION NOTES:

1. AREA CHOSEN FOR STOCKPILING OPERATIONS SHALL BE DRY AND STABLE.
2. MAXIMUM SLOPE OF STOCKPILE SHALL BE 2:1.
3. UPON COMPLETION OF SOIL STOCKPILING, EACH PILE SHALL BE SURROUNDED WITH EITHER SILT FENCING.
4. COORDINATE WITH ON-SITE INSPECTOR FOR STOCKPILE LOCATIONS

TEMPORARY STOCKPILE DETAIL



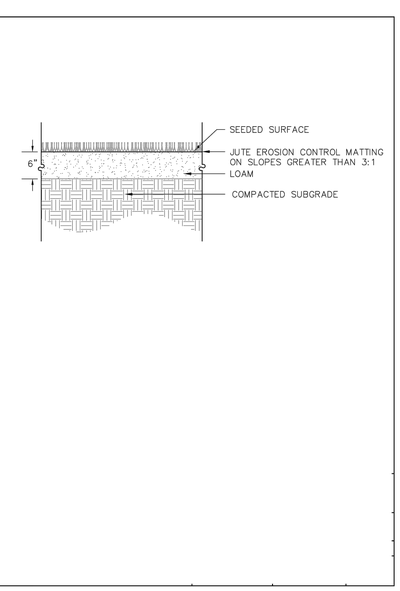




GENERAL NOTES:

1. POST A SIGN READING "CONCRETE WASHOUT PIT" NEXT TO THE PIT.
2. VERBALLY INSTRUCT THE CONCRETE TRUCK DRIVERS WHERE THE PIT IS AND TO WASHOUT THEIR TRUCKS IN THE PIT AND NOWHERE ELSE.
3. UPON THE CONCRETE SETTING UP (CURING, DRYING OUT), THE CONCRETE WASTE SHALL BE REMOVED FROM THE PROJECT SITE AND DISPOSED OF PROPERLY BY THE CONTRACTOR. AFTER REMOVAL OF THE CONCRETE WASTE, THE WASHOUT PIT SHALL BE FILLED WITH CLEAN FILL MATERIAL AND COMPACTED TO IN-SITU CONDITIONS, OR AS DIRECTED BY THE PROJECT SPECIFICATIONS.
4. CONCRETE WASHOUT PITS SHALL NOT BE LOCATED DIRECTLY ADJACENT TO, NOR AT ANY TIME DRAIN INTO THE STORM SEWER SYSTEM OR ANY OTHER SWALE, DITCH, OR WATERWAY.
5. CONSTRUCT ENTRY ROAD AND BOTTOM OF WASHOUT AREA TO SUPPORT EXPECTED LOADINGS FROM TRUCKS EQUIPMENT.

CONCRETE TRUCK WASHOUT AREA
SCALE: N.T.S.



LOAM AND SEED DETAIL

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
No. 59957
PROFESSIONAL ENGINEER
07/08/26

ISSUED FOR PERMIT
06/24/2026

NOTES:

1. SEE CONSTRUCTION EROSION AND SEDIMENT CONTROL PLAN DRAWING 00845-C.320-0004.
2. CONTRACTOR TO EVALUATE PROJECT AREA TO IMPLEMENT BMPS IN AREAS THAT BEST FIT FOR THE CURRENT CONDITIONS. CONSULT WITH THE ONSITE INSPECTOR FOR ANY ADJUSTMENTS AND/OR ADDITIONS TO THE CONSTRUCTION STORM MANAGEMENT PLAN.

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		C	06/24/26	JA	DT	ISSUED FOR PERMIT
		B	05/15/26	JA	DT	ISSUED FOR BID
		A	05/15/26	VN	DT	ISSUED FOR PERMIT

audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N, SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

DRAWN BY:	VN	05/15/26	
DESIGN CHECKER:	DT	06/24/26	
DESIGN ENGINEER:	PB	06/24/26	
PROJECT MANAGER:	AC	06/24/26	
TITLE	INITIALS	DATE	

CAPE COD CANAL PIPELINE RELOCATION PROJECT
PAVE PAWS ROAD METER STATION
M&R 00845
TITLE: DETAILS

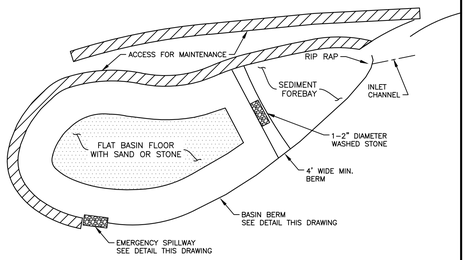
ENBRIDGE

LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

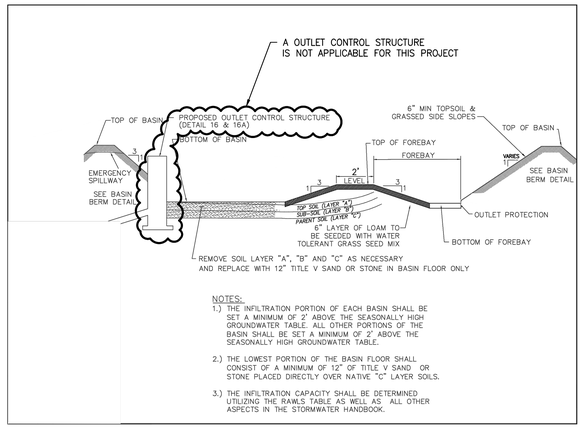
YEAR: 2026 | W.O.: | SCALE: N.T.S. | DWG.: 00845-C.320-0006 | REV.: C

S:\AE\Projects\Enbridge\Mass\026356-0011\200_civil_structural\170_drawings\e&s plans\pave paws road m&r\00845-c.320-0006.dwg - PLOT TIME: 6/24/2026 1:18 PM



NOTE:
THE INFILTRATION BASIN SHALL BE DESIGNED BY A PROFESSIONAL ENGINEER, AND SHALL COMPLY WITH ALL ASPECTS OF THE MA-DEP STORMWATER HANDBOOK.

INFILTRATION BASIN DETAIL

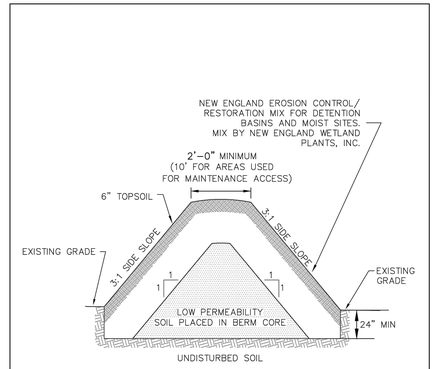


NOTES:
1.) THE INFILTRATION PORTION OF EACH BASIN SHALL BE SET A MINIMUM OF 2' ABOVE THE SEASONALLY HIGH GROUNDWATER TABLE. ALL OTHER PORTIONS OF THE BASIN SHALL BE SET A MINIMUM OF 2' ABOVE THE SEASONALLY HIGH GROUNDWATER TABLE.

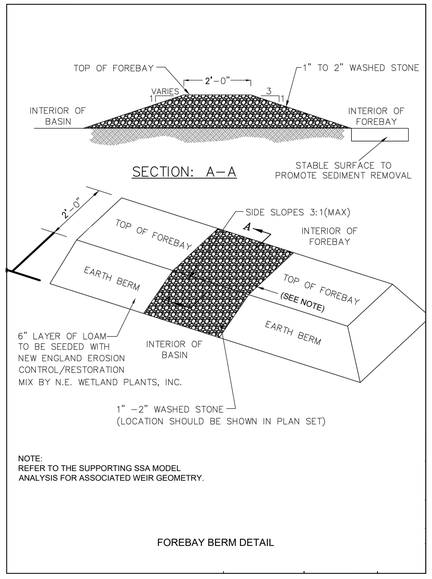
2.) THE LOWEST PORTION OF THE BASIN FLOOR SHALL CONSIST OF A MINIMUM OF 12" OF TITLE V SAND OR STONE PLACED DIRECTLY OVER NATIVE "C" LAYER SOILS.

3.) THE INFILTRATION CAPACITY SHALL BE DETERMINED UTILIZING THE RAWLS TABLE AS WELL AS ALL OTHER ASPECTS IN THE STORMWATER HANDBOOK.

INFILTRATION BASIN CROSS SECTION

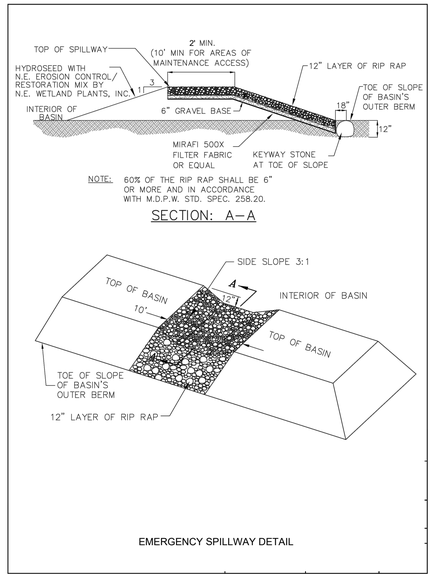


BASIN BERM DETAIL

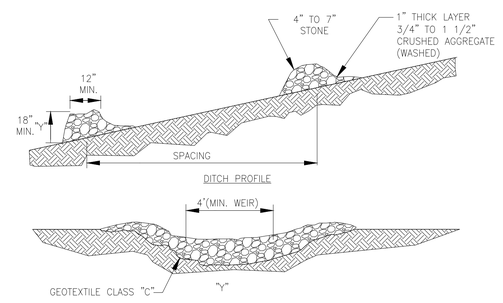


NOTE:
REFER TO THE SUPPORTING SSA MODEL ANALYSIS FOR ASSOCIATED WEIR GEOMETRY.

FOREBAY BERM DETAIL



EMERGENCY SPILLWAY DETAIL



STANDARD SYMBOL



STANDARD STONE CHECK DAM DESIGN

SLOPE	SPACING
2% OR LESS	80'
2.1% TO 4%	40'
4.1% TO 7%	25'
7.1% TO 10%	15'
OVER 10%	USE LINED WATERWAY DESIGN

NOTES:
1. SWALES AND DITCHES SHALL BE PREPARED IN ACCORDANCE WITH THE CONSTRUCTION SPECIFICATIONS DESCRIBED IN SECTION A-2, STANDARDS AND SPECIFICATIONS FOR THE TEMPORARY SWALE.
2. THE CHECK DAM SHALL BE CONSTRUCTED OF 4"-7" STONE. THE STONE SHALL BE PLACED SO THAT IT COMPLETELY COVERS THE WIDTH OF THE CHANNEL AND KEYED INTO THE CHANNEL BANKS.
3. THE TOP OF THE CHECK DAM SHALL BE CONSTRUCTED SO THE CENTER IS APPROXIMATELY 6" LOWER THAN THE OUTER EDGES, FORMING A WEIR THAT WATER CAN FLOW ACROSS.
4. THE MAXIMUM HEIGHT OF THE CHECK DAM AT THE CENTER SHALL NOT EXCEED 2'.
5. THE UPSTREAM SIDE OF THE CHECK DAM SHALL BE LINED WITH APPROXIMATELY 1" OF 3/4" TO 1 1/2" CRUSHED AGGREGATE.

TYPICAL ROCK CHECK DAM DETAIL

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
No. 58957
PROFESSIONAL ENGINEER
07/08/26

ISSUED FOR PERMIT
06/24/2026

NOTES:
1. SEE CONSTRUCTION EROSION AND SEDIMENT CONTROL PLAN DRAWING 00845-C.320-0004.
2. CONTRACTOR TO EVALUATE PROJECT AREA TO IMPLEMENT BMPS IN AREAS THAT BEST FIT FOR THE CURRENT CONDITIONS. CONSULT WITH THE ONSITE INSPECTOR FOR ANY ADJUSTMENTS AND/OR ADDITIONS TO THE CONSTRUCTION STORM MANAGEMENT PLAN.

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		C	06/24/26	JA	DT	ISSUED FOR PERMIT
		B	05/15/26	JA	DT	ISSUED FOR BID
		A	05/15/26	VN	CR	ISSUED FOR PERMIT

audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N, SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

TITLE	INITIALS	DATE
DRAWN BY:	JA	05/15/26
DESIGN CHECKER:	CR	06/24/26
DESIGN ENGINEER:	PB	06/24/26
PROJECT MANAGER:	AC	06/24/26

CAPE COD CANAL PIPELINE RELOCATION PROJECT
PAVE PAWS ROAD METER STATION
M&R 00845
TITLE: DETAILS

LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

YEAR: 2026 | W.O.: | SCALE: N.T.S.

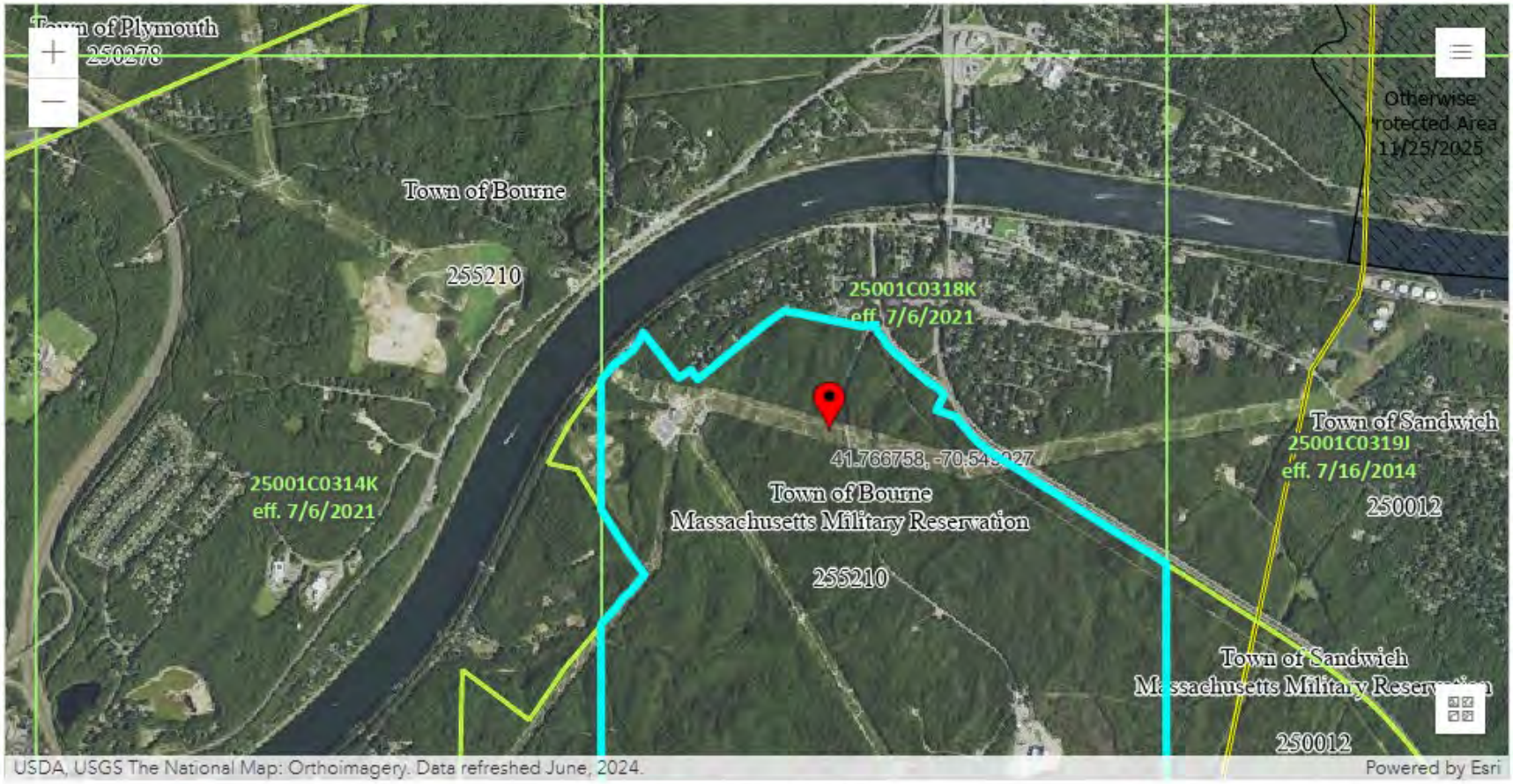
ENBRIDGE
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

DWG.: 00845-C.320-0007 | REV.: C

S:\AE\Projects\Enbridge\Mass\026356-0011\200_Civil_Structural\170_Drawings\E&S Plans\Pave Paws Road M&R\00845-C.320-0007.dwg - PLOT TIME: 6/24/2026 4:13 PM

Attachment G – Standard 9 Supporting Information

FEMA Floodway Mapping



PIN
Approximate location based on user input and does not represent an authoritative property location

MAP PANELS
Selected FloodMap Boundary
Digital Data Available
No Digital Data Available
Unmapped

OTHER AREAS
NO SCREEN Area of Minimal Flood Hazard Zone X
Effective LOMRs
Area of Undetermined Flood Hazard Zone D
Otherwise Protected Area
Coastal Barrier Resource System Area

SPECIAL FLOOD HAZARD AREAS
Without Base Flood Elevation (BFE) Zone A, V, A99
With BFE or Depth
Regulatory Floodway Zone AE, AO, AH, VE, AR

OTHER AREAS OF FLOOD HAZARD
0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile Zone X
Future Conditions 1% Annual Chance Flood Hazard Zone X
Area with Reduced Flood Risk due to Levee. See Notes. Zone X
Area with Flood Risk due to Levee Zone D

OTHER FEATURES
20.2 Cross Sections with 1% Annual Chance
17.5 Water Surface Elevation
Coastal Transect
Base Flood Elevation Line (BFE)
Limit of Study
Jurisdiction Boundary
Coastal Transect Baseline
Profile Baseline
Hydrographic Feature

GENERAL STRUCTURES
Channel, Culvert, or Storm Sewer
Levee, Dike, or Floodwall

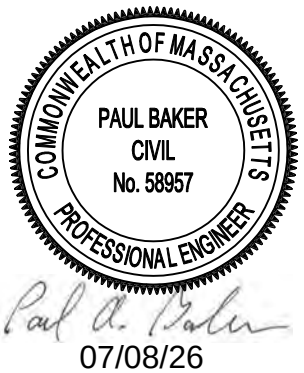
JULY 8, 2026

CAPE COD CANAL PIPELINE REPLACEMENT PROJECT

STORMWATER REPORT FOR THE BOURNE METER STATION

BOURNE, MA

Prepared For: Algonquin Gas Transmission, LLC



07/08/26

Prepared By: audubon

Audubon Companies, LC

3505 W. Sam Houston Pkwy N., Ste 150

Houston, TX 77043

Table of Contents

1 Checklist for Stormwater Report 1
2 Stormwater Report Narrative 8
2.1 Project Description 8
2.1.1 Site Description 8
2.2.1 Wetland Resources 8
2.2.2 Subsurface Soil Investigations 9
2.2 Existing Drainage Conditions 9
2.3 Proposed Drainage Conditions 10
3 Regulatory Compliance 15
3.1 Massachusetts Department of Environmental Protection (DEP) – Stormwater Management Standards 15
3.1.1 Standard 1: No New Untreated Discharges or Erosion to Wetlands 15
3.1.2 Standard 2: Peak Rate Attenuation 15
3.1.3 Standard 3: Stormwater Recharge 17
3.1.4 Standard 4: Water Quality 18
3.1.5 Standard 5: Land Uses and High Potential Pollutant Loads (LUHPPLs) 18
3.1.6 Standard 6: Critical Areas 19
3.1.7 Standard 7: Redevelopments and Other Projects Subject to the Standards only to the Maximum Extent Practicable 19
3.1.8 Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Controls 19
3.1.9 Standard 9: Operation and Maintenance Plan 19
3.1.10 Standard 10: Prohibition of Illicit Discharges 20
4 Local Municipal Rules and Regulations 20
5 FEMA Floodplain 21

Figure 1 - Site Location Map (Aerial)
Figure 2 - Site Location Map (Topo)

Table 1 - Existing Conditions Hydrologic Data
Table 2 - Proposed Conditions Hydrologic Data
Table 3 -NOAA Atlas 14 Volume 10 Design Depths for the 24 Hour Storm (inches)
Table 4 - Peak Discharge Rates
Table 5 - Summary of Recharge Calculations

Table 6 - Drainage Swale Design Summary

Attachment A - Existing and Proposed Drainage Conditions 15
Attachment B - Standard 1 Supporting Information 20
Attachment C - Standard 2 Supporting Information 29
Attachment D - Standard 3 Supporting Information 35
Attachment E - Standard 4 Supporting Information 40
Attachment F - Standard 8 Supporting Information 52
Attachment G - Standard 9 Supporting Information 56

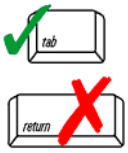
1 Checklist for Stormwater Report

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

A. Introduction

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.



A Stormwater Report must be submitted with the Notice of Intent permit application to document compliance with the Stormwater Management Standards. The following checklist is NOT a substitute for the Stormwater Report (which should provide more substantive and detailed information) but is offered here as a tool to help the applicant organize their Stormwater Management documentation for their Report and for the reviewer to assess this information in a consistent format. As noted in the Checklist, the Stormwater Report must contain the engineering computations and supporting information set forth in Volume 3 of the Massachusetts Stormwater Handbook. The Stormwater Report must be prepared and certified by a Registered Professional Engineer (RPE) licensed in the Commonwealth.

The Stormwater Report must include:

- The Stormwater Checklist completed and stamped by a Registered Professional Engineer (see page 2) that certifies that the Stormwater Report contains all required submittals.[1] This Checklist is to be used as the cover for the completed Stormwater Report.
- Applicant/Project Name
- Project Address
- Name of Firm and Registered Professional Engineer that prepared the Report
- Long-Term Pollution Prevention Plan required by Standards 4-6
- Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan required by Standard 8[2]
- Operation and Maintenance Plan required by Standard 9

In addition to all plans and supporting information, the Stormwater Report must include a brief narrative describing stormwater management practices, including environmentally sensitive site design and LID techniques, along with a diagram depicting runoff through the proposed BMP treatment train. Plans are required to show existing and proposed conditions, identify all wetland resource areas, NRCS soil types, critical areas, Land Uses with Higher Potential Pollutant Loads (LUHPPL), and any areas on the site where infiltration rate is greater than 2.4 inches per hour. The Plans shall identify the drainage areas for both existing and proposed conditions at a scale that enables verification of supporting calculations.

As noted in the Checklist, the Stormwater Management Report shall document compliance with each of the Stormwater Management Standards as provided in the Massachusetts Stormwater Handbook. The soils evaluation and calculations shall be done using the methodologies set forth in Volume 3 of the Massachusetts Stormwater Handbook.

To ensure that the Stormwater Report is complete, applicants are required to fill in the Stormwater Report Checklist by checking the box to indicate that the specified information has been included in the Stormwater Report. If any of the information specified in the checklist has not been submitted, the applicant must provide an explanation. The completed Stormwater Report Checklist and Certification must be submitted with the Stormwater Report.

[1] The Stormwater Report may also include the Illicit Discharge Compliance Statement required by Standard 10. If not included in the Stormwater Report, the Illicit Discharge Compliance Statement must be submitted prior to the discharge of stormwater runoff to the post-construction best management practices.

[2] For some complex projects, it may not be possible to include the Construction Period Erosion and Sedimentation Control Plan in the Stormwater Report. In that event, the issuing authority has the discretion to issue an Order of Conditions that approves the project and includes a condition requiring the proponent to submit the Construction Period Erosion and Sedimentation Control Plan before commencing any land disturbance activity on the site.

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

B. Stormwater Checklist and Certification

The following checklist is intended to serve as a guide for applicants as to the elements that ordinarily need to be addressed in a complete Stormwater Report. The checklist is also intended to provide conservation commissions and other reviewing authorities with a summary of the components necessary for a comprehensive Stormwater Report that addresses the ten Stormwater Standards.

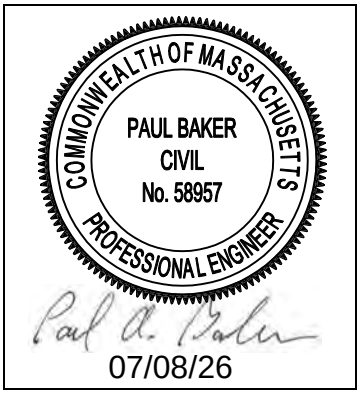
Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the item is not applicable (N.A.) and provide the reasons for that determination.

A complete checklist must include the Certification set forth below signed by the Registered Professional Engineer who prepared the Stormwater Report.

Registered Professional Engineer's Certification

I have reviewed the Stormwater Report, including the soil evaluation, computations, Long-term Pollution Prevention Plan, the Construction Period Erosion and Sedimentation Control Plan (if included), the Long-term Post-Construction Operation and Maintenance Plan, the Illicit Discharge Compliance Statement (if included) and the plans showing the stormwater management system, and have determined that they have been prepared in accordance with the requirements of the Stormwater Management Standards as further elaborated by the Massachusetts Stormwater Handbook. I have also determined that the information presented in the Stormwater Checklist is accurate and that the information presented in the Stormwater Report accurately reflects conditions at the site as of the date of this permit application.

Registered Professional Engineer Block and Signature



Paul Baker Digitally signed by Paul Baker DN: C=US, E=pbaker@audubooncompanies.com, O=Audubon Engineering, OU=Civil / Structural Engineer, CN=Paul Baker Reason: I am approving this document Date: 2026.07.02 21:04:05-05'00' 07/08/2026

Signature and Date

Checklist

Project Type: Is the application for new development, redevelopment, or a mix of new and redevelopment?

☐ New development

☐ Redevelopment

☐ Mix of New Development and Redevelopment

Checklist for Stormwater Report

Checklist (continued)

LID Measures: Stormwater Standards require LID measures to be considered. Document what environmentally sensitive design and LID Techniques were considered during the planning and design of the project:

- [X] No disturbance to any Wetland Resource Areas
- [ ] Site Design Practices (e.g. clustered development, reduced frontage setbacks)
- [ ] Reduced Impervious Area (Redevelopment Only)
- [ ] Minimizing disturbance to existing trees and shrubs
- [ ] LID Site Design Credit Requested:
  - [ ] Credit 1
  - [ ] Credit 2
  - [ ] Credit 3
- [ ] Use of "country drainage" versus curb and gutter conveyance and pipe
- [ ] Bioretention Cells (includes Rain Gardens)
- [ ] Constructed Stormwater Wetlands (includes Gravel Wetlands designs)
- [ ] Treebox Filter
- [ ] Water Quality Swale
- [X] Grass Channel
- [ ] Green Roof
- [X] Other (describe): Infiltration Basins

Standard 1: No New Untreated Discharges

- [X] No new untreated discharges
- [X] Outlets have been designed so there is no erosion or scour to wetlands and waters of the Commonwealth
- [X] Supporting calculations specified in Volume 3 of the Massachusetts Stormwater Handbook included.

Checklist for Stormwater Report

Checklist (continued)

Standard 2: Peak Rate Attenuation

☐ Standard 2 waiver requested because the project is located in land subject to coastal storm flowage and stormwater discharge is to a wetland subject to coastal flooding.

☐ Evaluation provided to determine whether off-site flooding increases during the 100-year 24-hour storm.

☒ Calculations provided to show that post-development peak discharge rates do not exceed pre-development rates for the 2-year and 10-year 24-hour storms. If evaluation shows that off-site flooding increases during the 100-year 24-hour storm, calculations are also provided to show that post-development peak discharge rates do not exceed pre-development rates for the 100-year 24-hour storm.

Standard 3: Recharge

☒ Soil Analysis provided.

☒ Required Recharge Volume calculation provided.

☐ Required Recharge volume reduced through use of the LID site Design Credits.

☒ Sizing the infiltration, BMPs is based on the following method: Check the method used.

☒ Static ☐ Simple Dynamic ☐ Dynamic Field[1]

☐ Runoff from all impervious areas at the site discharging to the infiltration BMP.

☒ Runoff from all impervious areas at the site is *not* discharging to the infiltration BMP and calculations are provided showing that the drainage area contributing runoff to the infiltration BMPs is sufficient to generate the required recharge volume.

☒ Recharge BMPs have been sized to infiltrate the Required Recharge Volume.

☐ Recharge BMPs have been sized to infiltrate the Required Recharge Volume *only* to the maximum extent practicable for the following reason:

- ☐ Site is comprised solely of C and D soils and/or bedrock at the land surface
- ☐ M.G.L. c. 21E sites pursuant to 310 CMR 40.0000
- ☐ Solid Waste Landfill pursuant to 310 CMR 19.000
- ☐ Project is otherwise subject to Stormwater Management Standards only to the maximum extent practicable.

☒ Calculations showing that the infiltration BMPs will drain in 72 hours are provided.

☐ Property includes a M.G.L. c. 21E site or a solid waste landfill and a mounding analysis is included.

[1] 80% TSS removal is required prior to discharge to infiltration BMP if Dynamic Field method is used.

Checklist for Stormwater Report

Checklist (continued)

Standard 3: Recharge (continued)

☐ The infiltration BMP is used to attenuate peak flows during storms greater than or equal to the 10-year 24-hour storm and separation to seasonal high groundwater is less than 4 feet and a mounding analysis is provided.

☐ Documentation is provided showing that infiltration BMPs do not adversely impact nearby wetland resource areas.

Standard 4: Water Quality

The Long-Term Pollution Prevention Plan typically includes the following:

- Good housekeeping practices;
- Provisions for storing materials and waste products inside or under cover;
- Vehicle washing controls;
- Requirements for routine inspections and maintenance of stormwater BMPs;
- Spill prevention and response plans;
- Provisions for maintenance of lawns, gardens, and other landscaped areas;
- Requirements for storage and use of fertilizers, herbicides, and pesticides;
- Pet waste management provisions;
- Provisions for operation and management of septic systems;
- Provisions for solid waste management;
- Snow disposal and plowing plans relative to Wetland Resource Areas;
- Winter Road Salt and/or Sand Use and Storage restrictions;
- Street sweeping schedules;
- Provisions for prevention of illicit discharges to the stormwater management system;
- Documentation that Stormwater BMPs are designed to provide for shutdown and containment in the event of a spill or discharges to or near critical areas or from LUHPPL;
- Training for staff or personnel involved with implementing Long-Term Pollution Prevention Plan;
- List of Emergency contacts for implementing Long-Term Pollution Prevention Plan.

☒ A Long-Term Pollution Prevention Plan is attached to Stormwater Report and is included as an attachment to the Wetlands Notice of Intent.

☒ Treatment BMPs subject to the 44% TSS removal pretreatment requirement and the one inch rule for calculating the water quality volume are included, and discharge:

- ☐ is within the Zone II or Interim Wellhead Protection Area
- ☐ is near or to other critical areas
- ☒ is within soils with a rapid infiltration rate (greater than 2.4 inches per hour)
- ☐ involves runoff from land uses with higher potential pollutant loads.

☐ The Required Water Quality Volume is reduced through use of the LID site Design Credits.

☒ Calculations documenting that the treatment train meets the 80% TSS removal requirement and, if applicable, the 44% TSS removal pretreatment requirement, are provided.

Checklist for Stormwater Report

Checklist (continued)

Standard 4: Water Quality (continued)

☒ The BMP is sized (and calculations provided) based on:

- ☒ The ½" or 1" Water Quality Volume or
- ☐ The equivalent flow rate associated with the Water Quality Volume and documentation is provided showing that the BMP treats the required water quality volume.

☐ The applicant proposes to use proprietary BMPs, and documentation supporting use of proprietary BMP and proposed TSS removal rate is provided. This documentation may be in the form of the propriety BMP checklist found in Volume 2, Chapter 4 of the Massachusetts Stormwater Handbook and submitting copies of the TARP Report, STEP Report, and/or other third party studies verifying performance of the proprietary BMPs.

☐ A TMDL exists that indicates a need to reduce pollutants other than TSS and documentation showing that the BMPs selected are consistent with the TMDL is provided.

Standard 5: Land Uses With Higher Potential Pollutant Loads (LUHPPLs)

☐ The NPDES Multi-Sector General Permit covers the land use and the Stormwater Pollution Prevention Plan (SWPPP) has been included with the Stormwater Report.

☐ The NPDES Multi-Sector General Permit covers the land use and the SWPPP will be submitted ***prior to*** the discharge of stormwater to the post-construction stormwater BMPs.

☒ The NPDES Multi-Sector General Permit does ***not*** cover the land use.

☐ LUHPPLs are located at the site and industry specific source control and pollution prevention measures have been proposed to reduce or eliminate the exposure of LUHPPLs to rain, snow, snow melt and runoff, and been included in the long term Pollution Prevention Plan.

☐ All exposure has been eliminated.

☐ All exposure has ***not*** been eliminated and all BMPs selected are on MassDEP LUHPPL list.

☐ The LUHPPL has the potential to generate runoff with moderate to higher concentrations of oil and grease (e.g. all parking lots with >1000 vehicle trips per day) and the treatment train includes an oil grit separator, a filtering bioretention area, a sand filter or equivalent.

Standard 6: Critical Areas

☐ The discharge is near or to a critical area and the treatment train includes only BMPs that MassDEP has approved for stormwater discharges to or near that particular class of critical area.

☐ Critical areas and BMPs are identified in the Stormwater Report.

Checklist for Stormwater Report

Checklist (continued)

Standard 7: Redevelopments and Other Projects Subject to the Standards only to the maximum extent practicable

☐ The project is subject to the Stormwater Management Standards only to the maximum Extent Practicable as a:

- ☐ Limited Project
- ☐ Small Residential Projects: 5-9 single family houses or 5-9 units in a multi-family development provided there is no discharge that may potentially affect a critical area.
- ☐ Small Residential Projects: 2-4 single family houses or 2-4 units in a multi-family development with a discharge to a critical area
- ☐ Marina and/or boatyard provided the hull painting, service and maintenance areas are protected from exposure to rain, snow, snow melt and runoff
- ☐ Bike Path and/or Foot Path
- ☐ Redevelopment Project
- ☐ Redevelopment portion of mix of new and redevelopment.

☐ Certain standards are not fully met (Standard No. 1, 8, 9, and 10 must always be fully met) and an explanation of why these standards are not met is contained in the Stormwater Report.

☐ The project involves redevelopment and a description of all measures that have been taken to improve existing conditions is provided in the Stormwater Report. The redevelopment checklist found in Volume 2 Chapter 3 of the Massachusetts Stormwater Handbook may be used to document that the proposed stormwater management system (a) complies with Standards 2, 3 and the pretreatment and structural BMP requirements of Standards 4-6 to the maximum extent practicable and (b) improves existing conditions.

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control

A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan must include the following information:

- Narrative;
- Construction Period Operation and Maintenance Plan;
- Names of Persons or Entity Responsible for Plan Compliance;
- Construction Period Pollution Prevention Measures;
- Erosion and Sedimentation Control Plan Drawings;
- Detail drawings and specifications for erosion control BMPs, including sizing calculations;
- Vegetation Planning;
- Site Development Plan;
- Construction Sequencing Plan;
- Sequencing of Erosion and Sedimentation Controls;
- Operation and Maintenance of Erosion and Sedimentation Controls;
- Inspection Schedule;
- Maintenance Schedule;
- Inspection and Maintenance Log Form.

☒ A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan containing the information set forth above has been included in the Stormwater Report.

Checklist for Stormwater Report

Checklist (continued)

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control (continued)

☐ The project is highly complex and information is included in the Stormwater Report that explains why it is not possible to submit the Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan with the application. A Construction Period Pollution Prevention and Erosion and Sedimentation Control has ***not*** been included in the Stormwater Report but will be submitted ***before*** land disturbance begins.

☒ The project is ***not*** covered by a NPDES Construction General Permit.

☐ The project is covered by a NPDES Construction General Permit and a copy of the SWPPP is in the Stormwater Report.

☐ The project is covered by a NPDES Construction General Permit but no SWPPP been submitted. The SWPPP will be submitted BEFORE land disturbance begins.

Standard 9: Operation and Maintenance Plan

☒ The Post Construction Operation and Maintenance Plan is included in the Stormwater Report and includes the following information:

- ☒ Name of the stormwater management system owners;
- ☒ Party responsible for operation and maintenance;
- ☒ Schedule for implementation of routine and non-routine maintenance tasks;
- ☒ Plan showing the location of all stormwater BMPs maintenance access areas;
- ☒ Description and delineation of public safety features;
- ☒ Estimated operation and maintenance budget; and
- ☒ Operation and Maintenance Log Form.

☐ The responsible party is ***not*** the owner of the parcel where the BMP is located and the Stormwater Report includes the following submissions:

- ☐ A copy of the legal instrument (deed, homeowner's association, utility trust or other legal entity) that establishes the terms of and legal responsibility for the operation and maintenance of the project site stormwater BMPs;
- ☐ A plan and easement deed that allows site access for the legal entity to operate and maintain BMP functions.

Standard 10: Prohibition of Illicit Discharges

☐ The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges;

☒ An Illicit Discharge Compliance Statement is attached;

☐ NO Illicit Discharge Compliance Statement is attached but will be submitted ***prior to*** the discharge of any stormwater to post-construction BMPs.

2 Stormwater Report Narrative

This stormwater report has been prepared to demonstrate compliance with the Massachusetts Stormwater Management Standards in accordance with the Massachusetts Wetland Protection Act Regulations (310 CMR 10.00). This report also demonstrates compliance with the Cape Cod Commission.

2.1 Project Description

The proposed project is part of the Massachusetts Department of Transportation (MassDOT) Cape Cod Canal Bridges Replacement Project and involves the construction of a new greenfield Metering and Regulating (M&R) Station at the Bourne Rotary in Bourne, Massachusetts.

The purpose of the project is to relocate existing gas infrastructure to maintain uninterrupted delivery of natural gas to National Grid and its customers during and after bridge replacement activities. The new facility will replace impacted infrastructure and support continued operation of the regional gas transmission system.

The proposed M&R station will include process and support equipment such as a filter separator, meter and control valve skids, regulator systems, water bath heaters, and an odorization system, along with associated electrical, control, and utility systems. Site development will include clearing, grading, access roads, equipment pads, and stormwater management infrastructure designed to meet applicable regulatory requirements.

2.1.1 Site Description

The project site is located near the Bourne Rotary along Route 28 (MacArthur Boulevard) in Bourne, Barnstable County, Massachusetts. The surrounding area consists primarily of undeveloped woodland with nearby roadway infrastructure and commercial properties to the west.

The site is currently undeveloped and consists of wooded land with an existing utility corridor and access road along the southern portion of the site. Existing drainage is characterized by pervious surfaces with runoff conveyed via sheet flow generally toward the west.

Topography across the site is generally a relatively flat plateau with localized slopes descending toward surrounding woodland areas. Subsurface conditions generally consist of a thin layer of topsoil and subsoil underlain by native sand deposits, with occasional cobbles and boulders present.

Groundwater was not observed during subsurface investigations, although seasonal variations may occur.

2.2.1 Wetland Resources

SWCA conducted a wetland delineation on the subject property in February 2025. No federal or state jurisdictional wetlands are located on the site or access roads.

.

2.2.2 Subsurface Soil Investigations

The Natural Resources Conservation Service (NRCS) identifies the soils at the Project Site as Plymouth loamy coarse sand (Map Unit #435B). The USDA NRCS soil report is included in Attachment C. Soil infiltration characteristics were evaluated using NRCS Web Soil Survey mapping and conservative design assumptions for infiltration BMP sizing.

In general, subsurface soil conditions at the Site consist of a thin organic surface layer underlain by loamy coarse sand, transitioning to coarse sand and gravelly sand deposits at depth, derived from glaciofluvial outwash materials.

The mapped soils are characterized as excessively drained with moderately high to very high permeability, and no restrictive layer was identified within at least 80 inches below ground surface.

- Groundwater was not encountered within the mapped soil profile, and the NRCS data indicates a depth to water table greater than 80 inches. Groundwater conditions may vary seasonally and with precipitation and should be considered approximate.
- Due to the Project not requiring sanitary sewer or septic system design, infiltration testing was not performed.
- Due to the coarse-grained nature of the soils, low available water capacity, and site slopes (approximately 3 to 8 percent), disturbed areas may be susceptible to erosion and sediment transport during storm events, and appropriate erosion and sediment controls will be implemented in accordance with the SWPPP.

2.2 Existing Drainage Conditions

The project site encompasses approximately 1.68 acres and is currently heavily wooded and undeveloped. Access to the site is provided by an existing unpaved roadway. Based on available NRCS Soil Survey mapping, the site consists entirely of Plymouth loamy coarse sand, which is classified as Hydrologic Soil Group A.

Site topography is variable, as the property is situated along a ridgeline that directs runoff in multiple directions. Stormwater runoff generally sheds to the east, northwest, southwest, and south, following natural topographic gradients across the forested landscape. Several subtle ridgelines and shallow topographic depressions influence runoff patterns throughout the site, creating localized drainage divides. While these depressions provide minor temporary surface storage during runoff events, they are generally poorly defined and do not exhibit concentrated or channelized flow. Runoff ultimately drains toward roadside swales associated with the existing access roadway or to natural low points adjacent to the ridgeline where more defined drainage pathways occur.

Under existing conditions, the site is divided into six drainage areas based on the minor ridgelines and localized depressions that influence runoff direction across the property. Drainage Areas E01 and E05 drain northwest toward shallow depressional areas. Drainage Areas E04 and E06 drain westward to localized depressions situated along the western side of the ridgeline. Drainage Area E02 drains eastward to a shallow depression, while Drainage Area E03 drains south toward an offsite wetland located approximately 800 feet from the project limits. For the purpose of

comparing existing and proposed runoff conditions, the existing drainage model was developed using analysis points at Drainage Areas E01, E02, E03, and E04. These locations correspond to the anticipated overflow points of the proposed stormwater management system during larger storm events and provide consistent comparison points between pre- and post-development peak discharge calculations. Existing times of concentration were developed to correspond with the proposed drainage configurations and anticipated runoff flow paths.

No formal stormwater management facilities or drainage infrastructure are present on the site. Due to the undeveloped and heavily vegetated nature of the property, stormwater runoff is conveyed primarily as shallow sheet flow through the wooded landscape, with no evidence of well-defined concentrated flow channels within the project limits.

A plan depicting Existing Drainage Conditions is included in Attachment A

Table 1 - Existing Conditions Hydrologic Data

Drainage Area	Area (acres)	Design Event	Curve Number	Time of Concentration (min)	Existing Outlet Discharge (cfs)
E01	0.42	8.8 in, 50Year (2070)	43	39.1	0.42
E02	0.37	8.8 in, 50Year (2070)	43	19.5	0.49
E03	0.36	8.8 in, 50Year (2070)	43	36.7	0.37
E04	0.36	8.8 in, 50Year (2070)	43	31.6	0.39

2.3 Proposed Drainage Conditions

Under proposed conditions, approximately 1.68 acres of the site will be developed with the construction of a gravel pad and associated access improvements. The proposed stormwater management system has been designed to incorporate a treatment train approach consisting of vegetated swales, pretreatment forebays, and infiltration basins. These BMPs provide runoff attenuation, groundwater recharge, sediment removal, and water quality treatment while maintaining drainage patterns generally consistent with existing site conditions.

Proposed grading will selectively clear and regrade portions of the site to direct runoff toward defined collection, conveyance, and treatment systems. Stormwater runoff will be conveyed by a combination of sheet flow, vegetated swales. Each infiltration basin has been designed to provide primary storage and infiltration, with overflow from larger storm events discharged in a controlled manner as stabilized sheet flow along existing downgradient flow paths.

Under proposed conditions, the site is divided into five primary drainage areas associated with the proposed improvements.

Drainage Area A1 encompasses the northwestern portion of the proposed development. Runoff from this area will be conveyed by two vegetated swales to a pretreatment forebay prior to discharging into Infiltration Basin 1. During larger storm events, runoff exceeding the storage

capacity of the basin will discharge in a controlled manner as sheet flow along existing downgradient flow paths.

Drainage Area A2 encompasses the eastern portion of the site. Runoff from this area will be collected by two vegetated swales that converge at a centralized pretreatment forebay. The forebay is designed with weirs on either side to distribute flow to two infiltration basins, Infiltration Basin 2A and Infiltration Basin 2B, which will operate simultaneously to provide storage, infiltration, groundwater recharge, and water quality treatment. Infiltration Basin 2A will also receive a portion of offsite runoff from the northeast. During larger storm events, overflow from these basins will be conveyed as stabilized sheet flow toward downgradient areas consistent with existing drainage patterns.

Drainage Area A3 encompasses the southern portion of the proposed development. Runoff from this area will be conveyed by a vegetated swale to a pretreatment forebay before entering Infiltration Basin 3. During larger storm events, overflow from the basin will discharge as sheet flow to the south, consistent with existing downgradient drainage patterns.

Drainage Area A4 encompasses the western portion of the site. Runoff will be routed through a vegetated swale to a pretreatment forebay and subsequently discharged to Infiltration Basin 4. During larger storm events, overflow from the basin will be conveyed as stabilized sheet flow toward downgradient areas consistent with existing drainage patterns.

Drainage Area A5 is associated with the proposed access roadway corridor. The roadway will be graded with a continuous cross slope to direct runoff toward a vegetated roadside swale. Due to the existing terrain and proposed roadway grading, stormwater runoff will be conveyed through the swale by a series of rock check dams designed to reduce flow velocities, minimize erosive conditions, and promote infiltration along the drainage path. A riprap apron will be provided at the downstream end of the vegetated swale to safely dissipate flow energy and discharge runoff to the natural terrain. The design information for the roadside ditch and internal swales mentioned above for the other drainage areas is provided in Table 6.

Overall, the proposed stormwater management system formalizes existing drainage patterns while incorporating infiltration-based BMPs, vegetated conveyance systems, pretreatment forebays, and infiltration basins to improve groundwater recharge, provide water quality treatment, and reduce post-development peak discharge rates. No adverse impacts to downgradient properties or natural resource areas are anticipated. A drawing of the Proposed Drainage Conditions is provided in Attachment A

Table 2 - Proposed Conditions Hydrologic Data

Drainage Area	Discharge Location	Design Event	Existing Area Distributions (acres)	Area (acres)	Curve Number	Time of Concentration (min)	Proposed Outlet Discharge (cfs)
A1	North	8.8 in, 50Year (2070)	E01(0.26) + E04(0.15) + E05(0.20)	0.61	76	6.0	0.38

Drainage Area	Discharge Location	Design Event	Existing Area Distributions (acres)	Area (acres)	Curve Number	Time of Concentration (min)	Proposed Outlet Discharge (cfs)
A2	East	8.8 in, 50Year (2070)	E01 (0.15) + E02(0.32) + E03(0.01)	0.48	76	6.0	0.47
A3	South	8.8 in, 50Year (2070)	E01(0.01) + E02(0.04) +E03 (0.33) + E04 (0.1)	0.39	76	6.0	0.11
A4	West	8.8 in, 50Year (2070)	E03 (0.03) + E04 (0.20)	0.23	76	6.0	0.08



Name: WGS 1984 Web Mercator Auxiliary Sphere
PCS: WGS 1984 Web Mercator Auxiliary Sphere; Authority: EPSG; WKID: 3857

0 12.5 25 50 Miles

FIGURE 1		SITE LOCATION MAP	Rev. No: 2
Drawn By: MH	Approved By: SR	CAPE COD CANAL PIPELINE REPLACEMENT PROJECT BOURNE ROTARY METER STATION BOURNE, MA	Rev. By:
Date: 6/24/26	Job No:	N	Rev. Date: 6/25/26
Sheet No: ___ of ___		audubon	Revision Description, Per OCM Request:



Name: WGS 1984 Web Mercator Auxiliary Sphere
PCS: WGS 1984 Web Mercator Auxiliary Sphere; Authority: EPSG; WKID: 3857

0 12.5 25 50 Miles

FIGURE 2		SITE LOCATION MAP	Rev. No: 2
Drawn By: MH	Approved By: SR	CAPE COD CANAL PIPELINE REPLACEMENT PROJECT BOURNE ROTARY METER STATION BOURNE, MA	Rev. By:
Date: 6/24/26	Job No:	N	Rev. Date: 6/25/26
Sheet No: ___ of ___		audubon	Revision Description, Per OCM Request:

3 Regulatory Compliance

3.1 Massachusetts Department of Environmental Protection (DEP) – Stormwater Management Standards

As demonstrated in the sections below, the proposed Project Complies with the DEP Stormwater Management Standards.

3.1.1 Standard 1: No New Untreated Discharges or Erosion to Wetlands

The Project has been designed to comply with Standard 1

The Best Management Practices (BMPs) included in the proposed stormwater management system have been designed in accordance with the Massachusetts Stormwater Handbook (MSH). Supporting information and computation demonstrating that no new untreated discharges will result from the Project are presented through compliance with Standards 4 through 6.

All proposed Project Stormwater Outlets and conveyances have been designed to not cause erosion or scour to wetlands or receiving waters.

Computations and supporting information for the sizing and selection of materials used to protect from scour and erosion are included in Attachment B.

3.1.2 Standard 2: Peak Rate Attenuation

The Project has been designed to comply with Standard 2. The project is not subject to coastal storm flowage; the Project is proposing to reduce peak flow rates from existing to proposed conditions. Future precipitation conditions were evaluated using projected 2070 rainfall depths in accordance with current guidance.

A hydrologic and hydraulic model was developed using Autodesk Storm and Sanitary Analysis (SSA) to evaluate the existing and proposed drainage conditions for the Site. The analysis utilizes the NRCS TR-20 hydrologic methodology, with time of concentration (Tc) calculated in accordance with NRCS TR-55 procedures, and a minimum Tc of 6 minutes applied across all subcatchments. Runoff hydrographs were generated using the NRCS dimensionless unit hydrograph approach, and hydraulic routing was performed using dynamic (hydrodynamic) wave routing within the SSA model. The results of the analyses indicate that there is no increase in peak discharge rates between pre- and post-development conditions at the evaluated design points for the 2-, 10-, 25-, 50-, and 100-year storm events, as well as the 50-year (2070) climate-adjusted storm event. Rainfall distributions utilized in the analysis are based on the NRCS Type III storm distribution. Precipitation depths for each storm event were obtained from the NOAA Atlas 14, Volume 10. Runoff curve numbers (CNs) for both existing and proposed conditions, as summarized in Tables 1 and 2, were determined in accordance with NRCS TR-55 methodology. Detailed model input parameters, assumptions, and computational results are provided in Attachment C.

Table 3 -NOAA Atlas 14 Volume 10 Design Depths for the 24 Hour Storm (inches)

2-year	10-year	25-year	50-year	100-year	50yr-2070
3.43	5.01	5.99	6.74	7.51	8.80

Table 4 - Peak Discharge Rates

Proposed Area	Storm Event	Design Point	Existing Areas (Acre)	Existing Peak Discharge (cfs)	Proposed Area (Acre)	Proposed Peak Discharge (cfs)
A1	2-year	DP-1	(Area -E01) - 0.42	0.00	A1-0.61	0.00
	10-year	DP-1	(Area -E01) - 0.42	0.04	A1-0.61	0.00
	25-year	DP-1	(Area -E01) - 0.42	0.10	A1-0.61	0.02
	50-year	DP-1	(Area -E01) - 0.42	0.17	A1-0.61	0.07
	100-year	DP-1	(Area -E01) - 0.42	0.25	A1-0.61	0.15
	50-year 2070	DP-1	(Area -E01) - 0.42	0.42	A1-0.61	0.38

Proposed Area	Storm Event	Design Point	Existing Areas (Acre)	Existing Peak Discharge (cfs)	Proposed Area (Acre)	Proposed Peak Discharge (cfs)
A2	2-year	DP-2	(Area E02) - 0.37	0.00	A2-0.48	0.00
	10-year	DP-2	(Area E02) - 0.37	0.04	A2-0.48	0.00
	25-year	DP-2	(Area E02) - 0.37	0.12	A2-0.48	0.05
	50-year	DP-2	(Area E02) - 0.37	0.19	A2-0.48	0.10
	100-year	DP-2	(Area E02) - 0.37	0.29	A2-0.48	0.18
	50-year 2070	DP-2	(Area E02) - 0.37	0.49	A2-0.48	0.47

Proposed Area	Storm Event	Design Point	Existing Areas (Acre)	Existing Peak Discharge (cfs)	Proposed Area (Acre)	Proposed Peak Discharge (cfs)
A3	2-year	DP-3	(Area E03) - 0.36	0.00	A3-0.39	0.00
	10-year	DP-3	(Area E03) - 0.36	0.03	A3-0.39	0.00
	25-year	DP-3	(Area E03) - 0.36	0.09	A3-0.39	0.00
	50-year	DP-3	(Area E03) - 0.36	0.15	A3-0.39	0.00
	100-year	DP-3	(Area E03) - 0.36	0.22	A3-0.39	0.02
	50-year 2070	DP-3	(Area E03) - 0.36	0.37	A3-0.39	0.11

Proposed Area	Storm Event	Design Point	Existing Areas (Acre)	Existing Peak Discharge (cfs)	Proposed Area (Acre)	Proposed Peak Discharge (cfs)
A4	2-year	DP-4	(Area E04) - 0.36	0.00	A4-0.23	0.00
	10-year	DP-4	(Area E04) - 0.36	0.04	A4-0.23	0.00
	25-year	DP-4	(Area E04) - 0.36	0.10	A4-0.23	0.00
	50-year	DP-4	(Area E04) - 0.36	0.16	A4-0.23	0.09
	100-year	DP-4	(Area E04) - 0.36	0.24	A4-0.23	0.11
	50-year 2070	DP-4	(Area E04) - 0.36	0.39	A4-0.23	0.08

3.1.3 Standard 3: Stormwater Recharge

The Project has been designed to comply with Standard 3 of the Massachusetts Stormwater Management Standards. In accordance with the Massachusetts Stormwater Handbook, the required recharge volume for the site is 2,208.85 cubic feet. Recharge of stormwater is provided through a series of best infiltration management practices, including multiple infiltration basins distributed across the site. The infiltration systems have been sized using the Static Method, with infiltration calculated based on the bottom area of each basin. Each infiltration BMP has been designed to fully dewater within 72 hours. Supporting drawdown calculations for each basin are provided in Appendix D, and a summary of the proposed infiltration BMPs is included in Table 5.

In the absence of site-specific geotechnical infiltration testing, design infiltration rates were estimated using published NRCS Web Soil Survey data for the mapped on-site soil unit (Plymouth loamy coarse sand, Map Unit 435B, Hydrologic Soil Group A). A saturated hydraulic conductivity (Ksat) value was obtained for the representative soil horizon and converted to inches per hour. A factor of safety of 2 was applied to the published infiltration rate to account for variability and uncertainty associated with generalized soil data.

The resulting design infiltration rate is approximately 2.625 inches per hour. This value reflects the most limiting anticipated soil conditions at the proposed infiltration interfaces and is intended to ensure reliable long-term performance in the absence of field verification. This assumed design infiltration rate was utilized in the project's drawdown analysis to evaluate dewatering performance and confirm compliance with required drawdown timeframes. Refer to the drawdown analysis for detailed calculations.

Table 5 - Summary of Recharge Calculations

Infiltration Basin	Provided Volume (cf)
1	7492.88
2A	3605.29
2B	2134.46
3	5941.50
4	3530.59
5	0.00
Total Provided Recharge	22704.72
Total Required Recharge	2208.85

Table 6 - Drainage Swale Design Summary

Drainage area	Peak flow (cfs) 2070 - 50 Year Event	Capacity	Max depth (ft)	Slope (%)	Velocity(ft/s)	Section Geometry
A1 West	0.96	4.95	1.00	0.50	2.46	Triangular, side slope max 2:1
A1 North	1.57	3.81	0.80	0.30	1.90	Triangular, side slope max 2:1
A2 East 1	1.04	5.94	1.00	0.30	1.98	Triangular, side slope max 3:1
A2 East2	0.54	5.94	1.00	0.30	1.98	Triangular, side slope max 3:1
A2 Road	0.54	3.81	1.00	0.30	1.90	Triangular, side slope max 2:1
A3	1.69	4.92	1.00	0.50	2.46	Triangular, side slope max 2:1
A4	0.73	1.34	0.50	1.50	2.68	Triangular, side slope max 2:1
A5	0.66	2.31	0.50	4.50	4.64	Triangular, side slope max 2:1

3.1.4 Standard 4: Water Quality

The Project has been designed to comply with Standard 4.

During construction of the project a comprehensive stormwater management system that includes; fiber rolls and silt-fence for slope and parameter control, a stabilized construction entrance to minimize off-site transport of sediment on to local roadways, inlet protection to prevent sediment from entering the existing roadway stormwater management system, and a dedicated concrete washout and containment area.

Following construction, permanent stormwater BMPs will include Vegetative Swales to minimize sediment transport, Sediment Forebays as pre-treatment, Riprap Aprons for outlet protection, and Stabilized Riprap Slopes to prevent potential future erosion. To control stormwater along the permanent access roads, a series of stone check dams and level spreaders will be installed.

Treatment Train

Swales → Forebays → Infiltration Basins → Overflow

Roles:

- Vegetated swales provide conveyance and initial filtration.
- Sediment forebays provide pretreatment and sediment capture.
- Infiltration basins provide primary water quality treatment and recharge.

Pretreatment is provided upstream of infiltration BMPs through sediment forebays and vegetated conveyance systems in accordance with MassDEP Stormwater Handbook guidance.

The Massachusetts Stormwater Handbook assigns an 80% TSS removal credit to infiltration basins. Additional guidance and literature sources indicate that infiltration systems may achieve higher removal efficiencies under favorable site conditions.

Computations and supporting information, including the Long-Term Pollution Prevention Plan, are included in Attachment D

3.1.5 Standard 5: Land Uses and High Potential Pollutant Loads (LUHPPLs)

The proposed facility does not include industrial process areas or outdoor pollutant handling activities that would constitute a LUHPPL under the Massachusetts Stormwater Handbook.

Operational areas are limited and supported by spill prevention and maintenance procedures intended to minimize pollutant exposure to stormwater. While the Project is not considered a LUHPPL it has been designed with suitable BMPs sized to treat the 1-inch Water Quality Volume and 44% TSS pretreatment prior to infiltration.

For computations and supporting information regarding the sizing of BMPs suitable for treatment of runoff, see Attachment E.

3.1.6 Standard 6: Critical Areas

The Project will discharge treated storm water flow through a treatment train where all storm water will be contained within a properly scaled infiltration basin based on a 72-hour total infiltration rate. Overflow from the infiltration system occurs only during larger storm events exceeding the design storage volume. Overflow discharge is directed through stabilized riprap outlets and conveyed as shallow sheet flow across vegetated areas prior to reaching downgradient wetland resource areas. The stabilized and vegetated discharge pathway is intended to minimize erosive velocities, promote infiltration, and reduce sediment transport. There are no critical or sensitive (i.e wetlands) with or adjacent to the Project Site.

Proposed source controls and pollution prevention measures have been identified in the Long-Term Pollution Prevention Plan included in Attachment E.

3.1.7 Standard 7: Redevelopments and Other Projects Subject to the Standards only to the Maximum Extent Practicable

The Project has been designed to comply with all ten of the Stormwater Management Standards. Refer directly to each Standard for applicable computations and supporting information demonstrating compliance with each.

3.1.8 Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Controls

The Project is associated with regulated oil and gas transmission activities and is therefore not subject to coverage under the EPA NPDES Construction General Permit. Nevertheless, construction-period erosion and sediment controls and stormwater pollution prevention measures will be implemented consistent with applicable permitting requirements. During construction of the project a comprehensive stormwater management system that includes; fiber rolls and silt-fence for slope and parameter control, stormwater inlet protection where applicable, stabilized construction entrances to minimize off-site transport of sediment on to local roadways, and a dedicated concrete washout and containment area. Recommended construction period pollution prevention and erosion and sedimentation controls are included in Attachment E.

3.1.9 Standard 9: Operation and Maintenance Plan

In compliance with Standard 9, a Post-Construction Stormwater Operation and Maintenance (O&M) Plan has been developed for the Project to ensure the long-term functionality of the proposed stormwater management system. Following construction, permanent stormwater BMPs will include vegetated swales for conveyance and sediment reduction, sediment forebays for pretreatment and sediment capture, infiltration basins for recharge and water quality treatment,

riprap aprons for outlet protection, and stabilized riprap slopes to minimize the potential for future erosion.

The O&M Plan establishes inspection frequencies, maintenance procedures, and responsible parties for all stormwater BMPs. Vegetated swales, infiltration basins, and stabilized overflow areas will be inspected at least semi-annually and following major storm events to identify erosion, sediment accumulation, vegetation loss, debris buildup, or evidence of impaired drainage. Sediment forebays will be inspected quarterly and cleaned when sediment accumulation reaches approximately 50 percent of the forebay storage depth or otherwise impairs pretreatment performance. Infiltration basins will also be monitored for standing water, and if ponded water remains for greater than 72 hours following a storm event, the system will be evaluated for potential clogging and corrective maintenance performed as necessary.

Maintenance activities may include sediment and debris removal, stabilization of eroded areas, restoration of vegetative cover, and repair or replacement of damaged stabilization materials. Stabilized overflow and riprap outlet areas will be inspected following overflow-producing storm events to confirm that erosion, scour, or sediment transport has not occurred. Access to all stormwater BMPs will be maintained to facilitate inspection and maintenance activities throughout the operational life of the Project.

The O&M Plan is included in Attachment E as part of the Long-Term Pollution Prevention Plan.

3.1.10 Standard 10: Prohibition of Illicit Discharges

The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges. A copy of the Long-term Pollution Prevention Plan is included in Attachment E.

4 Local Municipal Rules and Regulations

As a FERC-regulated interstate natural gas pipeline, Algonquin Gas Transmission, LLC's proposed Project facilities are not subject to review under local ordinances and bylaws.

5 FEMA Floodplain

The project site, located within the Massachusetts Military Reservation in the Town of Bourne, Massachusetts, is situated within Zone X (Area of Minimal Flood Hazard) as defined by the Federal Emergency Management Agency (FEMA) National Flood Hazard Layer (NFHL) mapping.

Based on review of FEMA mapping and site location, the project lies entirely outside of the 1-percent-annual-chance floodplain (100-year floodplain) and outside all Special Flood Hazard Areas (SFHAs), including Zones AE, VE, and AO. Zone X represents areas of minimal flood hazard located outside both the 1-percent-annual-chance and 0.2-percent-annual-chance floodplains.

The nearest mapped flood zones are limited to isolated low-lying areas in the vicinity that are not designated as Special Flood Hazard Areas and are separated from the project area by distance and upland terrain. Zone AE floodplains with established Base Flood Elevations are not mapped within or near the project site.

Zone VE is not mapped in the vicinity of the project area and no coastal high hazard areas subject to wave action are present. Zone AO (shallow flooding areas) is also not mapped within or near the project site.

Given that the project is located entirely within Zone X, no portion of the site is subject to flooding during the 1-percent-annual-chance storm event, and the proposed work will not result in impacts to flood storage capacity, flood elevations, or flood conveyance.

Attachment A - Existing and Proposed Drainage Conditions

Existing Conditions



PROPOSED BOURNE ROTARY METER STATION SITE

EXISTING CONDITIONS PLAN

SCALE: 1" = 200'

0 200' 400'
Scale: 1" = 200'

N 27.65°
STATION NORTH

NOTES:

1. ALL CONTOUR LABELS AND ELEVATION CALLOUTS ARE IN FEET.
2. PROPOSED SITE BOUNDARY WAS PROVIDED BY ENBRIDGE 3RD PARTY CONSULTANT.
3. SUPPLEMENTAL TAX PARCEL DATA IS SHOWN FOR REFERENCE ONLY AND WAS OBTAINED FROM THE CAPE COD COMMISSION OPEN GIS DATA HUB WEBSITE.
4. PROPERTY CONVEYED TO ALGONQUIN GAS TRANSMISSION, LLC.
5. TOPOGRAPHIC SURVEY INFORMATION WAS PROVIDED BY ALGONQUIN GAS TRANSMISSION, LLC. ADDITIONAL CONTOUR DATA WAS OBTAINED FROM 2022 USGS LIDAR POINT CLOUD DATA SETS. ALL COORDINATES AND DISTANCES SHOWN HEREON ARE REFERENCED TO THE MASSACHUSETTS STATE PLANE COORDINATE SYSTEM, US FEET.ELEVATIONS ARE REFERENCED TO NAVD 88.
6. THIS PROPERTY IS LOCATED IN ZONE X (AREA OF MINIMAL FLOOD HAZARD) AS DEPICTED ON FLOOD INSURANCE RATE MAP 25001C0318K DATED JULY 6, 2021.
7. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THE SITE THERE IS NOT A WETLAND WITHIN 100 FEET OF THE PROJECT LIMITS.
8. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THE SITE IS NOT LOCATED WITHIN AN AREA OF CRITICAL ENVIRONMENTAL CONCERN.
9. THIS PLAN SET IS PRELIMINARY. FOR PERMITTING PURPOSES ONLY. THIS PLAN IS NOT INTENDED FOR CONSTRUCTION PURPOSES.

LEGEND

- EXISTING MAJOR CONTOUR 70'
- EXISTING MINOR CONTOUR 72'
- EDGE OF GRAVEL
- PROPERTY LINE
- GIS TAX PARCELS
- PIPELINE EASMENT
- 100' WETLAND BUFFER

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
No. 58957
PROFESSIONAL ENGINEER

07/07/26

ISSUED FOR PERMIT
07/07/2026

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		D	07/07/26	VN	DT	REISSUED FOR PERMIT
		C	06/29/26	VN	DT	ISSUED FOR PERMIT
		B	05/15/26	VN	DT	ISSUED FOR BID
		A	05/15/26	VN	DT	ISSUED FOR REVIEW

audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

TITLE	INITIALS	DATE
DRAWN BY:	VN	05/15/26
DESIGN CHECKER:	CR	07/07/26
DESIGN ENGINEER:	PB	07/07/26
PROJECT MANAGER:	AC	07/07/26

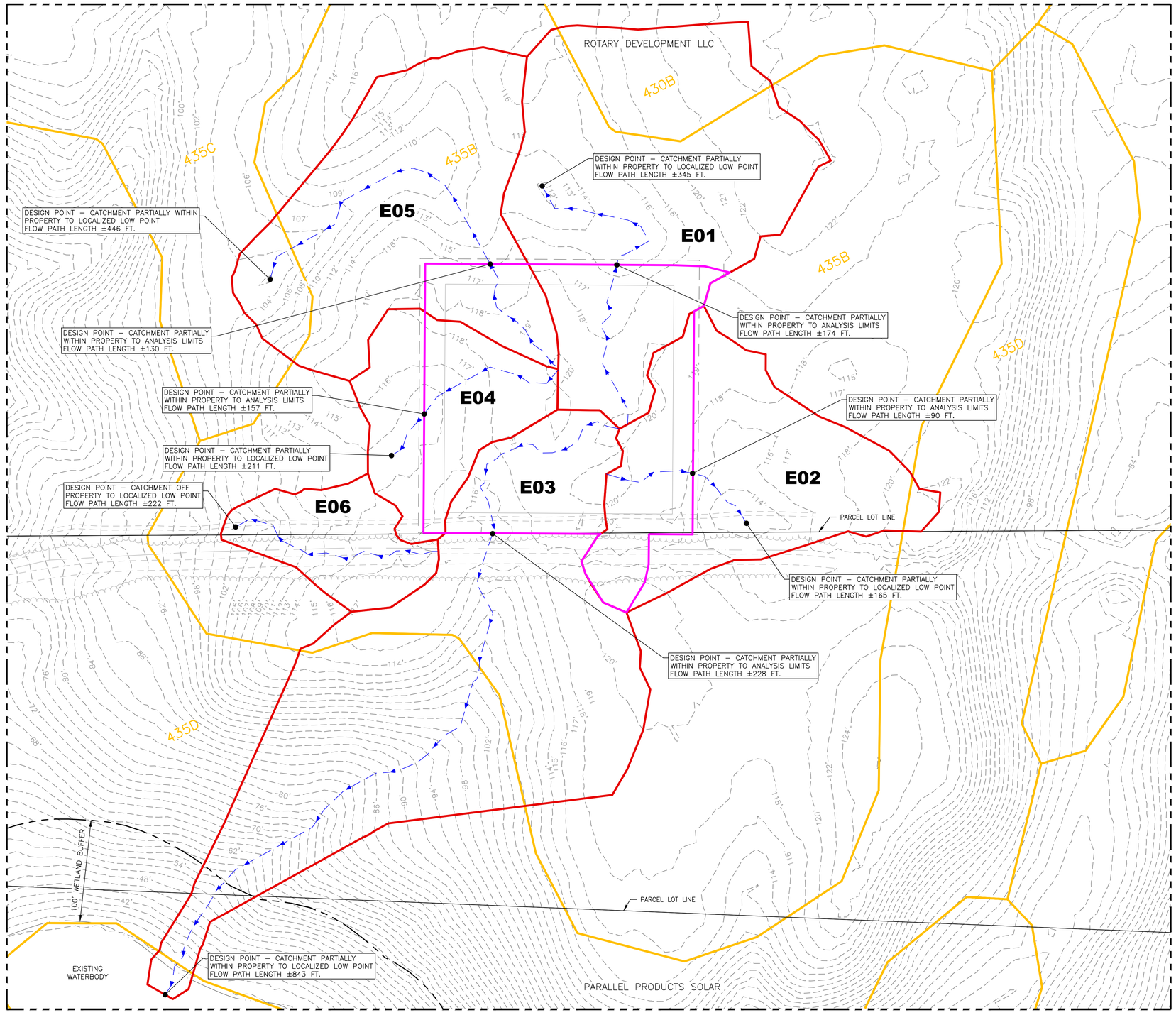
CAPE COD CANAL PIPELINE RELOCATION PROJECT
BOURNE ROTARY METER STATION
M&R 00846
TITLE: EXISTING CONDITIONS PLAN

LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

YEAR: 2026 | W.O.: | SCALE: 1"=200' | DWG.: 00846-C.320-0001 | REV.: D

ENBRIDGE
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

S:\AE\Projects\Enbridge\Mass\026356-001\200_Civil_Structural\170_Drawings\E&S Plans\Bourne Rotary\00846-C.320-0001.dwg - PLOT TIME: 7/6/2026 10:50 PM



PROPOSED BOURNE ROTARY METER STATION SITE

EXISTING SUBCATCHMENT AREAS PLAN

SCALE: 1" = 30'

0 50' 100'
Scale: 1" = 50'

N 27.65°
STATION NORTH

NOTES:

1. ALL CONTOUR LABELS AND ELEVATION CALLOUTS ARE IN FEET.
2. PROPOSED SITE BOUNDARY WAS PROVIDED BY ENBRIDGE 3RD PARTY CONSULTANT.
3. SUPPLEMENTAL TAX PARCEL DATA IS SHOWN FOR REFERENCE ONLY AND WAS OBTAINED FROM THE CAPE COD COMMISSION OPEN GIS DATA HUB WEBSITE.
4. PROPERTY CONVEYED TO ALGONQUIN GAS TRANSMISSION, LLC.
5. TOPOGRAPHIC SURVEY INFORMATION WAS PROVIDED BY ALGONQUIN GAS TRANSMISSION, LLC. ADDITIONAL CONTOUR DATA WAS OBTAINED FROM 2022 USGS LIDAR POINT CLOUD DATA SETS. ALL COORDINATES AND DISTANCES SHOWN HEREON ARE REFERENCED TO THE MASSACHUSETTS STATE PLANE COORDINATE SYSTEM, US FEET.ELEVATIONS ARE REFERENCED TO NAVD 88.
6. THIS PROPERTY IS LOCATED IN ZONE X (AREA OF MINIMAL FLOOD HAZARD) AS DEPICTED ON FLOOD INSURANCE RATE MAP 25001C0318K DATED JULY 6, 2021.
7. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT NATURAL RESOURCE STUDY THE SITE IS WITHIN THE NATURAL HERITAGE AND ENDANGERED SPECIES PROGRAM (NHESP), PRIORITY HABITATS OF RARE WILDLIFE, OR THE NHESP ESTIMATED HABITATS OF RARE WILDLIFE.
8. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THE SITE THERE IS NOT A WETLAND WITHIN 100 FEET OF THE PROJECT LIMITS.
9. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THE SITE IS NOT LOCATED WITHIN AN AREA OF CRITICAL ENVIRONMENTAL CONCERN.
10. THIS PLAN SET IS PRELIMINARY. FOR PERMITTING PURPOSES ONLY. THIS PLAN IS NOT INTENDED FOR CONSTRUCTION PURPOSES.
11. REFER TO THE "EROSION & SEDIMENT GENERAL NOTES" (DWG. 00846-C.020-0001) FOR SOIL TYPES INFORMATION.

LEGEND

PROPOSED FENCE	EXISTING MAJOR CONTOUR
PROPERTY LINE	EXISTING MINOR CONTOUR
GIS TAX PARCELS	PROPOSED MAJOR CONTOUR
SUBCATCHMENT AREA BOUNDARY	PROPOSED MINOR CONTOUR
ANALYSIS LIMITS BOUNDARY	PROPOSED DRAINAGE AREA BOUNDARY
NRCS SOIL BOUNDARY	TIME OF CONCENTRATION LINE
WORKSPACE LIMITS	
PROPOSED GRADE LIMITS	
EDGE OF ROAD	

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
No. 58957
PROFESSIONAL ENGINEER

07/07/26

ISSUED FOR PERMIT
06/29/2026

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		C	06/29/26	VN	DT	ISSUED FOR PERMIT
		B	05/15/26	VN	DT	ISSUED FOR BID
		A	05/15/26	VN	DT	ISSUED FOR PERMIT

audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

DRAWN BY:	VN	05/15/26
DESIGN CHECKER:	CR	06/29/26
DESIGN ENGINEER:	PB	06/29/26
PROJECT MANAGER:	AC	06/29/26
TITLE	INITIALS	DATE

CAPE COD CANAL PIPELINE RELOCATION PROJECT
BOURNE ROTARY METER STATION
M&R 00846
TITLE: EXISTING SUBCATCHMENT AREAS PLAN

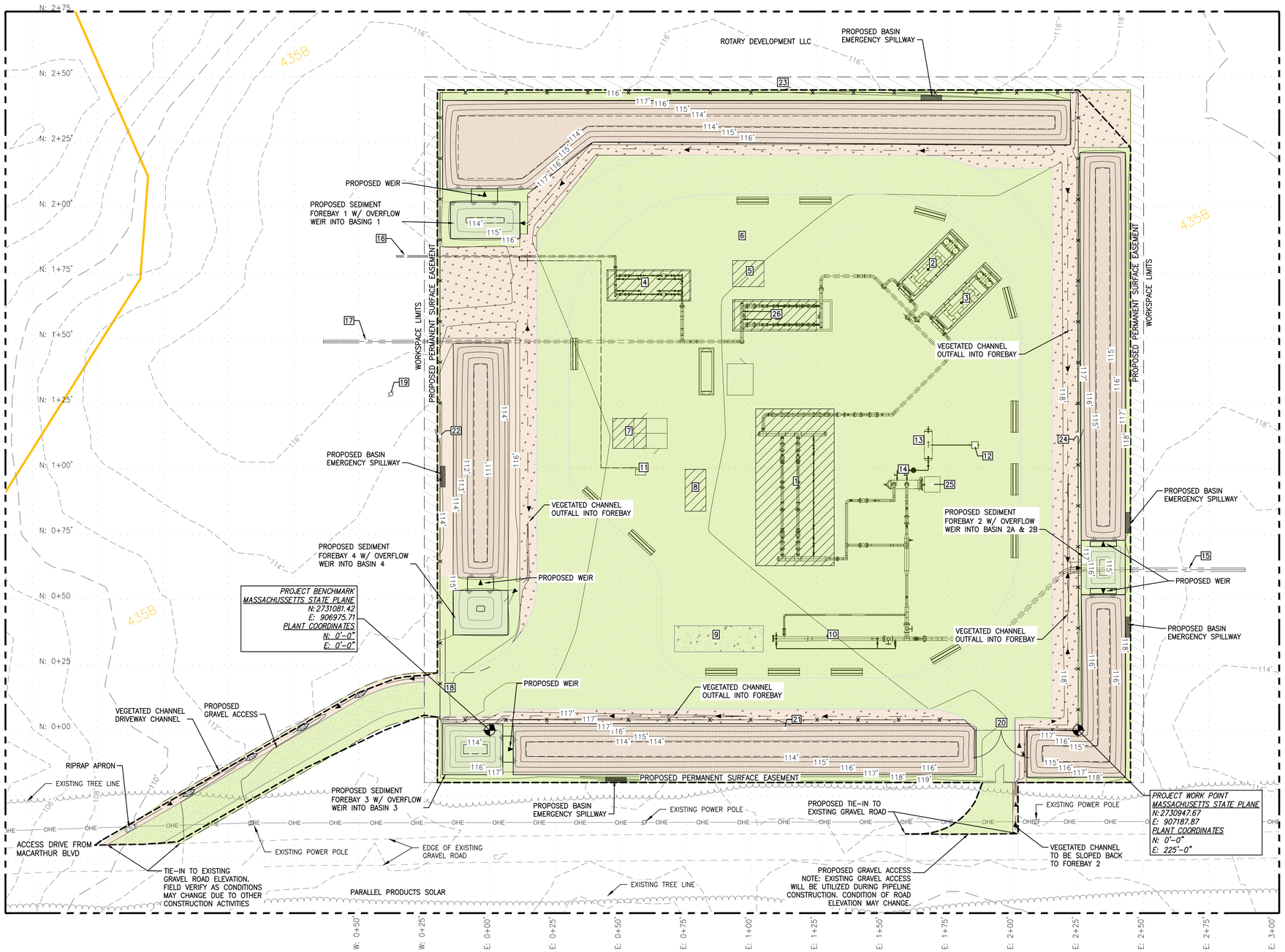
LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

YEAR: 2026 | W.O.: | SCALE: 1"=50' | DWG.: 00846-C.320-0002 | REV.: C

ENBRIDGE
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

S:\AE\Projects\Enbridge\Mass\026356-001\200_civil_structural\170_drawings\e&s plans\bourne rotary\00846-C.320-0002.dwg - PLOT TIME: 6/29/2026 6:14 PM

Proposed Conditions



METER STATION
PLAN VIEW
SCALE: 1" = 20'

0 20' 40'
Scale: 1" = 20'



NOTES:

1. ALL CONTOUR LABELS AND ELEVATION CALLOUTS ARE IN FEET.
2. PROPOSED SITE BOUNDARY WAS PROVIDED BY ALGONQUIN GAS TRANSMISSION, LLC 3RD PARTY.
3. SUPPLEMENTAL TAX PARCEL DATA IS SHOWN FOR REFERENCE ONLY AND WAS OBTAINED FROM THE CAPE COD COMMISSION OPEN GIS DATA HUB WEBSITE.
4. PROPERTY CONVEYED TO ALGONQUIN GAS TRANSMISSION.
5. TOPOGRAPHIC SURVEY INFORMATION WAS PROVIDED BY ALGONQUIN GAS TRANSMISSION, LLC. ADDITIONAL CONTOUR DATA WAS OBTAINED FROM 2022 USGS LIDAR POINT CLOUD DATA SETS. ALL COORDINATES AND DISTANCES SHOWN HEREON ARE REFERENCED TO THE MASSACHUSETTS STATE PLANE COORDINATE SYSTEM, US FEET.ELEVATIONS ARE REFERENCED TO NAVD 88.
6. THIS PROPERTY IS LOCATED IN ZONE X (AREA OF MINIMAL FLOOD HAZARD) AS DEPICTED ON FLOOD INSURANCE RATE MAP 25001C0318K DATED JULY 6, 2021.
7. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THE SITE THERE IS NOT A WETLAND WITHIN 100 FEET OF THE PROJECT LIMITS.
8. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THE SITE IS NOT LOCATED WITHIN AN AREA OF CRITICAL ENVIRONMENTAL CONCERN.
9. THIS PLAN SET IS PRELIMINARY. FOR PERMITTING PURPOSES ONLY. THIS PLAN IS NOT INTENDED FOR CONSTRUCTION PURPOSES.
10. SEE GRADING PLAN DRAWING 00846-C.301-0001 FOR DETAILS ON SITE GRADING AND STORM WATER MANAGEMENT.
11. TEMPORARY STOCK PILE LOCATIONS TO BE LOCATED WITHIN THE TEMPORARY WORKSPACE SHOWN ON THE PLANS AND COORDINATED WITH THE ON-SITE INSPECTOR. REFER TO DETAIL ON DRAWING 00846-C.320-0006.

KEY NOTE ID	
POINT #	DESCRIPTION
1	30'x50' METER BUILDING
2	HEATER
3	HEATER
4	32'x12' REGULATOR BUILDING
5	12'x10' ODORIZIER BUILDING
6	TANK
7	10'x12' N.G. EGM BUILDING
8	8'x16' ENBRIDGE EGM BUILDING
9	10'x34' MAINTANANCE SLAB
10	PIPELINE TRAP
11	NG GENERATOR
12	TRUCK BOX
13	AUXILIARY SUMP

KEY NOTE ID	
POINT #	DESCRIPTION
14	FILTER SEPARATOR
15	INCOMING PIPELINE
16	INCOMING OUT GOING
17	INCOMING OUT GOING
18	SLIDING GATE
19	FUTURE POWER POLE (LOC. TBD)
20	SECONDARY DRIVE GATE
21	EGRESS GATE
22	EGRESS GATE
23	EGRESS GATE
24	EGRESS GATE
25	PLATFORM
26	32'x12' REGULATOR BUILDINGE

LEGEND

- PROPOSED ACCESS ROAD
- PROPOSED CONCRETE
- PROPOSED STRUCTURE
- PROPOSED ROCK (FACILITY)
- PROPOSED VEGETATED
- PROPOSED INFILTRATION BASIN
- PROPOSED SEDIMENT FOREBAY
- PROPOSED ROCK
- EXISTING BUILDING
- EXISTING PAVED AREA
- WETLAND
- WORKSPACE
- INFILTRATION >2.4"/HR
- INFILTRATION <2.4"/HR
- PROPOSED ROCK CHECK DAM

- VENDOR SUPPLIED EQUIPMENT
- PROPOSED FENCE
- PROPOSED UG PIPING
- PROPERTY LINE
- GIS TAX PARCELS
- NRCS SOIL BOUNDARY
- WORKSPACE LIMITS
- PROPOSED GRADE LIMITS
- EDGE OF ROAD
- EDGE OF WATER
- EXISTING MAJOR CONTOUR 72'
- EXISTING MINOR CONTOUR 72'
- PROPOSED MAJOR CONTOUR 72'
- PROPOSED MINOR CONTOUR 72'
- PROPOSED FLOW LINE
- PROPOSED WEIR

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
No. 58957
PROFESSIONAL ENGINEER
07/07/26

ISSUED FOR PERMIT
06/29/2026

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		C	06/29/26	CR	DT	ISSUED FOR PERMIT
		B	05/15/26	CR	DT	ISSUED FOR BID
		A	05/15/26	CR	DT	ISSUED FOR PERMIT

audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N, SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

TITLE	INITIALS	DATE
DRAWN BY:	CR	05/15/26
DESIGN CHECKER:	AE	06/29/26
DESIGN ENGINEER:	PB	06/29/26
PROJECT MANAGER:	AC	06/29/26

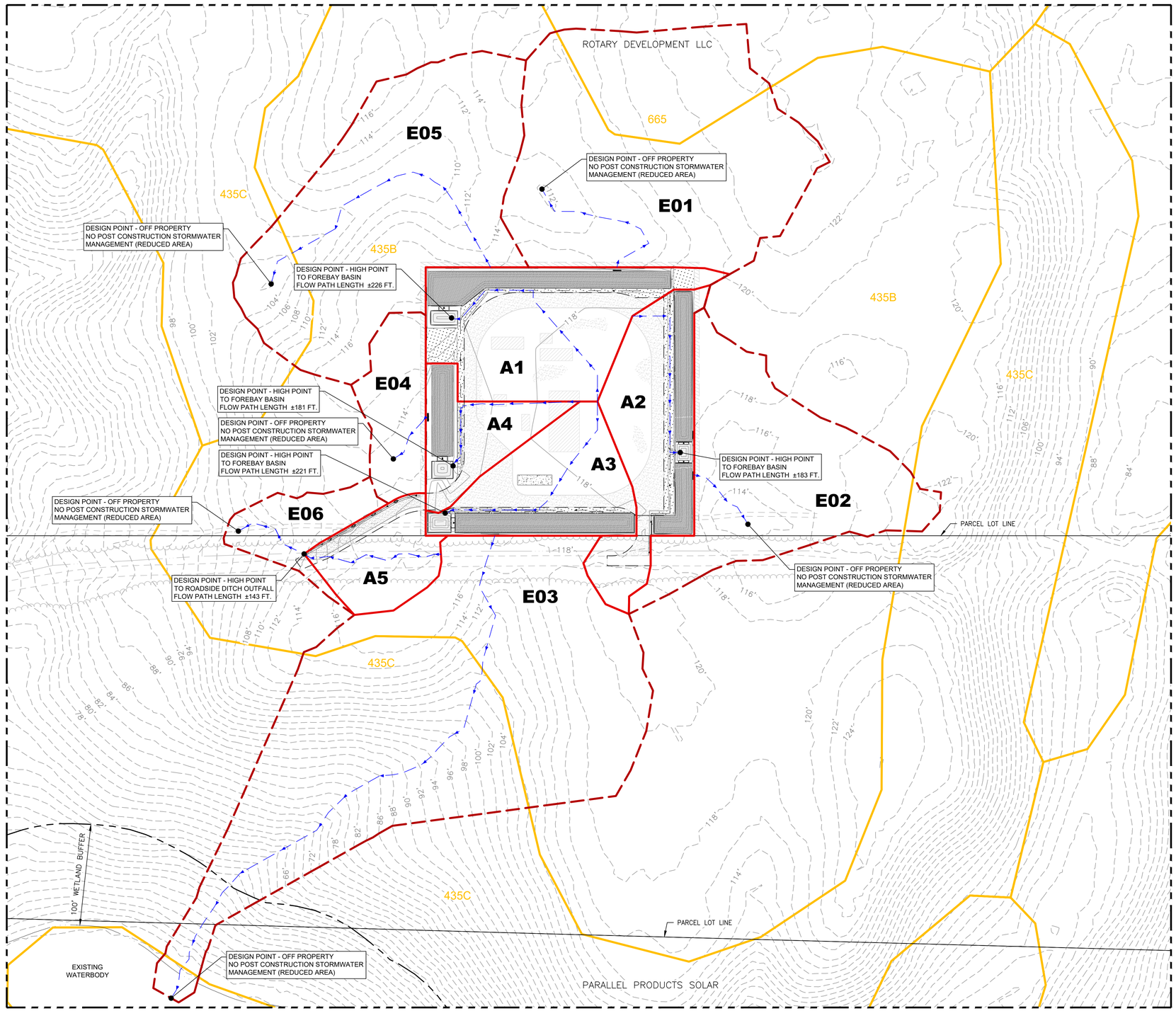
CAPE COD CANAL PIPELINE RELOCATION PROJECT
BOURNE ROTARY METER STATION
M&R 00846
TITLE: PROPOSED SITE LAYOUT PLAN

LOC.: BARNSTABLE COUNTY, MASSACHUSETTS
YEAR: 2026 | W.O.: | SCALE: 1"=20'

ENBRIDGE
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

DWG.: 00846-C.320-0003 | REV.: C

S:\AE\Projects\Enbridge\Mass\026356-001\200_Civil_Structural\170_Drawings\E&S Plans\Bourne Rotary\00846-C.320-0003.dwg - PLOT TIME: 6/29/2026 9:52 PM



PROPOSED BOURNE ROTARY METER STATION SITE

PROPOSED SUBCATCHMENT AREAS PLAN

SCALE: 1" = 30'

0 50' 100'
Scale: 1" = 50'

N 27.65°
STATION NORTH

NOTES:

1. ALL CONTOUR LABELS AND ELEVATION CALLOUTS ARE IN FEET.
2. PROPOSED SITE BOUNDARY WAS PROVIDED BY ENSBRIDGE 3RD PARTY CONSULTANT.
3. SUPPLEMENTAL TAX PARCEL DATA IS SHOWN FOR REFERENCE ONLY AND WAS OBTAINED FROM THE CAPE COD COMMISSION OPEN GIS DATA HUB WEBSITE.
4. PROPERTY CONVEYED TO ALGONQUIN GAS TRANSMISSION, LLC.
5. TOPOGRAPHIC SURVEY INFORMATION WAS PROVIDED BY ALGONQUIN GAS TRANSMISSION, LLC. ADDITIONAL CONTOUR DATA WAS OBTAINED FROM 2022 USGS LIDAR POINT CLOUD DATA SETS. ALL COORDINATES AND DISTANCES SHOWN HEREON ARE REFERENCED TO THE MASSACHUSETTS STATE PLANE COORDINATE SYSTEM, US FEET.ELEVATIONS ARE REFERENCED TO NAVD 88.
6. THIS PROPERTY IS LOCATED IN ZONE X (AREA OF MINIMAL FLOOD HAZARD) AS DEPICTED ON FLOOD INSURANCE RATE MAP 25001C0318K DATED JULY 6, 2021.
7. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT NATURAL RESOURCE STUDY THE SITE IS WITHIN THE NATURAL HERITAGE AND ENDANGERED SPECIES PROGRAM (NHESP), PRIORITY HABITATS OF RARE WILDLIFE, OR THE NHESP ESTIMATED HABITATS OF RARE WILDLIFE.
8. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THE SITE THERE IS NOT A WETLAND WITHIN 100 FEET OF THE PROJECT LIMITS.
9. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THE SITE IS NOT LOCATED WITHIN AN AREA OF CRITICAL ENVIRONMENTAL CONCERN.
10. THIS PLAN SET IS PRELIMINARY. FOR PERMITTING PURPOSES ONLY. PROPOSED GRADING MAY BE FURTHER OPTIMIZED TO ENSURE PROPER SHEET FLOW AROUND ASSUMED BUILDING LOCATIONS, FOUNDATIONS, AND MECHANICAL EQUIPMENT. THIS PLAN IS NOT INTENDED FOR CONSTRUCTION PURPOSES.
11. REFER TO THE "EROSION & SEDIMENT GENERAL NOTES" (DWG. 00846-C.020-0001) FOR SOIL TYPES INFORMATION.

LEGEND

PROPERTY LINE	PROPOSED MAJOR CONTOUR
GIS TAX PARCELS	PROPOSED MINOR CONTOUR
PROPOSED DRAINAGE AREAS	PROPOSED DRAINAGE AREA BOUNDARY
EXISTING DRAINAGE AREAS	TIME OR CONCENTRATION LINE
NRCS SOIL BOUNDARY	PROPOSED BUILDING
WORKSPACE LIMITS	PROPOSED INFILTRATION BASIN
PROPOSED GRADE LIMITS	PROPOSED SEDIMENT FOREBAY
PROPOSED ACCESS ROAD	
EDGE OF ROAD	
EXISTING MAJOR CONTOUR	
EXISTING MINOR CONTOUR	

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
No. 59957
PROFESSIONAL ENGINEER
07/07/26

ISSUED FOR PERMIT
06/29/2026

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		C	06/29/26	VN	DT	ISSUED FOR PERMIT
		B	05/15/26	VN	DT	ISSUED FOR BID
		A	05/15/26	VN	DT	ISSUED FOR PERMIT

audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

TITLE	INITIALS	DATE
DRAWN BY:	VN	05/15/26
DESIGN CHECKER:	CR	06/29/26
DESIGN ENGINEER:	PB	06/29/26
PROJECT MANAGER:	AC	06/29/26

CAPE COD CANAL PIPELINE RELOCATION PROJECT
BOURNE ROTARY METER STATION
M&R 00846
TITLE: PROPOSED SUBCATCHMENT AREAS PLAN
LOC.: BARNSTABLE COUNTY, MASSACHUSETTS
YEAR: 2026 | W.O.: | SCALE: 1"=50'

ENBRIDGE
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

DWG.: 00846-C.320-0005 | REV.: C

S:\AE\Projects\Enbridge\Mass\026356-001\200_Civil_Structural\170_Drawings\E&S Plans\Bourne Rotary\00846-C.320-0005.dwg - PLOT TIME: 6/29/2026 9:12 PM

Attachment B - Standard 1 Supporting Information

Grass Swales

Sediment Forebays

Infiltration Basin

Rock Check Dam

Grassed Channel



Description

Grassed Channels are treatment systems with a longer hydraulic residence time than drainage channels. The removal mechanisms are sedimentation and gravity separation, rather than filtration. To receive TSS credit, a sediment forebay or equivalent must be provided for pretreatment. Note that the sediment forebay does not receive a separate TSS removal credit.

Ability to Meet Massachusetts Stormwater Management Standards

Standard	Description
2 - Peak Flow	N/A
3 - Recharge	No infiltration credit
4 - TSS Removal	50% TSS with adequate pretreatment
5 - Higher Pollutant Loading	N/A
6 - Discharges near or to Critical Areas	Not suitable for vernal pools or bathing beaches. At other critical areas, may be used as a pretreatment device.
7 - Redevelopment	Typically not suited for retrofits.

Advantages/Benefits

- Provides pretreatment if used as the first part of a treatment train.
- Open drainage system aids maintenance
- Accepts sheet or pipe flow
- Compatible with LID design measures.
- Little or no entrapment hazard for amphibians or other small animals
- Disadvantages/Limitations
- Short retention time does not allow for full gravity separation
- Limited biofiltration provided by grass lining.
- Cannot alone achieve 80% TSS removal
- Must be designed carefully to achieve low flow rates for Water Quality Volume purposes (<1.0 fps)
- Mosquito control considerations
- Pollutant Removal Efficiencies
- Total Suspended Solids (TSS) 50%[1] for Regulatory Purposes (47%)[2]
- Total phosphorus (TP) -121%[2]
- Total Nitrogen Insufficient Data
- Metals (copper, lead, zinc, cadmium) insufficient Data
- Pathogens (coliform, e. coli) Insufficient Data

Maintenance

Activity	Frequency
Remove sediment from forebay	Annually
Remove sediment from grass channel	Annually
Mow	Once a month during growing season
Repair areas of erosion and revegetate	As needed, but no less than once a year

Special Features

Reduces volume and rate of runoff.

Maintenance

Access

Maintenance access must be designed as part of the grass channel. If located adjacent to a roadway, make the maintenance access at least 15 feet wide, which can also be combined with a breakdown lane along a highway or on- street parking along a residential street. When combined

with on-street parking, post signs prohibiting parking when the swale is to be inspected and cleaned. Do not use travel lanes along highways and streets as the required maintenance access.

Mowing

Set the mower blades no lower than 3 to 4 inches above the ground. Do not mow beneath the depth of the design flow during the storm associated with the water quality event (e.g., if the design flow is no more than 4 inches, do not cut the grass shorter than 4 inches). Mow on an as-needed basis during the growing season so that the grass height does not exceed 6 inches. Inspection: Inspect semi-annually the first year, and at least once a year thereafter. Inspect the grass for growth and the side slopes for signs of erosion and formation of rills and gullies. Plant an alternative grass species if the original grass cover is not successfully established. If grass growth is impaired by winter road salt or other deicer use, re-establish the grass in the spring. Trash/Debris Removal: Remove accumulated trash and debris prior to mowing.

Sediment Removal

Check on a yearly basis and clean as needed. Use hand methods (i.e., a person with a shovel) when cleaning to minimize disturbance to vegetation and underlying soils. Sediment build-up in the grass channel reduces its capacity to treat and convey the water quality event, 2-year and 10-year 24-hour storm.

Sediment Forebays



Description

A sediment forebay is a post-construction practice consisting of an excavated pit, bermed area, or cast structure combined with a weir, designed to slow incoming stormwater runoff and facilitating the gravity separation of suspended solids. This practice is different from a sediment trap used as a construction period BMP.

Ability to Meet Massachusetts Stormwater Management Standards

Standard	Description
2 - Peak Flow	Provides no peak flow attenuation
3 - Recharge	Provides no groundwater recharge
4 - TSS Removal	MassDEP requires a sediment forebay as pretreatment before stormwater is discharged to an extended dry detention basin, wet basin, constructed stormwater wetland or infiltration basin. No separate credit is given for the sediment forebay. For example, extended dry detention basins with sediment forebays receive a credit for 50% TSS removal. Wet basins and constructed stormwater wetlands with sediment forebays receive a credit for 80% TSS removal. When they provide pretreatment for other BMPs, sediment forebays receive a 25% TSS removal credit.
5 - Higher Pollutant Loading	Recommended as a pretreatment BMP
6 - Discharges near or to Critical Areas	Recommended as a pretreatment BMP
7 - Redevelopment	Usually not suitable due to land use constraints

Advantages/Benefits

- Provides pretreatment of runoff before delivery to other BMPs.
- Slows velocities of incoming stormwater.
- Easily accessed for sediment removal.
- Longevity is high with proper maintenance.
- Relatively inexpensive compared to other BMPs.
- Greater detention time than proprietary separators.
- Disadvantages/Limitations
- Removes only coarse sediment fractions.
- No removal of soluble pollutants.
- Provides no recharge to groundwater.
- No control of the volume of runoff.
- Frequent maintenance is essential.
- Pollutant Removal Efficiencies
- Total Suspended Solids (TSS) - 25%.
- Nutrients (Nitrogen, phosphorus) - Insufficient data.
- Metals (copper, lead, zinc, cadmium) - Insufficient data.
- Pathogens (coliform, e coli) - Insufficient data

Maintenance

Sediments and associated pollutants are removed only when sediment forebays are actually cleaned out, so regular maintenance is essential. Frequently removing accumulated sediments will make it less likely that sediments will be resuspended. At a minimum, inspect sediment forebays monthly and clean them out at least four times per year. Stabilize the floor and sidewalls of the sediment forebay before making it operational, otherwise the practice will discharge excess amounts of suspended sediments. When mowing grasses, keep the grass height no greater than 6 inches. Set mower blades no lower than 3 to 4 inches. Check for signs of rilling and gullying and repair as needed. After removing the sediment, replace any vegetation damaged during the clean-out by either reseeding or re-sodding. When reseeding, incorporate practices such as hydroseeding with a tackifier, blanket, or similar practice to ensure that no scour occurs in the forebay, while the seeds germinate and develop roots.

Activity	Frequency
Inspect sediment forebays	Monthly
Clean sediment forebays	Four times per year and when sediment depth is between 3 to 6 feet.

Infiltration-Recharge Basins

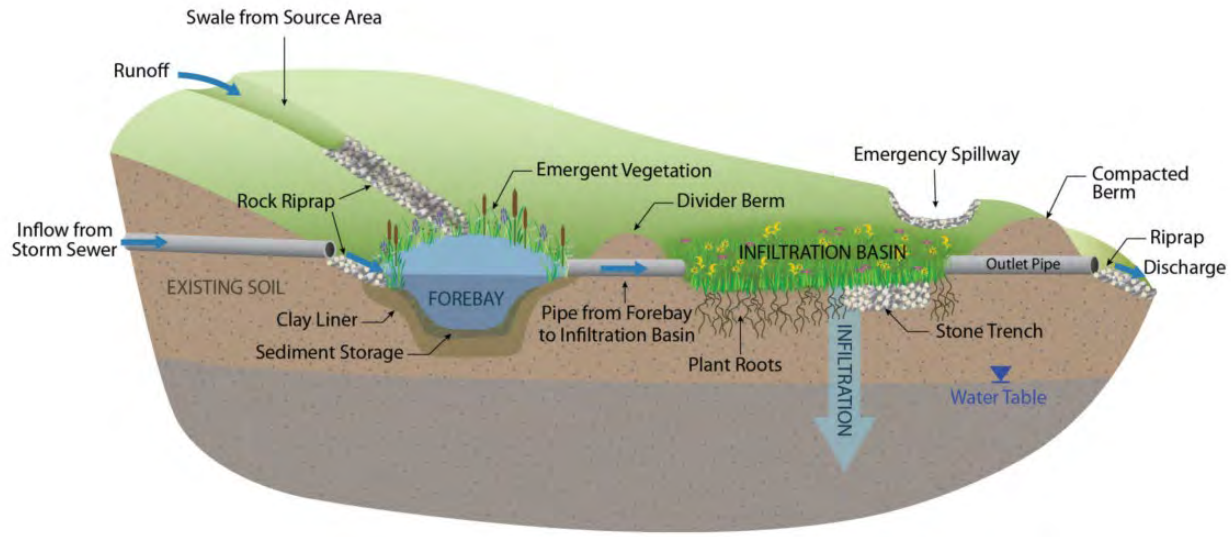


Illustration by Geosyntec Consultants, Inc.

Description

Recharge basins temporarily store runoff, but release at least a portion of that runoff by infiltrating the water into the ground. The recharge volume is stored and allowed to infiltrate into the underlying soils over a period of time following a storm event. The storage volume above this level may be released by an outlet structure designed to bypass all excess flows. Recharge Basins may be designed on-line or off-line. To maintain proper function of an infiltration-recharge basin, it is important to avoid soil compaction.

General Information		
Applicable DEP Stormwater Management Policy Performance Standards	Standards #3 and #4.	
TSS Removal	DEP Credit:	80% (for infiltration basin)
	Estimated Range from Literature:	>90%
Relative Cost	Construction: Moderate to high; varies depending on types soils of contributing drainage area, soils at site of system, storage depth, and type of outlet structure	

	Maintenance: Moderate to high
Potential Constraints to Use	Depth to groundwater Depth to bedrock or other impermeable stratum Suitability of site soils for infiltration
Other Considerations	Pre-treatment must be provided, to prevent clogging of soils surface by sediments in the influent storm water. Frequent maintenance may be required, to remove accumulated sediment and restore infiltrative capacity. Recharge systems can provide high levels of treatment of other pollutants, in addition to TSS removal.
Maintenance Requirements	Inspect a minimum of twice annually. Periodic mowing of embankments Removal of woody vegetation from embankments Removal of debris from outlet structures Clean forebay as required. Clean basin of accumulated sediment as required. Clean flow control structures at least once annually, or as indicated by inspection. Maintain vegetation in healthy condition.

Several of the design criteria regarding setbacks from slopes, foundations, and other site features have been adapted from the requirements for on-site sewage disposal systems described in Massachusetts Title 5 (310 CMR 15.000). However, storm water quantities and flow durations differ markedly from the hydraulic loadings to septic systems. The design engineer should be aware of these differences and may need to consider additional setbacks to provide for slope stability, protect structures, and provide for the satisfactory performance of the recharge system.

Check Dam



A check dam is a small dam constructed across a drainage ditch, swale, or channel to lower the velocity of flow. Reduced runoff velocity reduces erosion and gullying in the channel and allows sediments to settle out. A check dam may be built from stone, sandbags filled with pea gravel, or logs.

Applicability

Check dams can be used where temporary channels or permanent channels are not yet vegetated, channel lining is infeasible and velocity checks are required. This practice may be used as a temporary or emergency measure to limit erosion by reducing flow in small open channels. This practice should be used with drainage areas of 2 acres or less. Check dams may be used:

- To reduce flow in small temporary channels that are presently undergoing degradation,
- Where permanent stabilization is impractical due to the temporary nature of the problem,
- To reduce flow in small eroding channels where construction delays or weather conditions prevent timely installation of non-erosive liners.

Advantages

- Inexpensive and easy to install.
- Reduce velocity and may provide aeration of the water.
- Check dams prevent gully erosion from occurring before vegetation is established, and also cause a high proportion of the sediment load in runoff to settle out.
- In some cases, if carefully located and designed, these check dams can remain as permanent installations with very minor regrading, etc.
- They may be left as either spillways, in which case accumulated sediment would be graded and seeded, or as check dams to capture sediment coming off that site.

Maintenance

- Inspect after each rainfall event.
- Remove sediment accumulations.
- Check structure and abutments for erosion, piping, or rock displacement. Repair immediately.
- Remove check dam after the contributing drainage area has been permanently stabilized. Smooth site to blend with surrounding area and stabilize according to vegetation plan.

Attachment C - Standard 2 Supporting Information

NOAA Altas Rainfall Data

SSA Analysis: Existing and Proposed Conditions – Drainage Area A1

SSA Analysis: Existing and Proposed Conditions – Drainage Area A2

SSA Analysis: Existing and Proposed Conditions – Drainage Area A3

SSA Analysis: Existing and Proposed Conditions – Drainage Area A4

NOAA ATLAS RAINFALL DATA

NOAA Atlas 14, Volume 10, Version 3
Location name: Buzzards Bay, Massachusetts, USA*
Latitude: 41.7386°, Longitude: -70.5804°
Elevation: 120 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sandra Pavlovic, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Orlan Wilhite

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.291** (0.237-0.354)	**0.361** (0.294-0.441)	**0.477** (0.388-0.584)	**0.573** (0.462-0.703)	**0.706** (0.552-0.899)	**0.805** (0.616-1.04)	**0.910** (0.678-1.22)	**1.04** (0.724-1.39)	**1.22** (0.820-1.68)	**1.38** (0.904-1.92)
10-min	**0.412** (0.336-0.502)	**0.512** (0.417-0.625)	**0.676** (0.549-0.827)	**0.812** (0.655-0.997)	**1.00** (0.782-1.27)	**1.14** (0.873-1.48)	**1.29** (0.961-1.72)	**1.47** (1.02-1.97)	**1.73** (1.16-2.38)	**1.95** (1.28-2.72)
15-min	**0.484** (0.395-0.590)	**0.602** (0.491-0.735)	**0.795** (0.646-0.972)	**0.956** (0.771-1.17)	**1.18** (0.920-1.50)	**1.34** (1.03-1.74)	**1.52** (1.13-2.03)	**1.72** (1.21-2.31)	**2.03** (1.37-2.80)	**2.30** (1.51-3.20)
30-min	**0.698** (0.569-0.851)	**0.867** (0.706-1.06)	**1.14** (0.928-1.40)	**1.37** (1.11-1.69)	**1.69** (1.32-2.15)	**1.92** (1.47-2.49)	**2.18** (1.62-2.91)	**2.47** (1.73-3.32)	**2.92** (1.96-4.02)	**3.30** (2.16-4.60)
60-min	**0.911** (0.743-1.11)	**1.13** (0.922-1.38)	**1.49** (1.21-1.82)	**1.79** (1.44-2.20)	**2.20** (1.72-2.80)	**2.51** (1.92-3.25)	**2.84** (2.11-3.79)	**3.22** (2.25-4.32)	**3.81** (2.56-5.24)	**4.30** (2.82-6.00)
2-hr	**1.23** (1.01-1.49)	**1.53** (1.26-1.86)	**2.02** (1.65-2.46)	**2.43** (1.97-2.96)	**2.99** (2.36-3.78)	**3.40** (2.63-4.38)	**3.85** (2.90-5.12)	**4.39** (3.10-5.84)	**5.21** (3.54-7.11)	**5.92** (3.92-8.18)
3-hr	**1.46** (1.20-1.76)	**1.80** (1.48-2.18)	**2.37** (1.94-2.87)	**2.84** (2.32-3.45)	**3.48** (2.76-4.39)	**3.96** (3.08-5.08)	**4.48** (3.39-5.93)	**5.10** (3.62-6.76)	**6.06** (4.13-8.22)	**6.87** (4.58-9.45)
6-hr	**1.90** (1.58-2.28)	**2.32** (1.92-2.78)	**3.00** (2.48-3.60)	**3.56** (2.92-4.29)	**4.33** (3.45-5.41)	**4.91** (3.84-6.23)	**5.53** (4.21-7.23)	**6.26** (4.49-8.22)	**7.36** (5.08-9.90)	**8.30** (5.59-11.3)
12-hr	**2.41** (2.01-2.87)	**2.88** (2.40-3.42)	**3.64** (3.03-4.34)	**4.27** (3.53-5.12)	**5.14** (4.12-6.36)	**5.80** (4.56-7.27)	**6.49** (4.96-8.36)	**7.27** (5.26-9.46)	**8.41** (5.86-11.2)	**9.34** (6.36-12.6)
24-hr	**2.90** (2.44-3.43)	**3.43** (2.88-4.06)	**4.29** (3.60-5.09)	**5.01** (4.17-5.96)	**5.99** (4.84-7.33)	**6.74** (5.33-8.36)	**7.51** (5.77-9.55)	**8.36** (6.12-10.8)	**9.56** (6.74-12.6)	**10.5** (7.25-14.1)
2-day	**3.35** (2.84-3.93)	**3.96** (3.35-4.65)	**4.95** (4.18-5.83)	**5.78** (4.85-6.82)	**6.92** (5.63-8.40)	**7.78** (6.20-9.57)	**8.67** (6.72-10.9)	**9.65** (7.12-12.3)	**11.0** (7.84-14.4)	**12.1** (8.44-16.1)
3-day	**3.68** (3.12-4.29)	**4.31** (3.66-5.04)	**5.36** (4.54-6.28)	**6.22** (5.24-7.32)	**7.42** (6.06-8.96)	**8.32** (6.66-10.2)	**9.25** (7.20-11.6)	**10.3** (7.63-13.0)	**11.7** (8.37-15.2)	**12.8** (8.98-16.9)
4-day	**3.96** (3.38-4.61)	**4.61** (3.93-5.38)	**5.68** (4.82-6.63)	**6.56** (5.54-7.69)	**7.78** (6.37-9.36)	**8.70** (6.99-10.6)	**9.65** (7.53-12.0)	**10.7** (7.96-13.5)	**12.1** (8.70-15.7)	**13.2** (9.29-17.3)
7-day	**4.70** (4.03-5.45)	**5.38** (4.61-6.24)	**6.48** (5.54-7.53)	**7.40** (6.29-8.63)	**8.66** (7.14-10.3)	**9.63** (7.77-11.6)	**10.6** (8.31-13.1)	**11.6** (8.75-14.6)	**13.0** (9.44-16.7)	**14.1** (9.97-18.3)
10-day	**5.39** (4.64-6.22)	**6.09** (5.24-7.04)	**7.24** (6.20-8.38)	**8.19** (6.98-9.51)	**9.50** (7.85-11.3)	**10.5** (8.51-12.6)	**11.5** (9.04-14.1)	**12.5** (9.48-15.7)	**13.9** (10.1-17.7)	**14.9** (10.6-19.3)
20-day	**7.44** (6.44-8.52)	**8.23** (7.12-9.43)	**9.52** (8.22-10.9)	**10.6** (9.10-12.2)	**12.1** (10.1-14.2)	**13.2** (10.8-15.7)	**14.4** (11.3-17.3)	**15.4** (11.8-19.1)	**16.8** (12.4-21.2)	**17.7** (12.8-22.7)
30-day	**9.16** (7.97-10.4)	**10.0** (8.72-11.5)	**11.5** (9.94-13.1)	**12.6** (10.9-14.5)	**14.3** (11.9-16.7)	**15.6** (12.7-18.4)	**16.8** (13.3-20.1)	**17.9** (13.8-22.1)	**19.3** (14.4-24.3)	**20.2** (14.7-25.8)
45-day	**11.3** (9.91-12.9)	**12.3** (10.8-14.0)	**13.9** (12.1-15.8)	**15.2** (13.2-17.4)	**17.0** (14.3-19.8)	**18.5** (15.2-21.7)	**19.8** (15.8-23.6)	**21.0** (16.3-25.8)	**22.5** (16.8-28.1)	**23.4** (17.1-29.6)
60-day	**13.2** (11.6-14.9)	**14.2** (12.5-16.2)	**16.0** (14.0-18.1)	**17.4** (15.1-19.8)	**19.4** (16.3-22.4)	**21.0** (17.3-24.5)	**22.4** (17.9-26.5)	**23.7** (18.4-28.9)	**25.1** (18.9-31.3)	**26.0** (19.1-32.9)

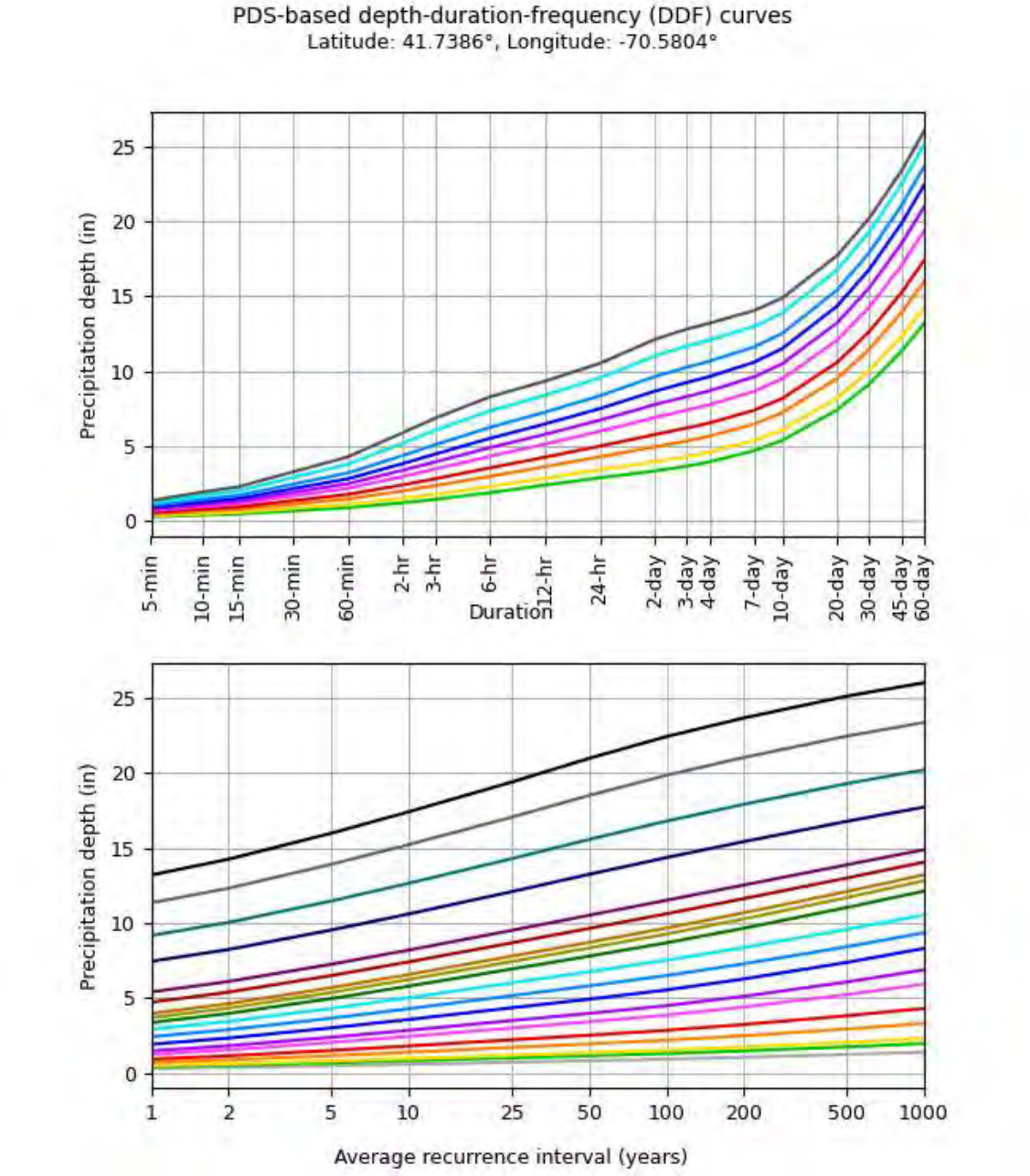
[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

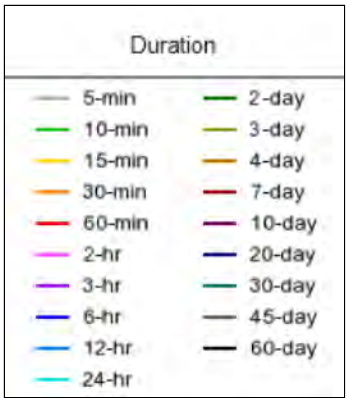
Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

Back to Top

PF graphical





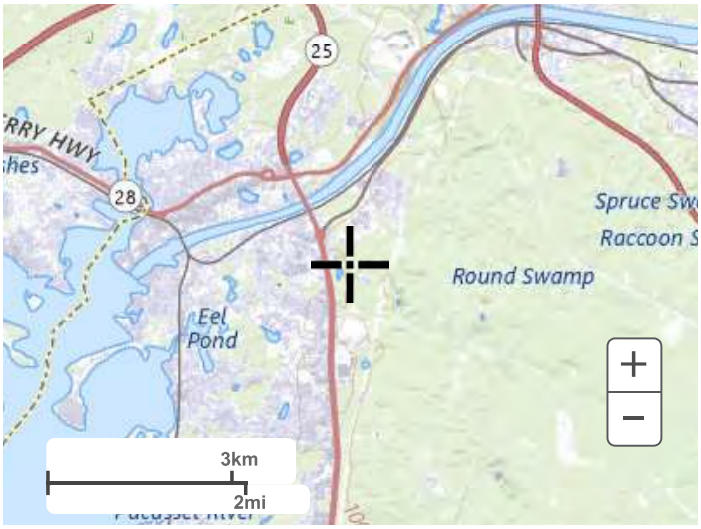
NOAA Atlas 14, Volume 10, Version 3

Created (GMT): Tue Apr 21 16:29:24 2026

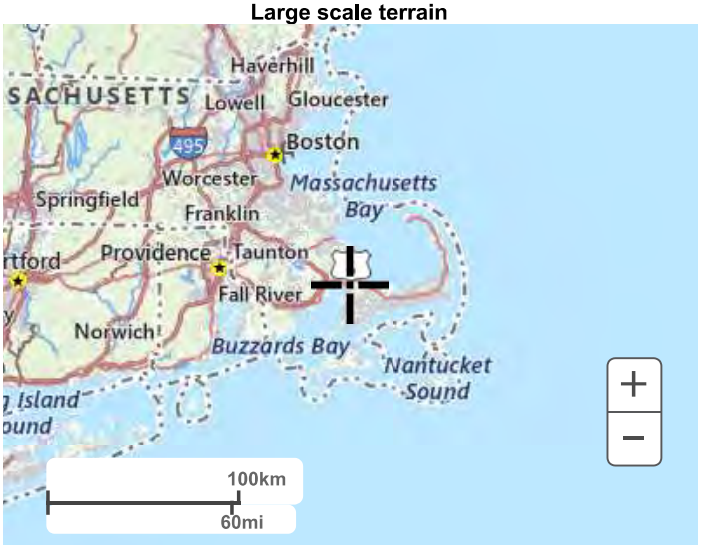
Back to Top

Maps & aerials

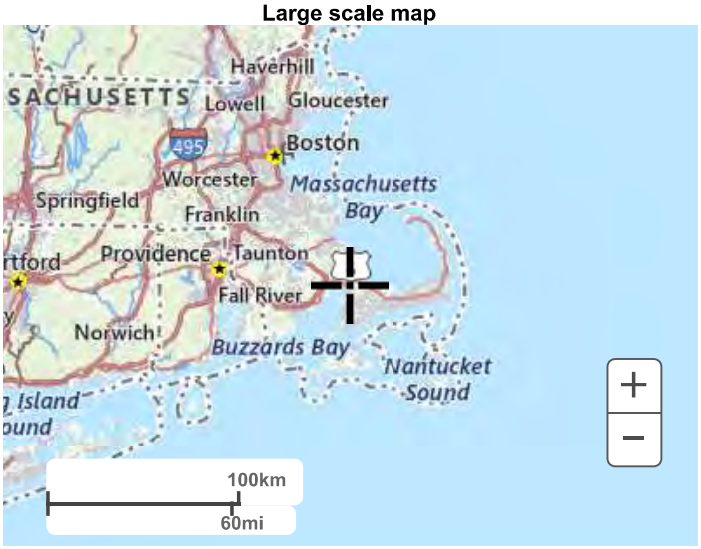
Small scale terrain



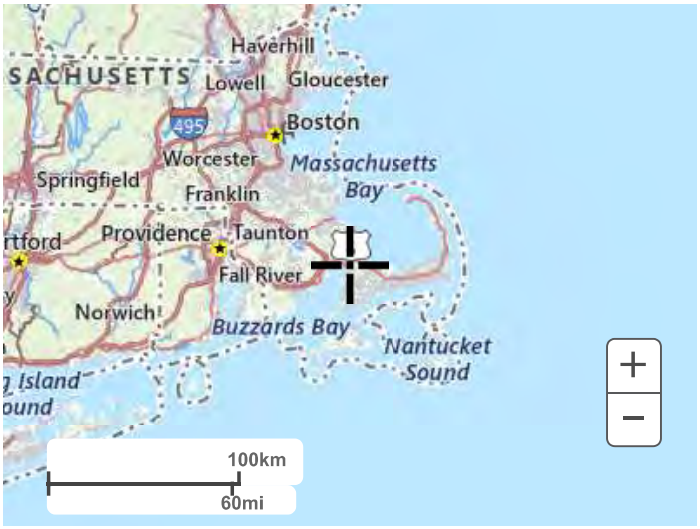
Large scale terrain



Large scale map



Large scale aerial



Back to Top

US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer

SSA Analysis – Drainage Area A1 – Existing and Proposed

Project Description

File Name ..... Bourne_A1.SPF

Project Options

Flow Units ..... CFS
Elevation Type ..... Elevation
Hydrology Method ..... SCS TR-20
Time of Concentration (TOC) Method ..... SCS TR-55
Link Routing Method ..... Hydrodynamic
Enable Overflow Ponding at Nodes ..... YES
Skip Steady State Analysis Time Periods ..... NO

Analysis Options

Start Analysis On ..... oct. 14, 2021 0:00:00
End Analysis On ..... oct. 17, 2021 0:00:00
Start Reporting On ..... oct. 14, 2021 0:00:00
Antecedent Dry Days ..... 0 days
Runoff (Dry Weather) Time Step ..... 0 01:00:00 days hh:mm:ss
Runoff (Wet Weather) Time Step ..... 0 00:05:00 days hh:mm:ss
Reporting Time Step ..... 0 00:05:00 days hh:mm:ss
Routing Time Step ..... 30 seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	2
Nodes	4
Junctions	0
Outfalls	2
Flow Diversions	0
Inlets	0
Storage Nodes	2
Links	2
Channels	0
Pipes	0
Pumps	0
Orifices	0
Weirs	2
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	2 years	Intensity	inches	Massachusetts	None	2.00	3.43	SCS Type III 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Sub-A1	0.61	484.00	76.00	3.43	1.32	0.80	0.82	0 00:06:00
2	Sub-E01	0.42	484.00	43.00	3.43	0.04	0.02	0.00	0 00:39:05

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Out-A1	Outfall	110.00					0.00	110.00					
2	Out-E01	Outfall	0.00					0.00	0.00					
3	Basin-A1	Storage Node	114.00	117.00	114.00		0.00	0.78	115.11				0.00	0.00
4	Forebay-A1	Storage Node	114.00	117.00	114.00		0.00	0.79	116.08				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(ft)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
1	Weir-A1	Weir	Basin-A1	Out-A1		114.00	110.00				0.00							
2	Weir-FA1	Weir	Forebay-A1	Basin-A1		114.00	114.00				0.78							

Subbasin Hydrology

Subbasin : Sub-A1

Input Data

Area (ac)	0.61
Peak Rate Factor	484
Weighted Curve Number	76
Rain Gage ID	Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	0.61	A	76
Composite Area & Weighted CN	0.61		76

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft^2)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	133.39	0	0
Slope (%) :	1.36	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	1.01	0	0
Computed Flow Time (min) :	2.21	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	92.85	0	0
Channel Slope (%) :	0.3	0	0
Cross Section Area (ft^2) :	3	0	0
Wetted Perimeter (ft) :	6.32	0	0
Velocity (ft/sec) :	1.66	0	0
Computed Flow Time (min) :	0.93	0	0

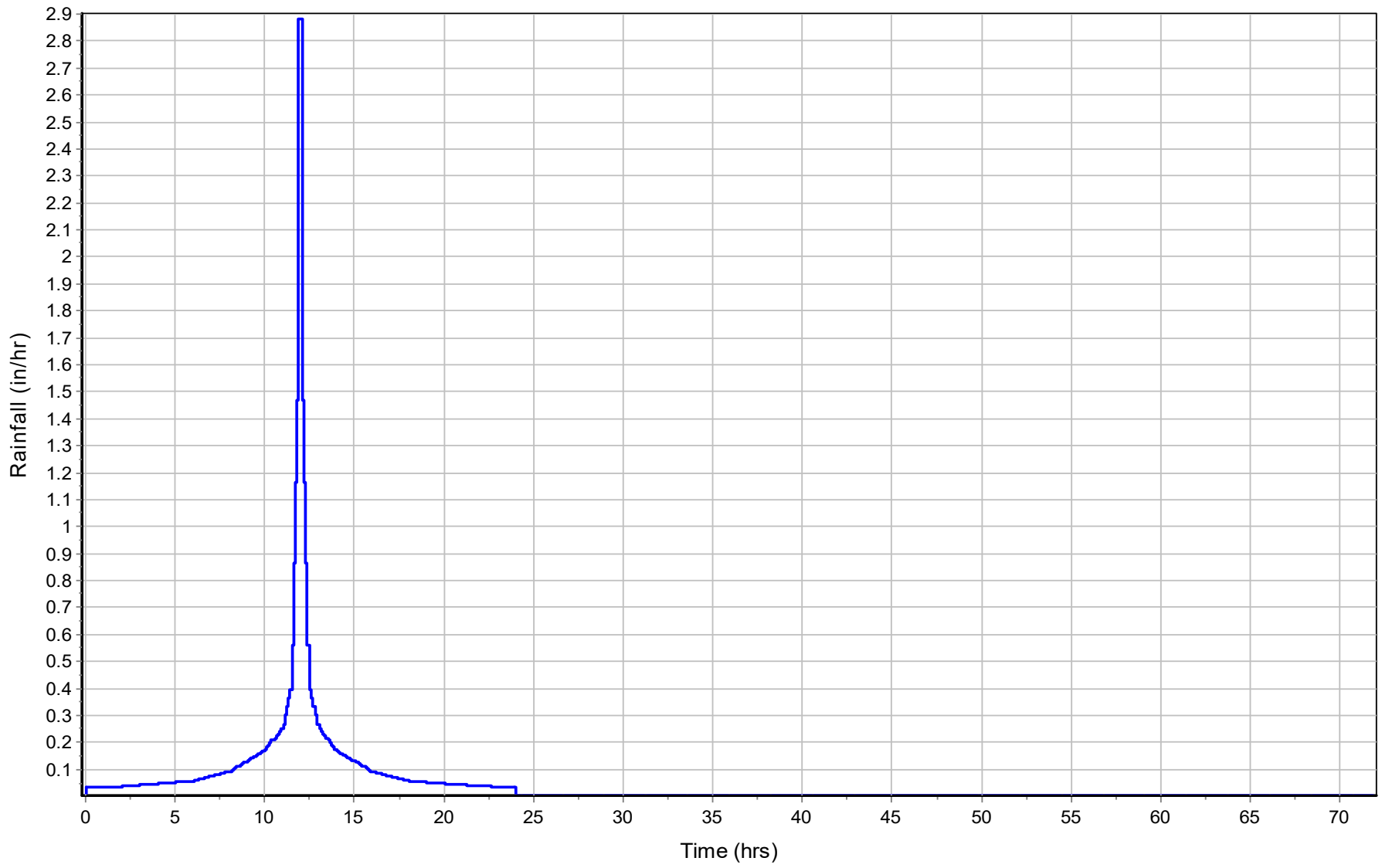
Total TOC (min) 3.15

Subbasin Runoff Results

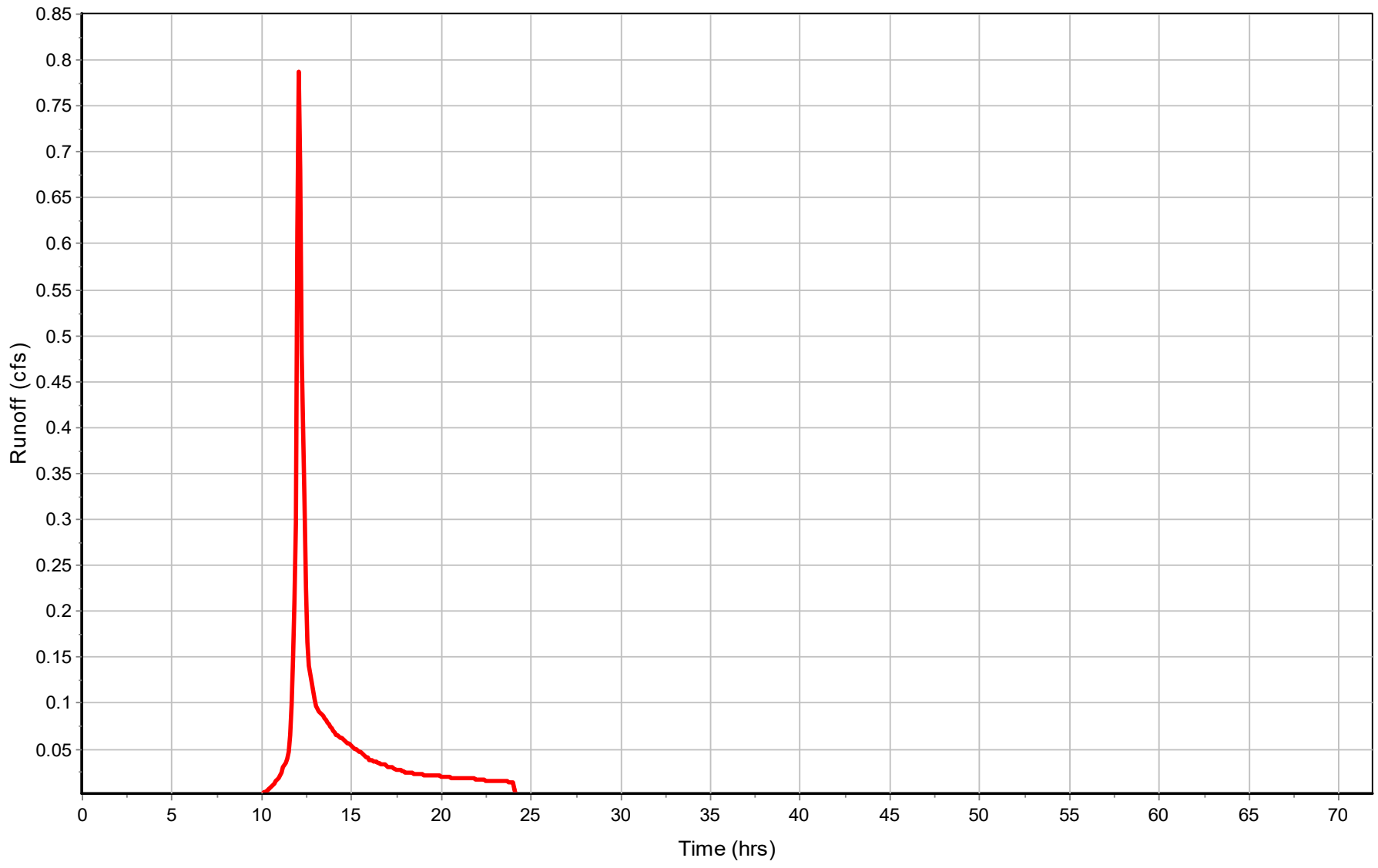
Total Rainfall (in)	3.43
Total Runoff (in)	1.32
Peak Runoff (cfs)	0.82
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:03:09

Subbasin : Sub-A1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E01

Input Data

Area (ac) 0.42
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.21	A	43
Composite Area & Weighted CN	0.21		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	173.96	0	0
Slope (%) :	5	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.07	0	0
Computed Flow Time (min) :	39.09	0	0

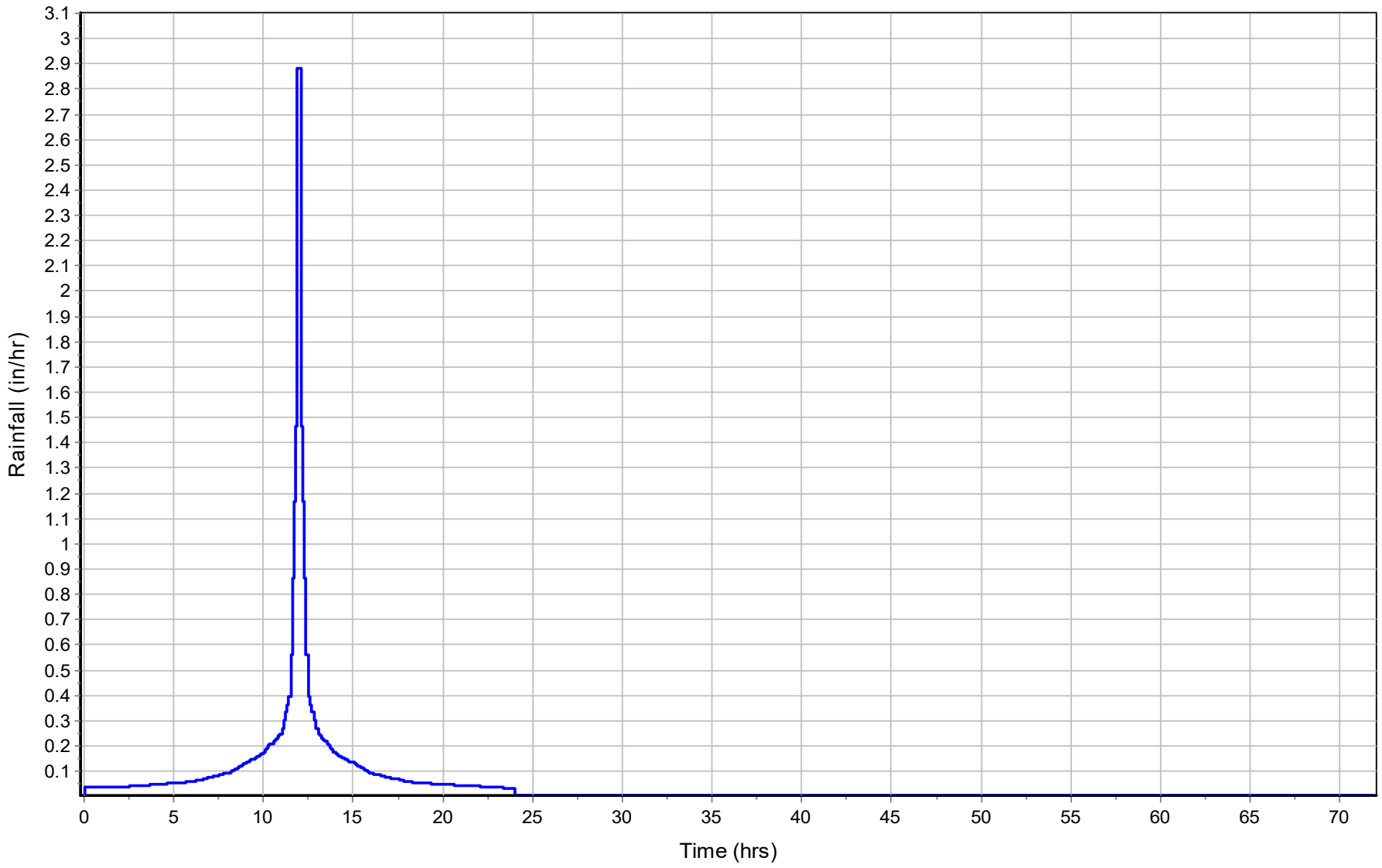
Total TOC (min) 39.09

Subbasin Runoff Results

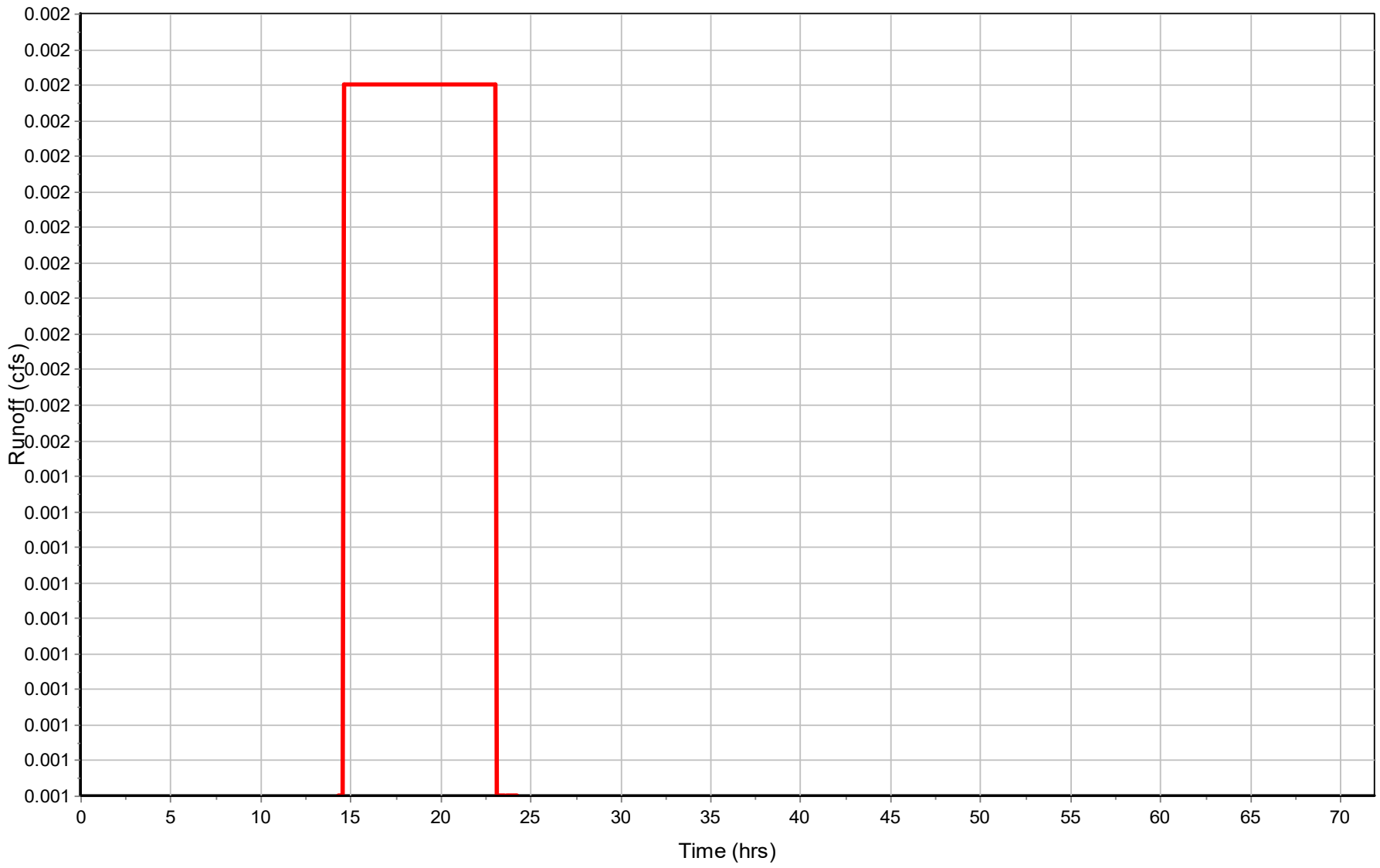
Total Rainfall (in) 3.43
Total Runoff (in) 0.04
Peak Runoff (cfs) 0
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:39:05

Subbasin : Sub-E01

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A1

Input Data

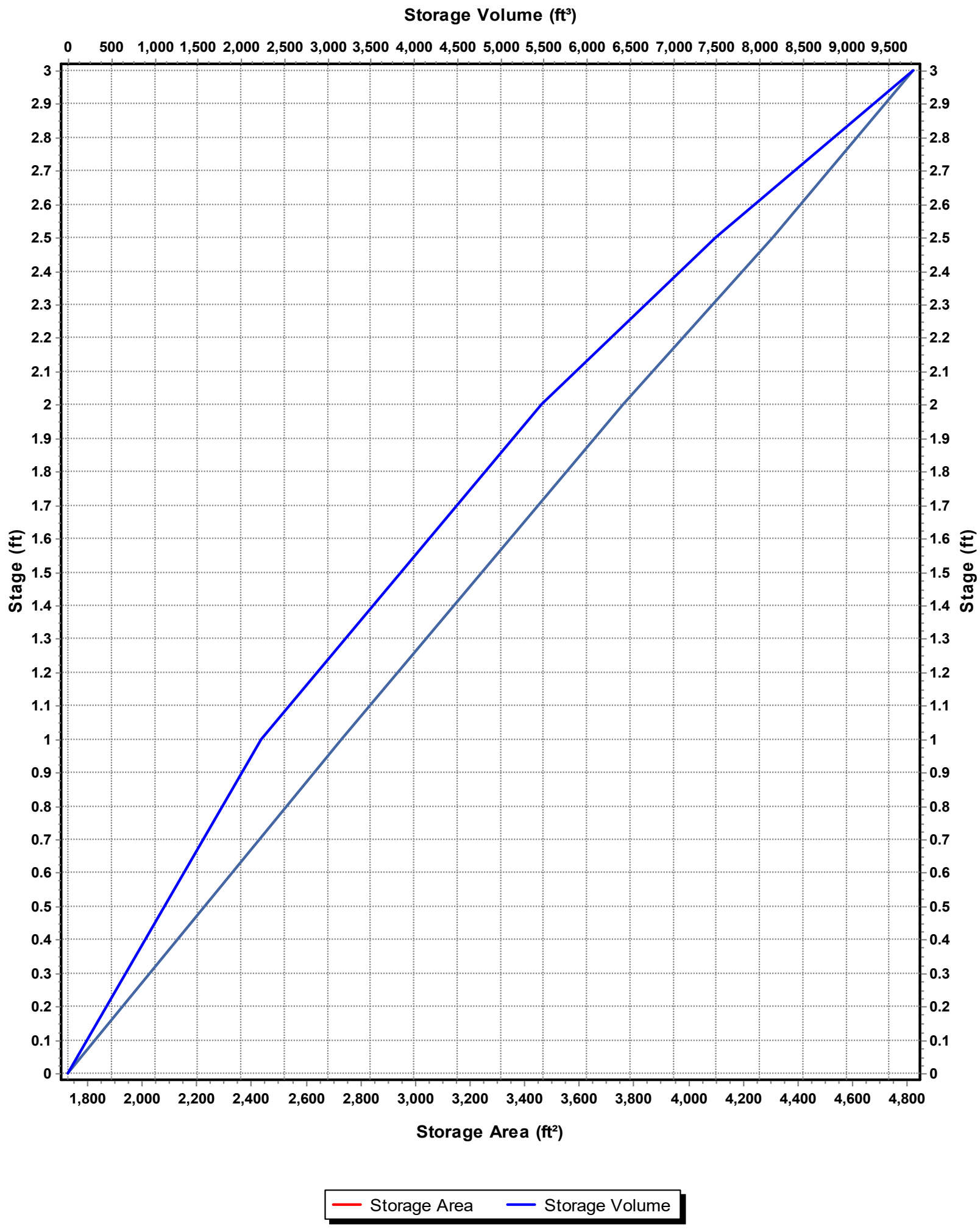
Invert Elevation (ft)	114.00
Max (Rim) Elevation (ft)	117.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Storage-10

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	1729.74	0
1	2729.32	2229.53
2	3760.91	5474.65
2.5	4312.03	7492.89
3	4824.52	9777.03

Storage Area Volume Curves



Storage Node : Basin-A1 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-A1	Trapezoidal	No	116.50	2.50	10.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	0.78
Peak Lateral Inflow (cfs)	0
Peak Outflow (cfs)	0
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	115.11
Max HGL Depth Attained (ft)	1.11
Average HGL Elevation Attained (ft)	114.89
Average HGL Depth Attained (ft)	0.89
Time of Max HGL Occurrence (days hh:mm)	1 00:42
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Forebay-A1

Input Data

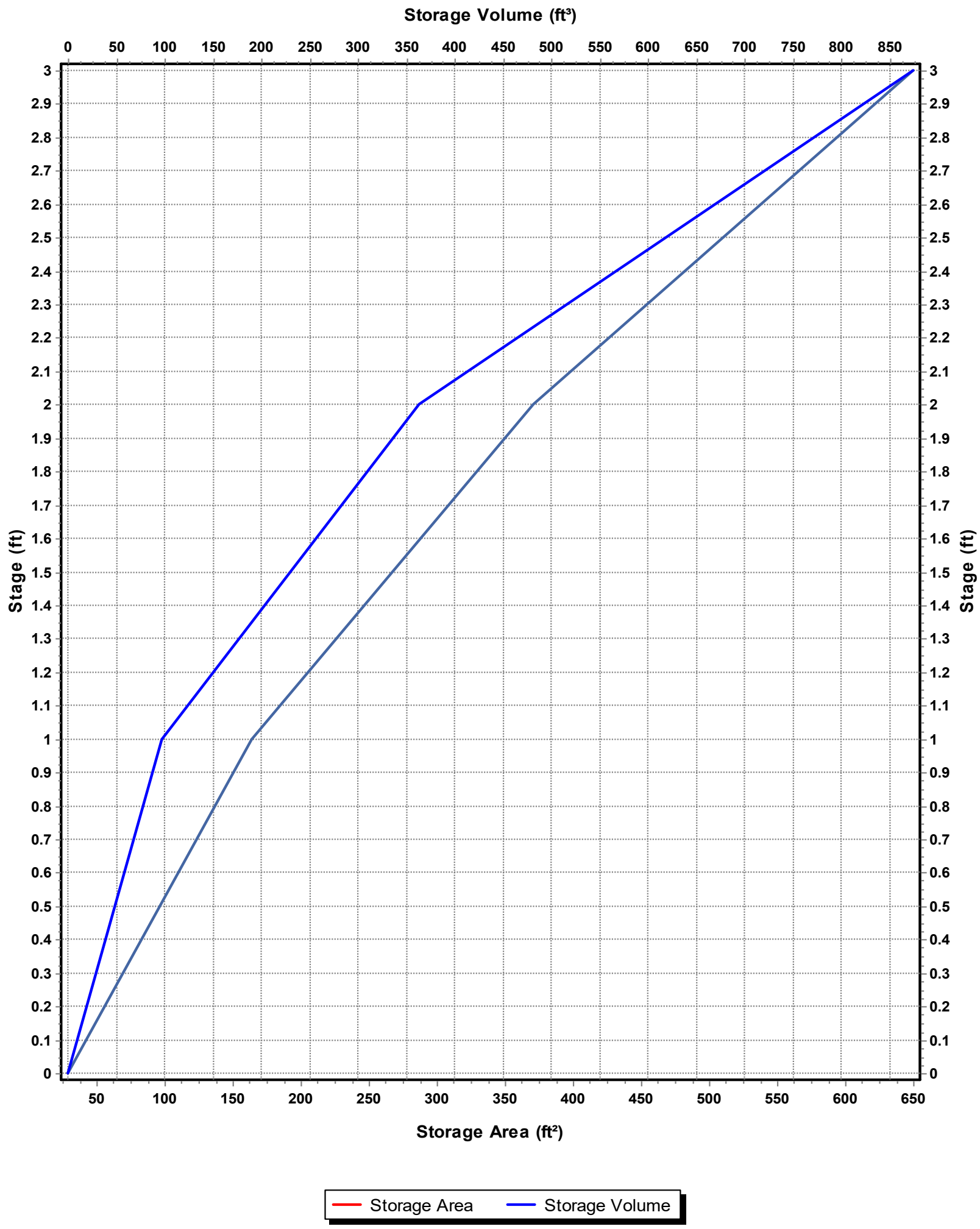
Invert Elevation (ft)	114.00
Max (Rim) Elevation (ft)	117.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Storage-11

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	29	0
1	164	96.5
2	371	364
3	650	874.5

Storage Area Volume Curves



Storage Node : Forebay-A1 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-FA1	Trapezoidal	No	116.00	2.00	10.00	1.00	3.33

Output Summary Results

Peak Inflow (cfs)	0.79
Peak Lateral Inflow (cfs)	0.79
Peak Outflow (cfs)	0.78
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	116.08
Max HGL Depth Attained (ft)	2.08
Average HGL Elevation Attained (ft)	115.68
Average HGL Depth Attained (ft)	1.68
Time of Max HGL Occurrence (days hh:mm)	0 12:10
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Project Description

File Name ..... Bourne_A1.SPF

Project Options

Flow Units ..... CFS
Elevation Type ..... Elevation
Hydrology Method ..... SCS TR-20
Time of Concentration (TOC) Method ..... SCS TR-55
Link Routing Method ..... Hydrodynamic
Enable Overflow Ponding at Nodes ..... YES
Skip Steady State Analysis Time Periods ..... NO

Analysis Options

Start Analysis On ..... oct. 14, 2021 0:00:00
End Analysis On ..... oct. 17, 2021 0:00:00
Start Reporting On ..... oct. 14, 2021 0:00:00
Antecedent Dry Days ..... 0 days
Runoff (Dry Weather) Time Step ..... 0 01:00:00 days hh:mm:ss
Runoff (Wet Weather) Time Step ..... 0 00:05:00 days hh:mm:ss
Reporting Time Step ..... 0 00:05:00 days hh:mm:ss
Routing Time Step ..... 30 seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	2
Nodes	4
Junctions	0
Outfalls	2
Flow Diversions	0
Inlets	0
Storage Nodes	2
Links	2
Channels	0
Pipes	0
Pumps	0
Orifices	0
Weirs	2
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	10 years	Intensity	inches	Massachusetts	None	10.00	5.01	SCS Type III 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Sub-A1	0.61	484.00	76.00	5.01	2.54	1.55	1.60	0 00:06:00
2	Sub-E01	0.42	484.00	43.00	5.01	0.36	0.15	0.04	0 00:39:05

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Out-A1	Outfall	110.00					0.00	110.00					
2	Out-E01	Outfall	0.00					0.04	0.00					
3	Basin-A1	Storage Node	114.00	117.00	114.00		0.00	1.55	115.94				0.00	0.00
4	Forebay-A1	Storage Node	114.00	117.00	114.00		0.00	1.55	116.13				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(ft)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
1	Weir-A1	Weir	Basin-A1	Out-A1		114.00	110.00				0.00							
2	Weir-FA1	Weir	Forebay-A1	Basin-A1		114.00	114.00				1.55							

Subbasin Hydrology

Subbasin : Sub-A1

Input Data

Area (ac)	0.61
Peak Rate Factor	484
Weighted Curve Number	76
Rain Gage ID	Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	0.61	A	76
Composite Area & Weighted CN	0.61		76

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft^2)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	133.39	0	0
Slope (%) :	1.36	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	1.01	0	0
Computed Flow Time (min) :	2.21	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	92.85	0	0
Channel Slope (%) :	0.3	0	0
Cross Section Area (ft^2) :	3	0	0
Wetted Perimeter (ft) :	6.32	0	0
Velocity (ft/sec) :	1.66	0	0
Computed Flow Time (min) :	0.93	0	0

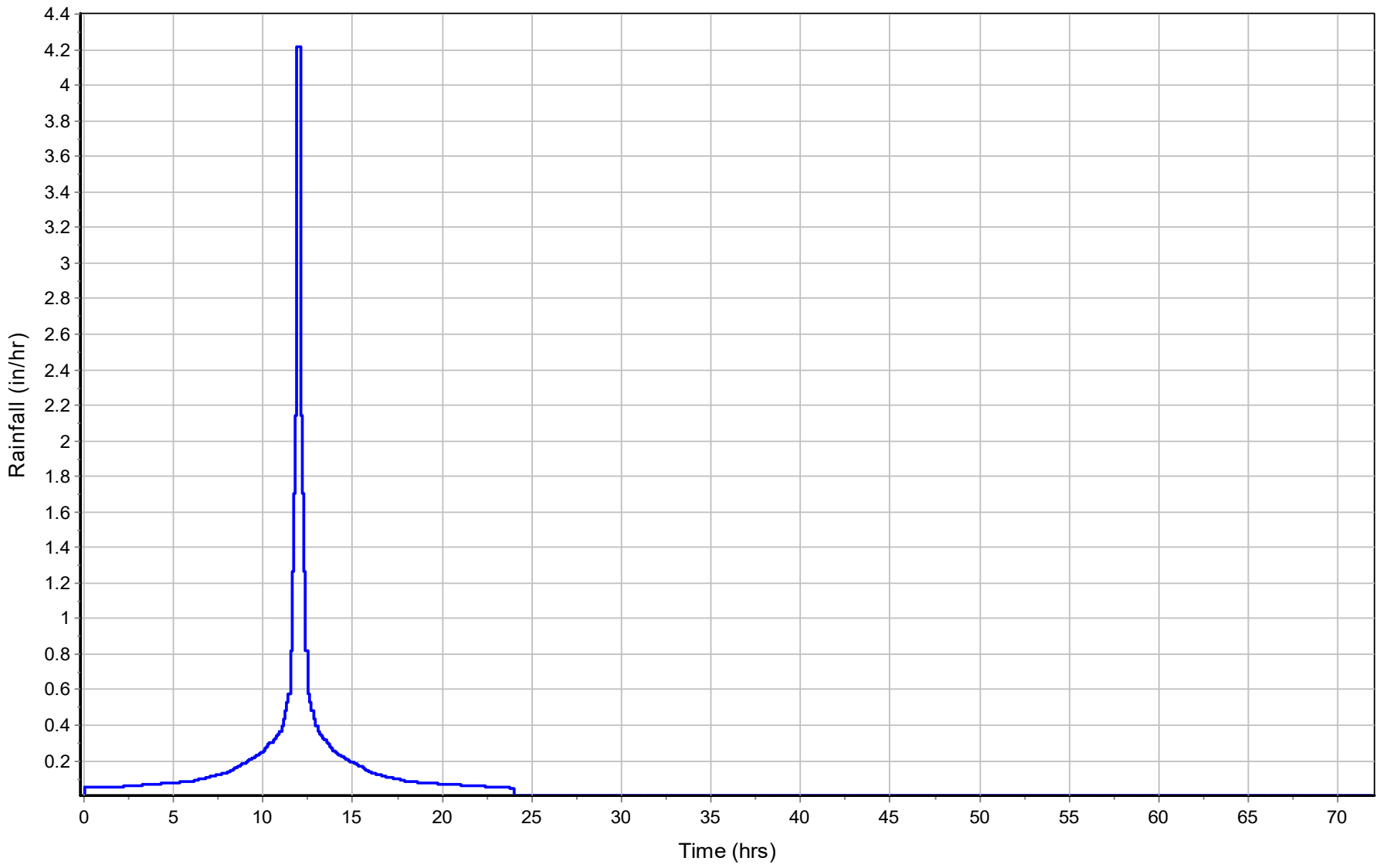
Total TOC (min) 3.15

Subbasin Runoff Results

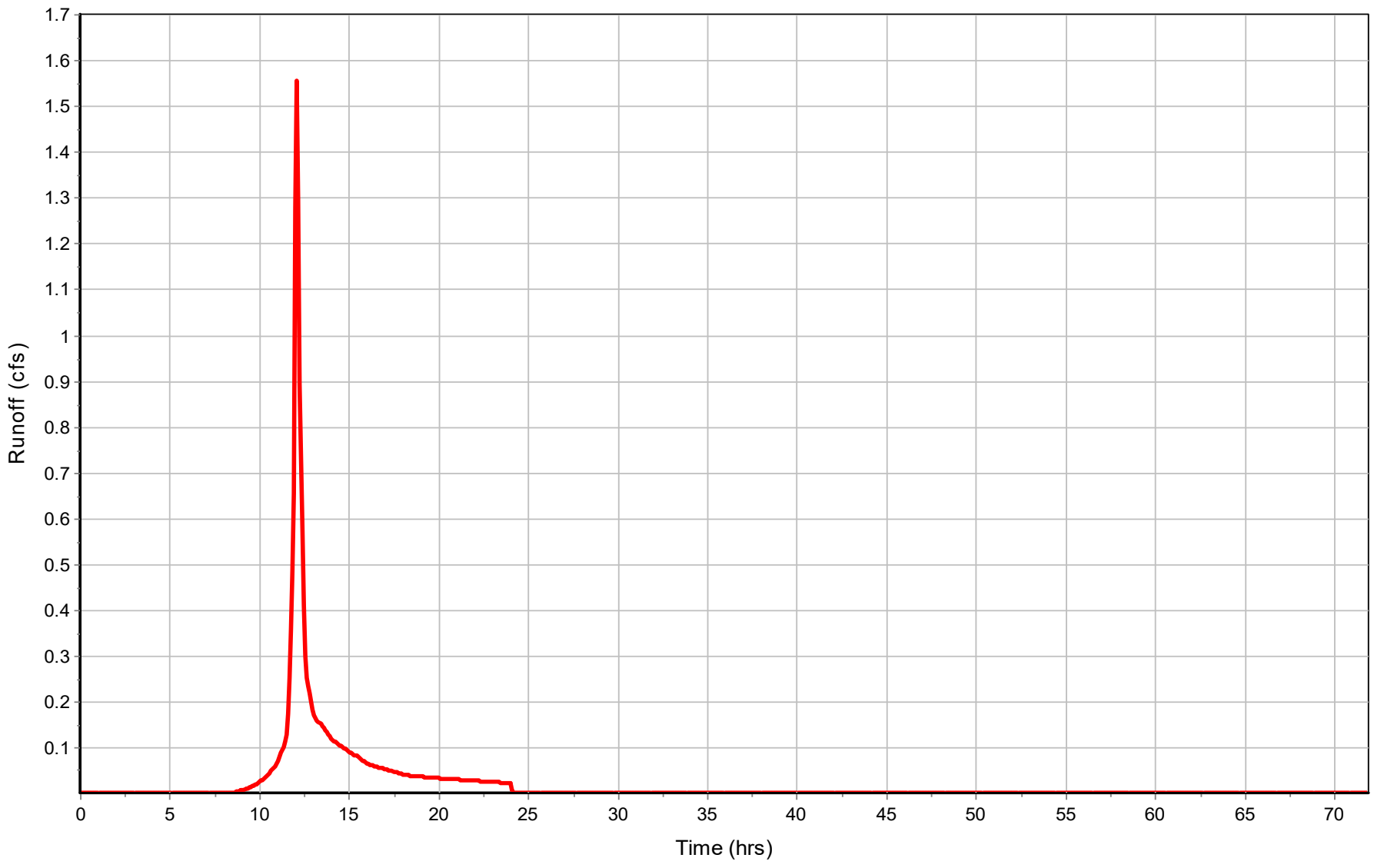
Total Rainfall (in)	5.01
Total Runoff (in)	2.54
Peak Runoff (cfs)	1.6
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:03:09

Subbasin : Sub-A1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E01

Input Data

Area (ac) 0.42
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.21	A	43
Composite Area & Weighted CN	0.21		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	173.96	0	0
Slope (%) :	5	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.07	0	0
Computed Flow Time (min) :	39.09	0	0

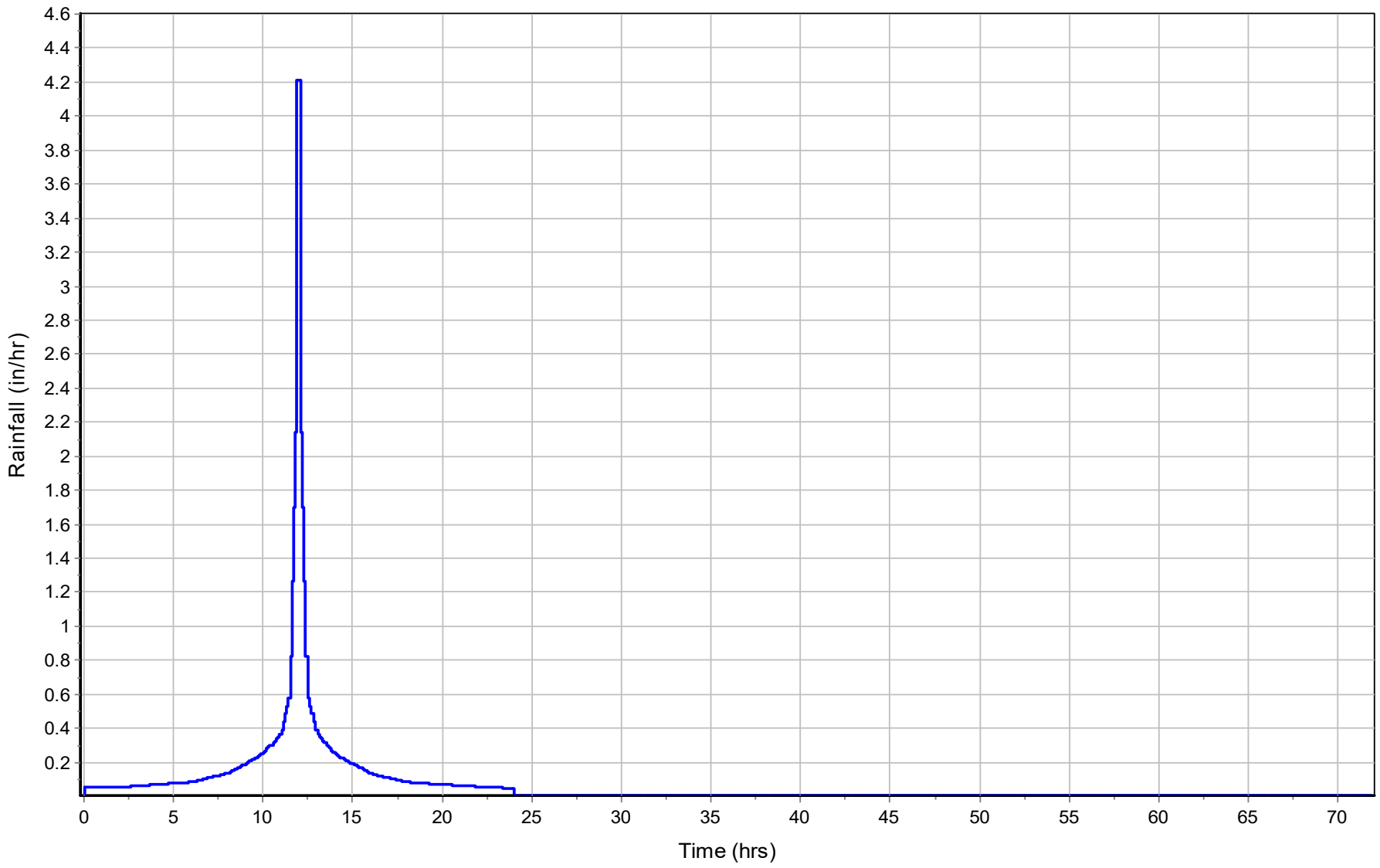
Total TOC (min) 39.09

Subbasin Runoff Results

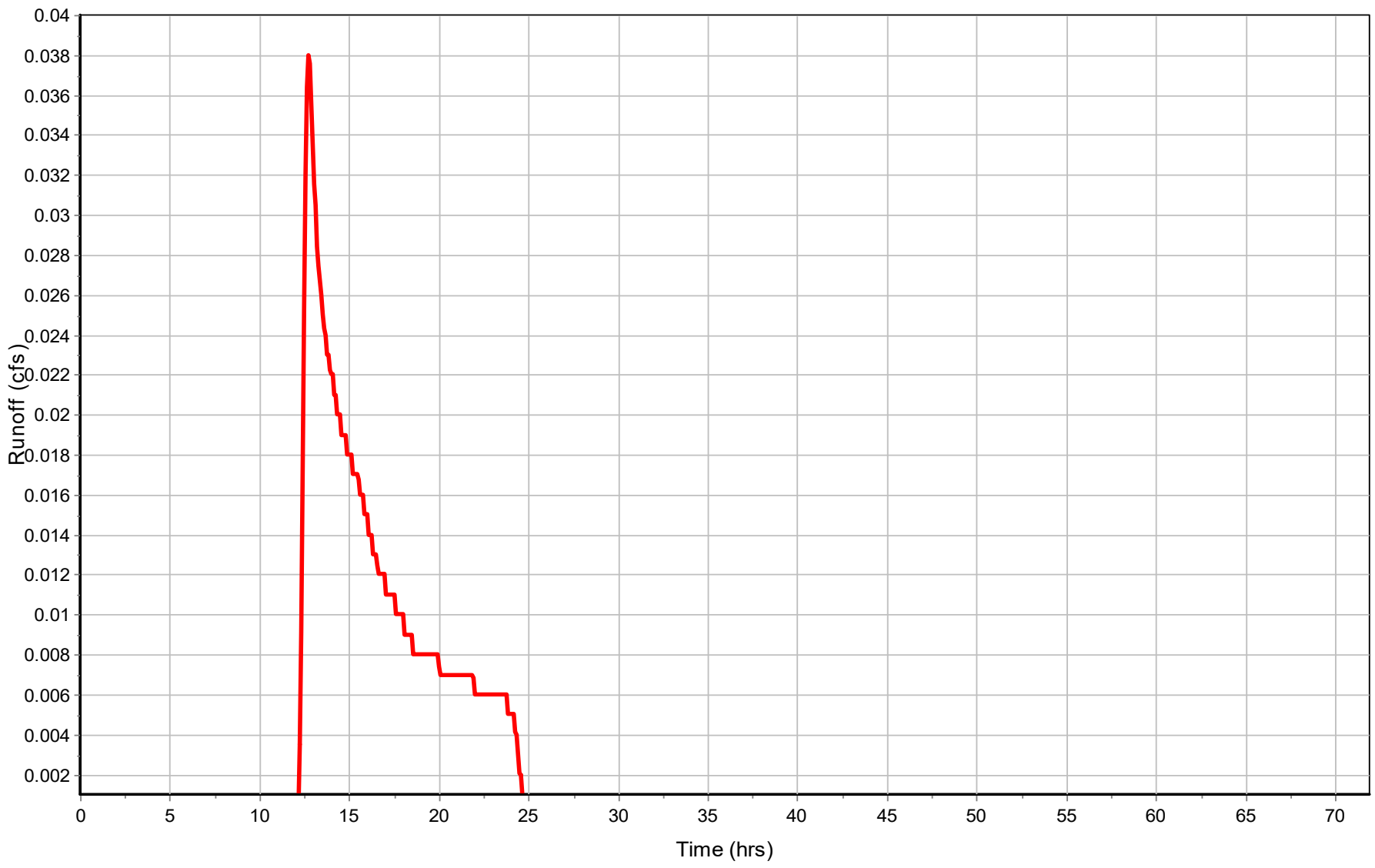
Total Rainfall (in) 5.01
Total Runoff (in) 0.36
Peak Runoff (cfs) 0.04
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:39:05

Subbasin : Sub-E01

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A1

Input Data

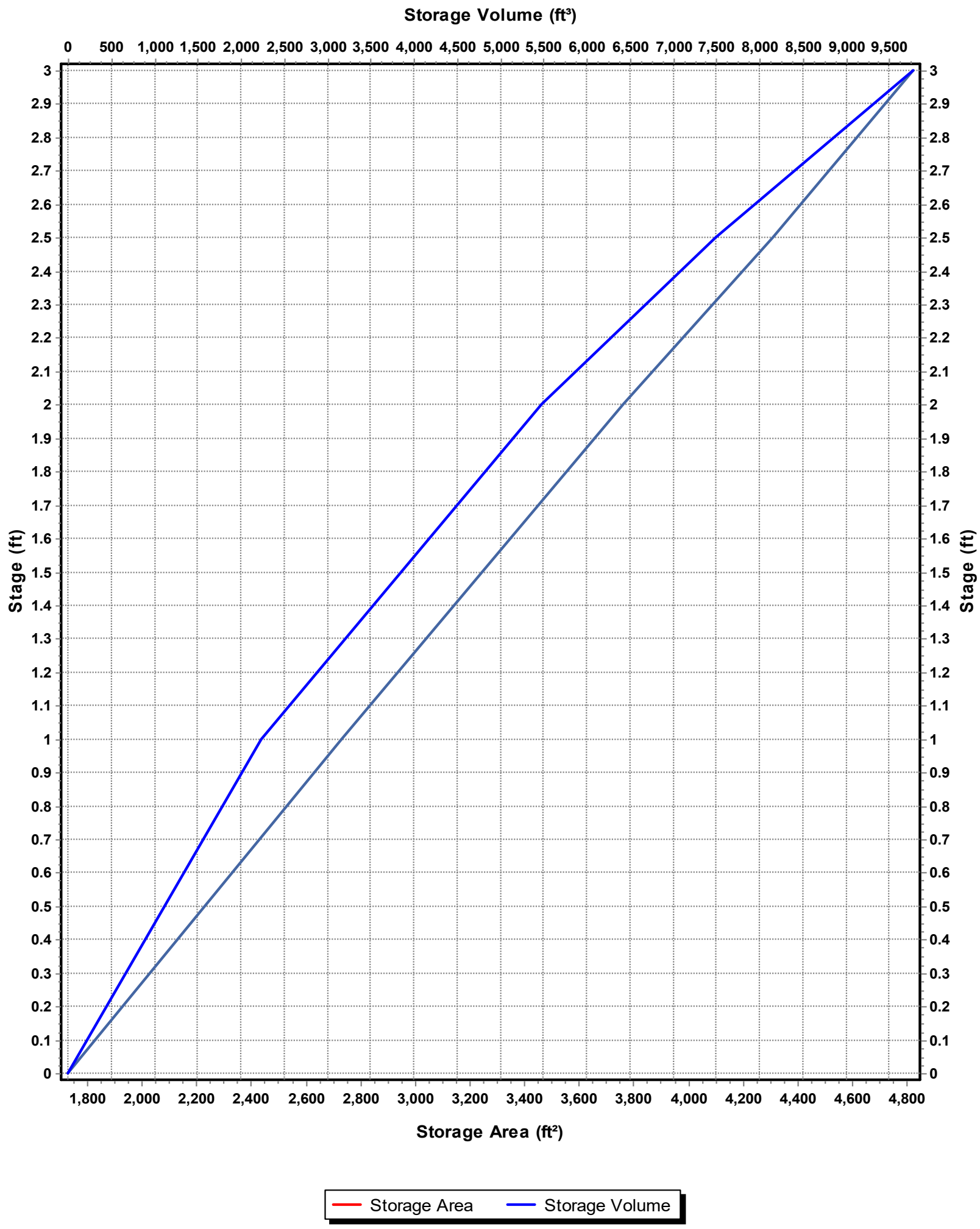
Invert Elevation (ft)	114.00
Max (Rim) Elevation (ft)	117.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Storage-10

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	1729.74	0
1	2729.32	2229.53
2	3760.91	5474.65
2.5	4312.03	7492.89
3	4824.52	9777.03

Storage Area Volume Curves



Storage Node : Basin-A1 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-A1	Trapezoidal	No	116.50	2.50	10.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	1.55
Peak Lateral Inflow (cfs)	0
Peak Outflow (cfs)	0
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	115.94
Max HGL Depth Attained (ft)	1.94
Average HGL Elevation Attained (ft)	115.57
Average HGL Depth Attained (ft)	1.57
Time of Max HGL Occurrence (days hh:mm)	1 00:43
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Forebay-A1

Input Data

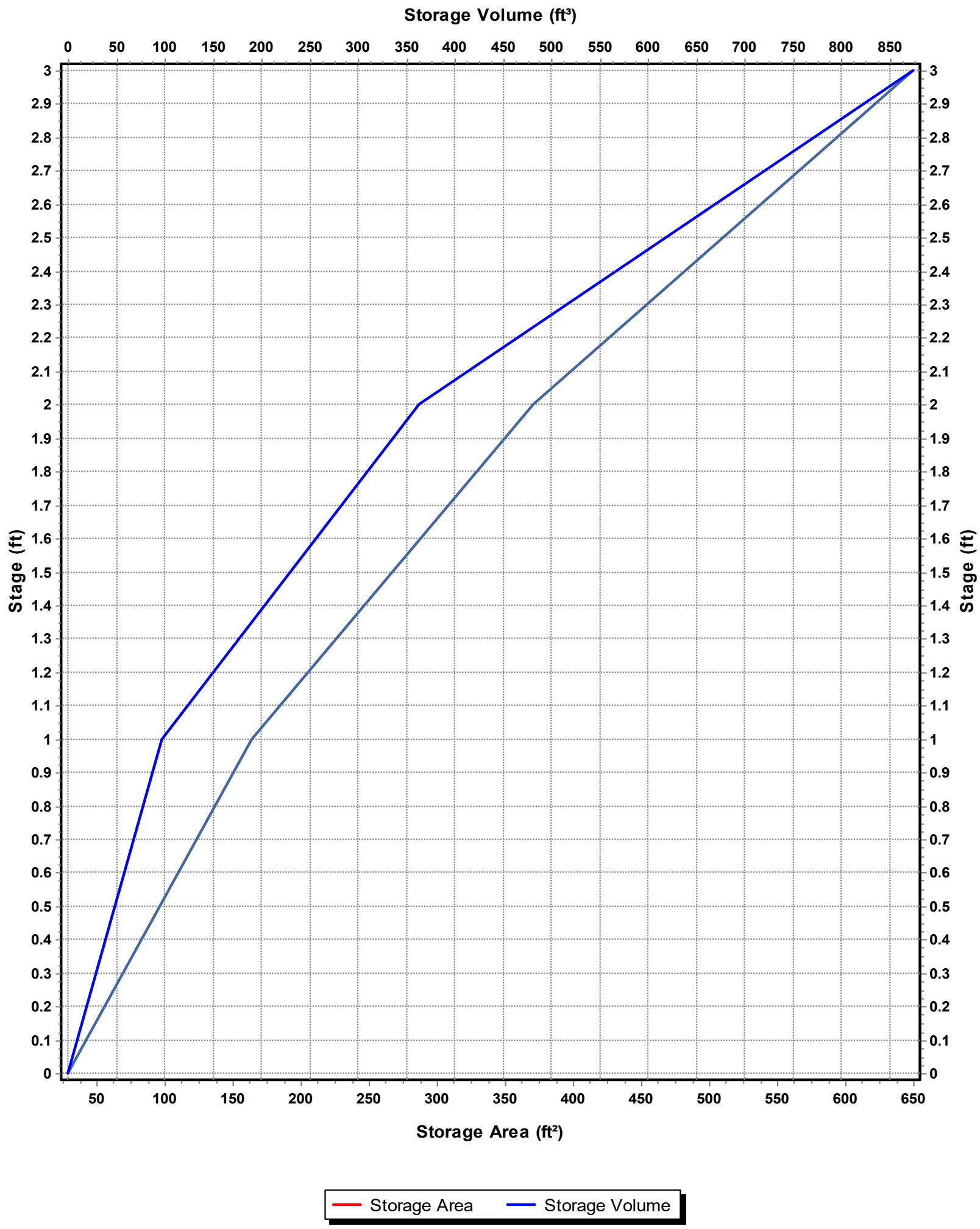
Invert Elevation (ft)	114.00
Max (Rim) Elevation (ft)	117.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Storage-11

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	29	0
1	164	96.5
2	371	364
3	650	874.5

Storage Area Volume Curves



Storage Node : Forebay-A1 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-FA1	Trapezoidal	No	116.00	2.00	10.00	1.00	3.33

Output Summary Results

Peak Inflow (cfs) 1.55
Peak Lateral Inflow (cfs) 1.55
Peak Outflow (cfs) 1.55
Peak Exfiltration Flow Rate (cfm) 0
Max HGL Elevation Attained (ft) 116.13
Max HGL Depth Attained (ft) 2.13
Average HGL Elevation Attained (ft) 115.72
Average HGL Depth Attained (ft) 1.72
Time of Max HGL Occurrence (days hh:mm) 0 12:10
Total Exfiltration Volume (1000-ft^3) 0
Total Flooded Volume (ac-in) 0
Total Time Flooded (min) 0
Total Retention Time (sec) 0

Project Description

File Name ..... Bourne_A1.SPF

Project Options

Flow Units ..... CFS
Elevation Type ..... Elevation
Hydrology Method ..... SCS TR-20
Time of Concentration (TOC) Method ..... SCS TR-55
Link Routing Method ..... Hydrodynamic
Enable Overflow Ponding at Nodes ..... YES
Skip Steady State Analysis Time Periods ..... NO

Analysis Options

Start Analysis On ..... oct. 14, 2021 0:00:00
End Analysis On ..... oct. 17, 2021 0:00:00
Start Reporting On ..... oct. 14, 2021 0:00:00
Antecedent Dry Days ..... 0 days
Runoff (Dry Weather) Time Step ..... 0 01:00:00 days hh:mm:ss
Runoff (Wet Weather) Time Step ..... 0 00:05:00 days hh:mm:ss
Reporting Time Step ..... 0 00:05:00 days hh:mm:ss
Routing Time Step ..... 30 seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	2
Nodes	4
Junctions	0
Outfalls	2
Flow Diversions	0
Inlets	0
Storage Nodes	2
Links	2
Channels	0
Pipes	0
Pumps	0
Orifices	0
Weirs	2
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	25 years	Intensity	inches	Massachusetts	None	25.00	5.99	SCS Type III 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Sub-A1	0.61	484.00	76.00	5.99	3.37	2.06	2.11	0 00:06:00
2	Sub-E01	0.42	484.00	43.00	5.99	0.67	0.28	0.10	0 00:39:05

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Out-A1	Outfall	110.00					0.02	110.00					
2	Out-E01	Outfall	0.00					0.10	0.00					
3	Basin-A1	Storage Node	114.00	117.00	114.00		0.00	2.05	116.50				0.00	0.00
4	Forebay-A1	Storage Node	114.00	117.00	114.00		0.00	2.06	116.55				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(ft)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
1	Weir-A1	Weir	Basin-A1	Out-A1		114.00	110.00				0.02							
2	Weir-FA1	Weir	Forebay-A1	Basin-A1		114.00	114.00				2.05							

Subbasin Hydrology

Subbasin : Sub-A1

Input Data

Area (ac)	0.61
Peak Rate Factor	484
Weighted Curve Number	76
Rain Gage ID	Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	0.61	A	76
Composite Area & Weighted CN	0.61		76

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft^2)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	133.39	0	0
Slope (%) :	1.36	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	1.01	0	0
Computed Flow Time (min) :	2.21	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	92.85	0	0
Channel Slope (%) :	0.3	0	0
Cross Section Area (ft^2) :	3	0	0
Wetted Perimeter (ft) :	6.32	0	0
Velocity (ft/sec) :	1.66	0	0
Computed Flow Time (min) :	0.93	0	0

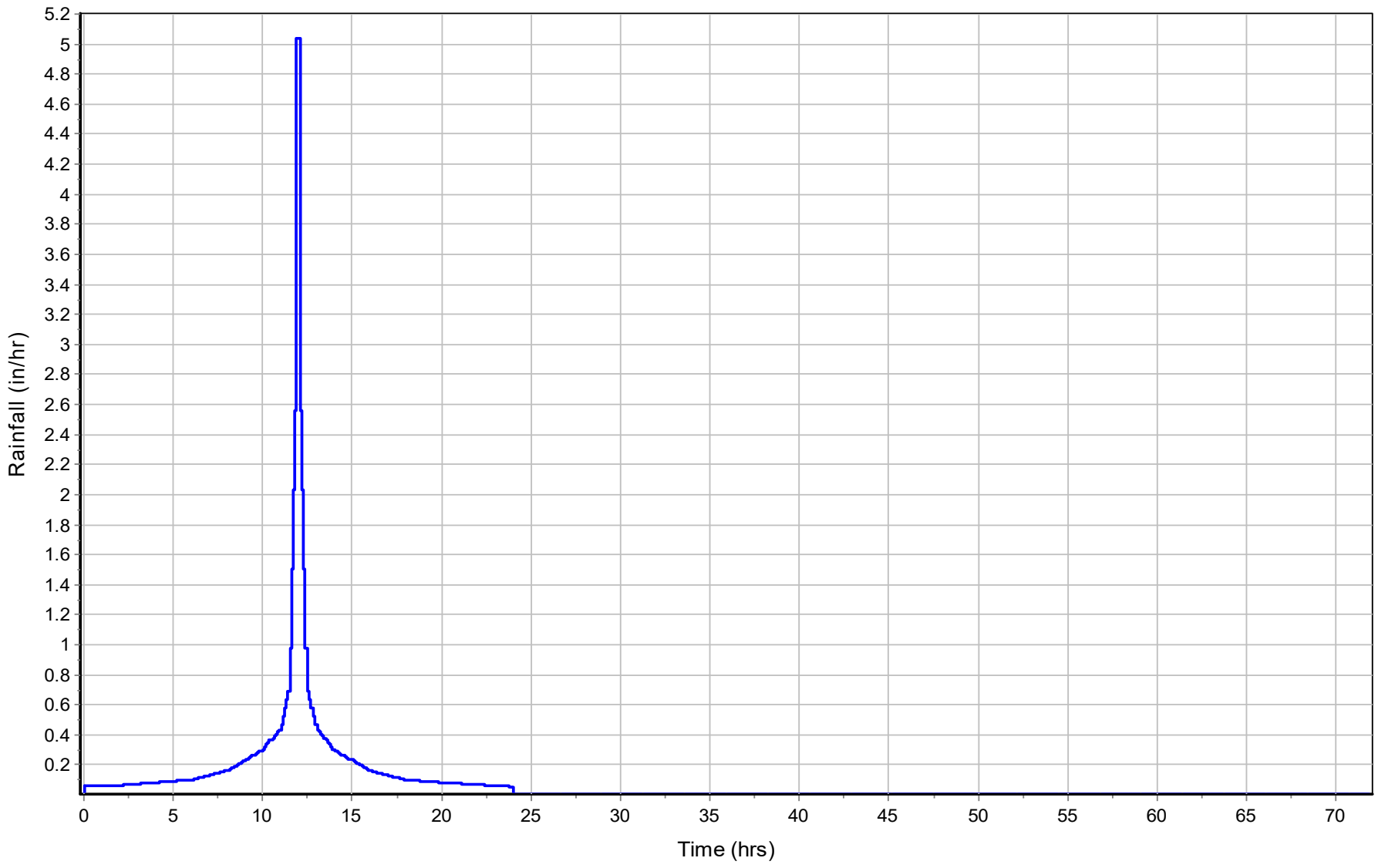
Total TOC (min) 3.15

Subbasin Runoff Results

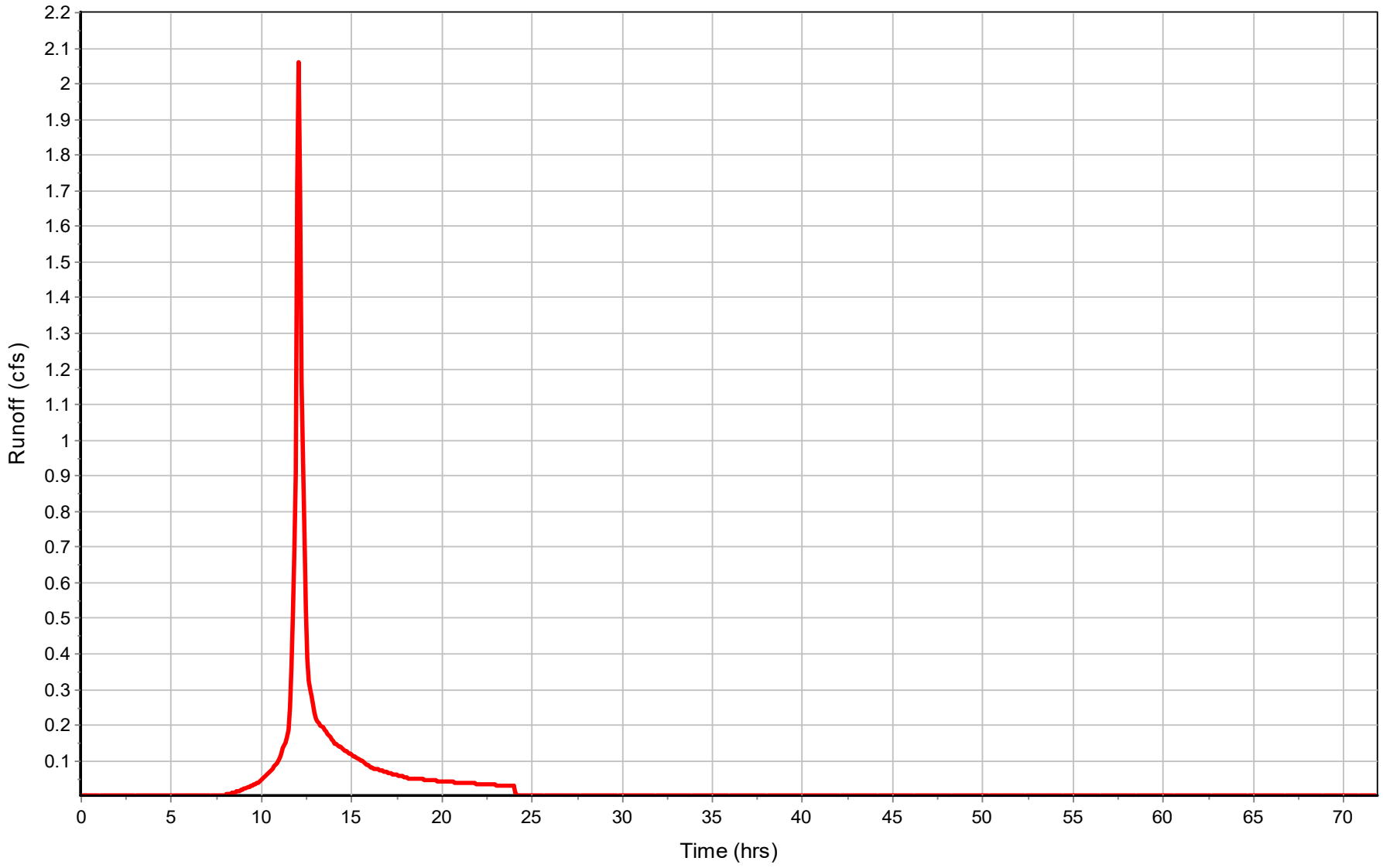
Total Rainfall (in)	5.99
Total Runoff (in)	3.37
Peak Runoff (cfs)	2.11
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:03:09

Subbasin : Sub-A1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E01

Input Data

Area (ac) 0.42
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.21	A	43
Composite Area & Weighted CN	0.21		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	173.96	0	0
Slope (%) :	5	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.07	0	0
Computed Flow Time (min) :	39.09	0	0

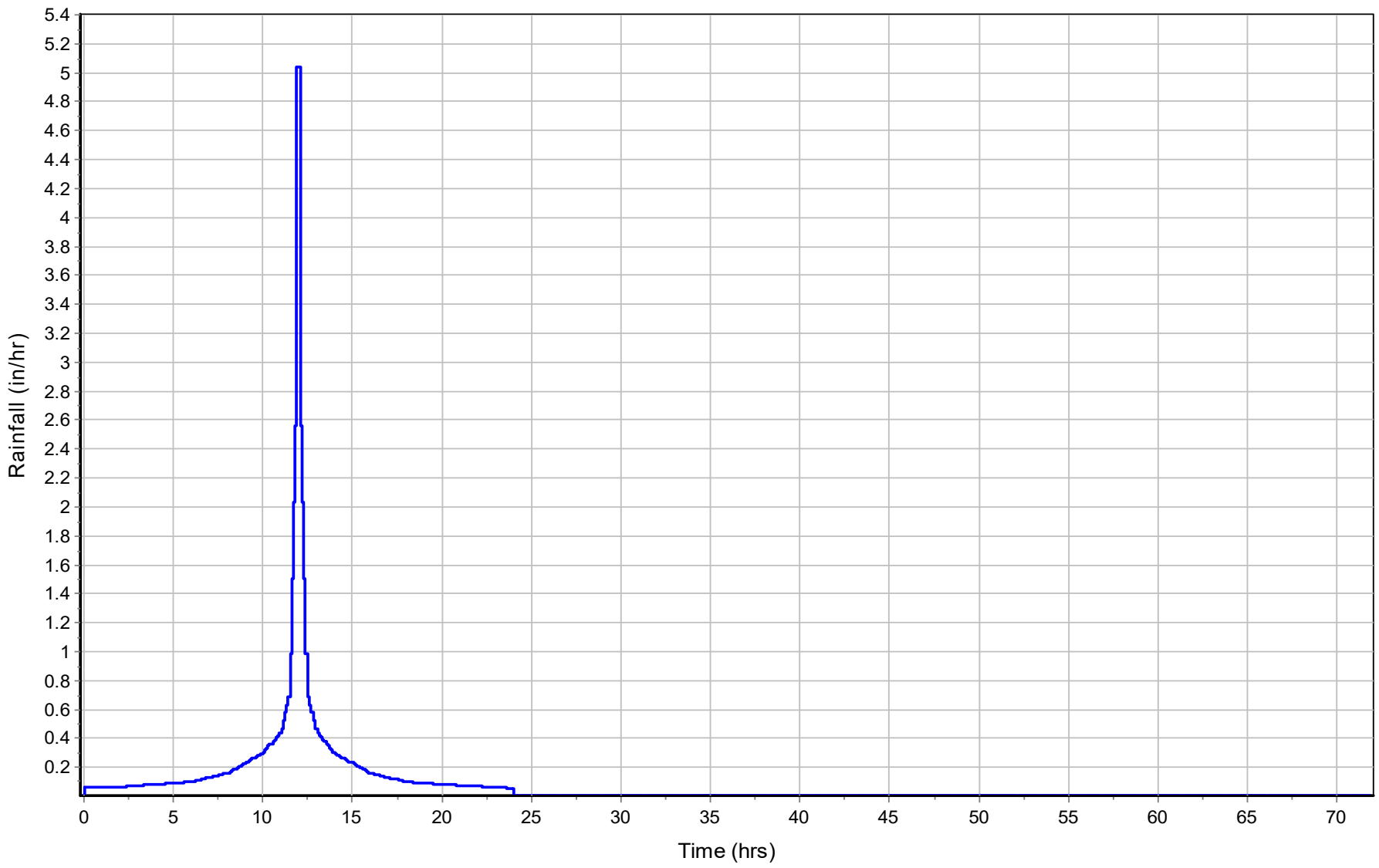
Total TOC (min) 39.09

Subbasin Runoff Results

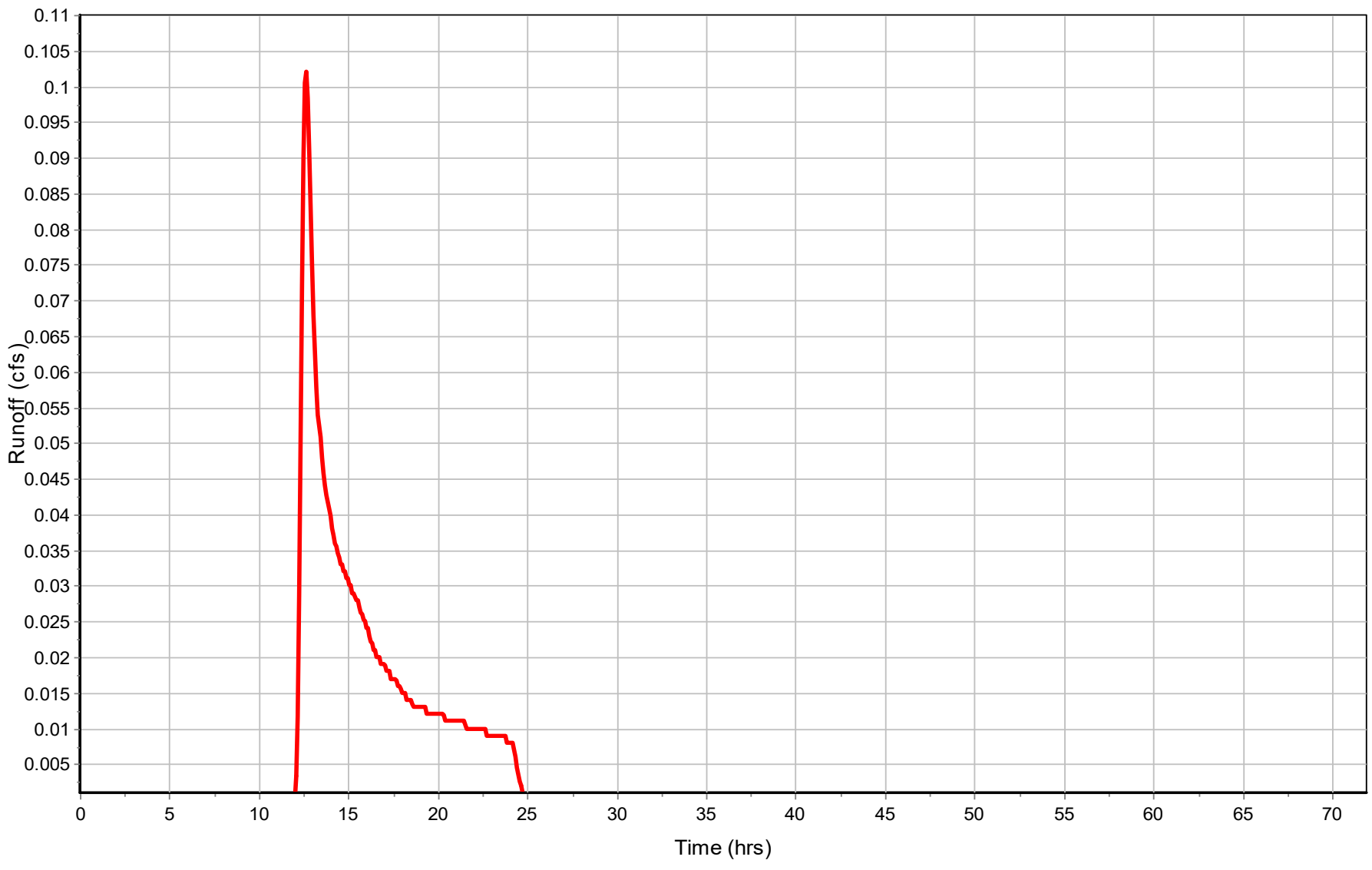
Total Rainfall (in) 5.99
Total Runoff (in) 0.67
Peak Runoff (cfs) 0.1
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:39:05

Subbasin : Sub-E01

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A1

Input Data

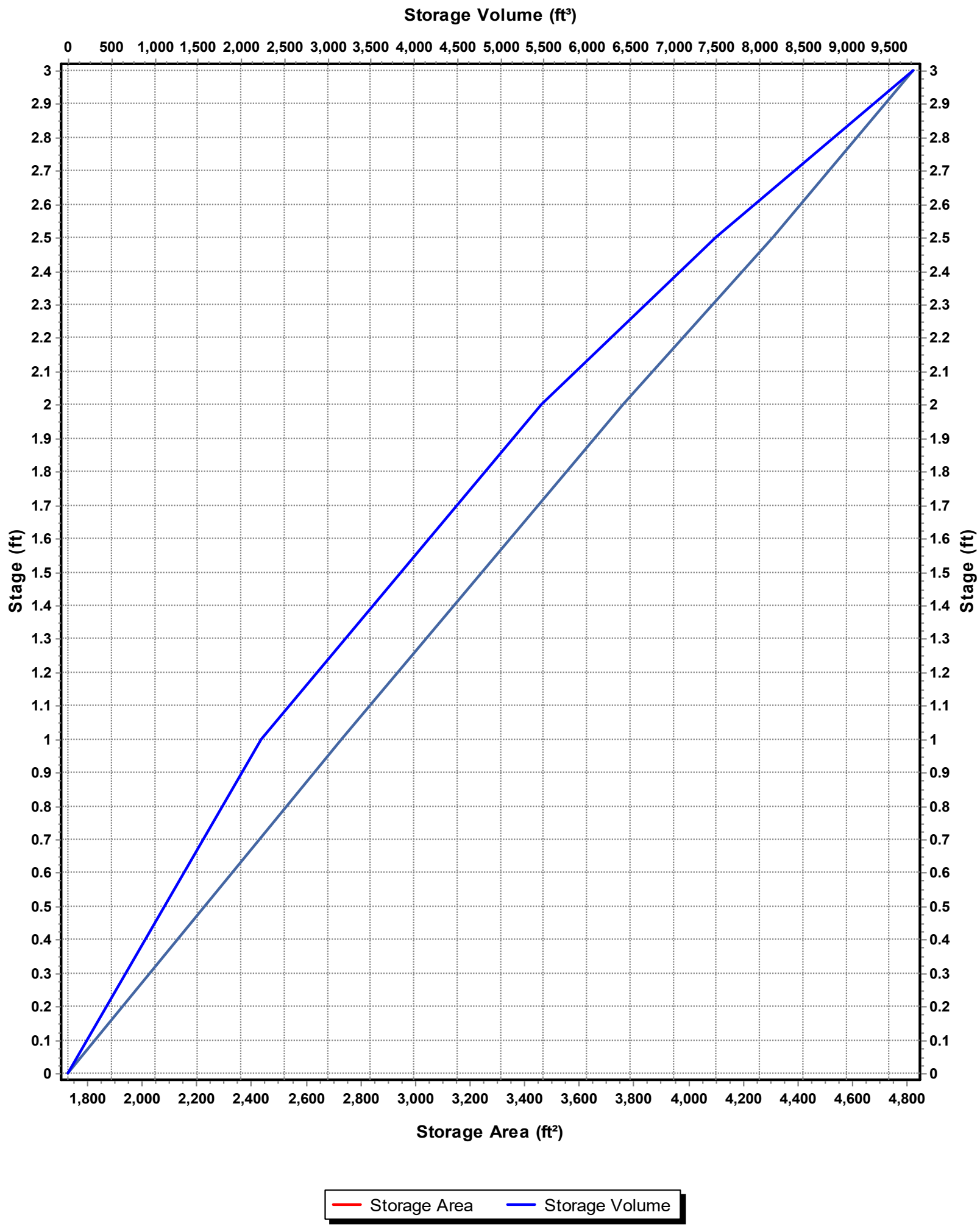
Invert Elevation (ft)	114.00
Max (Rim) Elevation (ft)	117.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Storage-10

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	1729.74	0
1	2729.32	2229.53
2	3760.91	5474.65
2.5	4312.03	7492.89
3	4824.52	9777.03

Storage Area Volume Curves



Storage Node : Basin-A1 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-A1	Trapezoidal	No	116.50	2.50	10.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	2.05
Peak Lateral Inflow (cfs)	0
Peak Outflow (cfs)	0.33
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	116.5
Max HGL Depth Attained (ft)	2.5
Average HGL Elevation Attained (ft)	116
Average HGL Depth Attained (ft)	2
Time of Max HGL Occurrence (days hh:mm)	2 02:28
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Forebay-A1

Input Data

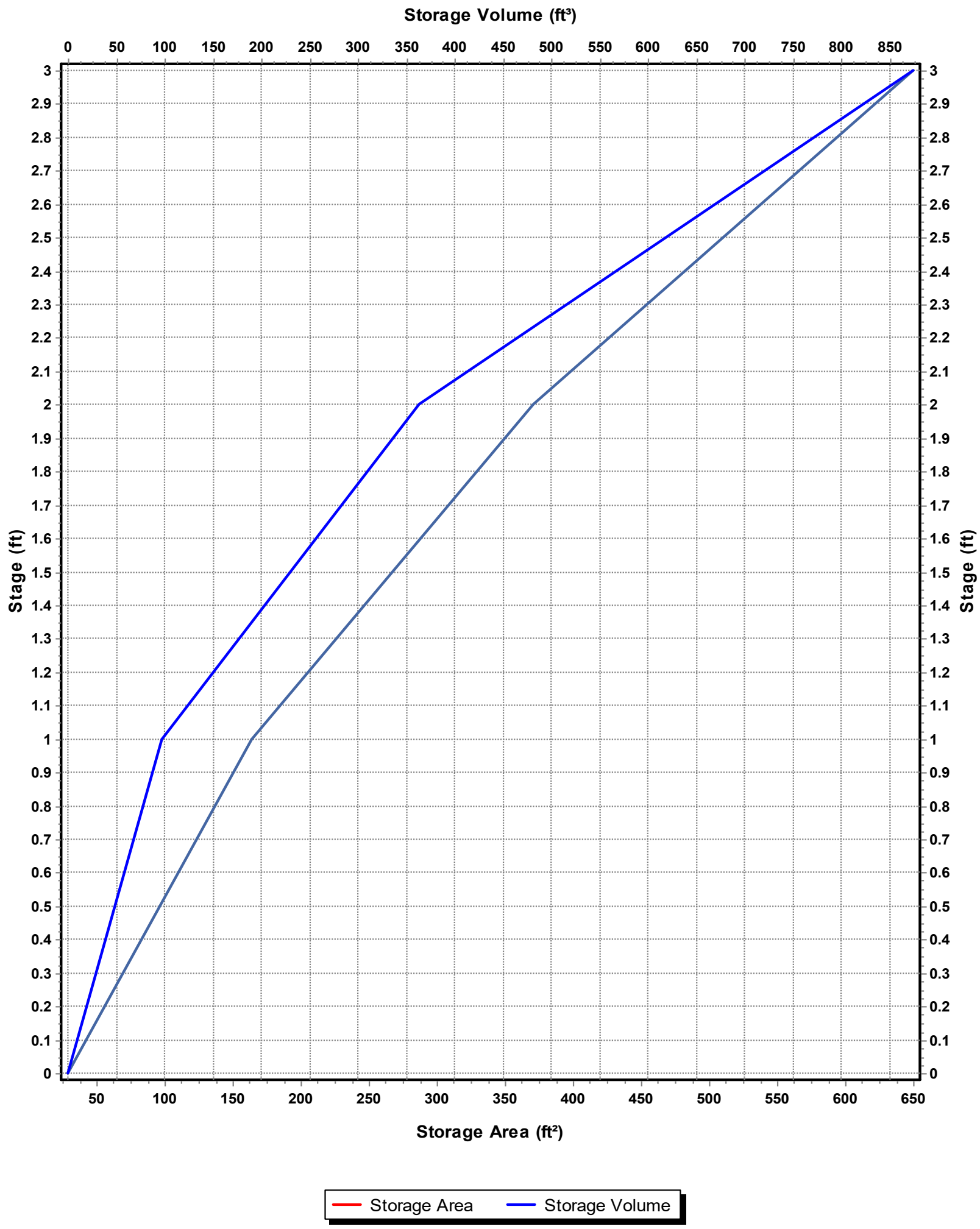
Invert Elevation (ft)	114.00
Max (Rim) Elevation (ft)	117.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Storage-11

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	29	0
1	164	96.5
2	371	364
3	650	874.5

Storage Area Volume Curves



Storage Node : Forebay-A1 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-FA1	Trapezoidal	No	116.00	2.00	10.00	1.00	3.33

Output Summary Results

Peak Inflow (cfs)	2.06
Peak Lateral Inflow (cfs)	2.06
Peak Outflow (cfs)	2.05
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	116.55
Max HGL Depth Attained (ft)	2.55
Average HGL Elevation Attained (ft)	116.12
Average HGL Depth Attained (ft)	2.12
Time of Max HGL Occurrence (days hh:mm)	2 02:33
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Project Description

File Name ..... Bourne_A1.SPF

Project Options

Flow Units ..... CFS
Elevation Type ..... Elevation
Hydrology Method ..... SCS TR-20
Time of Concentration (TOC) Method ..... SCS TR-55
Link Routing Method ..... Hydrodynamic
Enable Overflow Ponding at Nodes ..... YES
Skip Steady State Analysis Time Periods ..... NO

Analysis Options

Start Analysis On ..... oct. 14, 2021 0:00:00
End Analysis On ..... oct. 17, 2021 0:00:00
Start Reporting On ..... oct. 14, 2021 0:00:00
Antecedent Dry Days ..... 0 days
Runoff (Dry Weather) Time Step ..... 0 01:00:00 days hh:mm:ss
Runoff (Wet Weather) Time Step ..... 0 00:05:00 days hh:mm:ss
Reporting Time Step ..... 0 00:05:00 days hh:mm:ss
Routing Time Step ..... 30 seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	2
Nodes	4
Junctions	0
Outfalls	2
Flow Diversions	0
Inlets	0
Storage Nodes	2
Links	2
Channels	0
Pipes	0
Pumps	0
Orifices	0
Weirs	2
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	50 years	Intensity	inches	Massachusetts	None	50.00	6.74	SCS Type III 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Sub-A1	0.61	484.00	76.00	6.74	4.03	2.46	2.51	0 00:06:00
2	Sub-E01	0.42	484.00	43.00	6.74	0.96	0.40	0.17	0 00:39:05

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Out-A1	Outfall	110.00					0.07	110.00					
2	Out-E01	Outfall	0.00					0.17	0.00					
3	Basin-A1	Storage Node	114.00	117.00	114.00		0.00	2.44	116.51				0.00	0.00
4	Forebay-A1	Storage Node	114.00	117.00	114.00		0.00	2.45	116.57				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(ft)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
1	Weir-A1	Weir	Basin-A1	Out-A1		114.00	110.00				0.07							
2	Weir-FA1	Weir	Forebay-A1	Basin-A1		114.00	114.00				2.44							

Subbasin Hydrology

Subbasin : Sub-A1

Input Data

Area (ac)	0.61
Peak Rate Factor	484
Weighted Curve Number	76
Rain Gage ID	Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	0.61	A	76
Composite Area & Weighted CN	0.61		76

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft^2)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	133.39	0	0
Slope (%) :	1.36	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	1.01	0	0
Computed Flow Time (min) :	2.21	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	92.85	0	0
Channel Slope (%) :	0.3	0	0
Cross Section Area (ft^2) :	3	0	0
Wetted Perimeter (ft) :	6.32	0	0
Velocity (ft/sec) :	1.66	0	0
Computed Flow Time (min) :	0.93	0	0

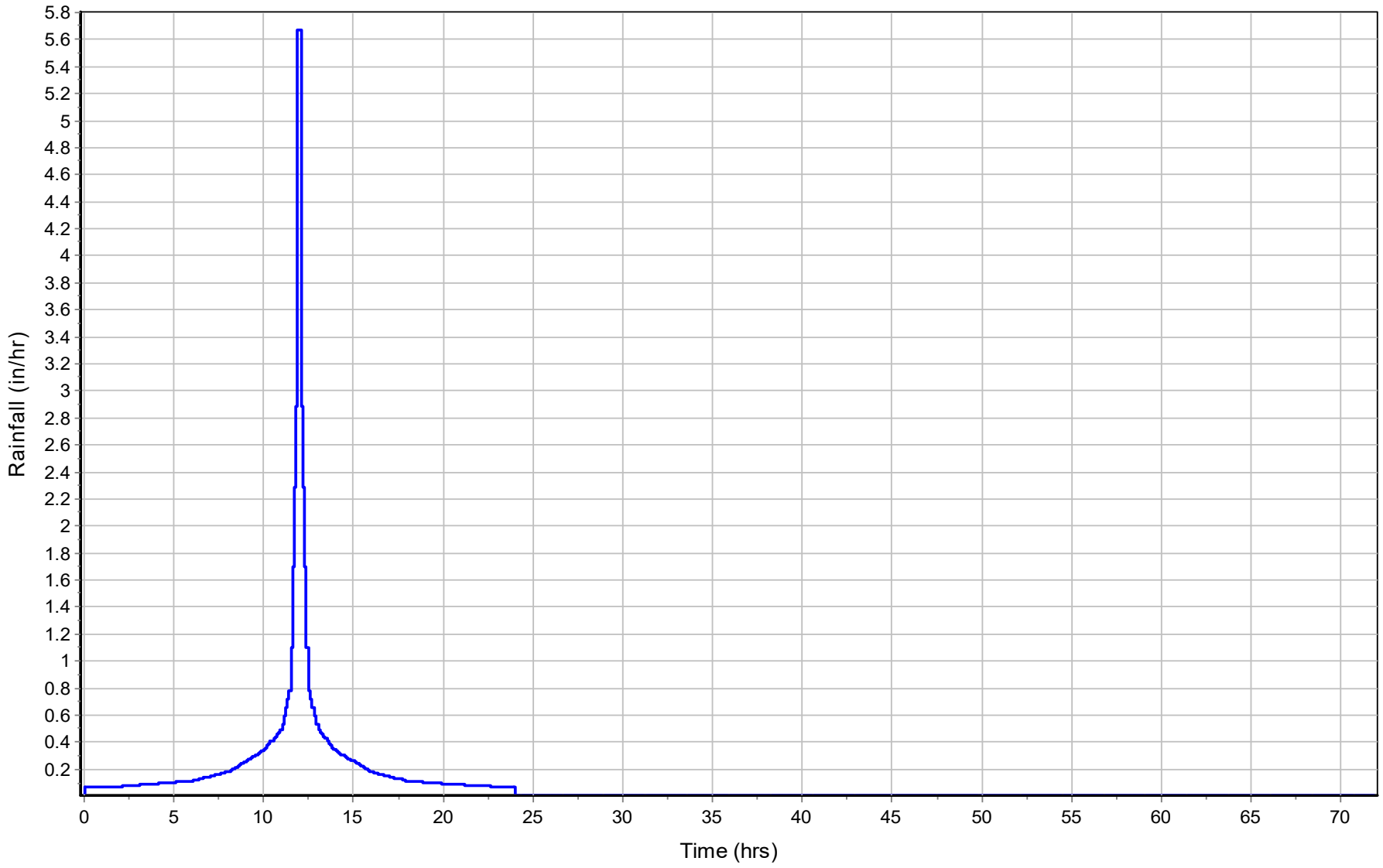
Total TOC (min) 3.15

Subbasin Runoff Results

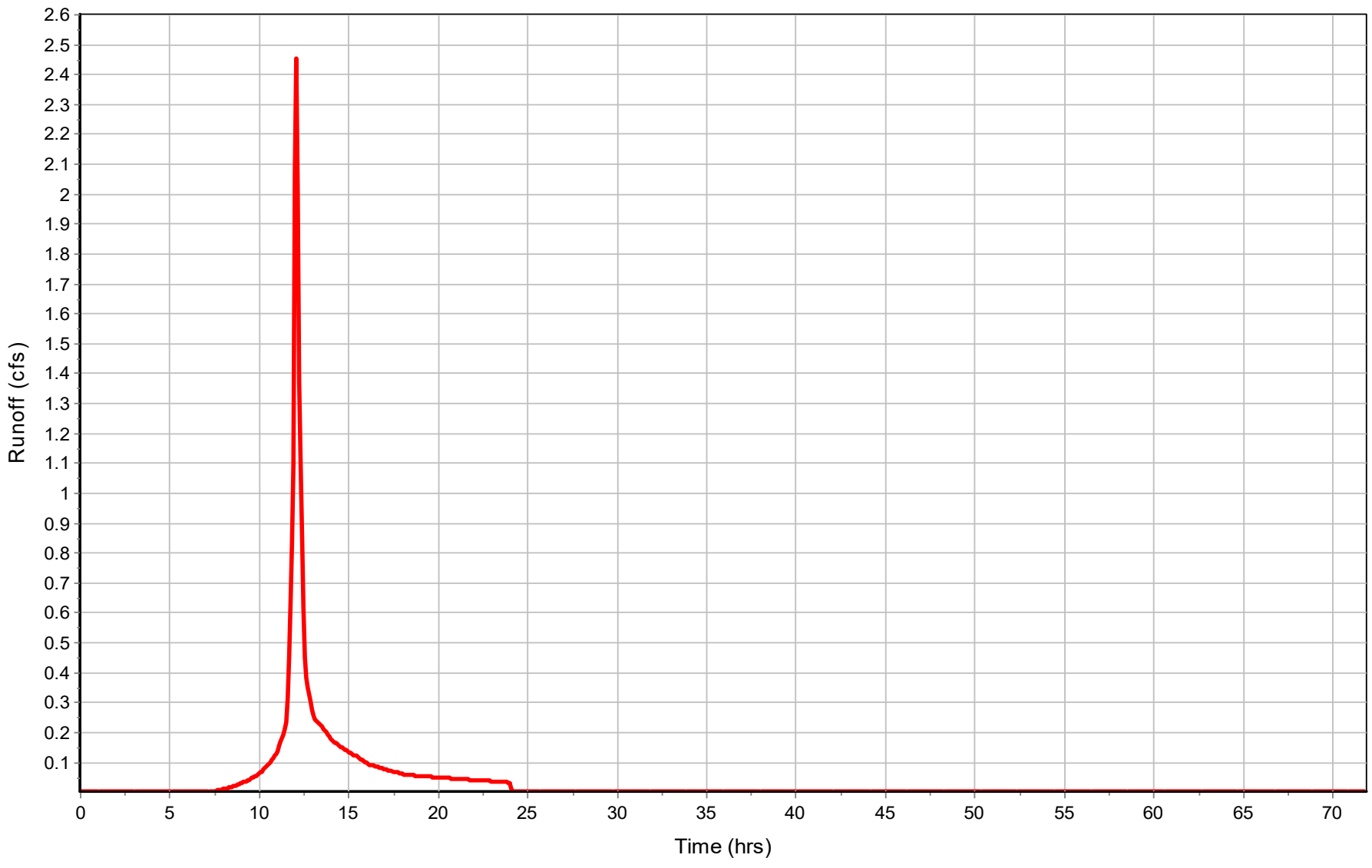
Total Rainfall (in)	6.74
Total Runoff (in)	4.03
Peak Runoff (cfs)	2.51
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:03:09

Subbasin : Sub-A1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E01

Input Data

Area (ac) 0.42
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.21	A	43
Composite Area & Weighted CN	0.21		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	173.96	0	0
Slope (%) :	5	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.07	0	0
Computed Flow Time (min) :	39.09	0	0

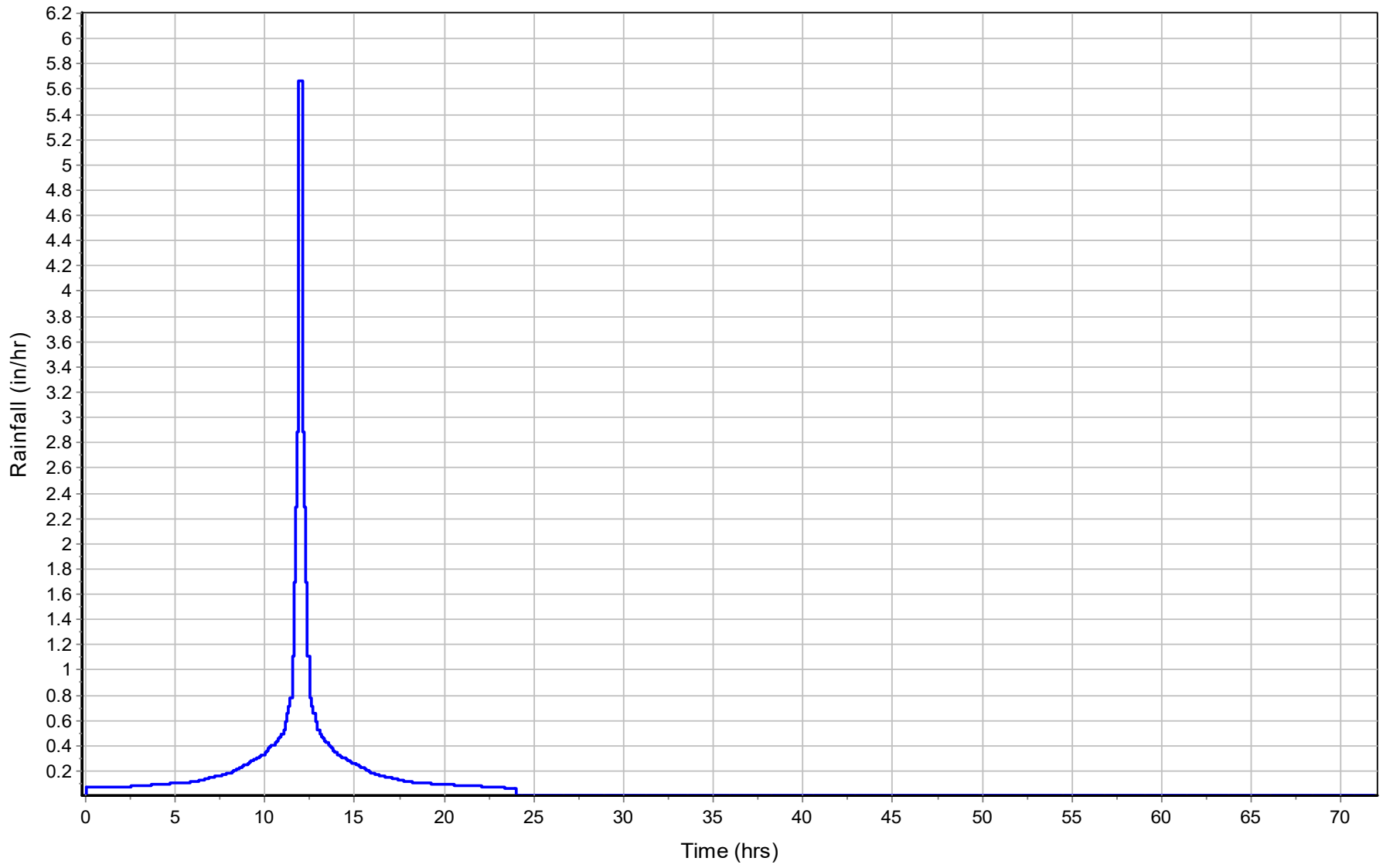
Total TOC (min) 39.09

Subbasin Runoff Results

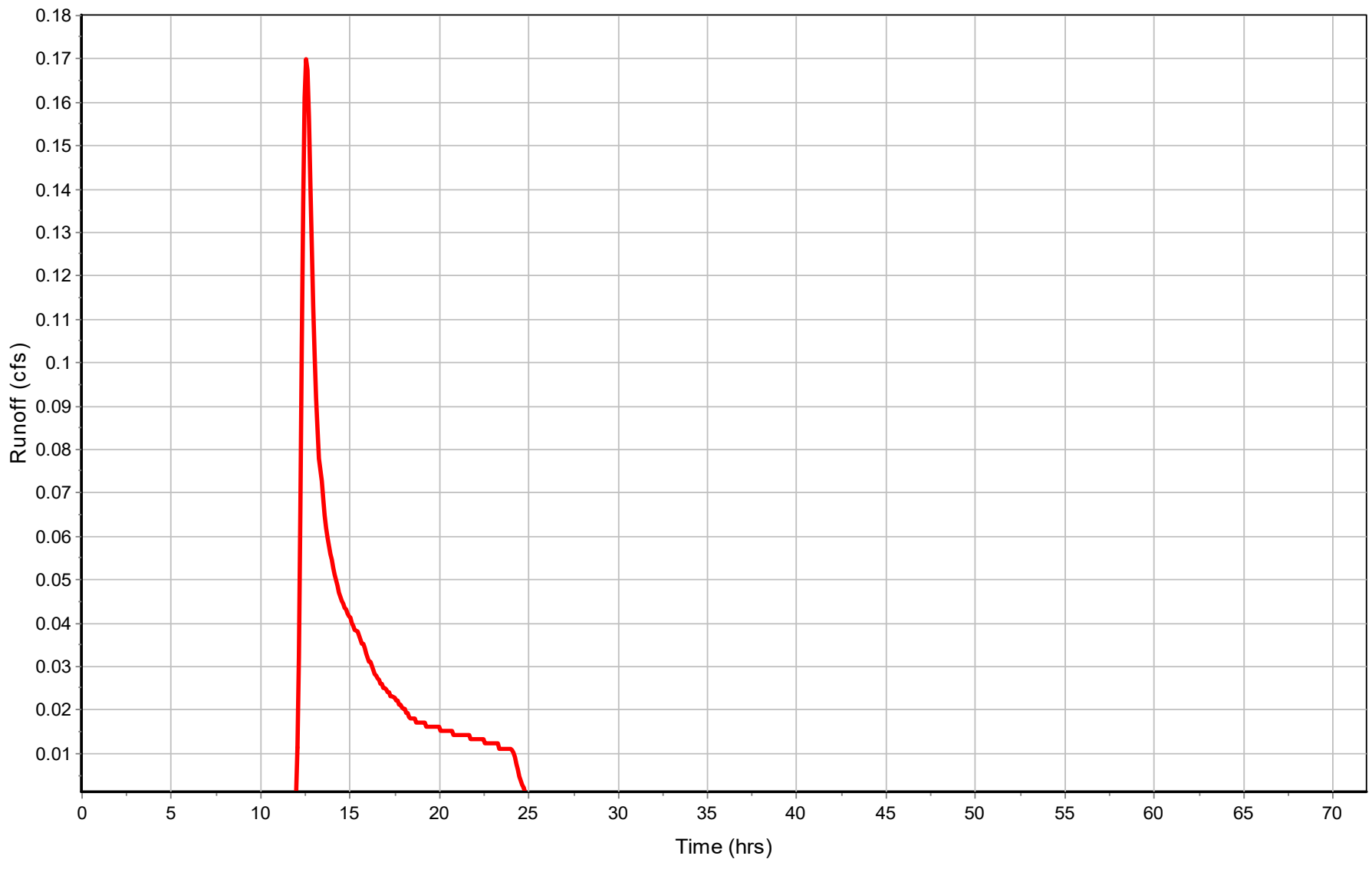
Total Rainfall (in) 6.74
Total Runoff (in) 0.96
Peak Runoff (cfs) 0.17
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:39:05

Subbasin : Sub-E01

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A1

Input Data

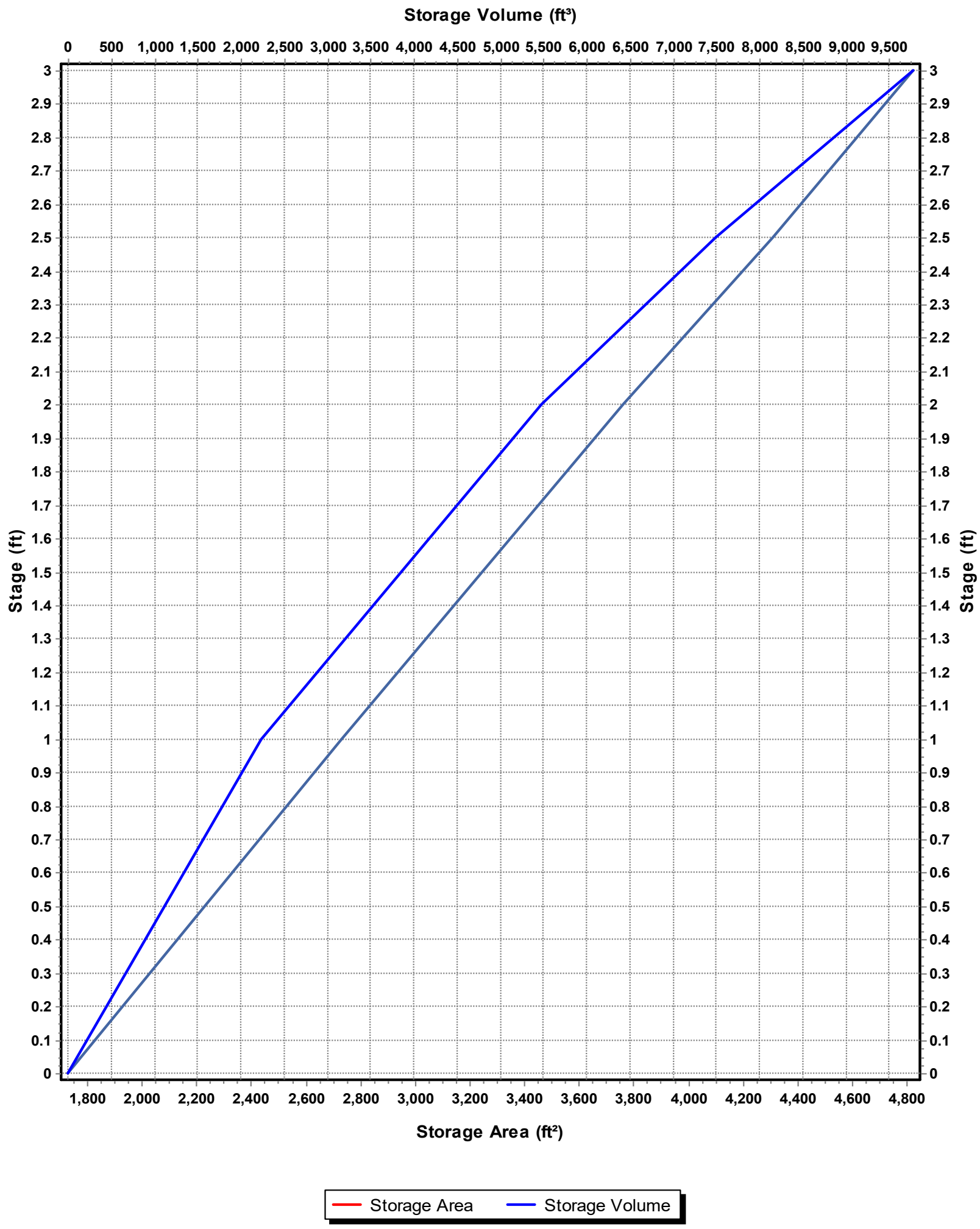
Invert Elevation (ft)	114.00
Max (Rim) Elevation (ft)	117.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Storage-10

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	1729.74	0
1	2729.32	2229.53
2	3760.91	5474.65
2.5	4312.03	7492.89
3	4824.52	9777.03

Storage Area Volume Curves



Storage Node : Basin-A1 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-A1	Trapezoidal	No	116.50	2.50	10.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	2.44
Peak Lateral Inflow (cfs)	0
Peak Outflow (cfs)	1.61
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	116.51
Max HGL Depth Attained (ft)	2.51
Average HGL Elevation Attained (ft)	116.06
Average HGL Depth Attained (ft)	2.06
Time of Max HGL Occurrence (days hh:mm)	0 19:16
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Forebay-A1

Input Data

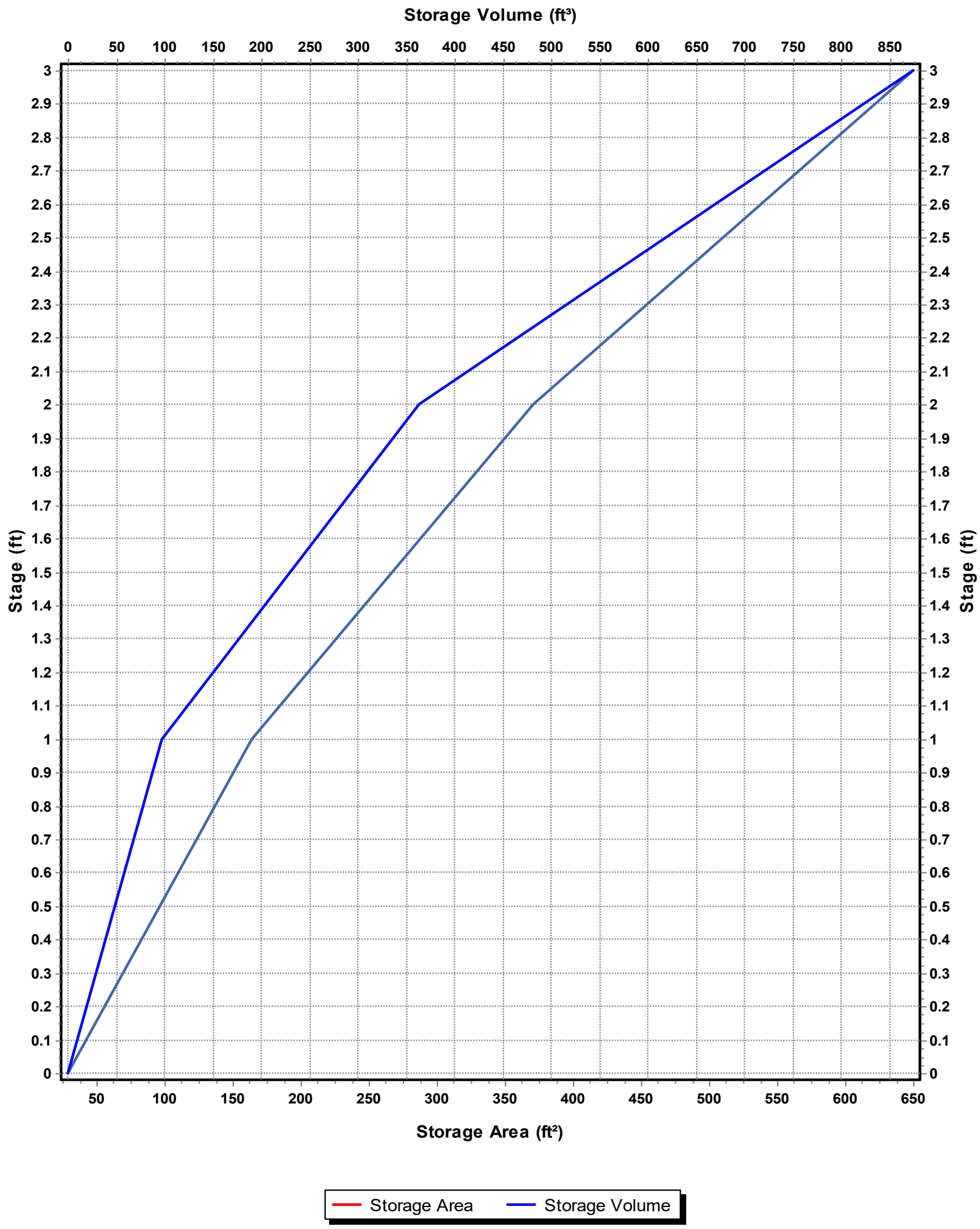
Invert Elevation (ft)	114.00
Max (Rim) Elevation (ft)	117.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Storage-11

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	29	0
1	164	96.5
2	371	364
3	650	874.5

Storage Area Volume Curves



Storage Node : Forebay-A1 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-FA1	Trapezoidal	No	116.00	2.00	10.00	1.00	3.33

Output Summary Results

Peak Inflow (cfs)	2.45
Peak Lateral Inflow (cfs)	2.45
Peak Outflow (cfs)	2.44
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	116.57
Max HGL Depth Attained (ft)	2.57
Average HGL Elevation Attained (ft)	116.18
Average HGL Depth Attained (ft)	2.18
Time of Max HGL Occurrence (days hh:mm)	0 19:06
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Project Description

File Name ..... Bourne_A1.SPF

Project Options

Flow Units ..... CFS
Elevation Type ..... Elevation
Hydrology Method ..... SCS TR-20
Time of Concentration (TOC) Method ..... SCS TR-55
Link Routing Method ..... Hydrodynamic
Enable Overflow Ponding at Nodes ..... YES
Skip Steady State Analysis Time Periods ..... NO

Analysis Options

Start Analysis On ..... oct. 14, 2021 0:00:00
End Analysis On ..... oct. 17, 2021 0:00:00
Start Reporting On ..... oct. 14, 2021 0:00:00
Antecedent Dry Days ..... 0 days
Runoff (Dry Weather) Time Step ..... 0 01:00:00 days hh:mm:ss
Runoff (Wet Weather) Time Step ..... 0 00:05:00 days hh:mm:ss
Reporting Time Step ..... 0 00:05:00 days hh:mm:ss
Routing Time Step ..... 30 seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	2
Nodes	4
Junctions	0
Outfalls	2
Flow Diversions	0
Inlets	0
Storage Nodes	2
Links	2
Channels	0
Pipes	0
Pumps	0
Orifices	0
Weirs	2
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	100 years	Intensity	inches	Massachusetts	None	100.00	7.51	SCS Type III 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Sub-A1	0.61	484.00	76.00	7.51	4.71	2.88	2.92	0 00:06:00
2	Sub-E01	0.42	484.00	43.00	7.51	1.30	0.55	0.25	0 00:39:05

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Out-A1	Outfall	110.00					0.15	110.00					
2	Out-E01	Outfall	0.00					0.25	0.00					
3	Basin-A1	Storage Node	114.00	117.00	114.00		0.00	3.20	116.53				0.00	0.00
4	Forebay-A1	Storage Node	114.00	117.00	114.00		0.00	3.12	116.53				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(ft)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
1	Weir-A1	Weir	Basin-A1	Out-A1		114.00	110.00				0.15							
2	Weir-FA1	Weir	Forebay-A1	Basin-A1		114.00	114.00				3.20							

Subbasin Hydrology

Subbasin : Sub-A1

Input Data

Area (ac)	0.61
Peak Rate Factor	484
Weighted Curve Number	76
Rain Gage ID	Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	0.61	A	76
Composite Area & Weighted CN	0.61		76

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft^2)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	133.39	0	0
Slope (%) :	1.36	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	1.01	0	0
Computed Flow Time (min) :	2.21	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	92.85	0	0
Channel Slope (%) :	0.3	0	0
Cross Section Area (ft^2) :	3	0	0
Wetted Perimeter (ft) :	6.32	0	0
Velocity (ft/sec) :	1.66	0	0
Computed Flow Time (min) :	0.93	0	0

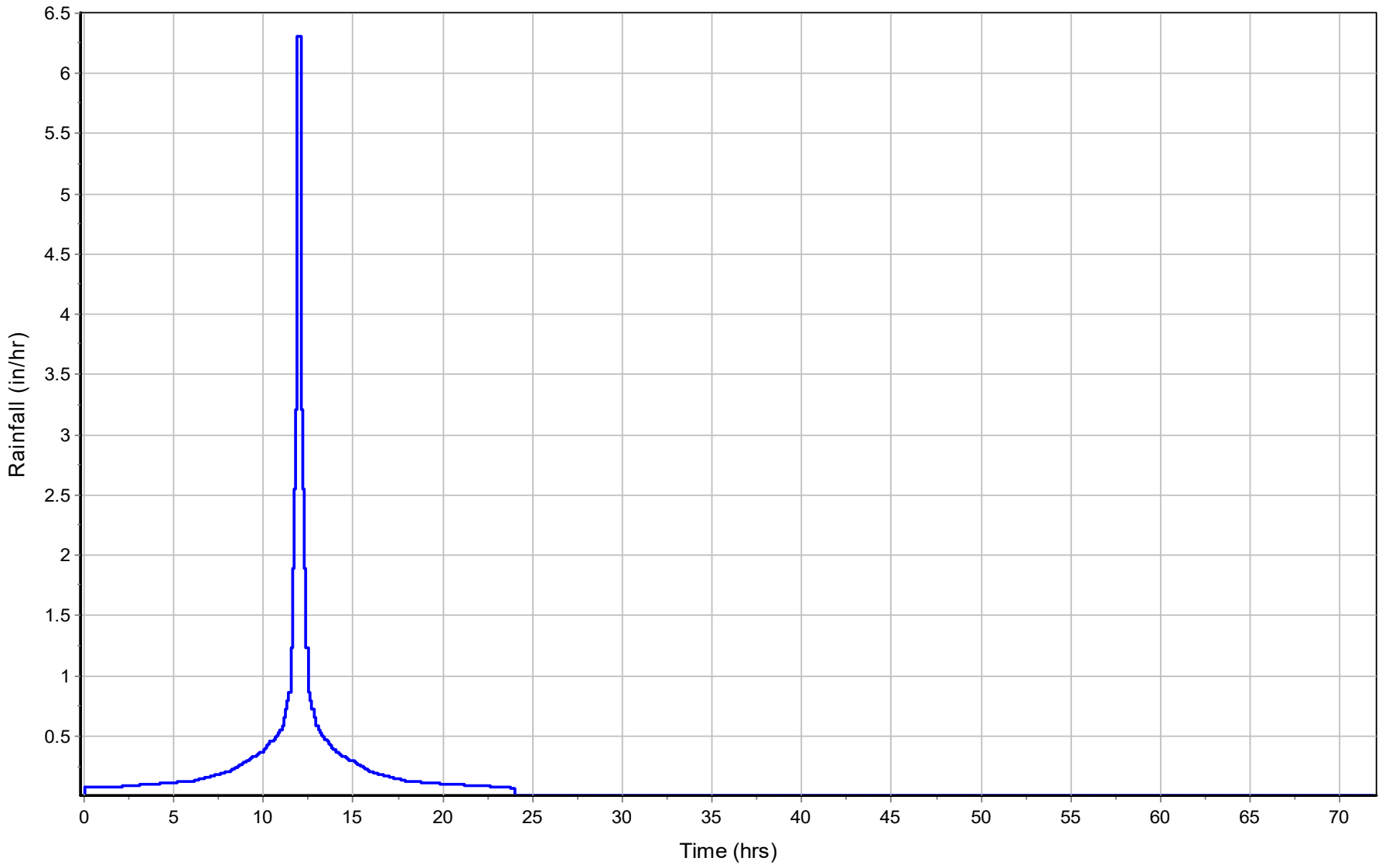
Total TOC (min) 3.15

Subbasin Runoff Results

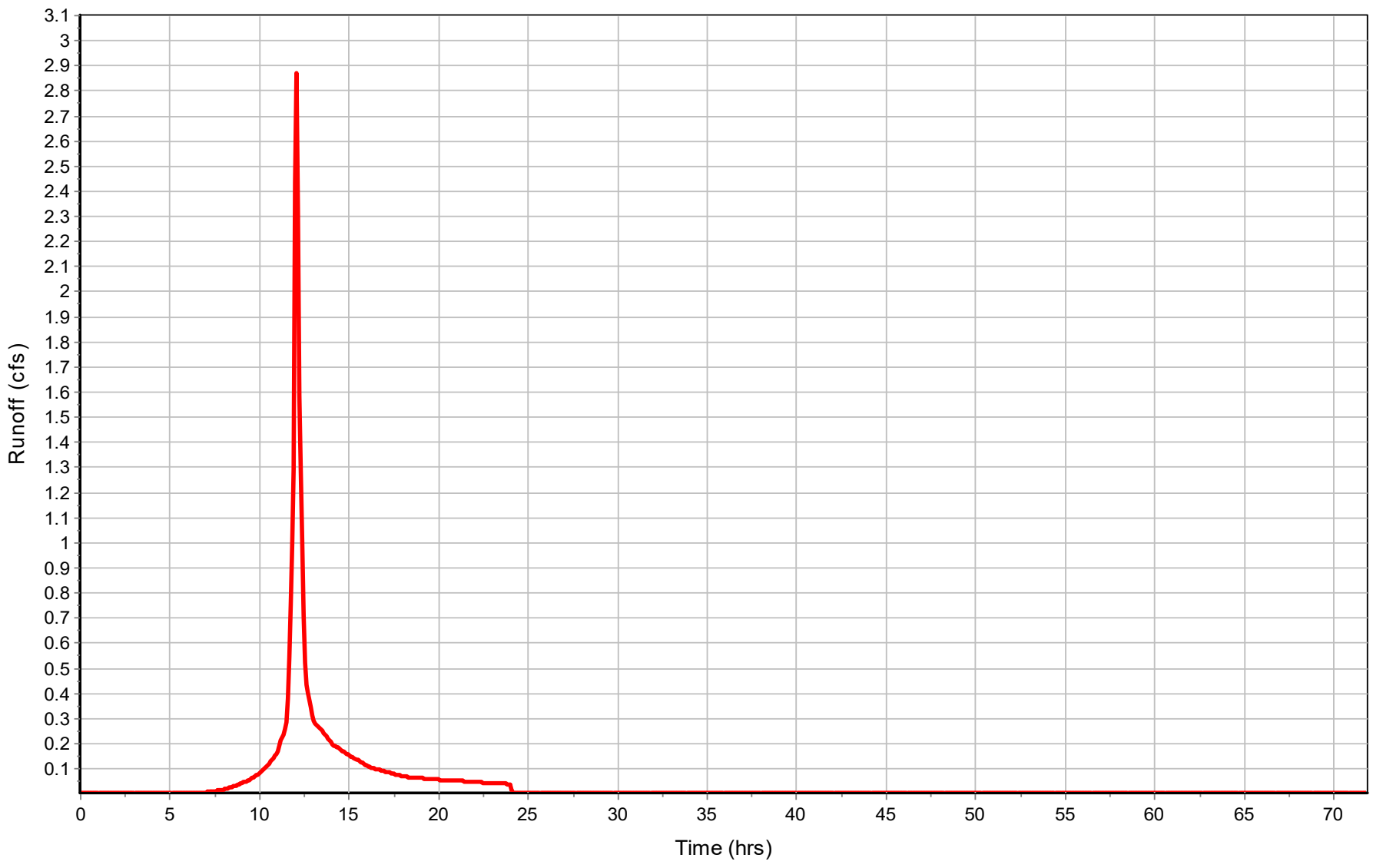
Total Rainfall (in)	7.51
Total Runoff (in)	4.71
Peak Runoff (cfs)	2.92
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:03:09

Subbasin : Sub-A1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E01

Input Data

Area (ac) 0.42
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.21	A	43
Composite Area & Weighted CN	0.21		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	173.96	0	0
Slope (%) :	5	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.07	0	0
Computed Flow Time (min) :	39.09	0	0

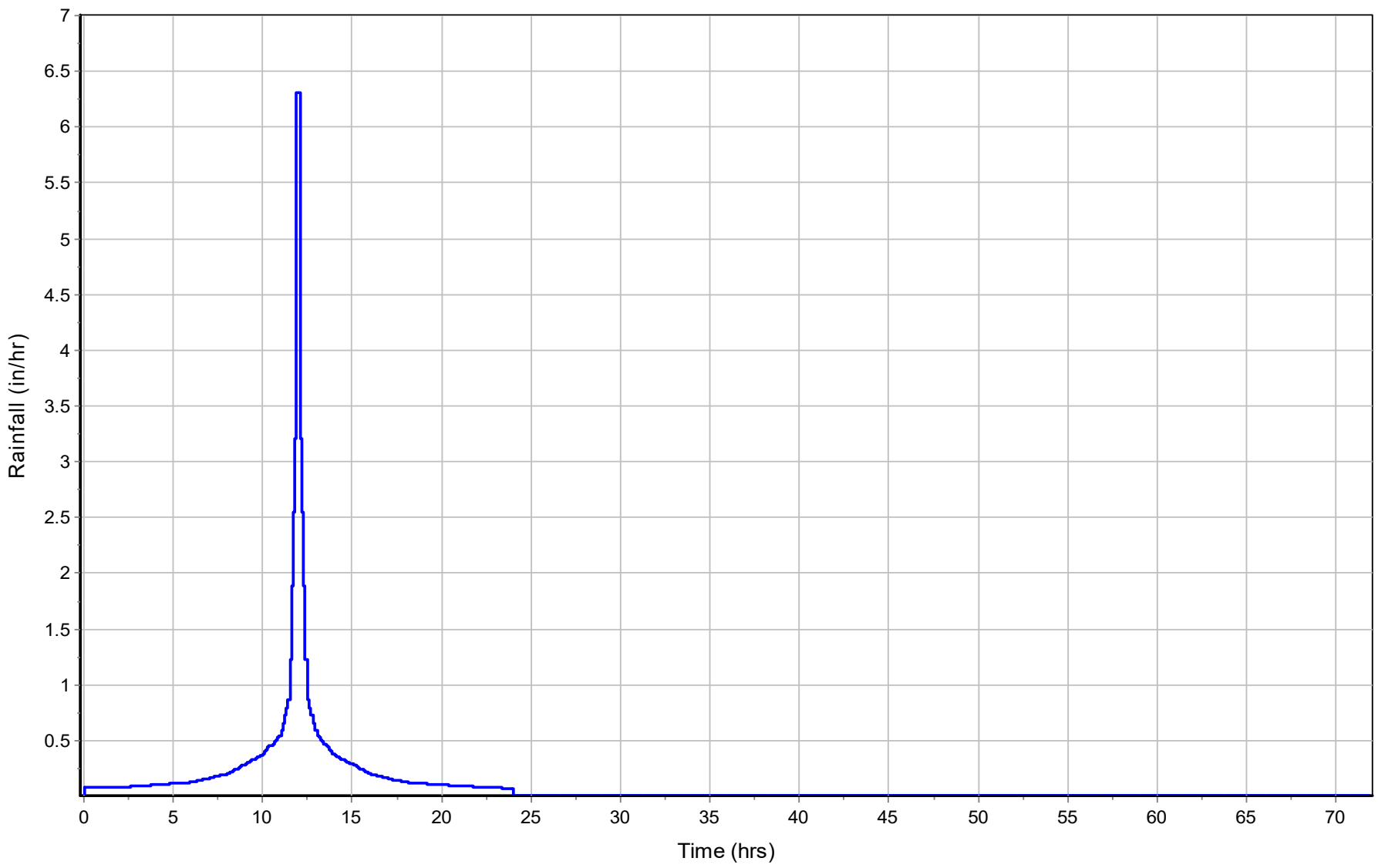
Total TOC (min) 39.09

Subbasin Runoff Results

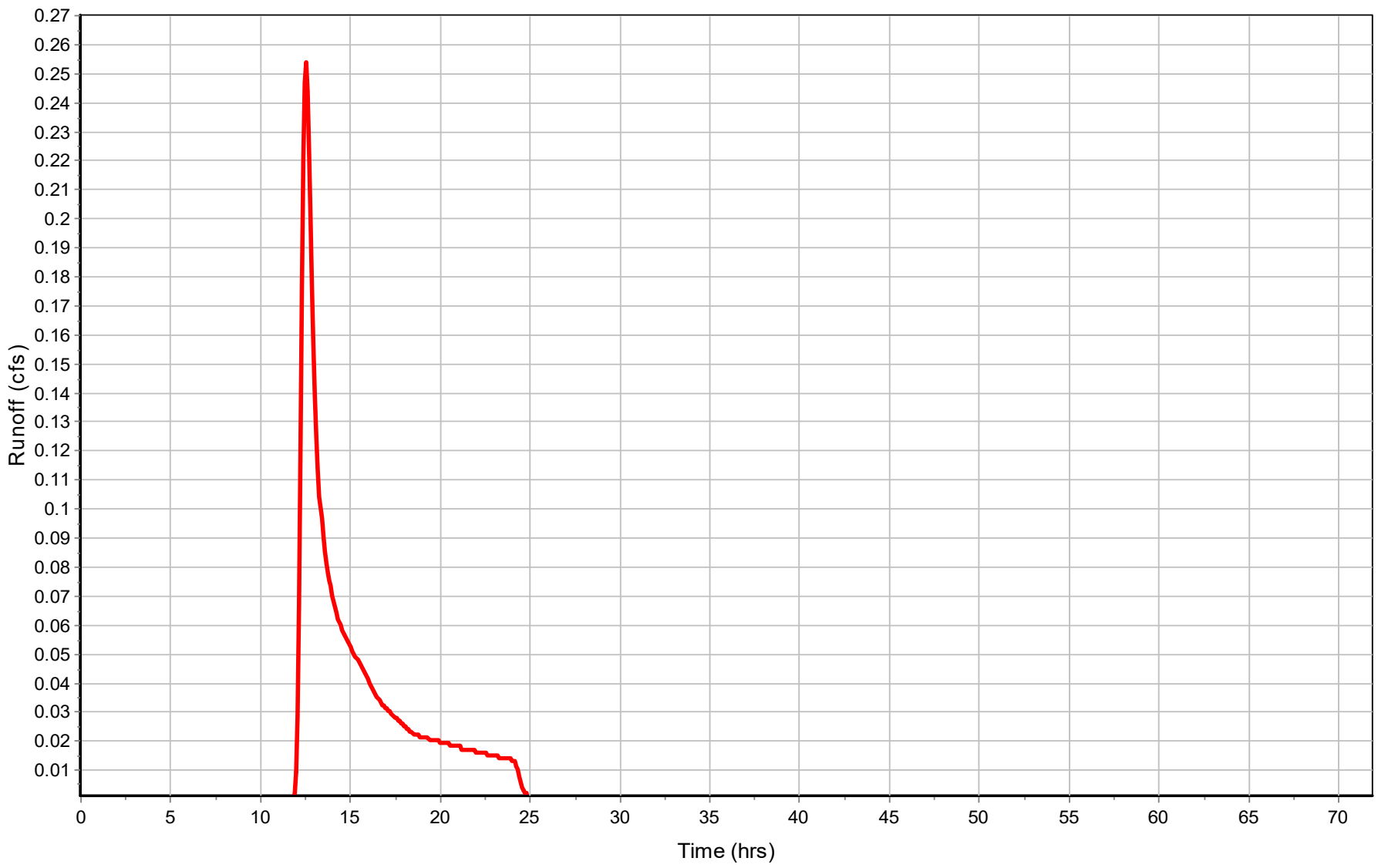
Total Rainfall (in) 7.51
Total Runoff (in) 1.3
Peak Runoff (cfs) 0.25
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:39:05

Subbasin : Sub-E01

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A1

Input Data

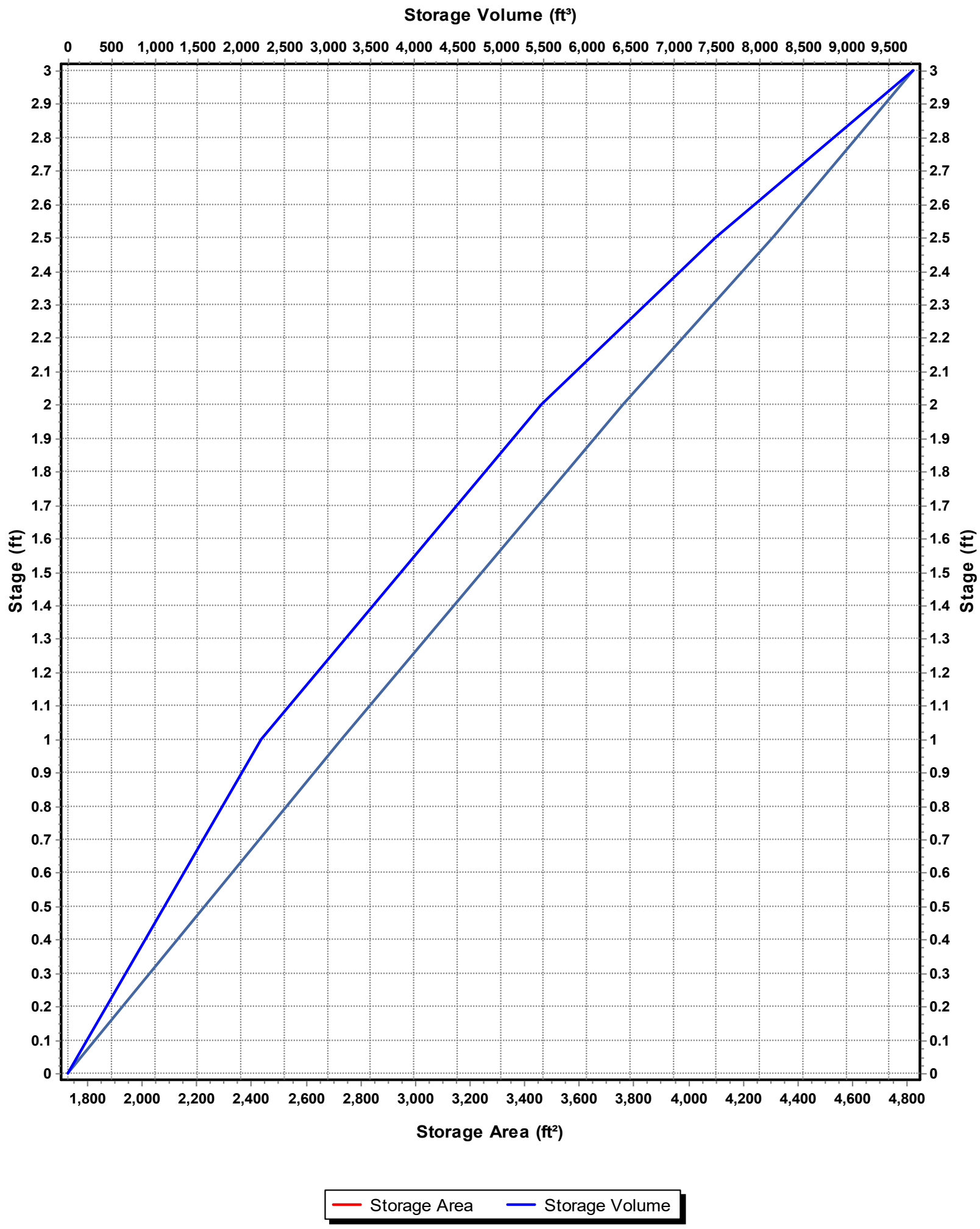
Invert Elevation (ft)	114.00
Max (Rim) Elevation (ft)	117.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Storage-10

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	1729.74	0
1	2729.32	2229.53
2	3760.91	5474.65
2.5	4312.03	7492.89
3	4824.52	9777.03

Storage Area Volume Curves



Storage Node : Basin-A1 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-A1	Trapezoidal	No	116.50	2.50	10.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	3.2
Peak Lateral Inflow (cfs)	0
Peak Outflow (cfs)	3.13
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	116.53
Max HGL Depth Attained (ft)	2.53
Average HGL Elevation Attained (ft)	116.08
Average HGL Depth Attained (ft)	2.08
Time of Max HGL Occurrence (days hh:mm)	0 15:27
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Forebay-A1

Input Data

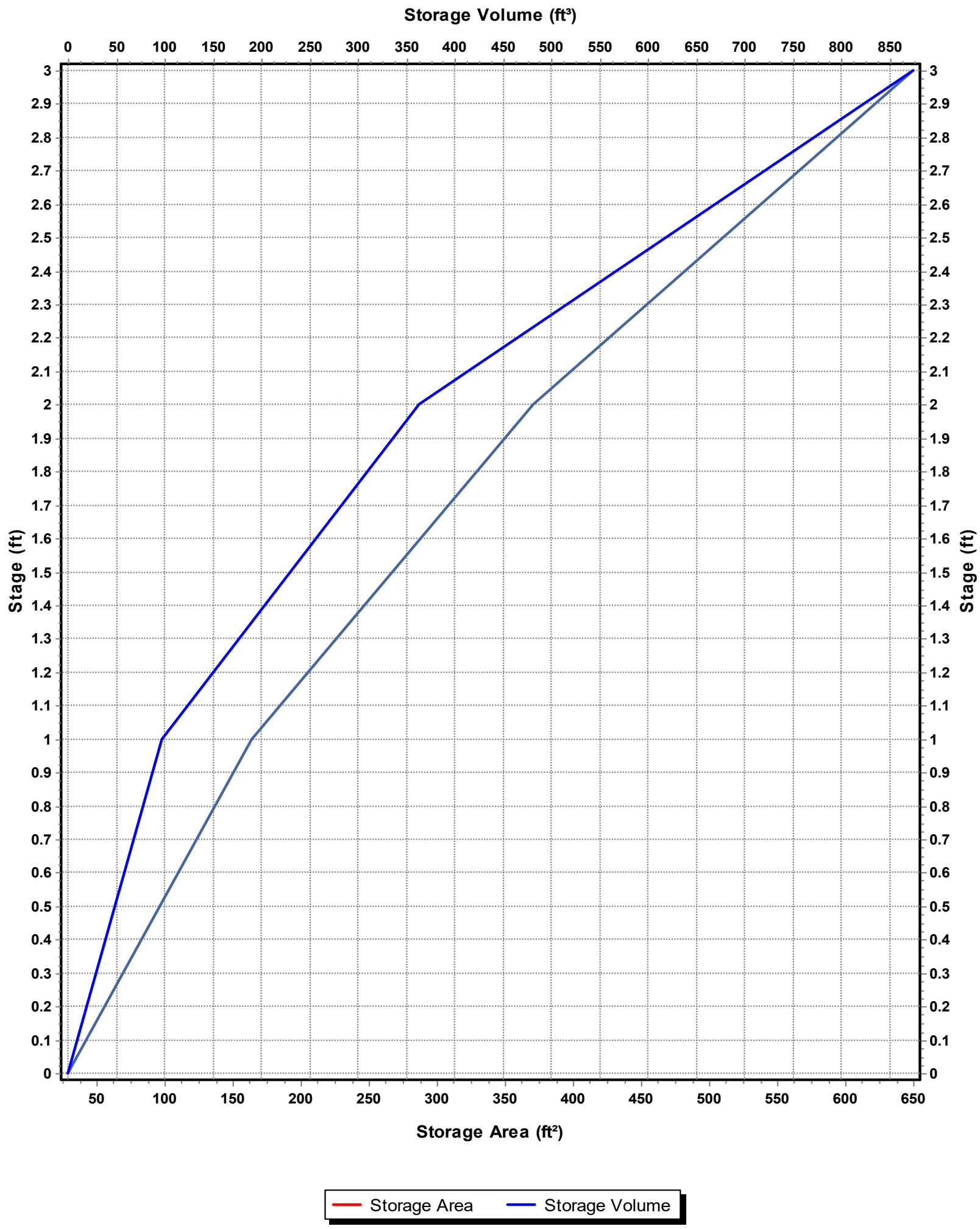
Invert Elevation (ft)	114.00
Max (Rim) Elevation (ft)	117.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Storage-11

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	29	0
1	164	96.5
2	371	364
3	650	874.5

Storage Area Volume Curves



Storage Node : Forebay-A1 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-FA1	Trapezoidal	No	116.00	2.00	10.00	1.00	3.33

Output Summary Results

Peak Inflow (cfs) 3.12
Peak Lateral Inflow (cfs) 2.87
Peak Outflow (cfs) 3.2
Peak Exfiltration Flow Rate (cfm) 0
Max HGL Elevation Attained (ft) 116.53
Max HGL Depth Attained (ft) 2.53
Average HGL Elevation Attained (ft) 116.16
Average HGL Depth Attained (ft) 2.16
Time of Max HGL Occurrence (days hh:mm) 1 00:42
Total Exfiltration Volume (1000-ft^3) 0
Total Flooded Volume (ac-in) 0
Total Time Flooded (min) 0
Total Retention Time (sec) 0

Project Description

File Name ..... Bourne_A1.SPF

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	SCS TR-20
Time of Concentration (TOC) Method	SCS TR-55
Link Routing Method	Hydrodynamic
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	NO

Analysis Options

Start Analysis On	oct. 14, 2021	0:00:00
End Analysis On	oct. 17, 2021	0:00:00
Start Reporting On	oct. 14, 2021	0:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	2
Nodes	4
Junctions	0
Outfalls	2
Flow Diversions	0
Inlets	0
Storage Nodes	2
Links	2
Channels	0
Pipes	0
Pumps	0
Orifices	0
Weirs	2
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	2070 50 years	Intensity	inches	Massachusetts	None	50.00	8.80	SCS Type III 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Sub-A1	0.61	484.00	76.00	8.80	5.89	3.59	3.61	0 00:06:00
2	Sub-E01	0.42	484.00	43.00	8.80	1.95	0.82	0.42	0 00:39:05

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Out-A1	Outfall	110.00					0.38	110.00					
2	Out-E01	Outfall	0.00					0.42	0.00					
3	Basin-A1	Storage Node	114.00	117.00	114.00		0.00	4.58	116.55				0.00	0.00
4	Forebay-A1	Storage Node	114.00	117.00	114.00		0.00	4.13	116.62				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(ft)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
1	Weir-A1	Weir	Basin-A1	Out-A1		114.00	110.00				0.38							
2	Weir-FA1	Weir	Forebay-A1	Basin-A1		114.00	114.00				4.58							

Subbasin Hydrology

Subbasin : Sub-A1

Input Data

Area (ac)	0.61
Peak Rate Factor	484
Weighted Curve Number	76
Rain Gage ID	Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	0.61	A	76
Composite Area & Weighted CN	0.61		76

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft^2)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	133.39	0	0
Slope (%) :	1.36	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	1.01	0	0
Computed Flow Time (min) :	2.21	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	92.85	0	0
Channel Slope (%) :	0.3	0	0
Cross Section Area (ft^2) :	3	0	0
Wetted Perimeter (ft) :	6.32	0	0
Velocity (ft/sec) :	1.66	0	0
Computed Flow Time (min) :	0.93	0	0

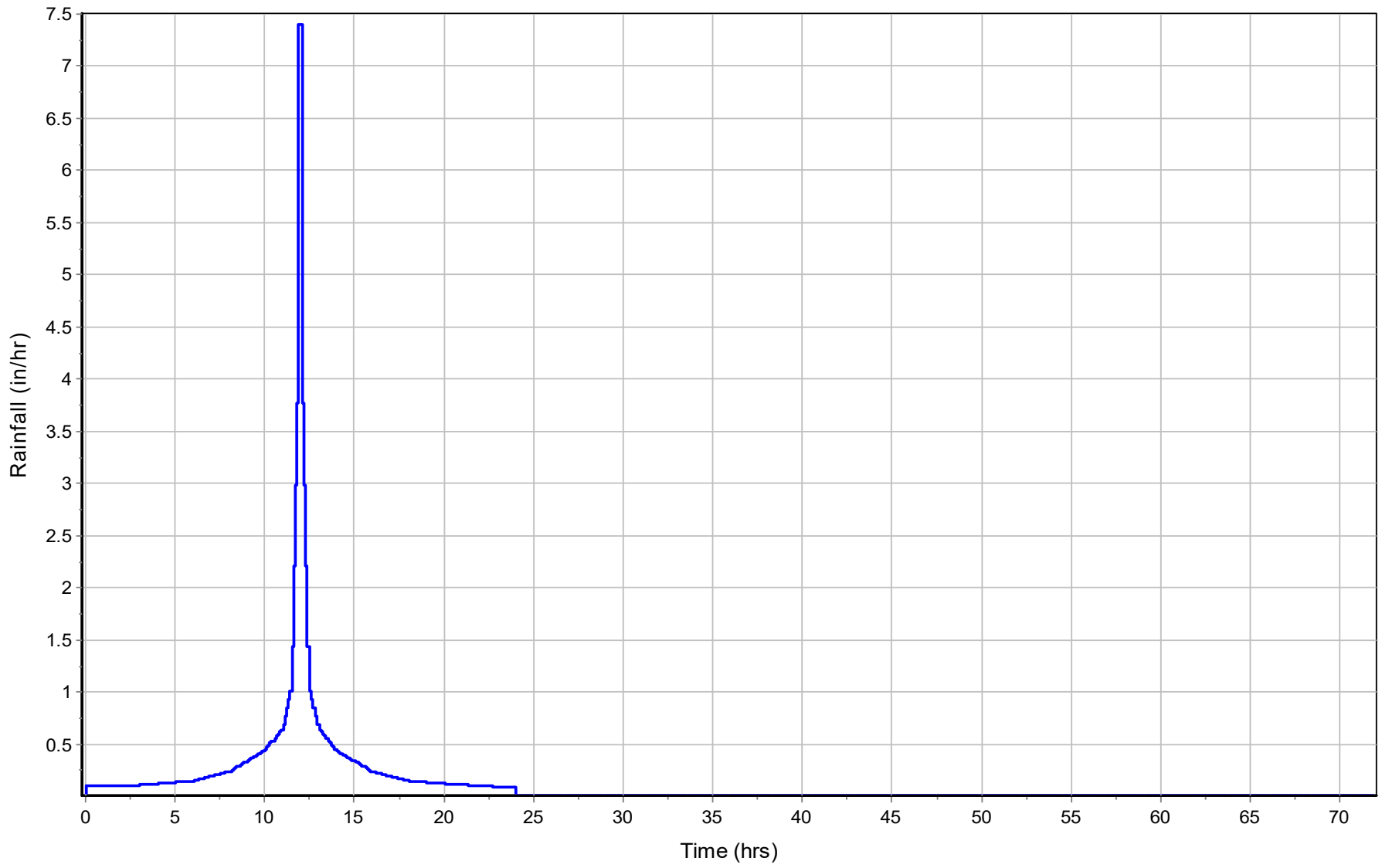
Total TOC (min) 3.15

Subbasin Runoff Results

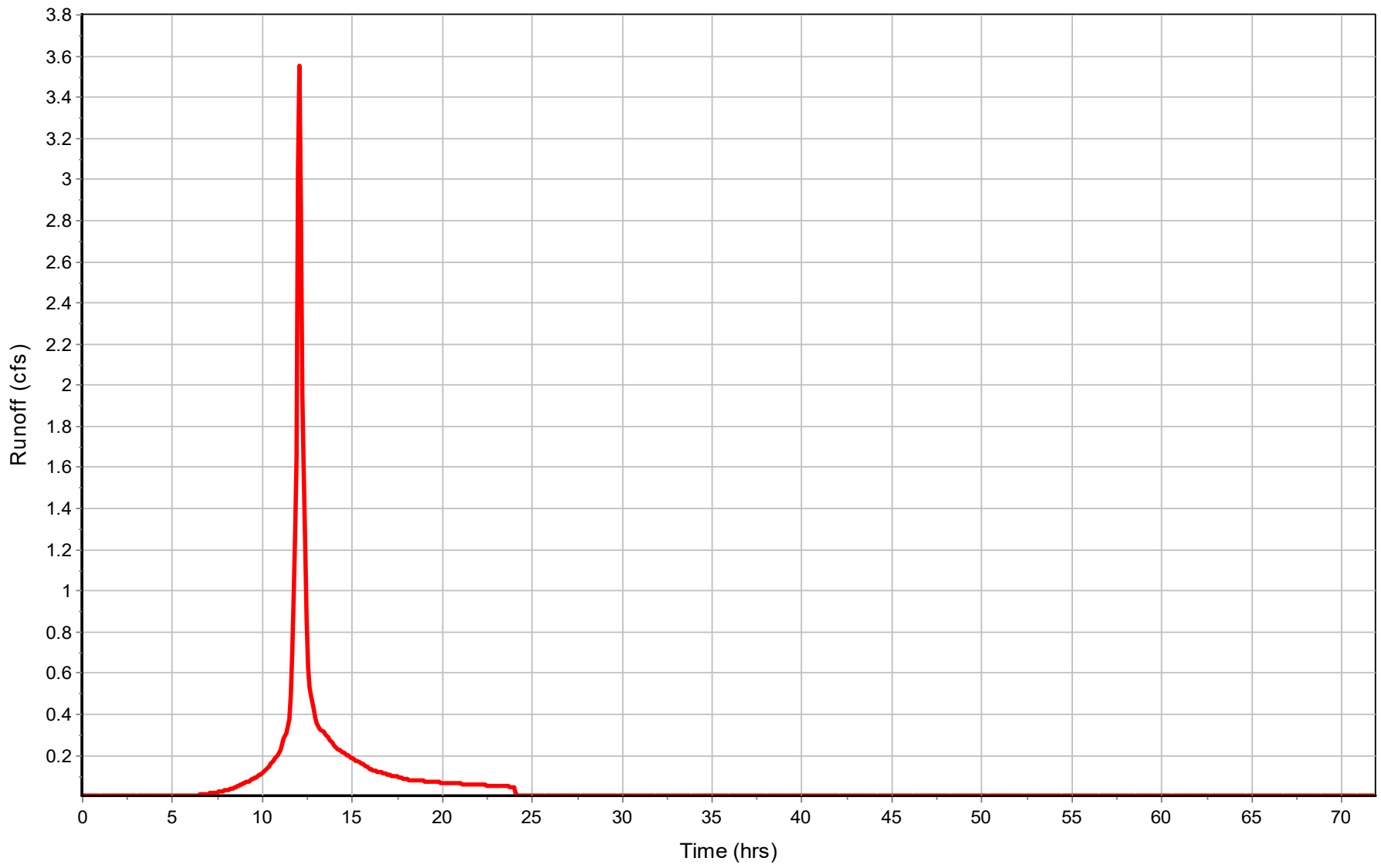
Total Rainfall (in)	8.8
Total Runoff (in)	5.89
Peak Runoff (cfs)	3.61
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:03:09

Subbasin : Sub-A1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E01

Input Data

Area (ac) 0.42
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.21	A	43
Composite Area & Weighted CN	0.21		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	173.96	0	0
Slope (%) :	5	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.07	0	0
Computed Flow Time (min) :	39.09	0	0

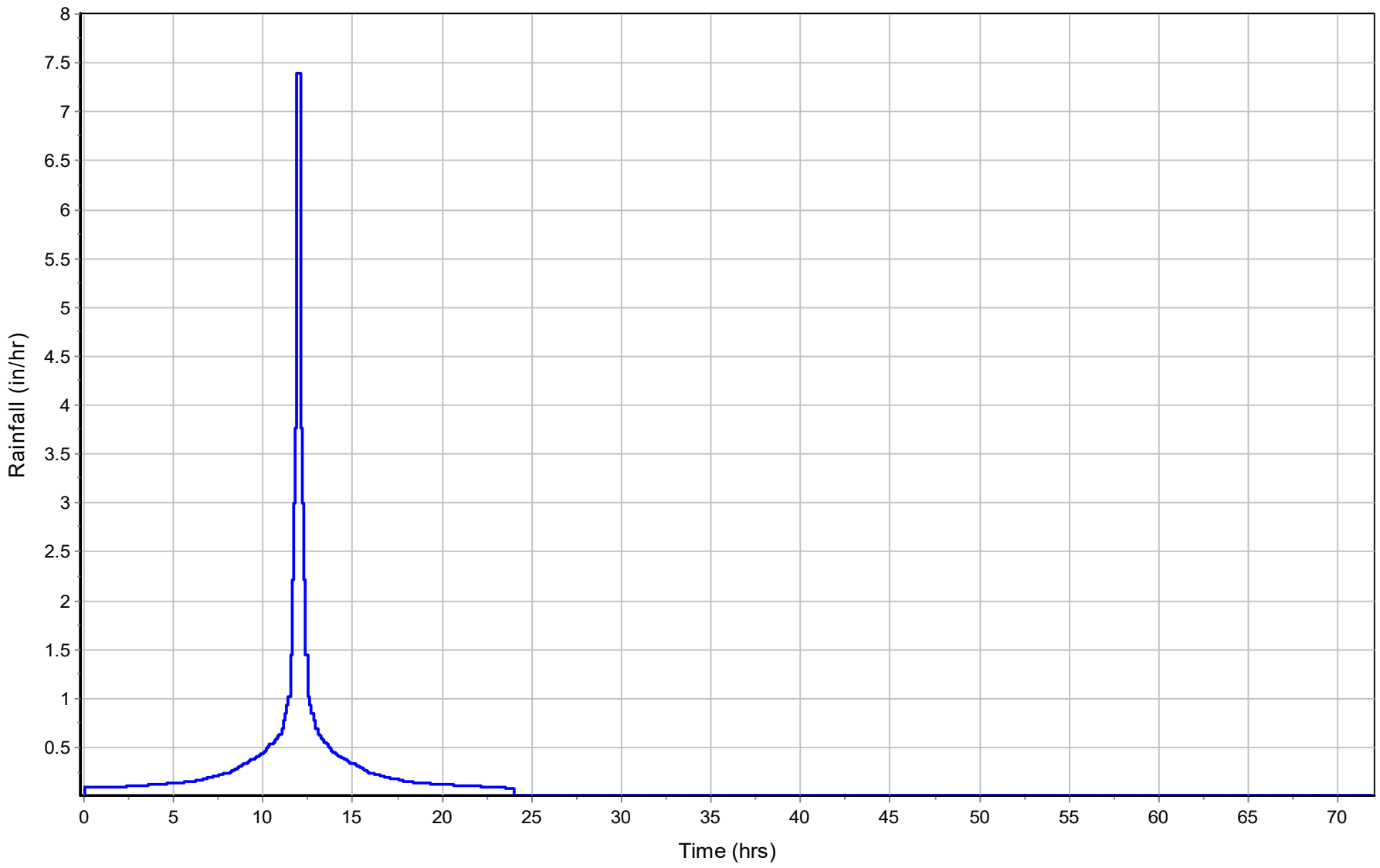
Total TOC (min) 39.09

Subbasin Runoff Results

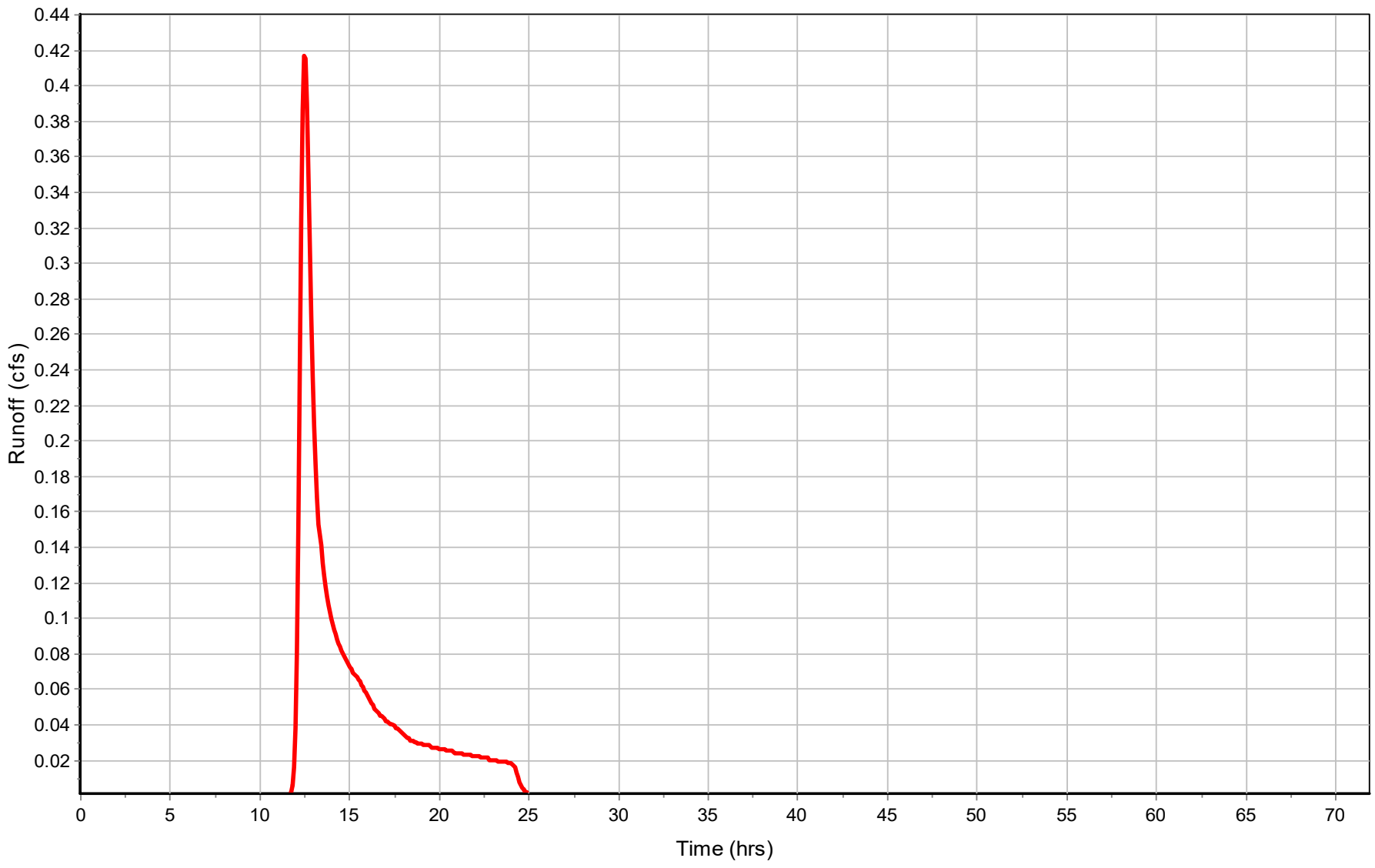
Total Rainfall (in) 8.8
Total Runoff (in) 1.95
Peak Runoff (cfs) 0.42
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:39:05

Subbasin : Sub-E01

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A1

Input Data

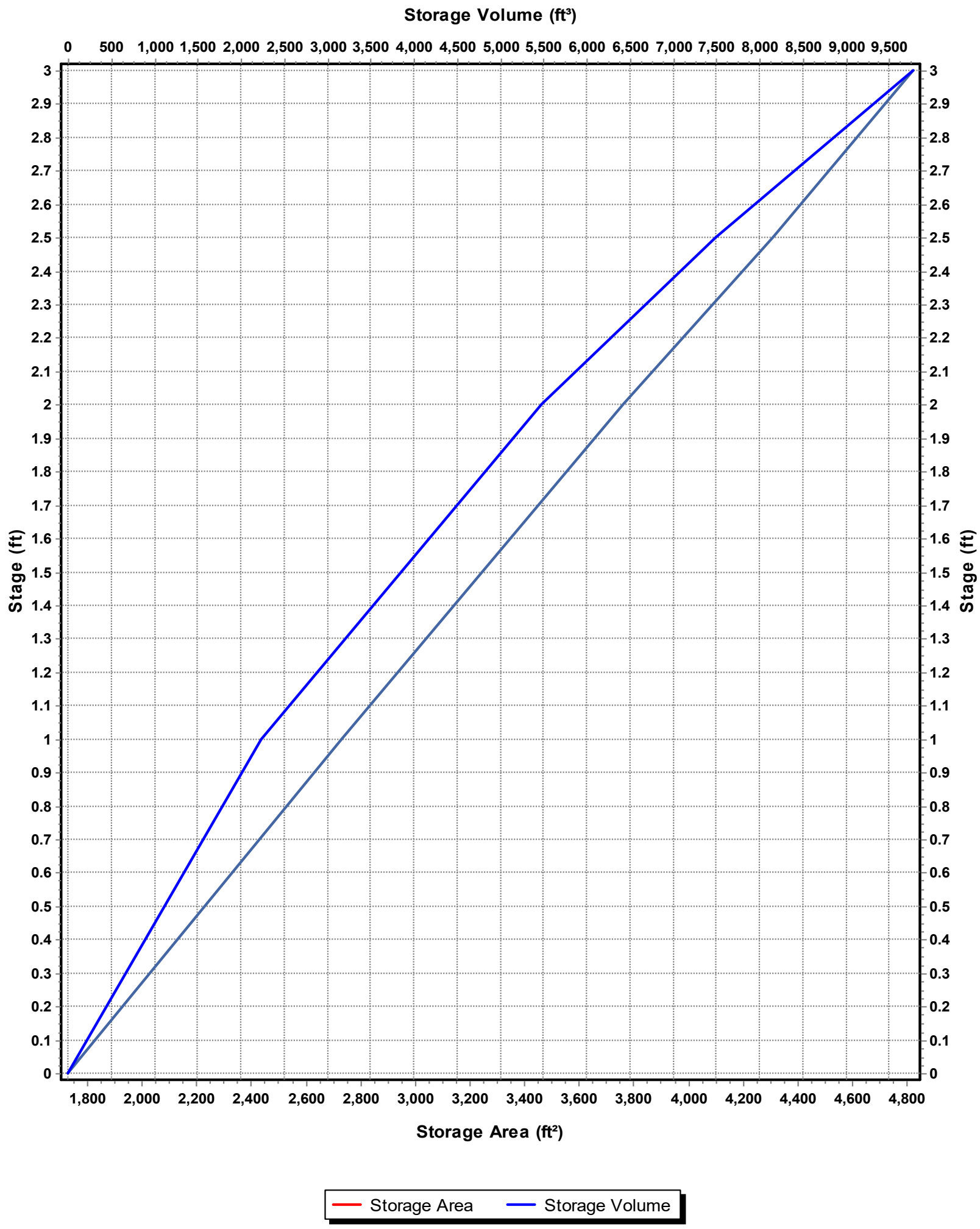
Invert Elevation (ft)	114.00
Max (Rim) Elevation (ft)	117.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Storage-10

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	1729.74	0
1	2729.32	2229.53
2	3760.91	5474.65
2.5	4312.03	7492.89
3	4824.52	9777.03

Storage Area Volume Curves



Storage Node : Basin-A1 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-A1	Trapezoidal	No	116.50	2.50	10.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	4.58
Peak Lateral Inflow (cfs)	0
Peak Outflow (cfs)	4.18
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	116.55
Max HGL Depth Attained (ft)	2.55
Average HGL Elevation Attained (ft)	116.09
Average HGL Depth Attained (ft)	2.09
Time of Max HGL Occurrence (days hh:mm)	0 13:12
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Forebay-A1

Input Data

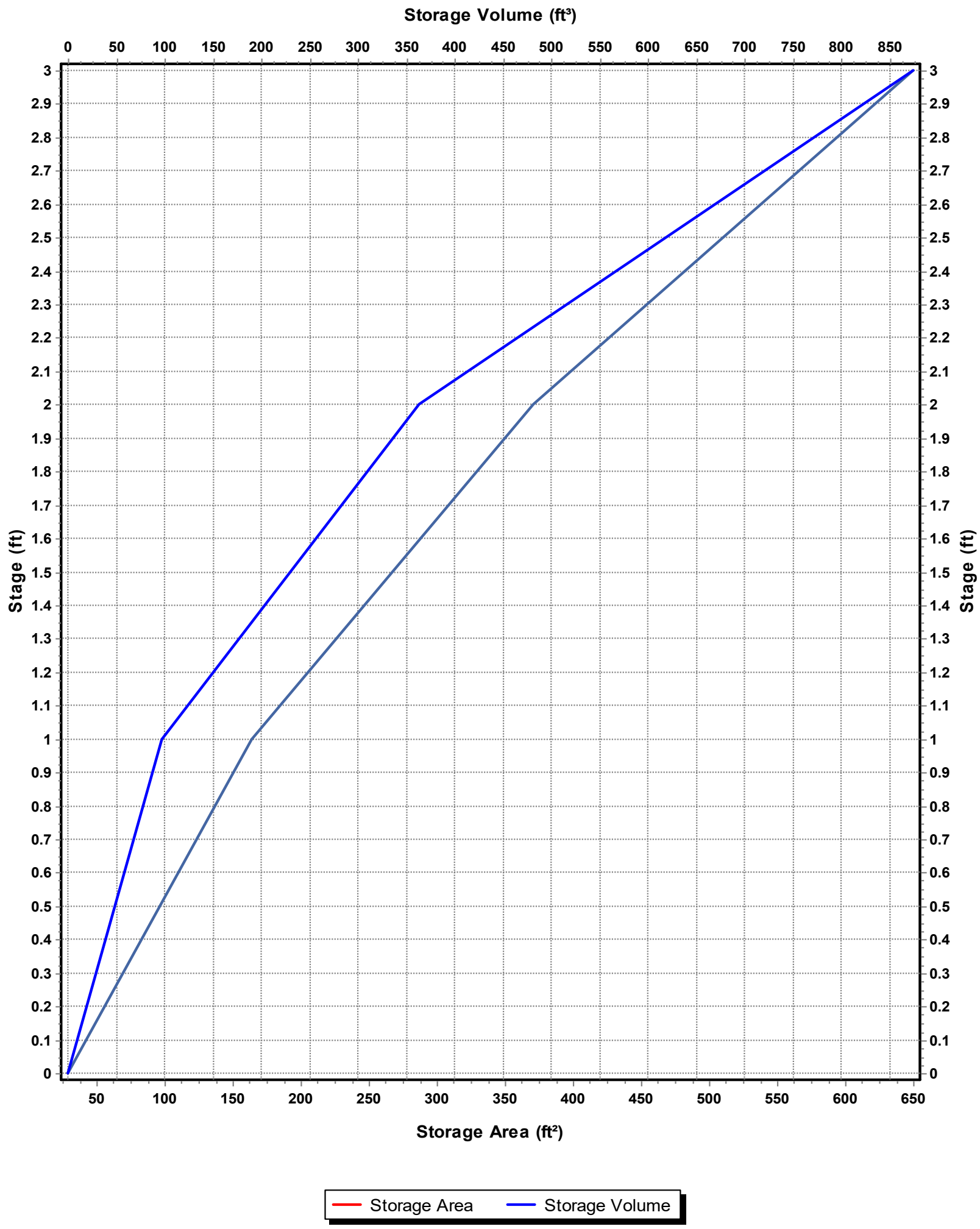
Invert Elevation (ft)	114.00
Max (Rim) Elevation (ft)	117.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Storage-11

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	29	0
1	164	96.5
2	371	364
3	650	874.5

Storage Area Volume Curves



Storage Node : Forebay-A1 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-FA1	Trapezoidal	No	116.00	2.00	10.00	1.00	3.33

Output Summary Results

Peak Inflow (cfs)	4.13
Peak Lateral Inflow (cfs)	3.55
Peak Outflow (cfs)	4.58
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	116.62
Max HGL Depth Attained (ft)	2.62
Average HGL Elevation Attained (ft)	116.19
Average HGL Depth Attained (ft)	2.19
Time of Max HGL Occurrence (days hh:mm)	0 13:18
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

SSA Analysis – Drainage Area A2 – Existing and Proposed

Project Description

File Name ..... Bourne_A2.SPF

Project Options

Flow Units ..... CFS
Elevation Type ..... Elevation
Hydrology Method ..... SCS TR-20
Time of Concentration (TOC) Method ..... SCS TR-55
Link Routing Method ..... Hydrodynamic
Enable Overflow Ponding at Nodes ..... YES
Skip Steady State Analysis Time Periods ..... NO

Analysis Options

Start Analysis On ..... oct. 14, 2021 0:00:00
End Analysis On ..... oct. 17, 2021 0:00:00
Start Reporting On ..... oct. 14, 2021 0:00:00
Antecedent Dry Days ..... 0 days
Runoff (Dry Weather) Time Step ..... 0 01:00:00 days hh:mm:ss
Runoff (Wet Weather) Time Step ..... 0 00:05:00 days hh:mm:ss
Reporting Time Step ..... 0 00:05:00 days hh:mm:ss
Routing Time Step ..... 30 seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	2
Nodes	6
Junctions	0
Outfalls	3
Flow Diversions	0
Inlets	0
Storage Nodes	3
Links	4
Channels	0
Pipes	0
Pumps	0
Orifices	0
Weirs	4
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	2 years	Intensity	inches	Massachusetts	None	2.00	3.43	SCS Type III 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Sub-A2	0.48	484.00	76.00	3.43	1.32	0.63	0.65	0 00:06:00
2	Sub-E02	0.37	484.00	43.00	3.43	0.04	0.02	0.00	0 00:19:32

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Out-A2A	Outfall	116.00					0.00	116.00					
2	Out-A2B	Outfall	116.00					0.00	116.00					
3	Out-E02	Outfall	116.00					0.00	116.00					
4	Basin-02A	Storage Node	115.00	118.00	115.00		0.00	0.31	116.02				0.00	0.00
5	Basin-A2B	Storage Node	115.00	118.00	115.00		0.00	0.31	116.52				0.00	0.00
6	Forebay-A2	Storage Node	114.50	118.00	114.50		0.00	0.62	117.04				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length (ft)	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Average Slope (%)	Diameter or Height (ft)	Manning's Roughness	Peak Flow (cfs)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Reported Condition
1	Weir-2A	Weir	Basin-02A	Out-A2A		115.00	116.00				0.00							
2	Weir-2B	Weir	Basin-A2B	Out-A2B		115.00	116.00				0.00							
3	Weir-A2A	Weir	Forebay-A2	Basin-02A		114.50	115.00				0.31							
4	Weir-A2B	Weir	Forebay-A2	Basin-A2B		114.50	115.00				0.31							

Subbasin Hydrology

Subbasin : Sub-A2

Input Data

Area (ac)	0.48
Peak Rate Factor	484
Weighted Curve Number	76
Rain Gage ID	Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	0.48	A	76
Composite Area & Weighted CN	0.48		76

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft^2)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	37.54	0	0
Slope (%) :	1.2	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.74	0	0
Computed Flow Time (min) :	0.84	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	145.78	0	0
Channel Slope (%) :	0.3	0	0
Cross Section Area (ft^2) :	3	0	0
Wetted Perimeter (ft) :	6.32	0	0
Velocity (ft/sec) :	1.66	0	0
Computed Flow Time (min) :	1.47	0	0

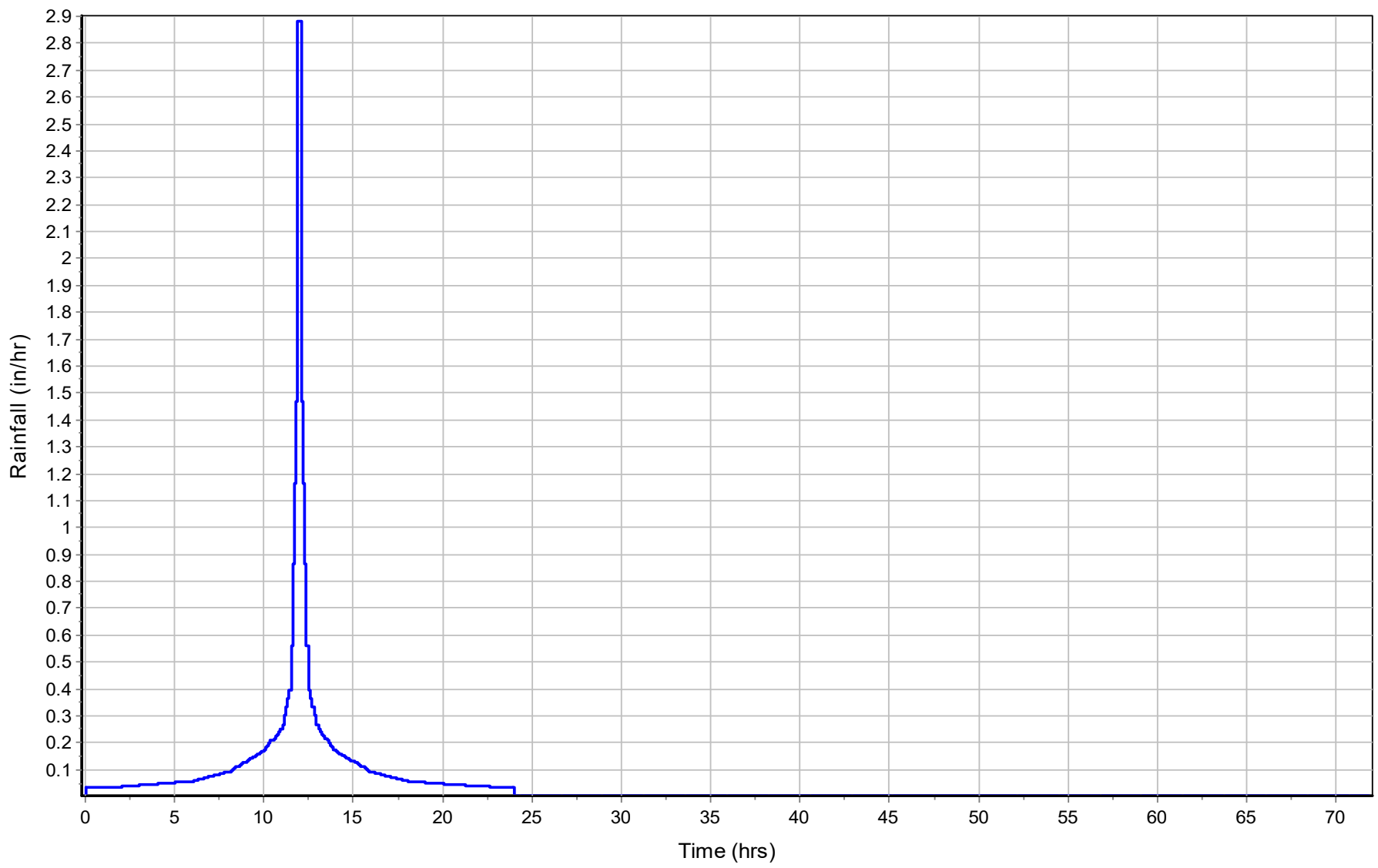
Total TOC (min) 2.31

Subbasin Runoff Results

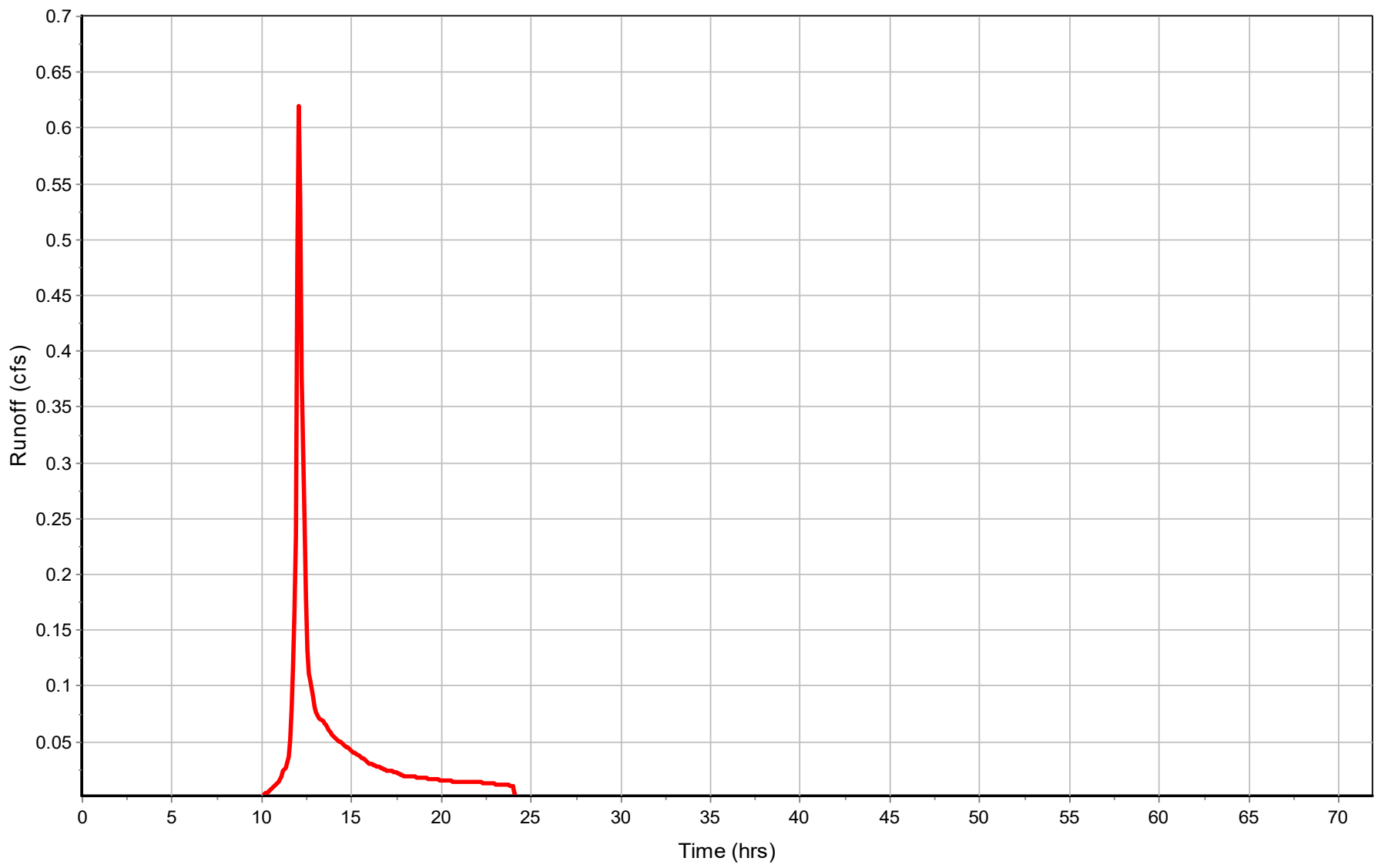
Total Rainfall (in)	3.43
Total Runoff (in)	1.32
Peak Runoff (cfs)	0.65
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:02:19

Subbasin : Sub-A2

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E02

Input Data

Area (ac) 0.37
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.37	A	43
Composite Area & Weighted CN	0.37		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	90.15	0	0
Slope (%) :	7.6	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.08	0	0
Computed Flow Time (min) :	19.54	0	0

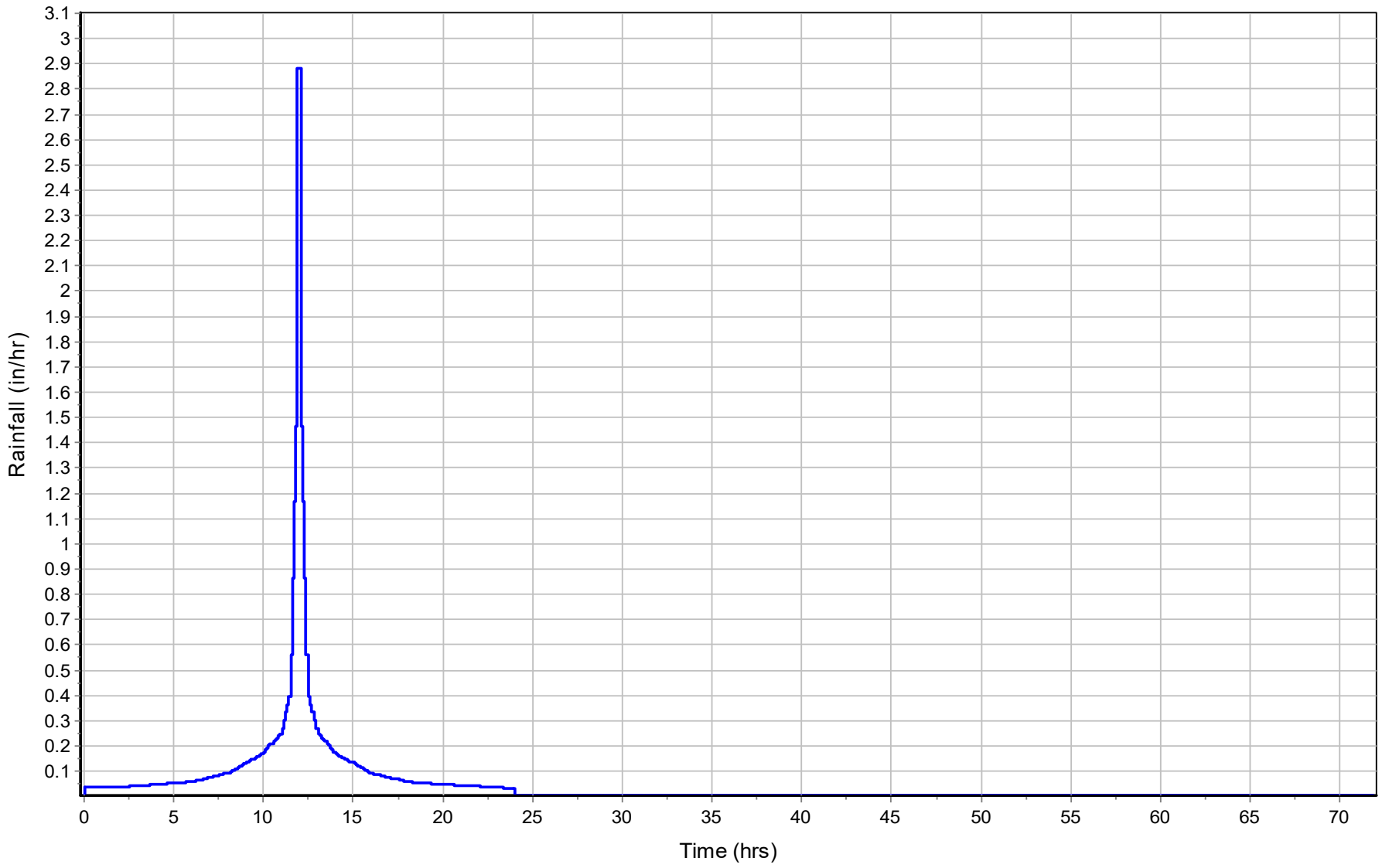
Total TOC (min) 19.54

Subbasin Runoff Results

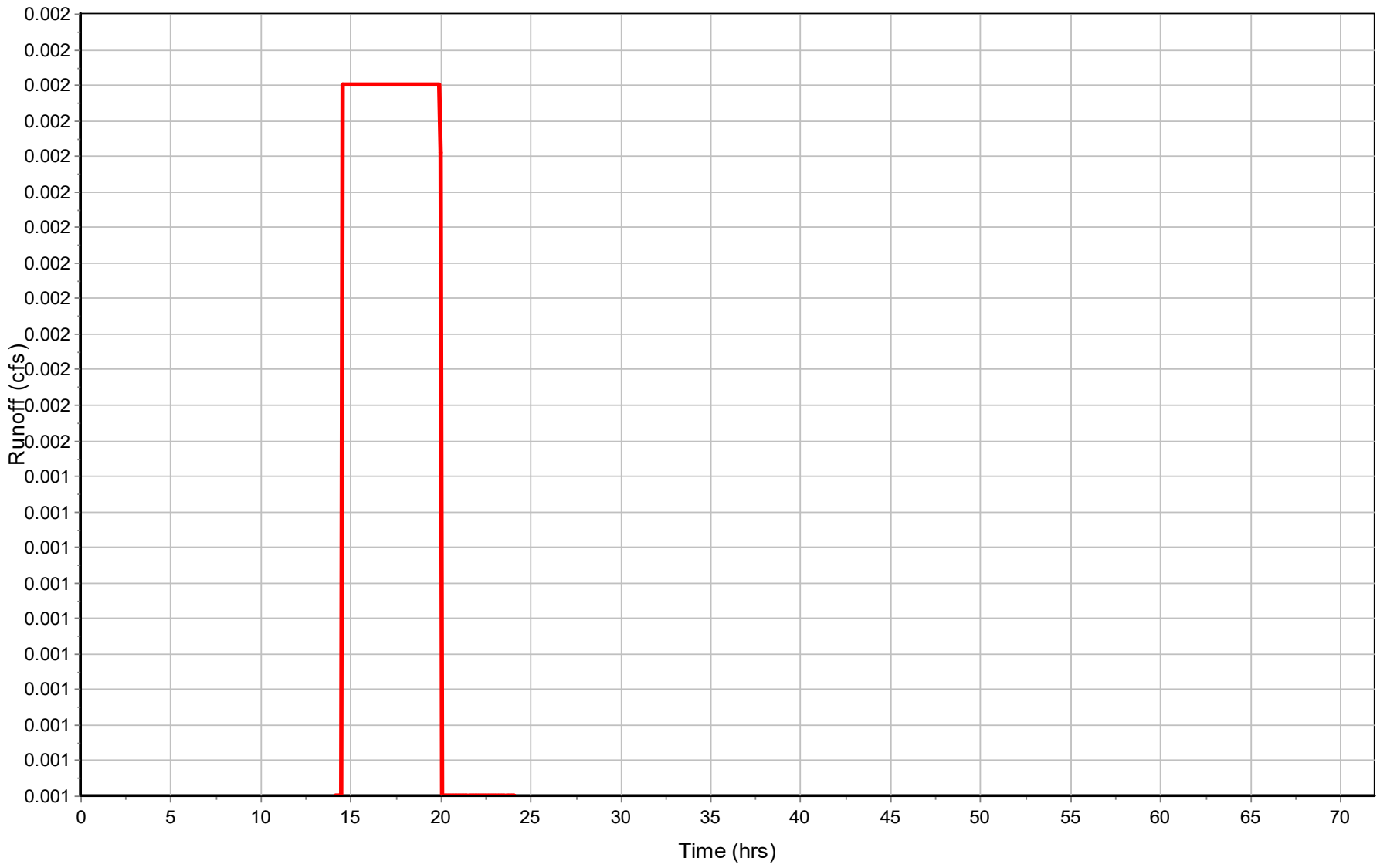
Total Rainfall (in) 3.43
Total Runoff (in) 0.04
Peak Runoff (cfs) 0
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:19:32

Subbasin : Sub-E02

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-02A

Input Data

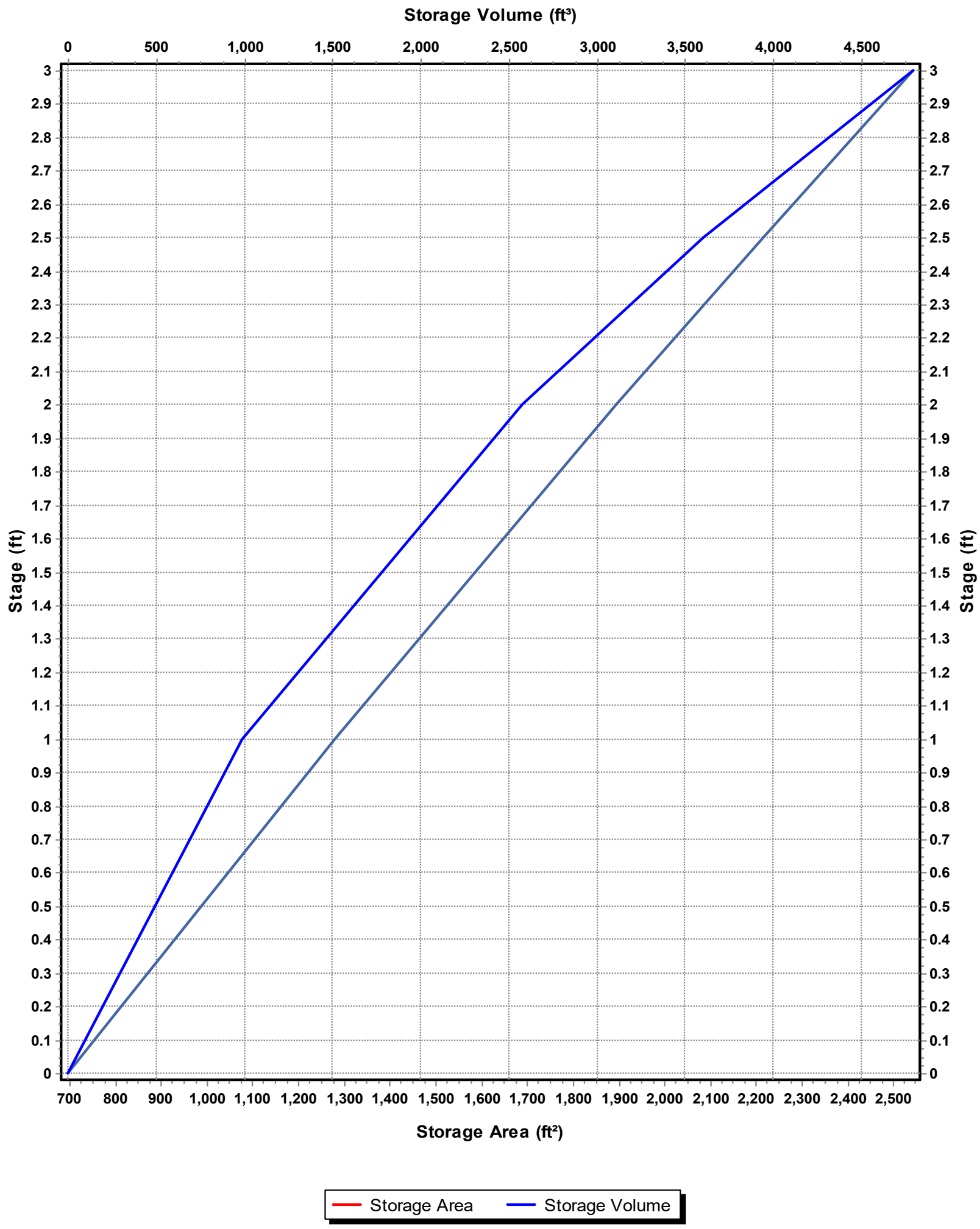
Invert Elevation (ft)	115.00
Max (Rim) Elevation (ft)	118.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	115.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Storage-13

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	697.24	0
1	1280.66	988.95
2	1896.08	2577.32
2.5	2215.79	3605.29
3	2543.5	4795.11

Storage Area Volume Curves



Storage Node : Basin-02A (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-2A	Trapezoidal	No	117.50	2.50	10.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	0.31
Peak Lateral Inflow (cfs)	0
Peak Outflow (cfs)	0
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	116.02
Max HGL Depth Attained (ft)	1.02
Average HGL Elevation Attained (ft)	115.82
Average HGL Depth Attained (ft)	0.82
Time of Max HGL Occurrence (days hh:mm)	1 00:20
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Basin-A2B

Input Data

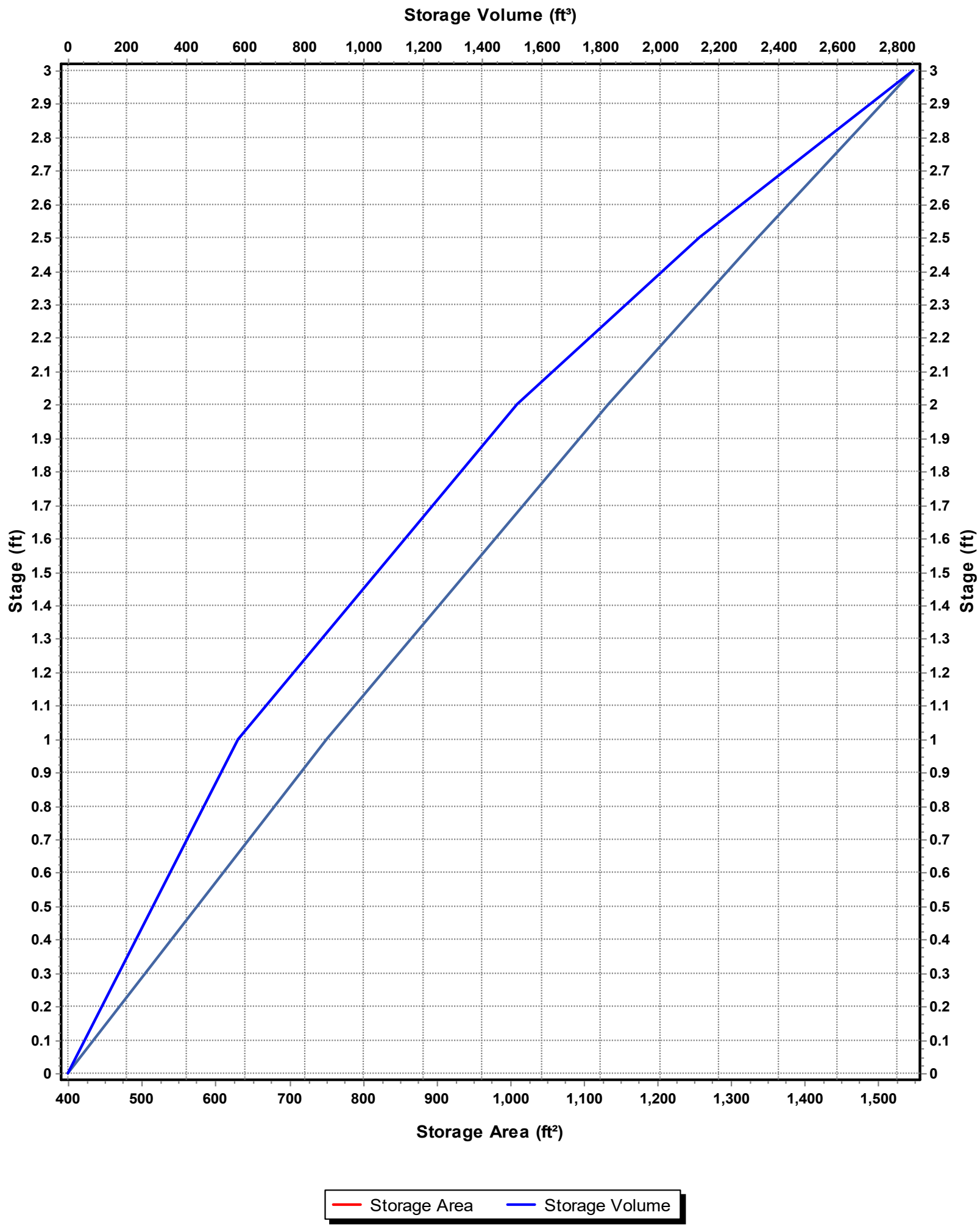
Invert Elevation (ft)	115.00
Max (Rim) Elevation (ft)	118.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	115.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Storage-14

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	399.14	0
1	750.37	574.76
2	1133.6	1516.75
2.5	1337.22	2134.46
3	1548.83	2855.97

Storage Area Volume Curves



Storage Node : Basin-A2B (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-2B	Trapezoidal	No	117.50	2.50	10.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	0.31
Peak Lateral Inflow (cfs)	0
Peak Outflow (cfs)	0
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	116.52
Max HGL Depth Attained (ft)	1.52
Average HGL Elevation Attained (ft)	116.23
Average HGL Depth Attained (ft)	1.23
Time of Max HGL Occurrence (days hh:mm)	1 00:20
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Forebay-A2

Input Data

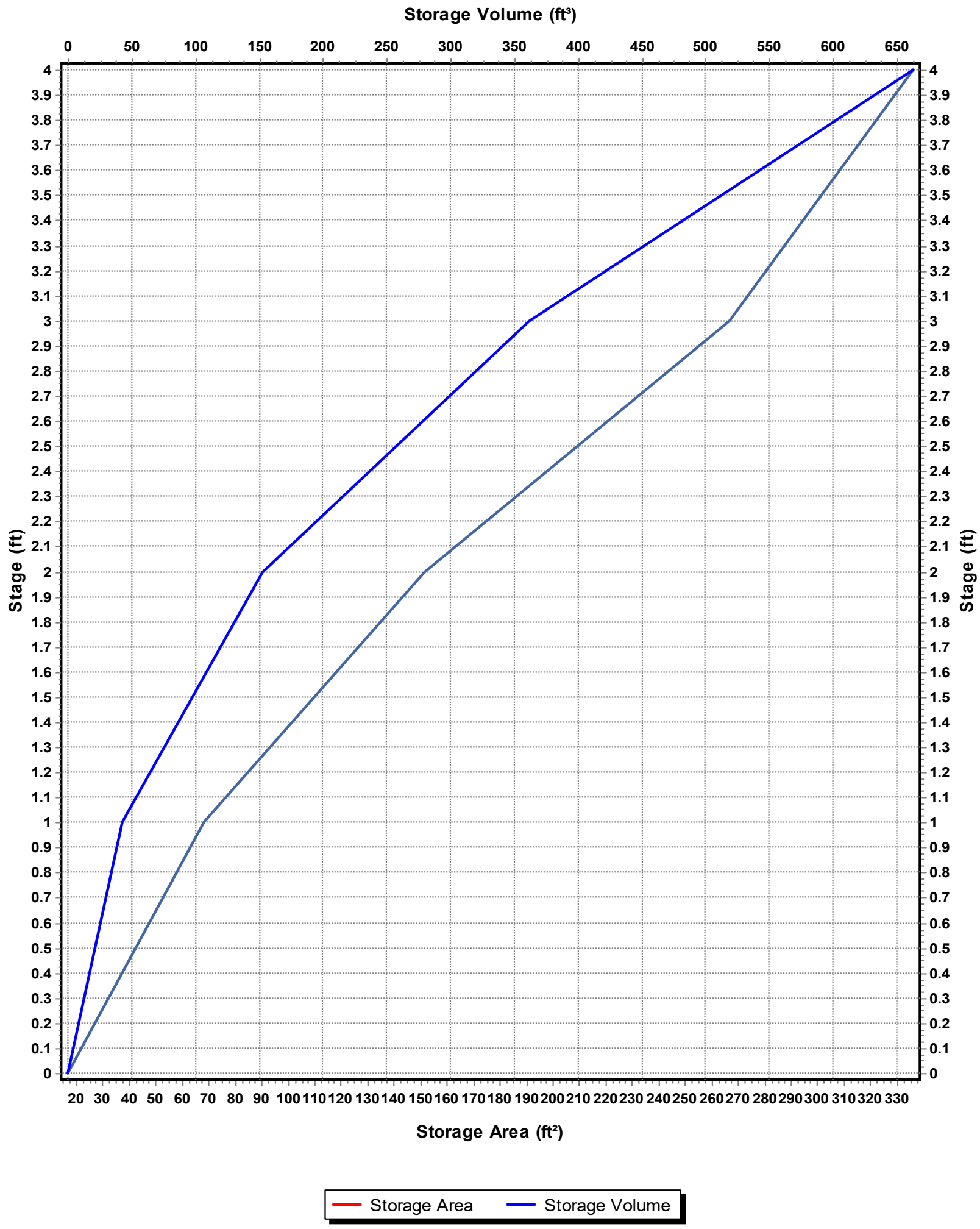
Invert Elevation (ft)	114.50
Max (Rim) Elevation (ft)	118.00
Max (Rim) Offset (ft)	3.50
Initial Water Elevation (ft)	114.50
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Storage-12

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	16.89	0
1	68.15	42.52
2	151.42	152.31
3	266.68	361.36
4	336.31	662.86

Storage Area Volume Curves



Storage Node : Forebay-A2 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-A2A	Trapezoidal	No	117.00	2.50	10.00	1.00	3.33
2	Weir-A2B	Trapezoidal	No	117.00	2.50	10.00	1.00	3.33

Output Summary Results

Peak Inflow (cfs)	0.62
Peak Lateral Inflow (cfs)	0.62
Peak Outflow (cfs)	0.62
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	117.04
Max HGL Depth Attained (ft)	2.54
Average HGL Elevation Attained (ft)	116.6
Average HGL Depth Attained (ft)	2.1
Time of Max HGL Occurrence (days hh:mm)	0 12:10
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Project Description

File Name ..... Bourne_A2.SPF

Project Options

Flow Units ..... CFS
Elevation Type ..... Elevation
Hydrology Method ..... SCS TR-20
Time of Concentration (TOC) Method ..... SCS TR-55
Link Routing Method ..... Hydrodynamic
Enable Overflow Ponding at Nodes ..... YES
Skip Steady State Analysis Time Periods ..... NO

Analysis Options

Start Analysis On ..... oct. 14, 2021 0:00:00
End Analysis On ..... oct. 17, 2021 0:00:00
Start Reporting On ..... oct. 14, 2021 0:00:00
Antecedent Dry Days ..... 0 days
Runoff (Dry Weather) Time Step ..... 0 01:00:00 days hh:mm:ss
Runoff (Wet Weather) Time Step ..... 0 00:05:00 days hh:mm:ss
Reporting Time Step ..... 0 00:05:00 days hh:mm:ss
Routing Time Step ..... 30 seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	2
Nodes	6
Junctions	0
Outfalls	3
Flow Diversions	0
Inlets	0
Storage Nodes	3
Links	4
Channels	0
Pipes	0
Pumps	0
Orifices	0
Weirs	4
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	10 years	Intensity	inches	Massachusetts	None	10.00	5.01	SCS Type III 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Sub-A2	0.48	484.00	76.00	5.01	2.54	1.22	1.26	0 00:06:00
2	Sub-E02	0.37	484.00	43.00	5.01	0.36	0.13	0.04	0 00:19:32

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Out-A2A	Outfall	116.00					0.00	116.00					
2	Out-A2B	Outfall	116.00					0.00	116.00					
3	Out-E02	Outfall	116.00					0.04	116.00					
4	Basin-02A	Storage Node	115.00	118.00	115.00		0.00	0.61	117.03				0.00	0.00
5	Basin-A2B	Storage Node	115.00	118.00	115.00		0.00	0.61	117.03				0.00	0.00
6	Forebay-A2	Storage Node	114.50	118.00	114.50		0.00	1.22	117.07				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length (ft)	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Average Slope (%)	Diameter or Height (ft)	Manning's Roughness	Peak Flow (cfs)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Reported Condition
1	Weir-2A	Weir	Basin-02A	Out-A2A		115.00	116.00				0.00							
2	Weir-2B	Weir	Basin-A2B	Out-A2B		115.00	116.00				0.00							
3	Weir-A2A	Weir	Forebay-A2	Basin-02A		114.50	115.00				0.61							
4	Weir-A2B	Weir	Forebay-A2	Basin-A2B		114.50	115.00				0.61							

Subbasin Hydrology

Subbasin : Sub-A2

Input Data

Area (ac)	0.48
Peak Rate Factor	484
Weighted Curve Number	76
Rain Gage ID	Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	0.48	A	76
Composite Area & Weighted CN	0.48		76

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft^2)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	37.54	0	0
Slope (%) :	1.2	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.74	0	0
Computed Flow Time (min) :	0.84	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	145.78	0	0
Channel Slope (%) :	0.3	0	0
Cross Section Area (ft^2) :	3	0	0
Wetted Perimeter (ft) :	6.32	0	0
Velocity (ft/sec) :	1.66	0	0
Computed Flow Time (min) :	1.47	0	0

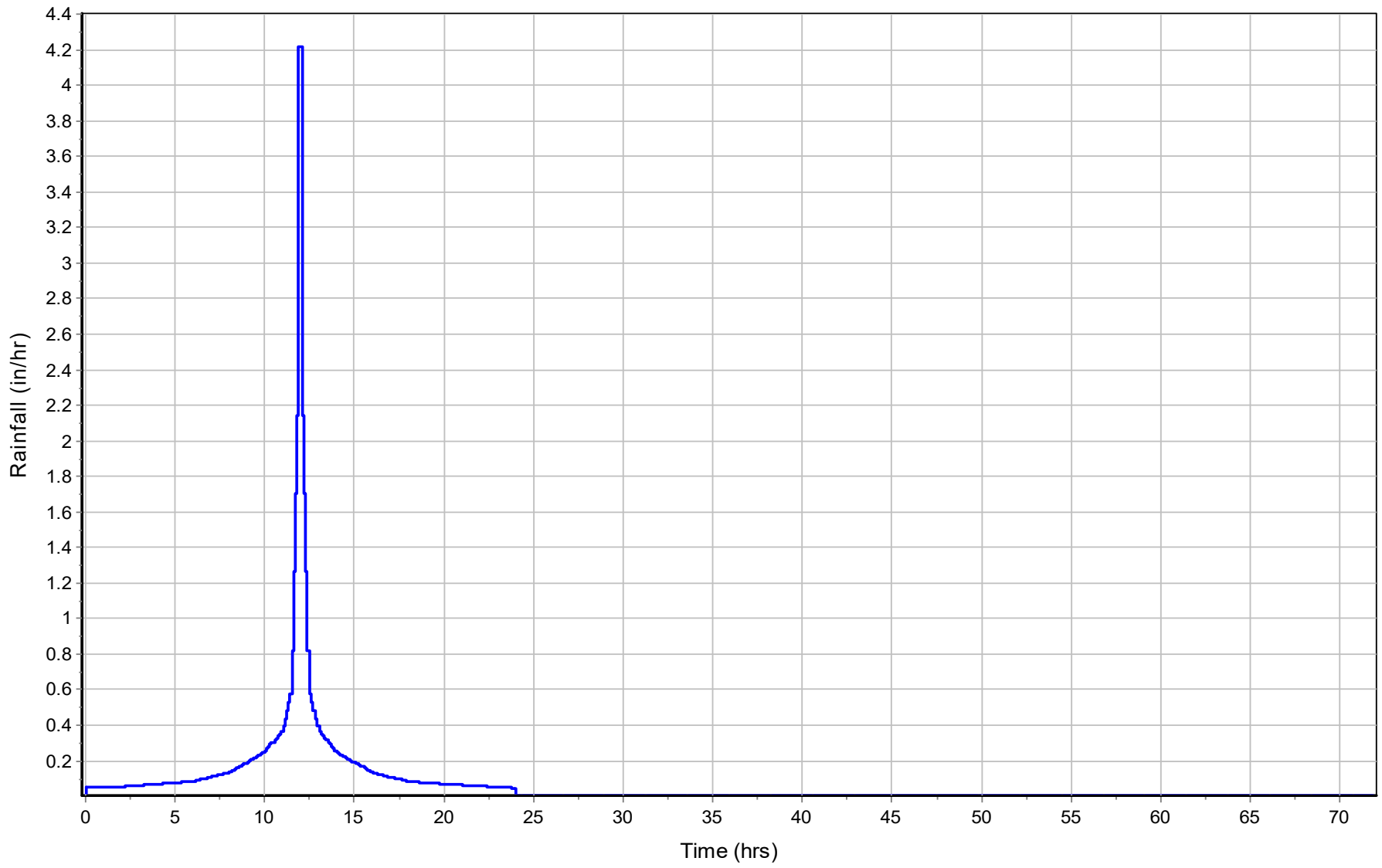
Total TOC (min) 2.31

Subbasin Runoff Results

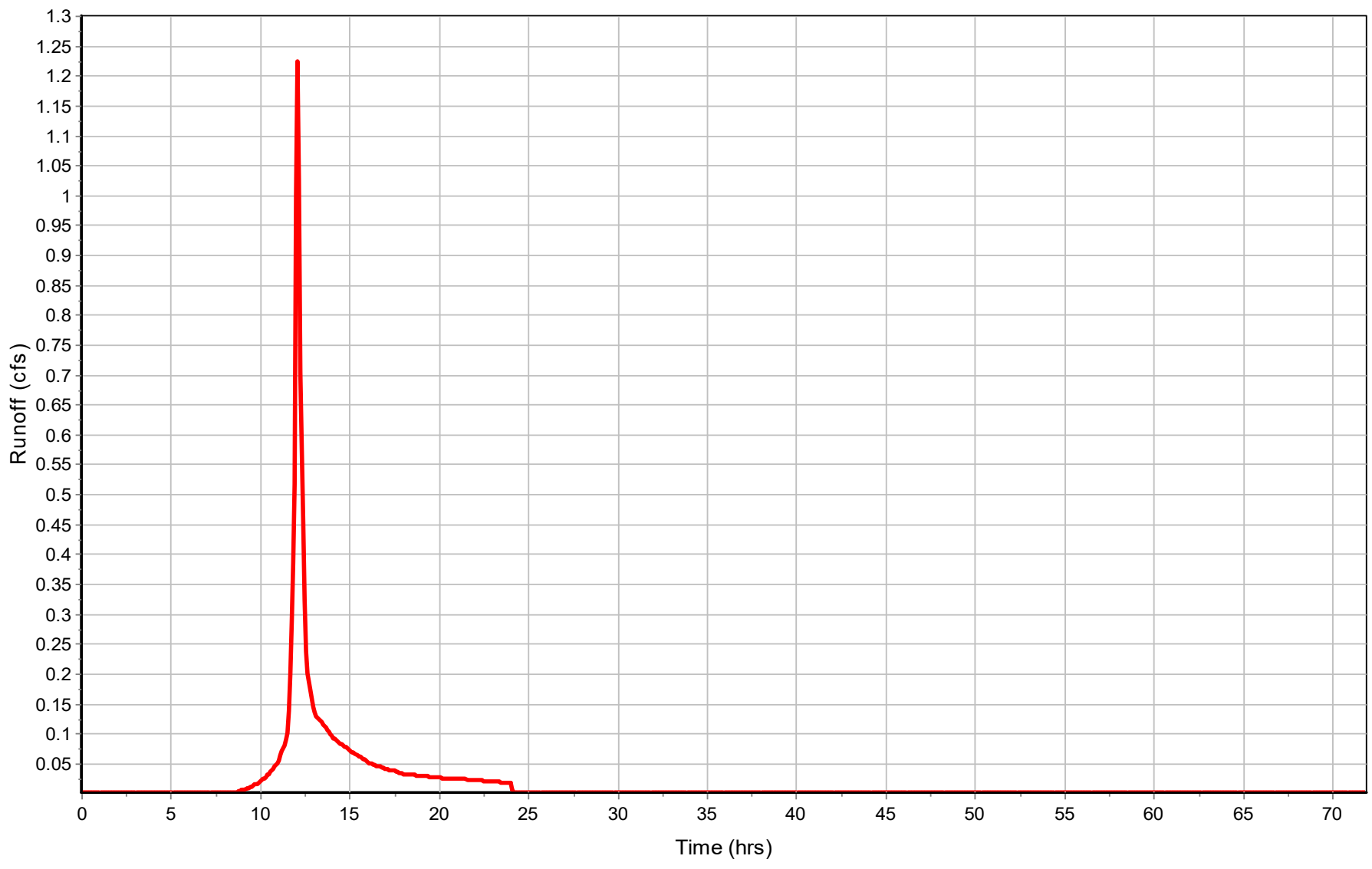
Total Rainfall (in) 5.01
Total Runoff (in) 2.54
Peak Runoff (cfs) 1.26
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:02:19

Subbasin : Sub-A2

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E02

Input Data

Area (ac) 0.37
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.37	A	43
Composite Area & Weighted CN	0.37		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	90.15	0	0
Slope (%) :	7.6	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.08	0	0
Computed Flow Time (min) :	19.54	0	0

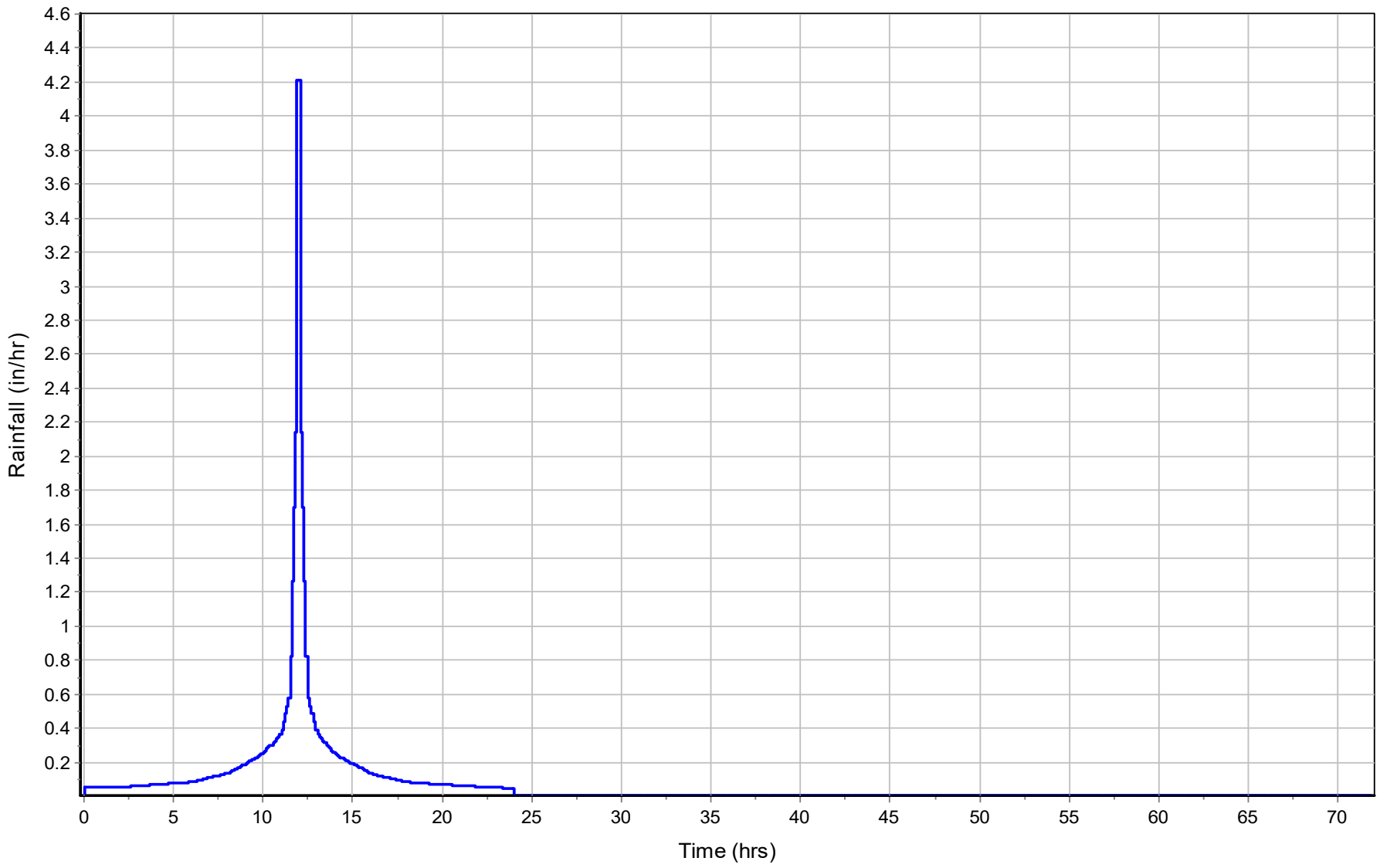
Total TOC (min) 19.54

Subbasin Runoff Results

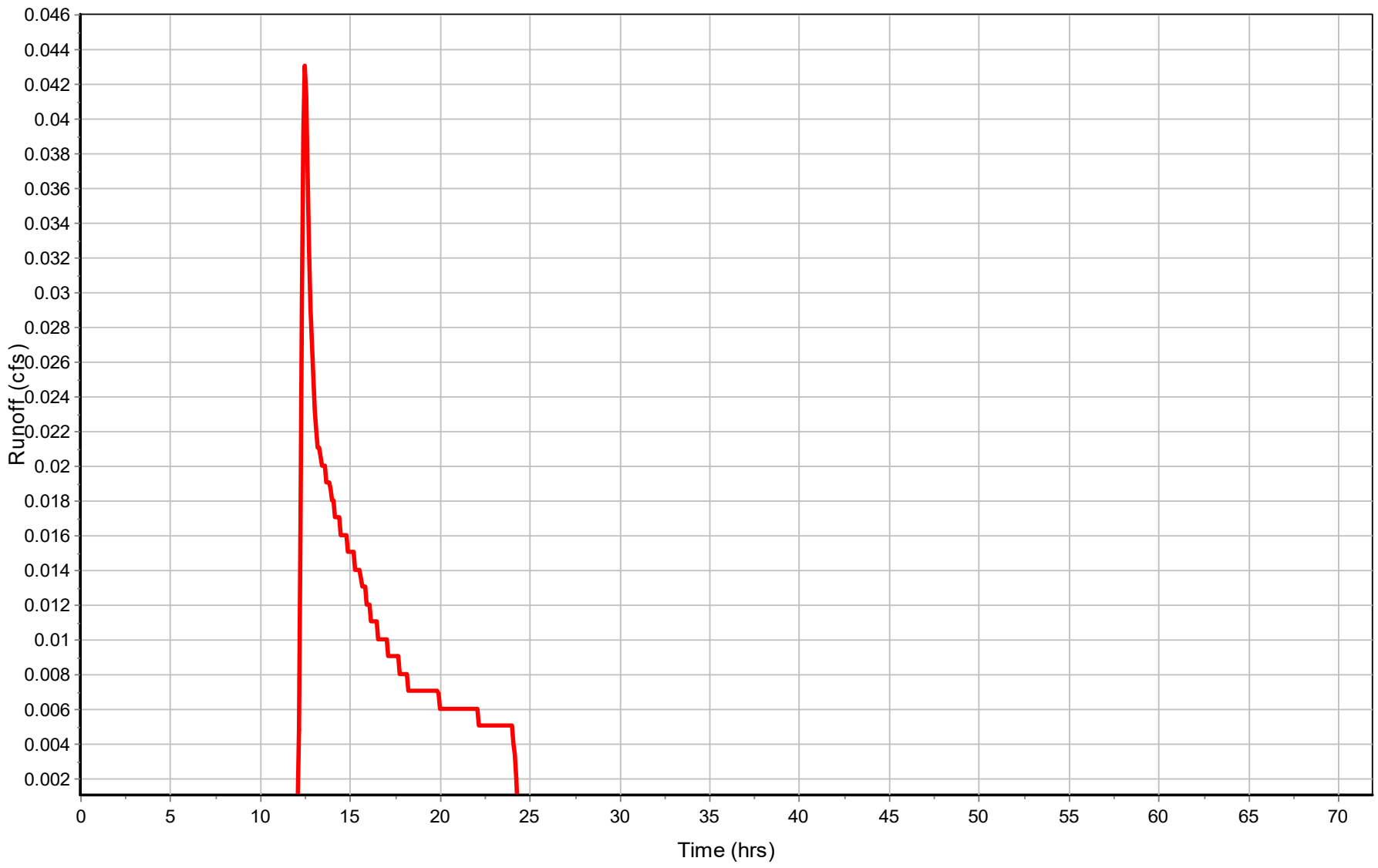
Total Rainfall (in) 5.01
Total Runoff (in) 0.36
Peak Runoff (cfs) 0.04
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:19:32

Subbasin : Sub-E02

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-02A

Input Data

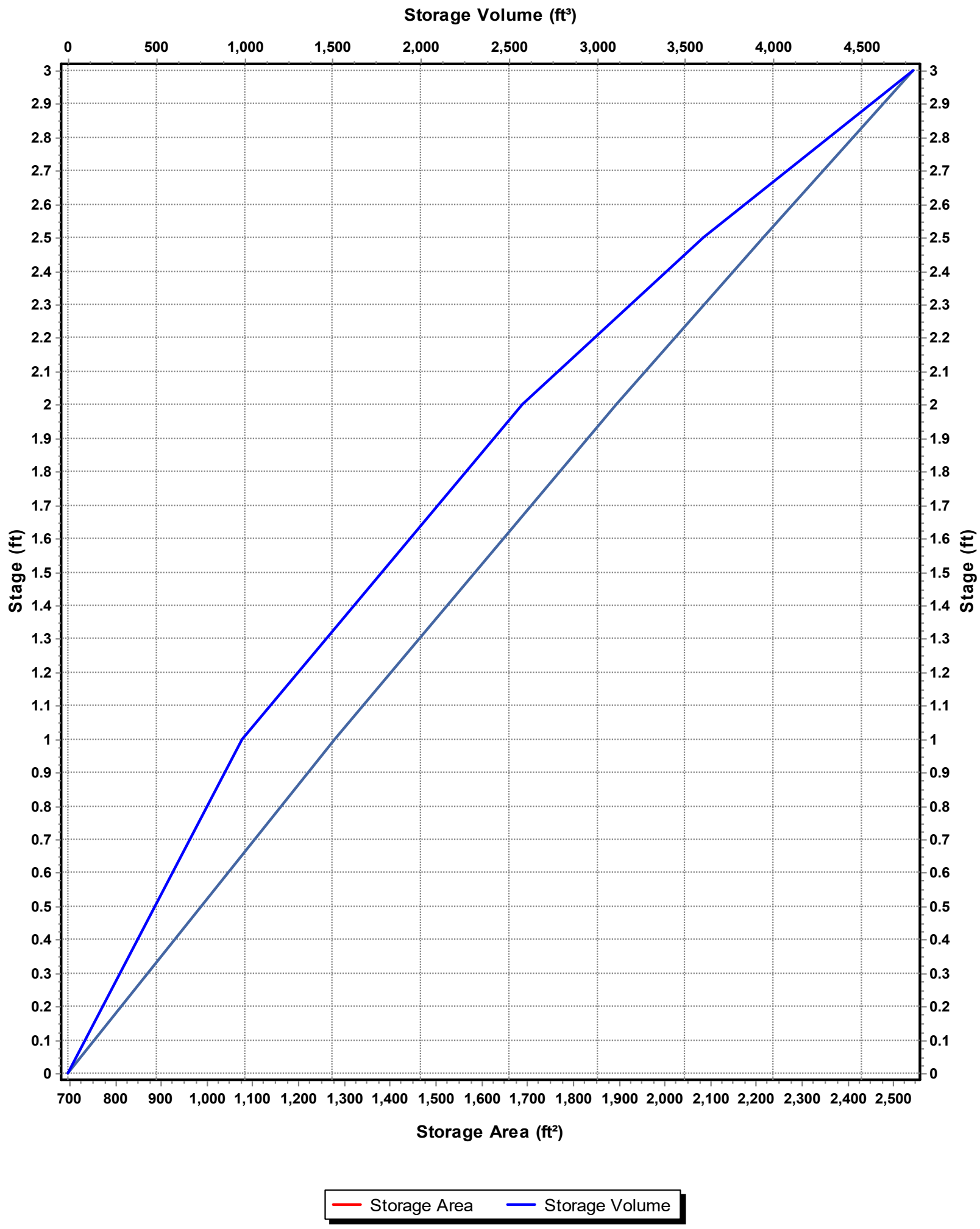
Invert Elevation (ft)	115.00
Max (Rim) Elevation (ft)	118.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	115.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Storage-13

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	697.24	0
1	1280.66	988.95
2	1896.08	2577.32
2.5	2215.79	3605.29
3	2543.5	4795.11

Storage Area Volume Curves



Storage Node : Basin-02A (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-2A	Trapezoidal	No	117.50	2.50	10.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	0.61
Peak Lateral Inflow (cfs)	0
Peak Outflow (cfs)	0.04
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	117.03
Max HGL Depth Attained (ft)	2.03
Average HGL Elevation Attained (ft)	116.63
Average HGL Depth Attained (ft)	1.63
Time of Max HGL Occurrence (days hh:mm)	3 00:00
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Basin-A2B

Input Data

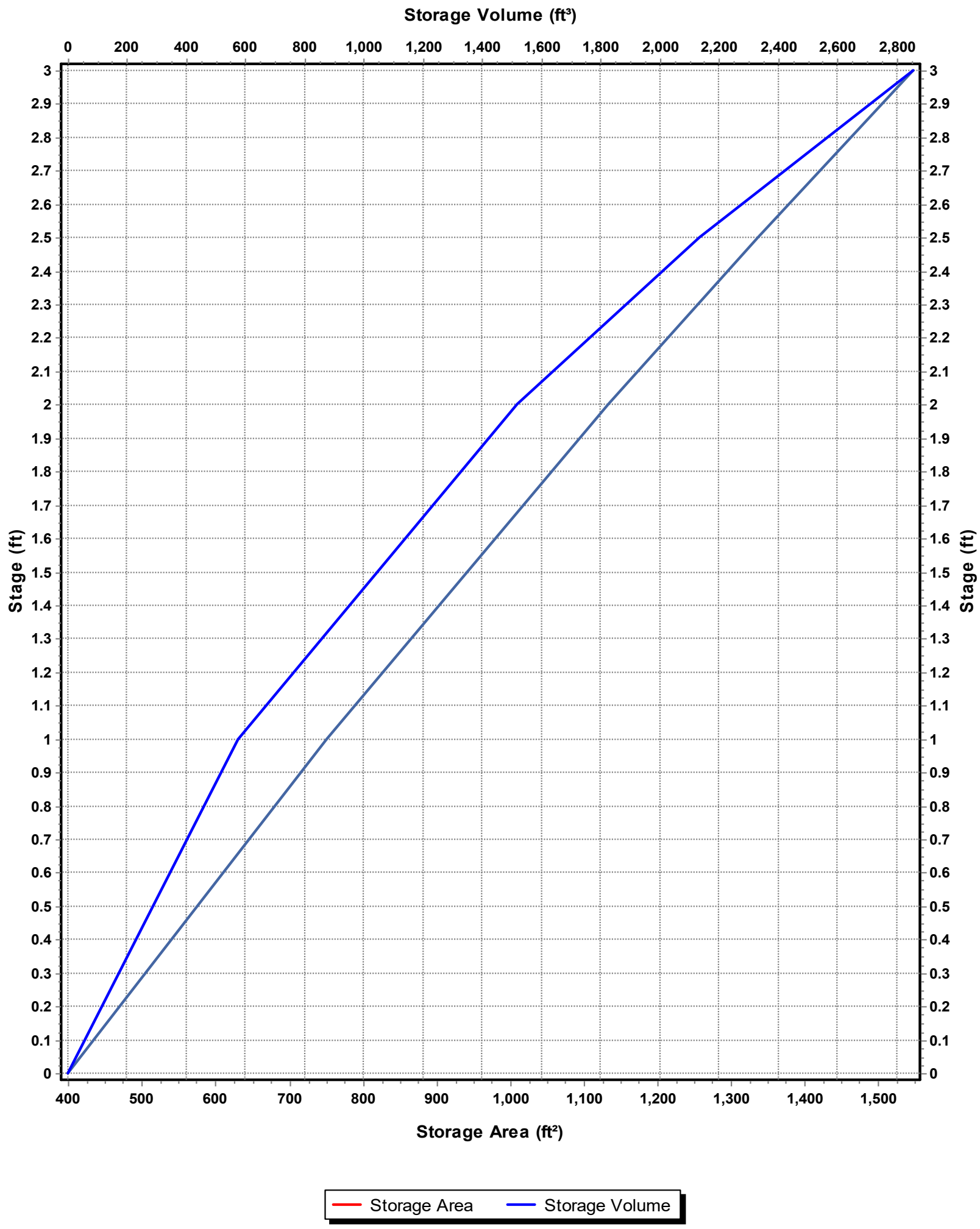
Invert Elevation (ft)	115.00
Max (Rim) Elevation (ft)	118.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	115.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Storage-14

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	399.14	0
1	750.37	574.76
2	1133.6	1516.75
2.5	1337.22	2134.46
3	1548.83	2855.97

Storage Area Volume Curves



Storage Node : Basin-A2B (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-2B	Trapezoidal	No	117.50	2.50	10.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	0.61
Peak Lateral Inflow (cfs)	0
Peak Outflow (cfs)	0.05
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	117.03
Max HGL Depth Attained (ft)	2.03
Average HGL Elevation Attained (ft)	116.68
Average HGL Depth Attained (ft)	1.68
Time of Max HGL Occurrence (days hh:mm)	3 00:00
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Forebay-A2

Input Data

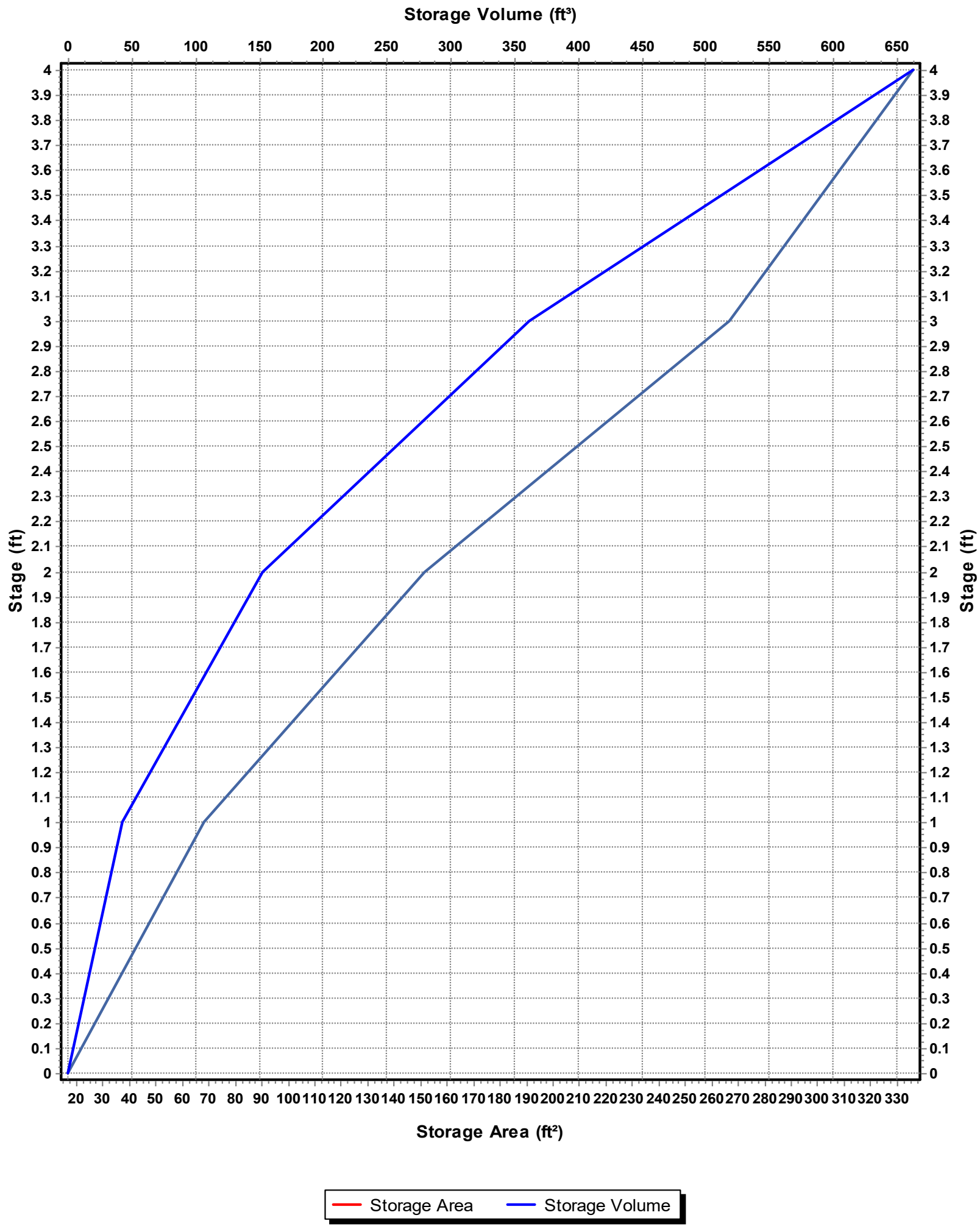
Invert Elevation (ft)	114.50
Max (Rim) Elevation (ft)	118.00
Max (Rim) Offset (ft)	3.50
Initial Water Elevation (ft)	114.50
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Storage-12

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	16.89	0
1	68.15	42.52
2	151.42	152.31
3	266.68	361.36
4	336.31	662.86

Storage Area Volume Curves



Storage Node : Forebay-A2 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-A2A	Trapezoidal	No	117.00	2.50	10.00	1.00	3.33
2	Weir-A2B	Trapezoidal	No	117.00	2.50	10.00	1.00	3.33

Output Summary Results

Peak Inflow (cfs)	1.22
Peak Lateral Inflow (cfs)	1.22
Peak Outflow (cfs)	1.22
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	117.07
Max HGL Depth Attained (ft)	2.57
Average HGL Elevation Attained (ft)	116.67
Average HGL Depth Attained (ft)	2.17
Time of Max HGL Occurrence (days hh:mm)	0 12:10
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Project Description

File Name ..... Bourne_A2.SPF

Project Options

Flow Units ..... CFS
Elevation Type ..... Elevation
Hydrology Method ..... SCS TR-20
Time of Concentration (TOC) Method ..... SCS TR-55
Link Routing Method ..... Hydrodynamic
Enable Overflow Ponding at Nodes ..... YES
Skip Steady State Analysis Time Periods ..... NO

Analysis Options

Start Analysis On ..... oct. 14, 2021 0:00:00
End Analysis On ..... oct. 17, 2021 0:00:00
Start Reporting On ..... oct. 14, 2021 0:00:00
Antecedent Dry Days ..... 0 days
Runoff (Dry Weather) Time Step ..... 0 01:00:00 days hh:mm:ss
Runoff (Wet Weather) Time Step ..... 0 00:05:00 days hh:mm:ss
Reporting Time Step ..... 0 00:05:00 days hh:mm:ss
Routing Time Step ..... 30 seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	2
Nodes	6
Junctions	0
Outfalls	3
Flow Diversions	0
Inlets	0
Storage Nodes	3
Links	4
Channels	0
Pipes	0
Pumps	0
Orifices	0
Weirs	4
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	25 years	Intensity	inches	Massachusetts	None	25.00	5.99	SCS Type III 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Sub-A2	0.48	484.00	76.00	5.99	3.37	1.62	1.67	0 00:06:00
2	Sub-E02	0.37	484.00	43.00	5.99	0.67	0.25	0.12	0 00:19:32

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Out-A2A	Outfall	116.00					0.02	116.00					
2	Out-A2B	Outfall	116.00					0.03	116.00					
3	Out-E02	Outfall	116.00					0.12	116.00					
4	Basin-02A	Storage Node	115.00	118.00	115.00		0.00	0.81	117.51				0.00	0.00
5	Basin-A2B	Storage Node	115.00	118.00	115.00		0.00	0.81	117.51				0.00	0.00
6	Forebay-A2	Storage Node	114.50	118.00	114.50		0.00	1.62	117.36				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(ft)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
1	Weir-2A	Weir	Basin-02A	Out-A2A		115.00	116.00				0.02							
2	Weir-2B	Weir	Basin-A2B	Out-A2B		115.00	116.00				0.03							
3	Weir-A2A	Weir	Forebay-A2	Basin-02A		114.50	115.00				0.81							
4	Weir-A2B	Weir	Forebay-A2	Basin-A2B		114.50	115.00				0.81							

Subbasin Hydrology

Subbasin : Sub-A2

Input Data

Area (ac)	0.48
Peak Rate Factor	484
Weighted Curve Number	76
Rain Gage ID	Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	0.48	A	76
Composite Area & Weighted CN	0.48		76

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft^2)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	37.54	0	0
Slope (%) :	1.2	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.74	0	0
Computed Flow Time (min) :	0.84	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	145.78	0	0
Channel Slope (%) :	0.3	0	0
Cross Section Area (ft^2) :	3	0	0
Wetted Perimeter (ft) :	6.32	0	0
Velocity (ft/sec) :	1.66	0	0
Computed Flow Time (min) :	1.47	0	0

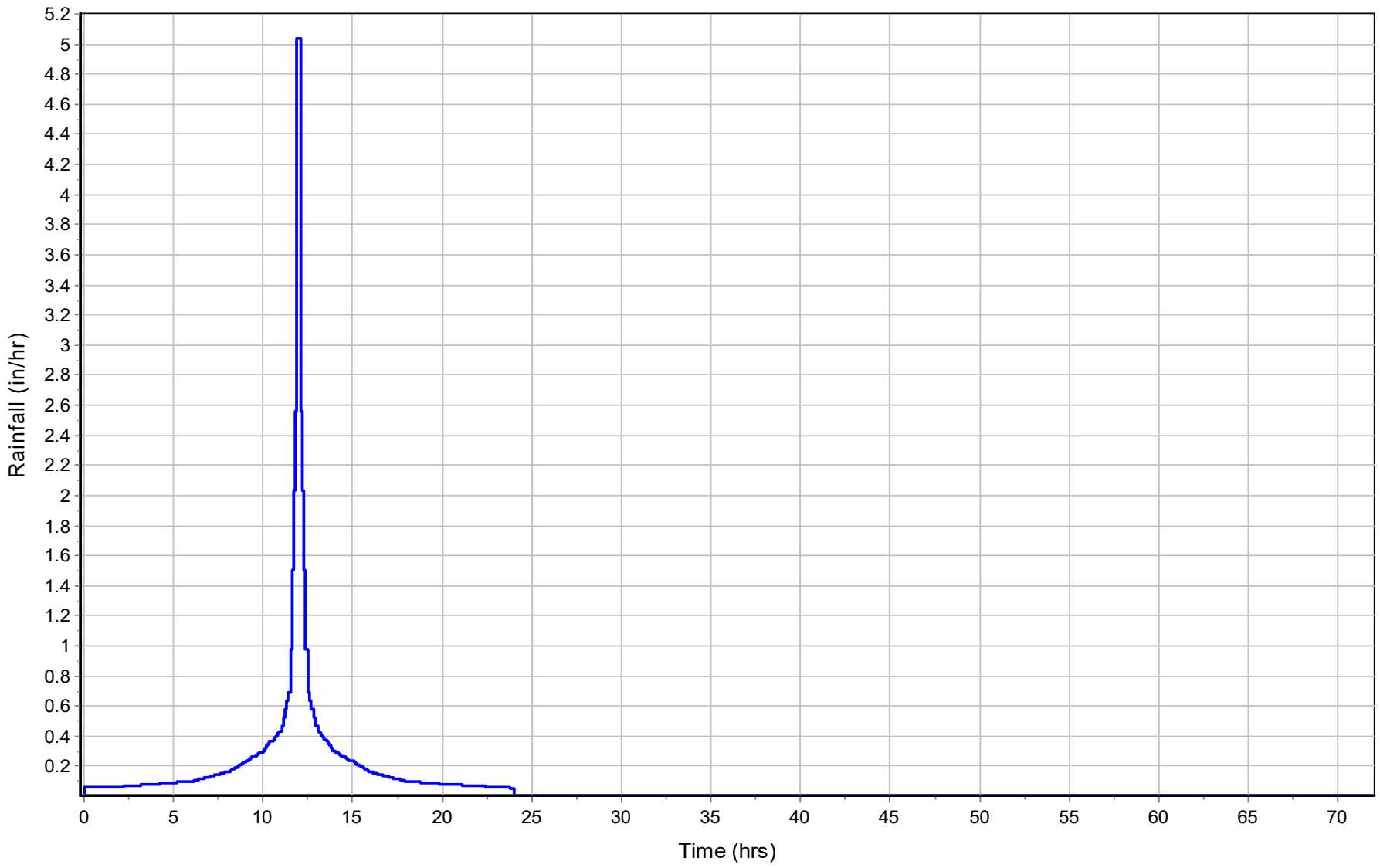
Total TOC (min) 2.31

Subbasin Runoff Results

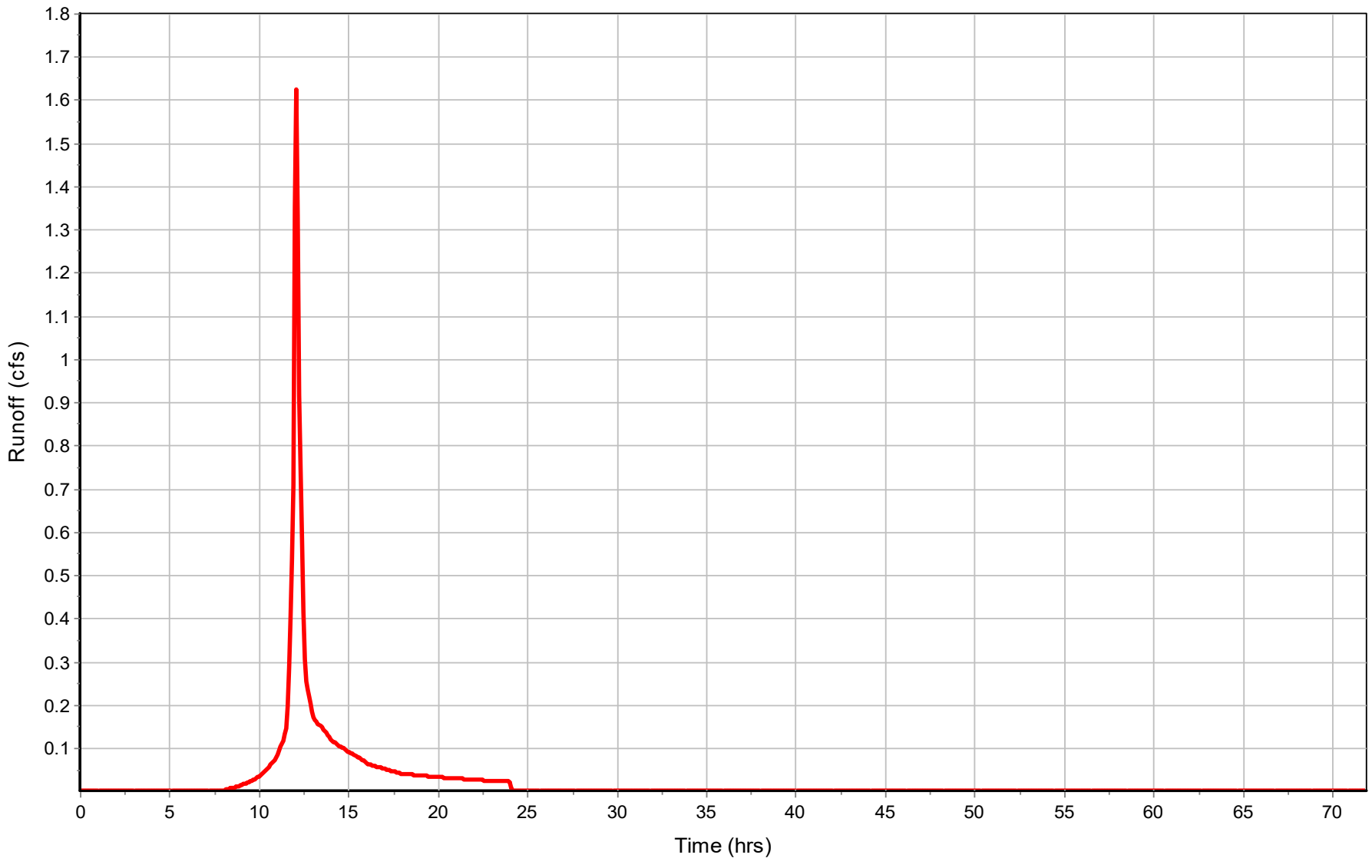
Total Rainfall (in)	5.99
Total Runoff (in)	3.37
Peak Runoff (cfs)	1.67
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:02:19

Subbasin : Sub-A2

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E02

Input Data

Area (ac) 0.37
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.37	A	43
Composite Area & Weighted CN	0.37		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	90.15	0	0
Slope (%) :	7.6	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.08	0	0
Computed Flow Time (min) :	19.54	0	0

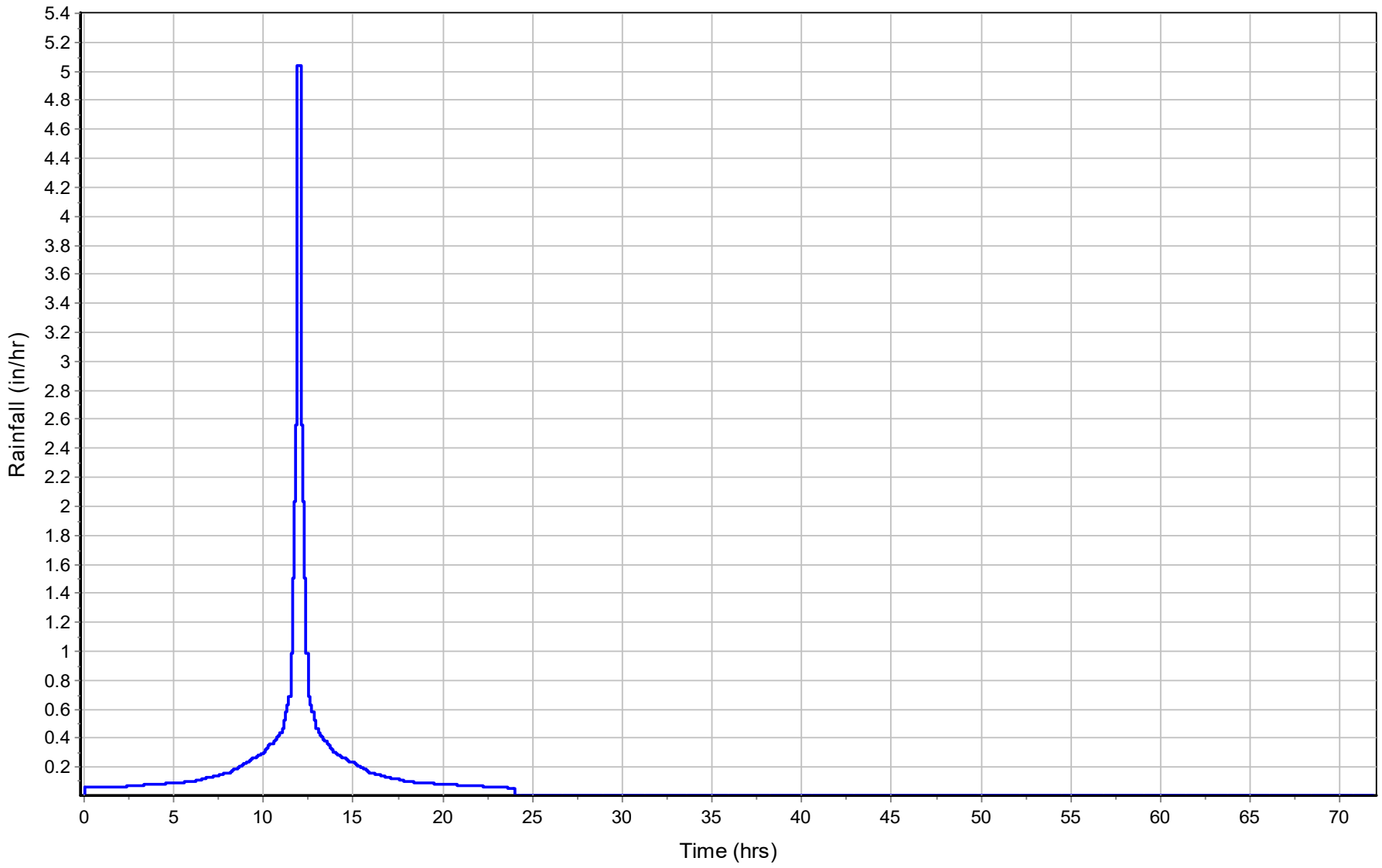
Total TOC (min) 19.54

Subbasin Runoff Results

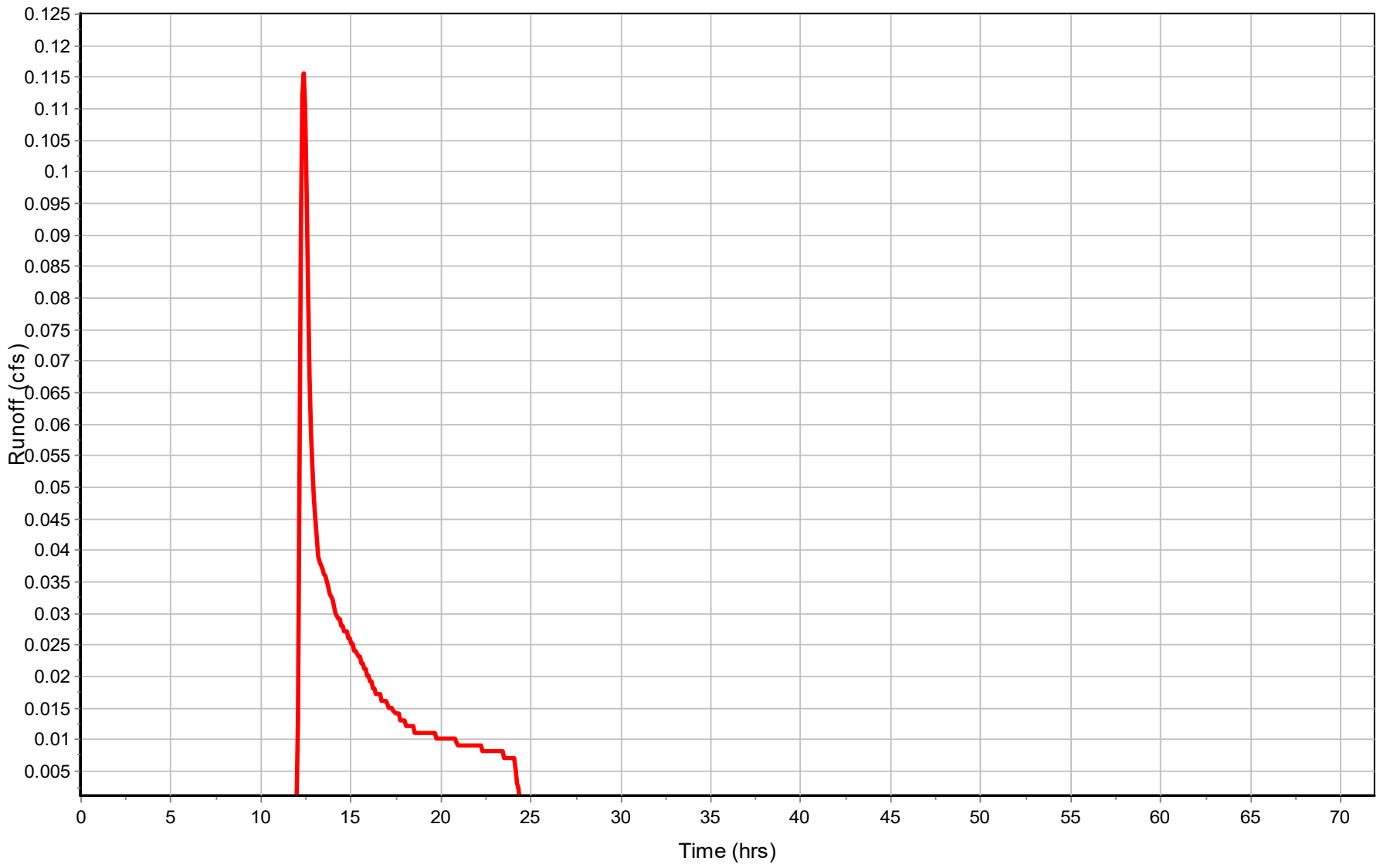
Total Rainfall (in) 5.99
Total Runoff (in) 0.67
Peak Runoff (cfs) 0.12
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:19:32

Subbasin : Sub-E02

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-02A

Input Data

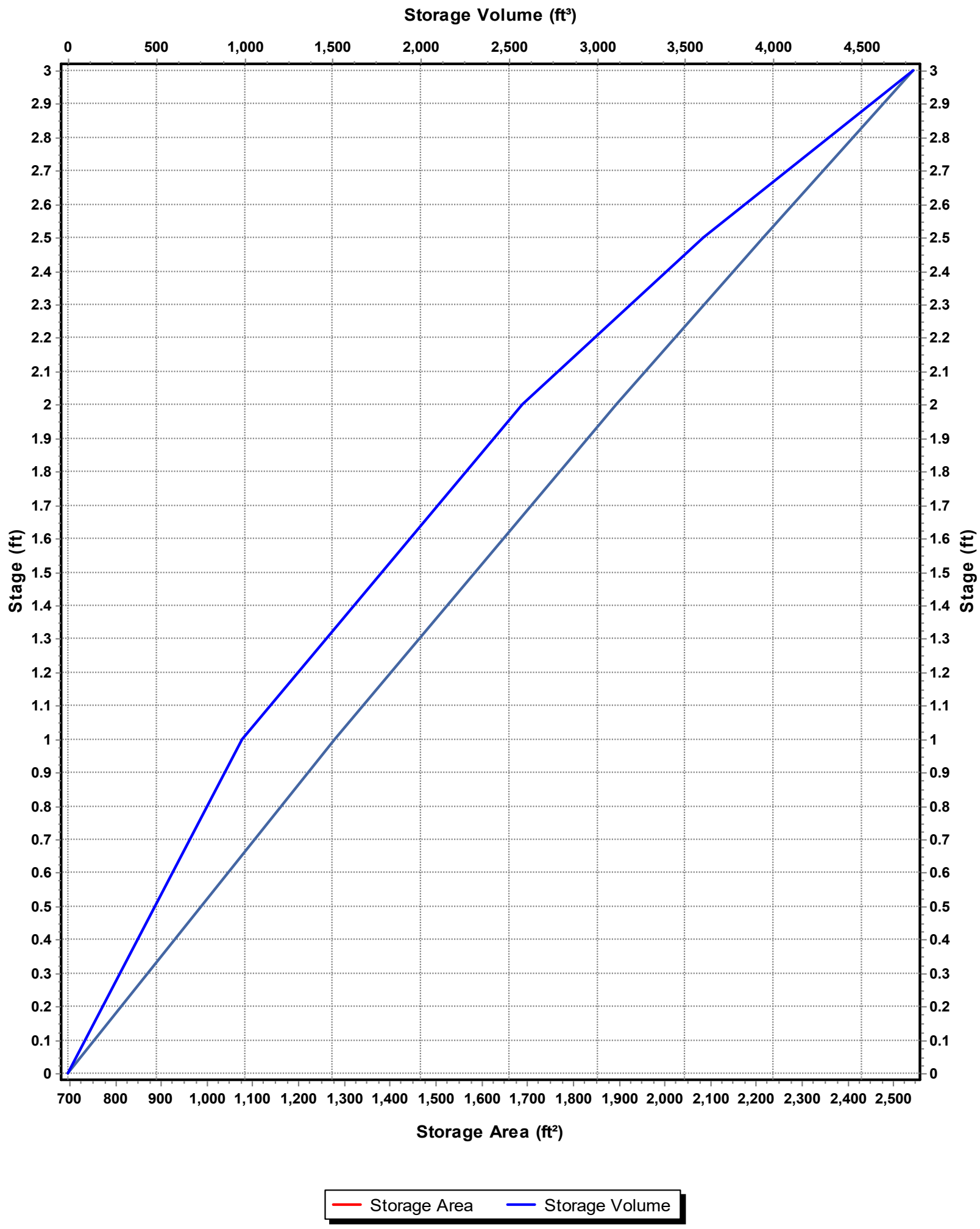
Invert Elevation (ft)	115.00
Max (Rim) Elevation (ft)	118.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	115.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Storage-13

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	697.24	0
1	1280.66	988.95
2	1896.08	2577.32
2.5	2215.79	3605.29
3	2543.5	4795.11

Storage Area Volume Curves



Storage Node : Basin-02A (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-2A	Trapezoidal	No	117.50	2.50	10.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	0.81
Peak Lateral Inflow (cfs)	0
Peak Outflow (cfs)	0.37
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	117.51
Max HGL Depth Attained (ft)	2.51
Average HGL Elevation Attained (ft)	117.03
Average HGL Depth Attained (ft)	2.03
Time of Max HGL Occurrence (days hh:mm)	0 22:36
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Basin-A2B

Input Data

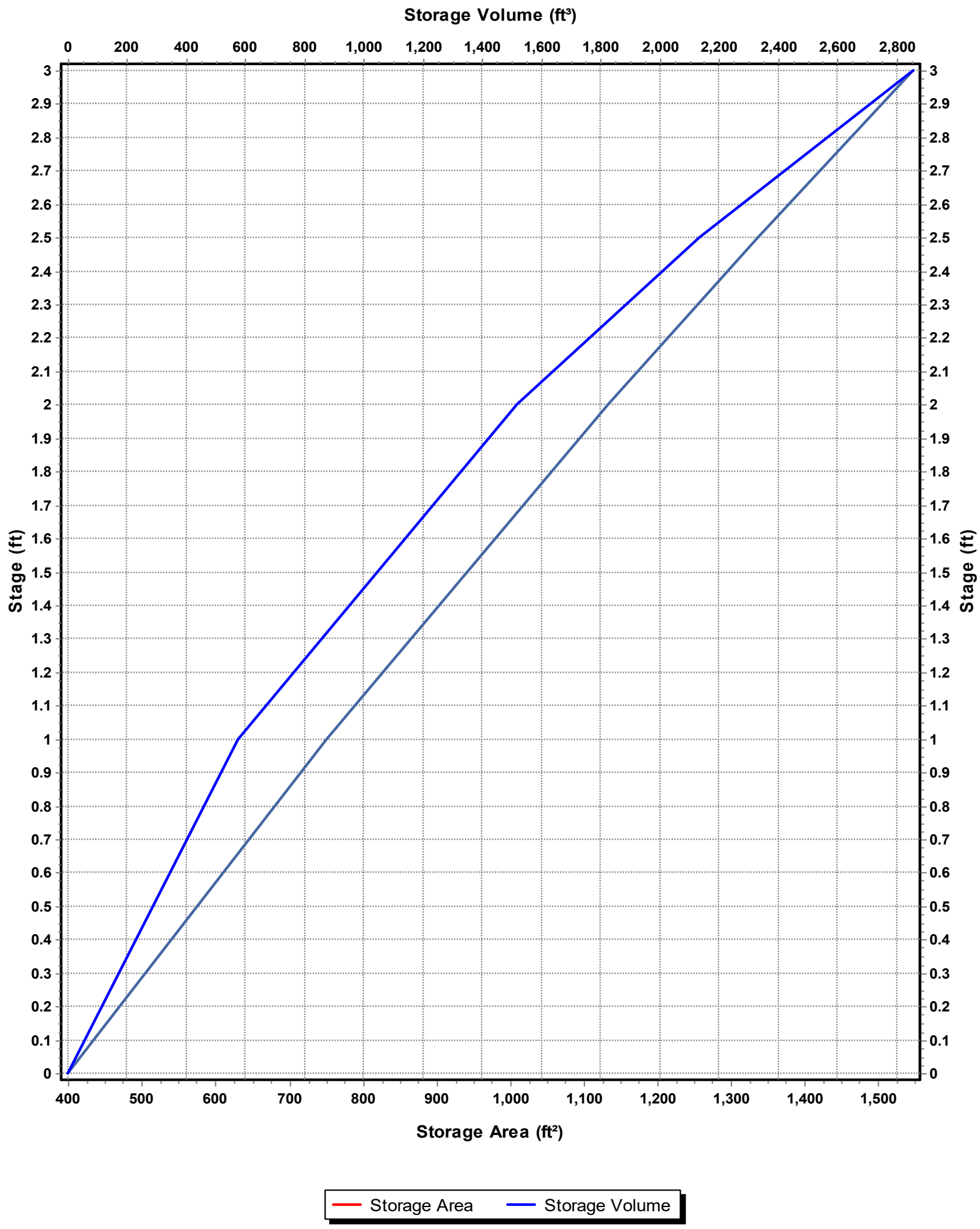
Invert Elevation (ft)	115.00
Max (Rim) Elevation (ft)	118.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	115.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Storage-14

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	399.14	0
1	750.37	574.76
2	1133.6	1516.75
2.5	1337.22	2134.46
3	1548.83	2855.97

Storage Area Volume Curves



Storage Node : Basin-A2B (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-2B	Trapezoidal	No	117.50	2.50	10.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	0.81
Peak Lateral Inflow (cfs)	0
Peak Outflow (cfs)	0.37
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	117.51
Max HGL Depth Attained (ft)	2.51
Average HGL Elevation Attained (ft)	117.05
Average HGL Depth Attained (ft)	2.05
Time of Max HGL Occurrence (days hh:mm)	0 22:36
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Forebay-A2

Input Data

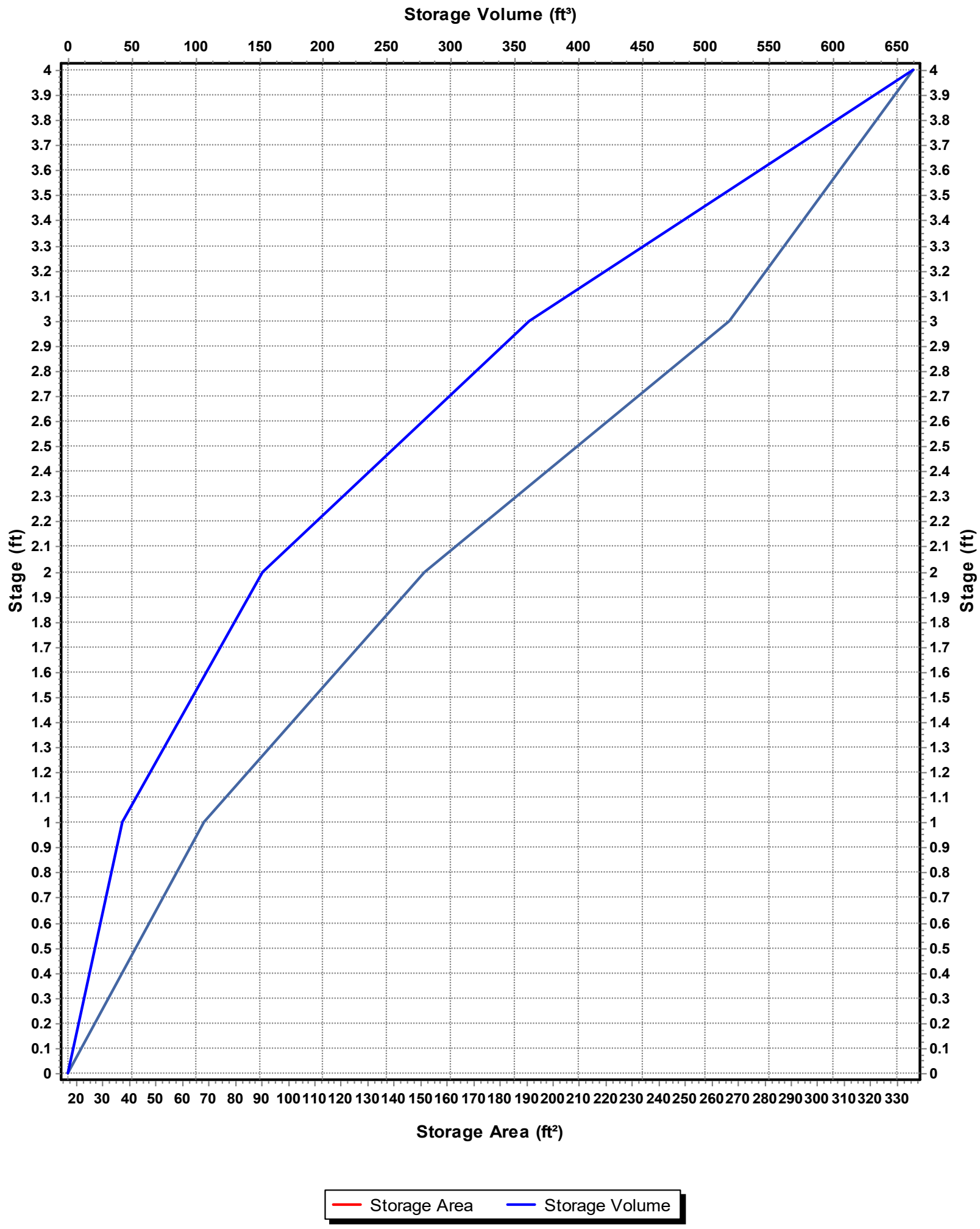
Invert Elevation (ft)	114.50
Max (Rim) Elevation (ft)	118.00
Max (Rim) Offset (ft)	3.50
Initial Water Elevation (ft)	114.50
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Storage-12

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	16.89	0
1	68.15	42.52
2	151.42	152.31
3	266.68	361.36
4	336.31	662.86

Storage Area Volume Curves



Storage Node : Forebay-A2 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-A2A	Trapezoidal	No	117.00	2.50	10.00	1.00	3.33
2	Weir-A2B	Trapezoidal	No	117.00	2.50	10.00	1.00	3.33

Output Summary Results

Peak Inflow (cfs)	1.62
Peak Lateral Inflow (cfs)	1.62
Peak Outflow (cfs)	1.62
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	117.36
Max HGL Depth Attained (ft)	2.86
Average HGL Elevation Attained (ft)	116.94
Average HGL Depth Attained (ft)	2.44
Time of Max HGL Occurrence (days hh:mm)	2 01:23
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Project Description

File Name ..... Bourne_A2.SPF

Project Options

Flow Units ..... CFS
Elevation Type ..... Elevation
Hydrology Method ..... SCS TR-20
Time of Concentration (TOC) Method ..... SCS TR-55
Link Routing Method ..... Hydrodynamic
Enable Overflow Ponding at Nodes ..... YES
Skip Steady State Analysis Time Periods ..... NO

Analysis Options

Start Analysis On ..... oct. 14, 2021 0:00:00
End Analysis On ..... oct. 17, 2021 0:00:00
Start Reporting On ..... oct. 14, 2021 0:00:00
Antecedent Dry Days ..... 0 days
Runoff (Dry Weather) Time Step ..... 0 01:00:00 days hh:mm:ss
Runoff (Wet Weather) Time Step ..... 0 00:05:00 days hh:mm:ss
Reporting Time Step ..... 0 00:05:00 days hh:mm:ss
Routing Time Step ..... 30 seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	2
Nodes	6
Junctions	0
Outfalls	3
Flow Diversions	0
Inlets	0
Storage Nodes	3
Links	4
Channels	0
Pipes	0
Pumps	0
Orifices	0
Weirs	4
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	50 years	Intensity	inches	Massachusetts	None	50.00	6.74	SCS Type III 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Sub-A2	0.48	484.00	76.00	6.74	4.03	1.93	1.98	0 00:06:00
2	Sub-E02	0.37	484.00	43.00	6.74	0.96	0.36	0.19	0 00:19:32

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Out-A2A	Outfall	116.00					0.04	116.00					
2	Out-A2B	Outfall	116.00					0.06	116.00					
3	Out-E02	Outfall	116.00					0.19	116.00					
4	Basin-02A	Storage Node	115.00	118.00	115.00		0.00	1.55	117.51				0.00	0.00
5	Basin-A2B	Storage Node	115.00	118.00	115.00		0.00	1.50	117.52				0.00	0.00
6	Forebay-A2	Storage Node	114.50	118.00	114.50		0.00	2.86	117.36				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(ft)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
1	Weir-2A	Weir	Basin-02A	Out-A2A		115.00	116.00				0.04							
2	Weir-2B	Weir	Basin-A2B	Out-A2B		115.00	116.00				0.06							
3	Weir-A2A	Weir	Forebay-A2	Basin-02A		114.50	115.00				1.55							
4	Weir-A2B	Weir	Forebay-A2	Basin-A2B		114.50	115.00				1.50							

Subbasin Hydrology

Subbasin : Sub-A2

Input Data

Area (ac)	0.48
Peak Rate Factor	484
Weighted Curve Number	76
Rain Gage ID	Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	0.48	A	76
Composite Area & Weighted CN	0.48		76

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft^2)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	37.54	0	0
Slope (%) :	1.2	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.74	0	0
Computed Flow Time (min) :	0.84	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	145.78	0	0
Channel Slope (%) :	0.3	0	0
Cross Section Area (ft^2) :	3	0	0
Wetted Perimeter (ft) :	6.32	0	0
Velocity (ft/sec) :	1.66	0	0
Computed Flow Time (min) :	1.47	0	0

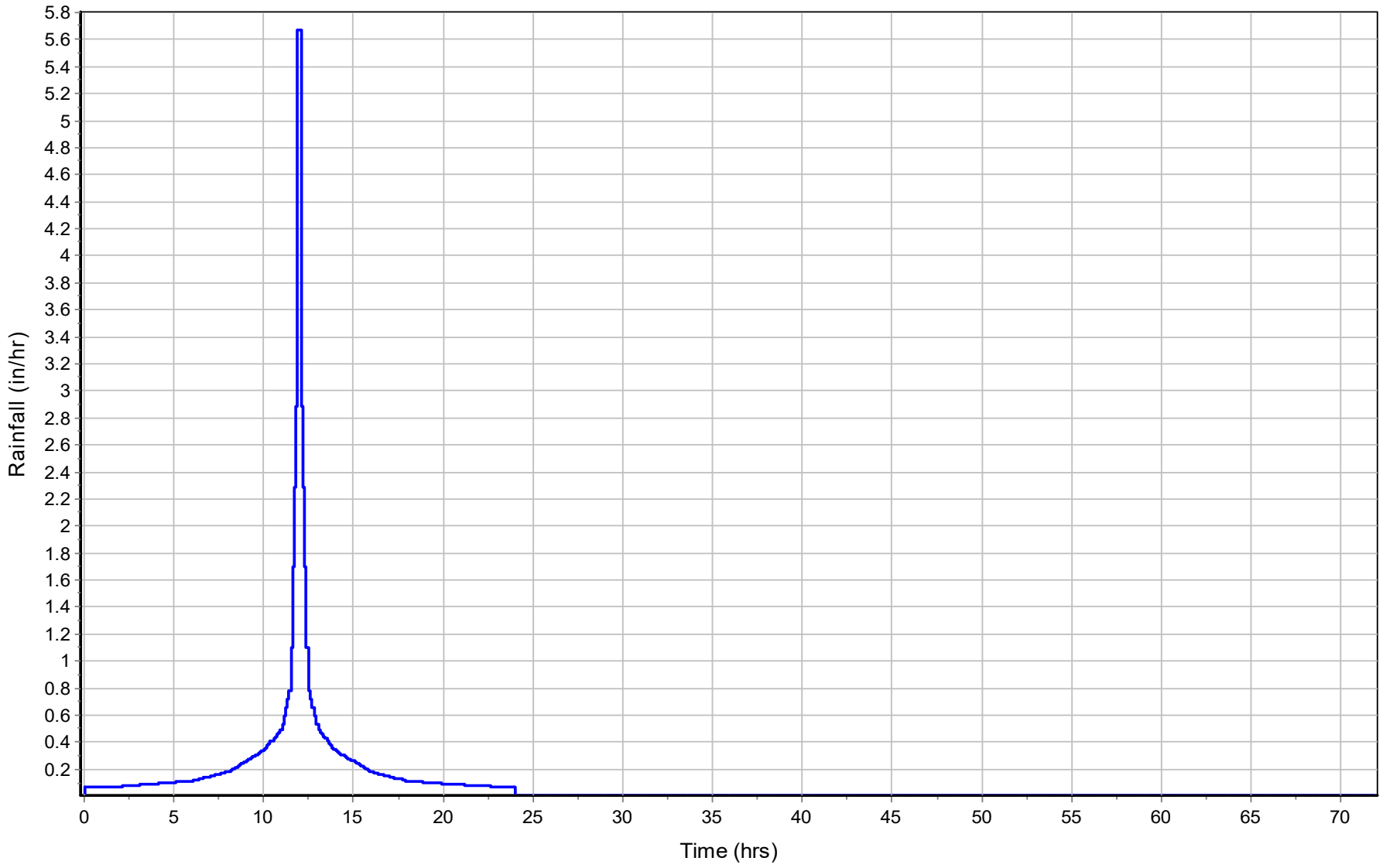
Total TOC (min) 2.31

Subbasin Runoff Results

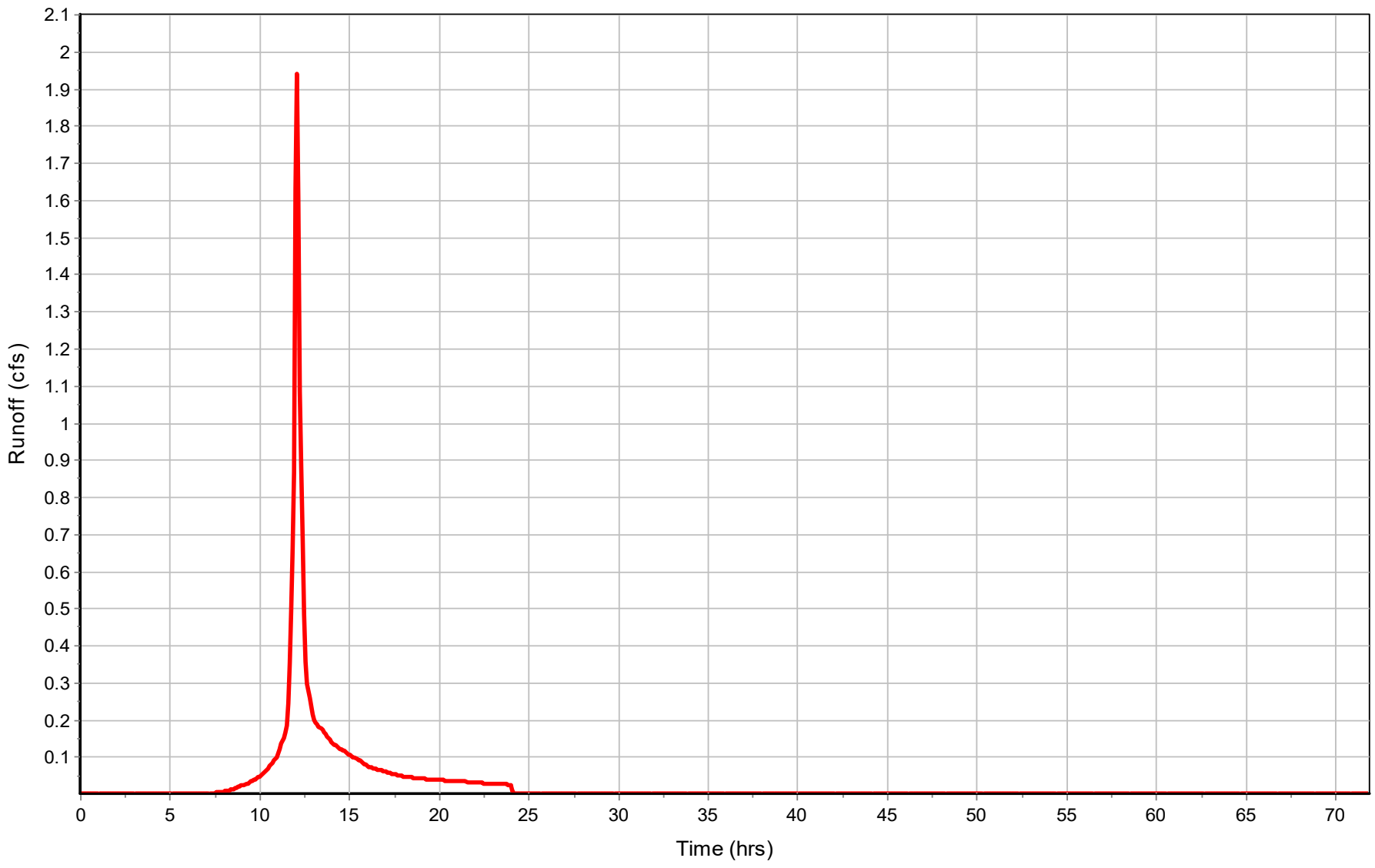
Total Rainfall (in)	6.74
Total Runoff (in)	4.03
Peak Runoff (cfs)	1.98
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:02:19

Subbasin : Sub-A2

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E02

Input Data

Area (ac) 0.37
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.37	A	43
Composite Area & Weighted CN	0.37		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	90.15	0	0
Slope (%) :	7.6	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.08	0	0
Computed Flow Time (min) :	19.54	0	0

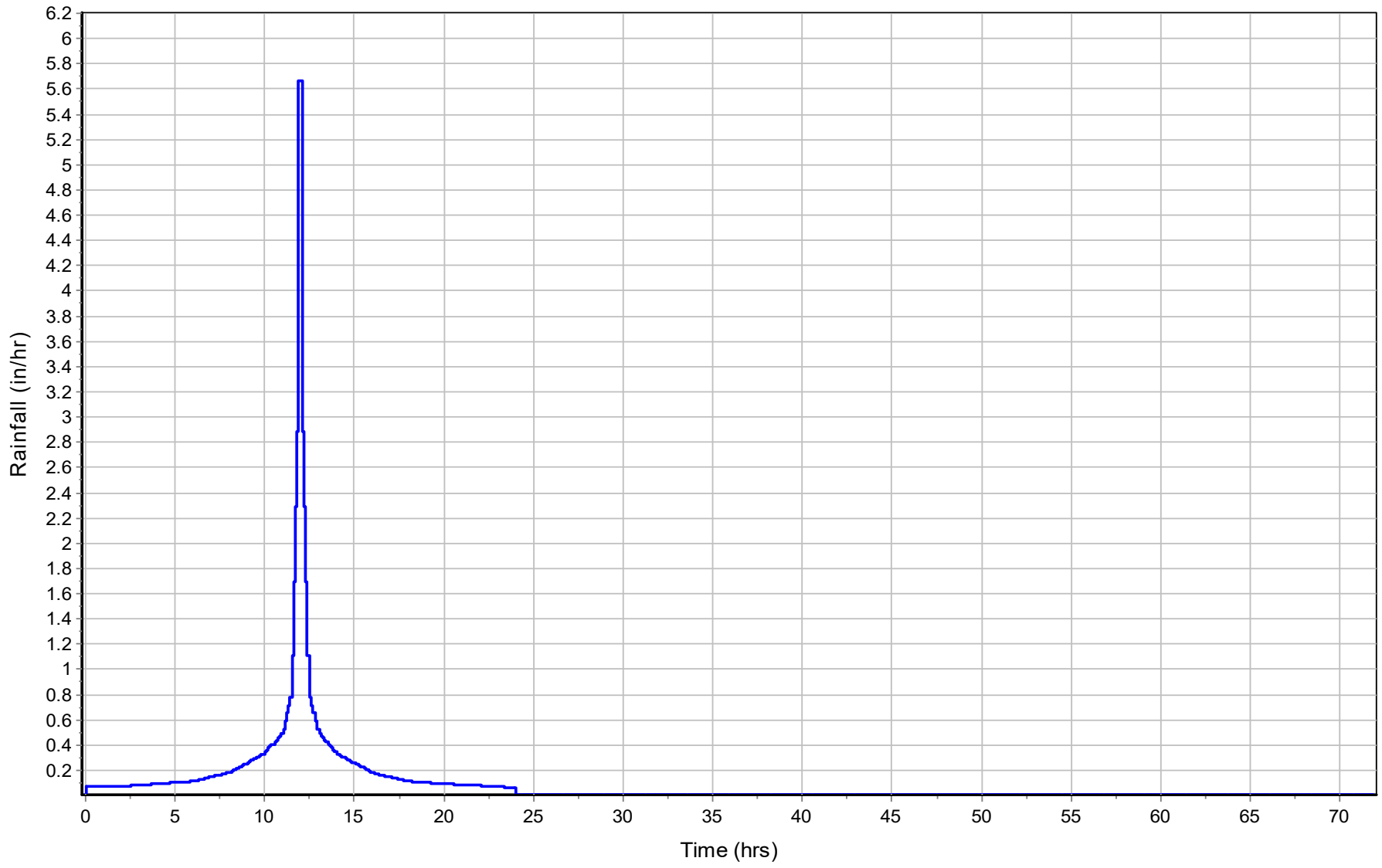
Total TOC (min) 19.54

Subbasin Runoff Results

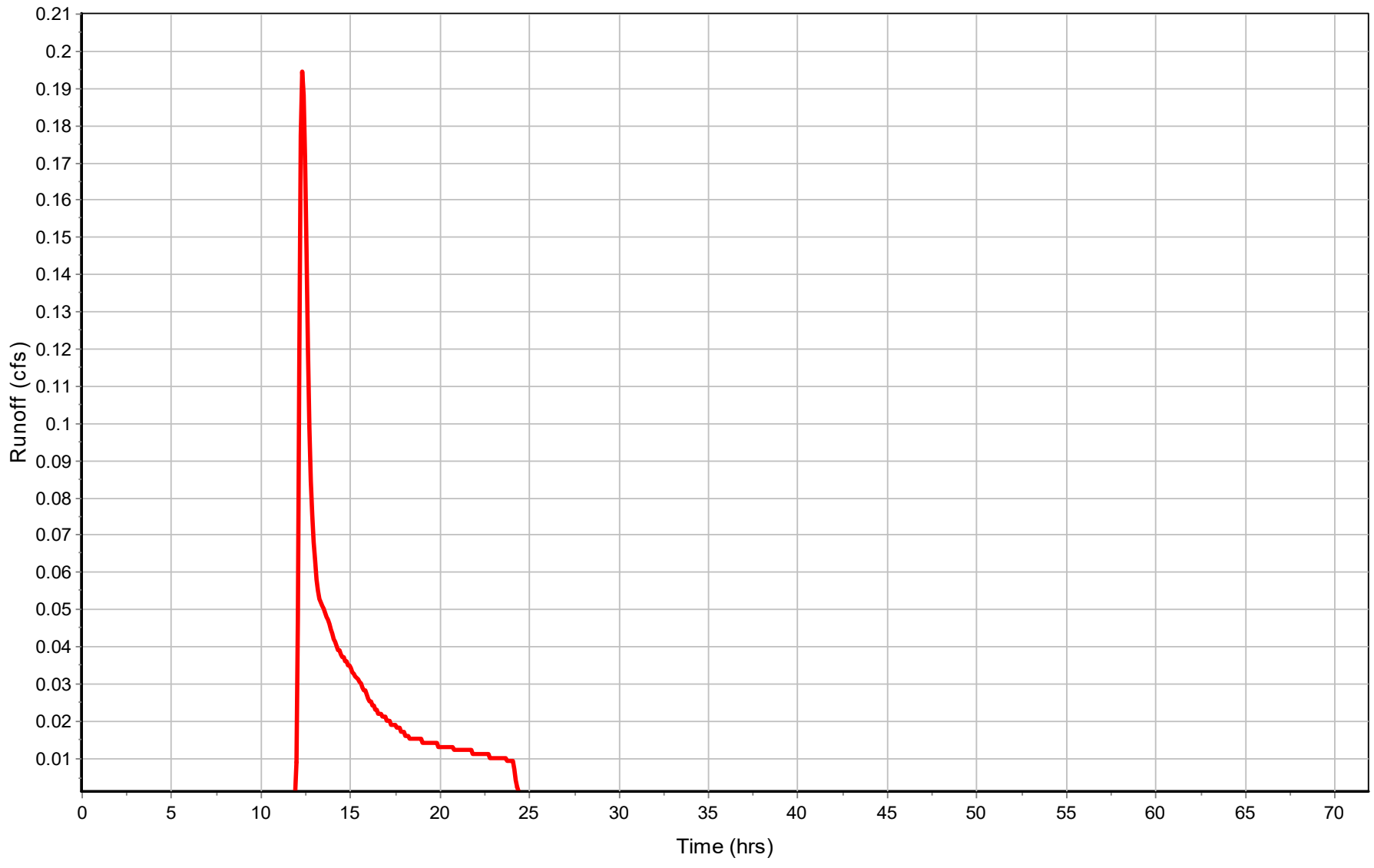
Total Rainfall (in) 6.74
Total Runoff (in) 0.96
Peak Runoff (cfs) 0.19
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:19:32

Subbasin : Sub-E02

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-02A

Input Data

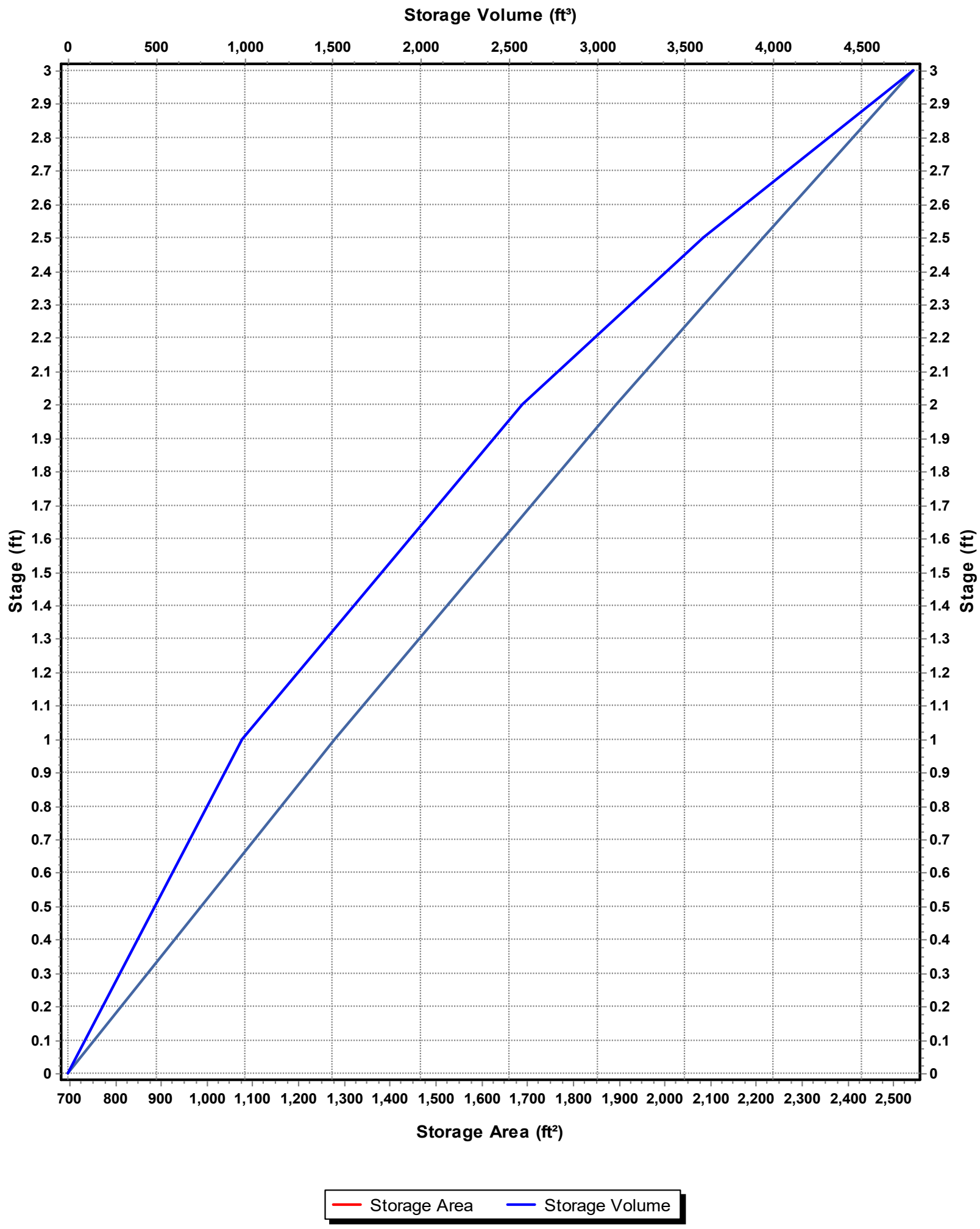
Invert Elevation (ft)	115.00
Max (Rim) Elevation (ft)	118.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	115.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Storage-13

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	697.24	0
1	1280.66	988.95
2	1896.08	2577.32
2.5	2215.79	3605.29
3	2543.5	4795.11

Storage Area Volume Curves



Storage Node : Basin-02A (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-2A	Trapezoidal	No	117.50	2.50	10.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	1.55
Peak Lateral Inflow (cfs)	0
Peak Outflow (cfs)	1.33
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	117.51
Max HGL Depth Attained (ft)	2.51
Average HGL Elevation Attained (ft)	117.07
Average HGL Depth Attained (ft)	2.07
Time of Max HGL Occurrence (days hh:mm)	0 16:46
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Basin-A2B

Input Data

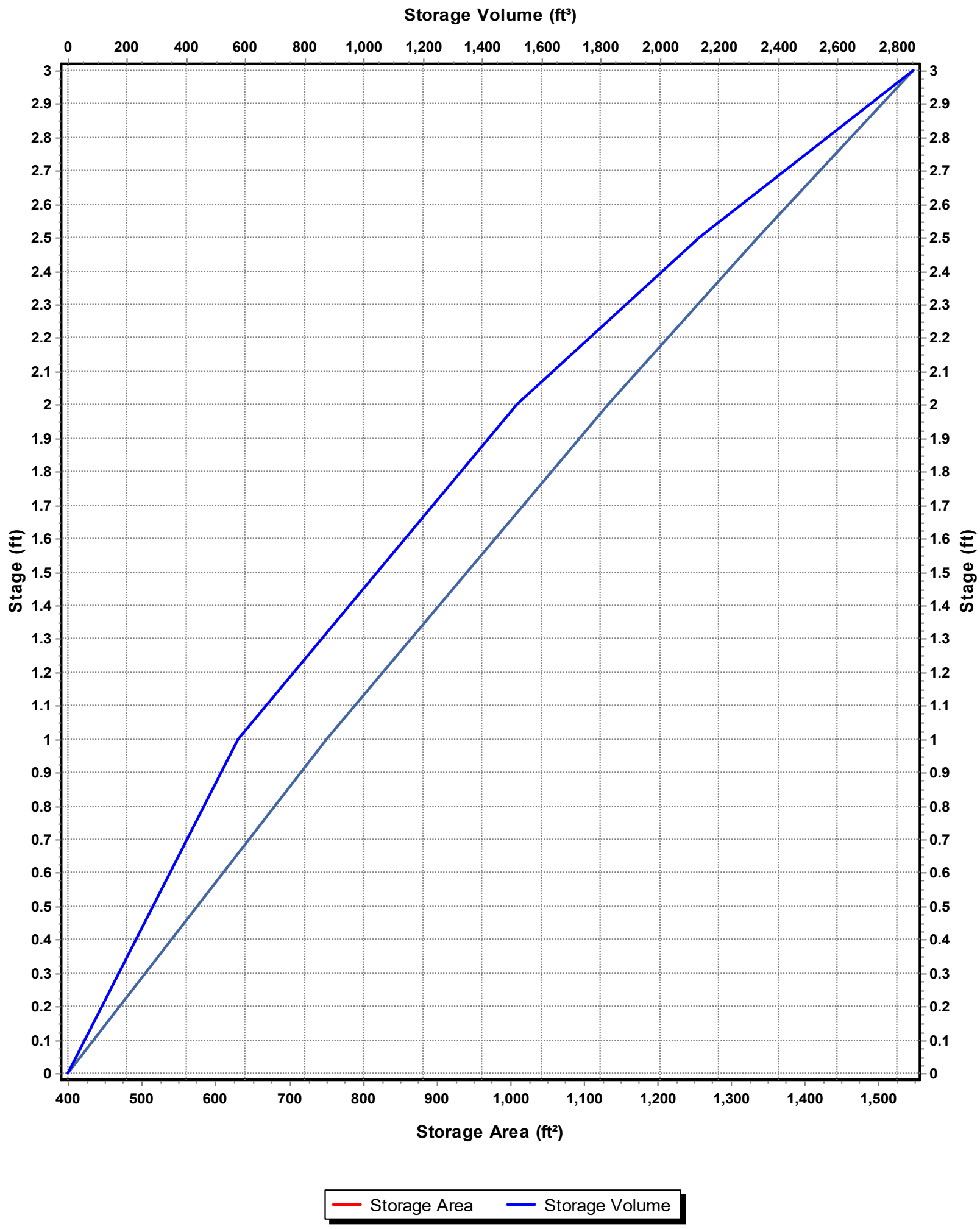
Invert Elevation (ft)	115.00
Max (Rim) Elevation (ft)	118.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	115.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Storage-14

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	399.14	0
1	750.37	574.76
2	1133.6	1516.75
2.5	1337.22	2134.46
3	1548.83	2855.97

Storage Area Volume Curves



Storage Node : Basin-A2B (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-2B	Trapezoidal	No	117.50	2.50	10.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	1.5
Peak Lateral Inflow (cfs)	0
Peak Outflow (cfs)	1.39
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	117.52
Max HGL Depth Attained (ft)	2.52
Average HGL Elevation Attained (ft)	117.08
Average HGL Depth Attained (ft)	2.08
Time of Max HGL Occurrence (days hh:mm)	0 16:45
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Forebay-A2

Input Data

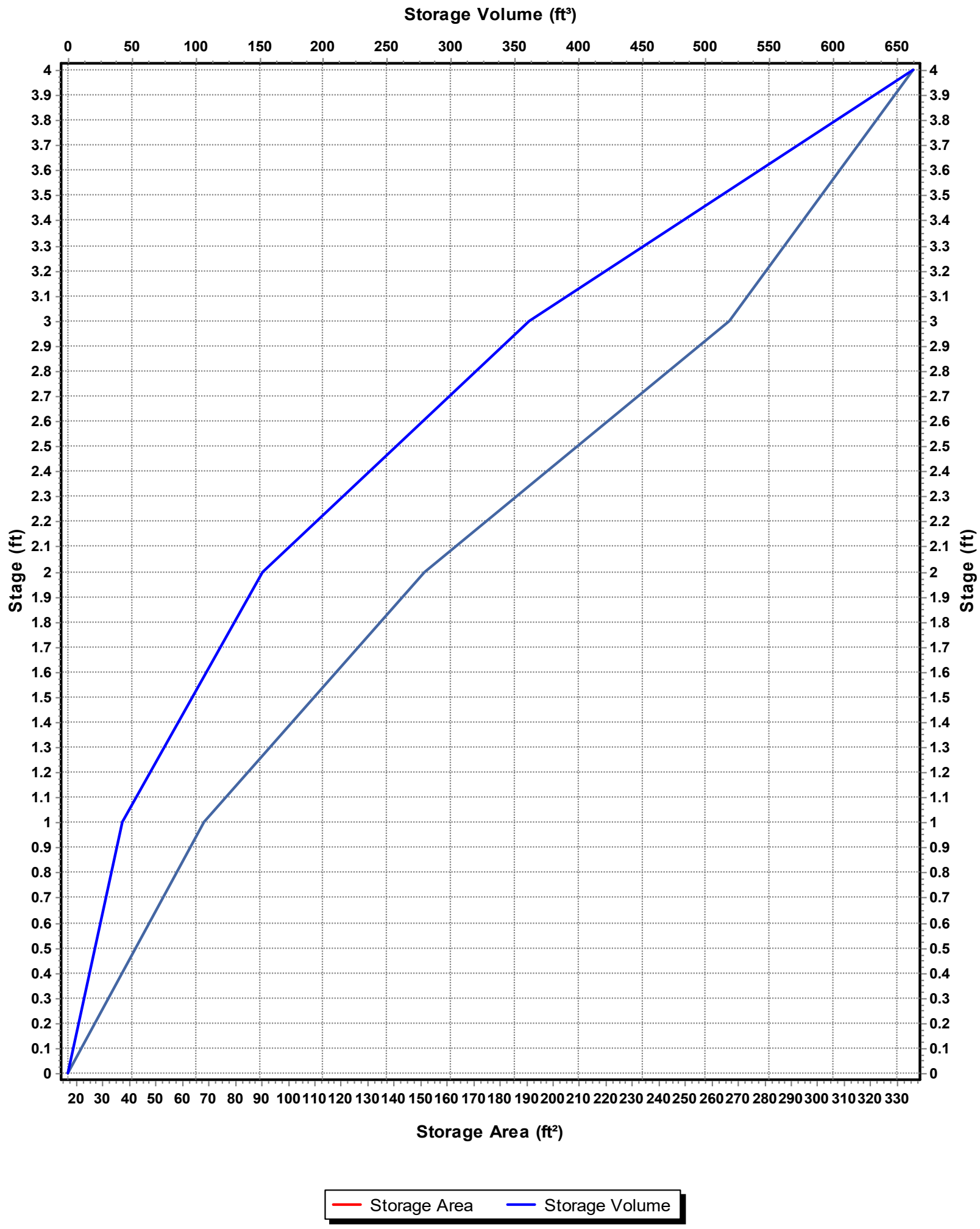
Invert Elevation (ft)	114.50
Max (Rim) Elevation (ft)	118.00
Max (Rim) Offset (ft)	3.50
Initial Water Elevation (ft)	114.50
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Storage-12

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	16.89	0
1	68.15	42.52
2	151.42	152.31
3	266.68	361.36
4	336.31	662.86

Storage Area Volume Curves



Storage Node : Forebay-A2 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-A2A	Trapezoidal	No	117.00	2.50	10.00	1.00	3.33
2	Weir-A2B	Trapezoidal	No	117.00	2.50	10.00	1.00	3.33

Output Summary Results

Peak Inflow (cfs)	2.86
Peak Lateral Inflow (cfs)	1.94
Peak Outflow (cfs)	3.05
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	117.36
Max HGL Depth Attained (ft)	2.86
Average HGL Elevation Attained (ft)	116.97
Average HGL Depth Attained (ft)	2.47
Time of Max HGL Occurrence (days hh:mm)	2 01:54
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Project Description

File Name ..... Bourne_A2.SPF

Project Options

Flow Units ..... CFS
Elevation Type ..... Elevation
Hydrology Method ..... SCS TR-20
Time of Concentration (TOC) Method ..... SCS TR-55
Link Routing Method ..... Hydrodynamic
Enable Overflow Ponding at Nodes ..... YES
Skip Steady State Analysis Time Periods ..... NO

Analysis Options

Start Analysis On ..... oct. 14, 2021 0:00:00
End Analysis On ..... oct. 17, 2021 0:00:00
Start Reporting On ..... oct. 14, 2021 0:00:00
Antecedent Dry Days ..... 0 days
Runoff (Dry Weather) Time Step ..... 0 01:00:00 days hh:mm:ss
Runoff (Wet Weather) Time Step ..... 0 00:05:00 days hh:mm:ss
Reporting Time Step ..... 0 00:05:00 days hh:mm:ss
Routing Time Step ..... 30 seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	2
Nodes	6
Junctions	0
Outfalls	3
Flow Diversions	0
Inlets	0
Storage Nodes	3
Links	4
Channels	0
Pipes	0
Pumps	0
Orifices	0
Weirs	4
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	100 years	Intensity	inches	Massachusetts	None	100.00	7.51	SCS Type III 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Sub-A2	0.48	484.00	76.00	7.51	4.71	2.26	2.30	0 00:06:00
2	Sub-E02	0.37	484.00	43.00	7.51	1.30	0.48	0.29	0 00:19:32

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Out-A2A	Outfall	116.00					0.08	116.00					
2	Out-A2B	Outfall	116.00					0.10	116.00					
3	Out-E02	Outfall	116.00					0.29	116.00					
4	Basin-02A	Storage Node	115.00	118.00	115.00		0.00	3.96	117.52				0.00	0.00
5	Basin-A2B	Storage Node	115.00	118.00	115.00		0.00	3.94	117.52				0.00	0.00
6	Forebay-A2	Storage Node	114.50	118.00	114.50		0.00	8.92	117.47				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(ft)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
1	Weir-2A	Weir	Basin-02A	Out-A2A		115.00	116.00				0.08							
2	Weir-2B	Weir	Basin-A2B	Out-A2B		115.00	116.00				0.10							
3	Weir-A2A	Weir	Forebay-A2	Basin-02A		114.50	115.00				4.28							
4	Weir-A2B	Weir	Forebay-A2	Basin-A2B		114.50	115.00				4.43							

Subbasin Hydrology

Subbasin : Sub-A2

Input Data

Area (ac)	0.48
Peak Rate Factor	484
Weighted Curve Number	76
Rain Gage ID	Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	0.48	A	76
Composite Area & Weighted CN	0.48		76

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft^2)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	37.54	0	0
Slope (%) :	1.2	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.74	0	0
Computed Flow Time (min) :	0.84	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	145.78	0	0
Channel Slope (%) :	0.3	0	0
Cross Section Area (ft^2) :	3	0	0
Wetted Perimeter (ft) :	6.32	0	0
Velocity (ft/sec) :	1.66	0	0
Computed Flow Time (min) :	1.47	0	0

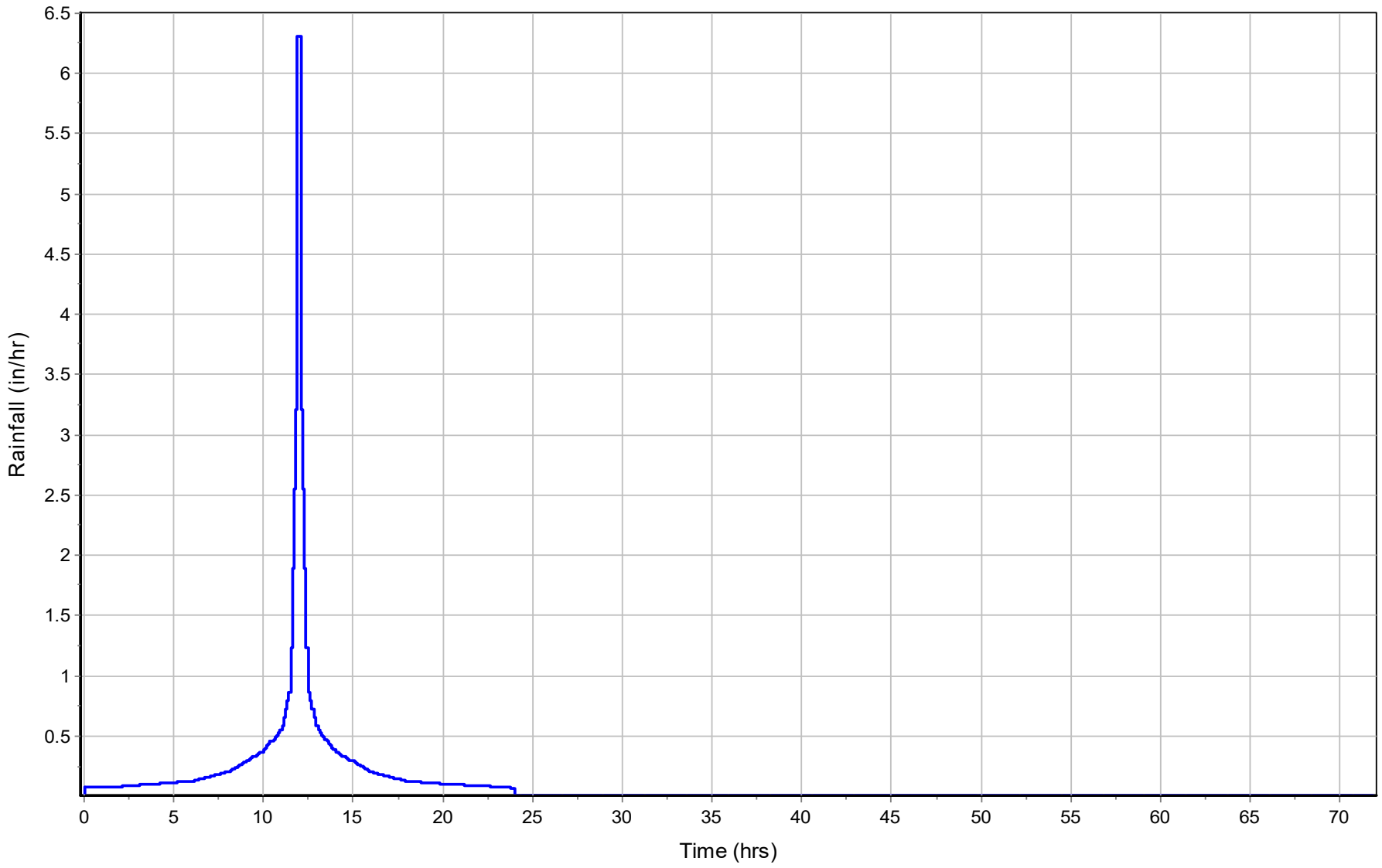
Total TOC (min) 2.31

Subbasin Runoff Results

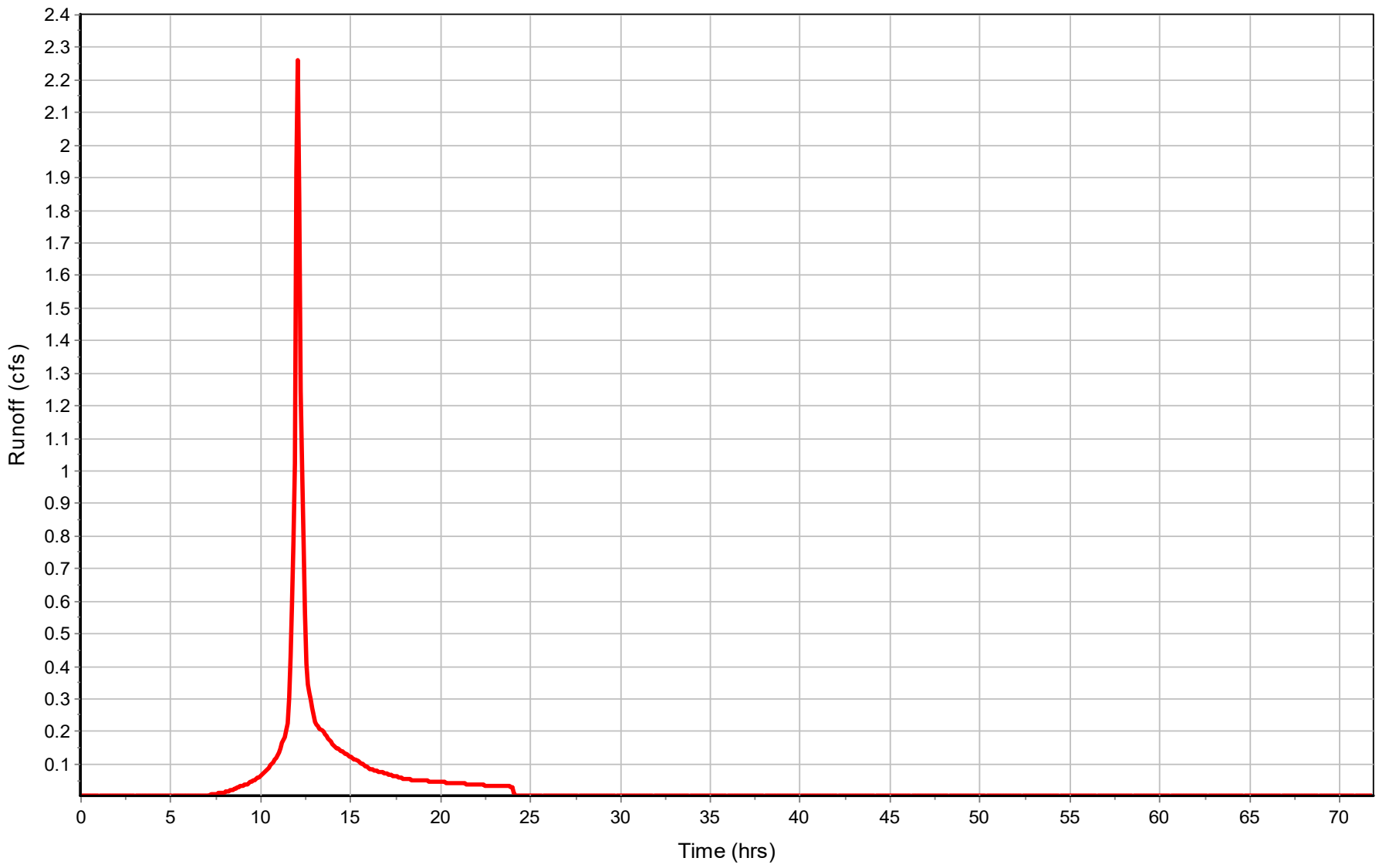
Total Rainfall (in)	7.51
Total Runoff (in)	4.71
Peak Runoff (cfs)	2.3
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:02:19

Subbasin : Sub-A2

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E02

Input Data

Area (ac) 0.37
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.37	A	43
Composite Area & Weighted CN	0.37		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	90.15	0	0
Slope (%) :	7.6	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.08	0	0
Computed Flow Time (min) :	19.54	0	0

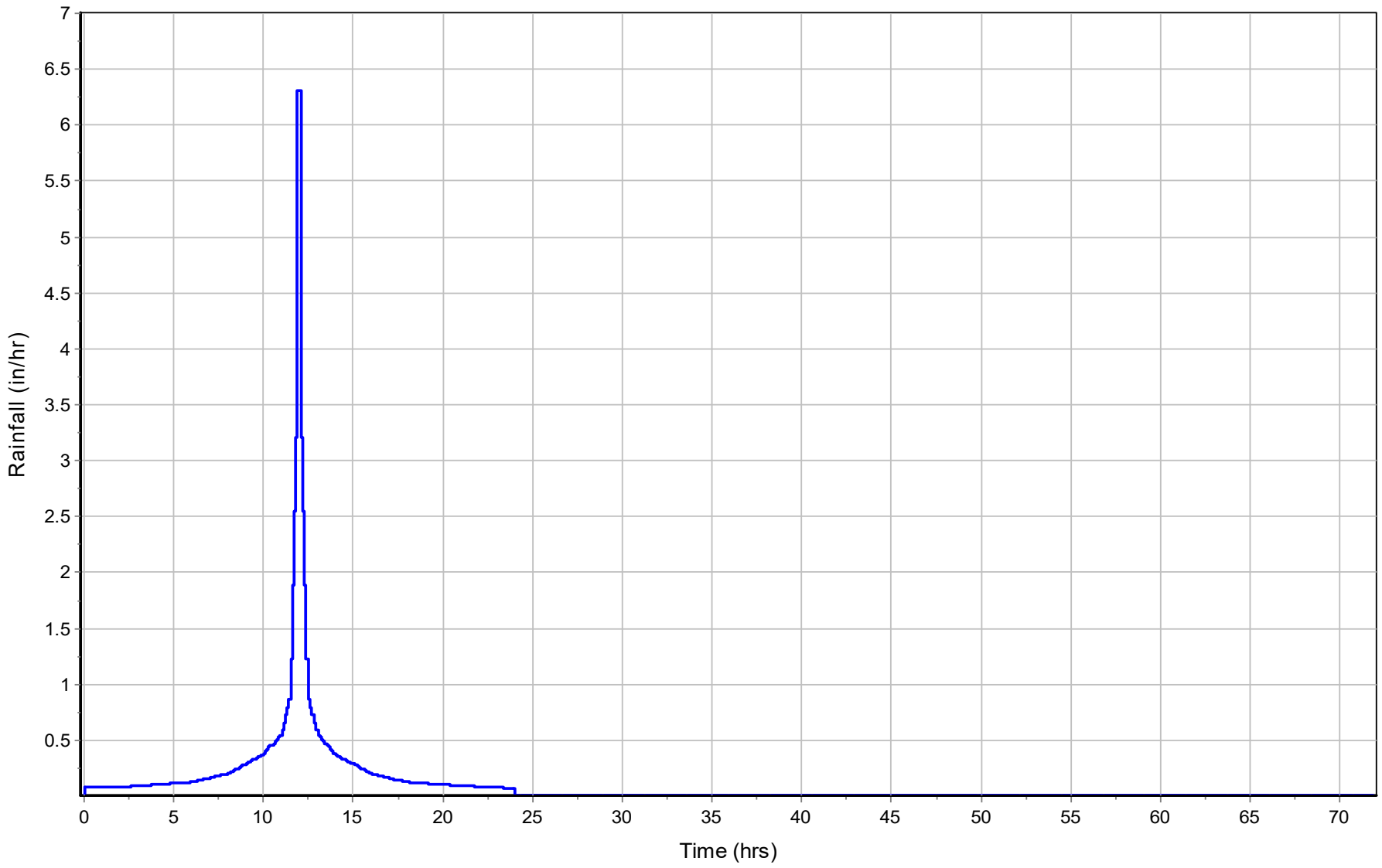
Total TOC (min) 19.54

Subbasin Runoff Results

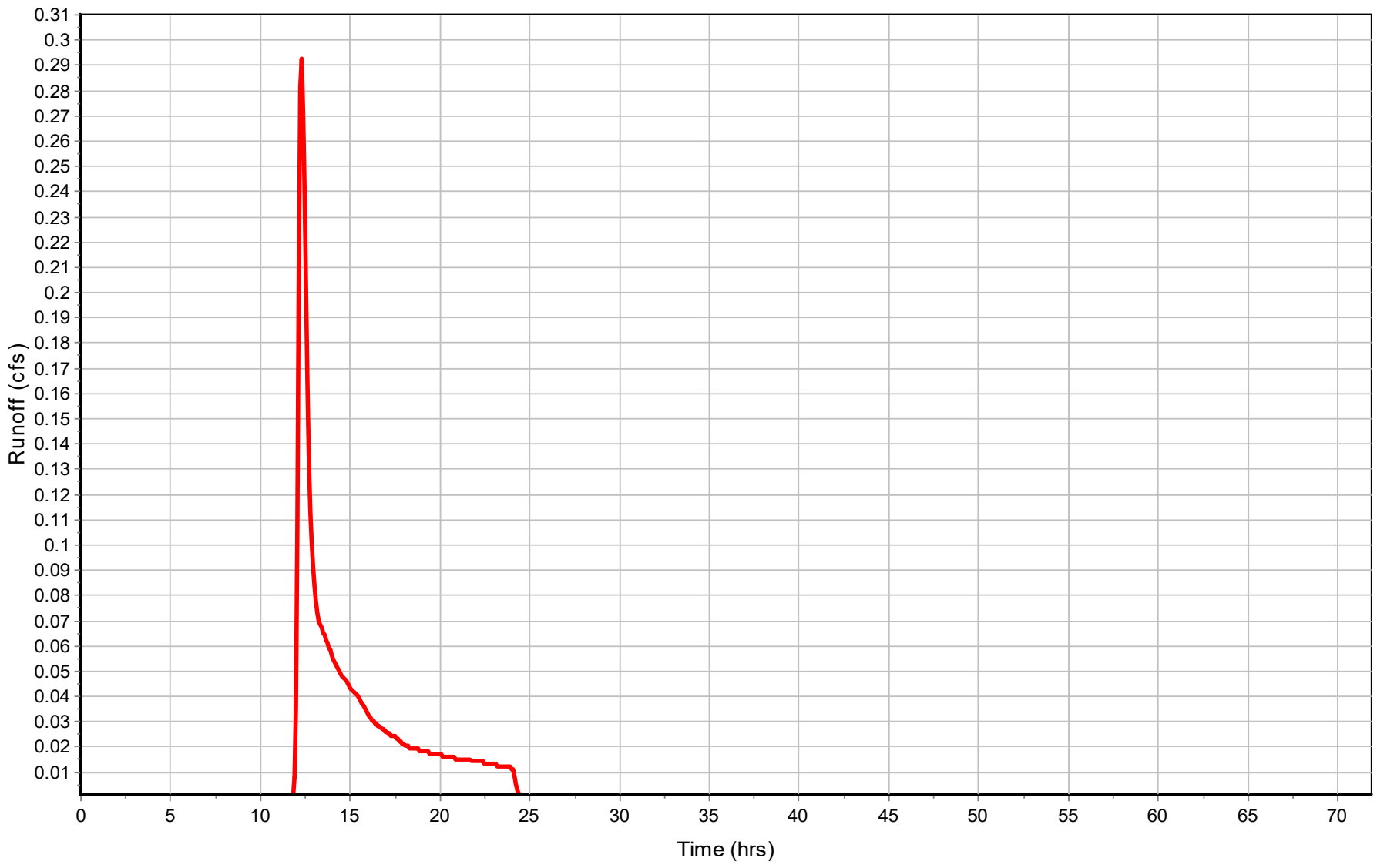
Total Rainfall (in) 7.51
Total Runoff (in) 1.3
Peak Runoff (cfs) 0.29
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:19:32

Subbasin : Sub-E02

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-02A

Input Data

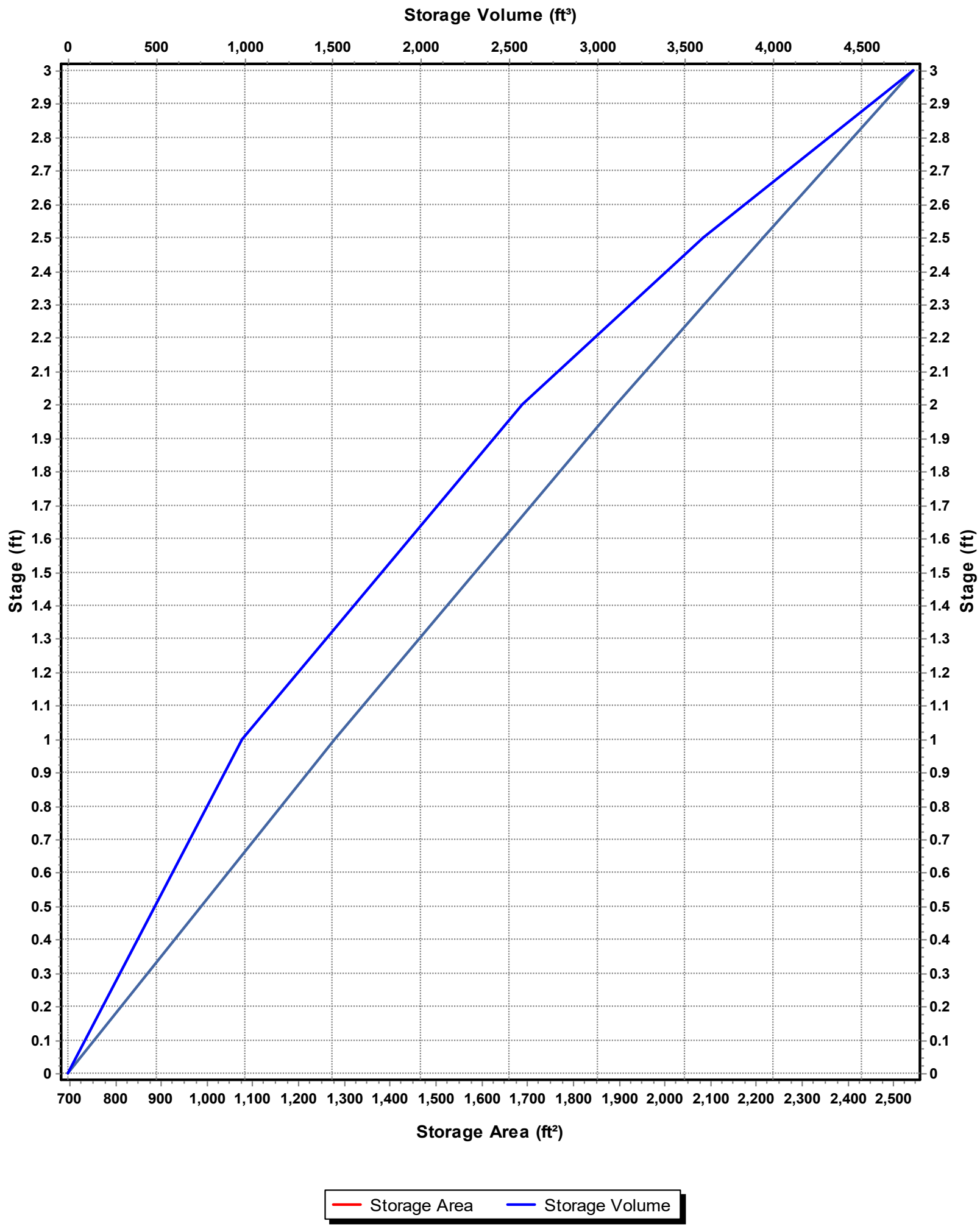
Invert Elevation (ft)	115.00
Max (Rim) Elevation (ft)	118.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	115.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Storage-13

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	697.24	0
1	1280.66	988.95
2	1896.08	2577.32
2.5	2215.79	3605.29
3	2543.5	4795.11

Storage Area Volume Curves



Storage Node : Basin-02A (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-2A	Trapezoidal	No	117.50	2.50	10.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	3.96
Peak Lateral Inflow (cfs)	0
Peak Outflow (cfs)	4.28
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	117.52
Max HGL Depth Attained (ft)	2.52
Average HGL Elevation Attained (ft)	117.08
Average HGL Depth Attained (ft)	2.08
Time of Max HGL Occurrence (days hh:mm)	0 14:28
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Basin-A2B

Input Data

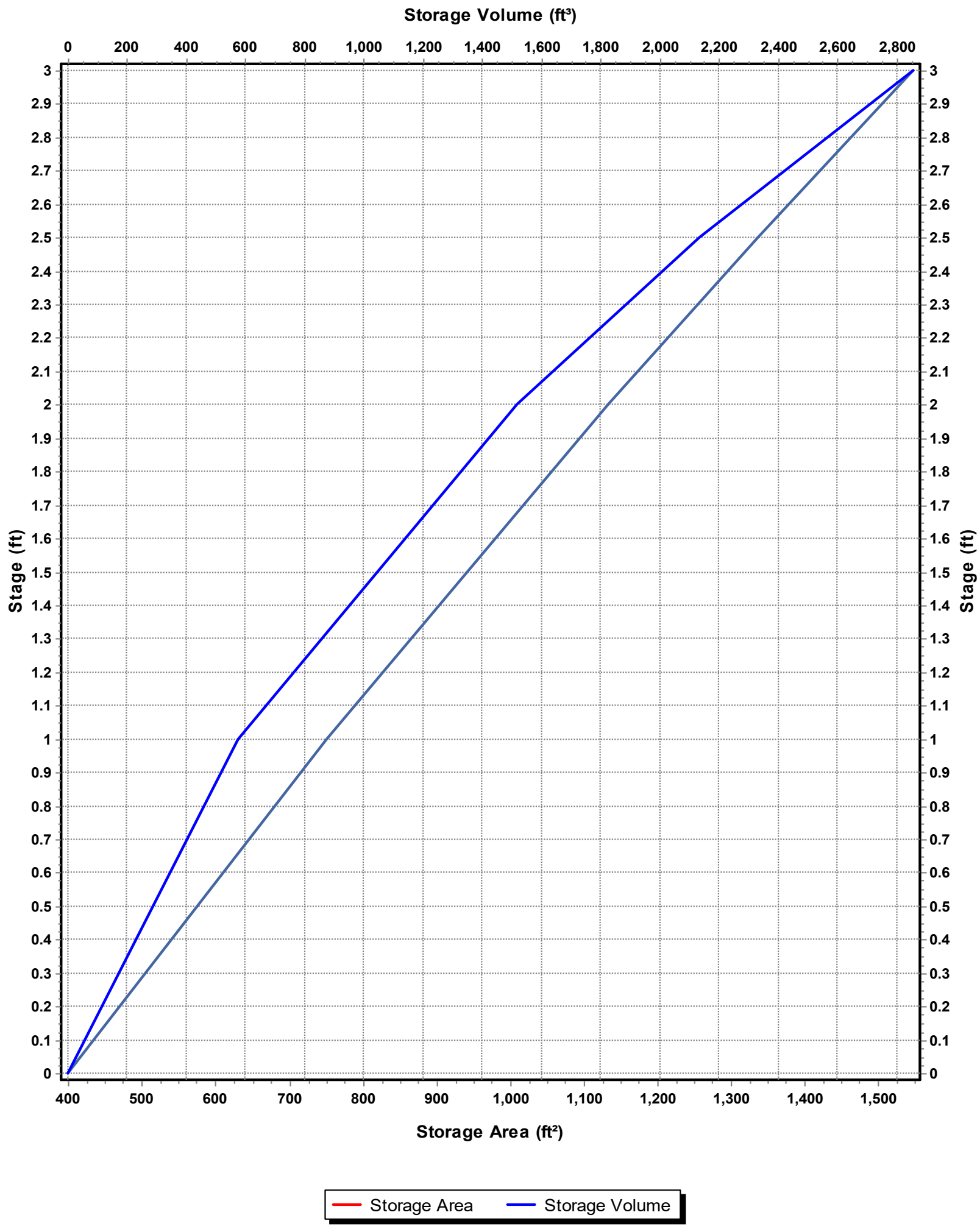
Invert Elevation (ft)	115.00
Max (Rim) Elevation (ft)	118.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	115.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Storage-14

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	399.14	0
1	750.37	574.76
2	1133.6	1516.75
2.5	1337.22	2134.46
3	1548.83	2855.97

Storage Area Volume Curves



Storage Node : Basin-A2B (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-2B	Trapezoidal	No	117.50	2.50	10.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	3.94
Peak Lateral Inflow (cfs)	0
Peak Outflow (cfs)	4.43
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	117.52
Max HGL Depth Attained (ft)	2.52
Average HGL Elevation Attained (ft)	117.09
Average HGL Depth Attained (ft)	2.09
Time of Max HGL Occurrence (days hh:mm)	0 14:26
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Forebay-A2

Input Data

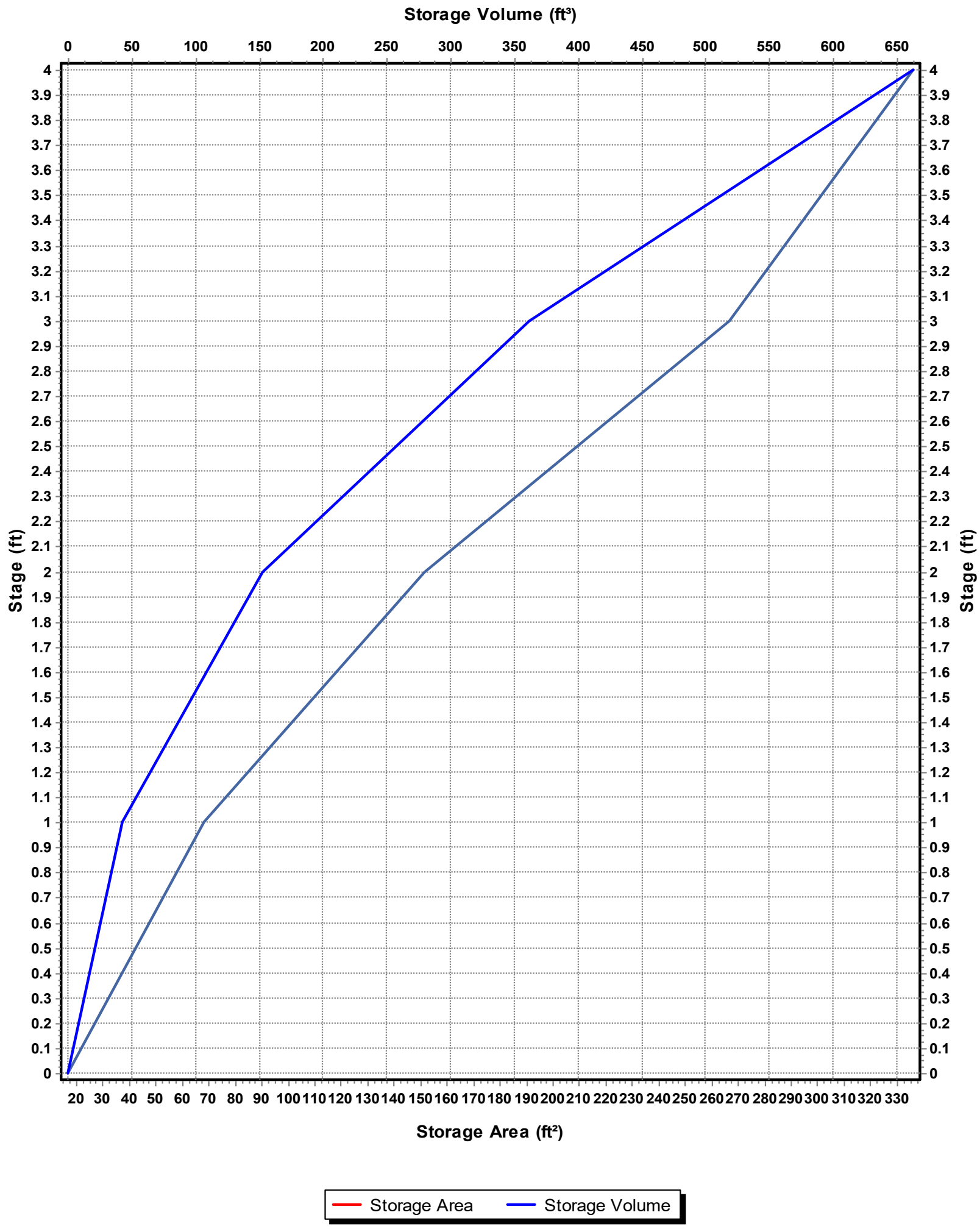
Invert Elevation (ft)	114.50
Max (Rim) Elevation (ft)	118.00
Max (Rim) Offset (ft)	3.50
Initial Water Elevation (ft)	114.50
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Storage-12

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	16.89	0
1	68.15	42.52
2	151.42	152.31
3	266.68	361.36
4	336.31	662.86

Storage Area Volume Curves



Storage Node : Forebay-A2 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-A2A	Trapezoidal	No	117.00	2.50	10.00	1.00	3.33
2	Weir-A2B	Trapezoidal	No	117.00	2.50	10.00	1.00	3.33

Output Summary Results

Peak Inflow (cfs)	8.92
Peak Lateral Inflow (cfs)	2.26
Peak Outflow (cfs)	7.9
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	117.47
Max HGL Depth Attained (ft)	2.97
Average HGL Elevation Attained (ft)	116.99
Average HGL Depth Attained (ft)	2.49
Time of Max HGL Occurrence (days hh:mm)	0 13:27
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Project Description

File Name ..... Bourne_A2.SPF

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	SCS TR-20
Time of Concentration (TOC) Method	SCS TR-55
Link Routing Method	Hydrodynamic
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	NO

Analysis Options

Start Analysis On	oct. 14, 2021	0:00:00
End Analysis On	oct. 17, 2021	0:00:00
Start Reporting On	oct. 14, 2021	0:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	2
Nodes	6
Junctions	0
Outfalls	3
Flow Diversions	0
Inlets	0
Storage Nodes	3
Links	4
Channels	0
Pipes	0
Pumps	0
Orifices	0
Weirs	4
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	2070 50 years	Intensity	inches	Massachusetts	None	50.00	8.80	SCS Type III 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Sub-A2	0.48	484.00	76.00	8.80	5.89	2.83	2.85	0 00:06:00
2	Sub-E02	0.37	484.00	43.00	8.80	1.95	0.72	0.49	0 00:19:32

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Out-A2A	Outfall	116.00					0.22	116.00					
2	Out-A2B	Outfall	116.00					0.25	116.00					
3	Out-E02	Outfall	116.00					0.48	116.00					
4	Basin-02A	Storage Node	115.00	118.00	115.00		0.00	7.40	117.54				0.00	0.00
5	Basin-A2B	Storage Node	115.00	118.00	115.00		0.00	6.94	117.54				0.00	0.00
6	Forebay-A2	Storage Node	114.50	118.00	114.50		0.00	12.56	117.59				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(ft)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
1	Weir-2A	Weir	Basin-02A	Out-A2A		115.00	116.00				0.22							
2	Weir-2B	Weir	Basin-A2B	Out-A2B		115.00	116.00				0.25							
3	Weir-A2A	Weir	Forebay-A2	Basin-02A		114.50	115.00				7.40							
4	Weir-A2B	Weir	Forebay-A2	Basin-A2B		114.50	115.00				7.08							

Subbasin Hydrology

Subbasin : Sub-A2

Input Data

Area (ac)	0.48
Peak Rate Factor	484
Weighted Curve Number	76
Rain Gage ID	Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	0.48	A	76
Composite Area & Weighted CN	0.48		76

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft^2)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	37.54	0	0
Slope (%) :	1.2	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.74	0	0
Computed Flow Time (min) :	0.84	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	145.78	0	0
Channel Slope (%) :	0.3	0	0
Cross Section Area (ft^2) :	3	0	0
Wetted Perimeter (ft) :	6.32	0	0
Velocity (ft/sec) :	1.66	0	0
Computed Flow Time (min) :	1.47	0	0

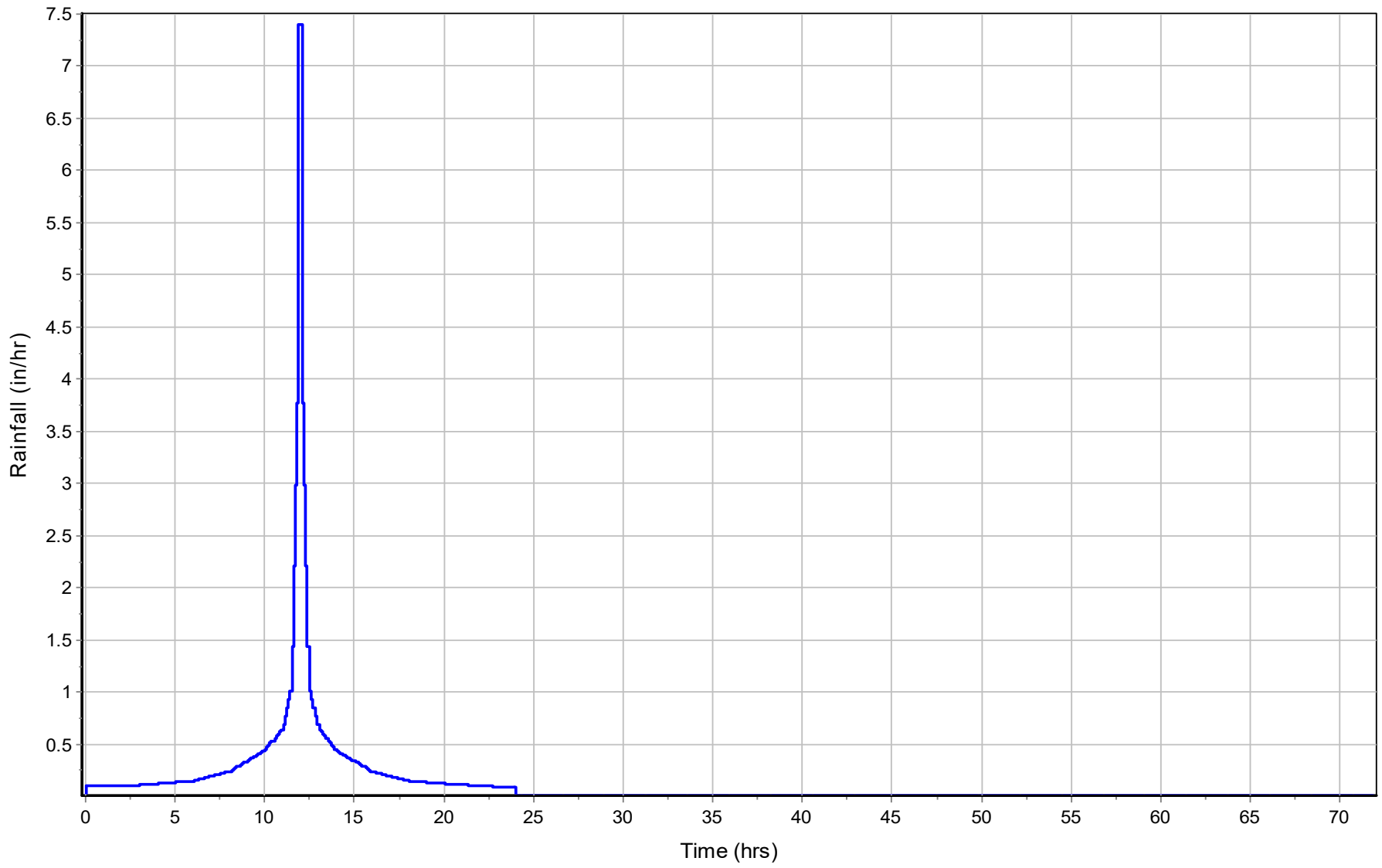
Total TOC (min) 2.31

Subbasin Runoff Results

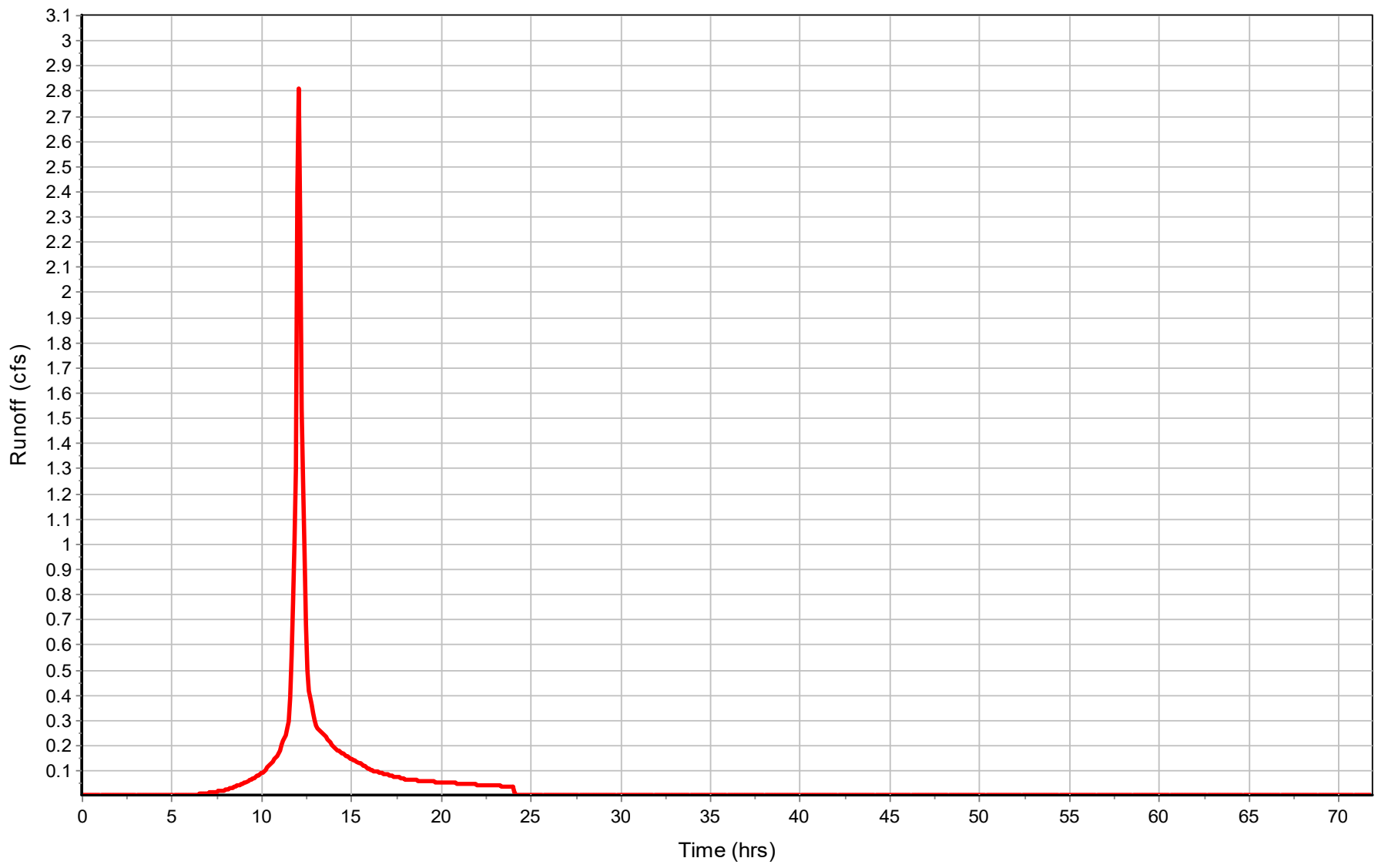
Total Rainfall (in)	8.8
Total Runoff (in)	5.89
Peak Runoff (cfs)	2.85
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:02:19

Subbasin : Sub-A2

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E02

Input Data

Area (ac) 0.37
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.37	A	43
Composite Area & Weighted CN	0.37		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	90.15	0	0
Slope (%) :	7.6	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.08	0	0
Computed Flow Time (min) :	19.54	0	0

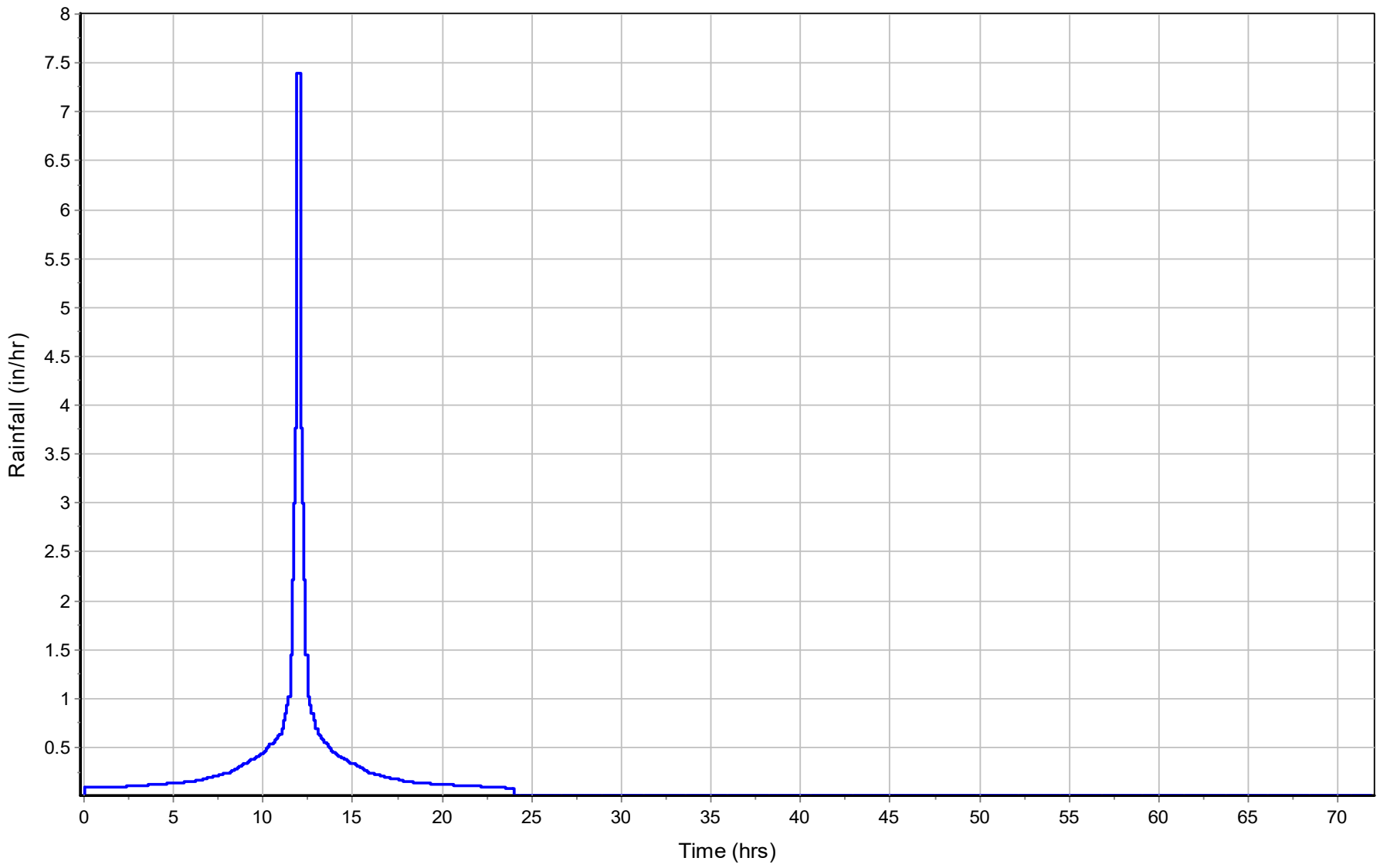
Total TOC (min) 19.54

Subbasin Runoff Results

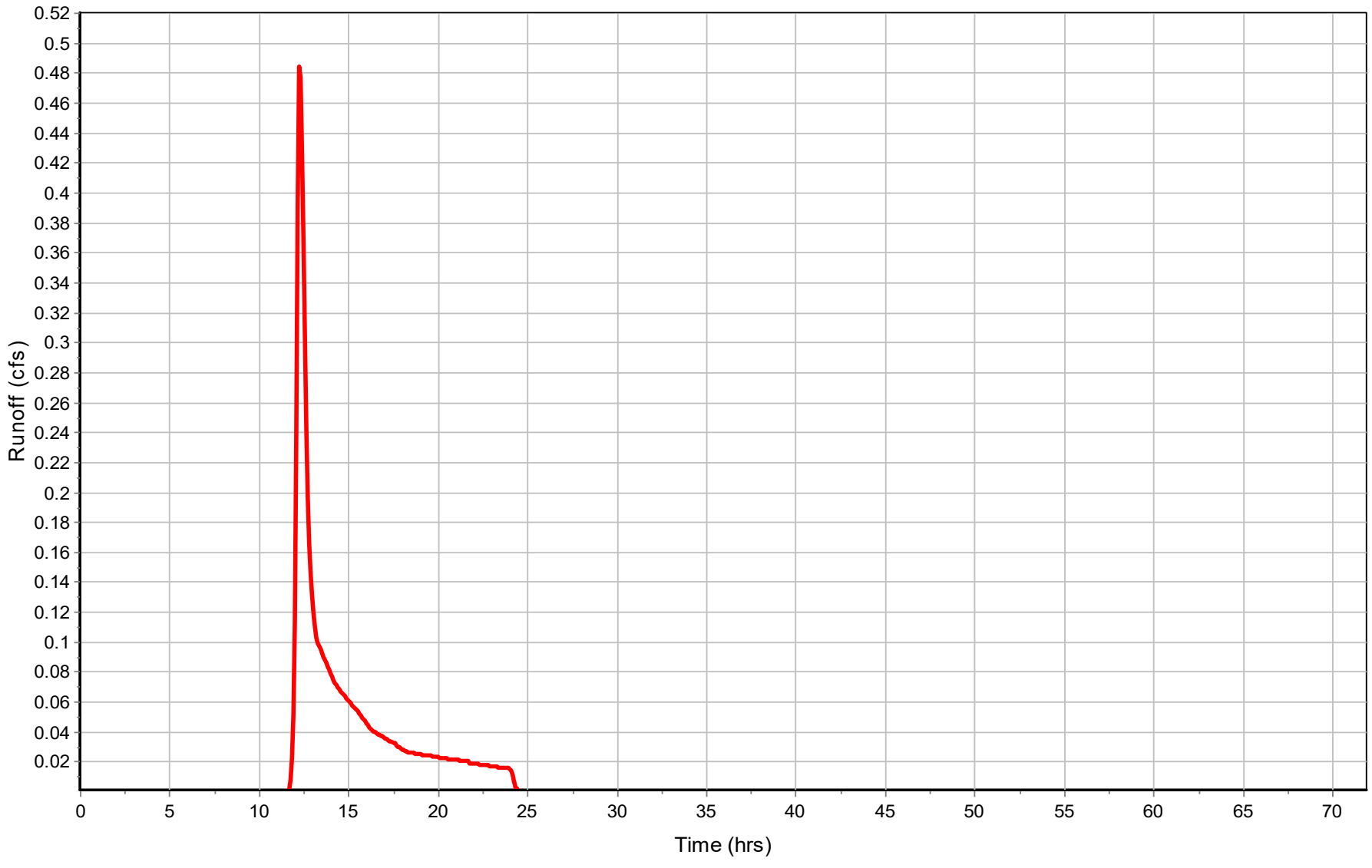
Total Rainfall (in) 8.8
Total Runoff (in) 1.95
Peak Runoff (cfs) 0.49
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:19:32

Subbasin : Sub-E02

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-02A

Input Data

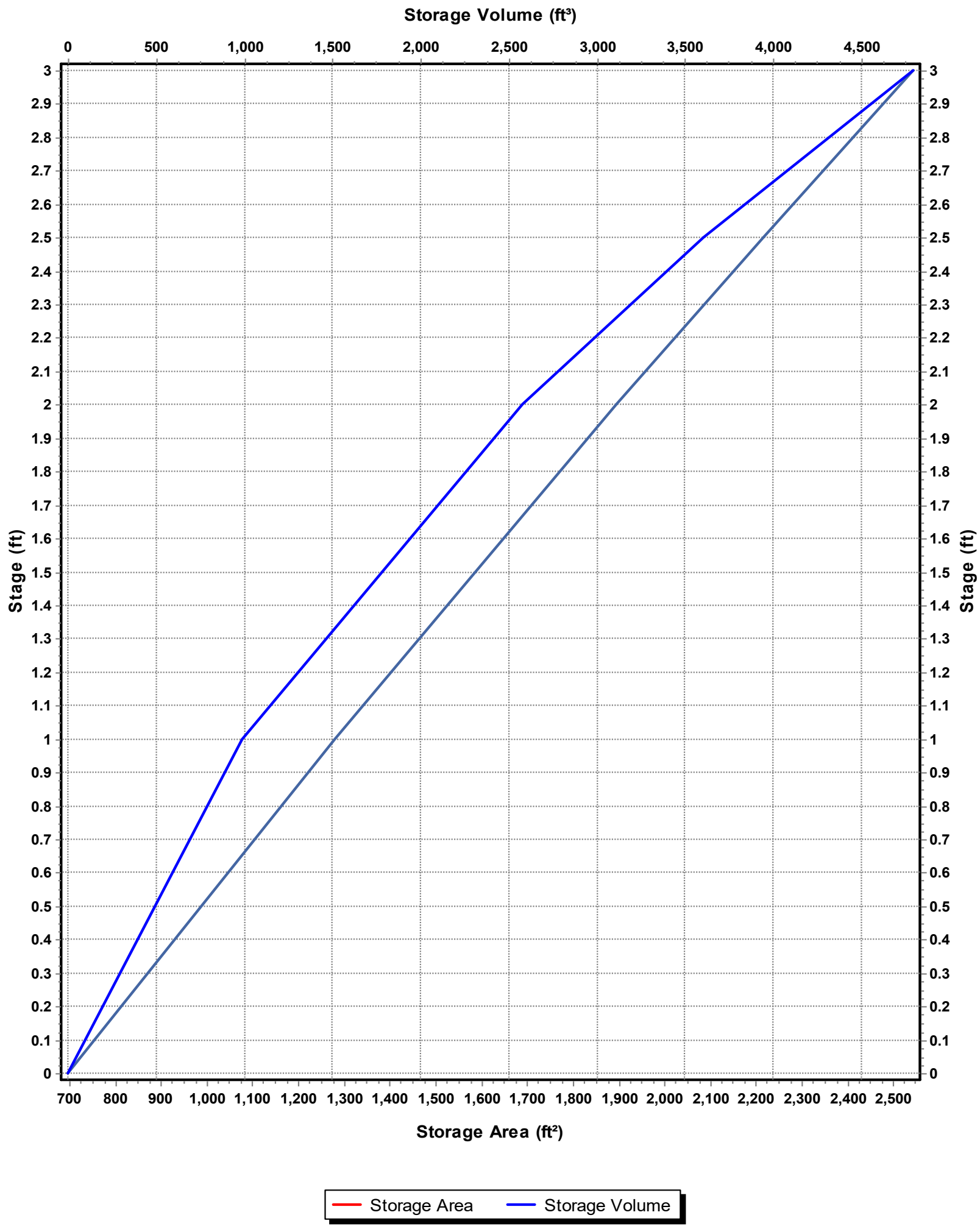
Invert Elevation (ft)	115.00
Max (Rim) Elevation (ft)	118.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	115.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Storage-13

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	697.24	0
1	1280.66	988.95
2	1896.08	2577.32
2.5	2215.79	3605.29
3	2543.5	4795.11

Storage Area Volume Curves



Storage Node : Basin-02A (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-2A	Trapezoidal	No	117.50	2.50	10.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	7.4
Peak Lateral Inflow (cfs)	0
Peak Outflow (cfs)	4.65
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	117.54
Max HGL Depth Attained (ft)	2.54
Average HGL Elevation Attained (ft)	117.09
Average HGL Depth Attained (ft)	2.09
Time of Max HGL Occurrence (days hh:mm)	0 12:50
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Basin-A2B

Input Data

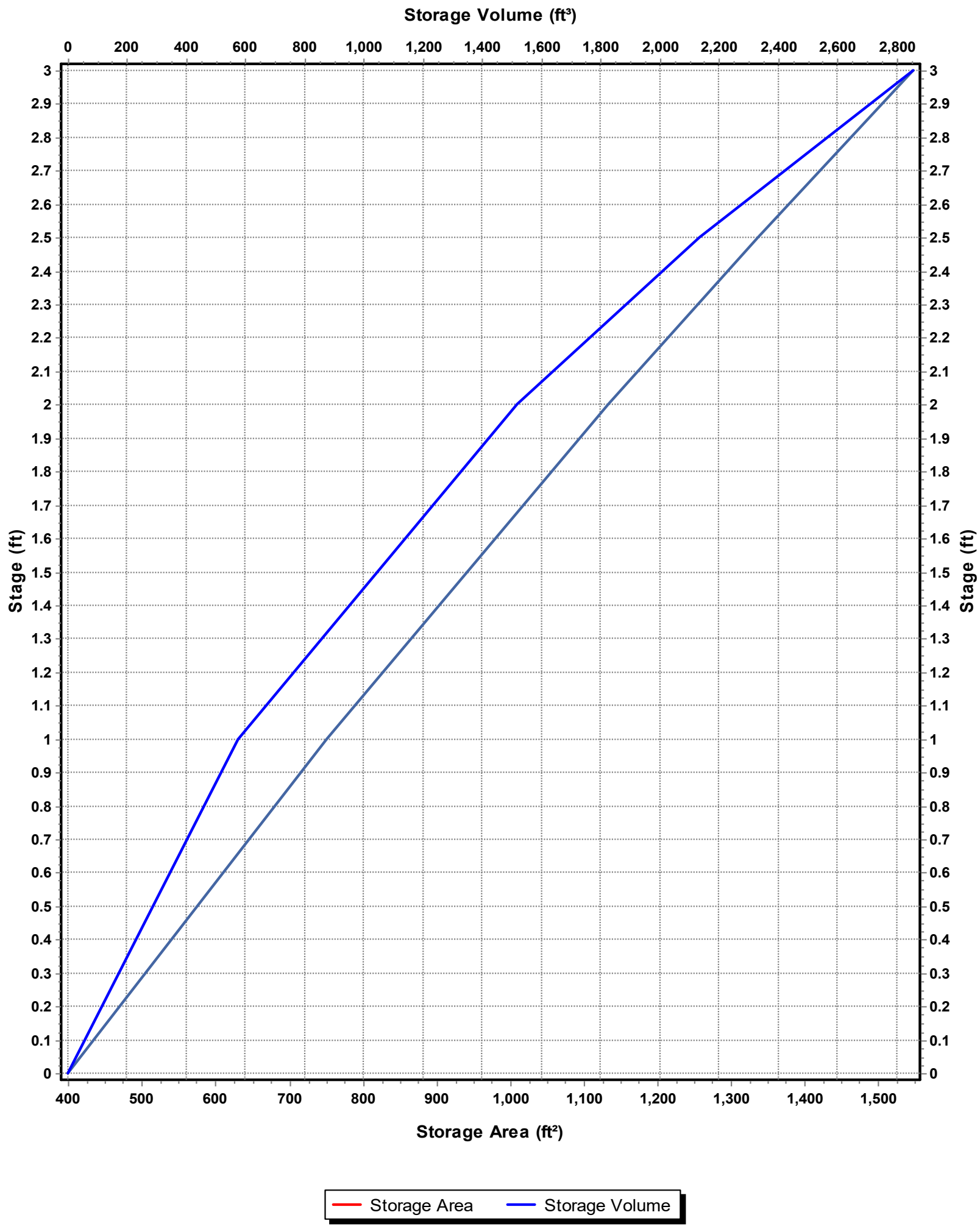
Invert Elevation (ft)	115.00
Max (Rim) Elevation (ft)	118.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	115.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Storage-14

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	399.14	0
1	750.37	574.76
2	1133.6	1516.75
2.5	1337.22	2134.46
3	1548.83	2855.97

Storage Area Volume Curves



Storage Node : Basin-A2B (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-2B	Trapezoidal	No	117.50	2.50	10.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	6.94
Peak Lateral Inflow (cfs)	0
Peak Outflow (cfs)	7.08
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	117.54
Max HGL Depth Attained (ft)	2.54
Average HGL Elevation Attained (ft)	117.11
Average HGL Depth Attained (ft)	2.11
Time of Max HGL Occurrence (days hh:mm)	0 12:45
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Forebay-A2

Input Data

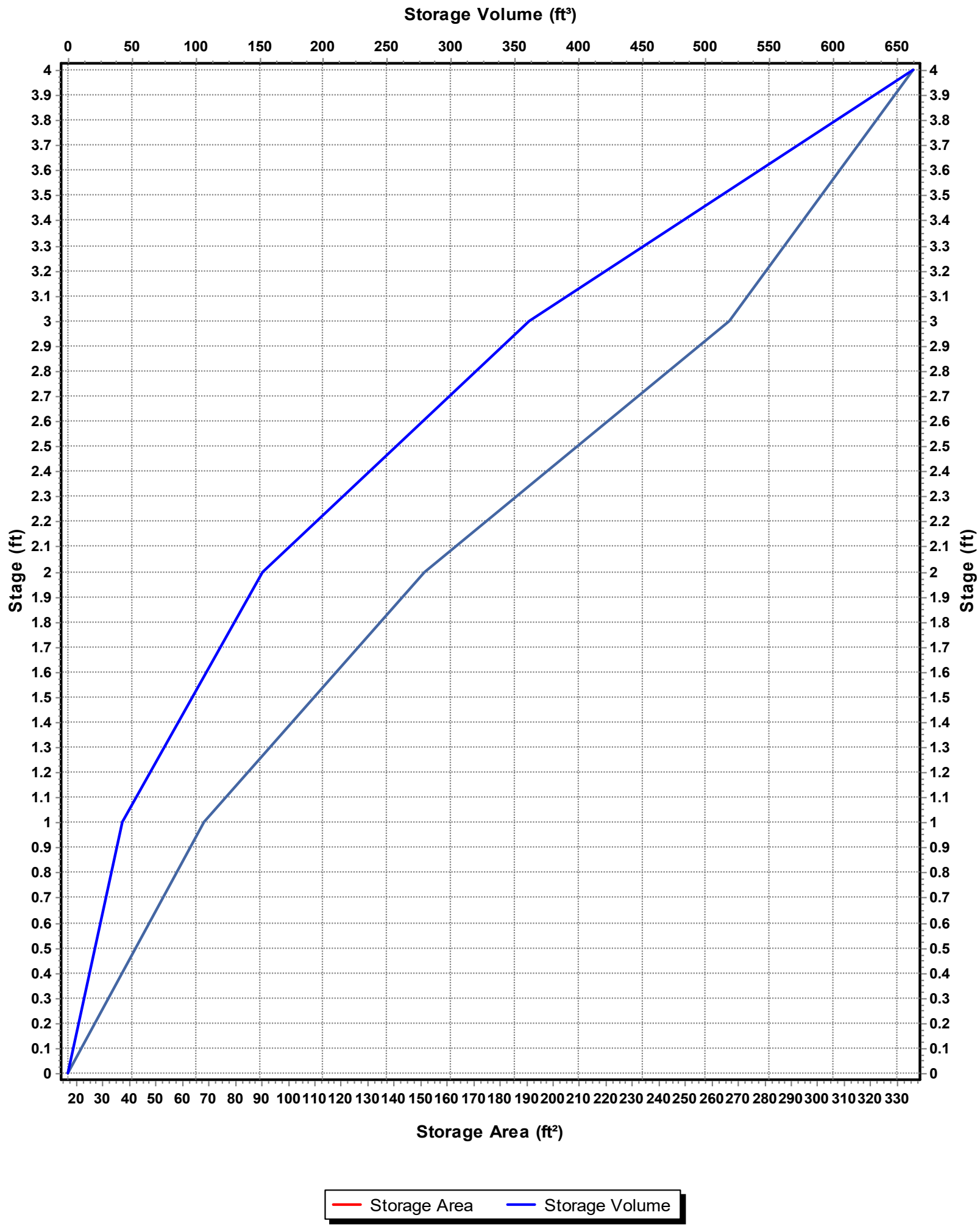
Invert Elevation (ft)	114.50
Max (Rim) Elevation (ft)	118.00
Max (Rim) Offset (ft)	3.50
Initial Water Elevation (ft)	114.50
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Storage-12

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	16.89	0
1	68.15	42.52
2	151.42	152.31
3	266.68	361.36
4	336.31	662.86

Storage Area Volume Curves



Storage Node : Forebay-A2 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-A2A	Trapezoidal	No	117.00	2.50	10.00	1.00	3.33
2	Weir-A2B	Trapezoidal	No	117.00	2.50	10.00	1.00	3.33

Output Summary Results

Peak Inflow (cfs)	12.56
Peak Lateral Inflow (cfs)	2.81
Peak Outflow (cfs)	12.56
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	117.59
Max HGL Depth Attained (ft)	3.09
Average HGL Elevation Attained (ft)	117.02
Average HGL Depth Attained (ft)	2.52
Time of Max HGL Occurrence (days hh:mm)	0 12:29
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

SSA Analysis – Drainage Area A3 – Existing and Proposed

Project Description

File Name ..... Bourne_A3.SPF

Project Options

Flow Units ..... CFS
Elevation Type ..... Elevation
Hydrology Method ..... SCS TR-20
Time of Concentration (TOC) Method ..... SCS TR-55
Link Routing Method ..... Hydrodynamic
Enable Overflow Ponding at Nodes ..... YES
Skip Steady State Analysis Time Periods ..... NO

Analysis Options

Start Analysis On ..... oct. 14, 2021 0:00:00
End Analysis On ..... oct. 17, 2021 0:00:00
Start Reporting On ..... oct. 14, 2021 0:00:00
Antecedent Dry Days ..... 0 days
Runoff (Dry Weather) Time Step ..... 0 01:00:00 days hh:mm:ss
Runoff (Wet Weather) Time Step ..... 0 00:05:00 days hh:mm:ss
Reporting Time Step ..... 0 00:05:00 days hh:mm:ss
Routing Time Step ..... 30 seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	2
Nodes	4
Junctions	0
Outfalls	2
Flow Diversions	0
Inlets	0
Storage Nodes	2
Links	2
Channels	0
Pipes	0
Pumps	0
Orifices	0
Weirs	2
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	2 years	Intensity	inches	Massachusetts	None	2.00	3.43	SCS Type III 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Sub-A3	0.39	484.00	76.00	3.43	1.31	0.51	0.53	0 00:06:00
2	Sub-E03	0.36	484.00	43.00	3.43	0.04	0.02	0.00	0 00:36:44

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Out-A3	Outfall	57.50					0.00	57.50					
2	Out-E03	Outfall	0.00					0.00	0.00					
3	Basin-A3	Storage Node	114.00	117.50	114.00		0.00	0.30	114.97				0.00	0.00
4	Forebay-A3	Storage Node	113.50	117.50	113.50		0.00	0.50	117.04				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(ft)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
1	Weir-A3	Weir	Basin-A3	Out-A3		114.00	57.50				0.00							
2	Weir-FA3	Weir	Forebay-A3	Basin-A3		113.50	114.00				0.30							

Subbasin Hydrology

Subbasin : Sub-A3

Input Data

Area (ac)	0.39
Peak Rate Factor	484
Weighted Curve Number	76
Rain Gage ID	Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	0.39	A	76
Composite Area & Weighted CN	0.39		76

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft^2)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	126.51	0	0
Slope (%) :	1.19	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.94	0	0
Computed Flow Time (min) :	2.23	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	94.52	0	0
Channel Slope (%) :	0.5	0	0
Cross Section Area (ft^2) :	3	0	0
Wetted Perimeter (ft) :	6.32	0	0
Velocity (ft/sec) :	2.14	0	0
Computed Flow Time (min) :	0.74	0	0

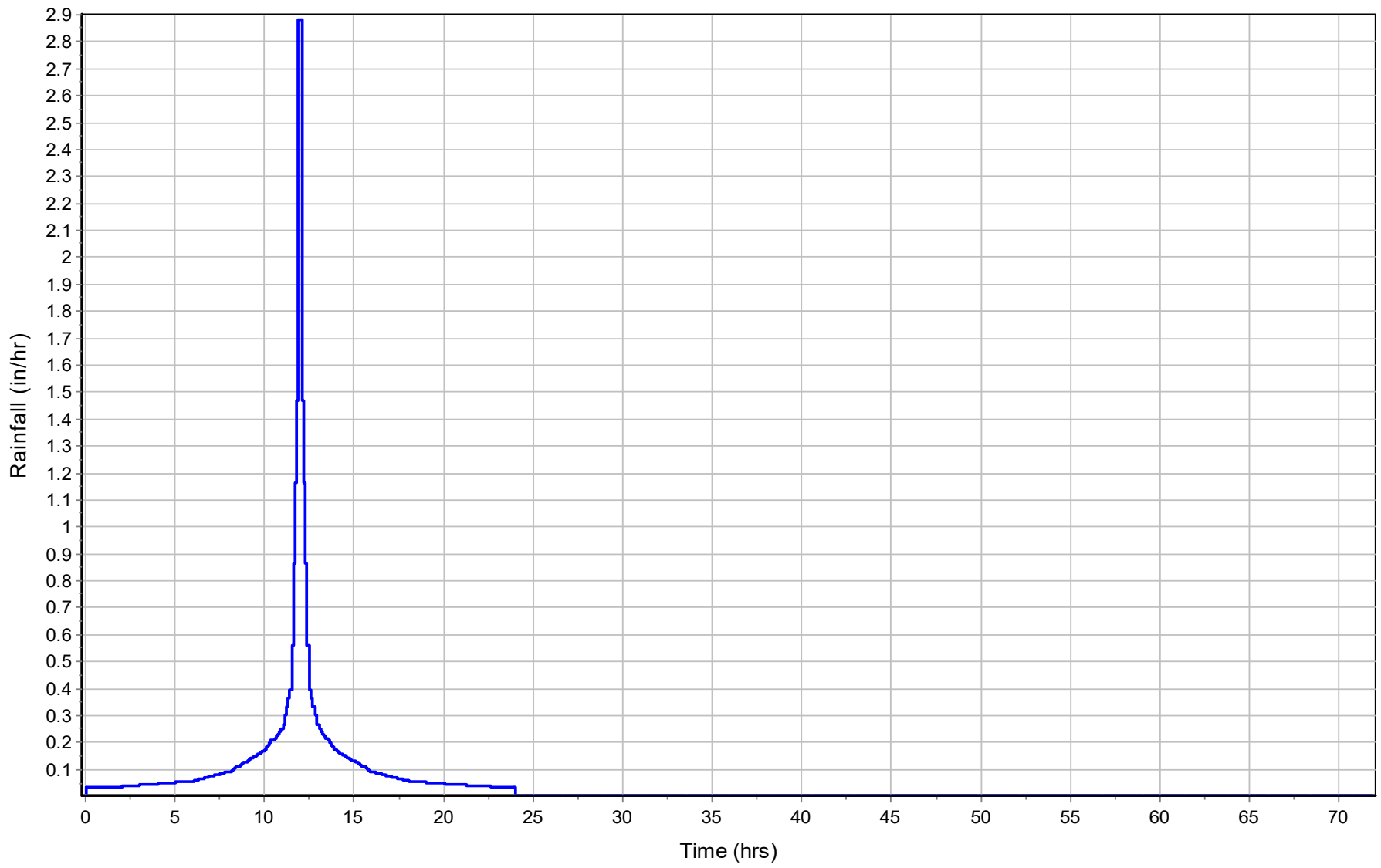
Total TOC (min) 2.97

Subbasin Runoff Results

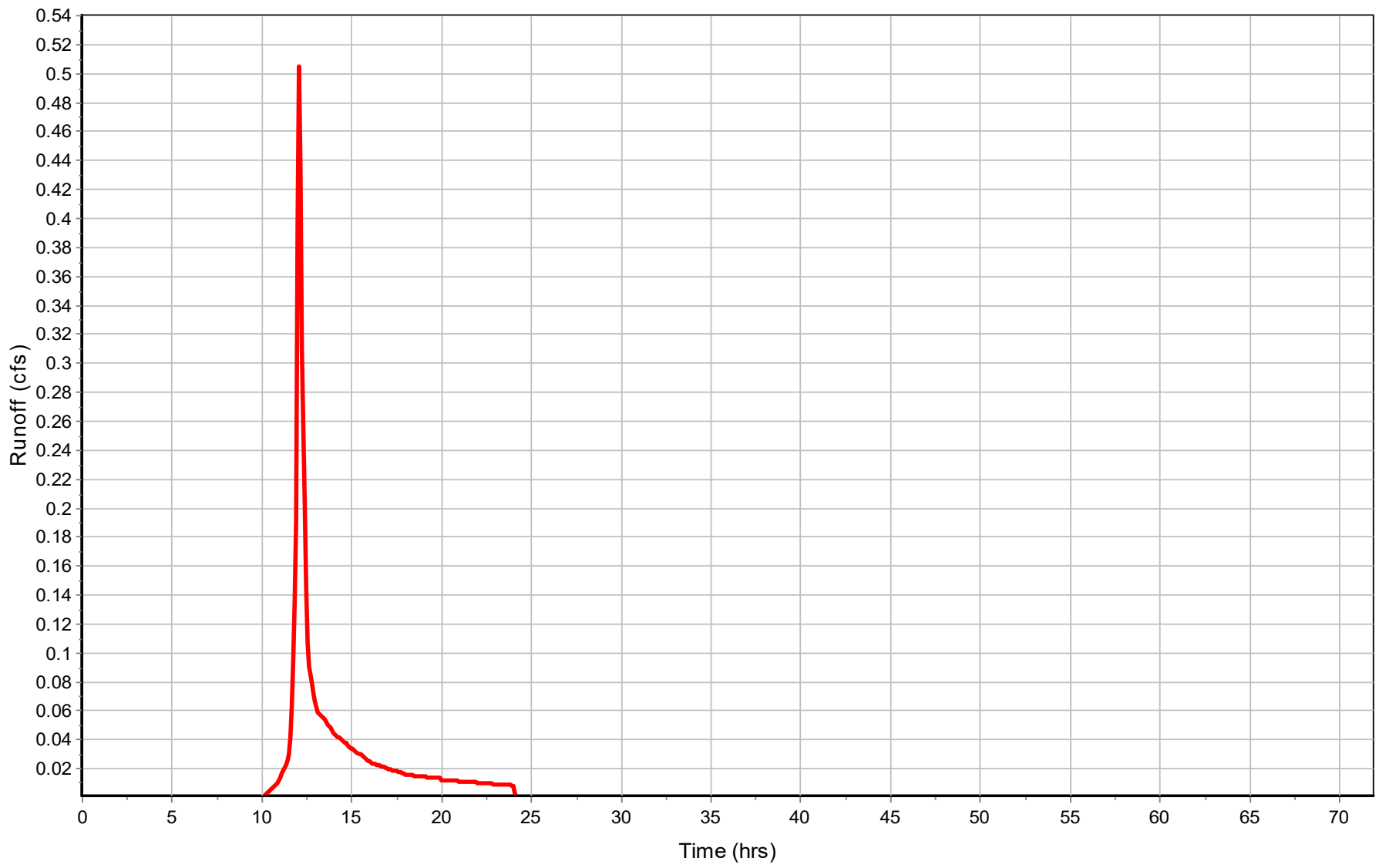
Total Rainfall (in) 3.43
Total Runoff (in) 1.31
Peak Runoff (cfs) 0.53
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:02:58

Subbasin : Sub-A3

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E03

Input Data

Area (ac) 0.36
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.36	A	43
Composite Area & Weighted CN	0.36		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	227.64	0	0
Slope (%) :	10	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.1	0	0
Computed Flow Time (min) :	36.74	0	0

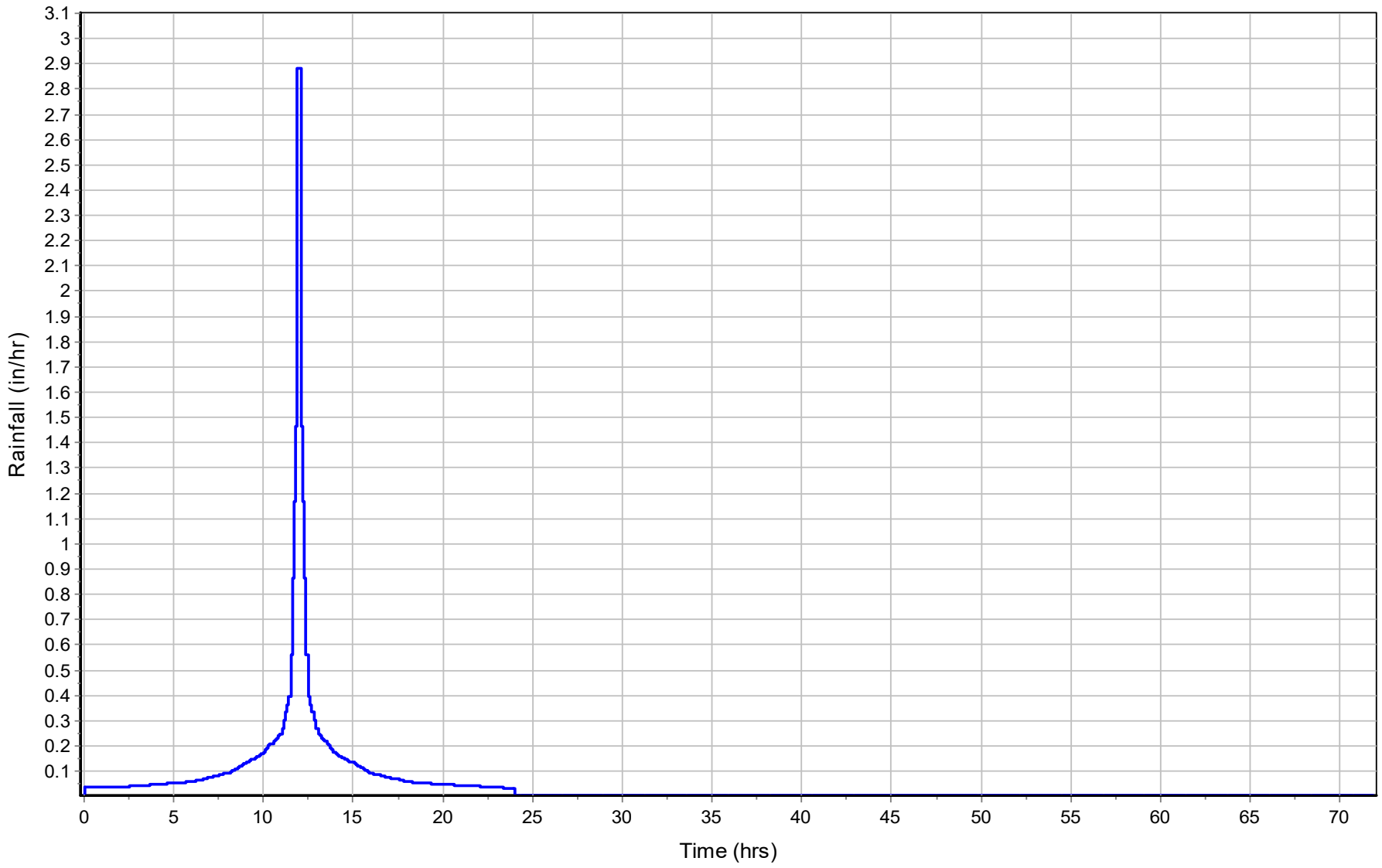
Total TOC (min) 36.74

Subbasin Runoff Results

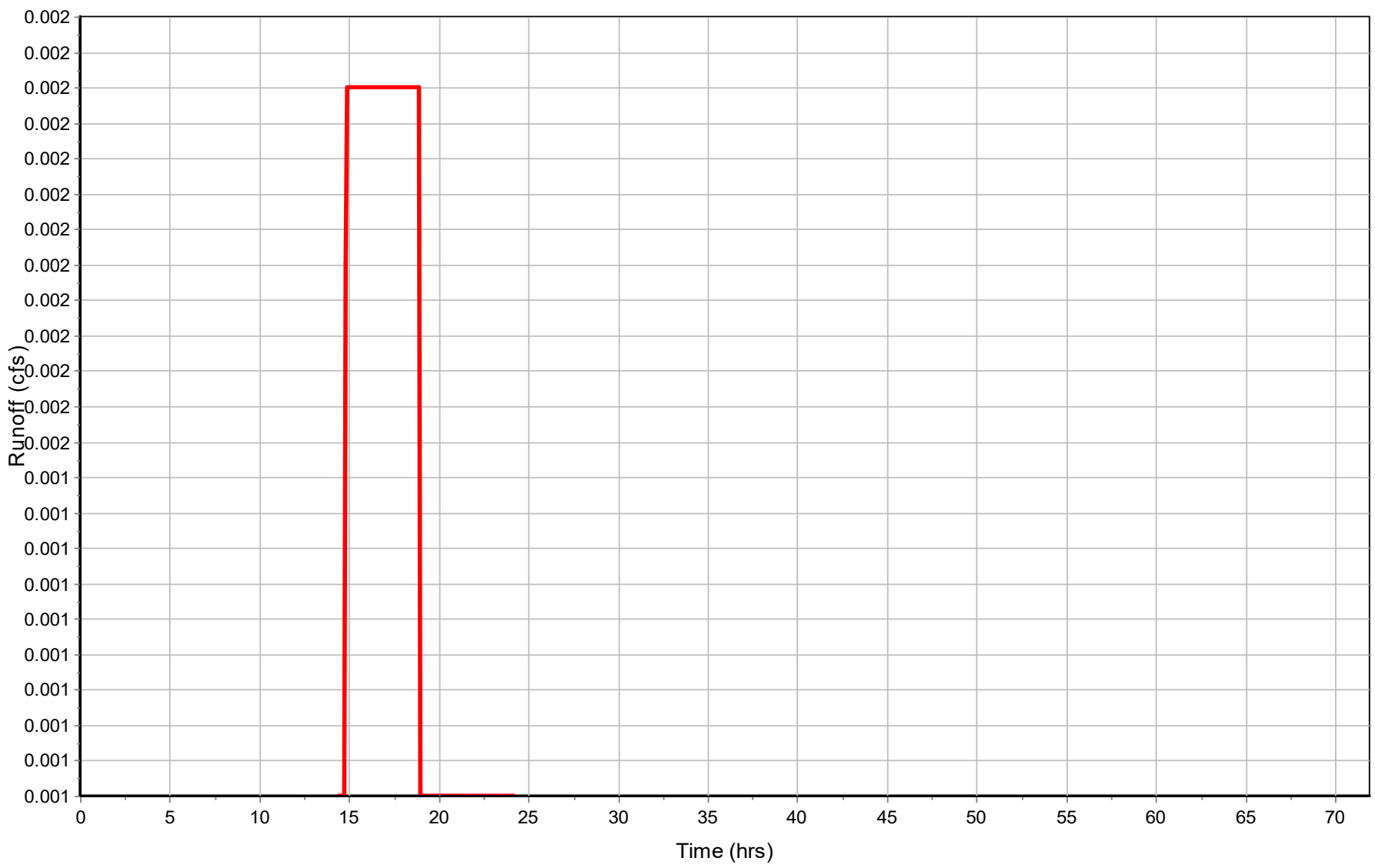
Total Rainfall (in) 3.43
Total Runoff (in) 0.04
Peak Runoff (cfs) 0
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:36:44

Subbasin : Sub-E03

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A3

Input Data

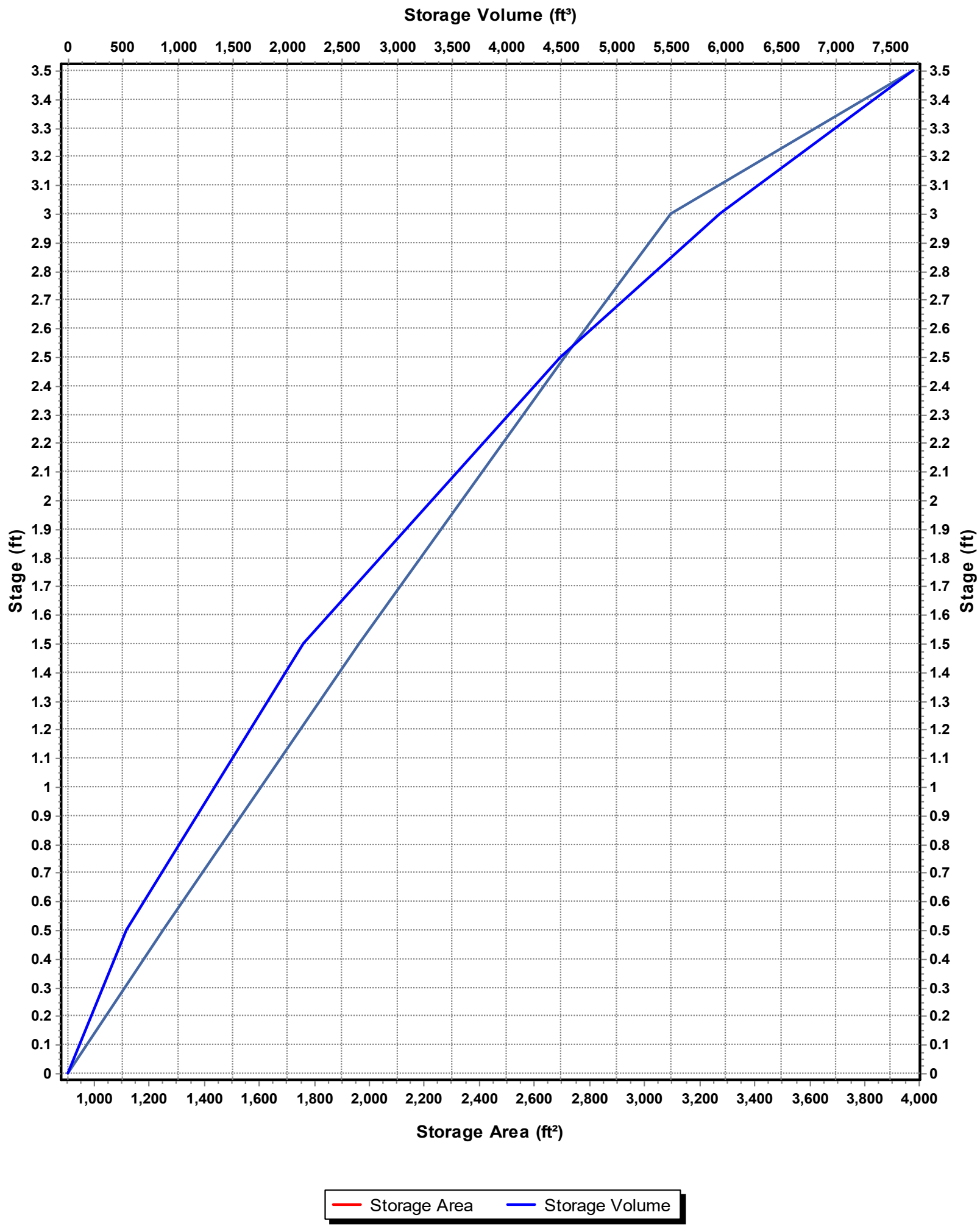
Invert Elevation (ft)	114.00
Max (Rim) Elevation (ft)	117.50
Max (Rim) Offset (ft)	3.50
Initial Water Elevation (ft)	114.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Storage-14

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	907.5	0
0.5	1252.5	540
1.5	1966.5	2149.5
2.5	2712.5	4489
3	3097.5	5941.5
3.5	3978	7710.38

Storage Area Volume Curves



Storage Node : Basin-A3 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-A3	Trapezoidal	No	117.00	3.00	10.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	0.3
Peak Lateral Inflow (cfs)	0
Peak Outflow (cfs)	0
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	114.97
Max HGL Depth Attained (ft)	0.97
Average HGL Elevation Attained (ft)	114.77
Average HGL Depth Attained (ft)	0.77
Time of Max HGL Occurrence (days hh:mm)	1 00:44
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Forebay-A3

Input Data

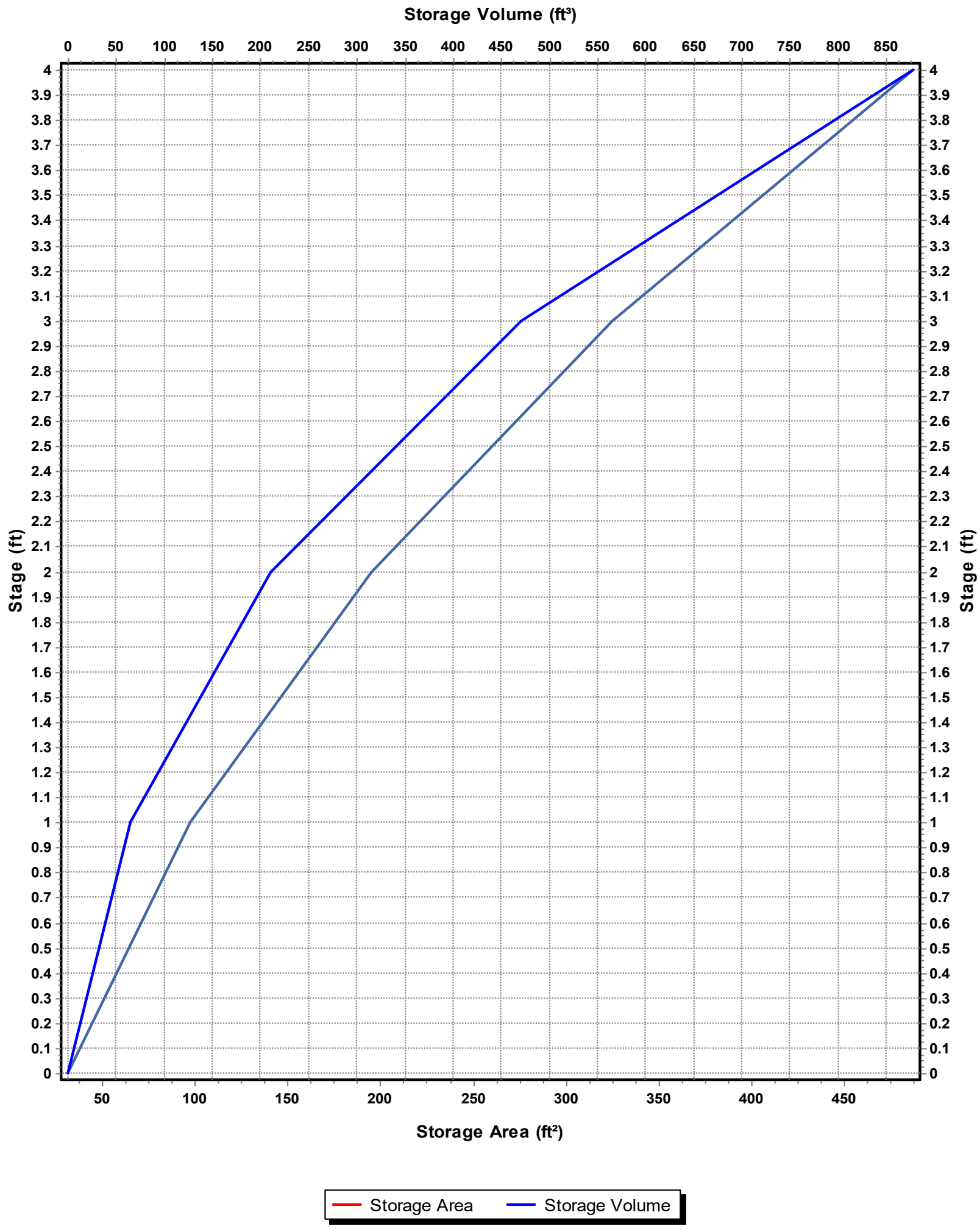
Invert Elevation (ft)	113.50
Max (Rim) Elevation (ft)	117.50
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	113.50
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Storage-15

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	31.5	0
1	97.5	64.5
2	195.5	211
3	325.5	471.5
4	487.5	878

Storage Area Volume Curves



Storage Node : Forebay-A3 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-FA3	Trapezoidal	No	117.00	3.50	10.00	1.00	3.33

Output Summary Results

Peak Inflow (cfs)	0.5
Peak Lateral Inflow (cfs)	0.5
Peak Outflow (cfs)	0.3
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	117.04
Max HGL Depth Attained (ft)	3.54
Average HGL Elevation Attained (ft)	116.43
Average HGL Depth Attained (ft)	2.93
Time of Max HGL Occurrence (days hh:mm)	0 12:21
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Project Description

File Name ..... Bourne_A3.SPF

Project Options

Flow Units ..... CFS
Elevation Type ..... Elevation
Hydrology Method ..... SCS TR-20
Time of Concentration (TOC) Method ..... SCS TR-55
Link Routing Method ..... Hydrodynamic
Enable Overflow Ponding at Nodes ..... YES
Skip Steady State Analysis Time Periods ..... NO

Analysis Options

Start Analysis On ..... oct. 14, 2021 0:00:00
End Analysis On ..... oct. 17, 2021 0:00:00
Start Reporting On ..... oct. 14, 2021 0:00:00
Antecedent Dry Days ..... 0 days
Runoff (Dry Weather) Time Step ..... 0 01:00:00 days hh:mm:ss
Runoff (Wet Weather) Time Step ..... 0 00:05:00 days hh:mm:ss
Reporting Time Step ..... 0 00:05:00 days hh:mm:ss
Routing Time Step ..... 30 seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	2
Nodes	4
Junctions	0
Outfalls	2
Flow Diversions	0
Inlets	0
Storage Nodes	2
Links	2
Channels	0
Pipes	0
Pumps	0
Orifices	0
Weirs	2
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	10 years	Intensity	inches	Massachusetts	None	10.00	5.01	SCS Type III 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Sub-A3	0.39	484.00	76.00	5.01	2.54	0.99	1.03	0 00:06:00
2	Sub-E03	0.36	484.00	43.00	5.01	0.36	0.13	0.03	0 00:36:44

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Out-A3	Outfall	57.50					0.00	57.50					
2	Out-E03	Outfall	0.00					0.03	0.00					
3	Basin-A3	Storage Node	114.00	117.50	114.00		0.00	0.99	115.88				0.00	0.00
4	Forebay-A3	Storage Node	113.50	117.50	113.50		0.00	1.00	117.10				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(ft)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
1	Weir-A3	Weir	Basin-A3	Out-A3		114.00	57.50				0.00							
2	Weir-FA3	Weir	Forebay-A3	Basin-A3		113.50	114.00				0.99							

Subbasin Hydrology

Subbasin : Sub-A3

Input Data

Area (ac)	0.39
Peak Rate Factor	484
Weighted Curve Number	76
Rain Gage ID	Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	0.39	A	76
Composite Area & Weighted CN	0.39		76

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft^2)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	126.51	0	0
Slope (%) :	1.19	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.94	0	0
Computed Flow Time (min) :	2.23	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	94.52	0	0
Channel Slope (%) :	0.5	0	0
Cross Section Area (ft^2) :	3	0	0
Wetted Perimeter (ft) :	6.32	0	0
Velocity (ft/sec) :	2.14	0	0
Computed Flow Time (min) :	0.74	0	0

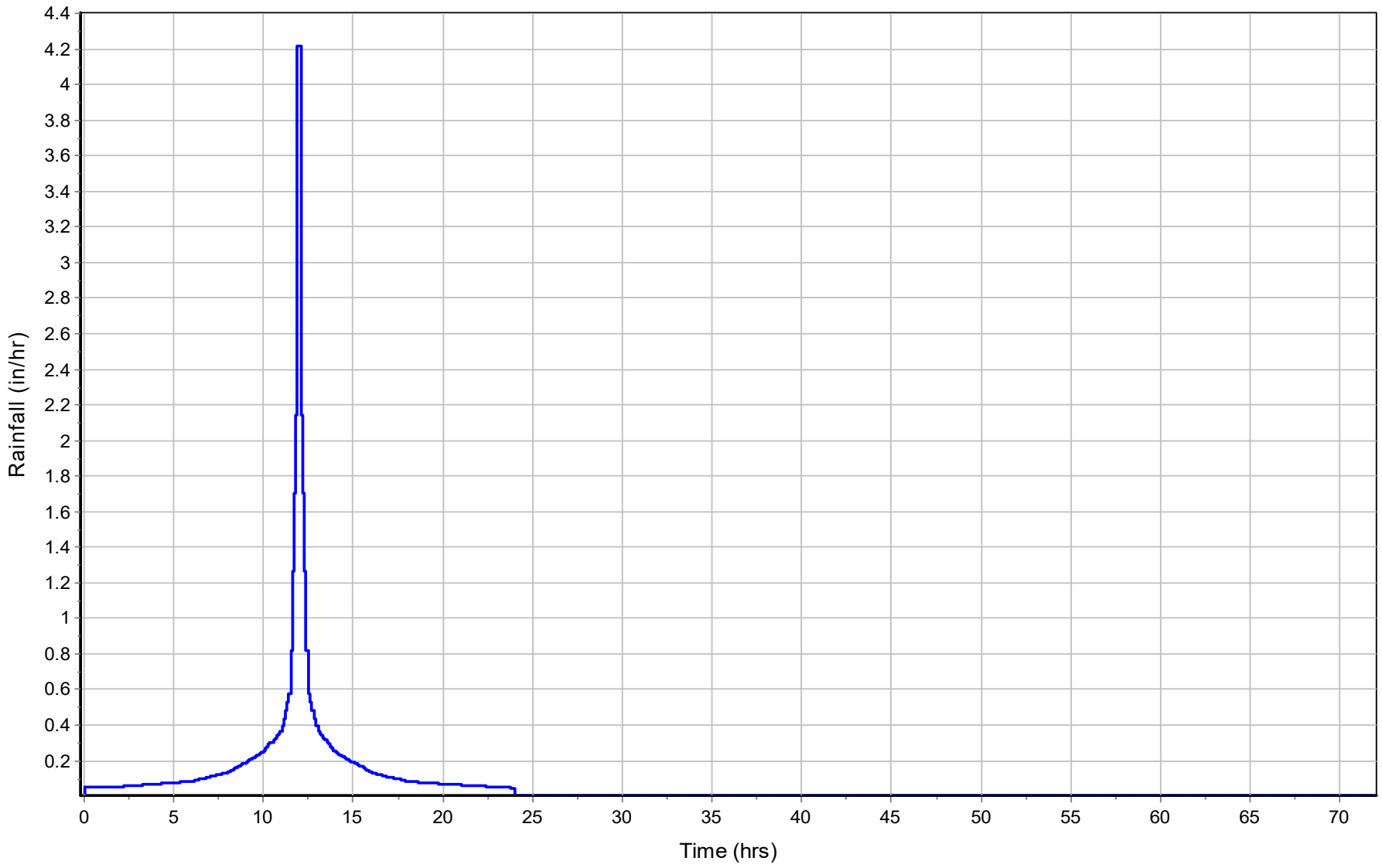
Total TOC (min) 2.97

Subbasin Runoff Results

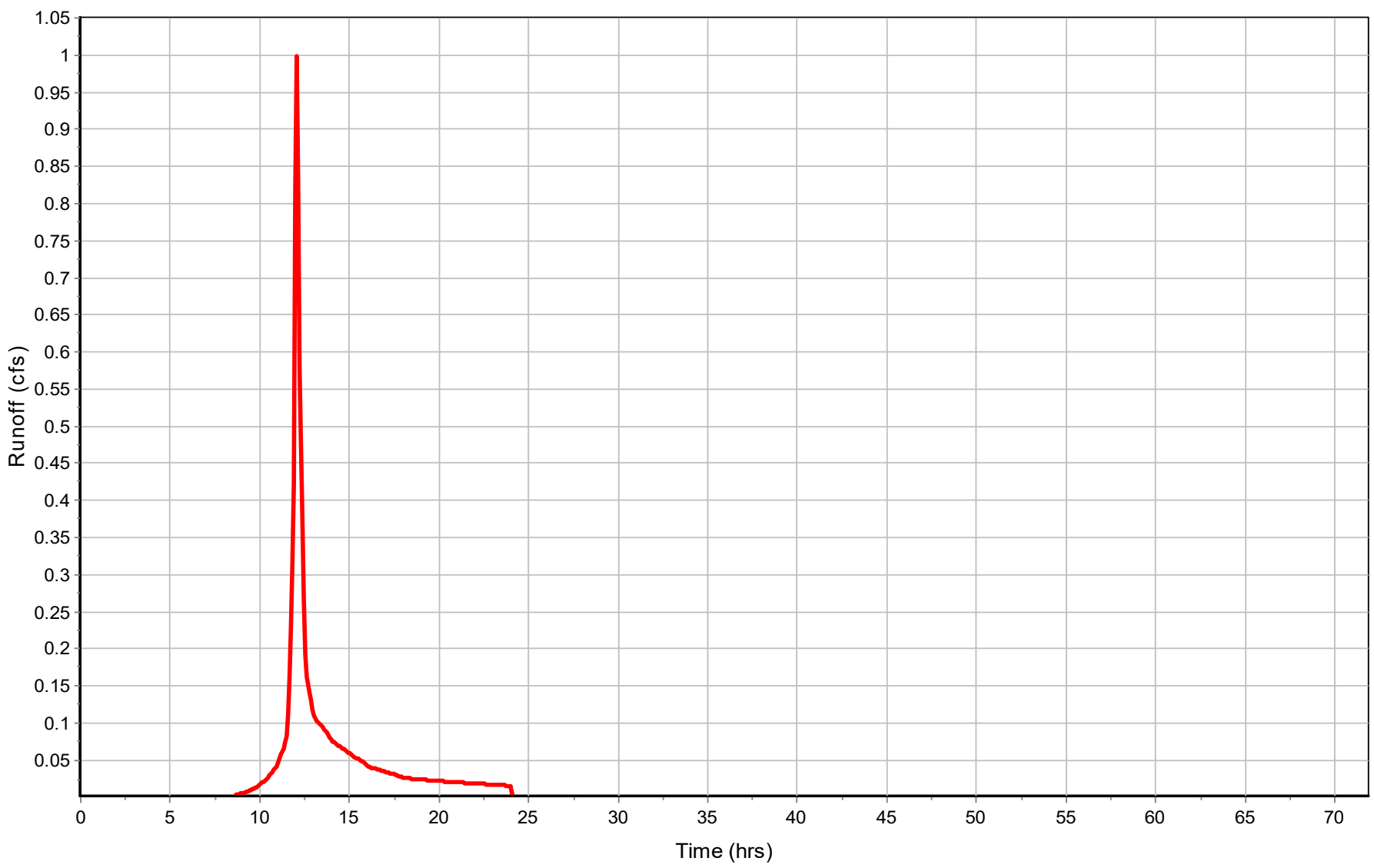
Total Rainfall (in)	5.01
Total Runoff (in)	2.54
Peak Runoff (cfs)	1.03
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:02:58

Subbasin : Sub-A3

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E03

Input Data

Area (ac) 0.36
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.36	A	43
Composite Area & Weighted CN	0.36		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	227.64	0	0
Slope (%) :	10	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.1	0	0
Computed Flow Time (min) :	36.74	0	0

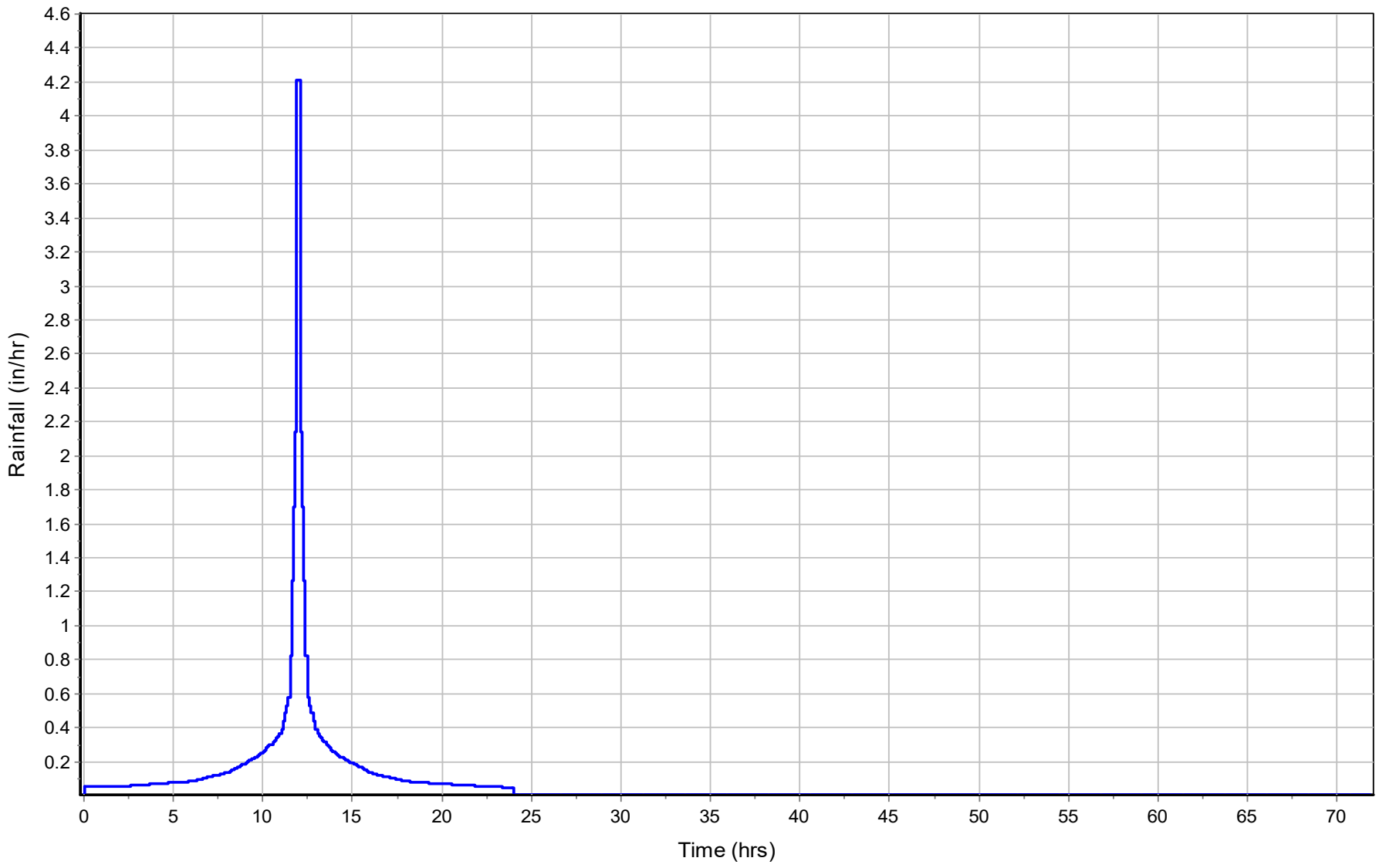
Total TOC (min) 36.74

Subbasin Runoff Results

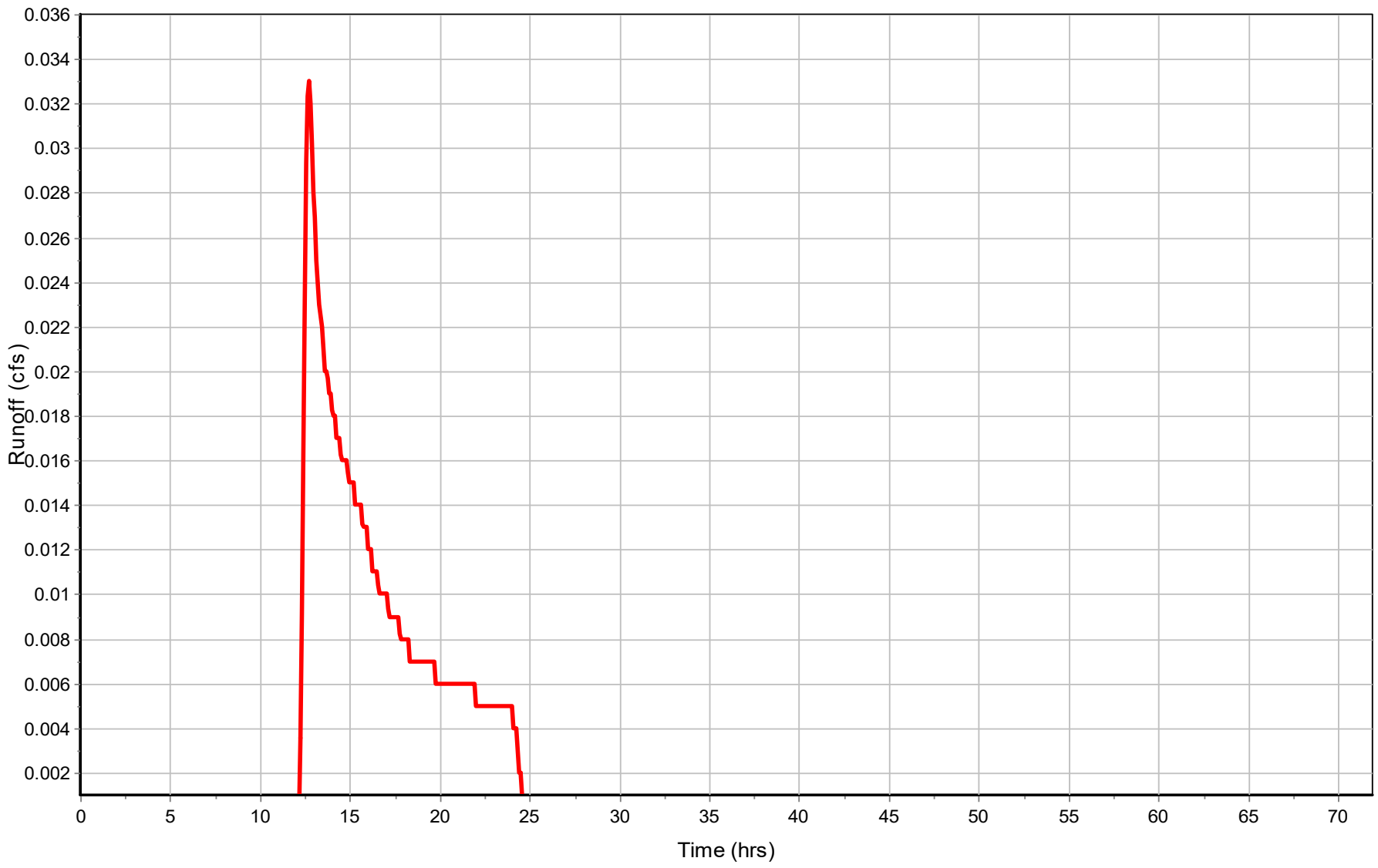
Total Rainfall (in) 5.01
Total Runoff (in) 0.36
Peak Runoff (cfs) 0.03
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:36:44

Subbasin : Sub-E03

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A3

Input Data

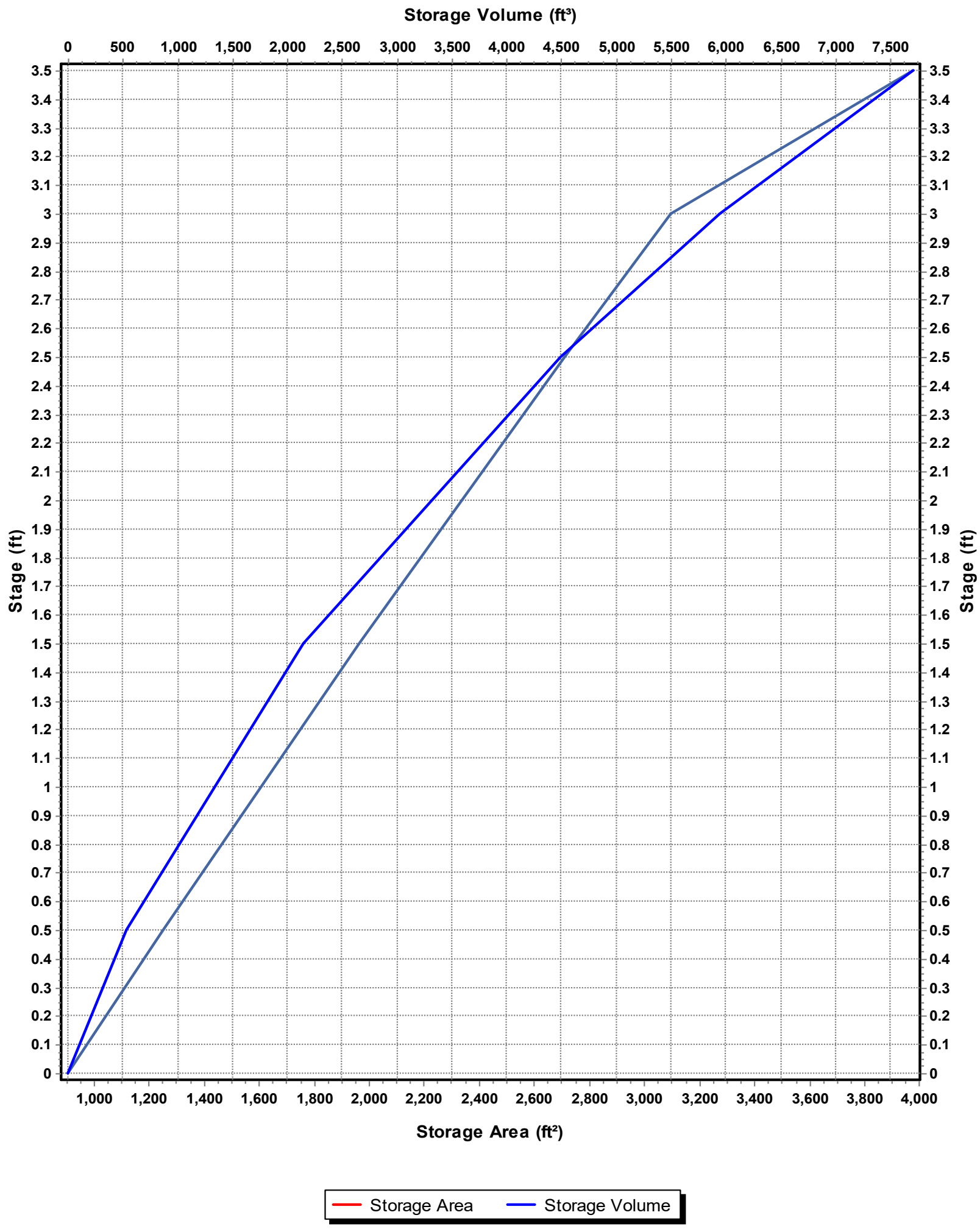
Invert Elevation (ft)	114.00
Max (Rim) Elevation (ft)	117.50
Max (Rim) Offset (ft)	3.50
Initial Water Elevation (ft)	114.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Storage-14

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	907.5	0
0.5	1252.5	540
1.5	1966.5	2149.5
2.5	2712.5	4489
3	3097.5	5941.5
3.5	3978	7710.38

Storage Area Volume Curves



Storage Node : Basin-A3 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-A3	Trapezoidal	No	117.00	3.00	10.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	0.99
Peak Lateral Inflow (cfs)	0
Peak Outflow (cfs)	0
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	115.88
Max HGL Depth Attained (ft)	1.88
Average HGL Elevation Attained (ft)	115.51
Average HGL Depth Attained (ft)	1.51
Time of Max HGL Occurrence (days hh:mm)	1 00:45
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Forebay-A3

Input Data

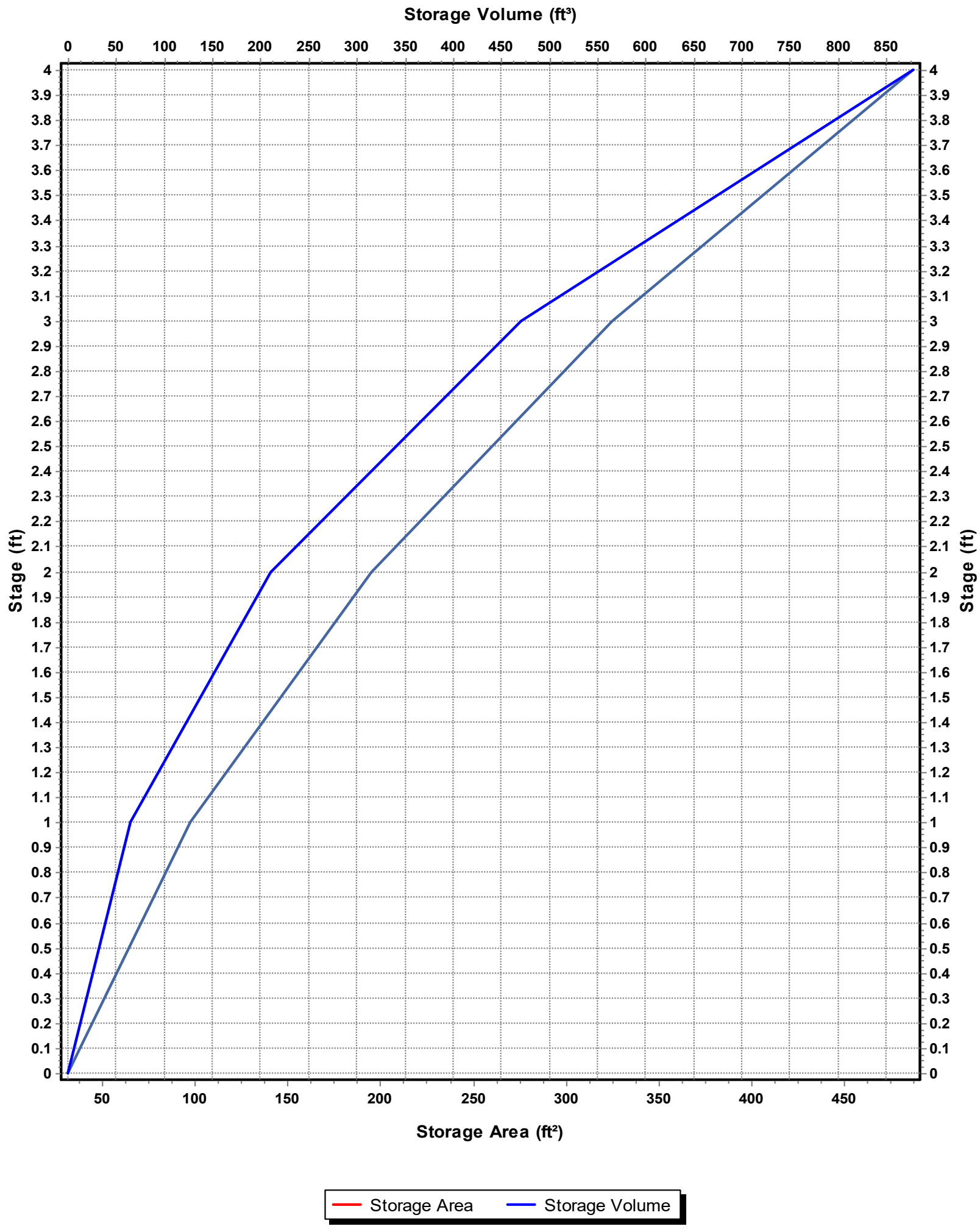
Invert Elevation (ft)	113.50
Max (Rim) Elevation (ft)	117.50
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	113.50
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Storage-15

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	31.5	0
1	97.5	64.5
2	195.5	211
3	325.5	471.5
4	487.5	878

Storage Area Volume Curves



Storage Node : Forebay-A3 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-FA3	Trapezoidal	No	117.00	3.50	10.00	1.00	3.33

Output Summary Results

Peak Inflow (cfs)	1
Peak Lateral Inflow (cfs)	1
Peak Outflow (cfs)	0.99
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	117.1
Max HGL Depth Attained (ft)	3.6
Average HGL Elevation Attained (ft)	116.47
Average HGL Depth Attained (ft)	2.97
Time of Max HGL Occurrence (days hh:mm)	0 12:10
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Project Description

File Name ..... Bourne_A3.SPF

Project Options

Flow Units ..... CFS
Elevation Type ..... Elevation
Hydrology Method ..... SCS TR-20
Time of Concentration (TOC) Method ..... SCS TR-55
Link Routing Method ..... Hydrodynamic
Enable Overflow Ponding at Nodes ..... YES
Skip Steady State Analysis Time Periods ..... NO

Analysis Options

Start Analysis On ..... oct. 14, 2021 0:00:00
End Analysis On ..... oct. 17, 2021 0:00:00
Start Reporting On ..... oct. 14, 2021 0:00:00
Antecedent Dry Days ..... 0 days
Runoff (Dry Weather) Time Step ..... 0 01:00:00 days hh:mm:ss
Runoff (Wet Weather) Time Step ..... 0 00:05:00 days hh:mm:ss
Reporting Time Step ..... 0 00:05:00 days hh:mm:ss
Routing Time Step ..... 30 seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	2
Nodes	4
Junctions	0
Outfalls	2
Flow Diversions	0
Inlets	0
Storage Nodes	2
Links	2
Channels	0
Pipes	0
Pumps	0
Orifices	0
Weirs	2
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	25 years	Intensity	inches	Massachusetts	None	25.00	5.99	SCS Type III 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Sub-A3	0.39	484.00	76.00	5.99	3.37	1.31	1.35	0 00:06:00
2	Sub-E03	0.36	484.00	43.00	5.99	0.67	0.24	0.09	0 00:36:44

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Out-A3	Outfall	57.50					0.00	57.50					
2	Out-E03	Outfall	0.00					0.09	0.00					
3	Basin-A3	Storage Node	114.00	117.50	114.00		0.00	1.31	116.36				0.00	0.00
4	Forebay-A3	Storage Node	113.50	117.50	113.50		0.00	1.32	117.12				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(ft)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
1	Weir-A3	Weir	Basin-A3	Out-A3		114.00	57.50				0.00							
2	Weir-FA3	Weir	Forebay-A3	Basin-A3		113.50	114.00				1.31							

Subbasin Hydrology

Subbasin : Sub-A3

Input Data

Area (ac)	0.39
Peak Rate Factor	484
Weighted Curve Number	76
Rain Gage ID	Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	0.39	A	76
Composite Area & Weighted CN	0.39		76

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft^2)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	126.51	0	0
Slope (%) :	1.19	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.94	0	0
Computed Flow Time (min) :	2.23	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	94.52	0	0
Channel Slope (%) :	0.5	0	0
Cross Section Area (ft^2) :	3	0	0
Wetted Perimeter (ft) :	6.32	0	0
Velocity (ft/sec) :	2.14	0	0
Computed Flow Time (min) :	0.74	0	0

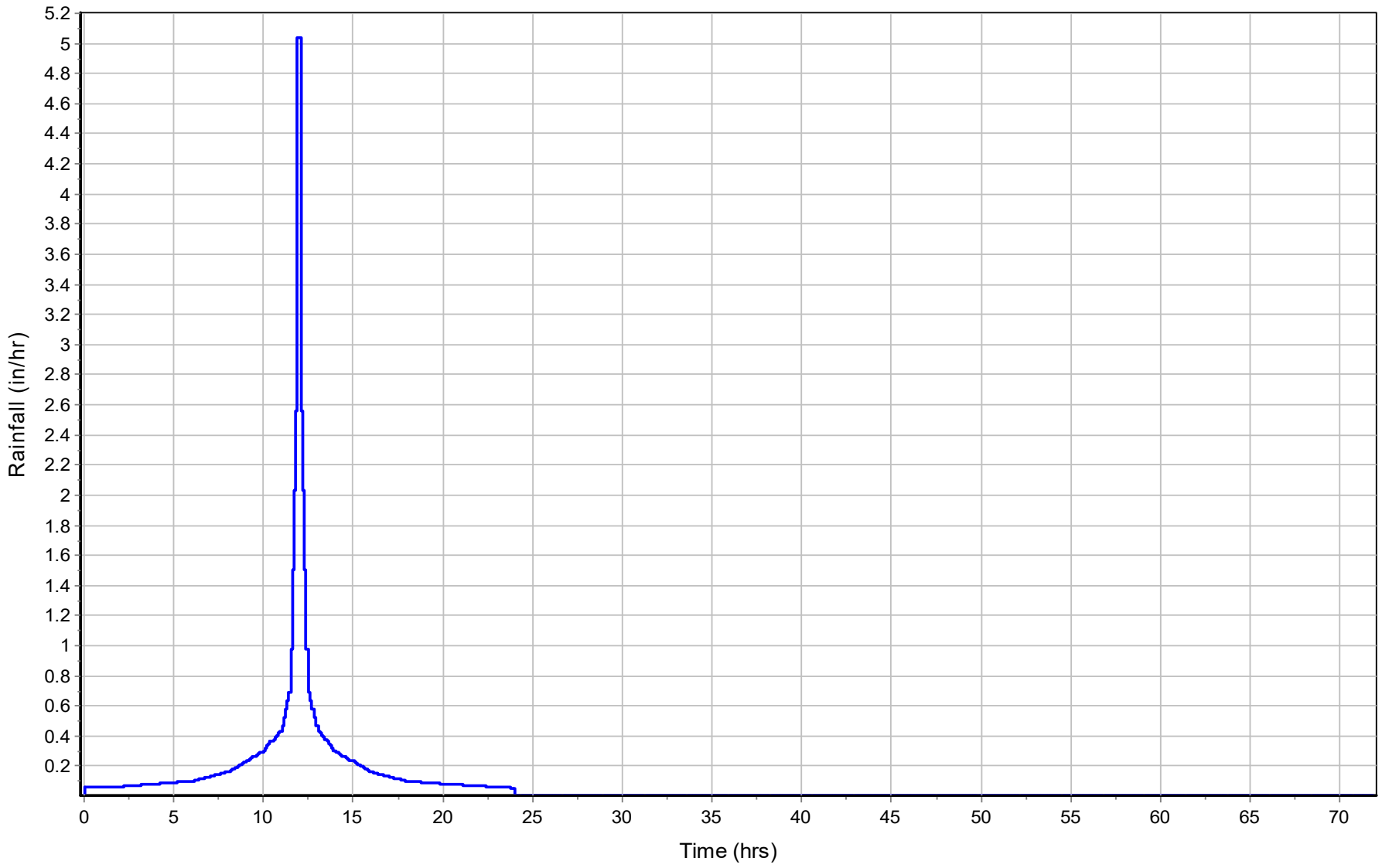
Total TOC (min) 2.97

Subbasin Runoff Results

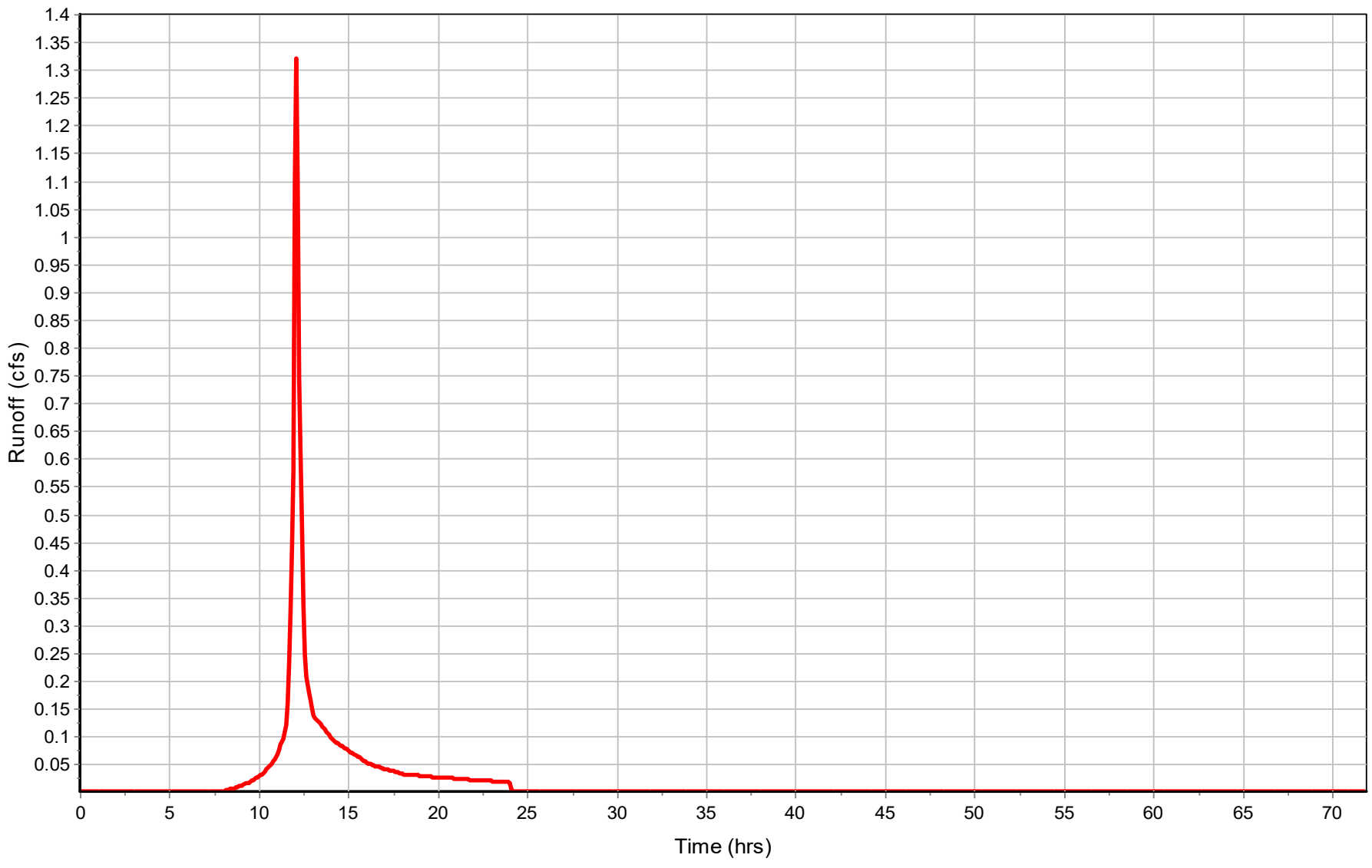
Total Rainfall (in)	5.99
Total Runoff (in)	3.37
Peak Runoff (cfs)	1.35
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:02:58

Subbasin : Sub-A3

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E03

Input Data

Area (ac) 0.36
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.36	A	43
Composite Area & Weighted CN	0.36		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	227.64	0	0
Slope (%) :	10	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.1	0	0
Computed Flow Time (min) :	36.74	0	0

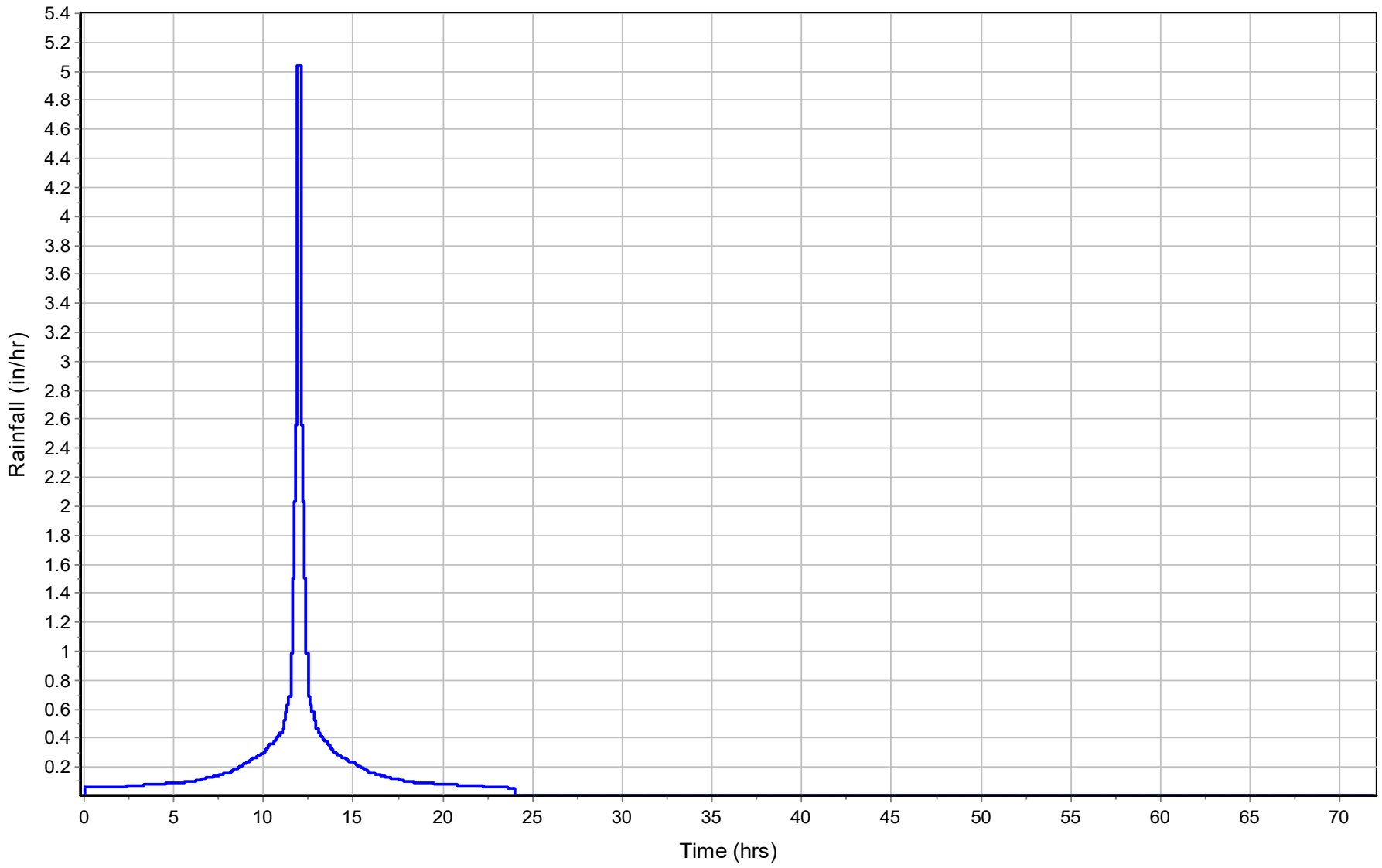
Total TOC (min) 36.74

Subbasin Runoff Results

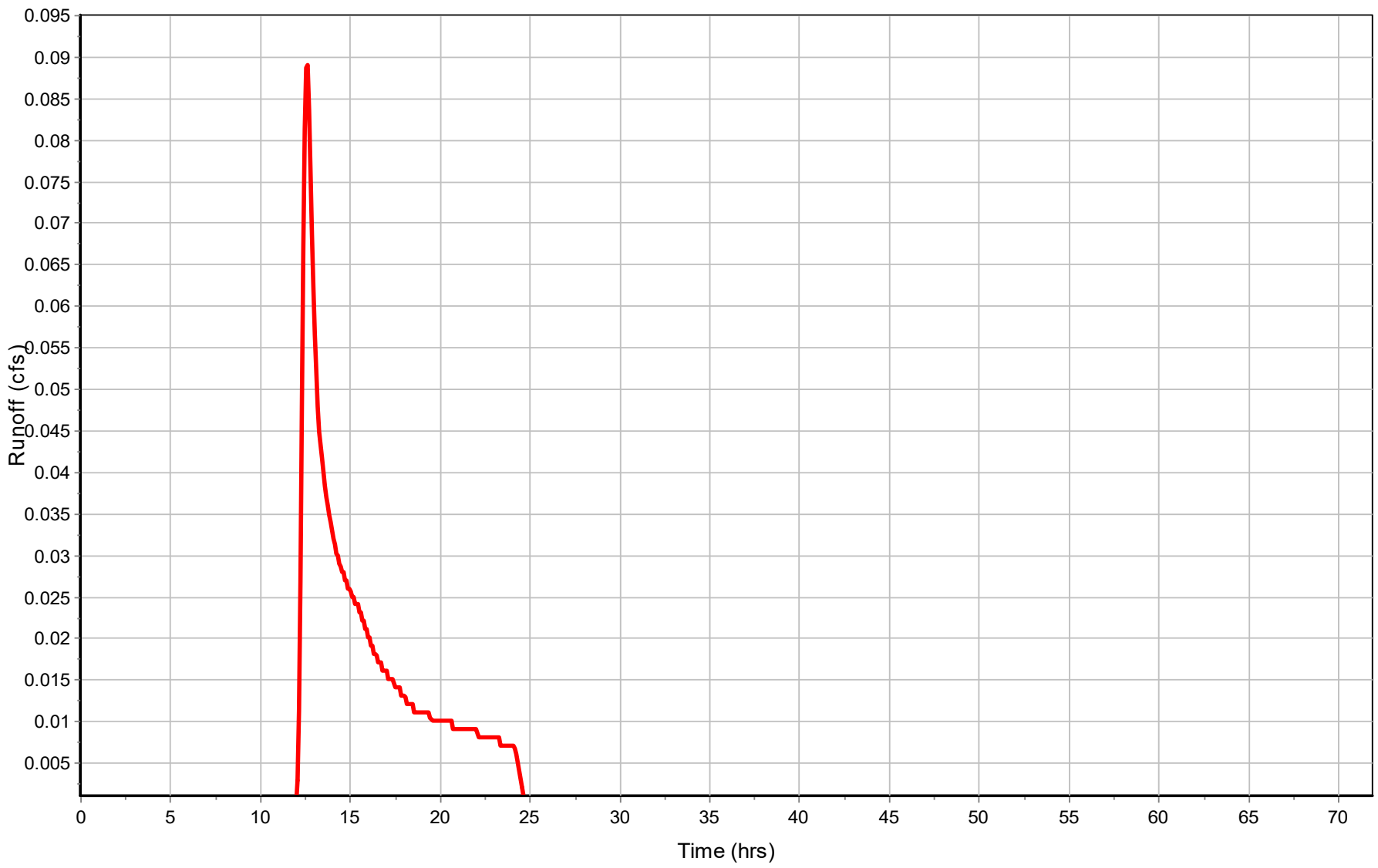
Total Rainfall (in) 5.99
Total Runoff (in) 0.67
Peak Runoff (cfs) 0.09
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:36:44

Subbasin : Sub-E03

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A3

Input Data

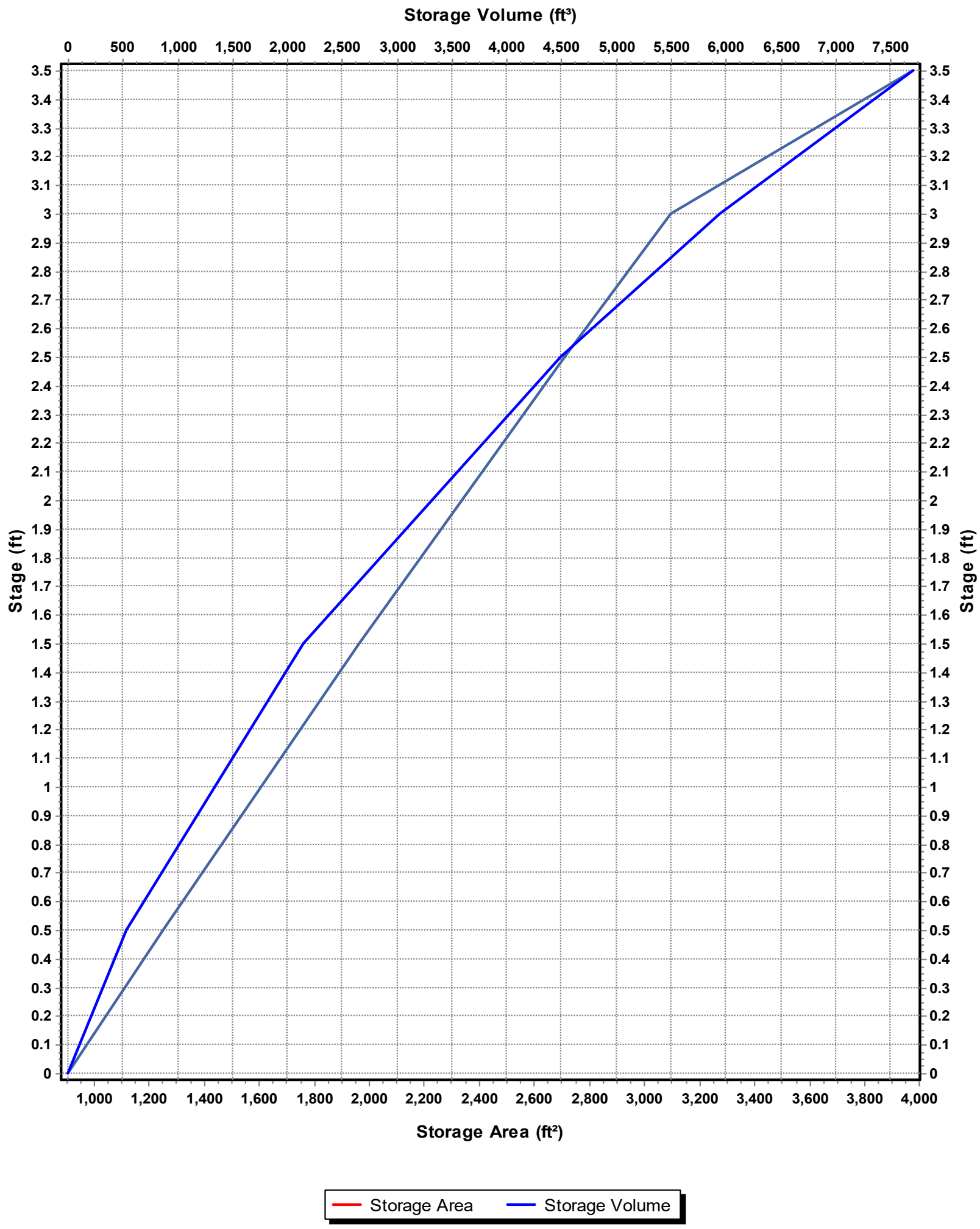
Invert Elevation (ft)	114.00
Max (Rim) Elevation (ft)	117.50
Max (Rim) Offset (ft)	3.50
Initial Water Elevation (ft)	114.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Storage-14

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	907.5	0
0.5	1252.5	540
1.5	1966.5	2149.5
2.5	2712.5	4489
3	3097.5	5941.5
3.5	3978	7710.38

Storage Area Volume Curves



Storage Node : Basin-A3 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-A3	Trapezoidal	No	117.00	3.00	10.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	1.31
Peak Lateral Inflow (cfs)	0
Peak Outflow (cfs)	0
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	116.36
Max HGL Depth Attained (ft)	2.36
Average HGL Elevation Attained (ft)	115.91
Average HGL Depth Attained (ft)	1.91
Time of Max HGL Occurrence (days hh:mm)	1 00:46
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Forebay-A3

Input Data

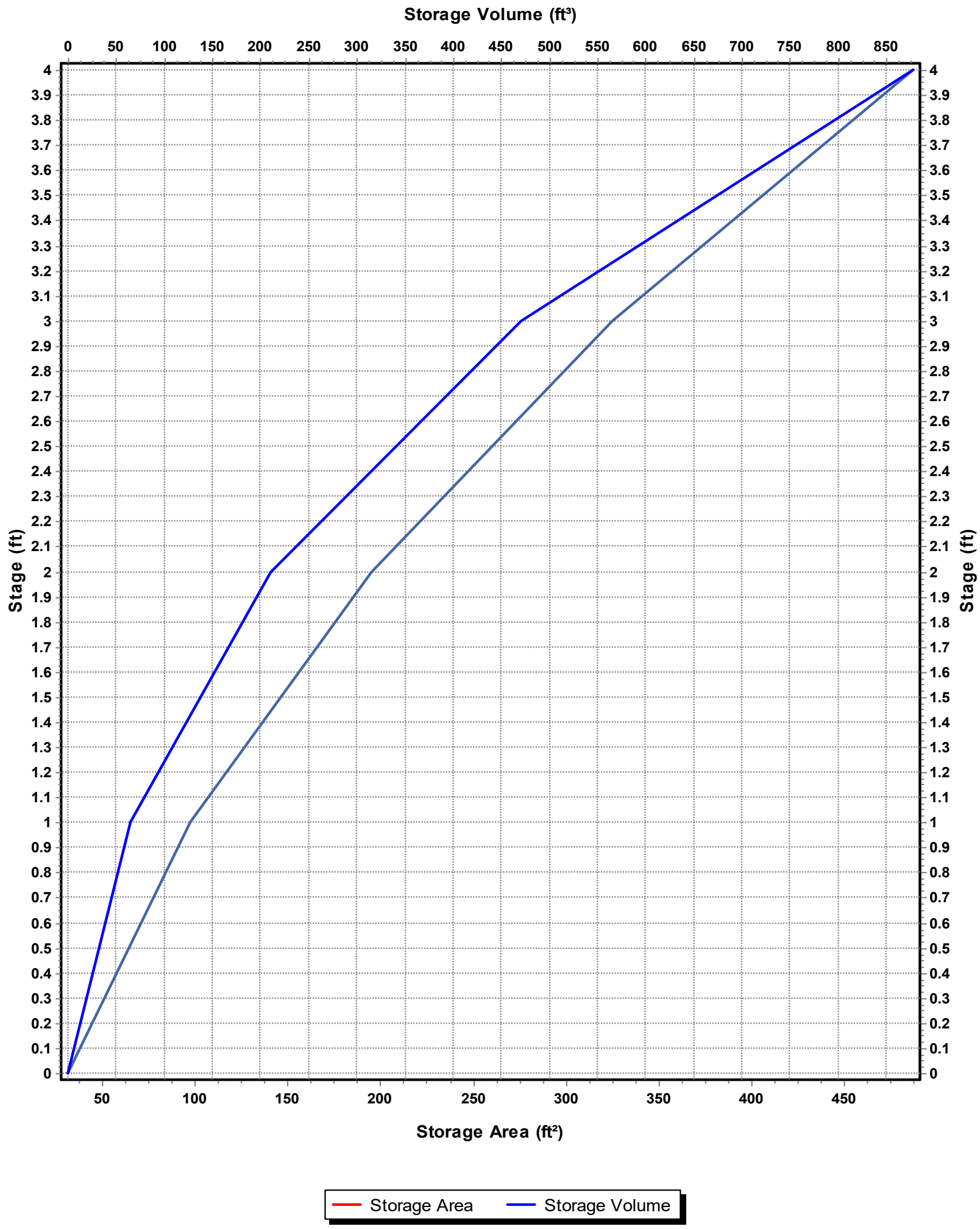
Invert Elevation (ft)	113.50
Max (Rim) Elevation (ft)	117.50
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	113.50
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Storage-15

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	31.5	0
1	97.5	64.5
2	195.5	211
3	325.5	471.5
4	487.5	878

Storage Area Volume Curves



Storage Node : Forebay-A3 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-FA3	Trapezoidal	No	117.00	3.50	10.00	1.00	3.33

Output Summary Results

Peak Inflow (cfs)	1.32
Peak Lateral Inflow (cfs)	1.32
Peak Outflow (cfs)	1.31
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	117.12
Max HGL Depth Attained (ft)	3.62
Average HGL Elevation Attained (ft)	116.49
Average HGL Depth Attained (ft)	2.99
Time of Max HGL Occurrence (days hh:mm)	0 12:10
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Project Description

File Name ..... Bourne_A3.SPF

Project Options

Flow Units ..... CFS
Elevation Type ..... Elevation
Hydrology Method ..... SCS TR-20
Time of Concentration (TOC) Method ..... SCS TR-55
Link Routing Method ..... Hydrodynamic
Enable Overflow Ponding at Nodes ..... YES
Skip Steady State Analysis Time Periods ..... NO

Analysis Options

Start Analysis On ..... oct. 14, 2021 0:00:00
End Analysis On ..... oct. 17, 2021 0:00:00
Start Reporting On ..... oct. 14, 2021 0:00:00
Antecedent Dry Days ..... 0 days
Runoff (Dry Weather) Time Step ..... 0 01:00:00 days hh:mm:ss
Runoff (Wet Weather) Time Step ..... 0 00:05:00 days hh:mm:ss
Reporting Time Step ..... 0 00:05:00 days hh:mm:ss
Routing Time Step ..... 30 seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	2
Nodes	4
Junctions	0
Outfalls	2
Flow Diversions	0
Inlets	0
Storage Nodes	2
Links	2
Channels	0
Pipes	0
Pumps	0
Orifices	0
Weirs	2
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	50 years	Intensity	inches	Massachusetts	None	50.00	6.74	SCS Type III 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Sub-A3	0.39	484.00	76.00	6.74	4.03	1.57	1.61	0 00:06:00
2	Sub-E03	0.36	484.00	43.00	6.74	0.96	0.35	0.15	0 00:36:44

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Out-A3	Outfall	57.50					0.00	57.50					
2	Out-E03	Outfall	0.00					0.15	0.00					
3	Basin-A3	Storage Node	114.00	117.50	114.00		0.00	1.57	116.70				0.00	0.00
4	Forebay-A3	Storage Node	113.50	117.50	113.50		0.00	1.58	117.13				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(ft)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
1	Weir-A3	Weir	Basin-A3	Out-A3		114.00	57.50				0.00							
2	Weir-FA3	Weir	Forebay-A3	Basin-A3		113.50	114.00				1.57							

Subbasin Hydrology

Subbasin : Sub-A3

Input Data

Area (ac)	0.39
Peak Rate Factor	484
Weighted Curve Number	76
Rain Gage ID	Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	0.39	A	76
Composite Area & Weighted CN	0.39		76

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft^2)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	126.51	0	0
Slope (%) :	1.19	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.94	0	0
Computed Flow Time (min) :	2.23	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	94.52	0	0
Channel Slope (%) :	0.5	0	0
Cross Section Area (ft^2) :	3	0	0
Wetted Perimeter (ft) :	6.32	0	0
Velocity (ft/sec) :	2.14	0	0
Computed Flow Time (min) :	0.74	0	0

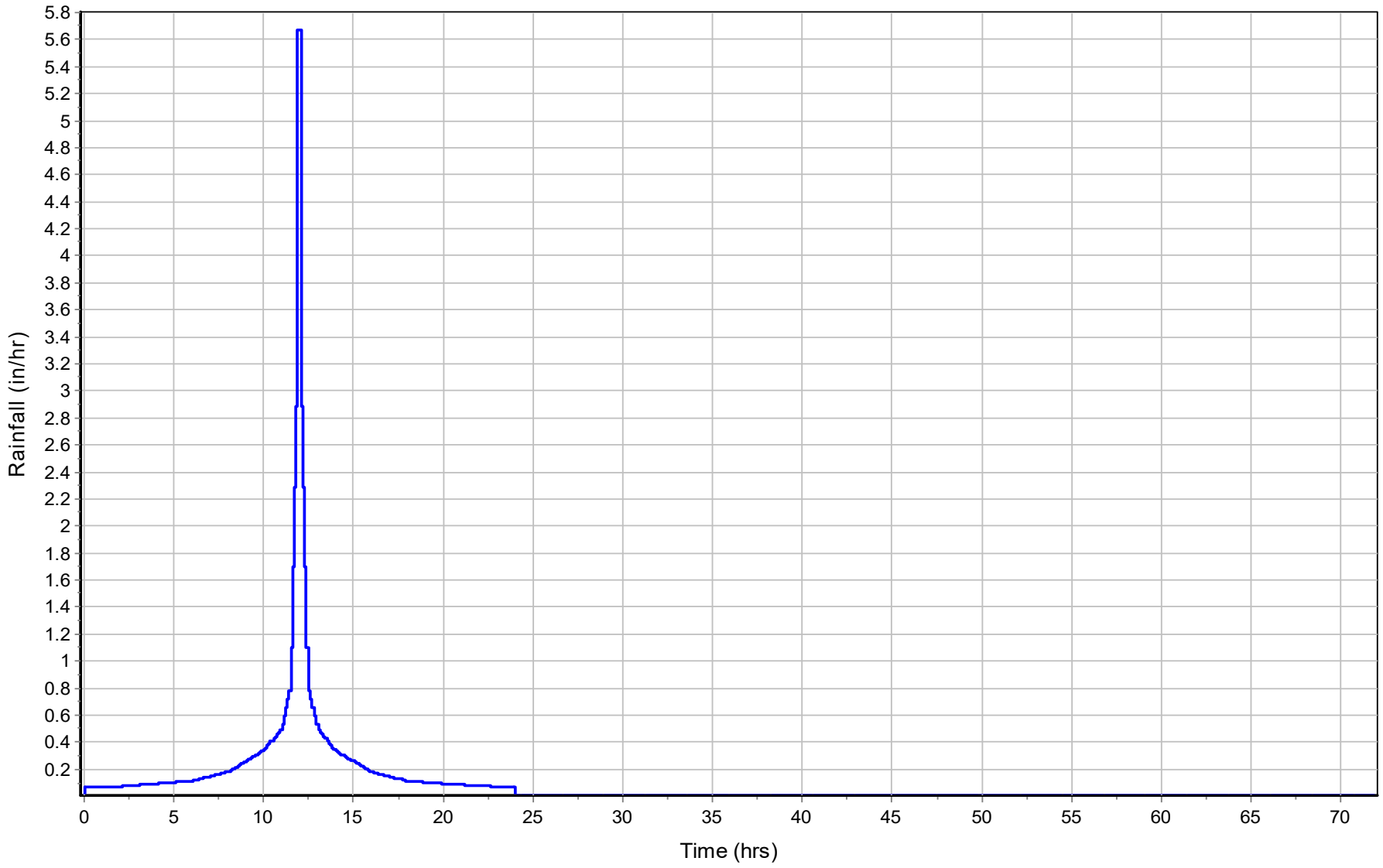
Total TOC (min) 2.97

Subbasin Runoff Results

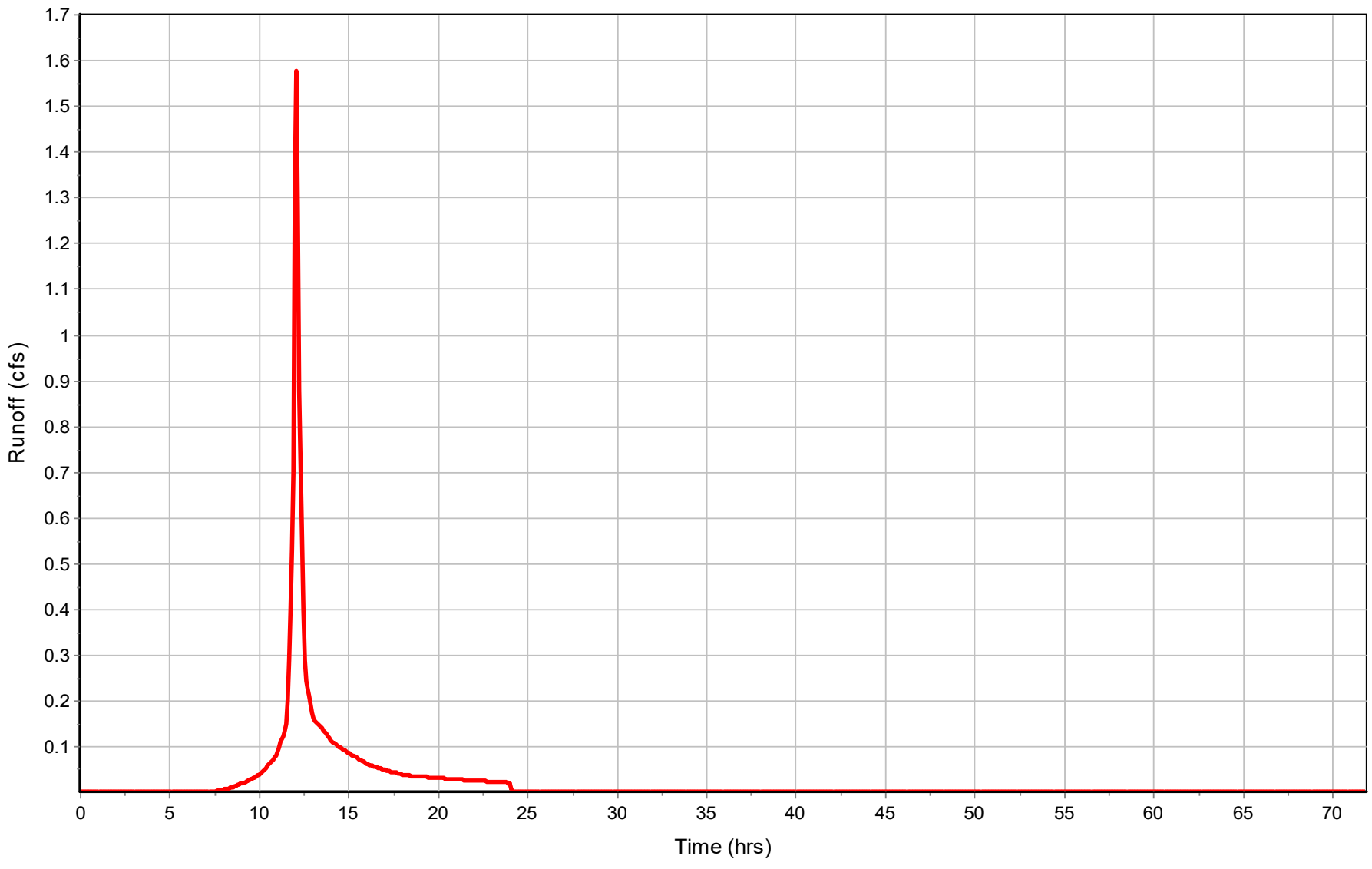
Total Rainfall (in)	6.74
Total Runoff (in)	4.03
Peak Runoff (cfs)	1.61
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:02:58

Subbasin : Sub-A3

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E03

Input Data

Area (ac) 0.36
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.36	A	43
Composite Area & Weighted CN	0.36		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	227.64	0	0
Slope (%) :	10	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.1	0	0
Computed Flow Time (min) :	36.74	0	0

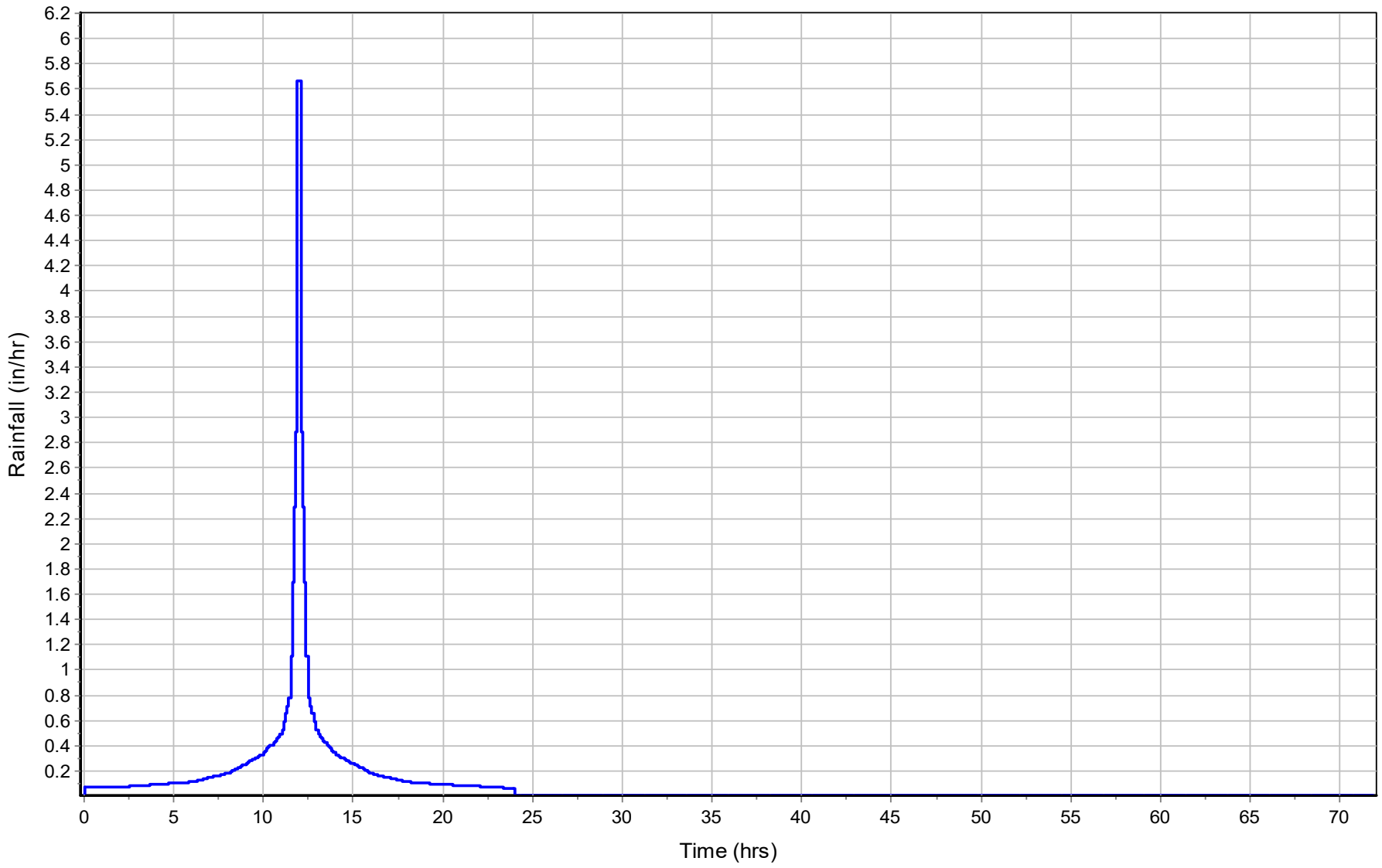
Total TOC (min) 36.74

Subbasin Runoff Results

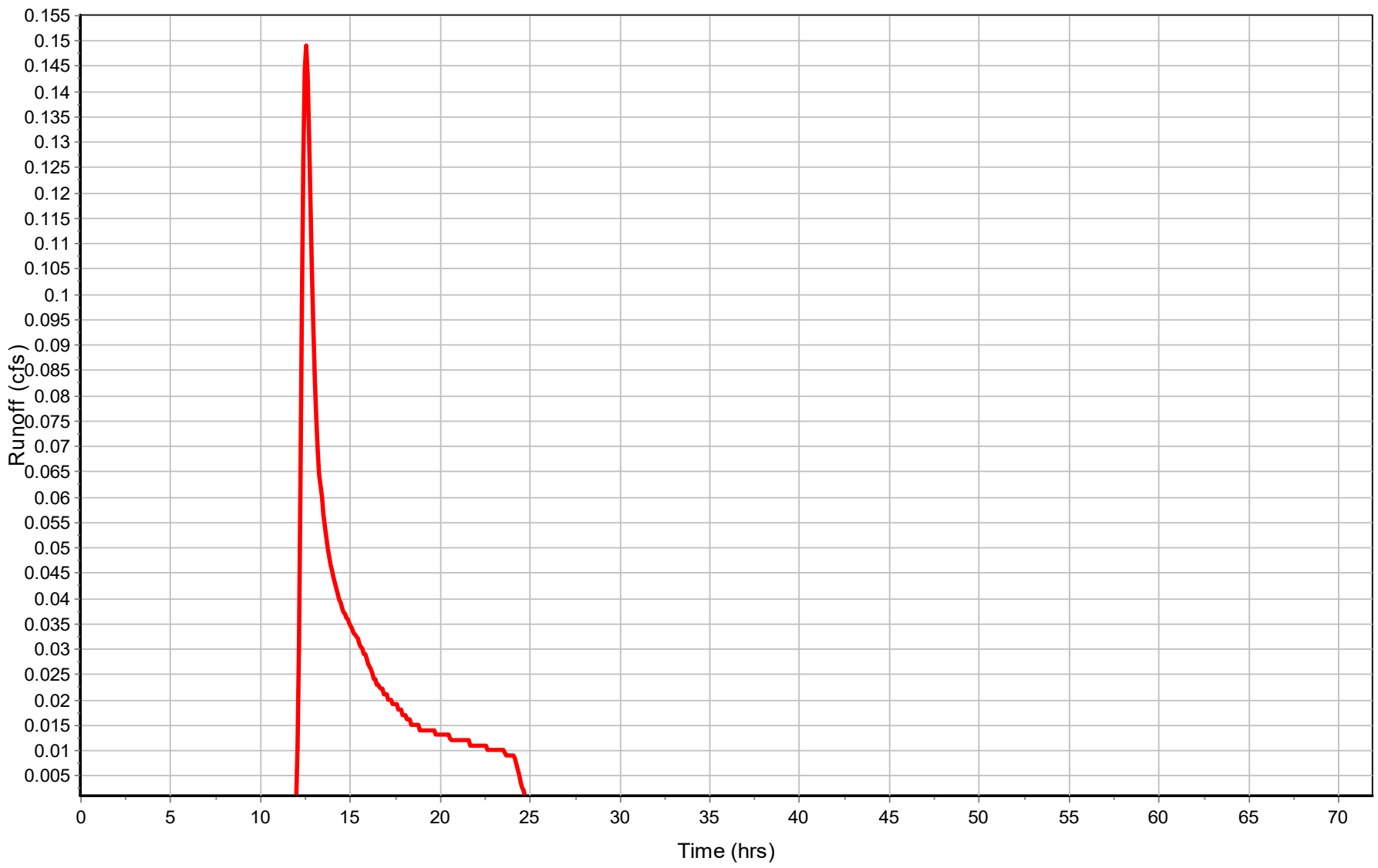
Total Rainfall (in) 6.74
Total Runoff (in) 0.96
Peak Runoff (cfs) 0.15
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:36:44

Subbasin : Sub-E03

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A3

Input Data

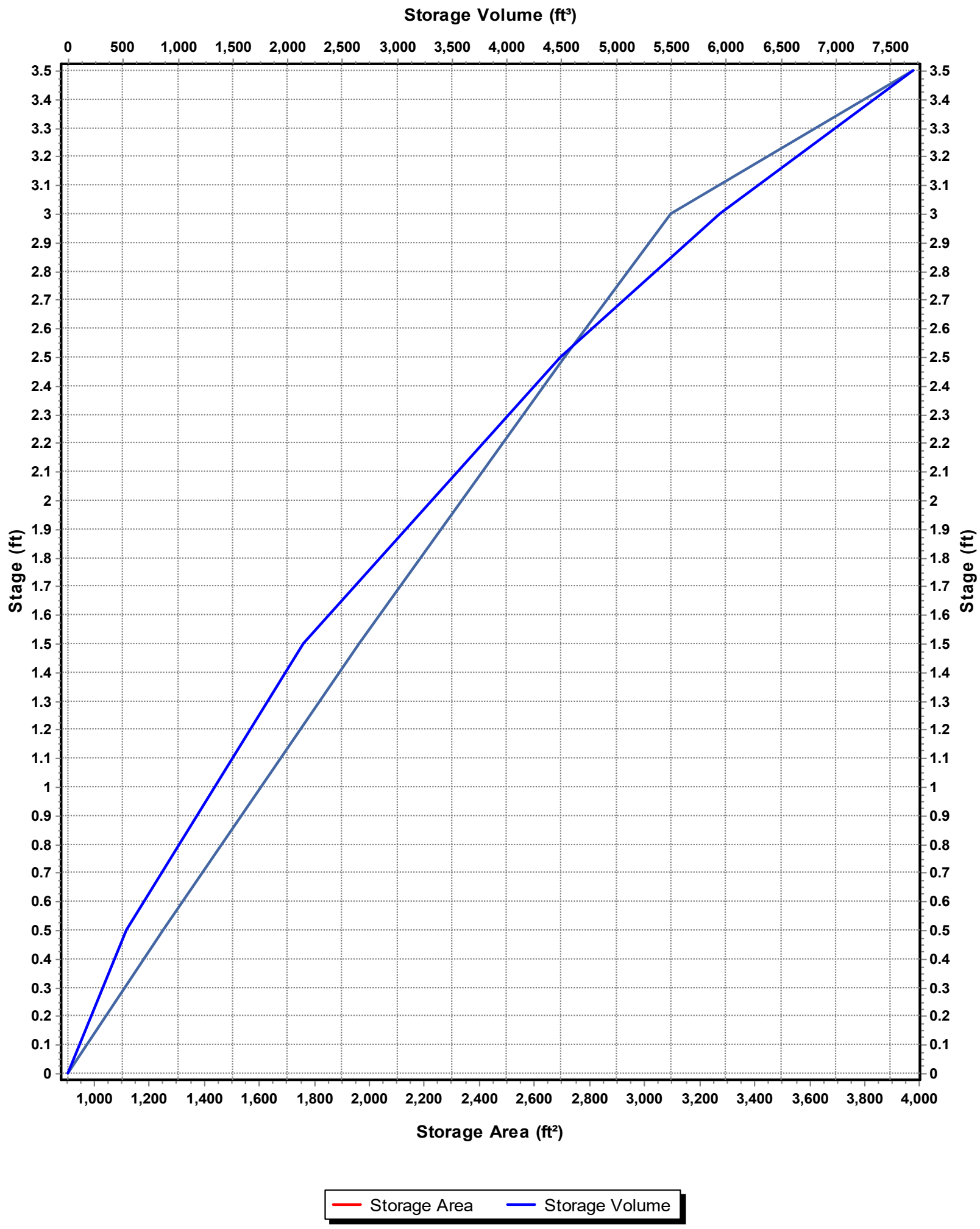
Invert Elevation (ft)	114.00
Max (Rim) Elevation (ft)	117.50
Max (Rim) Offset (ft)	3.50
Initial Water Elevation (ft)	114.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Storage-14

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	907.5	0
0.5	1252.5	540
1.5	1966.5	2149.5
2.5	2712.5	4489
3	3097.5	5941.5
3.5	3978	7710.38

Storage Area Volume Curves



Storage Node : Basin-A3 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-A3	Trapezoidal	No	117.00	3.00	10.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	1.57
Peak Lateral Inflow (cfs)	0
Peak Outflow (cfs)	0
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	116.7
Max HGL Depth Attained (ft)	2.7
Average HGL Elevation Attained (ft)	116.19
Average HGL Depth Attained (ft)	2.19
Time of Max HGL Occurrence (days hh:mm)	1 00:46
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Forebay-A3

Input Data

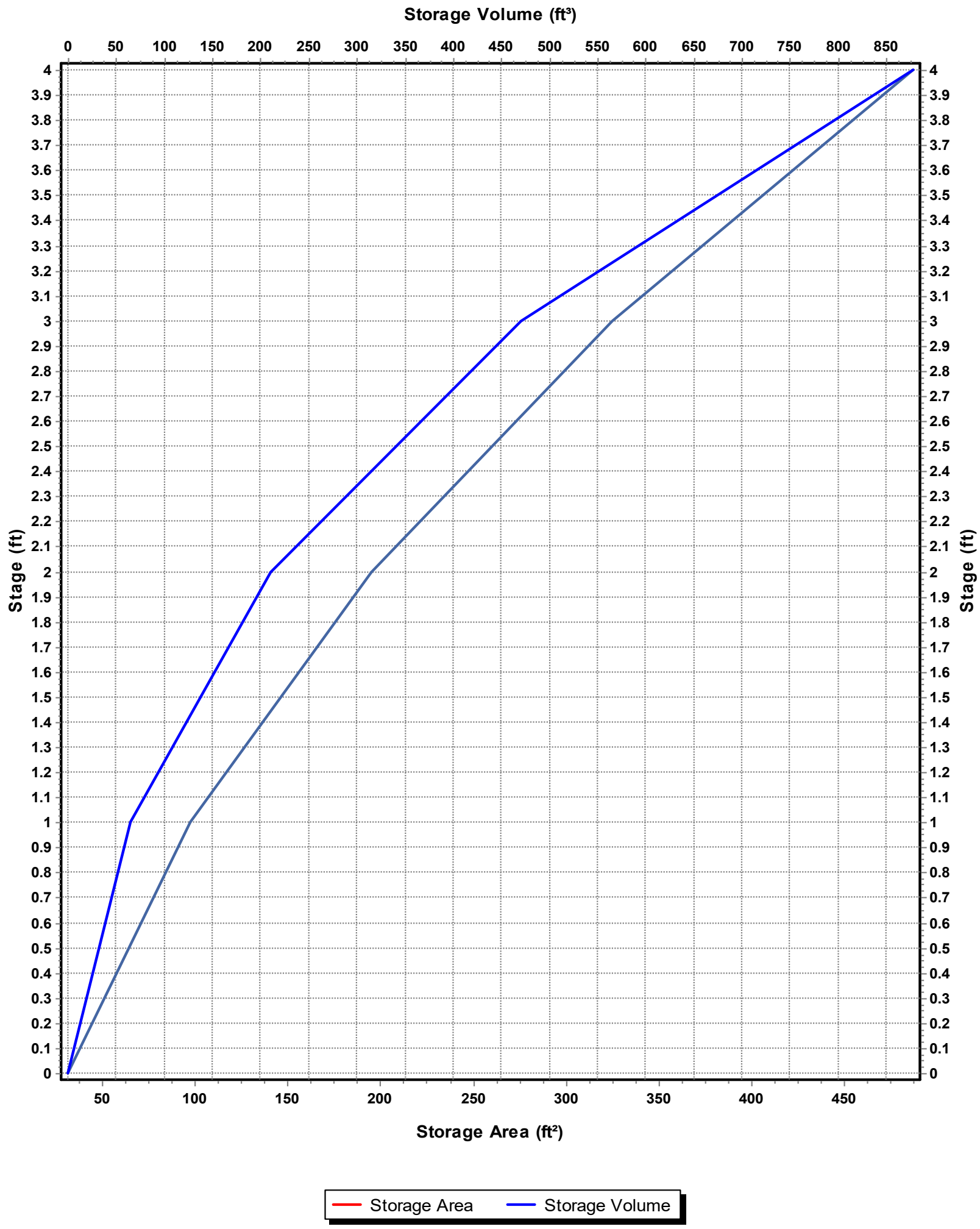
Invert Elevation (ft)	113.50
Max (Rim) Elevation (ft)	117.50
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	113.50
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Storage-15

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	31.5	0
1	97.5	64.5
2	195.5	211
3	325.5	471.5
4	487.5	878

Storage Area Volume Curves



Storage Node : Forebay-A3 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-FA3	Trapezoidal	No	117.00	3.50	10.00	1.00	3.33

Output Summary Results

Peak Inflow (cfs)	1.58
Peak Lateral Inflow (cfs)	1.58
Peak Outflow (cfs)	1.57
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	117.13
Max HGL Depth Attained (ft)	3.63
Average HGL Elevation Attained (ft)	116.51
Average HGL Depth Attained (ft)	3.01
Time of Max HGL Occurrence (days hh:mm)	0 12:10
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Project Description

File Name ..... Bourne_A3.SPF

Project Options

Flow Units ..... CFS
Elevation Type ..... Elevation
Hydrology Method ..... SCS TR-20
Time of Concentration (TOC) Method ..... SCS TR-55
Link Routing Method ..... Hydrodynamic
Enable Overflow Ponding at Nodes ..... YES
Skip Steady State Analysis Time Periods ..... NO

Analysis Options

Start Analysis On ..... oct. 14, 2021 0:00:00
End Analysis On ..... oct. 17, 2021 0:00:00
Start Reporting On ..... oct. 14, 2021 0:00:00
Antecedent Dry Days ..... 0 days
Runoff (Dry Weather) Time Step ..... 0 01:00:00 days hh:mm:ss
Runoff (Wet Weather) Time Step ..... 0 00:05:00 days hh:mm:ss
Reporting Time Step ..... 0 00:05:00 days hh:mm:ss
Routing Time Step ..... 30 seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	2
Nodes	4
Junctions	0
Outfalls	2
Flow Diversions	0
Inlets	0
Storage Nodes	2
Links	2
Channels	0
Pipes	0
Pumps	0
Orifices	0
Weirs	2
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	100 years	Intensity	inches	Massachusetts	None	100.00	7.51	SCS Type III 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Sub-A3	0.39	484.00	76.00	7.51	4.71	1.84	1.87	0 00:06:00
2	Sub-E03	0.36	484.00	43.00	7.51	1.30	0.47	0.22	0 00:36:44

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Out-A3	Outfall	57.50					0.02	57.50					
2	Out-E03	Outfall	0.00					0.22	0.00					
3	Basin-A3	Storage Node	114.00	117.50	114.00		0.00	1.83	117.01				0.00	0.00
4	Forebay-A3	Storage Node	113.50	117.50	113.50		0.00	1.84	117.14				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(ft)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
1	Weir-A3	Weir	Basin-A3	Out-A3		114.00	57.50				0.02							
2	Weir-FA3	Weir	Forebay-A3	Basin-A3		113.50	114.00				1.83							

Subbasin Hydrology

Subbasin : Sub-A3

Input Data

Area (ac)	0.39
Peak Rate Factor	484
Weighted Curve Number	76
Rain Gage ID	Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	0.39	A	76
Composite Area & Weighted CN	0.39		76

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft^2)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	126.51	0	0
Slope (%) :	1.19	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.94	0	0
Computed Flow Time (min) :	2.23	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	94.52	0	0
Channel Slope (%) :	0.5	0	0
Cross Section Area (ft^2) :	3	0	0
Wetted Perimeter (ft) :	6.32	0	0
Velocity (ft/sec) :	2.14	0	0
Computed Flow Time (min) :	0.74	0	0

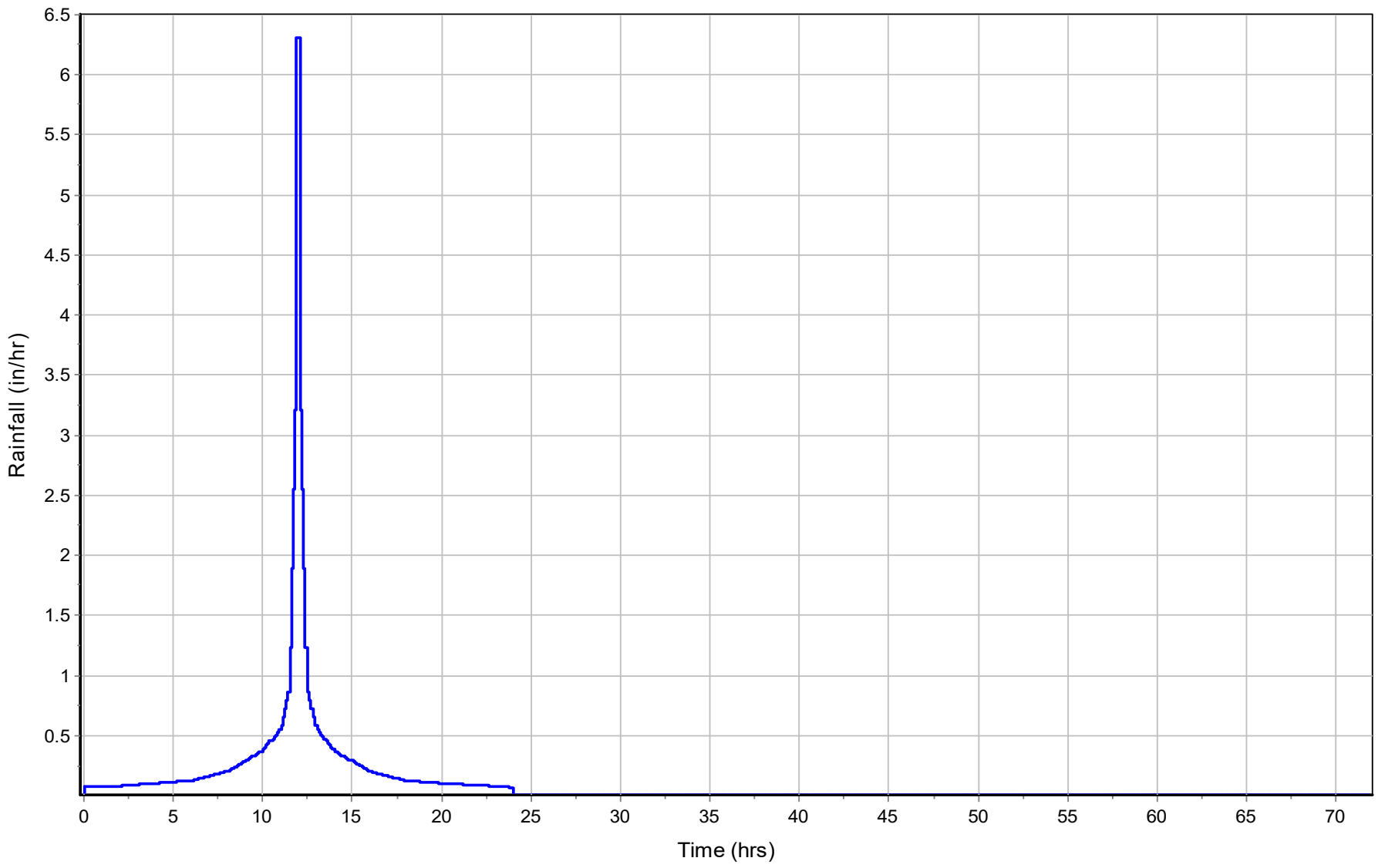
Total TOC (min) 2.97

Subbasin Runoff Results

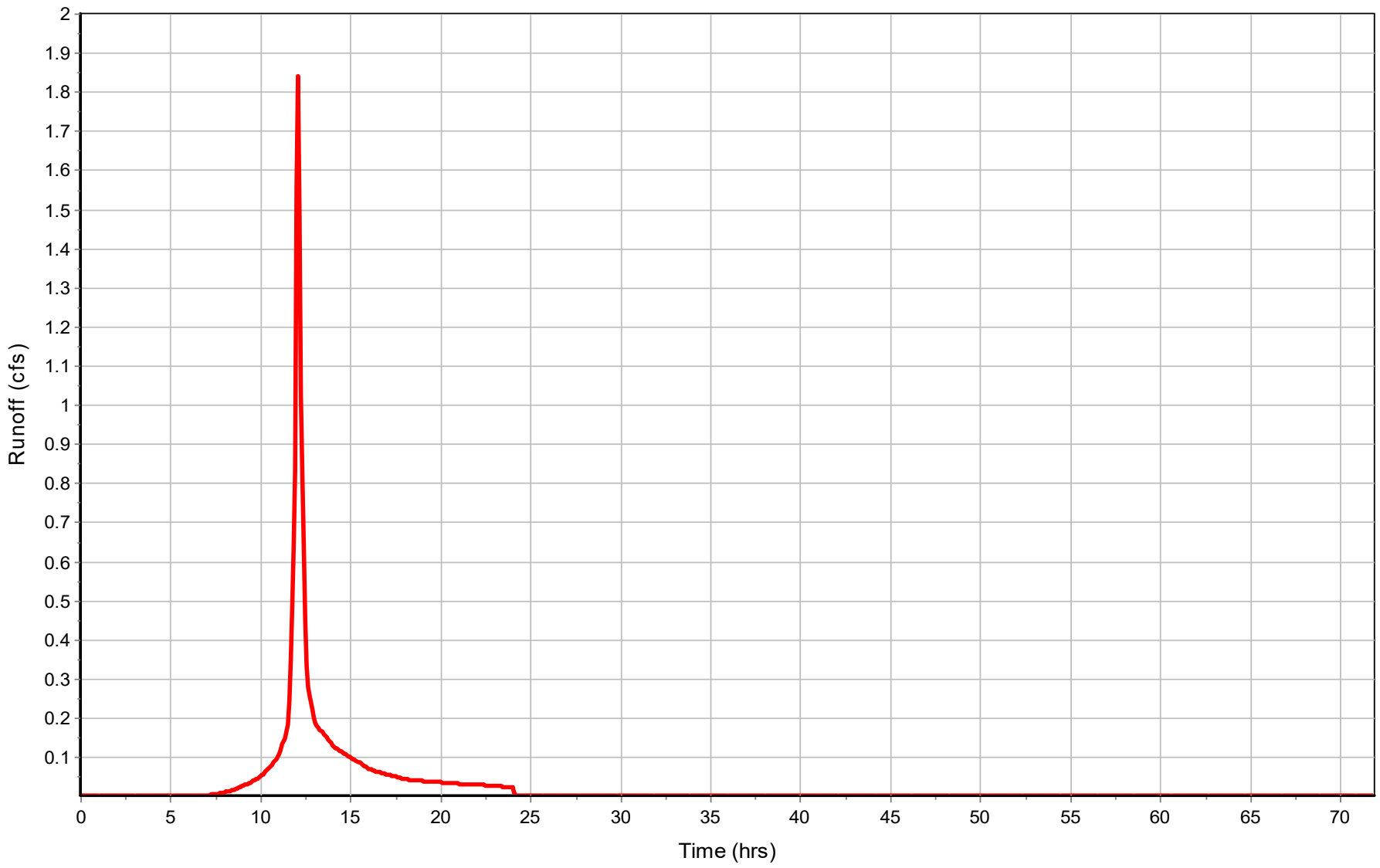
Total Rainfall (in)	7.51
Total Runoff (in)	4.71
Peak Runoff (cfs)	1.87
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:02:58

Subbasin : Sub-A3

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E03

Input Data

Area (ac) 0.36
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.36	A	43
Composite Area & Weighted CN	0.36		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	227.64	0	0
Slope (%) :	10	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.1	0	0
Computed Flow Time (min) :	36.74	0	0

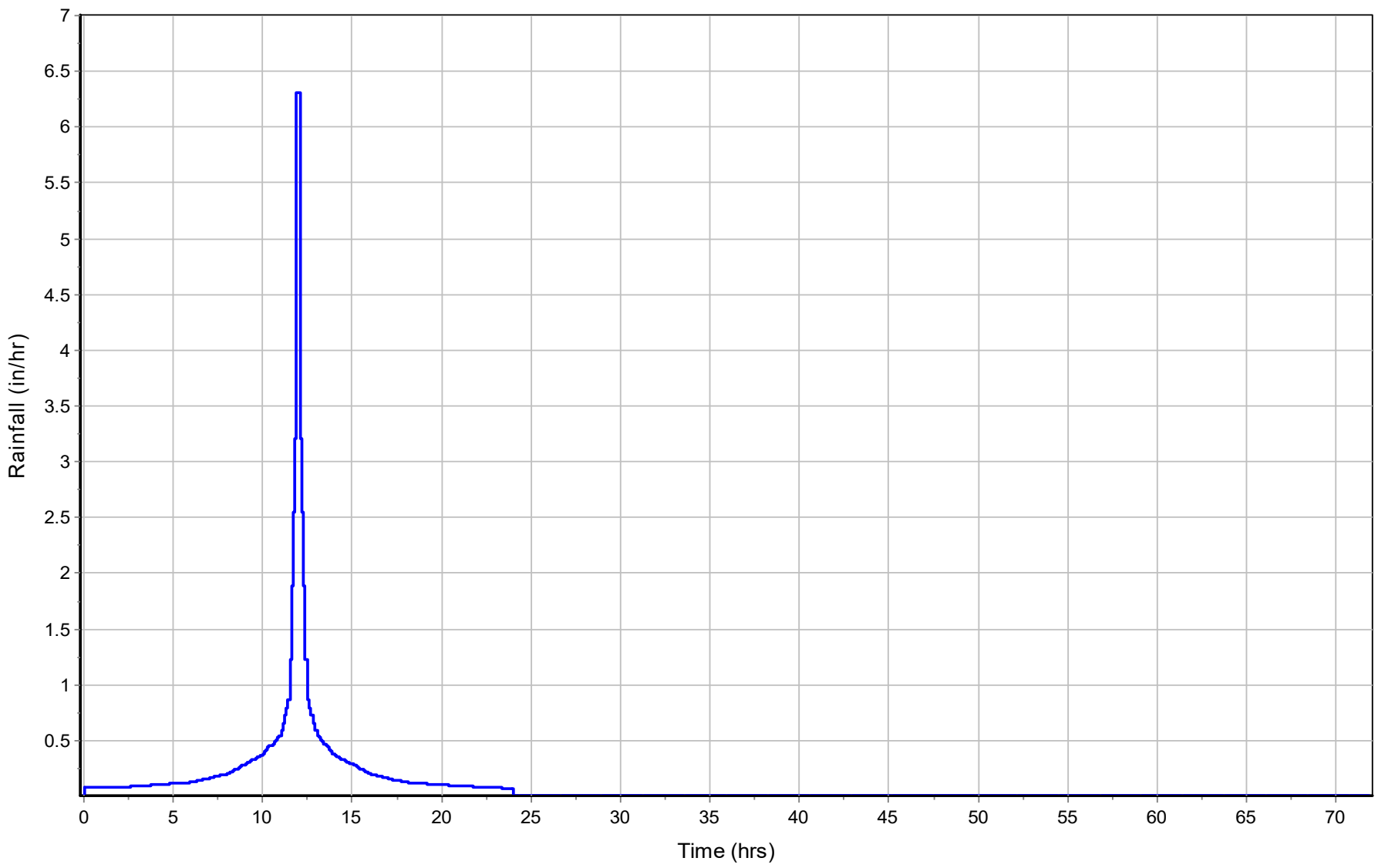
Total TOC (min) 36.74

Subbasin Runoff Results

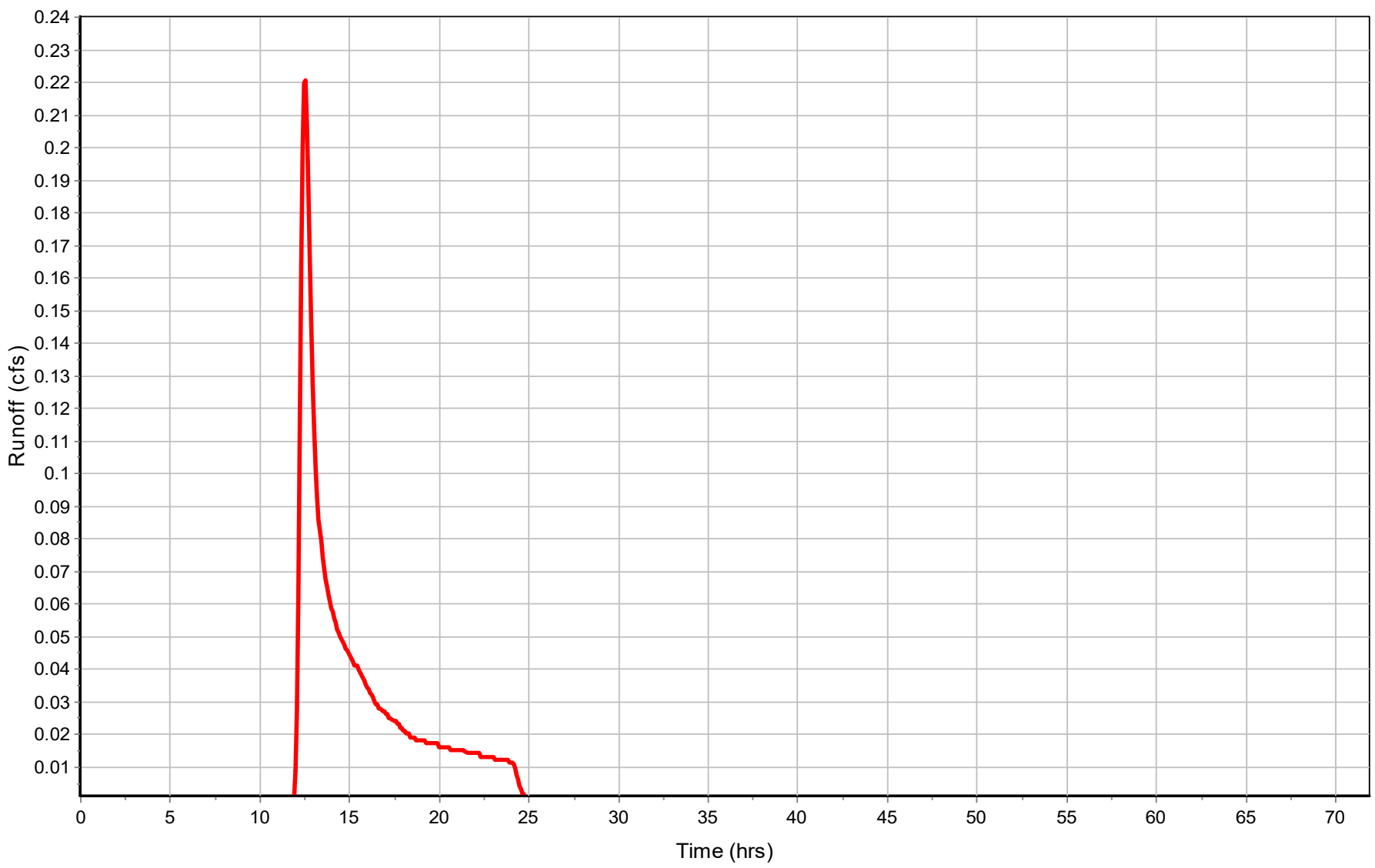
Total Rainfall (in) 7.51
Total Runoff (in) 1.3
Peak Runoff (cfs) 0.22
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:36:44

Subbasin : Sub-E03

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A3

Input Data

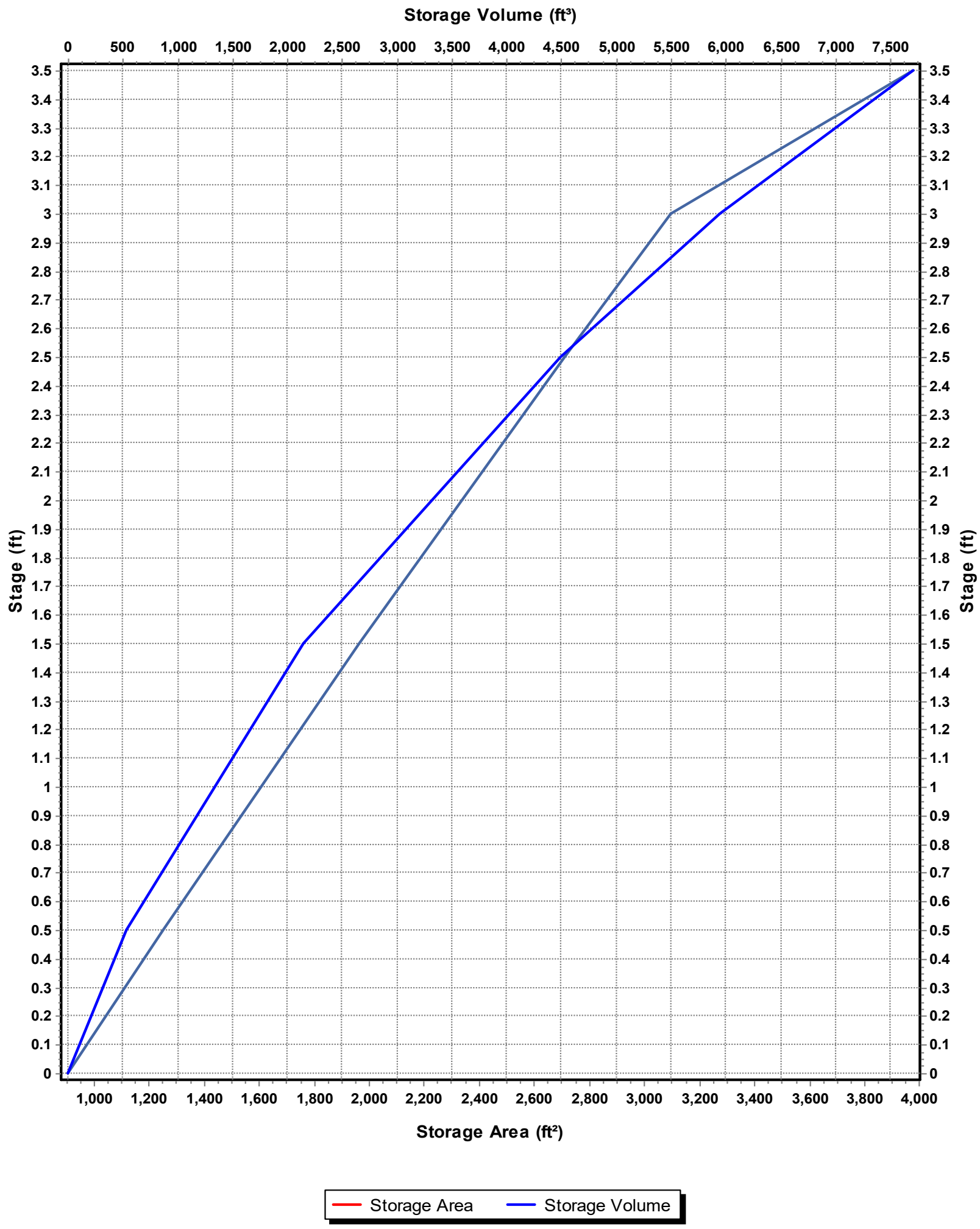
Invert Elevation (ft)	114.00
Max (Rim) Elevation (ft)	117.50
Max (Rim) Offset (ft)	3.50
Initial Water Elevation (ft)	114.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Storage-14

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	907.5	0
0.5	1252.5	540
1.5	1966.5	2149.5
2.5	2712.5	4489
3	3097.5	5941.5
3.5	3978	7710.38

Storage Area Volume Curves



Storage Node : Basin-A3 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-A3	Trapezoidal	No	117.00	3.00	10.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	1.83
Peak Lateral Inflow (cfs)	0
Peak Outflow (cfs)	0.02
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	117.01
Max HGL Depth Attained (ft)	3.01
Average HGL Elevation Attained (ft)	116.45
Average HGL Depth Attained (ft)	2.45
Time of Max HGL Occurrence (days hh:mm)	1 00:05
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Forebay-A3

Input Data

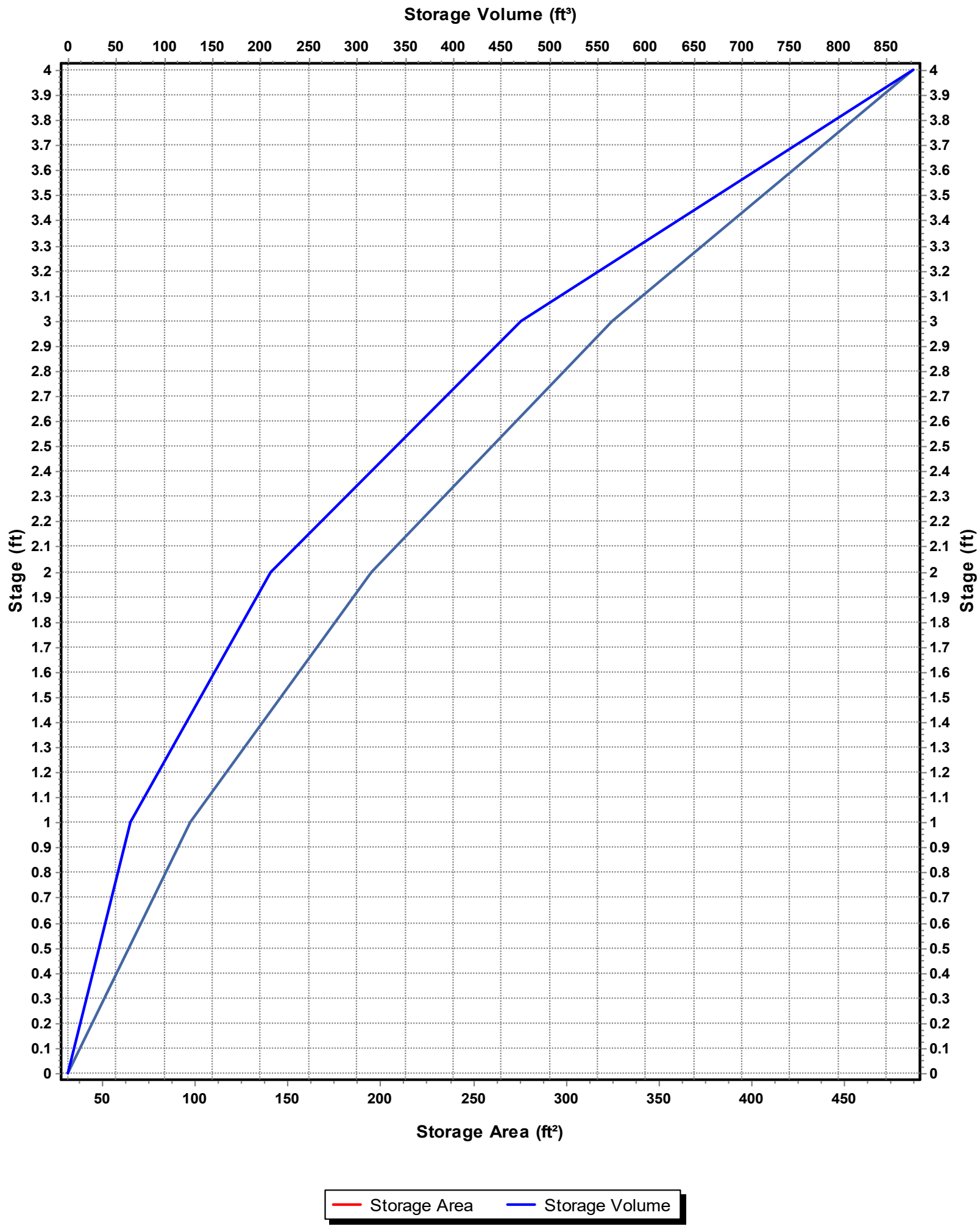
Invert Elevation (ft)	113.50
Max (Rim) Elevation (ft)	117.50
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	113.50
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Storage-15

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	31.5	0
1	97.5	64.5
2	195.5	211
3	325.5	471.5
4	487.5	878

Storage Area Volume Curves



Storage Node : Forebay-A3 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-FA3	Trapezoidal	No	117.00	3.50	10.00	1.00	3.33

Output Summary Results

Peak Inflow (cfs)	1.84
Peak Lateral Inflow (cfs)	1.84
Peak Outflow (cfs)	1.83
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	117.14
Max HGL Depth Attained (ft)	3.64
Average HGL Elevation Attained (ft)	116.53
Average HGL Depth Attained (ft)	3.03
Time of Max HGL Occurrence (days hh:mm)	0 12:10
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Project Description

File Name ..... Bourne_A3.SPF

Project Options

Flow Units ..... CFS
Elevation Type ..... Elevation
Hydrology Method ..... SCS TR-20
Time of Concentration (TOC) Method ..... SCS TR-55
Link Routing Method ..... Hydrodynamic
Enable Overflow Ponding at Nodes ..... YES
Skip Steady State Analysis Time Periods ..... NO

Analysis Options

Start Analysis On ..... oct. 14, 2021 0:00:00
End Analysis On ..... oct. 17, 2021 0:00:00
Start Reporting On ..... oct. 14, 2021 0:00:00
Antecedent Dry Days ..... 0 days
Runoff (Dry Weather) Time Step ..... 0 01:00:00 days hh:mm:ss
Runoff (Wet Weather) Time Step ..... 0 00:05:00 days hh:mm:ss
Reporting Time Step ..... 0 00:05:00 days hh:mm:ss
Routing Time Step ..... 30 seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	2
Nodes	4
Junctions	0
Outfalls	2
Flow Diversions	0
Inlets	0
Storage Nodes	2
Links	2
Channels	0
Pipes	0
Pumps	0
Orifices	0
Weirs	2
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	2070 50 years	Intensity	inches	Massachusetts	None	50.00	8.80	SCS Type III 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Sub-A3	0.39	484.00	76.00	8.80	5.89	2.30	2.32	0 00:06:00
2	Sub-E03	0.36	484.00	43.00	8.80	1.95	0.70	0.37	0 00:36:44

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Out-A3	Outfall	57.50					0.11	57.50					
2	Out-E03	Outfall	0.00					0.37	0.00					
3	Basin-A3	Storage Node	114.00	117.50	114.00		0.00	2.27	117.02				0.00	0.00
4	Forebay-A3	Storage Node	113.50	117.50	113.50		0.00	2.28	117.17				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(ft)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
1	Weir-A3	Weir	Basin-A3	Out-A3		114.00	57.50				0.11							
2	Weir-FA3	Weir	Forebay-A3	Basin-A3		113.50	114.00				2.27							

Subbasin Hydrology

Subbasin : Sub-A3

Input Data

Area (ac)	0.39
Peak Rate Factor	484
Weighted Curve Number	76
Rain Gage ID	Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	0.39	A	76
Composite Area & Weighted CN	0.39		76

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft^2)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	126.51	0	0
Slope (%) :	1.19	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.94	0	0
Computed Flow Time (min) :	2.23	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	94.52	0	0
Channel Slope (%) :	0.5	0	0
Cross Section Area (ft^2) :	3	0	0
Wetted Perimeter (ft) :	6.32	0	0
Velocity (ft/sec) :	2.14	0	0
Computed Flow Time (min) :	0.74	0	0

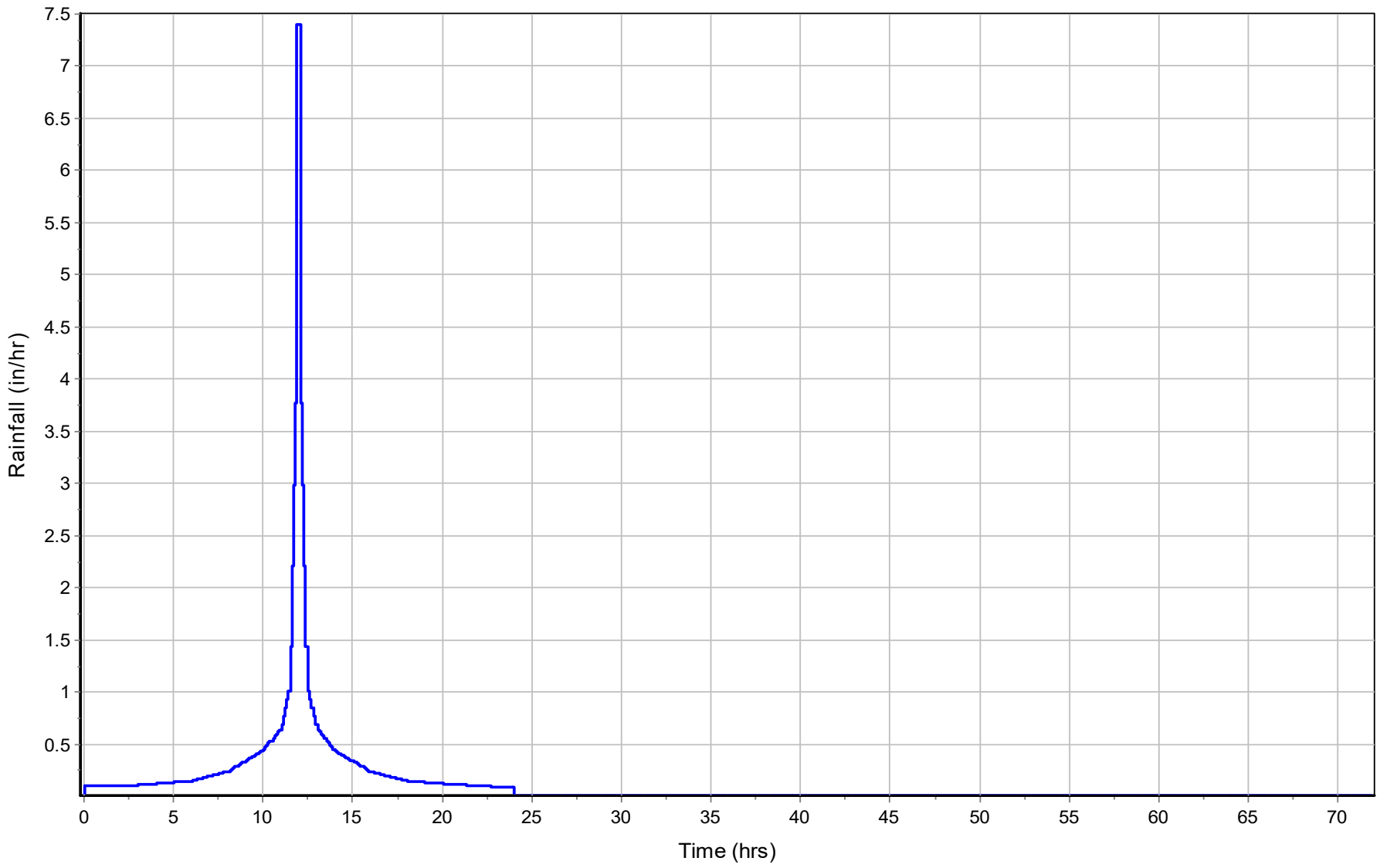
Total TOC (min) 2.97

Subbasin Runoff Results

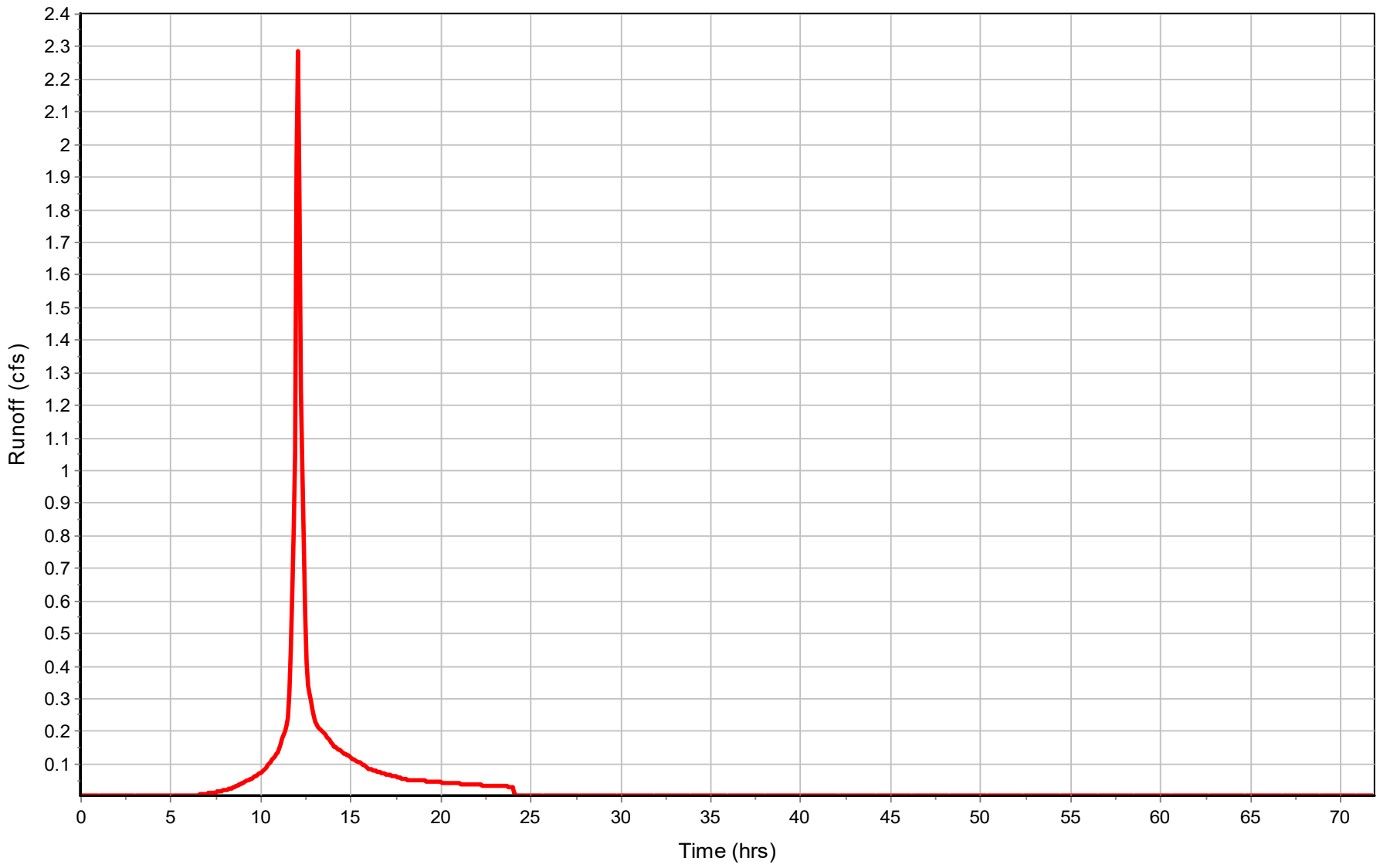
Total Rainfall (in)	8.8
Total Runoff (in)	5.89
Peak Runoff (cfs)	2.32
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:02:58

Subbasin : Sub-A3

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E03

Input Data

Area (ac) 0.36
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.36	A	43
Composite Area & Weighted CN	0.36		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	227.64	0	0
Slope (%) :	10	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.1	0	0
Computed Flow Time (min) :	36.74	0	0

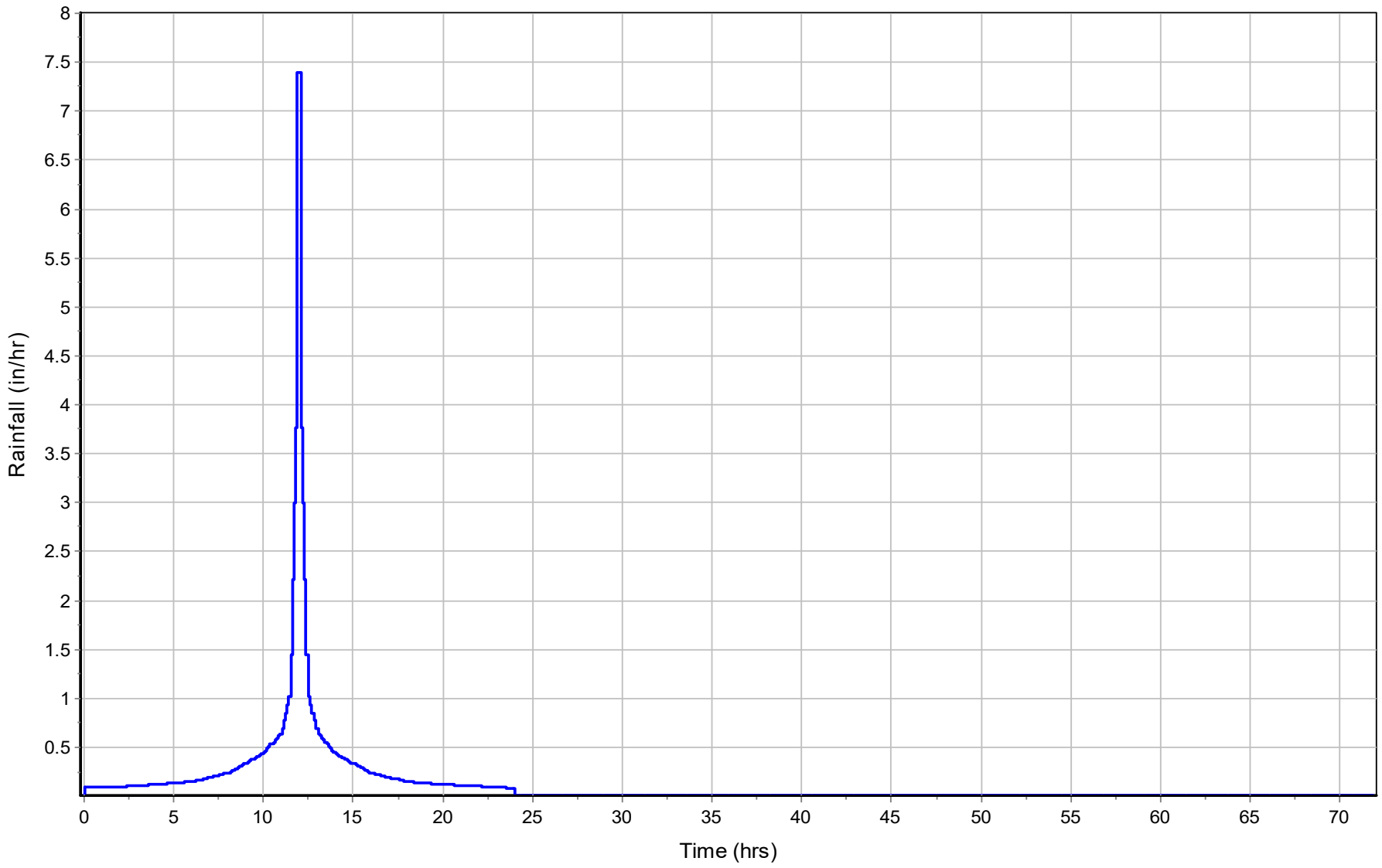
Total TOC (min) 36.74

Subbasin Runoff Results

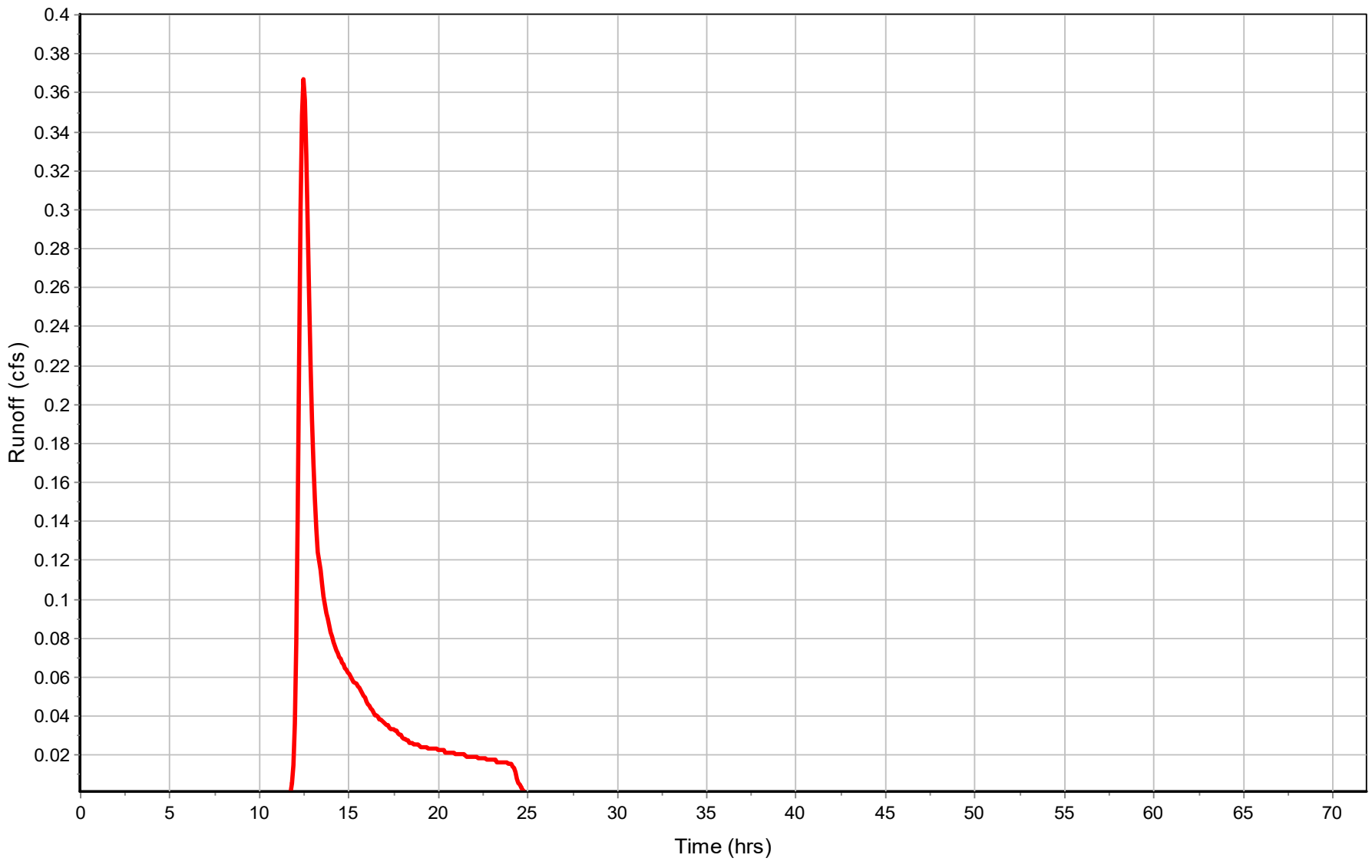
Total Rainfall (in) 8.8
Total Runoff (in) 1.95
Peak Runoff (cfs) 0.37
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:36:44

Subbasin : Sub-E03

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A3

Input Data

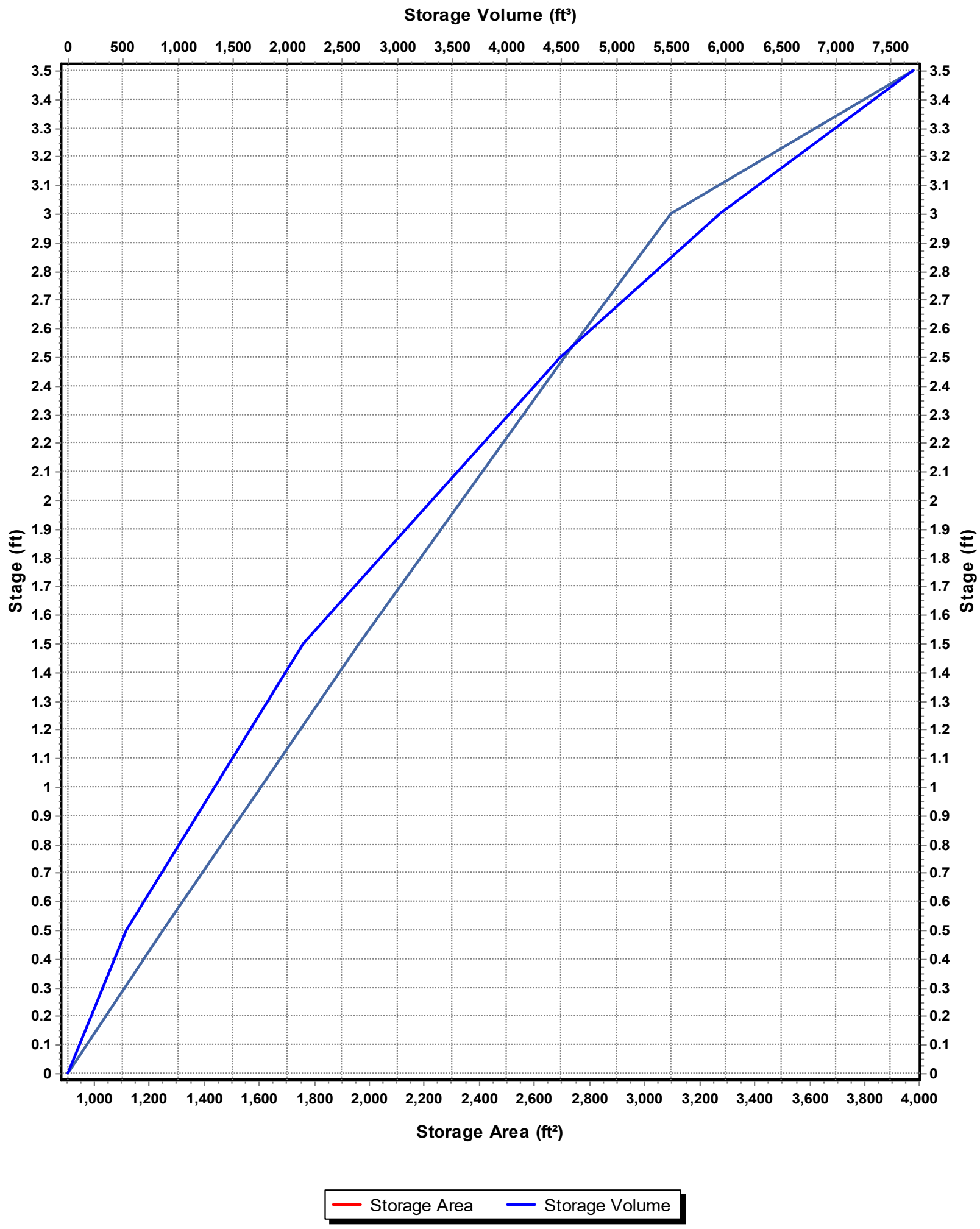
Invert Elevation (ft)	114.00
Max (Rim) Elevation (ft)	117.50
Max (Rim) Offset (ft)	3.50
Initial Water Elevation (ft)	114.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Storage-14

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	907.5	0
0.5	1252.5	540
1.5	1966.5	2149.5
2.5	2712.5	4489
3	3097.5	5941.5
3.5	3978	7710.38

Storage Area Volume Curves



Storage Node : Basin-A3 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-A3	Trapezoidal	No	117.00	3.00	10.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	2.27
Peak Lateral Inflow (cfs)	0
Peak Outflow (cfs)	0.11
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	117.02
Max HGL Depth Attained (ft)	3.02
Average HGL Elevation Attained (ft)	116.49
Average HGL Depth Attained (ft)	2.49
Time of Max HGL Occurrence (days hh:mm)	0 15:28
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Forebay-A3

Input Data

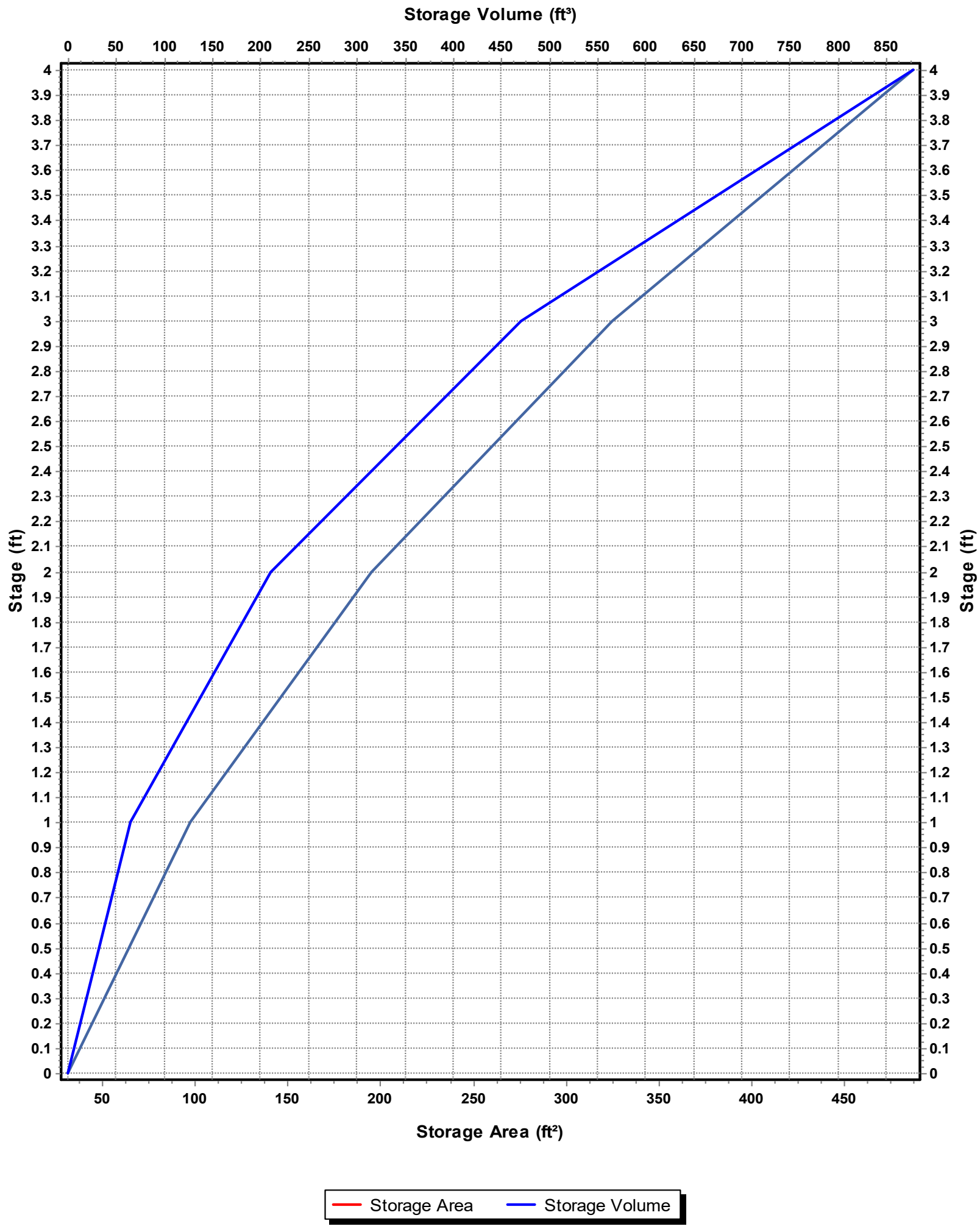
Invert Elevation (ft)	113.50
Max (Rim) Elevation (ft)	117.50
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	113.50
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Storage-15

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	31.5	0
1	97.5	64.5
2	195.5	211
3	325.5	471.5
4	487.5	878

Storage Area Volume Curves



Storage Node : Forebay-A3 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-FA3	Trapezoidal	No	117.00	3.50	10.00	1.00	3.33

Output Summary Results

Peak Inflow (cfs)	2.28
Peak Lateral Inflow (cfs)	2.28
Peak Outflow (cfs)	2.27
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	117.17
Max HGL Depth Attained (ft)	3.67
Average HGL Elevation Attained (ft)	116.56
Average HGL Depth Attained (ft)	3.06
Time of Max HGL Occurrence (days hh:mm)	0 12:10
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

SSA Analysis – Drainage Area A4 – Existing and Proposed

Project Description

File Name	Bourne_A4.SPF

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	SCS TR-20
Time of Concentration (TOC) Method	SCS TR-55
Link Routing Method	Hydrodynamic
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	NO

Analysis Options

Start Analysis On	00:00:00	0:00:00
End Analysis On	00:00:00	0:00:00
Start Reporting On	00:00:00	0:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	2
Nodes	4
Junctions	0
Outfalls	2
Flow Diversions	0
Inlets	0
Storage Nodes	2
Links	2
Channels	0
Pipes	0
Pumps	0
Orifices	0
Weirs	2
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	2 years	Intensity	inches	Massachusetts	None	2.00	3.43	SCS Type III 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Sub-A4	0.23	484.00	76.00	3.43	1.31	0.30	0.31	0 00:06:00
2	Sub-E04	0.36	484.00	43.00	3.43	0.04	0.02	0.00	0 00:31:33

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Out-A4	Outfall	113.00					0.00	113.00					
2	Out-E04	Outfall	0.00					0.00	0.00					
3	Basin-A4	Storage Node	111.00	115.00	111.00		0.00	0.30	112.46				0.00	0.00
4	Forebay-A4	Storage Node	112.00	115.00	112.00		0.00	0.30	114.04				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(ft)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
1	Weir-A4	Weir	Basin-A4	Out-A4		111.00	113.00				0.00							
2	Weir-FA4	Weir	Forebay-A4	Basin-A4		112.00	111.00				0.30							

Subbasin Hydrology

Subbasin : Sub-A4

Input Data

Area (ac)	0.23
Peak Rate Factor	484
Weighted Curve Number	76
Rain Gage ID	Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	0.23	A	76
Composite Area & Weighted CN	0.23		76

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft^2)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	122.43	0	0
Slope (%) :	1.28	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.97	0	0
Computed Flow Time (min) :	2.11	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	60.91	0	0
Channel Slope (%) :	1.5	0	0
Cross Section Area (ft^2) :	3	0	0
Wetted Perimeter (ft) :	6.32	0	0
Velocity (ft/sec) :	3.7	0	0
Computed Flow Time (min) :	0.27	0	0

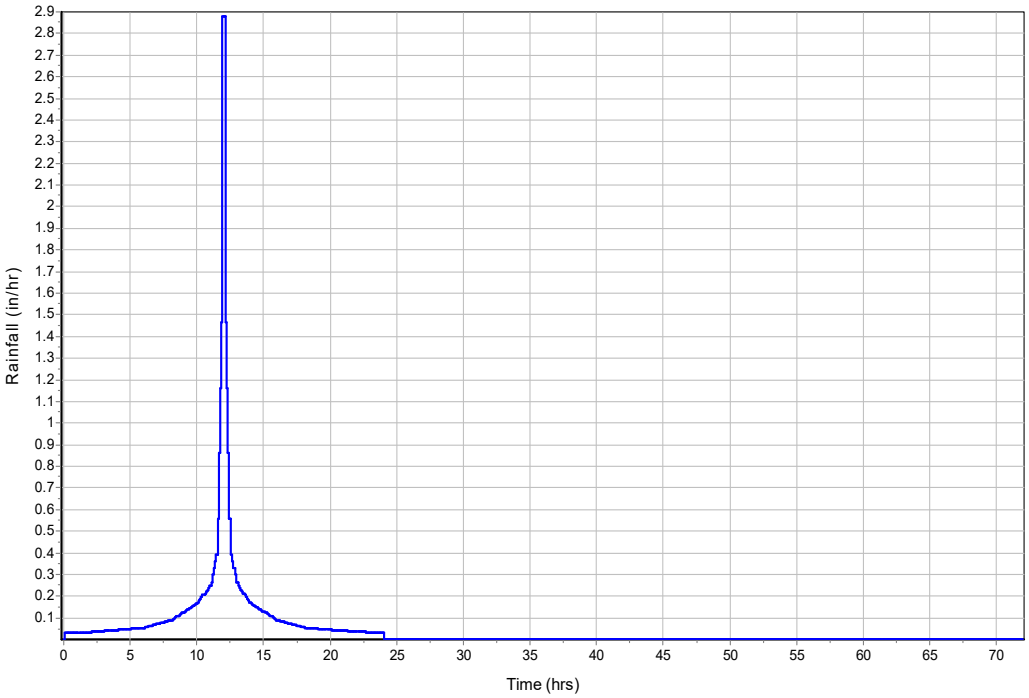
Total TOC (min) 2.39

Subbasin Runoff Results

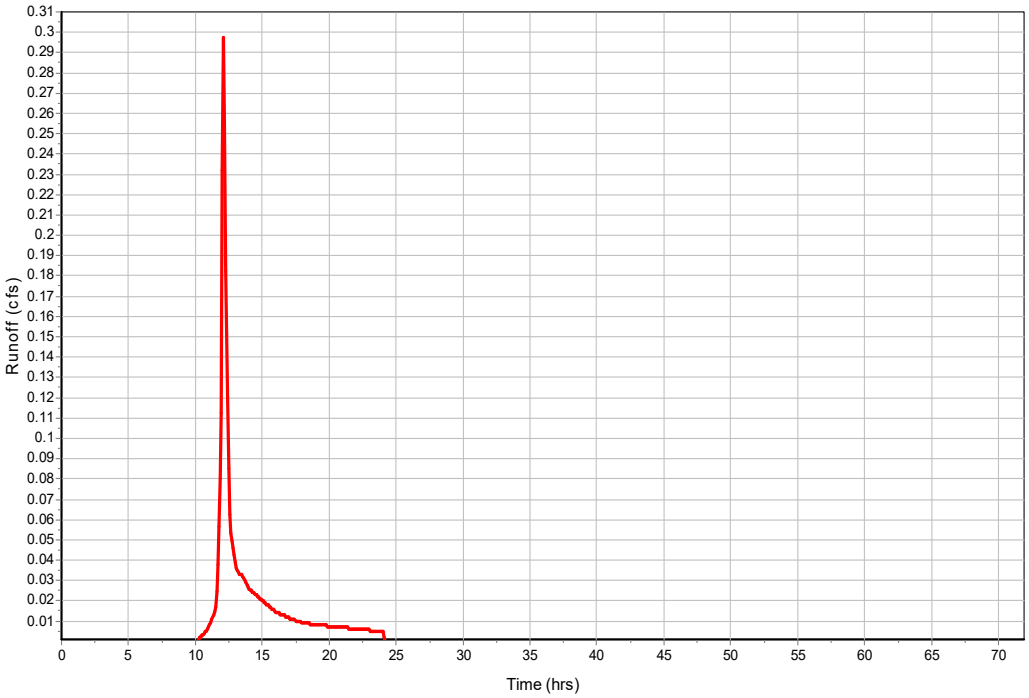
Total Rainfall (in)	3.43
Total Runoff (in)	1.31
Peak Runoff (cfs)	0.31
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:02:23

Subbasin : Sub-A4

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E04

Input Data

Area (ac)	0.36
Peak Rate Factor	484
Weighted Curve Number	43
Rain Gage ID	Rain Gage-01

Composite Curve Number

32	Area	Soil	Curve
Soil/Surface Description	(acres)	Group	Number
Woods & grass combination, Fair	0.36	A	43
Composite Area & Weighted CN	0.36		43

Time of Concentration

	Subarea	Subarea	Subarea
Sheet Flow Computations	A	B	C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	157.47	0	0
Slope (%) :	7	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.08	0	0
Computed Flow Time (min) :	31.55	0	0

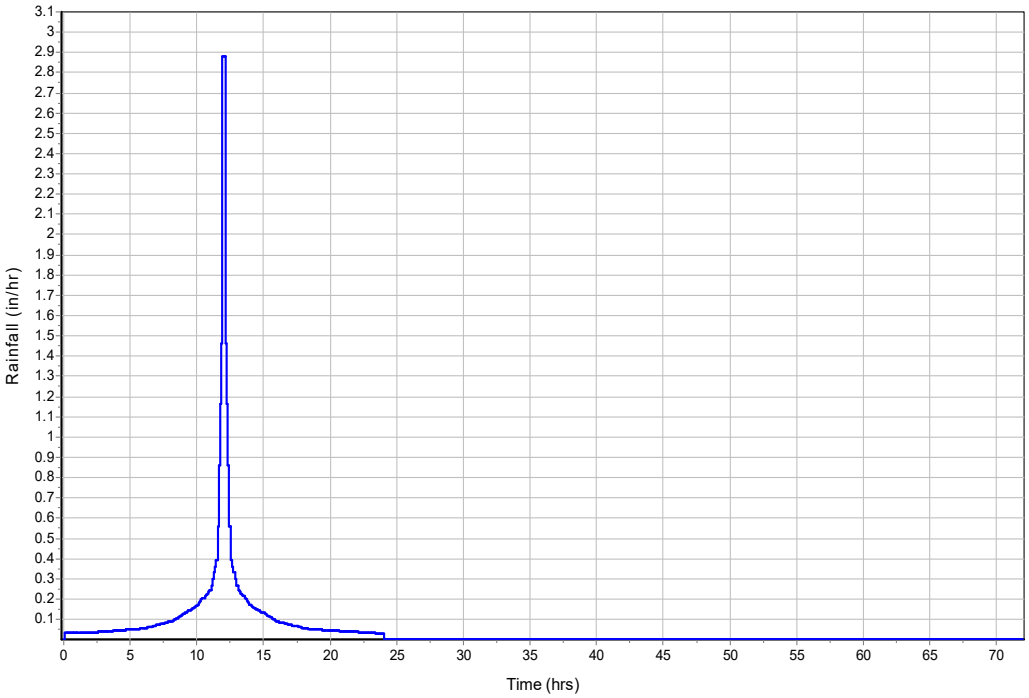
Total TOC (min) 31.55

Subbasin Runoff Results

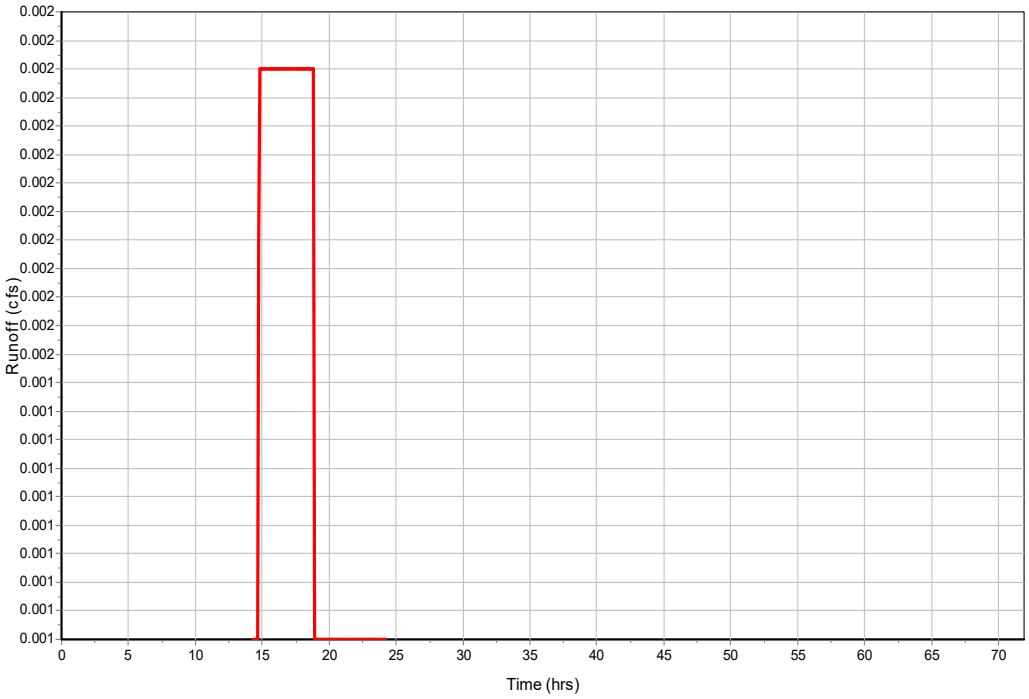
Total Rainfall (in)	3.43
Total Runoff (in)	0.04
Peak Runoff (cfs)	0
Weighted Curve Number	43
Time of Concentration (days hh:mm:ss)	0 00:31:33

Subbasin : Sub-E04

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A4

Input Data

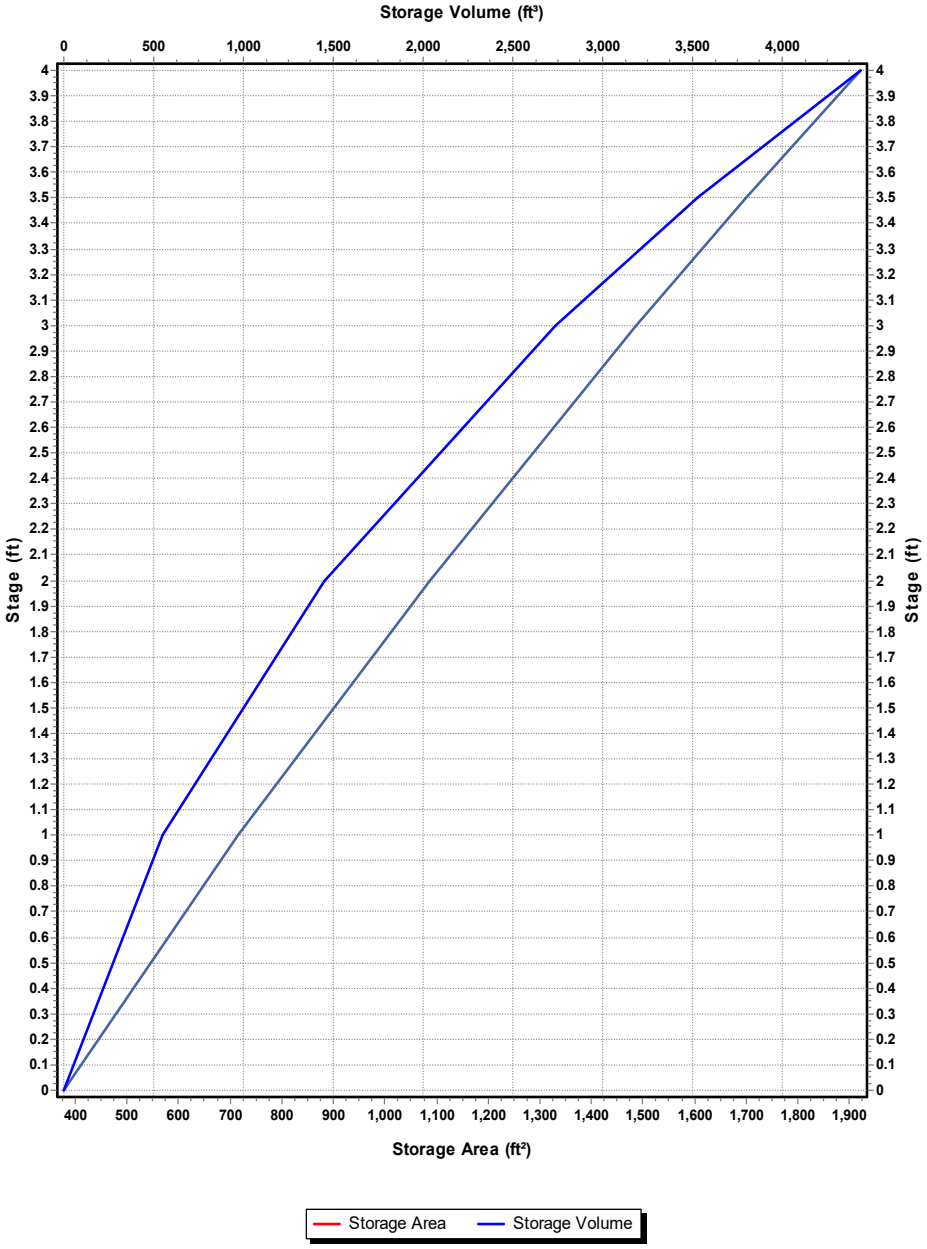
Invert Elevation (ft)	111.00
Max (Rim) Elevation (ft)	115.00
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	111.00
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Storage-17

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	377.51	0
1	715.52	546.52
2	1085.52	1447.04
3	1487.53	2733.57
3.5	1700.54	3530.59
4	1921.54	4436.11

Storage Area Volume Curves



Storage Node : Basin-A4 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-A4	Trapezoidal	No	114.50	3.50	10.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	0.3
Peak Lateral Inflow (cfs)	0
Peak Outflow (cfs)	0
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	112.46
Max HGL Depth Attained (ft)	1.46
Average HGL Elevation Attained (ft)	112.17
Average HGL Depth Attained (ft)	1.17
Time of Max HGL Occurrence (days hh:mm)	1 00:28
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Forebay-A4

Input Data

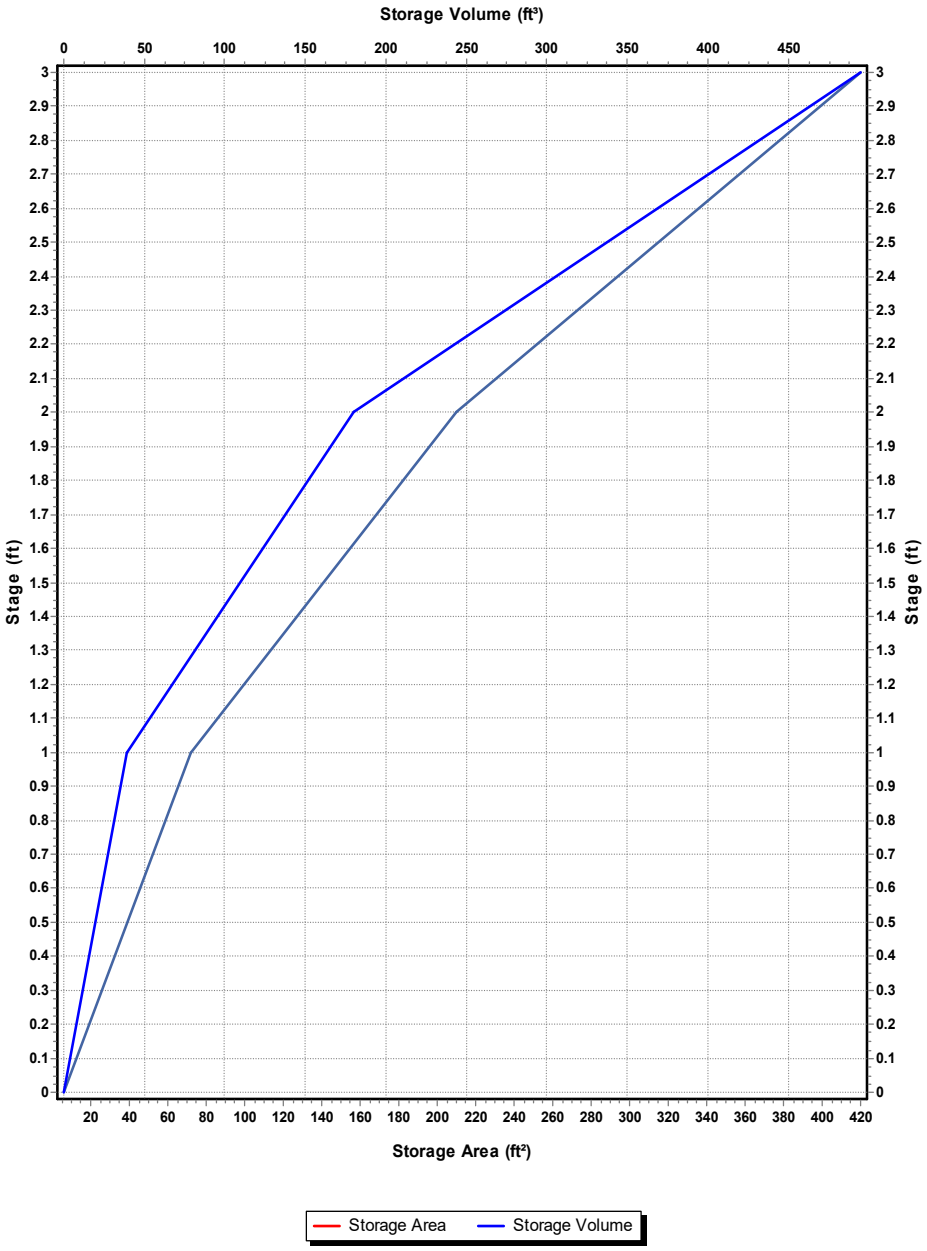
Invert Elevation (ft)	112.00
Max (Rim) Elevation (ft)	115.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	112.00
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Storage-16

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	6	0
1	72	39
2	210	180
3	420	495

Storage Area Volume Curves



Storage Node : Forebay-A4 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-FA4	Trapezoidal	No	114.00	2.00	10.00	1.00	3.33

Output Summary Results

Peak Inflow (cfs)	0.3
Peak Lateral Inflow (cfs)	0.3
Peak Outflow (cfs)	0.3
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	114.04
Max HGL Depth Attained (ft)	2.04
Average HGL Elevation Attained (ft)	113.68
Average HGL Depth Attained (ft)	1.68
Time of Max HGL Occurrence (days hh:mm)	0 12:07
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Project Description

File Name	Bourne_A4.SPF

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	SCS TR-20
Time of Concentration (TOC) Method	SCS TR-55
Link Routing Method	Hydrodynamic
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	NO

Analysis Options

Start Analysis On	00:00:00	0:00:00
End Analysis On	00:00:00	0:00:00
Start Reporting On	00:00:00	0:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	2
Nodes	4
Junctions	0
Outfalls	2
Flow Diversions	0
Inlets	0
Storage Nodes	2
Links	2
Channels	0
Pipes	0
Pumps	0
Orifices	0
Weirs	2
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	10 years	Intensity	inches	Massachusetts	None	10.00	5.01	SCS Type III 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Sub-A4	0.23	484.00	76.00	5.01	2.54	0.58	0.61	0 00:06:00
2	Sub-E04	0.36	484.00	43.00	5.01	0.36	0.13	0.04	0 00:31:33

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Out-A4	Outfall	113.00					0.00	113.00					
2	Out-E04	Outfall	0.00					0.03	0.00					
3	Basin-A4	Storage Node	111.00	115.00	111.00		0.00	0.59	113.43				0.00	0.00
4	Forebay-A4	Storage Node	112.00	115.00	112.00		0.00	0.59	114.07				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(ft)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
1	Weir-A4	Weir	Basin-A4	Out-A4		111.00	113.00				0.00							
2	Weir-FA4	Weir	Forebay-A4	Basin-A4		112.00	111.00				0.59							

Subbasin Hydrology

Subbasin : Sub-A4

Input Data

Area (ac)	0.23
Peak Rate Factor	484
Weighted Curve Number	76
Rain Gage ID	Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	0.23	A	76
Composite Area & Weighted CN	0.23		76

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft^2)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	122.43	0	0
Slope (%) :	1.28	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.97	0	0
Computed Flow Time (min) :	2.11	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	60.91	0	0
Channel Slope (%) :	1.5	0	0
Cross Section Area (ft^2) :	3	0	0
Wetted Perimeter (ft) :	6.32	0	0
Velocity (ft/sec) :	3.7	0	0
Computed Flow Time (min) :	0.27	0	0

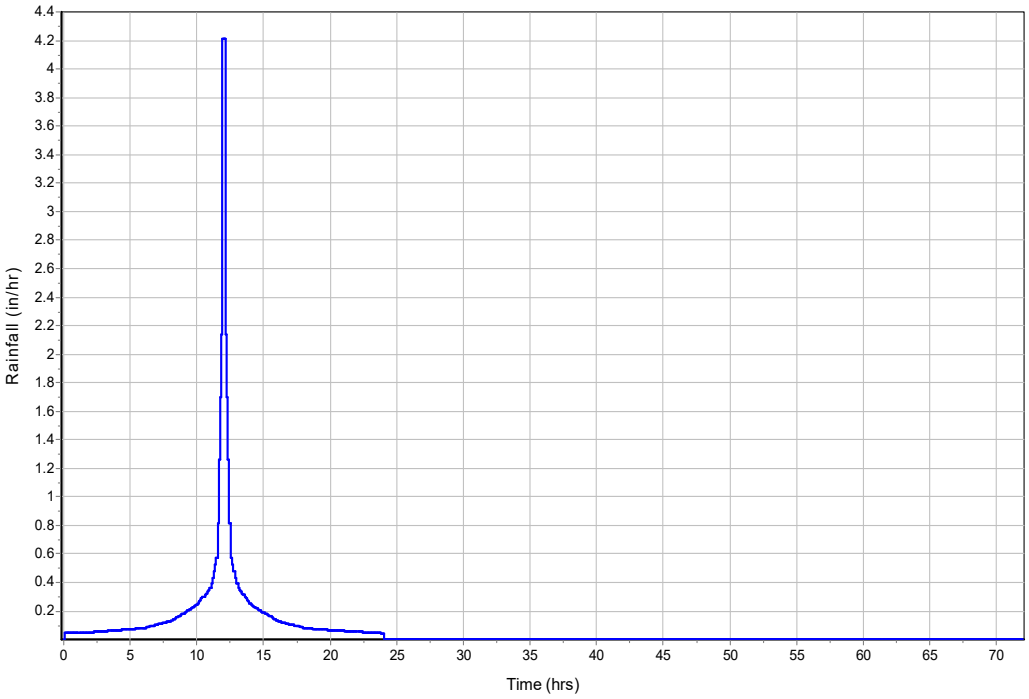
Total TOC (min) 2.39

Subbasin Runoff Results

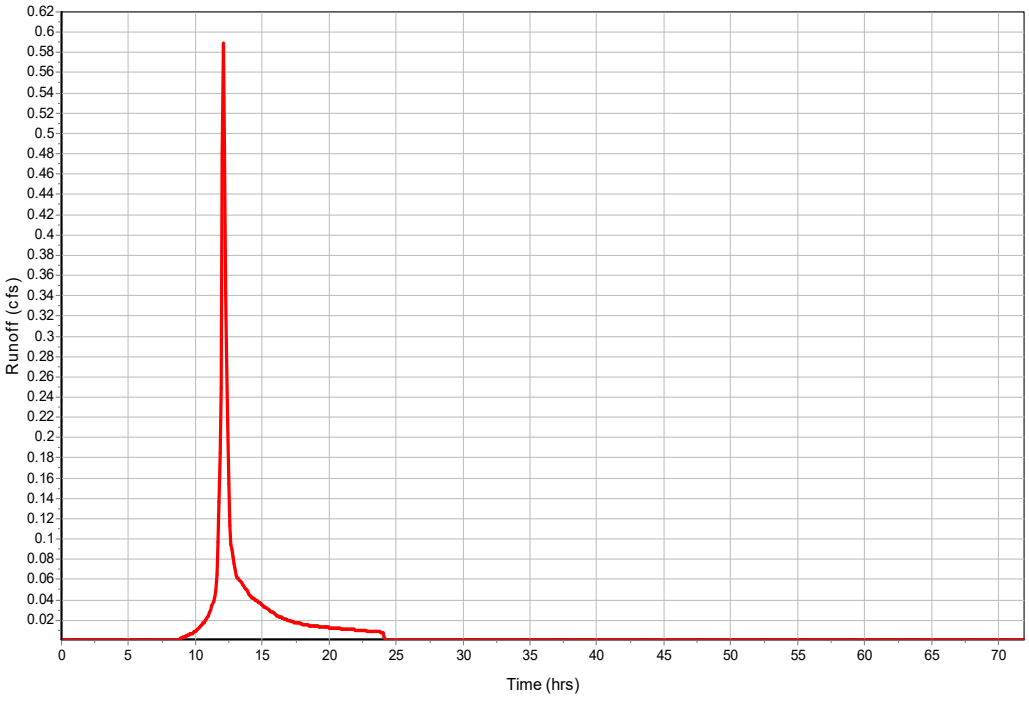
Total Rainfall (in)	5.01
Total Runoff (in)	2.54
Peak Runoff (cfs)	0.61
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:02:23

Subbasin : Sub-A4

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E04

Input Data

Area (ac)	0.36
Peak Rate Factor	484
Weighted Curve Number	43
Rain Gage ID	Rain Gage-01

Composite Curve Number

32	Area	Soil	Curve
Soil/Surface Description	(acres)	Group	Number
Woods & grass combination, Fair	0.36	A	43
Composite Area & Weighted CN	0.36		43

Time of Concentration

	Subarea	Subarea	Subarea
Sheet Flow Computations	A	B	C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	157.47	0	0
Slope (%) :	7	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.08	0	0
Computed Flow Time (min) :	31.55	0	0

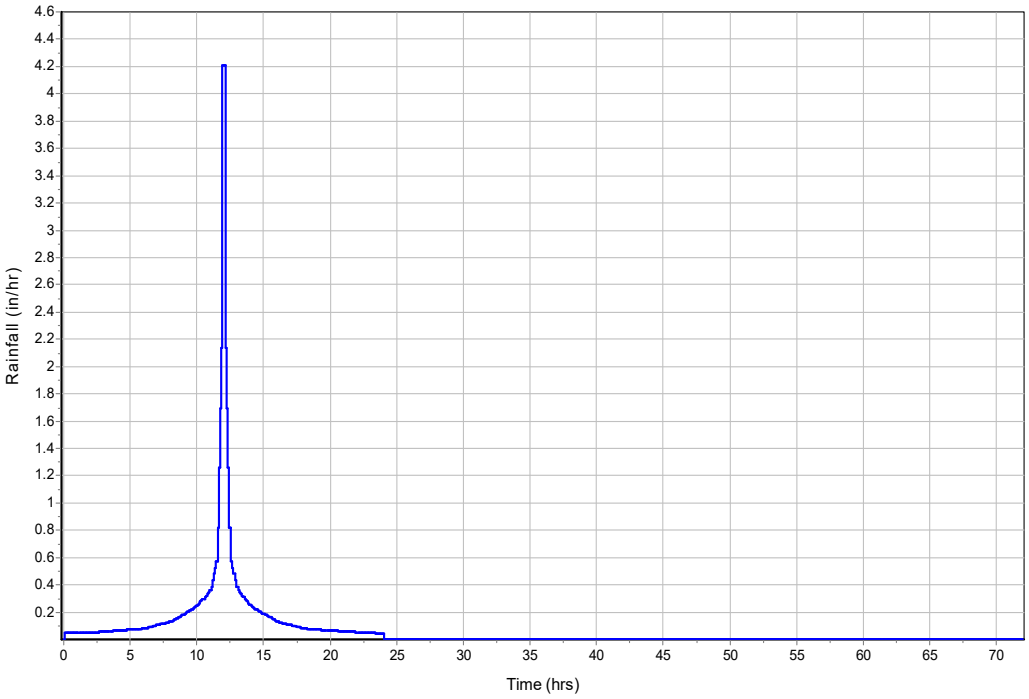
Total TOC (min) 31.55

Subbasin Runoff Results

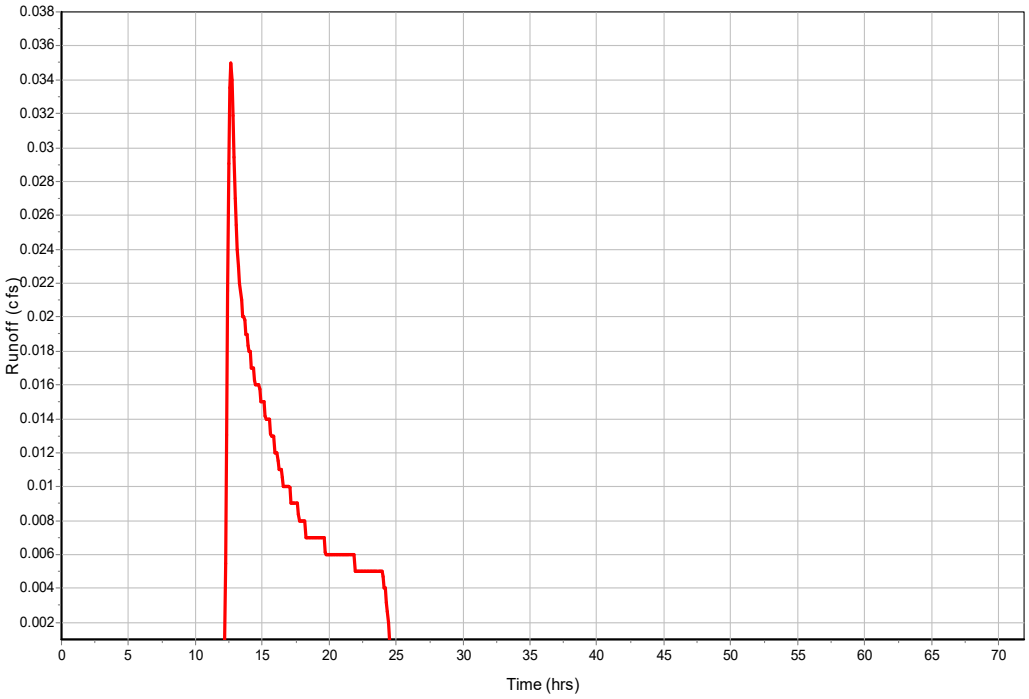
Total Rainfall (in)	5.01
Total Runoff (in)	0.36
Peak Runoff (cfs)	0.04
Weighted Curve Number	43
Time of Concentration (days hh:mm:ss)	0 00:31:33

Subbasin : Sub-E04

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A4

Input Data

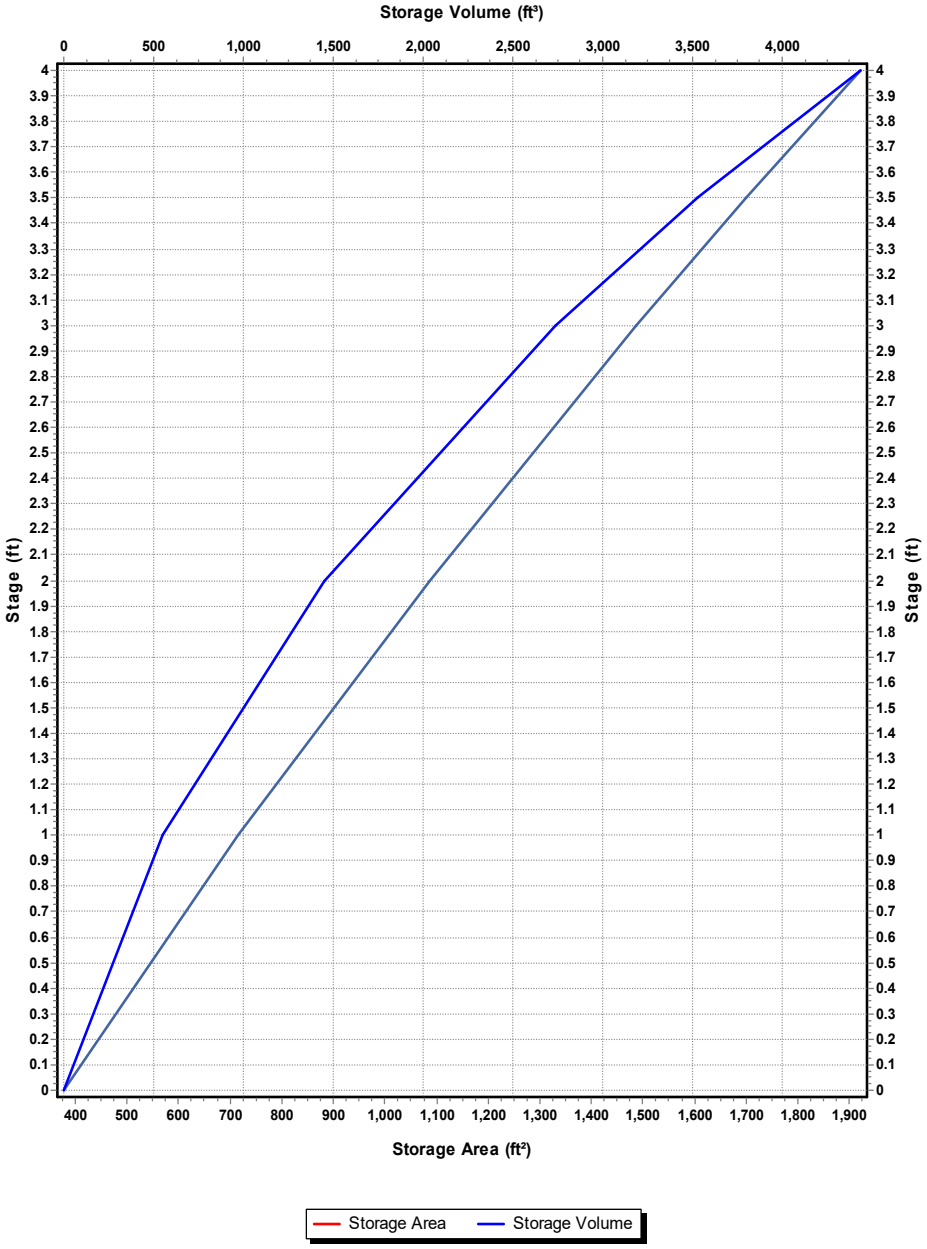
Invert Elevation (ft)	111.00
Max (Rim) Elevation (ft)	115.00
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	111.00
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Storage-17

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	377.51	0
1	715.52	546.52
2	1085.52	1447.04
3	1487.53	2733.57
3.5	1700.54	3530.59
4	1921.54	4436.11

Storage Area Volume Curves



Storage Node : Basin-A4 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-A4	Trapezoidal	No	114.50	3.50	10.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	0.59
Peak Lateral Inflow (cfs)	0
Peak Outflow (cfs)	0
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	113.43
Max HGL Depth Attained (ft)	2.43
Average HGL Elevation Attained (ft)	112.97
Average HGL Depth Attained (ft)	1.97
Time of Max HGL Occurrence (days hh:mm)	1 00:29
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Forebay-A4

Input Data

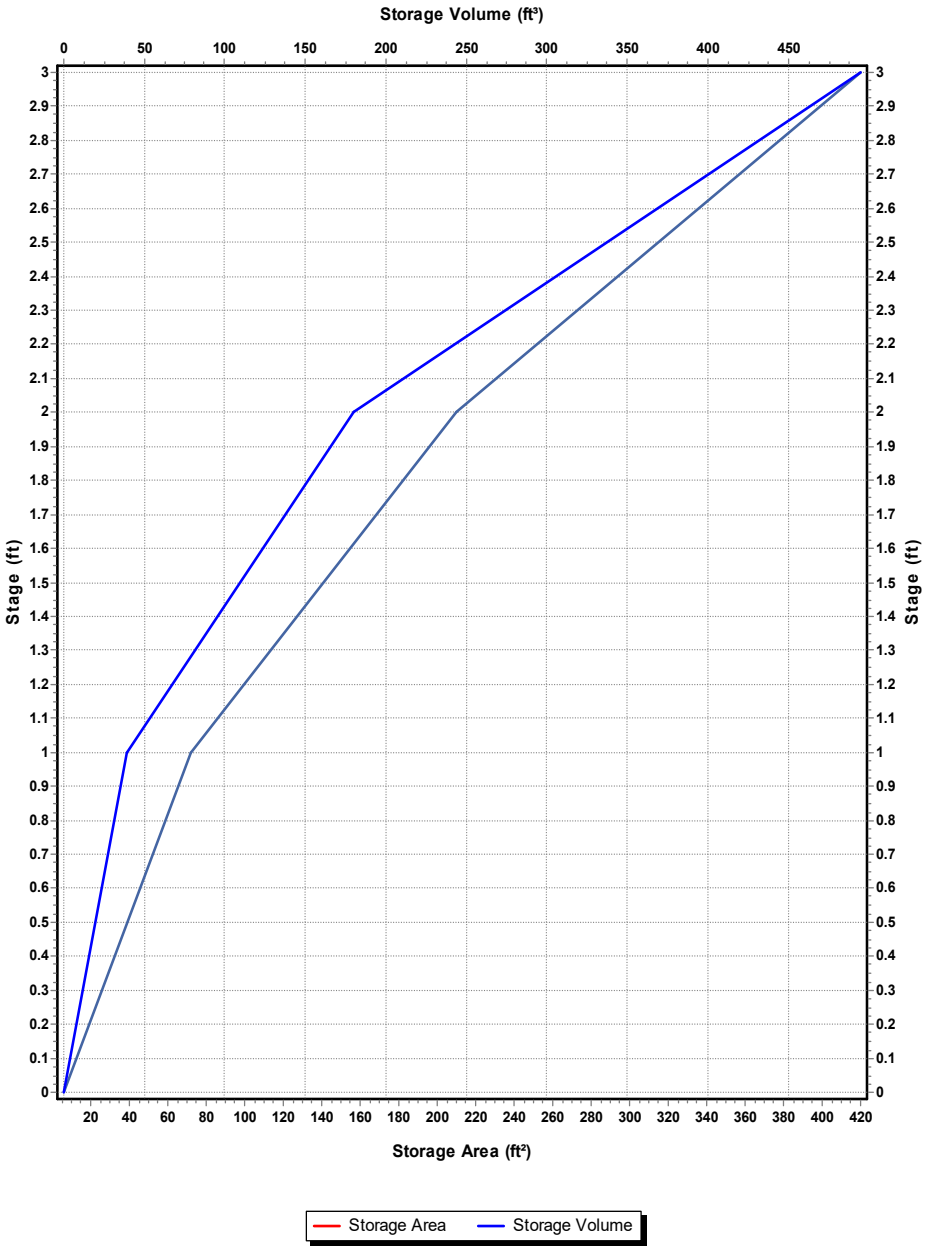
Invert Elevation (ft)	112.00
Max (Rim) Elevation (ft)	115.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	112.00
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Storage-16

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	6	0
1	72	39
2	210	180
3	420	495

Storage Area Volume Curves



Storage Node : Forebay-A4 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-FA4	Trapezoidal	No	114.00	2.00	10.00	1.00	3.33

Output Summary Results

Peak Inflow (cfs)	0.59
Peak Lateral Inflow (cfs)	0.59
Peak Outflow (cfs)	0.59
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	114.07
Max HGL Depth Attained (ft)	2.07
Average HGL Elevation Attained (ft)	113.71
Average HGL Depth Attained (ft)	1.71
Time of Max HGL Occurrence (days hh:mm)	0 12:10
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Project Description

File Name	Bourne_A4.SPF

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	SCS TR-20
Time of Concentration (TOC) Method	SCS TR-55
Link Routing Method	Hydrodynamic
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	NO

Analysis Options

Start Analysis On	00:00:00	0:00:00
End Analysis On	00:00:00	0:00:00
Start Reporting On	00:00:00	0:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	2
Nodes	4
Junctions	0
Outfalls	2
Flow Diversions	0
Inlets	0
Storage Nodes	2
Links	2
Channels	0
Pipes	0
Pumps	0
Orifices	0
Weirs	2
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	25 years	Intensity	inches	Massachusetts	None	25.00	5.99	SCS Type III 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Sub-A4	0.23	484.00	76.00	5.99	3.37	0.78	0.80	0 00:06:00
2	Sub-E04	0.36	484.00	43.00	5.99	0.67	0.24	0.10	0 00:31:33

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Out-A4	Outfall	113.00					0.00	113.00					
2	Out-E04	Outfall	0.00					0.10	0.00					
3	Basin-A4	Storage Node	111.00	115.00	111.00		0.00	0.78	113.93				0.00	0.00
4	Forebay-A4	Storage Node	112.00	115.00	112.00		0.00	0.78	114.08				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(ft)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
1	Weir-A4	Weir	Basin-A4	Out-A4		111.00	113.00				0.00							
2	Weir-FA4	Weir	Forebay-A4	Basin-A4		112.00	111.00				0.78							

Subbasin Hydrology

Subbasin : Sub-A4

Input Data

Area (ac)	0.23
Peak Rate Factor	484
Weighted Curve Number	76
Rain Gage ID	Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	0.23	A	76
Composite Area & Weighted CN	0.23		76

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft^2)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	122.43	0	0
Slope (%) :	1.28	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.97	0	0
Computed Flow Time (min) :	2.11	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	60.91	0	0
Channel Slope (%) :	1.5	0	0
Cross Section Area (ft^2) :	3	0	0
Wetted Perimeter (ft) :	6.32	0	0
Velocity (ft/sec) :	3.7	0	0
Computed Flow Time (min) :	0.27	0	0

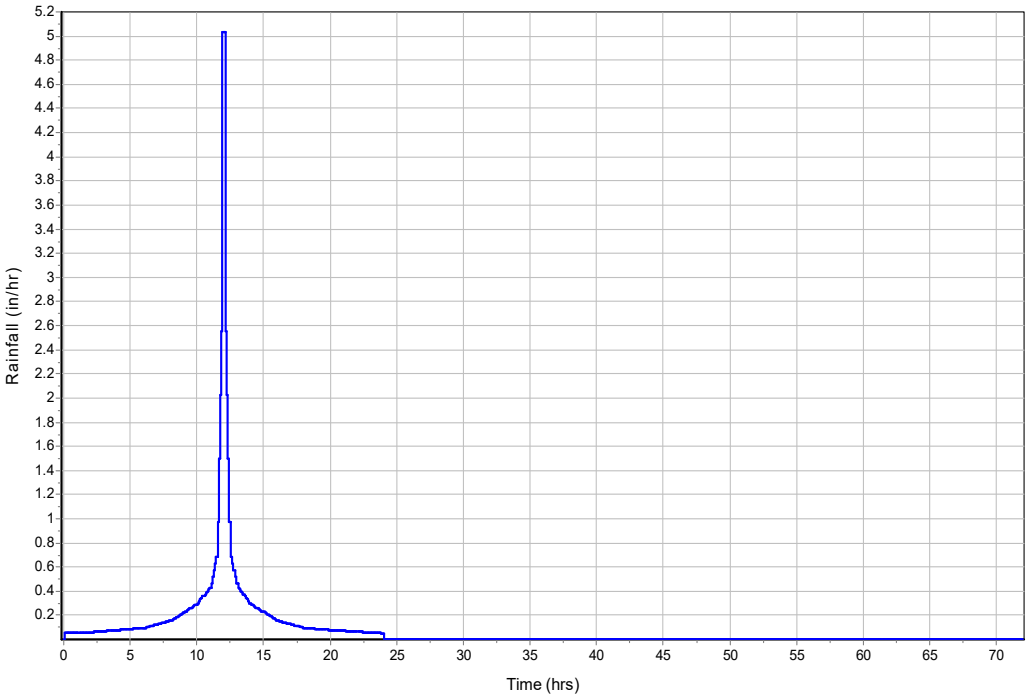
Total TOC (min) 2.39

Subbasin Runoff Results

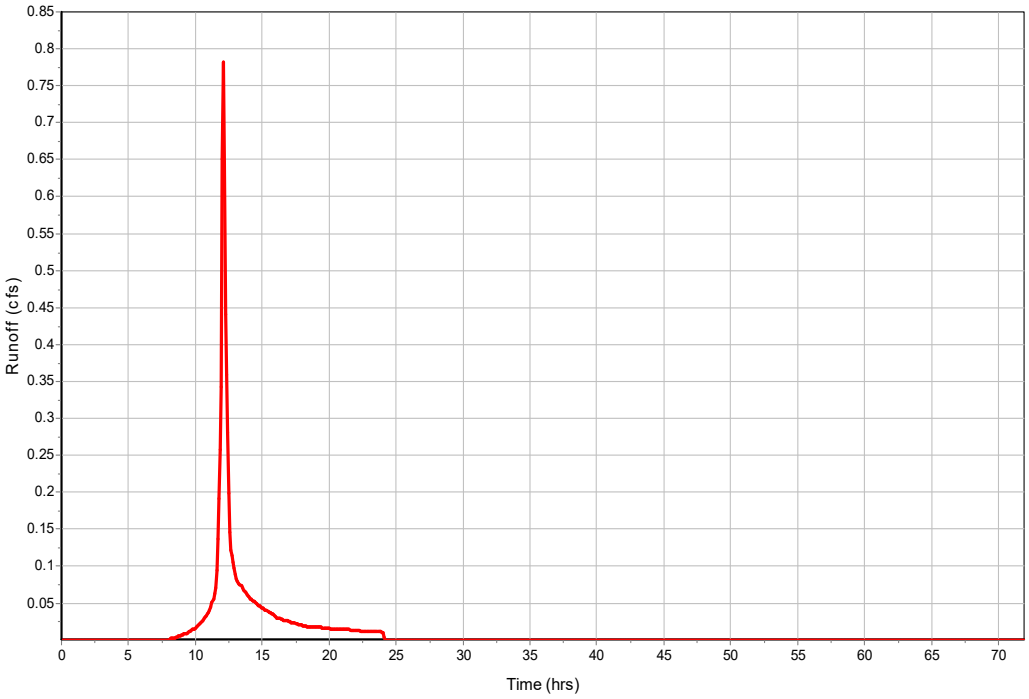
Total Rainfall (in)	5.99
Total Runoff (in)	3.37
Peak Runoff (cfs)	0.8
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:02:23

Subbasin : Sub-A4

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E04

Input Data

Area (ac)	0.36
Peak Rate Factor	484
Weighted Curve Number	43
Rain Gage ID	Rain Gage-01

Composite Curve Number

32	Area	Soil	Curve
Soil/Surface Description	(acres)	Group	Number
Woods & grass combination, Fair	0.36	A	43
Composite Area & Weighted CN	0.36		43

Time of Concentration

	Subarea	Subarea	Subarea
Sheet Flow Computations	A	B	C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	157.47	0	0
Slope (%) :	7	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.08	0	0
Computed Flow Time (min) :	31.55	0	0

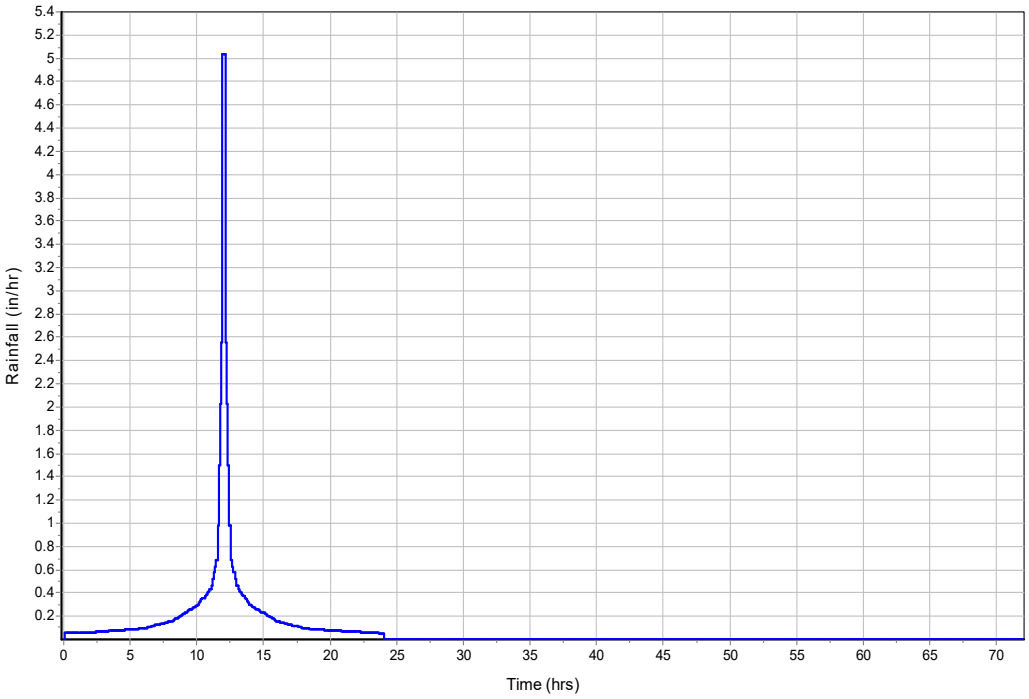
Total TOC (min) 31.55

Subbasin Runoff Results

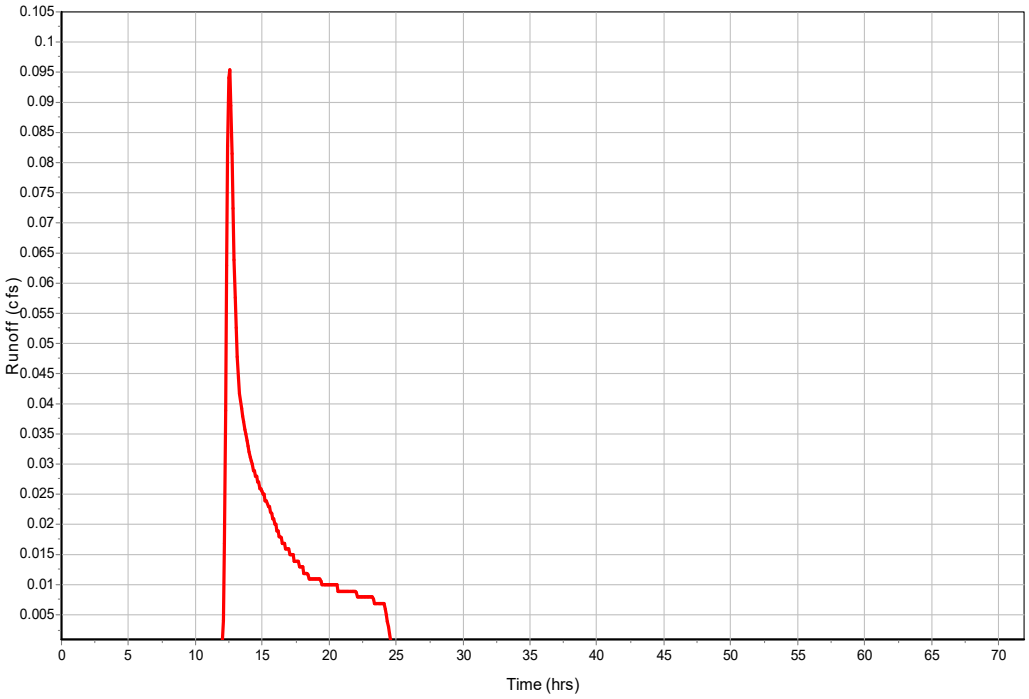
Total Rainfall (in)	5.99
Total Runoff (in)	0.67
Peak Runoff (cfs)	0.1
Weighted Curve Number	43
Time of Concentration (days hh:mm:ss)	0 00:31:33

Subbasin : Sub-E04

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A4

Input Data

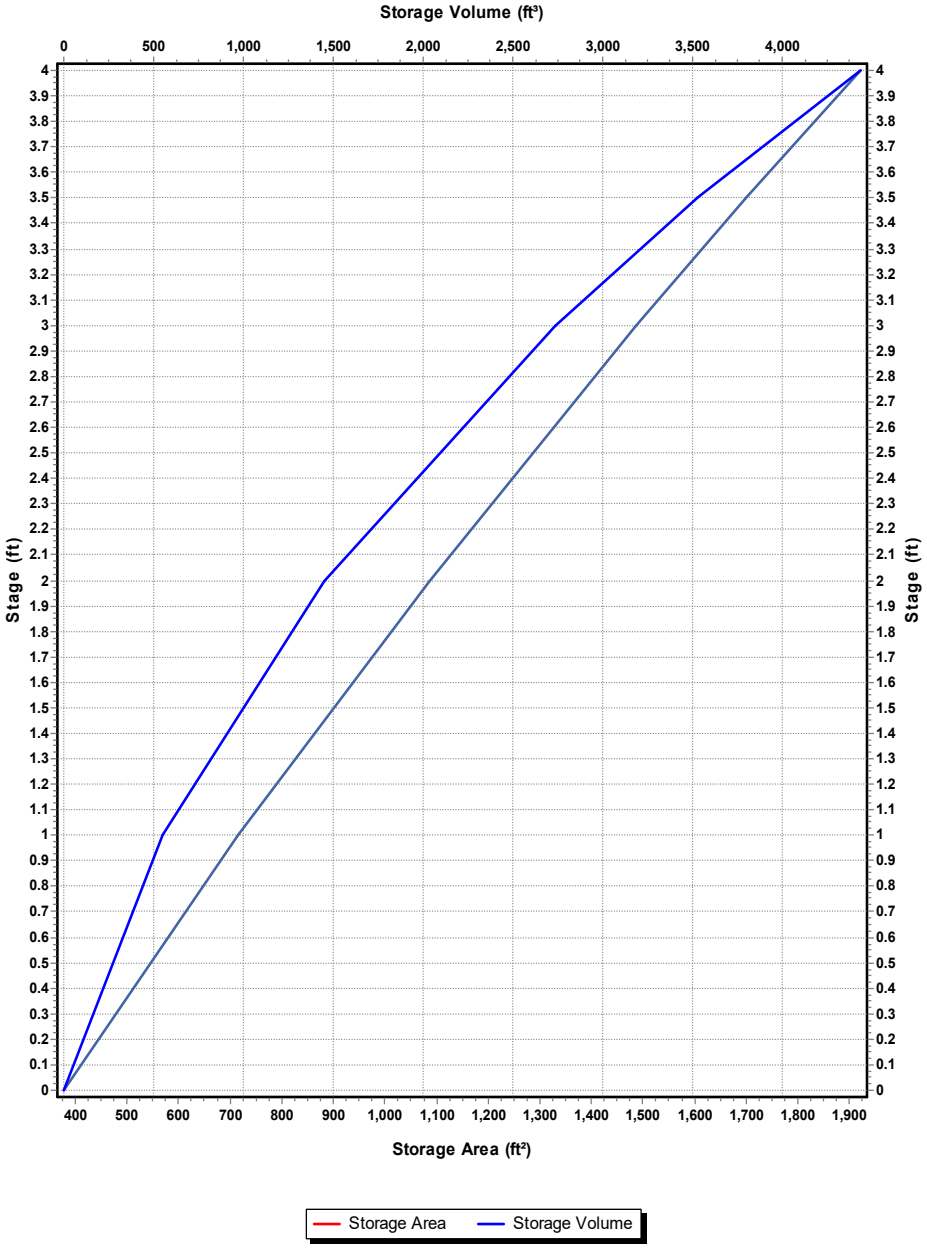
Invert Elevation (ft)	111.00
Max (Rim) Elevation (ft)	115.00
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	111.00
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Storage-17

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	377.51	0
1	715.52	546.52
2	1085.52	1447.04
3	1487.53	2733.57
3.5	1700.54	3530.59
4	1921.54	4436.11

Storage Area Volume Curves



Storage Node : Basin-A4 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-A4	Trapezoidal	No	114.50	3.50	10.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	0.78
Peak Lateral Inflow (cfs)	0
Peak Outflow (cfs)	0
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	113.93
Max HGL Depth Attained (ft)	2.93
Average HGL Elevation Attained (ft)	113.39
Average HGL Depth Attained (ft)	2.39
Time of Max HGL Occurrence (days hh:mm)	1 00:29
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Forebay-A4

Input Data

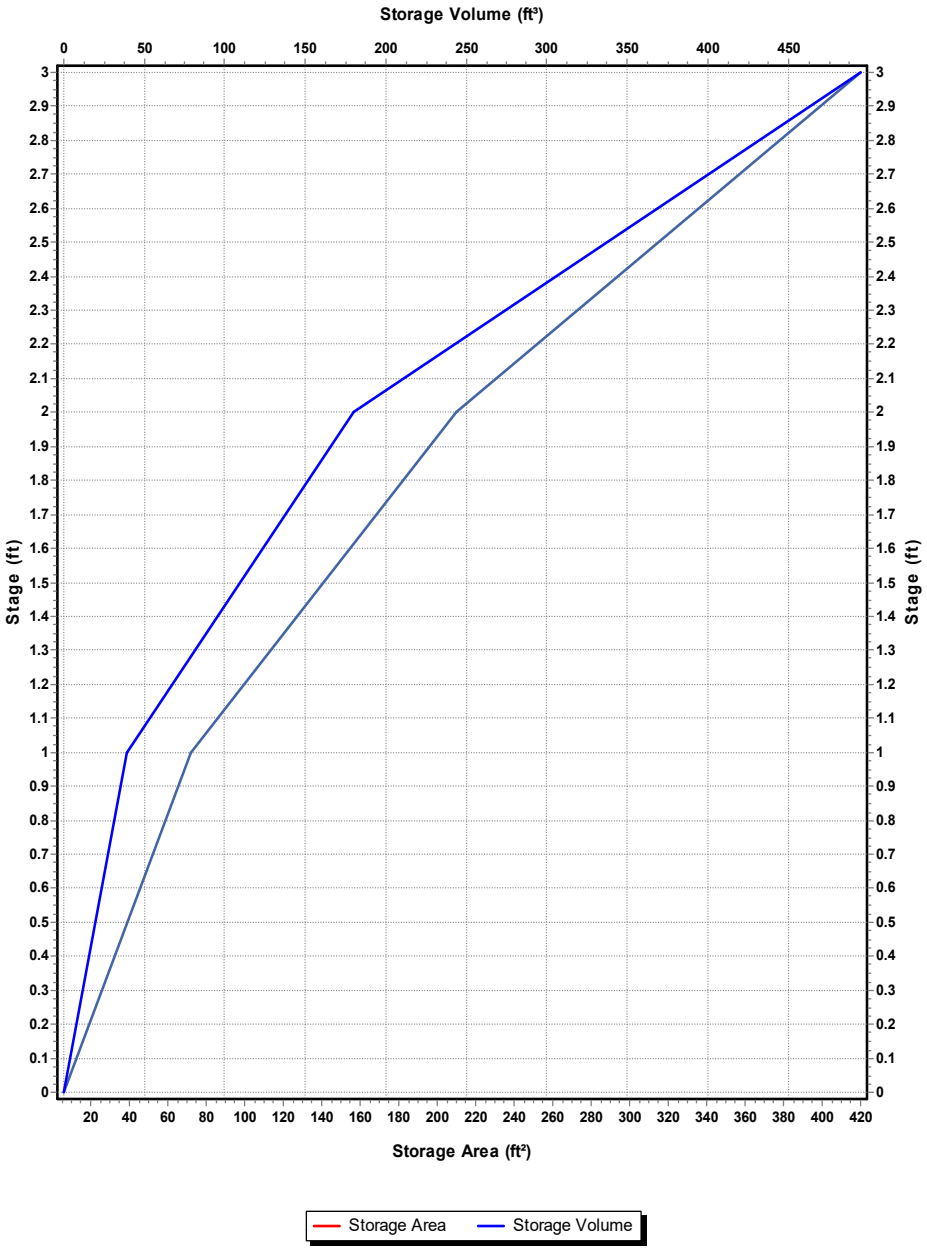
Invert Elevation (ft)	112.00
Max (Rim) Elevation (ft)	115.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	112.00
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Storage-16

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	6	0
1	72	39
2	210	180
3	420	495

Storage Area Volume Curves



Storage Node : Forebay-A4 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-FA4	Trapezoidal	No	114.00	2.00	10.00	1.00	3.33

Output Summary Results

Peak Inflow (cfs)	0.78
Peak Lateral Inflow (cfs)	0.78
Peak Outflow (cfs)	0.78
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	114.08
Max HGL Depth Attained (ft)	2.08
Average HGL Elevation Attained (ft)	113.73
Average HGL Depth Attained (ft)	1.73
Time of Max HGL Occurrence (days hh:mm)	0 12:10
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Project Description

File Name	Bourne_A4.SPF

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	SCS TR-20
Time of Concentration (TOC) Method	SCS TR-55
Link Routing Method	Hydrodynamic
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	NO

Analysis Options

Start Analysis On	00:00:00	0:00:00
End Analysis On	00:00:00	0:00:00
Start Reporting On	00:00:00	0:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	2
Nodes	4
Junctions	0
Outfalls	2
Flow Diversions	0
Inlets	0
Storage Nodes	2
Links	2
Channels	0
Pipes	0
Pumps	0
Orifices	0
Weirs	2
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	50 years	Intensity	inches	Massachusetts	None	50.00	6.74	SCS Type III 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Sub-A4	0.23	484.00	76.00	6.74	4.03	0.93	0.95	0 00:06:00
2	Sub-E04	0.36	484.00	43.00	6.74	0.96	0.35	0.16	0 00:31:33

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Out-A4	Outfall	113.00					0.09	113.00					
2	Out-E04	Outfall	0.00					0.16	0.00					
3	Basin-A4	Storage Node	111.00	115.00	111.00		0.00	0.92	114.47				0.00	0.00
4	Forebay-A4	Storage Node	112.00	115.00	112.00		0.00	0.93	114.61				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(ft)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
1	Weir-A4	Weir	Basin-A4	Out-A4		111.00	113.00				0.09							
2	Weir-FA4	Weir	Forebay-A4	Basin-A4		112.00	111.00				0.92							

Subbasin Hydrology

Subbasin : Sub-A4

Input Data

Area (ac)	0.23
Peak Rate Factor	484
Weighted Curve Number	76
Rain Gage ID	Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	0.23	A	76
Composite Area & Weighted CN	0.23		76

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft^2)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	122.43	0	0
Slope (%) :	1.28	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.97	0	0
Computed Flow Time (min) :	2.11	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	60.91	0	0
Channel Slope (%) :	1.5	0	0
Cross Section Area (ft^2) :	3	0	0
Wetted Perimeter (ft) :	6.32	0	0
Velocity (ft/sec) :	3.7	0	0
Computed Flow Time (min) :	0.27	0	0

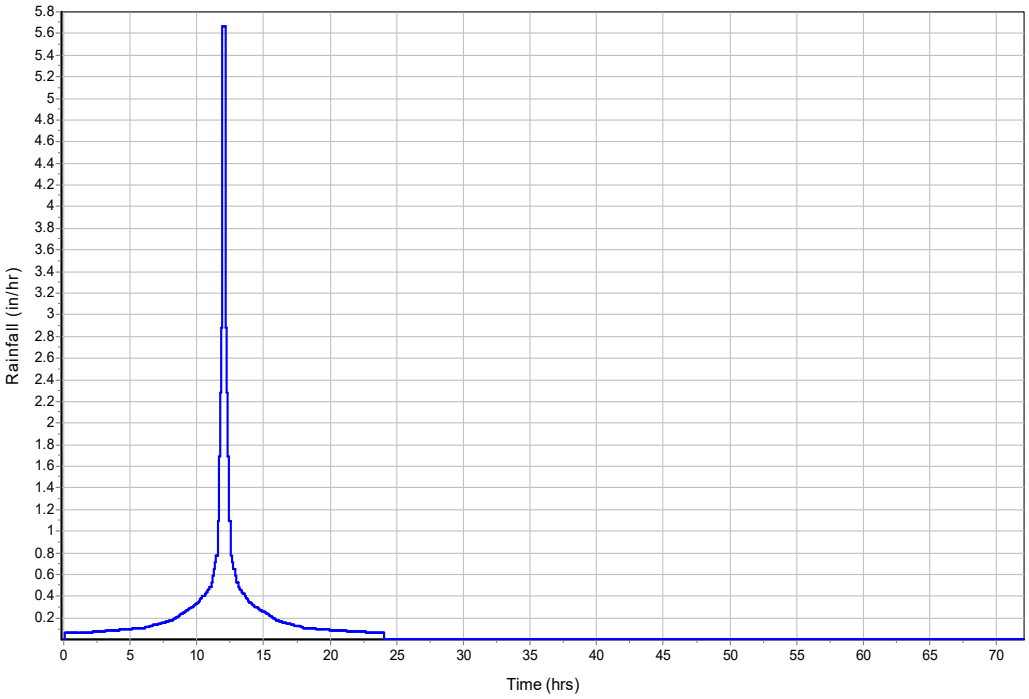
Total TOC (min) 2.39

Subbasin Runoff Results

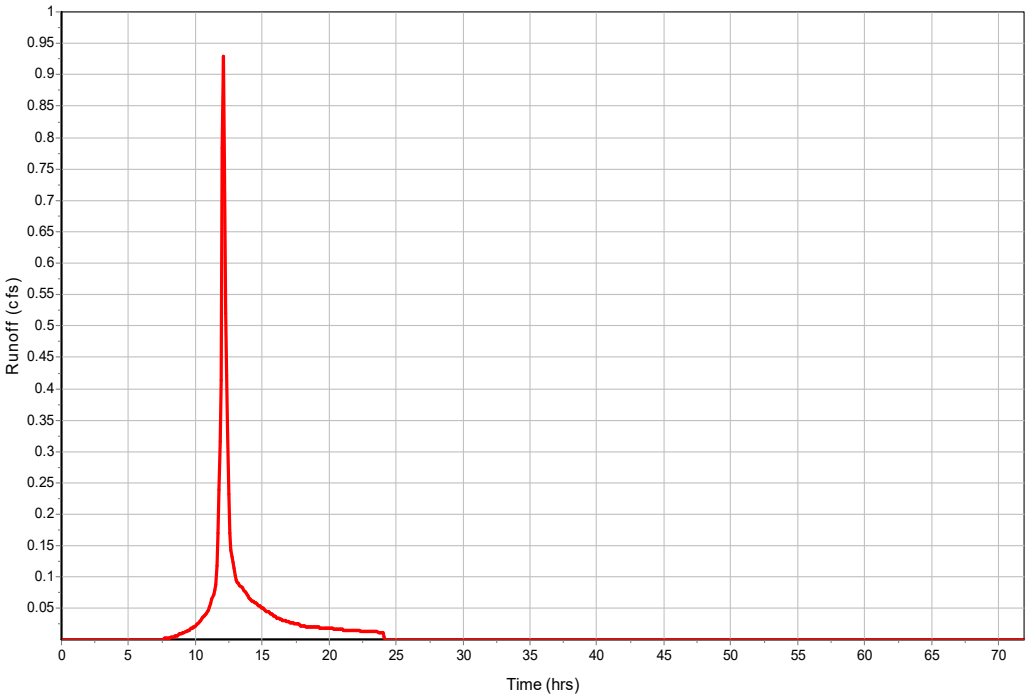
Total Rainfall (in)	6.74
Total Runoff (in)	4.03
Peak Runoff (cfs)	0.95
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:02:23

Subbasin : Sub-A4

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E04

Input Data

Area (ac)	0.36
Peak Rate Factor	484
Weighted Curve Number	43
Rain Gage ID	Rain Gage-01

Composite Curve Number

32	Area	Soil	Curve
Soil/Surface Description	(acres)	Group	Number
Woods & grass combination, Fair	0.36	A	43
Composite Area & Weighted CN	0.36		43

Time of Concentration

	Subarea	Subarea	Subarea
Sheet Flow Computations	A	B	C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	157.47	0	0
Slope (%) :	7	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.08	0	0
Computed Flow Time (min) :	31.55	0	0

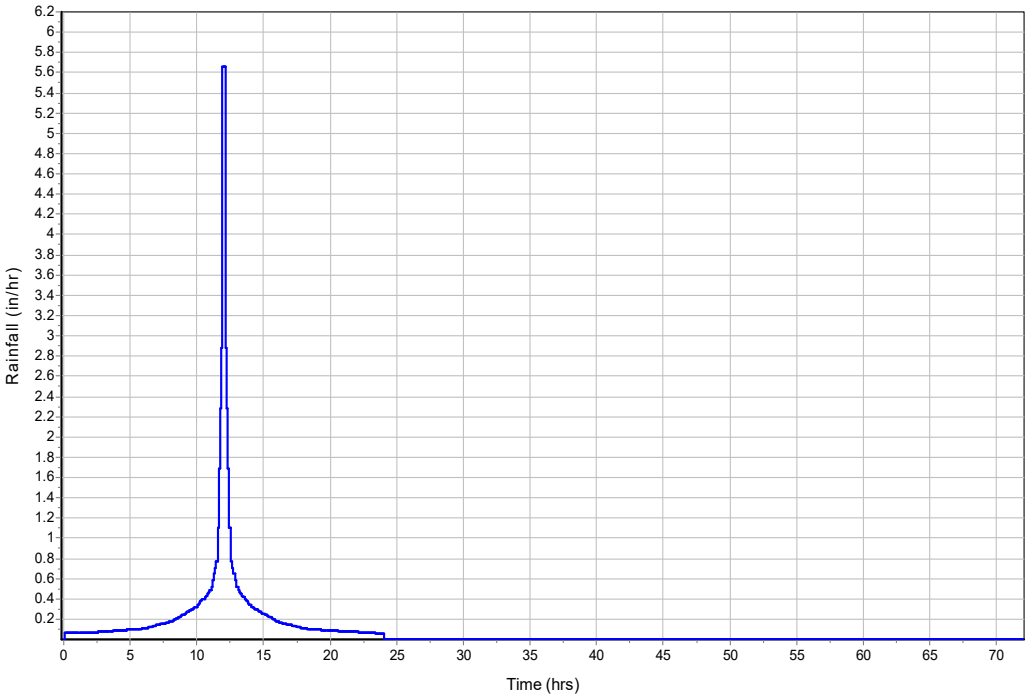
Total TOC (min) 31.55

Subbasin Runoff Results

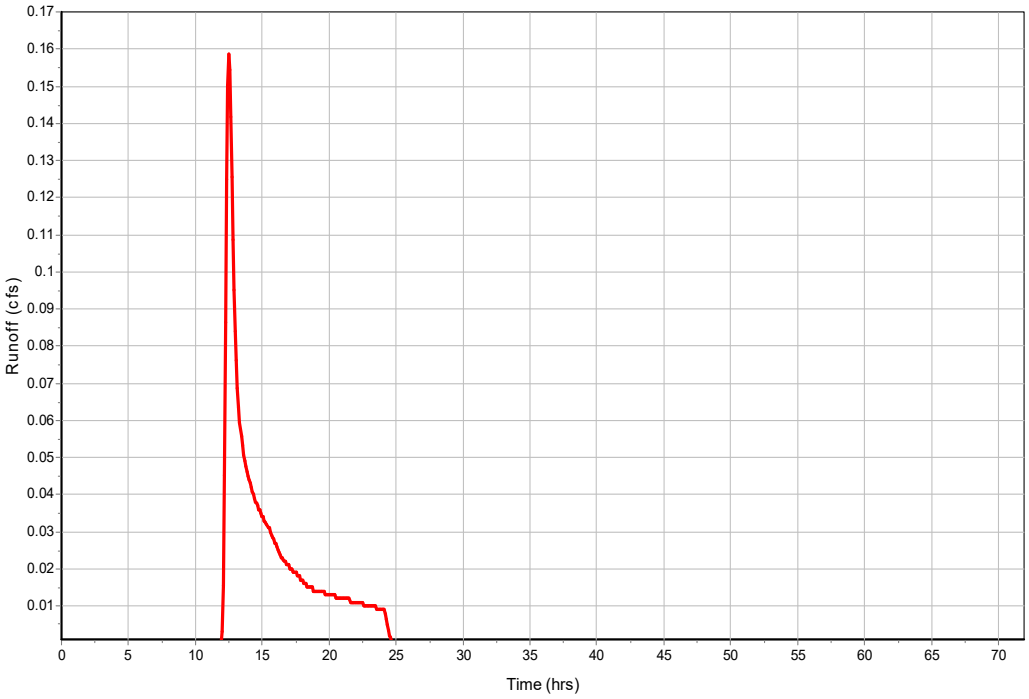
Total Rainfall (in)	6.74
Total Runoff (in)	0.96
Peak Runoff (cfs)	0.16
Weighted Curve Number	43
Time of Concentration (days hh:mm:ss)	0 00:31:33

Subbasin : Sub-E04

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A4

Input Data

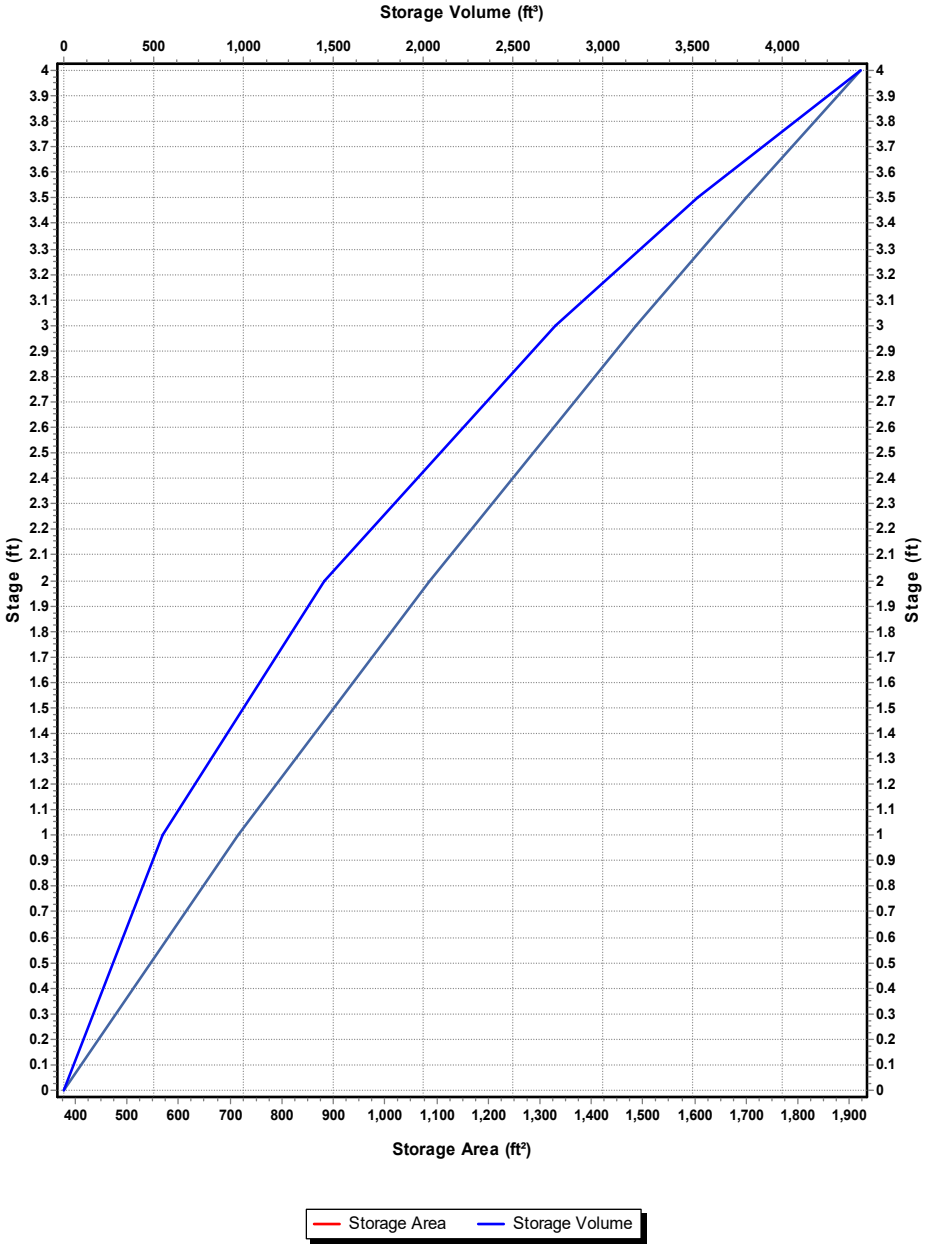
Invert Elevation (ft)	111.00
Max (Rim) Elevation (ft)	115.00
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	111.00
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Storage-17

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	377.51	0
1	715.52	546.52
2	1085.52	1447.04
3	1487.53	2733.57
3.5	1700.54	3530.59
4	1921.54	4436.11

Storage Area Volume Curves



Storage Node : Basin-A4 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-A4	Trapezoidal	No	114.50	3.50	10.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	0.92
Peak Lateral Inflow (cfs)	0
Peak Outflow (cfs)	0.09
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	114.47
Max HGL Depth Attained (ft)	3.47
Average HGL Elevation Attained (ft)	113.8
Average HGL Depth Attained (ft)	2.8
Time of Max HGL Occurrence (days hh:mm)	1 05:53
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Forebay-A4

Input Data

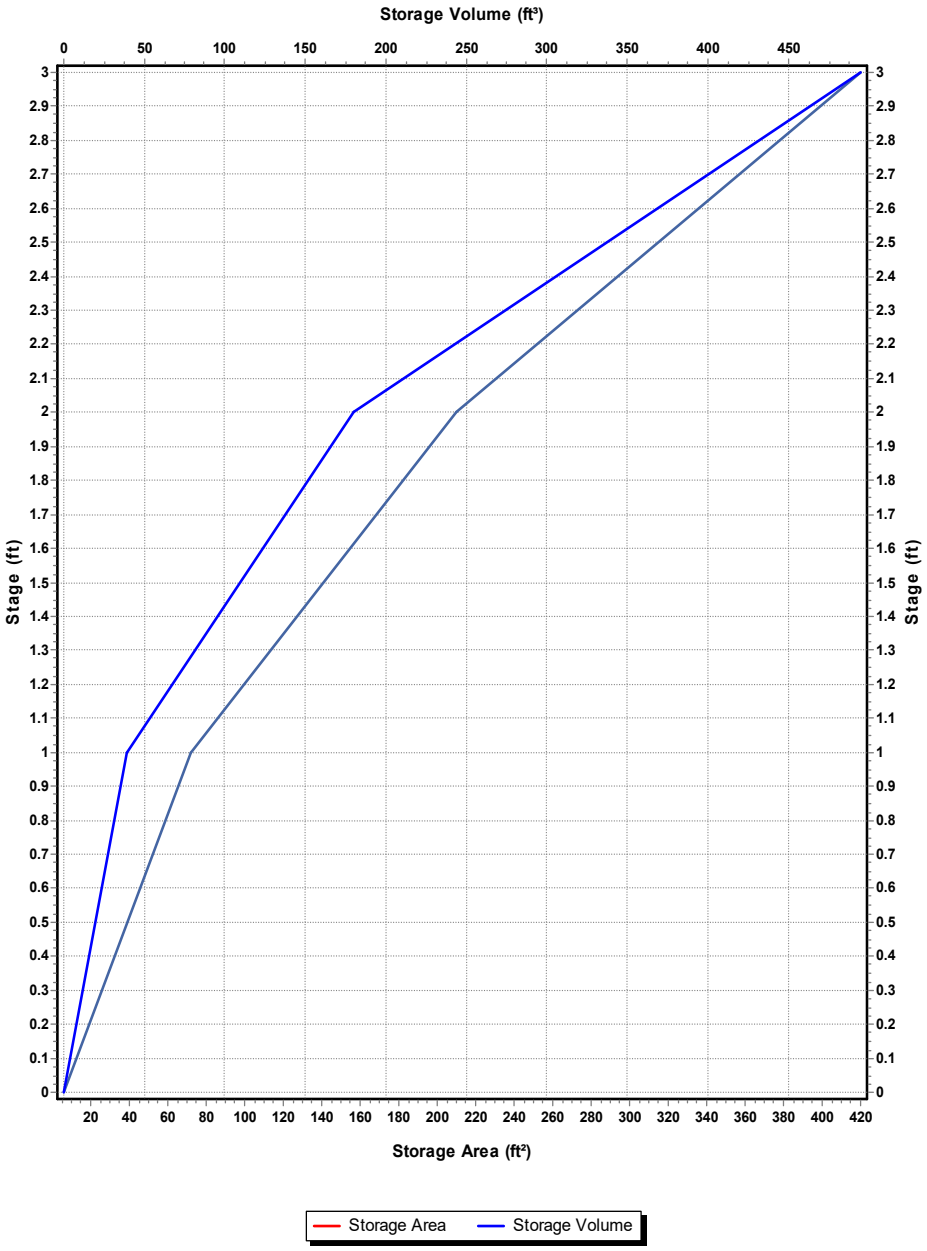
Invert Elevation (ft)	112.00
Max (Rim) Elevation (ft)	115.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	112.00
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Storage-16

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	6	0
1	72	39
2	210	180
3	420	495

Storage Area Volume Curves



Storage Node : Forebay-A4 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-FA4	Trapezoidal	No	114.00	2.00	10.00	1.00	3.33

Output Summary Results

Peak Inflow (cfs)	0.93
Peak Lateral Inflow (cfs)	0.93
Peak Outflow (cfs)	0.92
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	114.61
Max HGL Depth Attained (ft)	2.61
Average HGL Elevation Attained (ft)	114.16
Average HGL Depth Attained (ft)	2.16
Time of Max HGL Occurrence (days hh:mm)	1 05:48
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Project Description

File Name	Bourne_A4.SPF

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	SCS TR-20
Time of Concentration (TOC) Method	SCS TR-55
Link Routing Method	Hydrodynamic
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	NO

Analysis Options

Start Analysis On	00:00:00	0:00:00
End Analysis On	00:00:00	0:00:00
Start Reporting On	00:00:00	0:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	2
Nodes	4
Junctions	0
Outfalls	2
Flow Diversions	0
Inlets	0
Storage Nodes	2
Links	2
Channels	0
Pipes	0
Pumps	0
Orifices	0
Weirs	2
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	100 years	Intensity	inches	Massachusetts	None	100.00	7.51	SCS Type III 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Sub-A4	0.23	484.00	76.00	7.51	4.71	1.08	1.11	0 00:06:00
2	Sub-E04	0.36	484.00	43.00	7.51	1.30	0.47	0.24	0 00:31:33

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Out-A4	Outfall	113.00					0.11	113.00					
2	Out-E04	Outfall	0.00					0.24	0.00					
3	Basin-A4	Storage Node	111.00	115.00	111.00		0.00	1.08	114.48				0.00	0.00
4	Forebay-A4	Storage Node	112.00	115.00	112.00		0.00	1.09	114.62				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(ft)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
1	Weir-A4	Weir	Basin-A4	Out-A4		111.00	113.00				0.11							
2	Weir-FA4	Weir	Forebay-A4	Basin-A4		112.00	111.00				1.08							

Subbasin Hydrology

Subbasin : Sub-A4

Input Data

Area (ac)	0.23
Peak Rate Factor	484
Weighted Curve Number	76
Rain Gage ID	Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	0.23	A	76
Composite Area & Weighted CN	0.23		76

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft^2)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	122.43	0	0
Slope (%) :	1.28	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.97	0	0
Computed Flow Time (min) :	2.11	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	60.91	0	0
Channel Slope (%) :	1.5	0	0
Cross Section Area (ft^2) :	3	0	0
Wetted Perimeter (ft) :	6.32	0	0
Velocity (ft/sec) :	3.7	0	0
Computed Flow Time (min) :	0.27	0	0

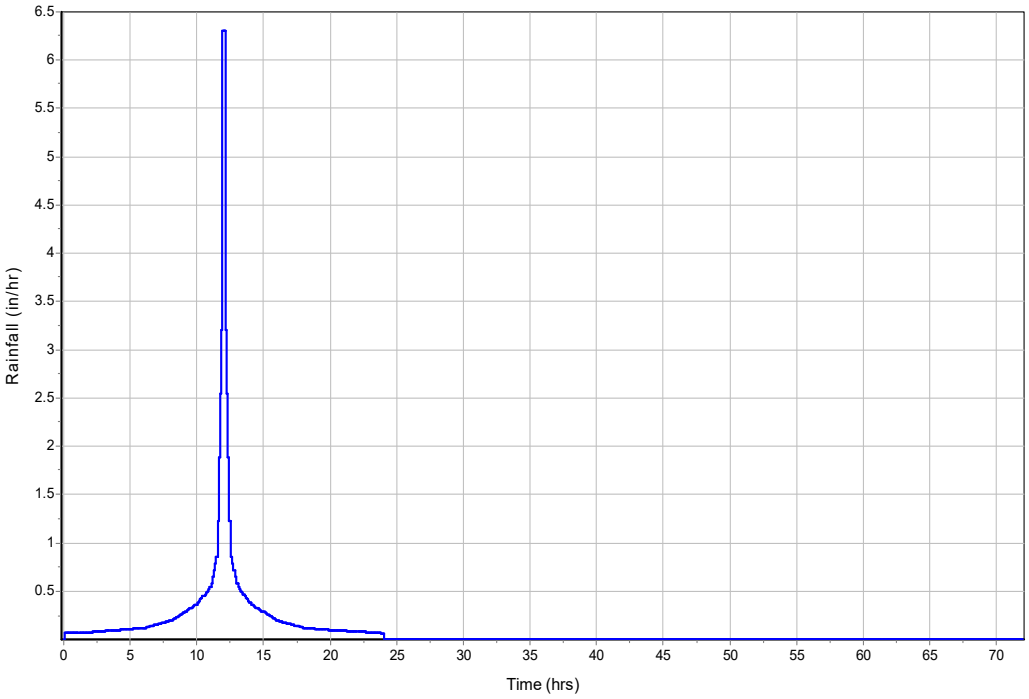
Total TOC (min) 2.39

Subbasin Runoff Results

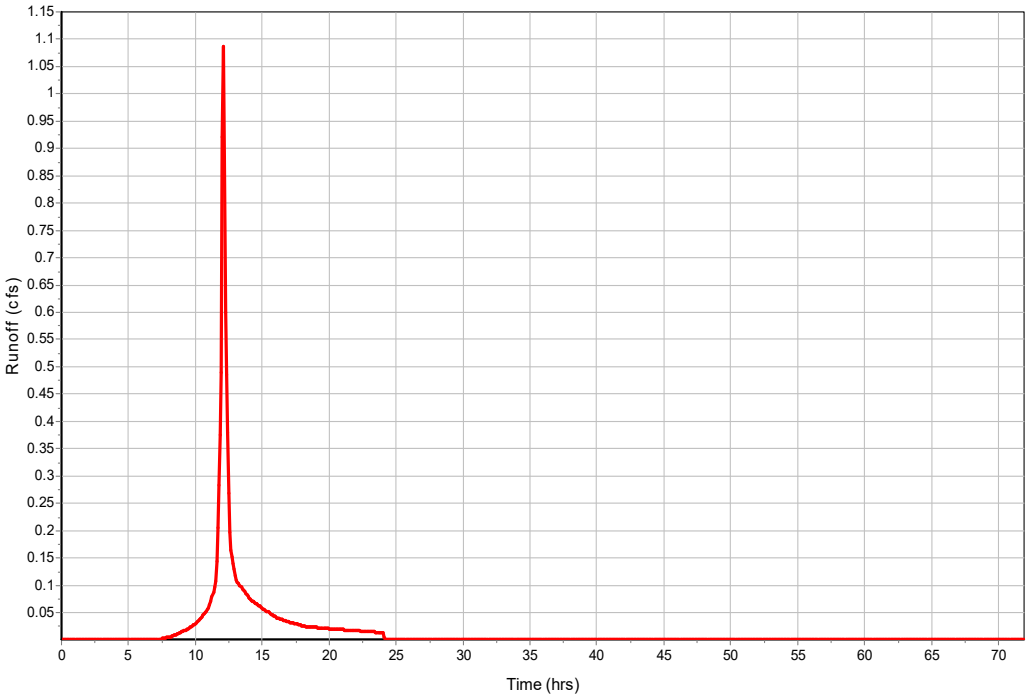
Total Rainfall (in)	7.51
Total Runoff (in)	4.71
Peak Runoff (cfs)	1.11
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:02:23

Subbasin : Sub-A4

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E04

Input Data

Area (ac)	0.36
Peak Rate Factor	484
Weighted Curve Number	43
Rain Gage ID	Rain Gage-01

Composite Curve Number

32	Area	Soil	Curve
Soil/Surface Description	(acres)	Group	Number
Woods & grass combination, Fair	0.36	A	43
Composite Area & Weighted CN	0.36		43

Time of Concentration

	Subarea	Subarea	Subarea
Sheet Flow Computations	A	B	C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	157.47	0	0
Slope (%) :	7	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.08	0	0
Computed Flow Time (min) :	31.55	0	0

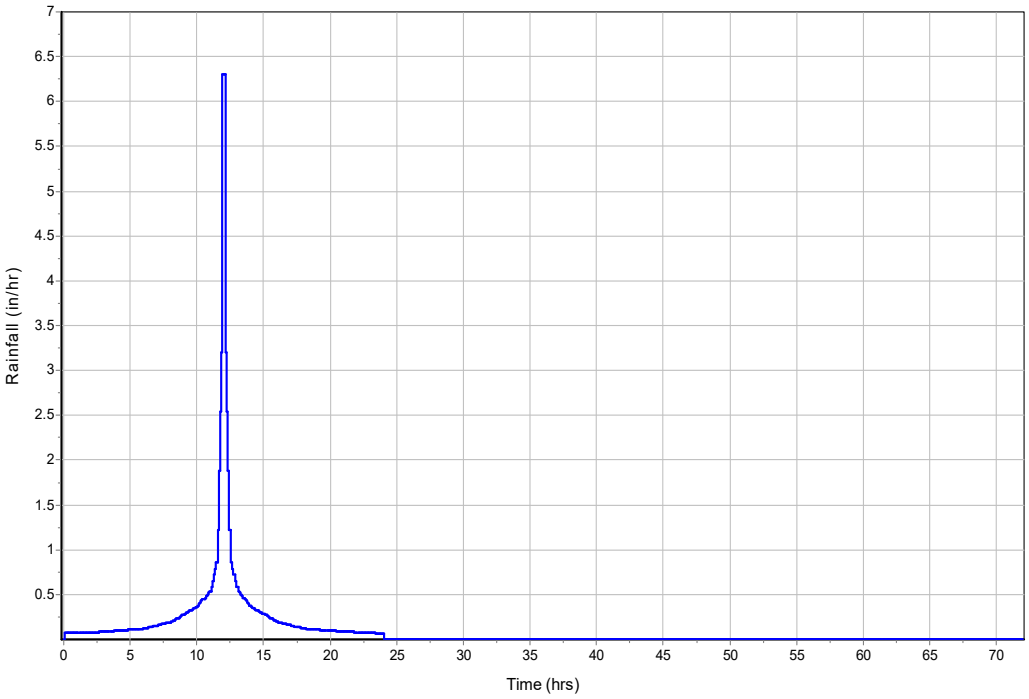
Total TOC (min) 31.55

Subbasin Runoff Results

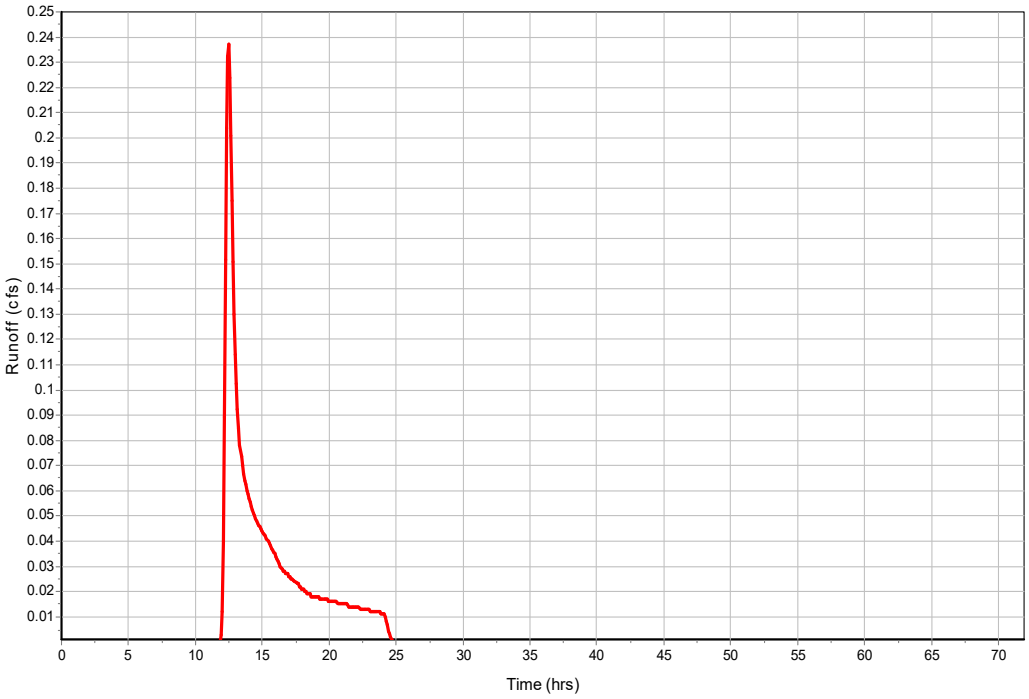
Total Rainfall (in)	7.51
Total Runoff (in)	1.3
Peak Runoff (cfs)	0.24
Weighted Curve Number	43
Time of Concentration (days hh:mm:ss)	0 00:31:33

Subbasin : Sub-E04

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A4

Input Data

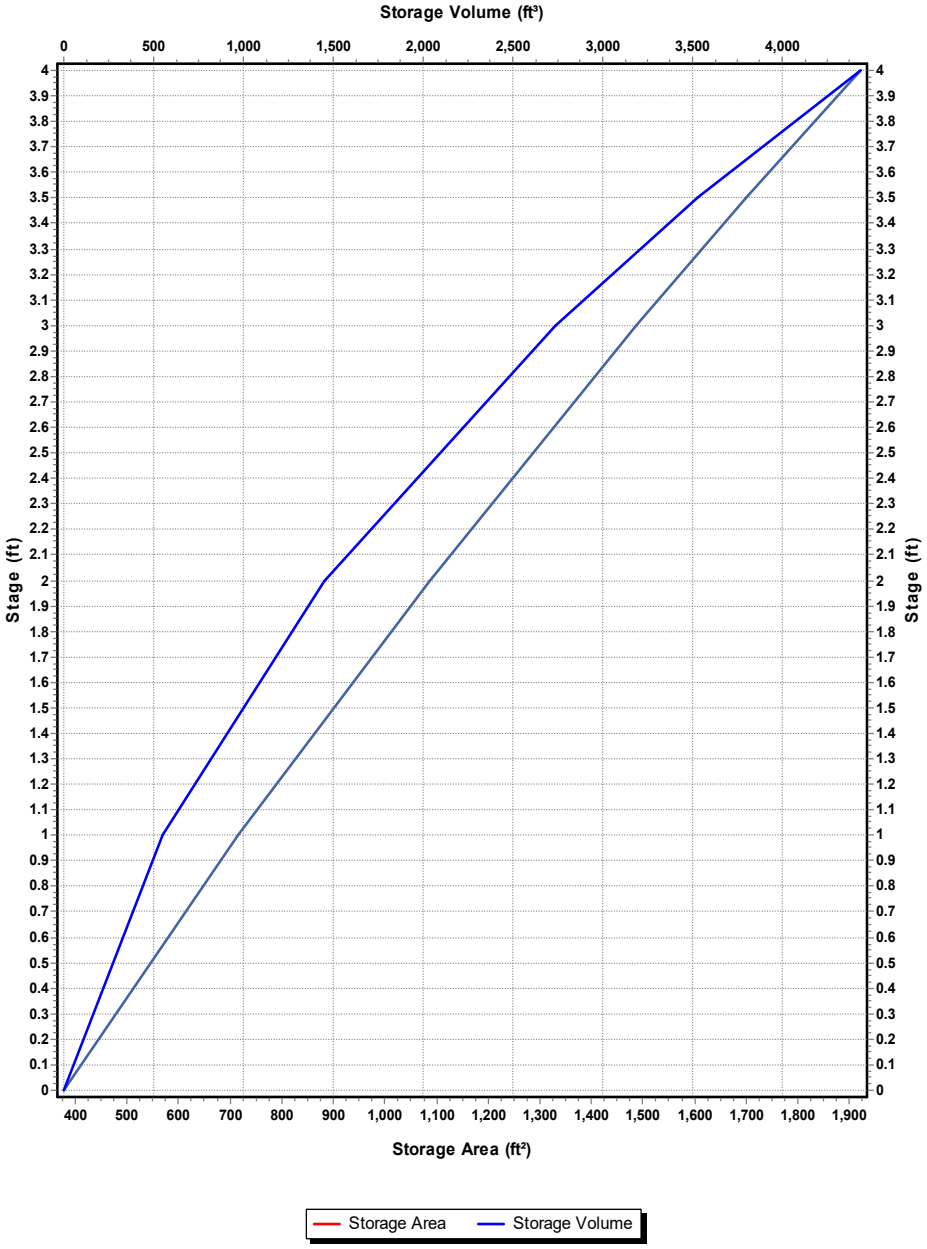
Invert Elevation (ft)	111.00
Max (Rim) Elevation (ft)	115.00
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	111.00
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Storage-17

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	377.51	0
1	715.52	546.52
2	1085.52	1447.04
3	1487.53	2733.57
3.5	1700.54	3530.59
4	1921.54	4436.11

Storage Area Volume Curves



Storage Node : Basin-A4 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-A4	Trapezoidal	No	114.50	3.50	10.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	1.08
Peak Lateral Inflow (cfs)	0
Peak Outflow (cfs)	0.5
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	114.48
Max HGL Depth Attained (ft)	3.48
Average HGL Elevation Attained (ft)	113.86
Average HGL Depth Attained (ft)	2.86
Time of Max HGL Occurrence (days hh:mm)	0 18:48
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Forebay-A4

Input Data

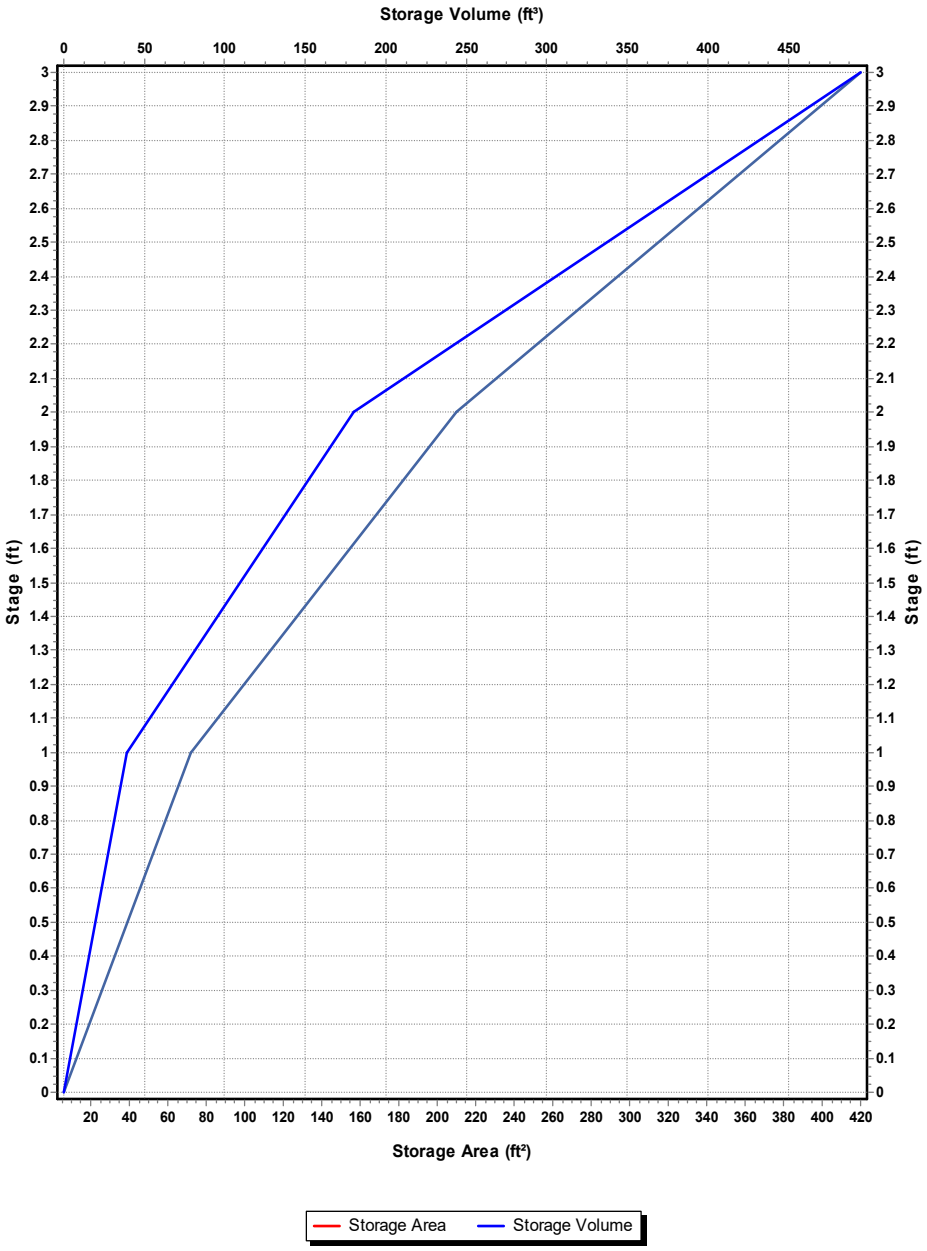
Invert Elevation (ft)	112.00
Max (Rim) Elevation (ft)	115.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	112.00
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Storage-16

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	6	0
1	72	39
2	210	180
3	420	495

Storage Area Volume Curves



Storage Node : Forebay-A4 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-FA4	Trapezoidal	No	114.00	2.00	10.00	1.00	3.33

Output Summary Results

Peak Inflow (cfs)	1.09
Peak Lateral Inflow (cfs)	1.09
Peak Outflow (cfs)	1.08
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	114.62
Max HGL Depth Attained (ft)	2.62
Average HGL Elevation Attained (ft)	114.22
Average HGL Depth Attained (ft)	2.22
Time of Max HGL Occurrence (days hh:mm)	0 18:43
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Project Description

File Name	Bourne_A4.SPF

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	SCS TR-20
Time of Concentration (TOC) Method	SCS TR-55
Link Routing Method	Hydrodynamic
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	NO

Analysis Options

Start Analysis On	00:00:00	0:00:00
End Analysis On	00:00:00	0:00:00
Start Reporting On	00:00:00	0:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	2
Nodes	4
Junctions	0
Outfalls	2
Flow Diversions	0
Inlets	0
Storage Nodes	2
Links	2
Channels	0
Pipes	0
Pumps	0
Orifices	0
Weirs	2
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	2070 50 years	Intensity	inches	Massachusetts	None	50.00	8.80	SCS Type III 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Sub-A4	0.23	484.00	76.00	8.80	5.89	1.35	1.37	0 00:06:00
2	Sub-E04	0.36	484.00	43.00	8.80	1.95	0.70	0.39	0 00:31:33

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Out-A4	Outfall	113.00					0.08	113.00					
2	Out-E04	Outfall	0.00					0.39	0.00					
3	Basin-A4	Storage Node	111.00	115.00	111.00		0.00	1.85	114.52				0.00	0.00
4	Forebay-A4	Storage Node	112.00	115.00	112.00		0.00	1.79	114.48				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(ft)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
1	Weir-A4	Weir	Basin-A4	Out-A4		111.00	113.00				0.08							
2	Weir-FA4	Weir	Forebay-A4	Basin-A4		112.00	111.00				1.85							

Subbasin Hydrology

Subbasin : Sub-A4

Input Data

Area (ac)	0.23
Peak Rate Factor	484
Weighted Curve Number	76
Rain Gage ID	Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	0.23	A	76
Composite Area & Weighted CN	0.23		76

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft^2)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	122.43	0	0
Slope (%) :	1.28	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.97	0	0
Computed Flow Time (min) :	2.11	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	60.91	0	0
Channel Slope (%) :	1.5	0	0
Cross Section Area (ft^2) :	3	0	0
Wetted Perimeter (ft) :	6.32	0	0
Velocity (ft/sec) :	3.7	0	0
Computed Flow Time (min) :	0.27	0	0

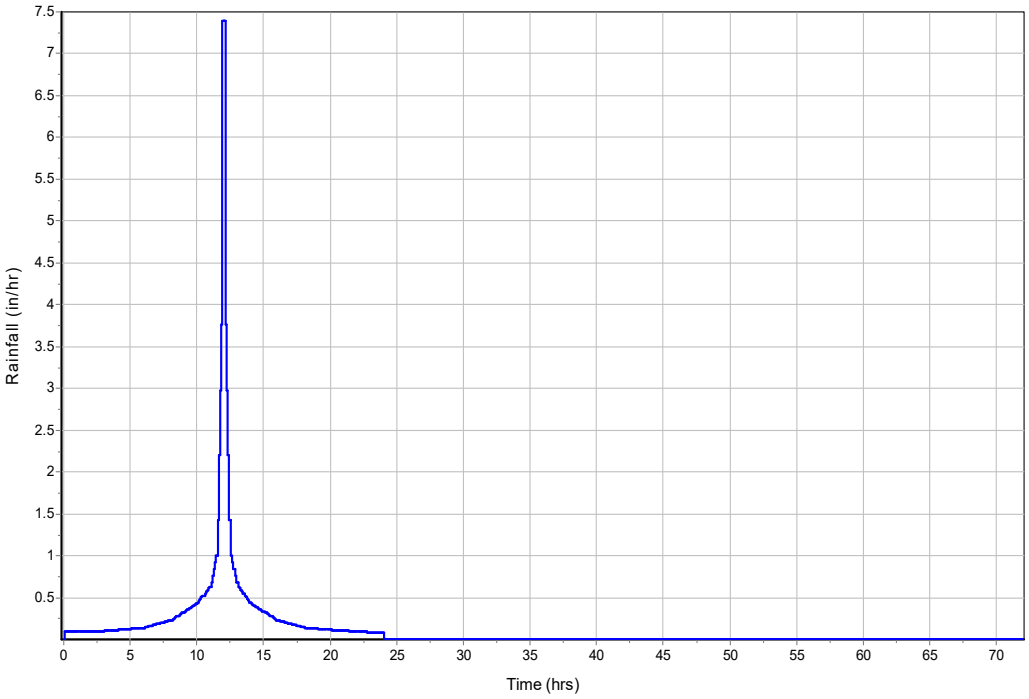
Total TOC (min) 2.39

Subbasin Runoff Results

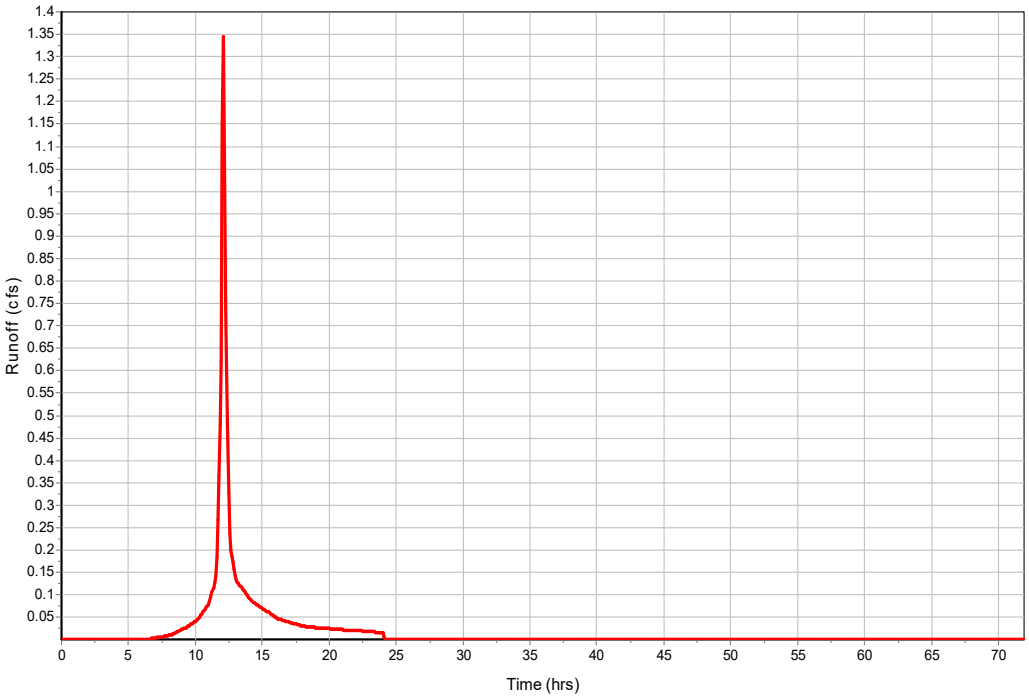
Total Rainfall (in)	8.8
Total Runoff (in)	5.89
Peak Runoff (cfs)	1.37
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:02:23

Subbasin : Sub-A4

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E04

Input Data

Area (ac)	0.36
Peak Rate Factor	484
Weighted Curve Number	43
Rain Gage ID	Rain Gage-01

Composite Curve Number

32	Area	Soil	Curve
Soil/Surface Description	(acres)	Group	Number
Woods & grass combination, Fair	0.36	A	43
Composite Area & Weighted CN	0.36		43

Time of Concentration

	Subarea	Subarea	Subarea
Sheet Flow Computations	A	B	C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	157.47	0	0
Slope (%) :	7	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.08	0	0
Computed Flow Time (min) :	31.55	0	0

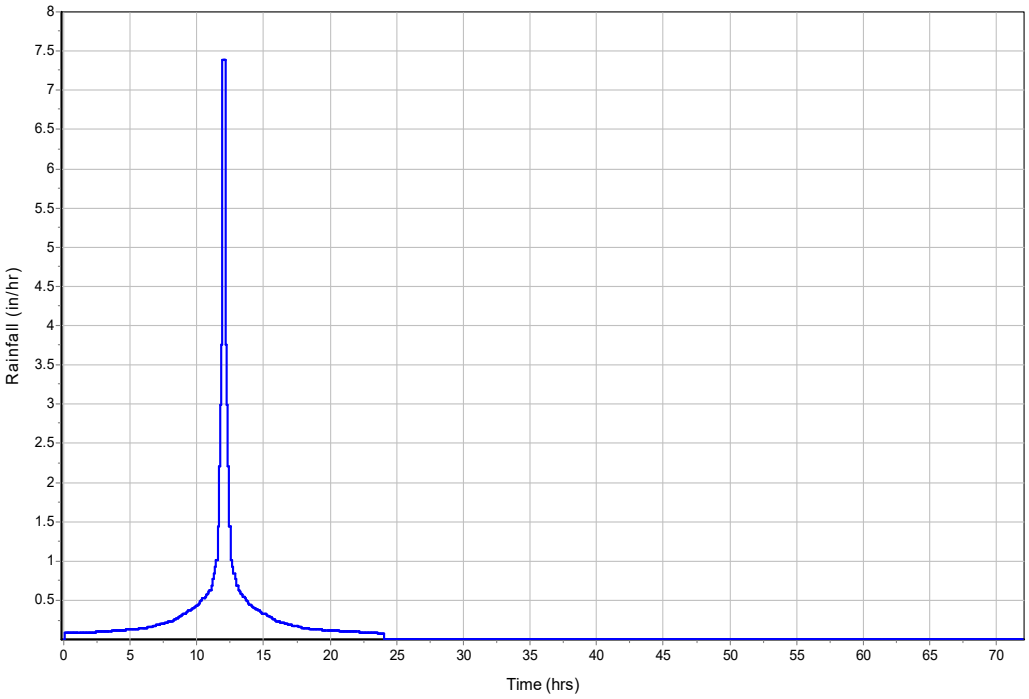
Total TOC (min) 31.55

Subbasin Runoff Results

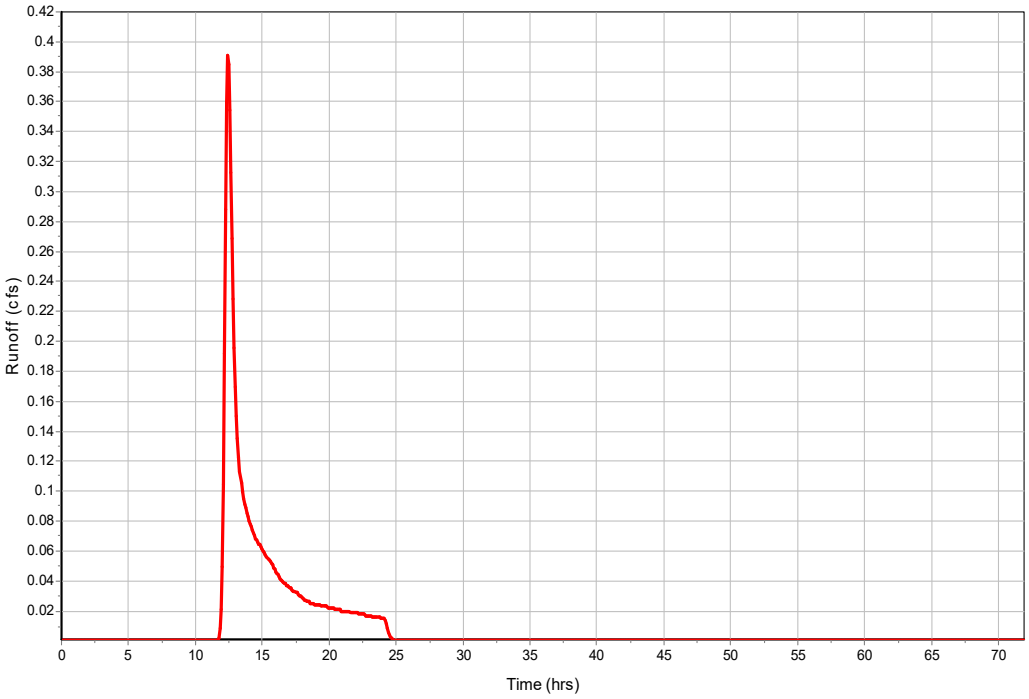
Total Rainfall (in)	8.8
Total Runoff (in)	1.95
Peak Runoff (cfs)	0.39
Weighted Curve Number	43
Time of Concentration (days hh:mm:ss)	0 00:31:33

Subbasin : Sub-E04

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A4

Input Data

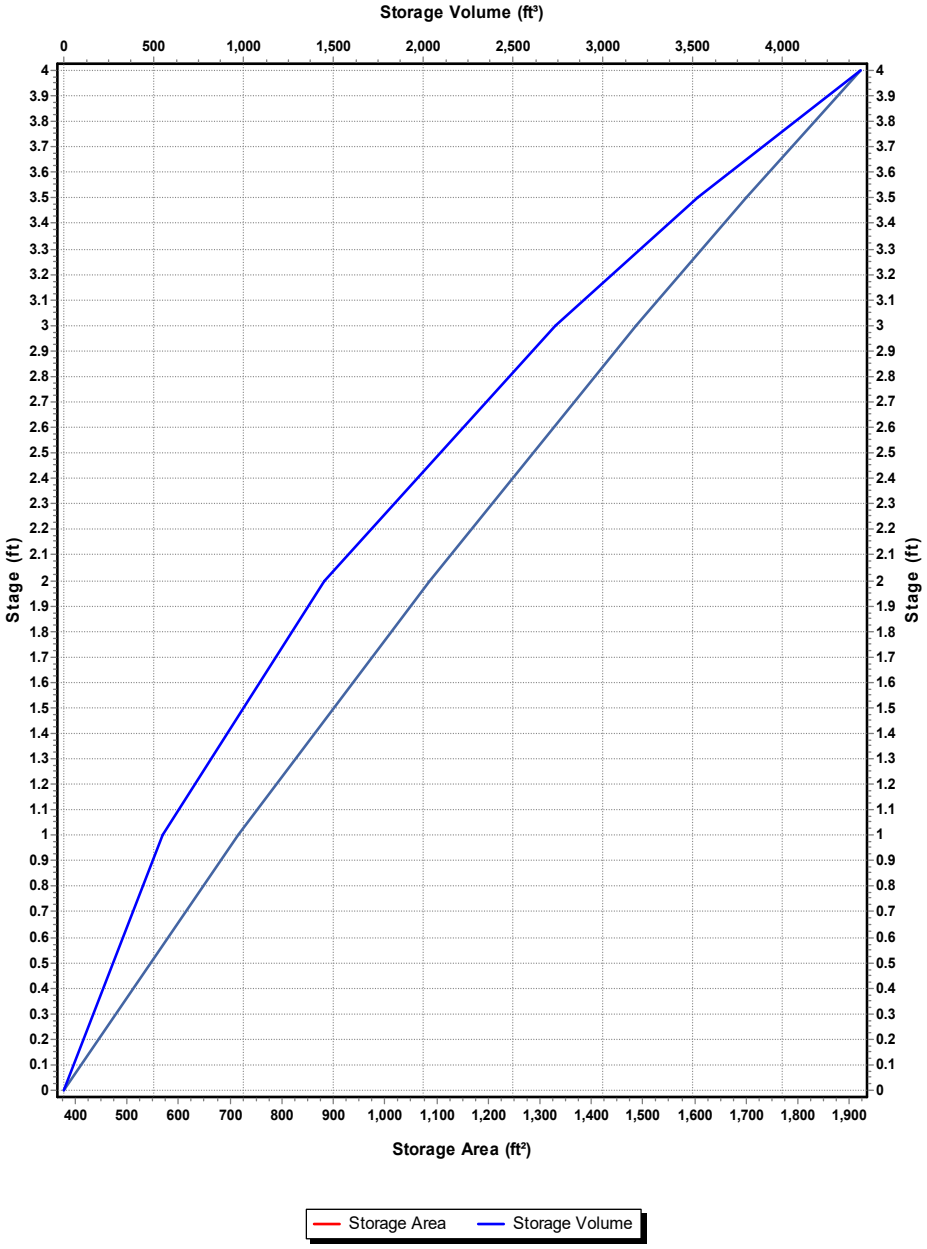
Invert Elevation (ft)	111.00
Max (Rim) Elevation (ft)	115.00
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	111.00
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Storage-17

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	377.51	0
1	715.52	546.52
2	1085.52	1447.04
3	1487.53	2733.57
3.5	1700.54	3530.59
4	1921.54	4436.11

Storage Area Volume Curves



Storage Node : Basin-A4 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-A4	Trapezoidal	No	114.50	3.50	10.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	1.85
Peak Lateral Inflow (cfs)	0
Peak Outflow (cfs)	1.67
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	114.52
Max HGL Depth Attained (ft)	3.52
Average HGL Elevation Attained (ft)	113.92
Average HGL Depth Attained (ft)	2.92
Time of Max HGL Occurrence (days hh:mm)	0 15:04
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Forebay-A4

Input Data

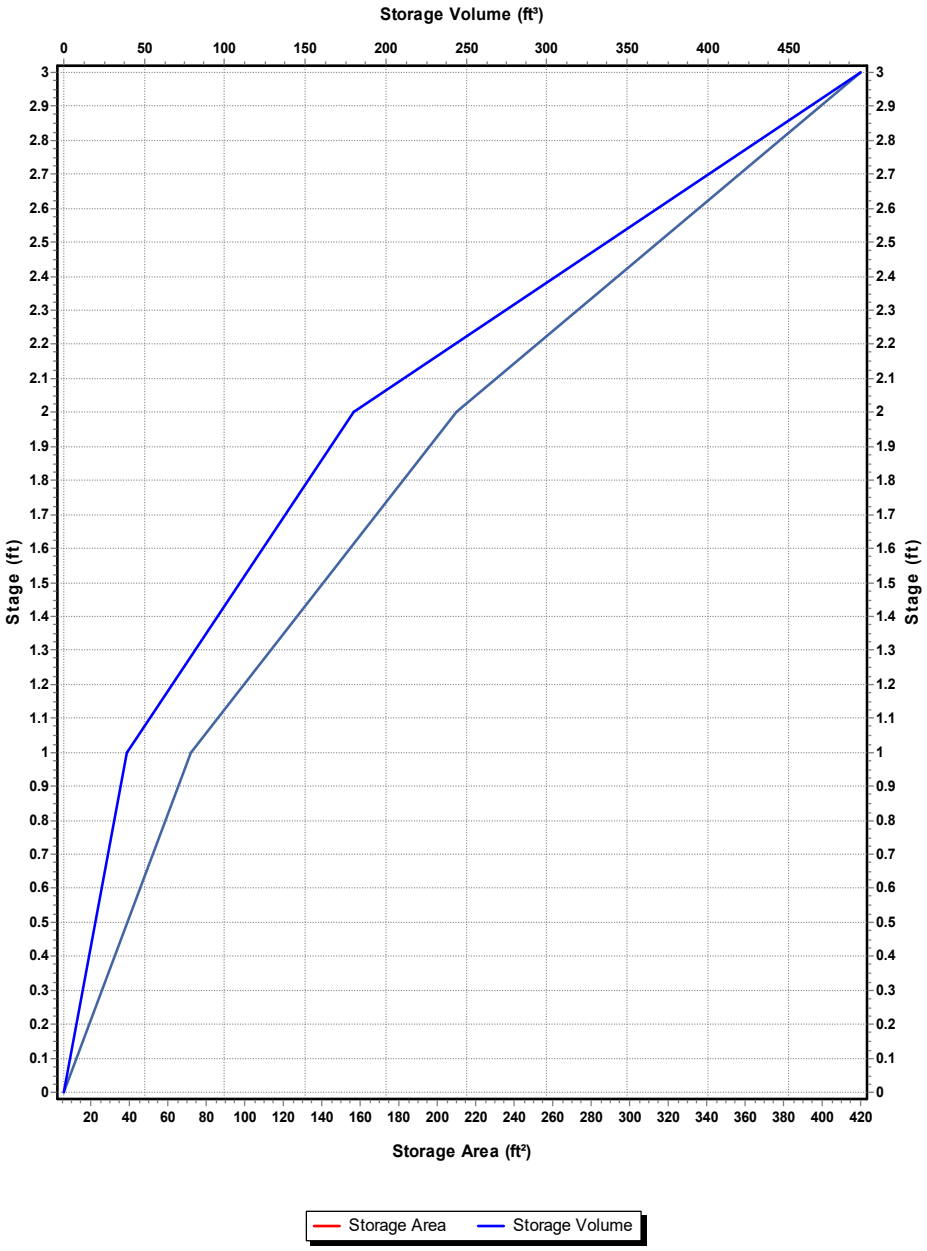
Invert Elevation (ft)	112.00
Max (Rim) Elevation (ft)	115.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	112.00
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Storage-16

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	6	0
1	72	39
2	210	180
3	420	495

Storage Area Volume Curves



Storage Node : Forebay-A4 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-FA4	Trapezoidal	No	114.00	2.00	10.00	1.00	3.33

Output Summary Results

Peak Inflow (cfs)	1.79
Peak Lateral Inflow (cfs)	1.35
Peak Outflow (cfs)	1.85
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	114.48
Max HGL Depth Attained (ft)	2.48
Average HGL Elevation Attained (ft)	114.15
Average HGL Depth Attained (ft)	2.15
Time of Max HGL Occurrence (days hh:mm)	0 15:04
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Attachment D - Standard 3 Supporting Information

NRCS Soil Report

Site Specific Geotechnical Engineering Report

Drawdown Analysis

Recharge Volume

NRCS Soils Report

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Barnstable County, Massachusetts



April 20, 2026

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require

alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

Contents

Preface.....2
How Soil Surveys Are Made.....5
Soil Map.....8
Soil Map.....9
Legend.....10
Map Unit Legend.....11
Map Unit Descriptions.....11
Barnstable County, Massachusetts.....13
435B—Plymouth loamy coarse sand, 3 to 8 percent slopes.....13
References.....16

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map



Map Scale: 1:867 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 10 20 40 60

Feet: 0 40 80 160 240

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 19N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:25,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Barnstable County, Massachusetts
Survey Area Data: Version 24, Sep 5, 2025

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jun 10, 2022—Jun 30, 2022

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
435B	Plymouth loamy coarse sand, 3 to 8 percent slopes	1.7	100.0%
Totals for Area of Interest		**1.7**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Barnstable County, Massachusetts

435B—Plymouth loamy coarse sand, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 2zggz
Landscape: Uplands
Elevation: 0 to 290 feet
Mean annual precipitation: 40 to 52 inches
Mean annual air temperature: 52 to 59 degrees F
Frost-free period: 190 to 250 days
Farmland classification: Not prime farmland

Map Unit Composition

Plymouth, loamy coarse sand, and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Plymouth, Loamy Coarse Sand

Setting

Landscape: Uplands
Landform: Outwash plains, Hills, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope
Landform position (three-dimensional): Head slope, side slope, crest, tread
Down-slope shape: Linear, concave, convex
Across-slope shape: Linear, concave, convex
Parent material: Siliceous sandy and gravelly glaciofluvial deposits and/or sandy and gravelly supraglacial meltout till

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
Oe - 1 to 2 inches: moderately decomposed plant material
A - 2 to 3 inches: loamy coarse sand
E - 3 to 5 inches: coarse sand
Bhs - 5 to 7 inches: cobbly loamy coarse sand
Bw1 - 7 to 11 inches: cobbly loamy coarse sand
Bw2 - 11 to 22 inches: gravelly coarse sand
BC - 22 to 31 inches: gravelly coarse sand
C1 - 31 to 43 inches: gravelly coarse sand
C2 - 43 to 66 inches: coarse sand

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Excessively drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to very high (1.42 to 14.17 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 1.9 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 5.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: A
Ecological site: F149BY005MA - Dry Outwash
Hydric soil rating: No

Minor Components

Barnstable

Percent of map unit: 5 percent
Landscape: Coastal lowlands, uplands
Landform: Moraines on outwash plains
Landform position (two-dimensional): Summit, shoulder, backslope, footslope
Landform position (three-dimensional): Head slope, side slope, crest, tread
Down-slope shape: Linear, concave, convex
Across-slope shape: Linear, concave, convex
Ecological site: F149BY011MA - Well Drained Till Uplands
Hydric soil rating: No

Montauk, sandy variant

Percent of map unit: 5 percent
Landscape: Uplands
Landform: Moraines
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Convex
Ecological site: F149BY009MA - Well Drained Dense Till Uplands
Hydric soil rating: No

Riverhead

Percent of map unit: 5 percent
Landscape: Coastal lowlands, uplands
Landform: Outwash plains, Moraines
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Side slope, crest, tread
Down-slope shape: Linear, convex
Across-slope shape: Linear
Ecological site: F149BY006NY - Well Drained Outwash
Hydric soil rating: No

Carver

Percent of map unit: 5 percent
Landscape: Uplands
Landform: Disected outwash plains, Moraines
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Side slope, crest, tread
Down-slope shape: Linear, convex
Across-slope shape: Linear
Ecological site: F149BY005MA - Dry Outwash
Hydric soil rating: No

References

American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deep-water habitats of the United States. U.S. Fish and Wildlife Service FWS/OBS-79/31.

Federal Register. July 13, 1994. Changes in hydric soils of the United States.

Federal Register. September 18, 2002. Hydric soils of the United States.

Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.

National Research Council. 1995. Wetlands: Characteristics and boundaries.

Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_054262

Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service, U.S. Department of Agriculture Handbook 436. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053577

Soil Survey Staff. 2010. Keys to soil taxonomy. 11th edition. U.S. Department of Agriculture, Natural Resources Conservation Service. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053580

Tiner, R.W., Jr. 1985. Wetlands of Delaware. U.S. Fish and Wildlife Service and Delaware Department of Natural Resources and Environmental Control, Wetlands Section.

United States Army Corps of Engineers, Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Waterways Experiment Station Technical Report Y-87-1.

United States Department of Agriculture, Natural Resources Conservation Service. National forestry manual. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2_053374

United States Department of Agriculture, Natural Resources Conservation Service. National range and pasture handbook. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/landuse/rangepasture/?cid=stelprdb1043084

United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053624

United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf

Boring Logs

GeoEngineers performed a geotechnical subsurface exploration program on March 12, 2025. The exploration program consisted of three (3) borings (designated MR-07, MR-08, and MR-08A) advanced to depths between 17 and 34 feet below the ground surface (bgs) by Geologic Earth Exploration, Inc.(Geologic) of Norfolk, Massachusetts. The borings were advanced using hollow-stem auger drilling methods with a track mounted Acker Rebel drill rig. The borings were continuously monitored by a representative from our firm who logged and classified the soils encountered, obtained representative soil samples, observed groundwater conditions, and prepared logs for the explorations.

Soils encountered in the borings were visually classified in general accordance with the classification system described in Figure A-1. A key to the boring log symbols is also presented in Figure A-1. The logs of the borings are presented in Figures A-2 through A-4 within Attachment A of the enclosed geotechnical report. The boring logs are based on our interpretation of the field and laboratory data and indicate the various types of soils and groundwater conditions encountered. The logs also indicate the depths at which these soils or their characteristic change, although the change may be gradual. If the change occurred between samples, it was interpreted.

The densities noted in the boring logs are based on the blow count data obtained in the borings and judgment based on the conditions encountered.

The soils encountered within the borings were generally sampled at the surface continuously until 10 feet Bgs, then at 5-foot vertical intervals thereafter with a 2-inch outside-diameter split-barrel standard penetration test (SPT) sampler. The disturbed samples were obtained by driving the sampler 24 inches into the soil with a 140-pound automatic hammer free-falling 30 inches. The number of blows required for each 6 inches of penetration was recorded. The blow count (“N-value”) of the soil was calculated as the number of blows required for the middle 12 inches of penetration. This resistance, or N-value, provides a measure of the relative density of granular soils and the relative consistency of cohesive soils. Where very dense soil conditions precluded driving the full 24 inches, the penetration resistance for the partial penetration was entered on the logs. The blow counts are shown in the boring logs at the respective sample depths. Auger refusal was encountered while auguring boring MR-08 at 17 feet bgs. An offset boring, MR-08A, was augured without sampling to 18 feet, at which the sampling continued.

Observations of groundwater conditions were made during drilling. The groundwater conditions encountered during drilling are presented in the boring logs. Groundwater conditions observed during drilling represent a short-term condition and may or may not be representative of the long-term groundwater conditions at the Site. Groundwater conditions observed during drilling should be considered approximate.

Logs of the test borings are provided in Attachment A of the enclosed geotechnical report, Subsurface Exploration and Laboratory Testing.

Site Specific Geotechnical Report

Geotechnical Engineering Report

Cape Canal Bridge Relocation Project
Cape Bourne Metering & Regulating Station
Barnstable County, Massachusetts

for
Enbridge, Inc.

May 15, 2025

239 Causeway Street, Suite 400
Boston, Massachusetts 02114
617.749.9220

GeoEngineers USA

Geotechnical Engineering Report

Cape Canal Bridge Relocation Project
Cape Bourne Metering & Regulating Station
Barnstable County, Massachusetts

File No. 15556-039-00
May 15, 2025

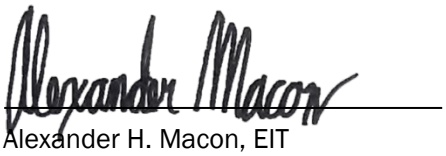
Prepared for:

Enbridge, Inc.
915 North Eldridge Parkway, Suite 1100
Houston, Texas 77079

Attention: Cindy Dilber

Prepared by:

GeoEngineers USA, PC
239 Causeway Street, Suite 400
Boston, Massachusetts 02114
617.749.9220



Alexander H. Macon, EIT
Staff Geotechnical Engineer 2



Heidi P. Cashman, PE
Associate Geotechnical Engineer

AHM:HPC:kjb

Disclaimer: Any electronic form, facsimile, or hard copy of the original document (email, text, table, and/or figure), if provided, and any attachments are only a copy of the original document. The original document is stored by GeoEngineers USA, PC and will serve as the official document of record.

Table of Contents

Executive Summary ES-1
1.0 Introduction 2
2.0 Site Location and Project Understanding 2
3.0 Subsurface Exploration Program 2
3.1. Subsurface Exploration 2
3.2. Laboratory Testing 3
4.0 Site Conditions 4
4.1. Surface Conditions 4
4.2. Available Subsurface Information 4
4.2.1. Surficial Material 4
4.2.2. Bedrock Geology 4
4.3. Subsurface Conditions 4
4.3.1. Groundwater Conditions 5
5.0 Geotechnical Recommendations 5
5.1. Seismic Design Parameters 6
5.1.1. Seismic Site Class and Design Parameters 6
5.1.2. Liquefaction Potential 6
5.2. Foundation Design recommendations 6
5.2.1. Allowable Bearing Pressure 7
5.2.2. Foundation Dimensions 7
5.2.3. Settlement 7
5.3. Slab-on-Grade 7
5.4. Gravel Roads 7
5.4.1. Drive Isles 7
5.4.2. Embankments and Slopes 8
5.5. Earthwork and Subgrade Preparation 8
5.5.1. Boulder Removal 9
5.5.2. Structural Fill 9
5.5.3. Structural Fill Placement and Compaction Criteria 10
5.5.4. Weather Considerations 10
5.6. Material Reuse 11
5.6.1. Onsite Soil Reuse 11
5.7. Temporary Construction Dewatering 12
6.0 Limitations 12
7.0 References 12

List of Figures

Figure 1. Vicinity Map
Figure 2. Boring Location Map

Appendices

Appendix A. Subsurface Explorations and Laboratory Testing
Figure A-1. Key to Exploration Logs
Figures A-2 through A-4. Logs of Borings
Laboratory Test Results
Appendix B. Report Limitations and Guidelines for Use

Executive Summary

The proposed Site development involves the construction of a Metering and Regulation (M&R) facility on the cape side of the Bourne Bridge to facilitate a new horizontal directional drilling (HDD) gas line crossing the Cape Cod Canal. The Site is currently unimproved woodland with an overhead power utility easement along the southern edge of the Site.

Based on our understanding of the Site concepts and our review of the subsurface conditions, we recommend that the M&R station be supported by conventional spread footings and slab on grade bearing on natural inorganic natural soils (i.e. natural sand deposits).

Boulders were encountered during our exploration program and should be anticipated to be encountered during construction. Localized boulder removal should be anticipated to facilitate foundation and slab construction.

Additional design considerations and recommendations are provided in Section 5.0 of this report.

1.0 Introduction

This report presents the results of GeoEngineers USA, PC (GeoEngineers) geotechnical engineering services for the proposed Metering and Regulating (M&R) Station development at the cape side of the Bourne Bridge along the east side of MacArthur Boulevard (Route 28) in Bourne, Massachusetts (the Site). The Site is shown relative to surrounding physical features in Figure 1, Vicinity Map, and Figure 2, Boring Location Map.

The purpose of this report is to provide geotechnical engineering recommendations for the design and construction of the planned M&R station development on the cape side of the Bourne Bridge. Our services have been completed in general accordance with our signed agreement dated October 31, 2023, and revised April 4, 2025. This report is subject to the attached limitations.

2.0 Site Location and Project Understanding

The Site consists of undeveloped woodland, and it is completely bound by undeveloped woodland. An overhead power utility easement with an associated solar field and dirt road is located to the south of the Site. MacArthur Boulevard (Route 28) and Battles Buick GMC is located to the west of the Site. Existing noteworthy features beyond the Site boundaries include the Cape Cod Canal, which is generally further north of the Site, and the existing Bourne Bridge which is generally further northwest of the Site.

Project concepts are still in development; however, we understand site improvements will consist of removal of woodland and construction of single-story at grade M&R facility and associated equipment.

Building/structure loads are unavailable at this time, however based on discussion with the project team, and our experience with similar structures of this type, we anticipate individual column loads of less than 50 kips and wall loads of less than 4 kips/linear-foot. Building/structure loads once available should be provided to GeoEngineers to confirm our recommendations herein.

3.0 Subsurface Exploration Program

3.1. SUBSURFACE EXPLORATION

GeoEngineers performed a geotechnical subsurface exploration program on March 12, 2025. The exploration program consisted of three (3) borings (designated MR-07, MR-08, and MR-08A) advanced to depths between 17 and 34 feet below the ground surface (bgs) by Geologic Earth Exploration, Inc. (Geologic) of Norfolk, Massachusetts. The borings were advanced using hollow-stem auger drilling methods with a track mounted Acker Rebel drill rig. The borings were continuously monitored by a representative from our firm who logged and classified the soils encountered, obtained representative soil samples, observed groundwater conditions, and prepared logs for the explorations.

Soils encountered in the borings were visually classified in general accordance with the classification system described in Figure A-1. A key to the boring log symbols is also presented in Figure A-1. The logs of the borings are presented in Figures A-2 through A-4 within Appendix A. The boring logs are based on our interpretation of the field and laboratory data and indicate the various types of soils and groundwater

conditions encountered. The logs also indicate the depths at which these soils or their characteristics change, although the change may be gradual. If the change occurred between samples, it was interpreted. The densities noted in the boring logs are based on the blow count data obtained in the borings and judgment based on the conditions encountered.

The soils encountered within the borings were generally sampled at the surface continuously until 10 feet bgs, then at 5-foot vertical intervals thereafter with a 2-inch outside-diameter split-barrel standard penetration test (SPT) sampler. The disturbed samples were obtained by driving the sampler 24 inches into the soil with a 140-pound automatic hammer free-falling 30 inches. The number of blows required for each 6 inches of penetration was recorded. The blow count ("N-value") of the soil was calculated as the number of blows required for the middle 12 inches of penetration. This resistance, or N-value, provides a measure of the relative density of granular soils and the relative consistency of cohesive soils. Where very dense soil conditions precluded driving the full 24 inches, the penetration resistance for the partial penetration was entered on the logs. The blow counts are shown in the boring logs at the respective sample depths. Auger refusal was encountered while auguring boring MR-08 at 17 feet bgs. An offset boring, MR-08A, was augured without sampling to 18 feet, at which the sampling continued.

Observations of groundwater conditions were made during drilling. The groundwater conditions encountered during drilling are presented in the boring logs. Groundwater conditions observed during drilling represent a short-term condition and may or may not be representative of the long-term groundwater conditions at the Site. Groundwater conditions observed during drilling should be considered approximate.

Logs of the test borings are provided in Appendix A, Subsurface Exploration and Laboratory Testing.

3.2. LABORATORY TESTING

Eight (8) soil samples were submitted to Geotesting Express of Acton, Massachusetts for geotechnical laboratory testing in accordance with the standards provided in ASTM International (ASTM) and American Association of State Highway and Transportation Officials (AASHTO) procedures. One (1) representative composite sample was created of representative soil samples from MR-08/MR-8A and the following laboratory tests were conducted.

- One (1) Standard Classification, per ASTM D2488
- Three (3) gradation analysis (sieve only), per ASTM D6913.
- Three (3) moisture content determinations, per ASTM D2216.
- One (1) unit weight determination, per ASTM D7263.
- One (1) soil electric resistivity test on the composite sample, per ASTM G57.
- One (1) sulfate determination on the composite sample, per ASTM D516.
- One (1) chloride determination on the composite sample, per ASTM D512.
- One (1) pH determination on the composite sample, per ASTM D4972.

Laboratory test results are provided in Appendix A, Subsurface Exploration and Laboratory Testing.

4.0 Site Conditions

4.1. SURFACE CONDITIONS

Site survey information is unavailable at this time. The Site is generally a flat plateau that slopes down along the east, south, and west edge of the Site towards the undeveloped woodland. An overhead power utility easement corridor runs along the southern edge of the Site and an associated solar field is present to the southeast. An existing dirt road is present within the overhead power utility easement along the south edge of the Site connecting MacArthur Boulevard (Route 28) to the solar field.

4.2. AVAILABLE SUBSURFACE INFORMATION

4.2.1. Surficial Material

Surficial geologic mapping indicates that late Wisconsin Age (75,000 to 11,000 years ago) glacial stratified coarse deposits of gravel and sand are the predominant surficial materials present at the Site. The glacial deposits are typically composed of at least 50 percent gravel-size clasts; cobbles and boulders predominate; with minor amounts of sand within gravel layers, and minor layers of sand. The gravel layers are generally poorly sorted, and bedding is commonly distorted and faulted due to post-depositional collapse related to the melting of ice. The sand and gravel deposits occur as mixtures of gravel and sand within individual layers and as layers of sand alternating with layers of gravel. The sand and gravel layers generally range between 25 and 50 percent gravel particles and between 50 and 75 percent sand particles. Sand deposits are composed mainly of very coarse to fine sand, commonly in well-sorted layers and may contain up to 25 percent gravel. Finer layers may contain some very fine sand, silt, and clay. The thickness of the glacial deposits is expected to be over 100 feet, overlying the bedrock described below (Stone, et al, 2019), (Hartshorn, et al, 1991).

4.2.2. Bedrock Geology

Geologic mapping indicates the primary bedrock present at the Site is Proterozoic Age (2,500 to 542 million years ago) plutonic and metamorphic rocks consisting primarily of granite, gneiss, and schist (undivided) (Zen, et al, 1983).

4.3. SUBSURFACE CONDITIONS

In general, the soil conditions observed at the Site consist of topsoil, underlain by subsoil, and natural sand deposits. Details of the subsurface strata from the explorations by GeoEngineers are summarized below from the ground surface down:

- **Topsoil:** A topsoil layer was encountered at all boring locations and was observed at ground surface across the Site. The topsoil was observed to be approximately 4- to 5-inches thick. The topsoil was stripped while clearing vegetation from pathways to the boring locations and therefore information about topsoil density was not obtained.
- **Subsoil:** A layer of subsoil was observed beneath the topsoil layer at all boring locations. The bottom of subsoil was approximately 2 feet bgs at all boring locations. The subsoil layer primarily consists of silty fine to medium-grained sand with varying amounts of gravel, and trace amount of organic matter (roots). The N-values in the subsoil material generally indicated a very loose condition.

- **Natural Sand Deposits:** Natural sand deposits were observed underlying the subsoil, within all borings, and extend to the depths explored. Borings were terminated within the natural sand deposits, therefore the natural sand deposits depths are likely deeper than reported herein.

  The natural sand deposits primarily consist of fine to coarse-grained sand with varying amounts of gravel and silt. The N-values in the natural sand material indicate a condition ranging from loose to very dense but are generally medium dense to very dense. The gravel contents in natural sand samples selected for grain-size ranged from about 0 to 25 percent. The fines contents in the natural sand samples selected for grain-size analysis ranged from about 1 to 4 percent. The moisture contents in the natural sand samples selected for analyses ranged from about 3 to 5 percent. The unit weight of the natural sand sample selected for analysis was about 96 pounds per cubic foot (pcf). Auger refusal was encountered at 17 feet bgs within boring MR-08, which likely indicates the presence of cobbles and/or boulders within the natural sand deposits. Drill rig chatter was noted while drilling throughout the natural sand deposits, another potential indication of the presence of gravel, cobbles, and/or boulders within this layer.

4.3.1. Groundwater Conditions

Groundwater was not observed during drilling of the test borings. However, it should be noted that groundwater levels will vary depending on tidal action, seasonal variations in temperature and precipitation, and can also be influenced by subsurface utilities, construction activities and other factors.

5.0 Geotechnical Recommendations

Below is a summary of the geotechnical considerations associated with design and development of the Site. Additional details are provided in subsequent sections of this report.

- The proposed building/structures can be supported by conventional shallow spread footings and a slab-on-grade following removal of topsoil and subsoil containing roots. Foundations should bear directly on natural sand deposits or compacted structural fill placed over natural sand deposits. Foundations should not bear on topsoil or subsoil.
- The subsoil (both organic and inorganic) is not suitable for foundation support; however, the existing inorganic subsoil (i.e. subsoil free of roots) can remain in place below the slab provided the subgrade is prepared as specified herein.
- Localized boulders are anticipated within the natural sand deposits, as evidenced from drilling action and auger refusal during our field exploration program. Localized boulder removal should be anticipated at the proposed foundation, slab, and utility areas. We anticipate that boulders could be removed using large excavators or by mechanical means (i.e. hoe-ramming). We recommend that boulders (if encountered) should be removed to at least 12 inches below footings and sub-slab utilities.
- Inorganic granular soils (i.e., inorganic subsoil and natural sand deposits) from cut/fill activities can be re-used as backfill provided it is placed and compacted as specified herein.

5.1. SEISMIC DESIGN PARAMETERS

5.1.1. Seismic Site Class and Design Parameters

The Massachusetts State Building Code 10th edition (MSBC10) incorporates the 2021 International Building Code (2021 IBC) by reference with state specific amendments. We have considered the soil conditions encountered in the borings to be consistent and representative of the soil conditions in the top 100 feet of soil at this Site. Given this, it is GeoEngineers' opinion that the Site is best characterized as Site Class D. The 2021 IBC seismic design parameters are presented in Table 1.

TABLE 1. 2021 IBC SEISMIC DESIGN PARAMETERS

2021 IBC PARAMETER	RECOMMENDED VALUE
Mapped Spectral Acceleration for short periods, (S_S):	0.180
Mapped Spectral Acceleration for 1-sec period, (S_1):	0.052
Site Class:	D
Site Coefficient, (F_a):	1.6
Site Coefficient, (F_v):	2.4
5% damped design spectral response acceleration at short periods, (S_{DS}):	0.192
5% damped design spectral response acceleration at 1-sec periods, (S_{D1}):	0.083
Anticipated Risk Category:	IV
Seismic Design Category:	C

Note:

The anticipated risk category is based on the assumption that the M&R stations are critical to national defense and would be part of the gas line supplying the military base Joint Base Cape Cod. Should a lower anticipated risk category of III be permitted, a seismic design category of B can be justified.

5.1.2. Liquefaction Potential

The soils encountered at the Site are not considered susceptible to liquefaction based on the criteria set forth in section 1806.4 of MSBC10.

5.2. FOUNDATION DESIGN RECOMMENDATIONS

We recommend the proposed structures be supported on conventional shallow spread footings. Footings should bear directly on inorganic, natural, granular soil (i.e. natural sand deposits), or structural fill placed over the natural sand deposits.

Foundations should not bear directly on topsoil, subsoil, or boulders. Some over-excavation of the existing topsoil and subsoil may be necessary to expose the top of the natural sand deposits suitable for footing bearing. The existing topsoil and subsoil material (both organic and inorganic), where present, should be excavated from within the zone of influence (ZOI) of the footings. The ZOI is defined as a one (1) horizontal to one (1) vertical (1H:1V) line projecting outward and downward from the outside edge of the foundation element. Additional construction recommendations for subgrade preparation are provided in Section 5.5 Earthwork and Subgrade Preparation.

Where boulder removal is required to achieve the bottom of footing elevation, the boulder should be removed to allow placement of 12 inches of Gravel Fill to provide a soil cushion between the bottom of footing and boulder surface to minimize the potential for hard spots below the footing and the potential for differential settlement.

5.2.1. Allowable Bearing Pressure

For foundations constructed as recommended in this report, we recommend using a net allowable bearing pressure of 4 kips per square foot (ksf). The allowable bearing pressure applies to the total of dead and long-term live loads. Building/structure loads are unavailable at this time and the allowable soil bearing pressure is based upon assumed building/structure loads. Based on our experience with similar building/structures of this type we assume that individual column loads will likely be less than 50 kips and wall loads will likely be less than 4 kips/linear-foot. Building/structure loads once available should be provided to GeoEngineers to confirm our recommendations herein.

5.2.2. Foundation Dimensions

The minimum recommended lateral dimension for isolated spread footings is 36 inches, while continuous wall footings should be at least 18 inches wide. Footings in areas exposed to freezing temperatures should be founded at least 4 feet below exterior finished grade for frost protection. Interior footings, in areas not exposed to freezing temperatures, should be at least 24 inches below finished floor grade, or a depth that provides at least 12 inches between the top of footing and finished floor elevation, whichever is deeper. A minimum 12-inch soil cushion should be provided between the bottom of the footing and top of boulders.

5.2.3. Settlement

Provided that topsoil and subsoils (both organic and inorganic) are removed, and that the subgrade is prepared as recommended herein, we estimate that the total post-construction settlement, based on assumed column loads, will be less than 1 inch. Post-construction, differential settlements are estimated to be less than 0.5 inches between adjacent columns but will vary based on live load distribution and column spacing.

5.3. SLAB-ON-GRADE

The slab-on-grade should bear on a minimum of 12 inches of base course (Gravel Fill). For slabs designed as a beam on an elastic foundation, a modulus of subgrade reaction of 150 pounds per cubic inch (pci) may be used for subgrade soils prepared as recommended.

5.4. GRAVEL ROADS

5.4.1. Drive Isles

All surficial topsoil and subsoil containing roots should be removed from proposed gravel road subgrades and embankments. Exposed natural subgrades (i.e. the natural sand deposits) should be proofrolled, and soft or loose areas identified should be over-excavated and replaced with Gravel Fill as specified in Section 5.5 Earthwork and Subgrade Preparation.

Geogrid such as Tensar NX750, or equivalent, should be placed over the prepared subgrade materials (i.e. the natural sand deposits), and overlain with a minimum of 12-inches of Gravel Fill material. The Gravel Fill material will bind together better than the natural on-site soils, and (in combination with the geogrid) is

expected to distribute vehicular loads and minimize settlement over time. The Gravel Fill material should conform with MassDOT Item M2.01.7-1, dense-graded crushed stone, see Section 5.5.2 Structural Fill. If settlement control is not considered critical, the geogrid can be omitted and a filter fabric placed over the prepared subgrade materials (i.e. the natural sand deposits). The filter fabric would then be overlain with a minimum of 12-inches of Gravel Fill material.

It should be noted that the gravel road will require regular maintenance, with additional gravel placement and regrading, following potential rutting and long-term settlement, to maintain access to the site.

5.4.2. Embankments and Slopes

The following recommendations are applicable for the construction of gravel roadway embankment slopes, and for general site slopes required to facilitate site/road grades.

- For slopes with angles flatter than 3H:1V, the slope face should be established with vegetative cover as quickly as practical to prevent erosion. We recommend that the topsoil layer be limited to 4 to 6 inches thick and a jute mat be placed along the slope face. The contractor is responsible for maintaining the slope face (i.e., stability) until vegetation is fully established.
- For slopes with angles between 3H:1V and 2H:1V, we recommend the slope face be protected with a non-woven geotextile fabric such as Mirafi 140N, or equivalent, and overlain with a minimum of 18-inches of Riprap meeting the requirements for MassDOT Item M2.02.0, Riprap.
- Fill slopes should be constructed with Structural Fill as described herein.

Slopes with angles steeper than 2H:1V are not recommended. Should slopes with angles steeper than 2H:1V be required they should be coordinated with GeoEngineers and will require an evaluation for slope stability (i.e., performance of a slope stability analysis).

5.5. EARTHWORK AND SUBGRADE PREPARATION

The following paragraphs describe the recommended earthwork procedures for preparation of the building/structure areas.

- Unsuitable materials (topsoil and subsoil containing roots) should be removed in their entirety from the proposed building/structures footprint and 5 feet beyond.
- The existing topsoil and subsoil (both organic and inorganic) should be over-excavated below proposed footings, and perimeter foundation walls down to a subgrade consisting of inorganic, granular, natural soil (i.e. natural sand deposits). Over-excavation should extend to the ZOI of the footings as previously defined herein. Footings should not bear on subsoil; however, subsoil free of roots may remain below the proposed slab-on-grade.
- Following removal of the unsuitable materials noted above and prior to placing raise-in-grade fill, the exposed subgrade within the building/structures footprint, and 5 feet beyond the exterior walls, should be proof-compacted with at least eight (8) passes of a 20-ton smooth-drum, vibratory roller until visibly firm and stable as observed by the Geotechnical Engineer or their qualified representative. Any soft or loose areas identified during proof-compaction should be over-excavated and replaced with Gravel Fill as specified herein.

- Footing subgrades should be excavated with a smooth-edge bucket to limit disturbance to the underlying subgrade. If footings are excavated with a toothed bucket, the subgrade should be compacted with at least six (6) passes of a 1,000-pound vibratory plate compactor, or equivalent effort, until the subgrade is visibly firm and stable as observed by the Geotechnical Engineer or his/her qualified representative. Footings should bear directly on the natural, inorganic, granular soil (i.e. natural sand deposits) or Gravel Fill placed directly over the natural sand deposits.
- Localized areas of boulders are anticipated below within the proposed building and structures, and should be removed using large excavators or mechanical means (i.e. hoe-ramming) to at least 12 inches below the base course for slabs and 12 inches below the bottom of footing in the building areas.
- Where boulders are present at the footing subgrade, the boulders should be removed 12 inches below the bottom of footing and replaced with a soil cushion of compacted Gravel Fill. Footings should bear directly on soil, to avoid the potential for differential settlement due to hard spots below the footing.
- Raise-in-grade fill placed within the building pad and structure areas to achieve Site grades should consist of Structural Fill, as specified herein. Structural Fill should be placed in 12-inch-thick, loose lifts and compacted to at least 95 percent of its maximum dry density as determined by ASTM D1557, Method C (modified proctor).
- For the slab-on-grade, the exposed subgrade (for base course) should be proof-compacted with at least eight (8) passes of a 20-ton smooth-drum, vibratory roller until visibly firm and stable as observed by the Geotechnical Engineer or their qualified representative. The final 12 inches of soil directly below the slab-on-grade should consist of Gravel Fill as defined herein and compacted to at least 95 percent of its maximum dry density as determined by ASTM D1557 Method C (Modified Proctor).
- The excavated on-site soils may be re-used as raise-in-grade fill, provided it meets the requirements for Structural Fill provided herein. Raise-in-grade fill and backfill should be placed and compacted in maximum 12-inch-thick loose lifts and compacted as specified herein.
- Temporary cut slopes of natural material below proposed footings for building and structure foundations should be conducted at a 1.5H:1V slope angle (or shallower) to maintain a safe excavation.

5.5.1. Boulder Removal

Boulders were encountered within the natural sand deposits during drilling, as such localized boulders are expected to be present at subgrades elevations. It is recommended that boulders, if encountered, be removed to at least 12 inches below the bottom of utility corridors, foundations, and slabs so that they are supported by a cushion of compacted soil to limit the potential for differential settlement due to hard spots. If boulders are encountered in areas where there are building/structures, boulders should be removed to allow construction of the base course layer below the slabs.

5.5.2. Structural Fill

Raise-in-grade fill placed within the building pad/structures and site areas should consist of Structural Fill as described below:

- Gravel Fill to serve as the base course for the building slab should consist of hard, inert, durable gravel and sand. The material should be free from organics, clay, loam, sticks, snow/ice, debris and other deleterious materials. Gravel Fill should be processed to meet the gradation requirements for MassDOT Item M2.01.7-1, dense-graded crushed stone.

- Soil material generated from on-site cut areas, free of organics and other deleterious material, may be used as raise-in-grade fill below the base course layer. On-site fill should have a maximum particle size of 6 inches. On-site fill meeting the gradation requirements below and free from roots and organics, may be used as general raise-in-grade fill below building, structure, and Site areas.

SIEVE SIZE	PERCENT PASSING BY WEIGHT
6-inch	100
1-inch	85-100
No. 4	20-90
No. 40	10-75
No. 200	0-40*

Note:
Silt content of the subsoil may vary. The on-site inorganic material is intended to be re-used as backfill below the base course layer provided it is placed and compacted as specified herein.

- Structural Fill imported from off-site sources and used as backfill within the building/structure areas, and as general raise in grade fill in non-building areas (below base course) should consist of the following:

SIEVE SIZE	PERCENT PASSING BY WEIGHT
4-inch	100
1-inch	70-100
No. 40	30-60
No. 200	0-10

- Structural Fill placed within irregularly shaped utility trenches or trenches not accessible to compaction equipment should consist of Controlled Density Fill (CDF) consisting of high slump Portland Cement Concrete (PCC) with a compressive strength less than 150 pci at 28 days; otherwise, the trench should be backfilled in accordance with the project specifications.

5.5.3. Structural Fill Placement and Compaction Criteria

Structural Fill should be mechanically compacted to a firm, non-yielding (stable) condition. Structural Fill should be placed in loose lifts approximately 12 inches thick. Each lift should be conditioned to the proper moisture content and compacted as specified herein before placing subsequent lifts. Structural Fill should be compacted to the following criteria:

- Structural Fill should be compacted to at least 95 percent of its maximum dry density as determined by ASTM D1557 Method C, Modified Proctor.

5.5.4. Weather Considerations

The subsoil contains a sufficient percentage of fines and should be considered sensitive to moisture and frost susceptible. When the moisture content of these soils is more than a few percent above the optimum moisture content, these soils become unstable, and operation of equipment on these soils and compaction

of these soils is difficult. Additionally, disturbance of near-surface soils should be expected if earthwork is completed during periods of wet weather. During wet weather, we recommend the following:

- The ground surface in and around the work area should be graded so that surface water is directed away from the work area. The ground surface should be graded such that areas of ponded water do not develop. The contractor should take measures to prevent surface water from collecting in excavations and trenches. Measures should be implemented to remove surface water from the work area, and it should not be directed towards downslope structures, unless properly collected and conveyed to appropriate catch basins.
- Earthwork activities should not take place during periods of moderate to heavy precipitation.
- Slopes with exposed soils should be covered with plastic sheeting or similar means.
- The contractor should take necessary measures to prevent on-site soils, and soils to be used as fill, from becoming wet or unstable. These measures may include temporary construction dewatering, the use of plastic sheeting, sumps with pumps, and grading. The Site soils should not be left uncompacted and exposed to moisture. Sealing the surficial soils by rolling with a smooth-drum roller prior to periods of precipitation will reduce the extent to which these soils become wet or unstable.
- The contractor should cover all soil stockpiles that will be used as structural fill with plastic sheeting.
- Construction traffic should be restricted to specific areas of the Site, preferably areas that are surfaced with materials not susceptible to wet weather disturbance.
- Construction activities should be scheduled so that the length of time that soils are left exposed to moisture is reduced to the extent practicable.
- Footings and backfill should not be placed over a subgrade with standing water or that is frozen.

In the event that standing water is present on the subgrade, the water should be removed from the surface and any soft and yielding soils should be removed or allowed to dry prior to the placement of backfill. In the event that the subgrade is frozen, the soil that is frozen should be removed, or thawed and re compacted prior to placement of backfill.

5.6. MATERIAL REUSE

5.6.1. Onsite Soil Reuse

Based on available data, we anticipate that the natural soils (inorganic subsoil and natural sand deposits, free of organics and other deleterious materials) may be suitable for reuse below building/structures and Site areas provided they can be placed and compacted in accordance with the project specifications and recommendations herein. Subsoil may be sensitive to excess moisture as described herein.

Subsoil containing organics could be screened of organics and reused in Site. Natural on-site soil (i.e., subsoil or natural sand deposits) containing organics are suitable for re-use in landscaped areas. Stripped on-site topsoil can be reused as topsoil within landscaped areas provided it meets project environmental and landscape architecture requirements.

5.7. TEMPORARY CONSTRUCTION DEWATERING

Groundwater, while generally not encountered at the Site, may still impact Site construction activities during the wet seasons due to surficial runoff and ponding. As such localized dewatering may be necessary for deep construction activities (i.e., deep excavations). We anticipate that dewatering can be achieved by installing sumps at low points in the excavation. Sumps should be constructed with crushed stone wrapped in a geotextile fabric. Groundwater is anticipated to be recharged on Site to the ground surface, and should be performed in accordance with local, State, and Federal regulations.

6.0 Limitations

We have prepared this report for Enbridge, Inc., who may distribute copies of this report to their authorized agents and regulatory agencies as may be required for the project.

Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices in the field of geotechnical engineering in this area at the time this report was prepared. The conclusions, recommendations, and opinions presented in this report are based on our professional knowledge, judgment, and experience. No warranty or other conditions, express or implied, should be understood.

Any electronic form, facsimile or hard copy of the original document (email, text, table and/or figure), if provided, and any attachments should be considered a copy of the original document. The original document is stored by GeoEngineers USA, PC and will serve as the official document of record.

Please refer to Appendix B entitled “Report Limitations and Guidelines for Use” for additional information pertaining to use of this report.

7.0 References

ASCE 7-16, 2017. “Minimum Design Loads for Buildings and Other Structures,” American Society of Civil Engineers.

ASTM D-1557, 2012. “Standard Testing Method for Laboratory Compaction Characteristics of Soil Using Modified Effort,” ASTM International.

Commonwealth of Massachusetts Department of Transportation (MassDOT), 2022, “Standard Specifications for Highways and Bridges.”

Hartshorn, J.H., Thompson, W.B., Chapman, W.F., Black, R.F., Richmond, G.M., Grant, D.R., and Fullerton, D.S., 1991, Quaternary Geologic Map of the Boston 4 Degrees x 6 Degrees Quadrangle, United States and Canada, U.S. Geological Survey, Miscellaneous Investigations Series Map I-1420 (Nk-19), Scale 1:1,000,000.

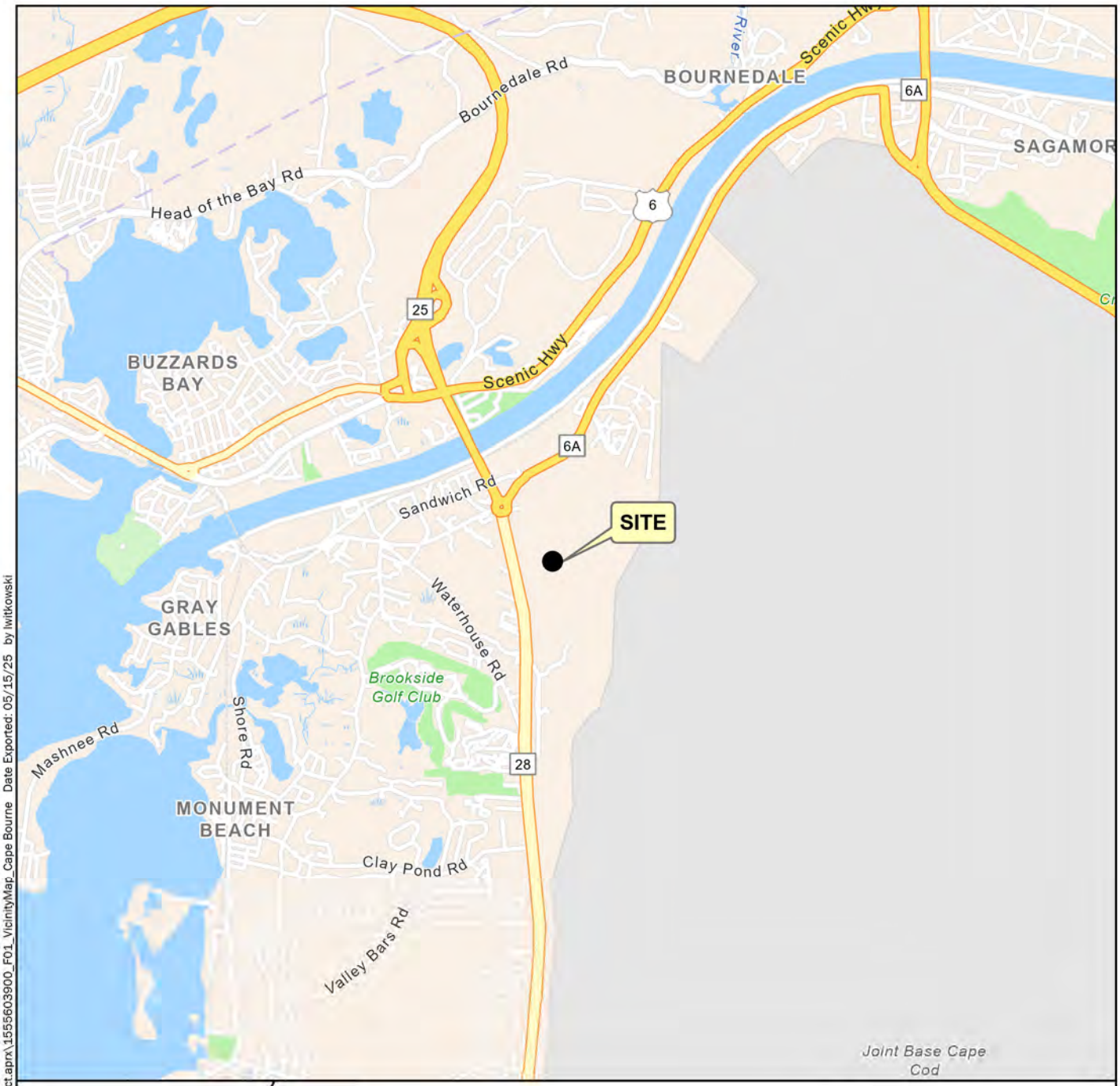
International Code Council, 2021, “International Building Code.”

Massachusetts State Building Code, 2021, “780 CMR Tenth Edition.”

Stone, J.R., Stone, B.D., Digiacomo-Cohen, M.L., and Mabee, S.B., 2019, Surficial Materials of Massachusetts—A 1:24,000-Scale Geologic Map Database, U.S. Geological Survey, Scientific Investigations Map Sim-3402, Scale 1: 24,000.

Een, E-An, Goldsmith, Richard, Ratcliffe, N.M., Robinson, Peter, Stanley, R.S., Hatch, N.L., Shride, A.F., Weed, E.G.A., and Wones, D.R., 1983, Bedrock Geologic Map of Massachusetts, U.S. Geological Survey, Scale 1:250,000.

Figures





N

0 2,000

Feet

Source(s):
- ESRI

Coordinate System: NAD 1983 StatePlane Massachusetts Mainland FIPS 2001 Feet

Disclaimer: This figure was created for a specific purpose and project. Any use of this figure for any other project or purpose shall be at the user's sole risk and without liability to GeoEngineers. The locations of features shown may be approximate. GeoEngineers makes no warranty or representation as to the accuracy, completeness, or suitability of the figure, or data contained therein. The file containing this figure is a copy of a master document, the original of which is retained by GeoEngineers and is the official document of record.

Vicinity Map

Cape Canal Bridge Replacement Project
Cape Bourne M&R Station
Barnstable County, Massachusetts

GeoEngineers USA

Figure 1

P:\15\15556039\GIS\15556039_Project\15556039_Project\15556039_Project.aprx\1555603900_F01_VicinityMap_Cape Bourne Date Exported: 05/15/25 by lwitkowski



Note(s):
1. GeoEngineers, USA, P.C. has not verified the field location of the existing utilities.

Source(s):
- Aerial from Google Earth Pro, dated 05/27/23.

Coordinate System: MA State Plane, Mainland Zone, NAD83, US Foot

Disclaimer: This figure was created for a specific purpose and project. Any use of this figure for any other project or purpose shall be at the user's sole risk and without liability to GeoEngineers USA, P.C. The locations of features shown may be approximate. GeoEngineers, USA, P.C makes no warranty or representation as to the accuracy, completeness, or suitability of the figure, or data contained therein. The file containing this figure is a copy of a master document, the original of which is retained by GeoEngineers and is the official document of record.

Legend

Boring Location

Site Boundary

N

0 200

Feet

Boring Location Map

Cape Canal Bridge Replacement Project
Cape Bourne M&R Station
Barnstable County, Massachusetts

GeoEngineers USA

Figure 2

TJP : BTL

P:\15\15556039\CAD\00\HDD\Cape Bourne\15556039OO_F2 BLM.dwg\TAB:FIGURE 2 modified on May 14, 2025 - 11:29am LWITKOWSKI

Appendices

Appendix A
Subsurface Exploration and Laboratory Testing

Appendix A
Field Explorations and Laboratory Testing

FIELD EXPLORATIONS

We explored subsurface conditions at the site on March 12, 2025 by drilling three (3) geotechnical borings (MR-07, MR-08, and MR-08A). The geotechnical borings were drilled to depths of up to approximately 17 and 34 feet below ground surface (bgs) and utilized a track-mounted drill rig. The locations of the borings are shown in the attached Boring Location Map, Figure 2. The Massachusetts DigSafe utility locating agency was contacted to locate utilities in the project area prior to the start of the exploratory borings.

A GeoEngineers representative observed field activities, classified the soil encountered, obtained representative samples, and prepared a log of each exploration. The soils encountered were classified visually in general accordance with American Society for Testing and Materials (ASTM) D2487, which is described in Figure A-1.

In general, soil samples were obtained from the borings continuously to a depth of 10-feet and then at 5-foot-depth intervals using 2-inch I.D. split-spoon samplers. The split-spoon samplers were driven 24 inches during Standard Penetration Tests (SPT), using a 140-pound automatic hammer with a 30-inch drop. The number of hammer blows required to drive the sampler the middle 12-inches was recorded on field logs. Each boring was backfilled upon completion with cement-bentonite grout.

The relative density of the SPT samples recovered at each interval was evaluated based on correlations with lab and field observations in general accordance with the values outlined in Table A-1 below.

TABLE A-1 CORRELATION BETWEEN BLOW COUNTS AND RELATIVE DENSITY[1]

COHESIVE SOILS (CLAY/SILT)						
Parameter	Very Soft	Soft	Medium Stiff	Stiff	Very Stiff	Hard
Blows, N	< 2	2 – 4	4 – 8	8 – 16	16 – 32	> 32
COHESIONLESS SOILS (GRAVEL/SAND/SILTY SAND)[2]						
Parameter	Very Loose	Loose	Medium Dense		Dense	Very Dense
Blows, N	0 – 4	4 – 10	10 – 30		30 – 50	> 50

Notes:

[1]After Terzaghi, K and Peck, R.B., "Soil Mechanics in Engineering Practice," John Wiley & Sons, Inc., 1962.

[2]Classification applies to soils containing additional constituents; that is, organic clay, silty or clayey sand, etc.

The exploration logs are presented in Figures A-2 through A-4. The logs are based on our interpretation of the field data and indicate the various types of soil encountered while indicating the approximate depths at which the subsurface conditions change. Unless noted on the boring logs, the lines between soil units represent approximate boundaries. The transition between materials may be gradual or may occur between recovered samples. Additionally, the boring logs represent conditions observed at the time of drilling and have been edited to incorporate results of the laboratory tests performed as appropriate.

LABORATORY TESTING

General

Soil samples obtained from the borings were transported to Geocomp Corporation's GeoTesting Express' laboratory in Acton, Massachusetts and examined to confirm or modify field classifications. Representative soil samples were selected for laboratory testing consisting of standard classification, sieve analyses, moisture content determination, unit weight determination, resistivity testing, sulfate determination, chloride determination, and pH determination. The laboratory testing procedures are discussed in more detail below. A summary of the lab results is shown in the attached Laboratory Test Results.

Standard Classification of Soils

Standard classification of soils was performed on selected coarse-grained samples in general accordance with ASTM D2488. The results of the of the classification are in general accordance with the Unified Soil Classification System (USCS) and are presented in the attached Laboratory Test Results.

Sieve Analysis

Sieve analyses were performed on selected coarse-grained samples in general accordance with ASTM D6913. The results of the sieve analyses were plotted and classified in general accordance with the Unified Soil Classification System (USCS) and are presented in the attached Laboratory Test Results. The percentage passing the U.S. No. 200 sieve is shown on the boring logs at the respective sample depths.

Moisture Content

Moisture content determinations were performed on selected coarse-grained samples in general accordance with ASTM D2216. The results of the moisture content determinations are shown on the boring logs at the respective sample depths and presented in the attached Laboratory Test Results.

Unit Weight Determination

Unit weight determinations were performed on selected coarse-grained samples in general accordance with ASTM D7263. The results of the unit weight determinations are presented in the attached Laboratory Test Results.

Soil Resistivity

Laboratory measurements of soil resistivity in general accordance with AASHTO T288 were performed on selected samples. The results of the soil resistivity testing are shown are presented in the attached Laboratory Test Results.

Sulfate Determination

Sulfate determinations were performed on selected coarse-grained samples in general accordance with ASTM D516. The results of the sulfate content determinations are presented in the attached Laboratory Test Results.

Chloride Determination

Chloride determinations were performed on selected coarse-grained samples in general accordance with ASTM D512. The results of the chloride content determinations are presented in the attached Laboratory Test Results.

pH Determination

pH determinations were performed on selected coarse-grained samples in general accordance with ASTM D4972. The results of the pH determinations are presented in the attached Laboratory Test Results.

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES
	MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
MORE THAN 50% RETAINED ON NO. 200 SIEVE	SAND AND SANDY SOILS	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS
				SP	POORLY-GRADED SANDS, GRAVELLY SAND
	MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS, ROCK FLOUR, CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
MORE THAN 50% PASSING NO. 200 SIEVE	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS AND SILTS OF MEDIUM TO HIGH PLASTICITY
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: Multiple symbols are used to indicate borderline or dual soil classifications

ADDITIONAL MATERIAL SYMBOLS

SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
	AC	Asphalt Concrete
	CC	Cement Concrete
	CR	Crushed Rock/ Quarry Spalls
	SOD	Sod/Forest Duff
	TS	Topsoil

Groundwater Contact

Measured groundwater level in exploration, well, or piezometer

Measured free product in well or piezometer

Graphic Log Contact

Distinct contact between soil strata

Approximate contact between soil strata

Material Description Contact

Contact between geologic units

Contact between soil of the same geologic unit

Sampler Symbol Descriptions

Modified California Sampler (6-inch sleeve) or Dames & Moore

Standard Penetration Test (SPT)

Shelby tube

Piston

Direct-Push

Bulk or grab

Continuous Coring

Blowcount is recorded for driven samplers as the number of blows required to advance sampler 12 inches (or distance noted). See exploration log for hammer weight and drop.

"P" indicates sampler pushed using the weight of the drill rig.

"WOH" indicates sampler pushed using the weight of the hammer.

Laboratory / Field Tests

%F	Percent fines
%G	Percent gravel
AL	Atterberg limits
CA	Chemical analysis
CP	Laboratory compaction test
CS	Consolidation test
DD	Dry density
DS	Direct shear
HA	Hydrometer analysis
MC	Moisture content
MD	Moisture content and dry density
Mohs	Mohs hardness scale
OC	Organic content
PM	Permeability or hydraulic conductivity
PI	Plasticity index
PL	Point load test
PP	Pocket penetrometer
SA	Sieve analysis
TX	Triaxial compression
UC	Unconfined compression
UU	Unconsolidated undrained triaxial compression
VS	Vane shear

Sheen Classification

NS	No Visible Sheen
SS	Slight Sheen
MS	Moderate Sheen
HS	Heavy Sheen

NOTE: The reader must refer to the discussion in the report text and the logs of explorations for a proper understanding of subsurface conditions. Descriptions on the logs apply only at the specific exploration locations and at the time the explorations were made; they are not warranted to be representative of subsurface conditions at other locations or times.

Key to Exploration Logs

GeoEngineers USA

Figure A-1

Drilled: Start 3/12/2025 End 3/12/2025	Total Depth (ft): 32	Logged By: AM Checked By: HPC	Driller: Geologic Earth Exploration, Inc.	Drilling Method: Hollow-stem Auger	
Surface Elevation (ft): 116.196 Vertical Datum: NAVD88		Hammer Data: Autohammer 140 (lbs) / 30 (in) Drop		Drilling Equipment: Acker Rebel	
Easting (X): 907051.755 Northing (Y): 2731171.657		System Datum: Mass State Plane Mainland NAD83 (feet)		Groundwater not observed at time of exploration	

Notes:

Elevation (feet)	Depth (feet)	FIELD DATA: Interval	Recovered (in)	Blows/foot	Sample Name Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
115	0		12	WOH-WOH-1-3 (1)	S-1		SM	Orange brown silty fine to medium sand with trace organic matter (roots), trace fine gravel (very loose, moist) (subsoil)			Topsoil stripped while clearing vegetation prior to drilling. Adjacent topsoil approximately 5-inches thick
			12	2-2-5-13 (7)	S-2		SP	Light brown fine to coarse sand with fine gravel, trace silt (loose, moist)			
			13	3-6-8-16 (14)	S-3			Becomes fine to medium sand with trace fine gravel and dense			
110	5		14	11-9-7-10 (16)	S-4						Light rig chatter from 7 to 9 feet
			14	3-7-9-14 (16)	S-5						
105	10										
100	15		18	6-6-6-8 (12)	S-6 MC, SA			Becomes fine to coarse, with gravel	4.6	2.2	% Gravel = 14.2
								Becomes fine to medium with fine gravel and medium dense			
95	20		13	18-19-20-30 (39)	S-7		SP	Light brown fine to coarse sand with trace silt and gravel (dense, moist)			Moderate rig chatter from 20 to 24 feet. Inferred cobbles from 20 to 24 feet
90	25		10	8-10-14-35 (24)	S-8 MC, SA			Becomes medium dense	3.2	4.2	Moderate rig chatter from 25 to 27 feet % Gravel = 24.6
85	30		12	7-8-11-16 (19)	S-9			Becomes fine to medium			
								Boring terminated at 32 feet below ground surface. Backfilled to grade with drilling cuttings.			

Note: See Figure A-1 for explanation of symbols.
Coordinates Data Source: Horizontal approximated based on survey data completed by Enbridge. Vertical approximated based on survey data completed by Enbridge.

Log of Boring MR-7

GeoEngineers USA

Project: Cape Canal Bridge Relocation - M&R Stations
Project Location: Barnstable County, Massachusetts
Project Number: 15556-039-00

Figure A-2
Sheet 1 of 1

Date:5/14/25 Path:P:\15\15556039\GINT\15556039OO.GPJ DBLibrary/Library:GEOUSA_DF_STD_US.GLB/GEI8_GEOTECH_STANDARD_%F_NO_GW_4BC

Drilled	Start 3/12/2025	End 3/12/2025	Total Depth (ft) 17	Logged By AM / Checked By HPC	Driller Geologic Earth Exploration, Inc.	Drilling Method Hollow-stem Auger
Surface Elevation (ft) / Vertical Datum	119.38 NAVD88		Hammer Data	Autohammer 140 (lbs) / 30 (in) Drop	Drilling Equipment	Acker Rebel
Easting (X) / Northing (Y)	907231.26 2731085.47		System Datum	Mass State Plane Mainland NAD83 (feet)	Groundwater not observed at time of exploration	

Notes:

Elevation (feet)	Depth (feet)	Interval	Recovered (in)	Blows/foot	Sample Name Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
	0		14	WOH-1-1-2 (2)	S-1		SM	Orange brown silty fine to medium sand with trace organic matter (roots) (very loose, moist) (subsoil)			Topsoil stripped while clearing vegetation prior to drilling. Adjacent topsoil approximately 4-inches thick
			9	4-6-13-12 (19)	S-2		SP	Light brown fine to coarse sand with fine gravel, trace silt (medium dense, moist)			
115			16	2-7-6-8 (13)	S-3 MC, SA, DD			Becomes fine to medium, without gravel	3.1	1	% Gravel = 0.0; Dry density = 96.1 pcf
	5		15	7-6-7-12 (13)	S-4			Becomes with trace fine gravel			
110			14	8-4-7-9 (14)	S-5						
	10										
105											
	15			6-10-11-25 (21)	S-6			Becomes fine to coarse, with gravel			Light rig chatter at 15 feet. Moderate rig chatter from 15 to 17 feet
								Boring terminated at 17 feet below ground surface due to auger refusal. Backfilled to grade with drilling cuttings.			Auger refusal at 17 feet below ground surface, offset boring

Note: See Figure A-1 for explanation of symbols.
Coordinates Data Source: Horizontal approximated based on survey data completed by Enbridge. Vertical approximated based on survey data completed by Enbridge.

Log of Boring MR-8

GeoEngineers USA

Project: Cape Canal Bridge Relocation - M&R Stations
Project Location: Barnstable County, Massachusetts
Project Number: 15556-039-00

Figure A-3
Sheet 1 of 1

Date:5/14/25 Path:P:\15\15556039\GINT\15556039OO.GPJ DBLibrary/Library:GEOUSA_DF_STD_US.GLB/GEI8_GEOTECH_STANDARD_%F_NO_GW_4BC

Drilled Start 3/12/2025 End 3/12/2025	Total Depth (ft) 33.5	Logged By AM Checked By HPC	Driller Geologic Earth Exploration, Inc.	Drilling Method Hollow-stem Auger	
Surface Elevation (ft) 119.848 Vertical Datum NAVD88		Hammer Data Autohammer 140 (lbs) / 30 (in) Drop		Drilling Equipment Acker Rebel	
Easting (X) 907209.848 Northing (Y) 2731102.268		System Datum Mass State Plane Mainland NAD83 (feet)		Groundwater not observed at time of exploration	

Notes:

Elevation (feet)	Depth (feet)	FIELD DATA: Interval Recovered (in)	FIELD DATA: Blows/foot	FIELD DATA: Sample Name Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
	0									Boring offset from MR-08 and drilled down to 18 feet below ground surface to continue sampling
115	5									
110	10									
105	15									
						SP	Light brown fine to coarse sand with trace silt and gravel (medium dense, moist)			Moderate rig chatter from 17 to 17½ feet. Very difficult augering at 18 feet Moderate rig chatter from 18 to 20 feet. Inferred boulders 17 to 20 feet
100	20	16	20-10-7-6 (17)	S-1						Light rig chatter from 20 to 25 feet.
95	25	16	12-14-18-22 (32)	S-2			Becomes with trace fine gravel and dense			Moderate rig chatter from 27½ to 30 feet
90	30	0	20-28-25-33 (53)	S-3			Cobble pieces in tip of spoon, no recovery Becomes very dense			
		11	28-30-50/5" (80)	S-4						

Boring terminated at 33½ feet below ground surface.
Backfilled to grade with drilling cuttings.

Note: See Figure A-1 for explanation of symbols.
Coordinates Data Source: Horizontal approximated based on survey data completed by Enbridge. Vertical approximated based on survey data completed by Enbridge.

Date:5/14/25 Path:P:\15\15556039\GINT\15556039000.GPJ DBLibrary/Library:GEOUSA_DF_STD_US.GLB/GEI8_GEOTECH_STANDARD_%F_NO_GW_4BC

Log of Boring MR-8A

GeoEngineers USA

Project: Cape Canal Bridge Relocation - M&R Stations
Project Location: Barnstable County, Massachusetts
Project Number: 15556-039-00

Figure A-4
Sheet 1 of 1

Client:	GeoEngineers, Inc.				
Project:	Cape Cod - En bridge				
Location:	MA			Project No:	GTX-320749
Boring ID:	---	Sample Type:	---	Tested By:	ajl
Sample ID:	---	Test Date:	03/25/25	Checked By:	ank
Depth :	---	Test Id:	808067		

Moisture Content of Soil and Rock - ASTM D2216

Boring ID	Sample ID	Depth	Description	Moisture Content, %
MR-06	S- 14	49-51	Moist, grayish brown gravel with sand	8.1
MR-06	S- 7	19-21	Moist, dark grayish brown silty sand	15.2
MR-07	S- 6A	15-17	Moist, brown sand	4.6
MR-07	S- 8	25-27	Moist, very pale brown sand with gravel	3.2
MR-08	S- 3	4-6	Moist, brown sand	3.1

Notes: Temperature of Drying : 110° Celsius

Client:	GeoEngineers, Inc.				
Project:	Cape Cod - En bridge				
Location:	MA			Project No:	GTX-320749
Boring ID:	---	Sample Type:	---	Tested By:	ajl
Sample ID:	---	Test Date:	03/31/25	Checked By:	ank
Depth :	---	Test Id:	808070		

pH of Soil by ASTM D4972

Boring ID	Sample ID	Depth	Visual Description	pH of Soil in Distilled Water	pH of Soil in Calcium Chloride
[redacted]					
[redacted]					
[redacted]					
MR-08/08A	S-3, S-4, S-5, S-6/S-1, S-2	Composite	Moist, light yellowish brown sand with silt and gravel	7.7	6.9

Notes: Sample Preparation: screened through #10 sieve

Method A, pH meter used

Client:	GeoEngineers, Inc.				
Project:	Cape Cod - En bridge				
Location:	MA			Project No:	GTX-320749
Boring ID:	---	Sample Type:	---	Tested By:	ajl
Sample ID:	---	Test Date:	03/24/25	Checked By:	ank
Depth :	---	Test Id:	808068		

Laboratory Determination of Density (Unit Weight) of Soil Specimens by ASTM D7263

Boring ID	Sample ID	Depth	Visual Description	Bulk Density pcf	Moisture Content %	Dry Density pcf	*
[redacted]							
[redacted]							
[redacted]							
[redacted]							
MR-08	S- 3	4-6	Moist, brown sand	99.12	3.106	96.13	(5)

* Sample Comments

(1): Method B-Volumetric, Reconstituted (compacted)

(2): Method B-Volumetric, Reconstituted (compacted)

(3): Method B-Volumetric, Reconstituted (compacted)

(4): Method B-Volumetric, Reconstituted (compacted)

(5): Method B-Volumetric, Reconstituted (compacted)

Notes: Moisture Content determined by ASTM D2216.

Client:	Geo Engineer, Inc.
Project:	Cape Cod-En Bridge
Location:	MA
GTX#:	320749
Test Date:	04/01/25
Due Date:	04/03/25
Tested By:	NMK
Checked By:	ank

Minimum Laboratory Soil Resistivity by AASHTO T 288

Boring ID	Sample ID	Depth, ft.	Sample Description	Electrical Resistivity, ohm-cm	Electrical Conductivity, $(ohm\text{-}cm)^{-1}$
[redacted]					
[redacted]					
[redacted]					
MR-08/08A	S-3, S-4, S-5, S-6/S-1, S-2	Composite	Moist, light brown sand with silt and gravel	28,506	3.51E-05

Notes: Test Equipment: Nilsson Model 400 Soil Resistance Meter, MC Miller Soil Box

Water added to sample to create a thick slurry prior to testing (saturated condition).

Electrical Conductivity is calculated as inverse of Electrical Resistivity (per ASTM G57)

Test conducted in standard laboratory atmosphere: 68-73 F

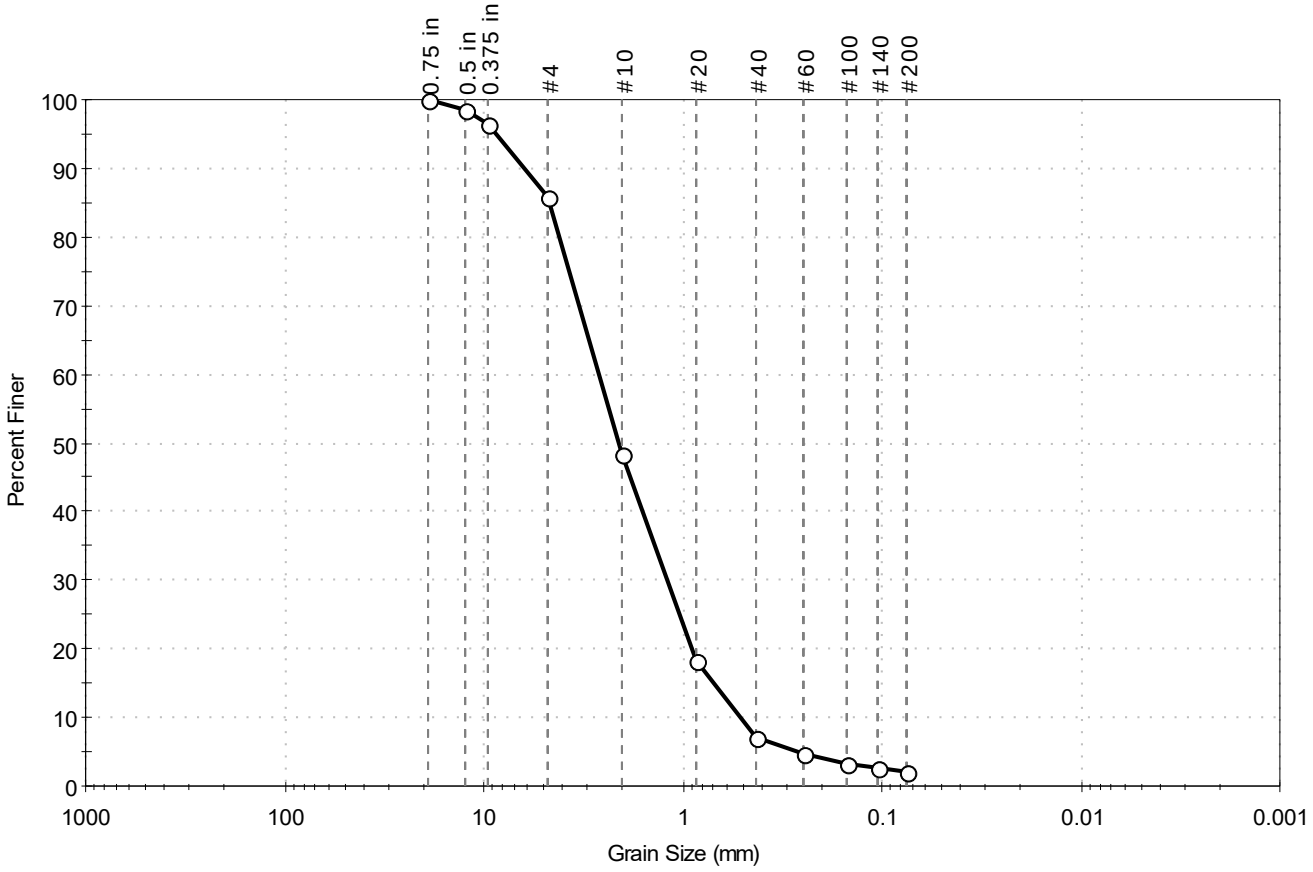
Client:	GeoEngineers, Inc.				
Project:	Cape Cod - En bridge				
Location:	MA			Project No:	GTX-320749
Boring ID:	MR-08	Sample Type:	Jar	Tested By:	ajl
Sample ID:	S-3	Test Date:	03/27/25	Checked By:	ank
Depth :	4-6	Test Id:	808069		
Test Comment:	---				
Visual Description:	Moist, brown sand				
Sample Comment:	---				

Description and Classification of Soils (Visual-Manual) - ASTM D2488

Parameter	Result
Group Name	Sand
Group Symbol	SW
% Cobbles/Boulders	0
% Gravel	0
% Sand	99
% Fines	1
Angularity (coarse grained)	---
Shape (coarse grained)	N/A
Maximum Particle Size (mm)	0.85
Hardness (coarse grained)	CRUMBLE
Plasticity (fine grained)	NONPLASTIC
Dry Strength (fine grained)	NONE
Dilatancy (fine grained)	RAPID
Toughness (fine grained)	---
Color	Brown
Odor	NONE
Moisture	MOIST
Reaction with HCL	NONE
Consistency (intact,fine grained)	---
Structure (intact)	---
Cementation (intact, coarse grained)	---

Client:	GeoEngineers, Inc.				
Project:	Cape Cod - En bridge				
Location:	MA			Project No:	GTX-320749
Boring ID:	MR-07	Sample Type:	Jar	Tested By:	ajl
Sample ID:	S-6A	Test Date:	03/28/25	Checked By:	ank
Depth :	15-17	Test Id:	808083		
Test Comment:	---				
Visual Description:	Moist, brown sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D6913



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	14.2	83.6	2.2

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.75 in	19.00	100		
0.5 in	12.50	99		
0.375 in	9.50	97		
#4	4.75	86		
#10	2.00	48		
#20	0.85	18		
#40	0.42	7		
#60	0.25	5		
#100	0.15	3		
#140	0.11	3		
#200	0.075	2.2		

Coefficients

D_{85} = 4.6696 mm	D_{30} = 1.1873 mm
D_{60} = 2.6213 mm	D_{15} = 0.6945 mm
D_{50} = 2.0807 mm	D_{10} = 0.5104 mm
C_u = 5.136	C_c = 1.054

Classification

ASTM — Poorly graded SAND (SP)

AASHTO — Stone Fragments, Gravel and Sand (A-1-a (1))

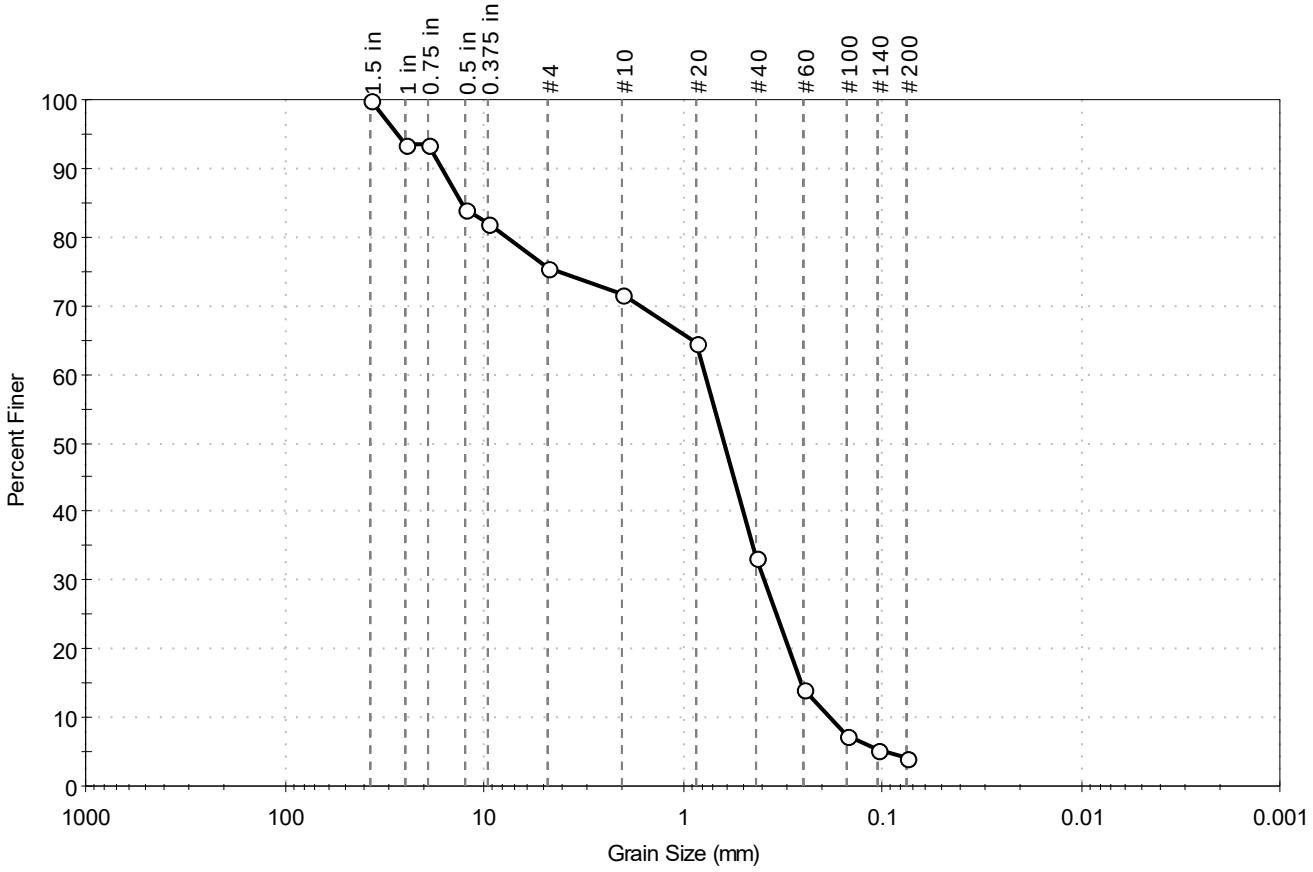
Sample / Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

Client:	GeoEngineers, Inc.				
Project:	Cape Cod - En bridge				
Location:	MA			Project No:	GTX-320749
Boring ID:	MR-07	Sample Type:	Jar	Tested By:	ajl
Sample ID:	S-8	Test Date:	03/28/25	Checked By:	ank
Depth :	25-27	Test Id:	808084		
Test Comment:	---				
Visual Description:	Moist, very pale brown sand with gravel				
Sample Comment:	---				

Particle Size Analysis - ASTM D6913



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	24.6	71.2	4.2

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1.5 in	37.50	100		
1 in	25.00	93		
0.75 in	19.00	93		
0.5 in	12.50	84		
0.375 in	9.50	82		
#4	4.75	75		
#10	2.00	72		
#20	0.85	65		
#40	0.42	33		
#60	0.25	14		
#100	0.15	7		
#140	0.11	5		
#200	0.075	4.2		

Coefficients

D_{85} = 12.9717 mm	D_{30} = 0.3883 mm
D_{60} = 0.7677 mm	D_{15} = 0.2561 mm
D_{50} = 0.6155 mm	D_{10} = 0.1836 mm
C_u = 4.181	C_c = 1.070

Classification

ASTM — Poorly graded SAND with Gravel (SP)

AASHTO — Stone Fragments, Gravel and Sand (A-1-b (1))

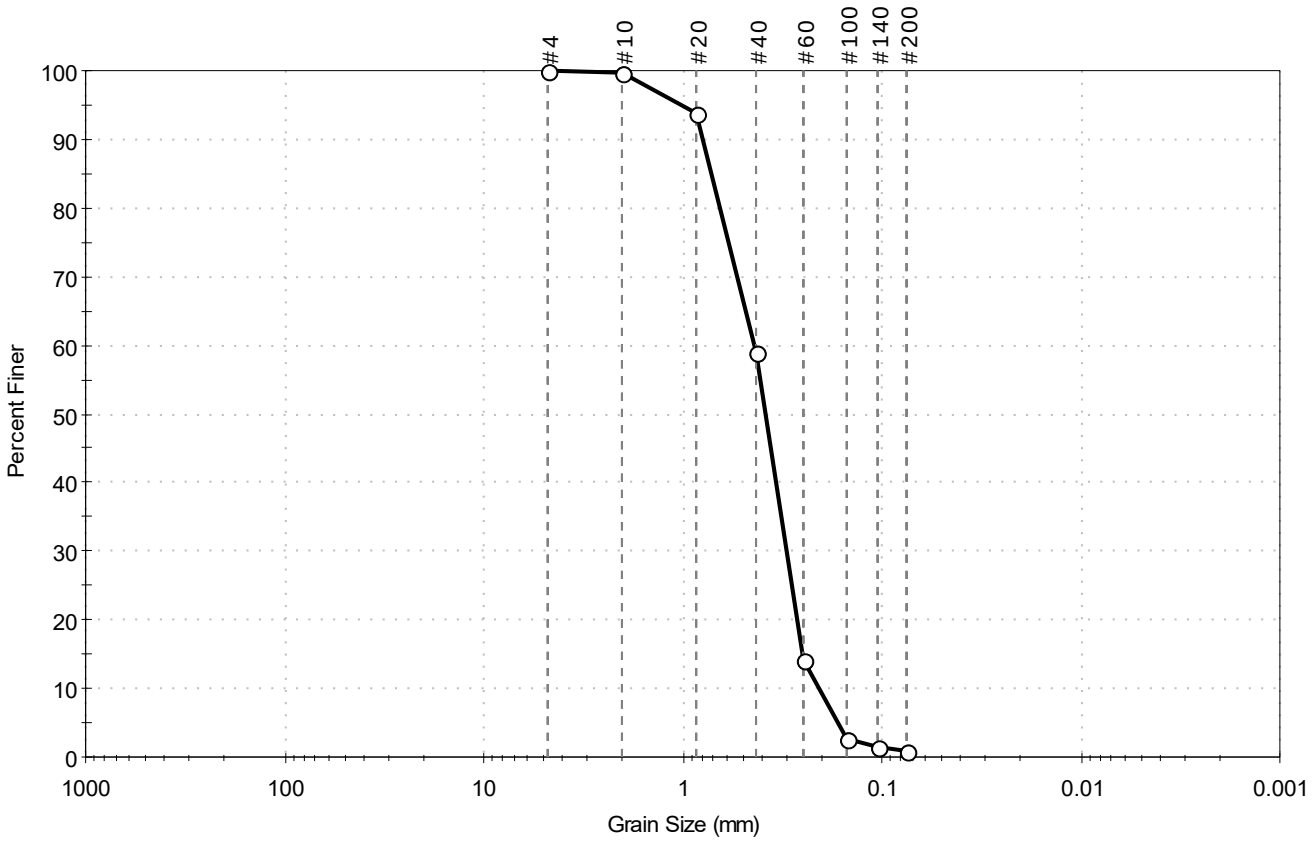
Sample / Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

Client:	GeoEngineers, Inc.				
Project:	Cape Cod - En bridge				
Location:	MA			Project No:	GTX-320749
Boring ID:	MR-08	Sample Type:	Jar	Tested By:	ajl
Sample ID:	S-3	Test Date:	03/26/25	Checked By:	ank
Depth :	4-6	Test Id:	808066		
Test Comment:	---				
Visual Description:	Moist, brown sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D6913



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	99.0	1.0

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	94		
#40	0.42	59		
#60	0.25	14		
#100	0.15	3		
#140	0.11	1		
#200	0.075	1.0		

Coefficients

D_{85} = 0.7152 mm	D_{30} = 0.3015 mm
D_{60} = 0.4347 mm	D_{15} = 0.2523 mm
D_{50} = 0.3825 mm	D_{10} = 0.2069 mm
C_u = 2.101	C_c = 1.011

Classification

ASTM Poorly graded SAND (SP)

AASHTO Fine Sand (A-3 (1))

Sample / Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

PO Box 572455 / Salt Lake City UT 84157-2455 / USA
TEL +1 801 262 2448 · FAX +1 801 262 9870 · www.TEi-TS.com

GEOTESTING EXPRESS INCORPORATED
125 NAGOG PARK
ACTON MA 01720-3451
USA

Analysis No.	TS-A2512584
Report Date	31 March 2025
Date Sampled	24 March 2025
Date Received	27 March 2025
Where Sampled	Acton, MA USA
Sampled By	Client

This is to attest that we have examined: Soil: Project: Cape Cod – En Bridge; Site Location: - — -; Job Number: GTX-320749

When examined to the applicable requirements of:

ASTM D 512-12*	“Standard Test Methods for Chloride Ion in Water” Method B
ASTM D 516-22	“Standard Test Method for Sulfate Ion in Water”

Results:

ASTM D 512 - Chloride Method B

Sample		Results		Minimum Detection Limit
		ppm (mg/kg)	%[1]	
MR-02/02A		< 10.	< 0.0010	10.
[redacted]				
MR-08/08A		< 10.	< 0.0010	
S-3, S-4, S-6/S-1, S-2	Composite			

NOTE: [1]Percent by weight after drying and prepared as per the Standard. *Withdrawn 2021 without Replacement

Testing Services analytical Laboratory
3455 South 500 West
Salt Lake City, UT 84115-4234 USA
TEL: +1 801 262 2448
FAX: +1 801 262 9870

ASTM D 516 - Sulfates (Soluble)

Sample		Results		Minimum Detection Limit
		ppm (mg/kg)	%[1]	
[redacted]				10.
MR-08/08A		10.	0.0010	
S-3, S-4, S-6/S-1, S-2	Composite			

NOTE: [1]Percent by weight after drying and prepared as per the Standard.

END OF ANALYSIS

USEPA Laboratory ID UT00930

Merrill Gee P.E. – Engineer in Charge

© 2025 by Testing Engineers International, Inc. CAVEAT: This certificate may not be reproduced except in full, without the expressed written consent of TEi-Testing Services, LLC. Note: The values in this certificate are the values obtained under standard test conditions as reported in the appropriate Report of Test and thus may be used for purposes of demonstrating compliance or for comparison with other units tested under the same standard. The results do not indicate the function of the sample(s) under nonstandard or field conditions. Statement of Risk: Client understands and agrees that declarations of conformity are made by directly comparing the measurement results against the test limits given in the standard without consideration to factors that may contribute to measurement uncertainty and accepts the shared risk that arises from this approach. This certificate gives the characteristics of the sample(s) submitted for testing only. It does not and may not be used to certify the characteristics of the product, nor to imply that the product in general meets the requirements of any standard, nor its acceptability in the marketplace. TEi stylized lettering and logo are registered trademarks, and use is by contract and/or written permission only. USEPA Laboratory ID UT00930 TEi-Testing Services is a wholly owned LLC of Testing Engineers International, Inc.

Appendix B
Report Limitations and Guidelines for Use

Appendix B
Report Limitations and Guidelines For Use[1]

This appendix provides information to help you manage your risks with respect to the use of this report.

READ THESE PROVISIONS CLOSELY

It is important to recognize that the geoscience practices (geotechnical engineering, geology, and environmental science) rely on professional judgment and opinion to a greater extent than other engineering and natural science disciplines, where more precise and/or readily observable data may exist. To help clients better understand how this difference pertains to our services, GeoEngineers includes the following explanatory "limitations" provisions in its reports. Please confer with GeoEngineers if you need to know more how these "Report Limitations and Guidelines for Use" apply to your project or site.

GEOTECHNICAL SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES, PERSONS, AND PROJECTS

This report has been prepared for Enbridge, Inc. and for the Project specifically identified in the report. The information contained herein is not applicable to other sites or projects.

GeoEngineers structures its services to meet the specific needs of its clients. No party other than the party to whom this report is addressed may rely on the product of our services unless we agree to such reliance in advance and in writing. Within the limitations of the agreed scope of services for the Project, and its schedule and budget, our services have been executed in accordance with our Agreement with Enbridge, Inc. dated October 31, 2023, and revised April 4, 2025 and generally accepted geotechnical practices in this area at the time this report was prepared. We do not authorize, and will not be responsible for, the use of this report for any purposes or projects other than those identified in the report.

A GEOTECHNICAL ENGINEERING OR GEOLOGIC REPORT IS BASED ON A UNIQUE SET OF PROJECT-SPECIFIC FACTORS

This report has been prepared for Enbridge Inc. for the proposed Cape Bourne M&R Station Site, in Bourne, Massachusetts. GeoEngineers considered a number of unique, project-specific factors when establishing the scope of services for this project and report. Unless GeoEngineers specifically indicates otherwise, it is important not to rely on this report if it was:

- Not prepared for you,
- Not prepared for your project,
- Not prepared for the specific site explored, or
- Completed before important project changes were made.

1 Developed based on material provided by GBA, GeoProfessional Business Association; www.geoprofessional.org.

For example, changes that can affect the applicability of this report include those that affect:

- The function of the proposed structure;
- Elevation, configuration, location, orientation, or weight of the proposed structure;
- Composition of the design team; or
- Project ownership.

If changes occur after the date of this report, GeoEngineers cannot be responsible for any consequences of such changes in relation to this report unless we have been given the opportunity to review our interpretations and recommendations. Based on that review, we can provide written modifications or confirmation, as appropriate.

ENVIRONMENTAL CONCERNS ARE NOT COVERED

Unless environmental services were specifically included in our scope of services, this report does not provide any environmental findings, conclusions, or recommendations, including but not limited to, the likelihood of encountering underground storage tanks or regulated contaminants.

SUBSURFACE CONDITIONS CAN CHANGE

This geotechnical or geologic report is based on conditions that existed at the time the study was performed. The findings and conclusions of this report may be affected by the passage of time, by man-made events such as construction on or adjacent to the site, new information or technology that becomes available subsequent to the report date, or by natural events such as floods, earthquakes, slope instability or groundwater fluctuations. If more than a few months have passed since issuance of our report or work product, or if any of the described events may have occurred, please contact GeoEngineers before applying this report for its intended purpose so that we may evaluate whether changed conditions affect the continued reliability or applicability of our conclusions and recommendations.

TOPSOIL

For the purposes of this report, we consider topsoil to consist of generally fine-grained soil with an appreciable amount of organic matter based on visual examination and to be unsuitable for direct support of the proposed improvements. However, the organic content and other mineralogical and gradational characteristics used to evaluate the suitability of soil for use in landscaping and agricultural purposes was not determined, nor considered in our analyses. Therefore, the information and recommendations in this report and our logs and descriptions should not be used as a basis for estimating the volume of topsoil available for such purposes.

GEOTECHNICAL AND GEOLOGIC FINDINGS ARE PROFESSIONAL OPINIONS

Our interpretations of subsurface conditions are based on field observations from widely spaced sampling locations at the site. Site exploration identifies the specific subsurface conditions only at those points where subsurface tests are conducted or samples are taken. GeoEngineers reviewed field and laboratory data and then applied its professional judgment to render an informed opinion about subsurface conditions at other locations. Actual subsurface conditions may differ, sometimes significantly, from the opinions

presented in this report. Our report, conclusions and interpretations are not a warranty of the actual subsurface conditions.

GEOTECHNICAL ENGINEERING REPORT RECOMMENDATIONS ARE NOT FINAL

We have developed the following recommendations based on data gathered from subsurface investigation(s). These investigations sample just a small percentage of a site to create a snapshot of the subsurface conditions elsewhere on the site. Such sampling on its own cannot provide a complete and accurate view of subsurface conditions for the entire site. Therefore, the recommendations included in this report are preliminary and should not be considered final. GeoEngineers' recommendations can be finalized only by observing actual subsurface conditions revealed during construction. GeoEngineers cannot assume responsibility or liability for the recommendations in this report if we do not perform construction observation.

We recommend that you allow sufficient monitoring, testing and consultation during construction by GeoEngineers to confirm that the conditions encountered are consistent with those indicated by the explorations, to provide recommendations for design changes if the conditions revealed during the work differ from those anticipated, and to evaluate whether earthwork activities are completed in accordance with our recommendations. Retaining GeoEngineers for construction observation for this project is the most effective means of managing the risks associated with unanticipated conditions. If another party performs field observation and confirms our expectations, the other party must take full responsibility for both the observations and recommendations. Please note, however, that another party would lack our project-specific knowledge and resources.

A GEOTECHNICAL ENGINEERING OR GEOLOGIC REPORT COULD BE SUBJECT TO MISINTERPRETATION

Misinterpretation of this report by members of the design team or by contractors can result in costly problems. GeoEngineers can help reduce the risks of misinterpretation by conferring with appropriate members of the design team after submitting the report, reviewing pertinent elements of the design team's plans and specifications, participating in pre-bid and preconstruction conferences, and providing construction observation.

DO NOT REDRAW THE EXPLORATION LOGS

Geotechnical engineers and geologists prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. The logs included in a geotechnical engineering or geologic report should never be redrawn for inclusion in architectural or other design drawings. Photographic or electronic reproduction is acceptable, but separating logs from the report can create a risk of misinterpretation.

GIVE CONTRACTORS A COMPLETE REPORT AND GUIDANCE

To help reduce the risk of problems associated with unanticipated subsurface conditions, GeoEngineers recommends giving contractors the complete geotechnical engineering or geologic report, including these "Report Limitations and Guidelines for Use." When providing the report, you should preface it with a clearly written letter of transmittal that:

- Advises contractors that the report was not prepared for purposes of bid development and that its accuracy is limited; and
- Encourages contractors to conduct additional study to obtain the specific types of information they need or prefer.

CONTRACTORS ARE RESPONSIBLE FOR SITE SAFETY ON THEIR OWN CONSTRUCTION PROJECTS

Our geotechnical recommendations are not intended to direct the contractor's procedures, methods, schedule, or management of the work site. The contractor is solely responsible for job site safety and for managing construction operations to minimize risks to on-site personnel and adjacent properties.

BIOLOGICAL POLLUTANTS

GeoEngineers' Scope of Work specifically excludes the investigation, detection, prevention, or assessment of the presence of Biological Pollutants. Accordingly, this report does not include any interpretations, recommendations, findings, or conclusions regarding the detecting, assessing, preventing or abating of Biological Pollutants, and no conclusions or inferences should be drawn regarding Biological Pollutants as they may relate to this project. The term "Biological Pollutants" includes, but is not limited to, molds, fungi, spores, bacteria, and viruses, and/or any of their byproducts.

A Client that desires these specialized services is advised to obtain them from a consultant who offers services in this specialized field.

INFORMATION PROVIDED BY OTHERS

GeoEngineers has relied upon certain data or information provided or compiled by others in the performance of our services. Although we use sources that we reasonably believe to be trustworthy, GeoEngineers cannot warrant or guarantee the accuracy or completeness of information provided or compiled by others.

Drawdown Analysis

Drawdown Analysis

Required Drawdown Time

Infiltration Basin	Bottom Area (sf)	100-Year Storage (cf)	Infiltration Rate (in/hr)	Drawdown Time (hr)
1	1729.24	7493.21	2.625	19.8
2A	697.24	3606.13	2.625	23.6
2B	399.14	2135.20	2.625	24.5
3	907.5	5941.50	2.625	29.9
4	377.51	3531.02	2.625	42.8

NRCS Web Soil Infiltration Data

NRCS Web Soil Map Symbol and Soil Name	Ksat rv (micro m/sec)	Ksat rv (in/hr)	Safety Factor (0.5)	Design Infitlration Rate
Plymouth loamy coarse sand, 3 to 8 percent slopes				
435B	37.05	5.25	0.5	2.625

Design Infiltration Rate = 2.625 in/hr

Recharge Volume

Recharge Volume Calculations

Proposed Impervious Surface Summary

Drainage Area	HSG	Impervious Area (sf)	Recharge Depth (in)	Required Volume (cf)	Provided Volume (cf)
1	A	15909.62	0.6	795.48	7492.88
2	A	9497.14	0.6	474.86	5739.75
3	A	11768.63	0.6	588.43	5941.5
4	A	5396.65	0.6	269.83	3530.59
5	A	1605	0.6	80.25	0

Total Required Recharge Volume = 2208.85 cf
Total Provided Recharge Volume = 22704.72 cf

Provided Storage Volumes

	Depth (ft)	Area (sf)	Cumulative Volume (cf)
Forebay 1	0	29	0
	1	164	96.5
	2	371	364
	3	650	874.5

	Depth (ft)	Area (sf)	Cumulative Volume (cf)
Forebay 2	0	16.89	0
	1	68.15	42.52
	2	151.42	152.31
	3	266.68	361.36
	4	336.31	662.86

	Depth (ft)	Area (sf)	Cumulative Volume (cf)
Forebay 3	0	31.5	0
	1	97.5	64.5
	2	195.5	211
	3	325.5	471.5
	4	487.5	878

	Depth (ft)	Area (sf)	Cumulative Volume (cf)
Forebay 4	0	6	0
	1	72	39
	2	210	180
	3	420	495

	Depth (ft)	Area (sf)	Cumulative Volume (cf)
Infiltration Basin 1	0	1729.74	0
	1	2729.32	2229.53
	2	3760.91	5474.64
	2.5	4312.03	7492.88
	3	4824.52	9777.02

	Depth (ft)	Area (sf)	Cumulative Volume (cf)
Infiltration Basin 2A	0	697.24	0
	1	1280.66	988.95
	2	1896.08	2577.32
	2.5	2215.79	3605.29
	3	2543.5	4795.11

	Depth (ft)	Area (sf)	Cumulative Volume (cf)
Infiltration Basin 2B	0	399.14	0
	1	750.37	574.76
	2	1133.6	1516.75
	2.5	1337.22	2134.46
	3	1548.83	2855.97

	Depth (ft)	Area (sf)	Cumulative Volume (cf)
Infiltration Basin 3	0	907.5	0
	0.5	1252.5	540
	1.5	1966.5	2149.5
	2.5	2712.5	4489
	3	3097.5	5941.5
	3.5	3978	7710.38

	Depth (ft)	Area (sf)	Cumulative Volume (cf)
Infiltration Basin 4	0	377.51	0
	1	715.52	546.52
	2	1085.52	1447.04
	3	1487.53	2733.57
	3.5	1700.54	3530.59
	4	1921.54	4436.11

Attachment E - Standard 4 Supporting Information

Long-Term Pollution Prevention Plan

Water Quality Volume Calculations

TSS Removal Work Sheet

Nitrogen Loading Calculations

Long – Term Pollution Prevention Plan

This Long-Term Pollution Prevention Plan has been developed to establish site management practices that improve the quality of stormwater discharges from the Project.

Pollutant Control Approach

Maintenance of Pavement Systems

Standard Gravel Areas

Gravel area maintenance involves regular raking to redistribute stones, removing debris with a leaf blower, and replenishing aggregate every 2–4 years to fix sinking or bare spots. For longevity, ensure proper drainage with a crown, clean debris from edges, and remove sediment to prevent clogging. Maintain Proper Grading on roads with a 3% grade to shed water and reduce erosion and sediment runoff.

Key Maintenance Activities:

- **Raking & Leveling:** Regularly rake in ruts and maintain a level surface, especially in high-traffic areas.
- **Debris Removal:** Use a leaf blower or rake to remove leaves and debris, preventing decomposition that creates soil for weeds.
- **Replenishing:** Top off gravel every 2-4 years as it settles or sinks into the ground.
- **Weed Management:** Pull weeds regularly and apply mulch glue or similar products to help keep gravel in place and reduce weed growth.
- **Drainage & Erosion Control:** Ensure the area has a slight slope (crown) to prevent standing water. Inspect for erosion and fill in low spots with clean, washed stone.
- **Edge Maintenance:** Clean edges to maintain a clear boundary.

O&M for Specific Gravel Uses:

- **Gravel Driveways:** Use a rake or land plane to keep the surface level and remove potholes. Maintain 3% grade to promote sheet flow and avoid erosion and sedimentation.
- **Pervious Gravel Areas:** Remove sediment that clogs voids to maintain infiltration. If clogged, remove the top layer of rock to wash or replace it.

Maintenance of Vegetated Areas

Proper maintenance of vegetated areas can prevent the pollution of stormwater runoff by controlling the source of pollutants such as suspended sediments, excess nutrients, and chemicals from landscape care products. Practices that should be followed under the regular maintenance of the vegetated landscape include:

- Inspect vegetated areas on a semi-annual basis and remove any litter.

- Maintain vegetated areas adjacent to pavement to prevent soil washout.
- Immediately clean any soil deposited on pavement.
- Re-seed bare areas; install appropriate erosion control measures when native soil is exposed or erosion channels are forming.

Management of Snow and Ice

Storage and Disposal

Snow shall be stockpiled on standard pavement surfaces so sand and salt may be swept in the spring or removed as snow melts and drains through the stormwater management system. Key practices for the safe storage and disposal of snow include:

- Under no circumstances shall snow be disposed or stored in wetland resource areas.
- Under no circumstances shall snow be disposed or stored in stormwater basins, ponds, rain gardens, swales, channels, or trenches.

Salt and Deicing Chemicals

The amount of salt and deicing chemicals to be used on the site shall be reduced to the minimum amount needed to provide safe pedestrian and vehicle travel. The following practices should be followed to control the amount of salt and deicing

materials that come into contact with stormwater runoff:

- Devices used for spreading salt and deicing chemicals should be capable of varying the rate of application based on the site specific conditions.
- Sand and salt should be stockpiled under covered storage facilities that prevent precipitation and adjacent runoff from coming in contact with the deicing materials

Spill Prevention and Response Plan

Initial Notification

In the event of a spill or release, the Facility Operator, Construction Supervisor, or designated Site Representative shall be notified immediately and appropriate response actions shall be initiated in accordance with the site spill response procedures.

The designated Site Representative shall promptly notify emergency response personnel, including the Fire Department, as appropriate based on the nature and severity of the incident. Additional notifications to local authorities, including the Police Department, Health Department, and Conservation Commission, shall be made as necessary and in accordance with applicable regulatory requirements.

Emergency contact information for facility personnel, contractors, and response agencies shall be maintained on-site and updated prior to construction and facility operation

Further Notification

Based on the nature, size, and potential environmental impact of the spill or release, additional notifications may be made to appropriate local, state, and federal agencies, as well as qualified cleanup contractors and emergency response personnel.

Applicable regulatory notifications may include the Massachusetts Department of Environmental Protection (MassDEP), the National Response Center (NRC), and other agencies as required by law or permit conditions. Emergency response personnel and the designated Site Representative shall coordinate response actions and determine appropriate cleanup and reporting measures based on site conditions and regulatory requirements.

Emergency contact information shall be maintained at the site office and made readily accessible to project personnel during construction and facility operations. Spill incidents and corrective actions shall be documented and maintained as part of the project records, and spill reporting forms shall be completed as necessary.

Emergency Notification Phone Numbers

1. FACILITY MANAGER NAME: Joseph Bruno ALERNATE CONTACT: William Rogers	PHONE: 508-938-7710 CELL: 617-281-3984 PHONE: 508-699-5471 CELL: 781-844-2725
2. FIRE AND POLICE DEPARTMENT	EMERGENCY: 911
3. CLEANUP CONTRACTOR: Waste Management (TBD) ADDRESS: _____ _____	PHONE: _____
4. STATE DEPARTMENT OF ENVIRONMENTAL PROTECTIO (DEP)/ DEPARTMENT OF ENVIRONMENTAL SERVICES (DES)	EMERGENCY PHONE: 508-946-2700
5. NATIONAL RESPONSE CENTER U.S ENVIORNMENTAL PROTECTION AGENCY	PHONE: (800) 424-8802 PHONE: 1-888-372-7341
6. BARNSTABLE HEATH DEPARTMENT BARNSTABLE CONSERVATION COMISSION:	PHONE: 508-862-4644 PHONE: 508-362-3828

Hazardous Waste / Oil Spill Report

Date: ____/____/_____ Time: _____ AM / PM

Exact location _____

Type of equipment:_____ Make:_____ Size:_____

License or S/N:_____ Weather Conditions:_____

On or near water ☐ Yes If yes, name of body of water:_____

☐ No

Type of chemical / oil spilled: _____

Amount of chemical / oil spilled: _____

Cause of spill: _____

_____

_____

Measures taken to contain or clean up spill: _____

_____

_____

Amount of chemical / oil recovered: _____ Method:_____

Material collected as a result of clean up

_____ drums containing: _____

_____ drums containing: _____

_____ drums containing: _____

Location and method of debris disposal:_____

Name and address of any person, firm, or corporation suffering damages:_____

_____

Procedures, method, and precautions instituted to prevent a similar occurrence from recurring: :_____

_____

Spill reported to General Office by:_____Time: _____AM / PM

Spill reported to DEP / National Response Center by:_____

DEP Date: ____/____/_____ Time:_____AM / PM Inspector:_____

NRC Date: ____/____/_____ Time:_____AM / PM Inspector: _____

Additional comments: _____

_____

Assessment – Initial Containment

- The supervisor or manager will assess the incident and initiate containment
- control measures with the appropriate spill containment equipment included in the spill kit kept on-site. A list of recommended spill equipment to be kept on site is included on the following page.
- Fire / Police Department: 911
- Municipality Health Department: (508) 862-4644
- Municipality Conservation Commission: (508) 862-4093

Stormwater Operation and Maintenance Plan

Project Information

Cape Cod Canal Pipeline Replacement Project

Site

Bourne Rotary M&R Station

Owner

Algonquin Gas Transmission, LLC

Site Supervisor

Name: Joseph Bruno (Area Manager) & William Rogers (Area Supervisor)

Telephone: 508-938-7710 508-699-5471

Cell phone: 508-699-5471 781-844-2725

Email: Joseph.Bruno@enbridge.com & William.Rogers@enbridge.com

Description of Stormwater Maintenance Measures

The following Operation and Maintenance (O&M) program is proposed to ensure the continued effectiveness of the stormwater management system. Attached to this plan are a Stormwater Best Management Practices Checklist and Maintenance Figure for use during the long-term operation and maintenance of the stormwater management system.

The long-term O&M of the stormwater management system is estimated to cost approximately $20,000 annually.

Grass Swales

Grass swales shall be inspected semi-annually and after storm events exceeding 1 inch of rainfall. Swales shall be maintained to ensure proper flow conveyance without erosion or standing water. Sediment and debris shall be removed as needed to maintain design capacity. Vegetation shall be mowed and maintained to promote uniform flow and infiltration. Eroded areas shall be repaired and stabilized.

Sediment Forebays

Sediment forebays shall be inspected semi-annually and after major storm events. Accumulated sediment shall be removed when it reaches 50% of the design storage capacity or as needed to maintain function. Inlet and outlet structures shall be checked for blockages or damage. Removed sediment shall be disposed of in accordance with applicable regulations.

Infiltration Basin

The infiltration basin shall be inspected semi-annually and after storm events exceeding 1 inch of rainfall. The basin shall be maintained to ensure proper infiltration, including removal of accumulated sediment, trash, and debris. Sediment shall be removed when accumulation exceeds 3 inches. The basin shall be evaluated if standing water persists longer than 72 hours, and corrective actions shall be implemented as needed. Vegetation shall be maintained to ensure proper function.

Inspections and Cleaning

A routine inspection and maintenance program shall be implemented in accordance with the Massachusetts Stormwater Management Standards (310 CMR 10.00). Inspection records shall include the date, inspector name, observations, and corrective actions taken. Maintenance activities, including sediment removal and repairs, shall be documented and retained on-site or made available upon request. Any deficiencies identified during inspections shall be corrected in a timely manner to ensure continued compliance.

Long Term Best Management Practices – Maintenance / Evaluation Checklist

Best Management Practices	Inspection Frequency	Date	Inspector	Minimum Maintenance and Key items to check	Cleaning/Repair needed	Date of Cleaning/ Repair	Preformed by:

Stormwater Control Manager: _____

Water Quality Volume Calculations

Water Quality Volume Calculations

Storage Volume Summary

Forebay	Treatment Depth (in)	Impervious Area (Acres)	Required Volume (cf)	Provided Volume (cf)
1	0.10	0.37	134.31	364.00
2	0.10	0.22	79.86	361.36
3	0.10	0.27	98.01	471.50
4	0.10	0.12	43.56	180.00

Min. Storage Volume = 0.1-inch per impervious acre tributary to BMP (per Volume 2, Chapter 2, p.13 of the 2008 MA DEP Stormwater Management Handbook)

Basin	Treatment Depth (in)	Impervious Area (Acres)	Required Volume (cf)	Provided Volume (cf)
1	1.00	0.37	1343.11	7492.88
2A + 2B	1.00	0.22	798.60	5739.75
3	1.00	0.27	980.10	5941.50
4	1.00	0.12	435.60	3530.59
5	1.00	0.04	133.75	0.00

Provided Storage Volumes

	Depth (ft)	Area (sf)	Cumulative Volume (cf)
Forebay 1	0	29	0
	1	164	96.5
	2	371	364
	3	650	874.5

	Depth (ft)	Area (sf)	Cumulative Volume (cf)
Forebay 2	0	16.89	0
	1	68.15	42.52
	2	151.42	152.31
	3	266.68	361.36
	4	336.31	662.86

	Depth (ft)	Area (sf)	Cumulative Volume (cf)
Forebay 3	0	31.5	0
	1	97.5	64.5
	2	195.5	211
	3	325.5	471.5
	4	487.5	878

	Depth (ft)	Area (sf)	Cumulative Volume (cf)
Forebay 4	0	6	0
	1	72	39
	2	210	180
	3	420	495

	Depth (ft)	Area (sf)	Cumulative Volume (cf)
Infiltration Basin 1	0	1729.74	0
	1	2729.32	2229.53
	2	3760.91	5474.64
	2.5	4312.03	7492.88
	3	4824.52	9777.02

	Depth (ft)	Area (sf)	Cumulative Volume (cf)
Infiltration Basin 2A	0	697.24	0
	1	1280.66	988.95
	2	1896.08	2577.32
	2.5	2215.79	3605.29
	3	2543.5	4795.11

	Depth (ft)	Area (sf)	Cumulative Volume (cf)
Infiltration Basin 2B	0	399.14	0
	1	750.37	574.76
	2	1133.6	1516.75
	2.5	1337.22	2134.46
	3	1548.83	2855.97

	Depth (ft)	Area (sf)	Cumulative Volume (cf)
Infiltration Basin 3	0	907.5	0
	0.5	1252.5	540
	1.5	1966.5	2149.5
	2.5	2712.5	4489
	3	3097.5	5941.5
	3.5	3978	7710.38

	Depth (ft)	Area (sf)	Cumulative Volume (cf)
Infiltration Basin 4	0	377.51	0
	1	715.52	546.52
	2	1085.52	1447.04
	3	1487.53	2733.57
	3.5	1700.54	3530.59
	4	1921.54	4436.11

TSS Removal Worksheets

INSTRUCTIONS:
1. In BMP Column, click on Blue Cell to Activate Drop Down Menu
2. Select BMP from Drop Down Menu
3. After BMP is selected, TSS Removal and other Columns are automatically completed.

Version 1, Automated: Mar. 4, 2008

Location: Barnstable County - Drainage Area 1

TSS Removal Calculation Worksheet

B BMP[1]	C TSS Removal Rate[1]	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
Grass Channel	0.50	1.00	0.50	0.50
Sediment Forebay	0.25	0.50	0.13	0.38
Infiltration Basin	0.80	0.38	0.30	0.08
	0.00	0.08	0.00	0.08
	0.00	0.08	0.00	0.08

Total TSS Removal = 93%

Separate Form Needs to be Completed for Each Outlet or BMP Train

Project: MASS DOT Canal Bridges Relocation
Prepared By: Drake Trawhon
Date: 5/3/2026

*Equals remaining load from previous BMP (E) which enters the BMP

Non-automated TSS Calculation Sheet must be used if Proprietary BMP Proposed
1. From MassDEP Stormwater Handbook Vol. 1

INSTRUCTIONS:
1. In BMP Column, click on Blue Cell to Activate Drop Down Menu
2. Select BMP from Drop Down Menu
3. After BMP is selected, TSS Removal and other Columns are automatically completed.

Version 1, Automated: Mar. 4, 2008

Location: Barnstable County - Drainage Area 2

TSS Removal Calculation Worksheet

B BMP[1]	C TSS Removal Rate[1]	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
Grass Channel	0.50	1.00	0.50	0.50
Sediment Forebay	0.25	0.50	0.13	0.38
Infiltration Basin	0.80	0.38	0.30	0.08
	0.00	0.08	0.00	0.08
	0.00	0.08	0.00	0.08

Total TSS Removal = 93%

Separate Form Needs to be Completed for Each Outlet or BMP Train

Project: MASS DOT Canal Bridges Relocation
Prepared By: Drake Trawhon
Date: 5/3/2026

*Equals remaining load from previous BMP (E) which enters the BMP

Non-automated TSS Calculation Sheet must be used if Proprietary BMP Proposed
1. From MassDEP Stormwater Handbook Vol. 1

INSTRUCTIONS:
1. In BMP Column, click on Blue Cell to Activate Drop Down Menu
2. Select BMP from Drop Down Menu
3. After BMP is selected, TSS Removal and other Columns are automatically completed.

Version 1, Automated: Mar. 4, 2008

Location: Barnstable County - Drainage Area 3

TSS Removal Calculation Worksheet

B BMP[1]	C TSS Removal Rate[1]	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
Grass Channel	0.50	1.00	0.50	0.50
Sediment Forebay	0.25	0.50	0.13	0.38
Infiltration Basin	0.80	0.38	0.30	0.08
	0.00	0.08	0.00	0.08
	0.00	0.08	0.00	0.08

Total TSS Removal = 93%

Separate Form Needs to be Completed for Each Outlet or BMP Train

Project: MASS DOT Canal Bridges Relocation
Prepared By: Drake Trawhon
Date: 5/3/2026

*Equals remaining load from previous BMP (E) which enters the BMP

Non-automated TSS Calculation Sheet must be used if Proprietary BMP Proposed
1. From MassDEP Stormwater Handbook Vol. 1

INSTRUCTIONS:
1. In BMP Column, click on Blue Cell to Activate Drop Down Menu
2. Select BMP from Drop Down Menu
3. After BMP is selected, TSS Removal and other Columns are automatically completed.

Version 1, Automated: Mar. 4, 2008

Location: Barnstable County - Drainage Area 4

TSS Removal Calculation Worksheet

B BMP[1]	C TSS Removal Rate[1]	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
Grass Channel	0.50	1.00	0.50	0.50
Sediment Forebay	0.25	0.50	0.13	0.38
Infiltration Basin	0.80	0.38	0.30	0.08
	0.00	0.08	0.00	0.08
	0.00	0.08	0.00	0.08

Total TSS Removal = 93%

Separate Form Needs to be Completed for Each Outlet or BMP Train

Project: MASS DOT Canal Bridges Relocation
Prepared By: Drake Trawhon
Date: 5/3/2026

*Equals remaining load from previous BMP (E) which enters the BMP

Non-automated TSS Calculation Sheet must be used if Proprietary BMP Proposed
1. From MassDEP Stormwater Handbook Vol. 1

INSTRUCTIONS:
1. In BMP Column, click on Blue Cell to Activate Drop Down Menu
2. Select BMP from Drop Down Menu
3. After BMP is selected, TSS Removal and other Columns are automatically completed.

Version 1, Automated: Mar. 4, 2008

Location: Barnstable County - Drainage Area 5

TSS Removal Calculation Worksheet

B BMP[1]	C TSS Removal Rate[1]	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
Grass Channel	0.50	1.00	0.50	0.50
	0.00	0.50	0.00	0.50
	0.00	0.50	0.00	0.50
	0.00	0.50	0.00	0.50
	0.00	0.50	0.00	0.50

Total TSS Removal = 50%

Separate Form Needs to be Completed for Each Outlet or BMP Train

Project: MASS DOT Canal Bridges Relocation
Prepared By: Drake Trawhon
Date: 5/3/2026

*Equals remaining load from previous BMP (E) which enters the BMP

Non-automated TSS Calculation Sheet must be used if Proprietary BMP Proposed

1. From MassDEP Stormwater Handbook Vol. 1

Nitrogen Loading Calculations

NITROGEN LOADING CALCULATION

Based on Cape Cod Commission Technical Bulletin 91-001 (April 1992)

SECTION 1 — INPUT DATA

Property Information

Parameter	Description	Value	Units		Source / Notes	
Property Name	Project ID	Bourne Rotary	—		Source: Project data	
Town / Municipality	Cape Cod Commission town	Bourne	—		TB 91-001 Table 1	
Target NO_3-N Conc.	Max allowable concentration	5	ppm		TB 91-001, Section B.1	

Site Areas (Editable Inputs — Blue)

Surface Type	Description	Area (ft²)	Area (acres)		Notes	
Gravel Area	Impervious — site runoff	43,230	0.992		Source: Site plan	
Paved Area	Impervious — road runoff	0	0.000		Source: Site plan	
Pervious Area	Natural — recharge only	27,749	0.637		Source: Site plan	
Roof Area	Impervious — roof runoff	2,388	0.055		Enter if applicable	
Lawn Area	Fertilized turf	0	0.000		Enter if applicable	
TOTAL SITE AREA		**73,368**	**1.684**		**ft²**	

CCC Standard Parameters (per Technical Bulletin 91-001)

Parameter	Value	Units			Source	
Recharge — Impervious surfaces	40	in/yr			TB 91-001, Section B.5	
Recharge — Natural (Bourne)	21	in/yr			TB 91-001, Table 1	
NO_3-N conc. — Road/Gravel runoff	1.5	ppm			TB 91-001, Section B.5	
NO_3-N conc. — Roof runoff	0.75	ppm			TB 91-001, Section B.5	
NO_3-N conc. — Wastewater	35	ppm			TB 91-001, Section B.2	
Fertilizer application rate	3	lbs N/1000 ft²/yr			TB 91-001, Section B.4	
Fertilizer leaching rate	0.25	%			TB 91-001, Section B.4	
Unit conversion — L per ft³	28.32	L/ft³			Standard conversion	
Unit conversion — days per year	365	d/yr			Standard	
Unit conversion — ft per inch	0.083333333	ft/in			Standard	
mg per lb	454000	mg/lb			Standard	

SECTION 2 — MASS BALANCE CALCULATIONS

Surface / Source	Area or Flow	Units	Flow (L/d)	Conc. (mg/L)	Load (mg/d)	Notes
A. Impervious Surfaces						
Gravel Area	43230.4	ft²	11,180.68	1.50	16,771.03	Road runoff @ 1.5 ppm
Paved Area	0	ft²	0.00	1.50	0.00	Road runoff @ 1.5 ppm
Roof Area	2388	ft²	617.61	0.75	463.21	Roof runoff @ 0.75 ppm
Subtotal — Impervious			**11,798.29**	**—**	**17,234.23**	
B. Natural / Pervious Area (contributes to denominator only — N load = 0)						
Natural Area	27749.11	ft²	3,767.80	0.00	0.00	N load ignored per TB 91-001 B.5
C. Lawn Areas						
Lawn Area	0	ft²	0.00	N/A	0.00	3 lbs/1000ft²/yr × 25% leaching
D. Wastewater						
Wastewater Flow	0	L/d	0.00	35.00	0.00	Enter Title 5 flow (L/d) in col B

SECTION 3 — SUMMARY & RESULT

Component		Flow (L/d)		Load (mg/d)		
Impervious Surfaces (Gravel + Paved + Roof)		11,798.29		17,234.23		
Natural / Pervious Areas		3,767.80		0.00		
Lawn Areas		0.00		0.00		
Wastewater		0.00		0.00		
TOTAL		**15,566.09**		**17,234.23**		

Calculated NO_3-N Concentration	**1.107 ppm**	**ppm NO_3-N**
Target Concentration	**5.0 ppm**	**ppm NO_3-N (max)**
COMPLIANCE STATUS	**✓ COMPLIES — Below Target**	

Note: Per TB 91-001, natural recharge nitrogen load is negligible and excluded from numerator. Gravel treated as road runoff (1.5 ppm). Lawn N load adds to numerator only (no dilution volume).

Attachment F - Standard 8 Supporting Information

Site Specific Erosion and Sediment Control Plan Narrative

Site Specific Erosion and Sediment Control Plan

Site Specific Erosion and Sediment Control Narrative

Erosion and Sedimentation Control Measures

The following erosion and sedimentation controls were selected based on existing and proposed site conditions for use during the earthwork and construction phases of the project. In addition to those outlined below, additional practices are included in Enbridge's Standard Erosion and Sediment Control Manual.

Silt Fence/Straw Wattle

Straw wattle barriers will be placed to trap sediment transported by runoff before it reaches the drainage system or leaves the construction site. In areas where high runoff velocities or high sediment loads are expected, straw wattles will be backed up with silt fencing. This semi-permeable barrier made of a synthetic porous fabric will provide additional protection. The silt fence and straw wattle barrier will be replaced as determined by periodic field inspections.

Catch Basin Protection

Newly constructed and existing nearby catch basins will be protected with silt sacks throughout construction.

Concrete Wash Area

The best management practice objectives for concrete washout are to (a) collect and retain all the concrete washout water and solids in leak proof containers, so that this caustic material does not reach the soil surface and then migrate to surface waters or into the ground water, and (b) recycle 100 percent of the collected concrete washout water and solids. Another objective is to support the diversion of recyclable materials from landfills.

Concrete washout facilities should be inspected daily and after heavy rains to check for leaks, identify any plastic linings and sidewalls have been damaged by construction activities, and determine whether they have been filled to over 75 percent capacity. When the washout container is filled to over 75 percent of its capacity, the washwater should be vacuumed off or allowed to evaporate to avoid overflows. Then when the remaining cementitious solids have hardened, they should be removed and recycled. Damages to the container should be repaired promptly. Before heavy rains, the washout container's liquid level should be lowered or the container should be covered to avoid an overflow during the rain storm.

Temporary Diversion Channels

Diversion channels will be used to collect runoff from construction areas and discharge to either sedimentation basins or protected catch basin inlets.

Vegetative Slope Stabilization

Stabilization of open soil surfaces will be implemented within 14 days after grading or construction activities have temporarily or permanently ceased, unless there is sufficient snow cover to prohibit implementation. Vegetative slope stabilization will be used to minimize erosion on slopes of 3:1 or flatter. Annual grasses, such as annual rye, will be used to ensure rapid germination and production of root mass. Permanent stabilization will be completed with the planting of perennial grasses or legumes. Establishment of temporary and permanent vegetative cover may be established by hydro-seeding or sodding. A suitable topsoil, good seedbed preparation, and

adequate lime, fertilizer and water will be provided for effective establishment of these vegetative stabilization methods. Mulch will also be used after permanent seeding to protect soil from the impact of falling rain and to increase the capacity of the soil

Maintenance

- The contractor or subcontractor will be responsible for implementing each control shown on the Sedimentation and Erosion Control Plan. In accordance with EPA regulations, the contractor must sign a copy of a certification to verify that a plan has been prepared and that permit regulations are understood.
- The on-site contractor will inspect all sediment and erosion control structures periodically and after each rainfall event. Records of the inspections will be prepared and maintained on-site by the contractor.
- Silt shall be removed from behind barriers if greater than 6-inches deep or as needed.
- Damaged or deteriorated items will be repaired immediately after
- identification.
- The underside of straw wattles should be kept in close contact with the earth and reset as necessary.
- Sediment that is collected in structures shall be disposed of properly and covered if stored on-site.
- Erosion control structures shall remain in place until all disturbed earth has been securely stabilized. After removal of structures, disturbed areas shall be regraded and stabilized as necessary.

Construction Best Management Practices - Maintenance/Evaluation Checklist

Best Management Practice	Inspection Frequency	Date Inspected	Inspector	Minimum Maintenance and Key Items to Check	Cleaning/Repair Needed ☐ yes ☐ no	Date of Cleaning/Repair	Performed by:
					☐ yes ☐ no		
					☐ yes ☐ no		
					☐ yes ☐ no		
					☐ yes ☐ no		
					☐ yes ☐ no		
					☐ yes ☐ no		
					☐ yes ☐ no		

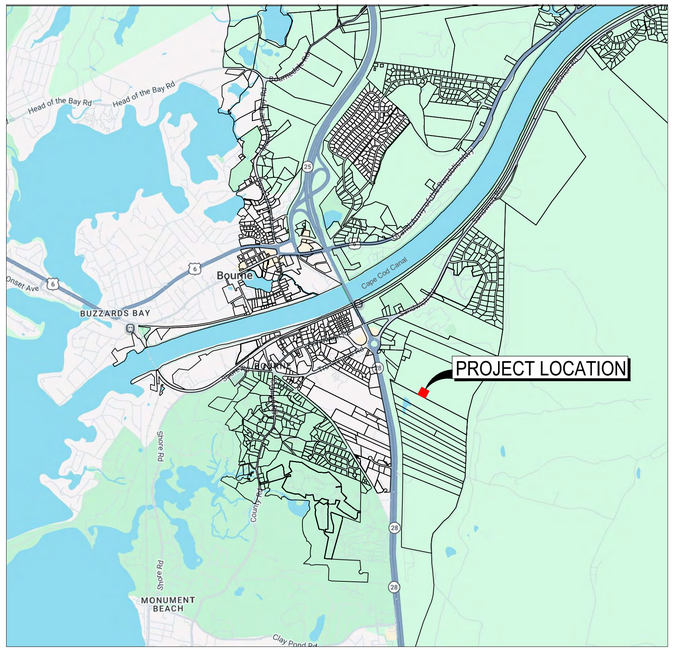
Stormwater Control Manager _____

Site Specific Erosion and Sediment Control Plan

CAPE COD CANAL PIPELINE RELOCATION PROJECT
BOURNE ROTARY
STATION RELOCATION PROJECT
M&R 00846
BARNSTABLE COUNTY, MASSACHUSETTS
2026

DATE	ISSUE	LEAD DFRS.	SECT. SUPV.	PROJ. ENG./ DESIGN ENG.	PROJ. MGR./ DESIGN MGR.	PROJECT DIRECTOR
		APPROVALS				
06/29/2026	☒ ISSUED FOR PERMIT	VN	DT	PB	AC	
05/15/2026	☒ ISSUED FOR BID	VN	DT	PB	AC	

DWG. NO.	DRAWING TITLE
	CIVIL DRAWINGS
00846-C.015-0002	EROSION & SEDIMENT CONTROL COVER SHEET
00846-C.020-0001	EROSION & SEDIMENT CONTROL GENERAL NOTES
00846-C.320-0001	EXISTING CONDITIONS PLAN
00846-C.320-0002	EXISTING SUBCATCHMENT AREAS PLAN
00846-C.320-0003	PROPOSED SITE LAYOUT PLAN
00846-C.301-0001	GRADING PLAN
00846-C.301-0002	GRADING CROSS SECTIONS
00846-C.320-0004	CONSTRUCTION EROSION AND SEDIMENT CONTROL PLAN
00846-C.320-0005	PROPOSED SUBCATCHMENT AREAS PLAN
00846-C.320-0006	DETAILS
00846-C.320-0007	DETAILS



VICINITY MAP

EXHIBIT A

SRO NO. XXXX

PLANT W.O. NO.

PIPELINE W.B.S. NO. 30002835

YEAR 2026

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
No. 58957
PROFESSIONAL ENGINEER
07/07/26

Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

ISSUED FOR PERMIT
06/29/2026

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		C	06/29/26	VN	DT	ISSUED FOR PERMIT
		B	05/15/26	VN	DT	ISSUED FOR BID
		A	05/15/26	VN	DT	ISSUED FOR PERMIT

audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

TITLE	INITIALS	DATE
DRAWN BY:	VN	05/15/26
DESIGN CHECKER:	DT	06/29/26
DESIGN ENGINEER:	PB	06/29/26
PROJECT MANAGER:	AC	06/29/26

CAPE COD CANAL PIPELINE RELOCATION PROJECT
BOURNE ROTARY METER STATION
M&R 00846
TITLE: EROSION & SEDIMENT CONTROL COVER SHEET
LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

YEAR: 2026 | W.O.: | SCALE: NTS | DWG.: 00846-C.320-0001 | REV.: C

ENBRIDGE
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

s:\AE\Projects\Enbridge\Mass\026356-001\200_civil_structural\170_drawings\e&s plans\bourne rotary\00846-C.320-0001.dwg - PLOT TIME: 6/29/2026 12:25 PM

SEDIMENTATION AND EROSION CONTROL NOTES

IT IS THE INTENT OF THE CONTRACT PLANS AND DETAILS TO CONTROL EROSION AND SEDIMENTATION IN ALL PORTIONS OF THE SITE. THE CONTRACTOR IS TO IMPLEMENT THE EROSION AND SEDIMENTATION CONTROLS INDICATED ON THE PLANS, IN ACCORDANCE WITH THE FOLLOWING NOTES, BUT IS ALERTED TO THE FACT THAT ADDITIONAL MEASURES MAY BE REQUIRED TO COMPLY WITH THIS INTENT, AS FIELD CONDITIONS MAY WARRANT. SHOULD SUCH MEASURES BE DETERMINED TO BE REQUIRED OR ORDERED BY THE ENGINEER, THEY ARE TO BE IMPLEMENTED IMMEDIATELY. IN ADDITION, THE CONTRACTOR SHALL PREPARE AND SUBMIT FOR ENGINEER'S REVIEW A STORMWATER POLLUTION PREVENTION PLAN (SWPPP) AND FILE A NOTICE OF INTENT WITH THE U.S. EPA AS REQUIRED UNDER THE NPDES CONSTRUCTION GENERAL PERMIT PROGRAM. A COPY OF THE SWPPP SHALL BE KEPT ON-SITE AT ALL TIMES AND UPDATED AS REQUIRED.

1. THE CONTRACTOR SHALL BE RESPONSIBLE FOR IMPLEMENTING EROSION CONTROL MEASURES IN ORDER TO PREVENT THE OFF-SITE TRACKING OF EARTH, SEDIMENT, AND DEBRIS; AND FOR GENERALLY CONTROLLING THE EROSION AND SEDIMENT TRANSPORT DURING THE CONSTRUCTION PROCESS. SITE SPECIFIC CONDITIONS MAY REQUIRE MODIFICATIONS IN THE FIELD, BUT THE CONTRACTOR MUST ENSURE THAT THAT MEASURES IMPLEMENTED IN THE FIELD MEET THE MINIMUM REQUIREMENTS OF THESE PLANS.

2. ALL WORK SHALL BE IN ACCORDANCE WITH THE CONTRACT DOCUMENTS, THE PROVISIONS OF ALL APPLICABLE PERMITS AND APPROVALS ISSUED BY LOCAL, STATE, AND FEDERAL REGULATION FOR ACTIVITIES INVOLVING WETLANDS, WATERCOURSES AND/OR EROSION CONTROLS. ALL EROSION AND SEDIMENTATION CONTROL MEASURES SHALL BE CONSTRUCTED IN ACCORDANCE WITH THE MASSACHUSETTS EROSION AND SEDIMENT CONTROL GUIDELINES FOR URBAN AND SUBURBAN AREAS, FEBRUARY 2008 AND THE MASSACHUSETTS STORMWATER HANDBOOK VOLUME 1, AS AMENDED.

3. THE CONTRACTOR IS RESPONSIBLE FOR THE INSTALLATION OF SILT FENCES, CHECK DAMS AND TEMPORARY SEDIMENT BASINS. SUCH PRACTICES DIVERT FLOWS FROM EXPOSED SOILS, LIMIT RUNOFF AND THE DISCHARGE OF POLLUTANTS FROM EXPOSED AREAS OF THE SITE TO THE DEGREE ATTAINABLE. TEMPORARY EROSION AND SEDIMENTATION CONTROL MEASURES SHALL BE INSTALLED PRIOR TO THE COMMENCEMENT OF ANY SITE WORK, SHALL BE MAINTAINED DURING CONSTRUCTION, AND SHALL REMAIN IN PLACE UNTIL ALL SITE WORK IS COMPLETED AND GROUND COVER IS ESTABLISHED BY NEW SEEDLINGS). (AT LEAST 751 UNIFORM COVERAGE BY NEW SEEDLINGS).

4. IN GENERAL, WORK REQUIRING EROSION CONTROL INCLUDES EXCAVATIONS, FILLS, RETAINING WALLS, DRAINAGE, ROUGH AND FINISH GRADING, AND STOCKPILING OF EARTH.

5. AREAS SUBJECT TO EROSION SHALL BE MINIMIZED IN TERMS OF TIME AND AREA. DO NOT DISTURB VEGETATION AND TOPSOIL BEYOND THE PROPOSED LIMIT OF SILT FENCE ACTIVITIES.

6. A STABILIZED CONSTRUCTION ENTRANCE SHALL BE INSTALLED AT ALL POINTS OF ACCESS TO THE SITE TO MINIMIZE TRACKING OF SEDIMENT ONTO PUBLIC ROADWAY.

7. EROSION CONTROL MEASURE SHALL BE INCORPORATED IN THE SEQUENCE OF CONSTRUCTION TO PREVENT SEDIMENT LADEN WATER FROM LEAVING THE SITE.

8. EARTHWORK ACTIVITY SHALL BE PERFORMED IN A MANNER SUCH THAT RUNOFF IS DIRECTED TO PERIMETER CONTROLS. IN NO CASE SHALL RUNOFF FROM ROADWAYS OR OTHER AREAS, UPGRADIENT FROM EMBANKMENTS, BE ALLOWED TO RUN DOWN ANY CUT OR FILL SLOPE, WITHOUT THE APPROVAL OF THE ENGINEER.

9. THE CONTRACTOR SHALL, AT ALL TIMES, HAVE A STOCKPILE OF HAY BALES, SILT FENCE, CRUSHED STONE, AND CATCH BASIN FILTER BAGS ADEQUATE TO REINFORCE/REPLACE EROSION AND SEDIMENT CONTROLS AS NEEDED.

10. ALL EROSION AND SEDIMENTATION CONTROL MEASURES SHALL BE MAINTAINED IN EFFECTIVE CONDITION THROUGHOUT THE CONSTRUCTION PERIOD SO THAT ALL AREAS ARE STABILIZED TO PREVENT THE MOVEMENT OF SOIL, SILT, SEDIMENT AND DEBRIS INTO DRAINAGE SYSTEMS OR WATERWAYS ON AND NEAR CONSTRUCTION ACTIVITY. THE CONTRACTOR SHALL INSPECT THE EROSION CONTROLS DAILY AND CLEAN ACCUMULATED MATERIALS FROM BEHIND THEM, AS NECESSARY. ALL EROSION AND SEDIMENTATION CONTROL MEASURES FOUND TO BE IN NEED OF REPAIR OR REPLACEMENT SHALL BE IMMEDIATELY CORRECTED, SO AS TO MAINTAIN THE INTEGRITY OF THE EROSION AND SEDIMENTATION CONTROL SYSTEM.

11. IN ORDER TO MINIMIZE EROSION AND SEDIMENT RUNOFF FROM THE SITE, THE CONTRACTOR SHOULD MAINTAIN EXISTING VEGETATION WHERE POSSIBLE AND STABILIZE THE DISTURBED PORTIONS OF THE SITE AS QUICKLY AS POSSIBLE. THE CONTRACTOR SHALL PHASE CONSTRUCTION TO MINIMIZE THE AREA OF DISTURBED EARTH OPEN TO THE ELEMENTS AT ANY GIVEN TIME. THIS SHALL BE ACHIEVED BY THE FOLLOWING METHODS OR OTHER BEST MANAGEMENT PRACTICES (BMP's):

    A. LOAMING AND SEEDING CUT SLOPES IMMEDIATELY UPON COMPLETION OF SUBGRADE PREPARATION, AND SECURING SUCH NEWLY ESTABLISHED SLOPES WITH EROSION CONTROL NETTING AND/OR MULCH.
    B. PLACING AND COMPACTING PAVEMENT GRAVEL BASE AND SUB- BASE IMMEDIATELY UPON COMPLETION OF SUBGRADE PREPARATION.
    C. LIMITING STRIPPING AND STOCKPILING OF LOAM TO AREAS SLATED FOR IMMEDIATE CONSTRUCTION AND STABILIZATION (I.E. PLACEMENT OF GRAVELS, LOAM AND SEED, EROSION CONTROL MATTING).

12. THE CONTRACTOR MUST ALSO ANTICIPATE INCREASED RUNOFF FROM STEEPER SLOPES AND DURING HIGH GROUNDWATER CONDITIONS.THIS MAY OCCUR DURING THE WET SEASON (TYPICALLY MARCH THROUGH APRIL) OR AFTER SIGNIFICANT PRECIPITATION EVENTS.

13. SEDIMENT REMOVED FROM CONTROL STRUCTURES SHALL BE DISPOSED OF LEGALLY OFF SITE. NO EQUIPMENT OR MATERIAL OF ANY KIND SHALL BE STOCKPILED OR DEPOSITED IN ANY REGULATED AREA, UNLESS SPECIFICALLY SHOWN ON THE CONTRACT PLANS OR AUTHORIZED BY PROJECT PERMITS/APPROVALS.

14. STOCKPILED SOIL SHALL BE SURROUNDED WITH SILTATION FENCES TO PREVENT AND CONTROL SILTATION AND EROSION. STOCKPILES THAT WILL REMAIN EXPOSED FOR MORE THAN 30 DAYS, SHALL BE STABILIZED WITH MULCH OR SEEDED FOR TEMPORARY VEGETATIVE COVER.

15. TEMPORARY STORAGE OF MATERIALS ON-SITE SHALL BE LOCATED GREATER THAN 1OO-FEET FROM WETLAND AREAS, AND AS APPROVED BY THE ENGINEER. EROSION CONTROLS INSTALLED ALONG WETLAND RESOURCE AREAS SHALL DEFINE THE LIMIT OF WORK AND SHALL NOT BE CROSSED. THERE SHALL BE NO LONG-TERM STORAGE OF MATERIAL ON -SITE OR ON -ROUTE. MATERIAL NOT USED ON -SITE OR ON -ROUTE SHALL BE TRUCKED TO AN ACCEPTABLE OFF-SITE DISPOSAL LOCATION.

16. ALL DISTURBED SURFACES SHALL BE STABILIZED WITHIN 14 DAYS AFTER CONSTRUCTION IN ANY PORTION OF THE SITE THAT HAS BEEN COMPLETED OR WHERE CONSTRUCTION HAS TEMPORARILY CEASED.

17. ALL AREAS OF DISTURBANCE MUST HAVE TEMPORARY OR FINAL STABILIZATION WITH MULCH OR MULCH NETTING, OR SEEDED FOR TEMPORARY VEGETATIVE COVER, WITHIN 14 DAYS OF THE INITIAL DISTURBANCE. AFTER THIS TIME, ANY DISTURBANCE IN THE AREA MUST BE STABILIZED AT THE END OF EACH WORK DAY. THE FOLLOWING EXCEPTIONS APPLY:

    A. STABILIZATION IS NOT REQUIRED IF WORK IS TO CONTINUE IN THE AREA WITHIN THE NEXT 24 HOURS AND THERE IS NO PRECIPITATION FORECAST FOR THE NEXT 24 HOURS.
    B. STABILIZATION IS NOT REQUIRED IF THE WORK IS OCCURRING IN A SELF-CONTAINED EXCAVATION WITH A DEPTH OF 2 FEET OR GREATER.

18. THERE SHALL BE NO DIRECT DISCHARGE FROM ANY REQUIRED DEWATERING OPERATIONS INTO ANY WETLAND, WATERCOURSE, OR DRAINAGE SYSTEM AND THEN ONLY AS ALLOWED BY REGULATORY PERMITS. ANY DEWATERING DISCHARGE CONTAINING SETTLEABLE SOLIDS (SEDIMENTS) SHALL BE PASSED THROUGH A SEDIMENTATION CONTROL BASIN, FRACTIONATION TANK OR SIMILAR TREATMENT, APPROVED BY THE ENGINEER, TO REMOVE THESE SOLIDS. CONTRACTOR SHALL MAINTAIN SAID SEDIMENT CONTROL DEVICES THROUGHOUT THE ENTIRE DEWATERING OPERATION AND SHALL CEASE DEWATERING, IF DEFICIENCIES ARE NOTED, UNTIL THE DEFICIENCIES ARE CORRECTED.

19. THE CONTRACTOR SHALL INSPECT ALL PORTIONS OF THE SITE IN ANTICIPATION OF RAINFALL EVENTS TO DETERMINE IF SITE GRADING IS SUFFICIENT TO PREVENT EROSION OF SLOPES AND/OR THE TRANSPORTATION OF SEDIMENTS TO WETLANDS OR WATERCOURSES, WITHIN THE PROJECT LIMITS. SHOULD ADDITIONAL MEASURES BE REQUIRED, THEY ARE TO BE IMPLEMENTED IMMEDIATELY. IN NO CASE SHALL THE INSTALLATION OF ADDITIONAL MEASURES, NECESSARY TO PROTECT SLOPES WITHIN THE PROJECT LIMITS, BE DELAYED BEYOND THE COMMENCEMENT OF PRECIPITATION.

20. EROSION CONTROL MEASURES SHALL BE INSPECTED EVERY WEEK, AND WITHIN 24-HOUR OF AN EVENT GREATER THAN 0.25 INCHES. ANY NECESSARY REPLACEMENT OF REPAIR SHALL BE PERFORMED PROMPTLY BY THE CONTRACTOR

21. ALL DISTURBED EARTH SLOPES SHALL BE STABILIZED WITH PERMANENT VEGETATIVE COVER AS SOON AS POSSIBLE. DISTURBED AREAS, THAT ARE NOT SUBJECT TO CONSTRUCTION TRAFFIC, SHALL RECEIVE A PERMANENT OR TEMPORARY VEGETATIVE COVER AS SOON AS FINAL CONTOURS ARE ESTABLISHED. IF THE SEASON PREVENTS THE ESTABLISHMENT OF A VEGETATIVE COVER, DISTURBED AREAS SHALL BE THOROUGHLY MULCHED. MULCHED AREAS SHALL BE SEEDED AS SOON AS WEATHER CONDITIONS ALLOW.

22. ALL SLOPES STEEPER THAN 2H:1V SHALL BE COVERED WITH MODIFIED ROCKFILL AND AN APPROVED EROSION CONTROL MATTING.

23. CONTRACTOR SHALL REMOVE ALL SEDIMENTATION CONTROL SYSTEMS, REMOVE ALL ACCUMULATED SEDIMENTS, AND SEED THE DISTURBED AREAS, WHEN THE CONTROL SYSTEMS ARE NO LONGER REQUIRED. CONTRACTOR SHALL REQUEST AND RECEIVE PERMISSION FROM THE ENGINEER PRIOR TO REMOVING ANY CONTROL SYSTEM.

24. THE CONTRACTOR SHALL REMOVE AND DISPOSE OF ALL SILT AND DEBRIS RESULTING FROM CONSTRUCTION OPERATIONS FROM EACH DRAINAGE STRUCTURE UPON COMPLETION OF THE PROJECT.

25. OBJECTS AND/OR AREAS DAMAGED BY THE CONTRACTOR'S OPERATIONS SHALL BE RESTORED TO THEIR ORIGINAL CONDITION AND ELEVATION.

26. ALL DISTURBED AREAS NOT OCCUPIED BY PAVEMENT, SIDEWALK OR RIPRAP SHALL BE COVERED WITH 4" (MIN.) OF LOAM AND SEED.

27. PERMANENT SEEDING SHALL OCCUR BETWEEN MARCH 1 AND JUNE 15, OR BETWEEN AUGUST 15 AND OCTOBER 15.

28. THE CONTRACTOR SHALL MODIFY, REPAIR, OR INSTALL ADDITIONAL EROSION AND SEDIMENTATION CONTROL MEASURES AS NECESSARY TO PREVENT SEDIMENT FROM LEAVING THE SITE AT NO ADDITIONAL COST.

A. GENERAL CONSTRUCTION NOTES

1. SITE PREPARATION, GRADING AND DRAINAGE SHALL BE IN ACCORDANCE WITH THESE GENERAL NOTES, APPROVED CONSTRUCTION DRAWINGS AND PROJECT SPECIFICATIONS. FOR EARTHWORK REQUIREMENTS AND THE CONSTRUCTION OF STRUCTURAL SUBGRADES, IF IN CONFLICT WITH THESE GENERAL NOTES, THE GEOTECHNICAL REPORT SHALL GOVERN IN DETAILS.
2. CONTRACTOR SHALL COMPLY WITH OSHA REGULATIONS, STATE SPECIFIC LAWS AND COMPANY SAFETY STANDARDS AT ALL TIMES.
3. CONTRACTOR SHALL OBTAIN ALL REQUIRED PERMITS PRIOR TO STARTING CONSTRUCTION. CONTRACTOR SHALL HAVE A COPY OF ALL DRIVEWAY PERMITS ON SITE AT ALL TIMES DURING CONSTRUCTION OF DRIVES AND DRIVEWAY CULVERTS.
4. CONTRACTOR TO PROVIDE ALL MATERIAL NECESSARY FOR INSTALLATION.
5. ALL PROJECT MATERIALS OR FOR THE REPAIR OF EXISTING ELEMENTS SHALL BE NEW PRODUCTS AND FREE FROM DEFECTS PER PROJECT SPECIFICATIONS.
6. PRIOR TO BACKFILLING PONDS, CREEKS, DITCHES, OR OTHER RUNOFF CHANNELS, ALL ACCUMULATED SEDIMENT, ORGANIC MATERIAL, AND DEBRIS SHALL BE REMOVED AND DISPOSED OF AS DIRECTED BY THE COMPANY.
7. WASTE MATERIALS INCLUDING PAVEMENT REMOVED DURING CONSTRUCTION, WASTE PIPING AND SUPPLIES AND CONSTRUCTION DEBRIS SHALL BECOME THE PROPERTY OF THE CONTRACTOR AND SHALL BE REMOVED FROM THE PROJECT SITE AND DISPOSED OF PROPERLY BY THE CONTRACTOR.
8. EARTHWORK QUANTITIES SHOWN ARE APPROXIMATE AND ARE PROVIDED FOR INFORMATION PURPOSES ONLY. QUANTITIES DO NOT ACCOUNT FOR SHRINKAGE, SWELL (BULK) FACTORS, LOSS OF MATERIAL, OR REMOVAL/REPLACEMENT OF UNSUITABLE MATERIALS ENCOUNTERED IN THE FIELD. FOUNDATION AREAS WERE NOT ACCOUNTED FOR IN THE EARTHWORK ANALYSIS CALCULATION. THE CONTRACTOR SHALL VERIFY ALL QUANTITIES AND CONDITIONS PRIOR TO CONSTRUCTION.

B. UTILITIES, RIGHT-OF-WAY AND EASEMENTS

1. THE CONTRACTOR SHALL VERIFY THE LOCATIONS, ELEVATIONS AND DIMENSIONS OF ALL EXISTING UTILITIES, STRUCTURES, ETC. AFFECTING HIS WORK PRIOR TO CONSTRUCTION.
2. CONTRACTOR SHALL NOTIFY THE LOCAL JURISDICTIONAL AUTHORITY BEFORE ANY WORK IS WITHIN THE STREET RIGHT-OF-WAY OR EASEMENTS.
3. CONTRACTOR SHALL GIVE NOTICE TO ALL AUTHORIZED INSPECTORS, SUPERINTENDENTS AND PERSONS IN CHARGE OF PUBLIC AND PRIVATE UTILITIES AFFECTED BY HIS OPERATIONS PRIOR TO STARTING WORK.
4. CONTRACTOR SHALL VERIFY THE LOCATIONS OF EXISTING UNDERGROUND UTILITIES PRIOR TO COMMENCING CONSTRUCTION AND SHALL REPORT DISCREPANCIES TO THE COMPANY REPRESENTATIVE IMMEDIATELY.
5. CONTRACTOR TO PROTECT ACTIVE UTILITY LINES OR ELECTRICAL CONDUITS SHOWN ON THE DRAWINGS OR OTHERWISE MADE KNOWN TO THE CONSTRUCTION MANAGEMENT PRIOR TO COMMENCING WORK.
6. ALL UTILITIES SHALL BE KEPT IN OPERATION EXCEPT WITH THE EXPRESS WRITTEN CONSENT OF THE UTILITY OWNER. IT SHALL BE THE CONTRACTOR'S RESPONSIBILITY TO PRESERVE EXISTING UTILITIES.
7. CONTRACTOR SHALL LOCATE ALL UNDERGROUND PIPELINES AND PROTECT THEM DURING CONSTRUCTION FROM IMPOSING HEAVY LOADS FROM SITE PREPARATION ACTIVITIES, MACHINERY AND ANY OTHER EQUIPMENT THAT MAY DAMAGE EXISTING FACILITIES. CONTRACTOR SHALL BE FULLY RESPONSIBLE FOR ANY DAMAGES DURING CONTRUCTION AND REPAIR IN ACCORDANCE WITH THE OWNING AUTHORITIES WITH NO COST TO THE OWNER.
8. ALL GRADING EXCAVATION WORK TO BE PERFORMED WITHIN PIPELINE RIGHT-OF-WAY OR EASEMENTS OR WITHIN 25 FT, MEASURED AT RIGHT ANGLES, OF PIPELINES, SHALL BE IN THE PRESENCE OF COMPANY REPRESENTATIVE.
9. WORK SHALL BE STOPPED IF ANY UNDERGROUND UTILITIES ARE ENCOUNTERED DURING EARTHWORK OPERATIONS AND THE COMPANY REPRESENTATIVE SHALL BE NOTIFIED FOR SPECIFIC DIRECTION.
10. CONTRACTOR SHALL LOCATE ALL OVERHEAD ELECTRICAL POWER LINES IN THE PROPERTY PRIOR TO BEGINNING ANY CONSTRUCTION. FEDERAL AND STATE REGULATIONS RELATED TO HEALTH AND SAFETY SHALL BE FOLLOWED FOR ANY WORK RELATED TO OVERHEAD ELECTRICAL POWER LINES.
11. CONTRACTOR SHALL BE FULLY RESPONSIBLE FOR ANY AND ALL DAMAGE TO FACILITIES, PROPERTY, UNDERGROUND UTILITIES AND TO EXISTING PUBLIC OR PRIVATE UTILITY LINES, INCLUDING BUT NOT LIMITED TO PIPELINES, WATER LINES, WASTEWATER COLLECTION SYSTEMS AND STORM SEWERS, DURING CONSTRUCTION. ALL DAMAGE SHALL BE REPAIRED IN ACCORDANCE WITH THE OWNING AUTHORITY, WITH NO COST TO THE OWNER.
12. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ANY REPAIR OR REPLACEMENT TO MEET THE STANDARDS OF THE APPROPRIATE REGULATORY AGENCY FOR ANY PAVEMENT, DRIVEWAYS, SIDEWALKS, CURBS AND OTHER EXISTING STRUCTURE THAT SUBJECTED TO MODIFICATION OR DAMAGED DURING OR AS A RESULT OF CONSTRUCTION.
13. THE CONTRACTOR SHALL BE RESPONSIBLE FOR CONTACTING THE APPROPRIATE UTILITY COMPANY OR OWNER AS APPLICABLE TO STABILIZE UTILITY POLES AND REMOVE AND REPLACE EXISTING GUY WIRES AS NECESSARY FOR CONSTRUCTION. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ALL COST ASSOCIATED WITH THE WORK.

C. CLEARING AND GRUBBING

1. CONTRACTOR SHALL BE RESPONSIBLE FOR CLEARING AND GRUBBING TO THE GRADING AREA LIMITS SHOWN ON THE CONSTRUCTION DRAWINGS AND FURTHER DESCRIBED BELOW. CONTRACTOR TO SPREAD ORGANIC SOILS FROM VEGETATION STRIP IN AREAS DESIGNATED BY THE OWNER REPRESENTATIVE.
2. UNLESS NOTED IN THE GEOTECHNICAL REPORT, STRIPPING OF TOP SOIL SHALL BE AT A MINIMUM DEPTH OF 12 IN. OR AS DIRECTED BY THE GEOTECHNICAL ENGINEER OR HIS DIRECT REPRESENTATIVE.
3. IN AREAS WHERE TREES, SHRUBS, GROWTH OR OTHER ITEMS ARE DESIGNATED TO REMAIN BY CONSTRUCTION MANAGEMENT, SELECTED CLEARING SHALL BE DONE AND ADEQUATELY PROTECTED FROM CONSTRUCTION EQUIPMENT WITHIN THE SURROUNDING AREAS.
4. CONTRACTOR SHALL STRIP ALL TREES, SHRUBS, VEGETATION, ORGANICS, LOOSE TOPSOIL AND OTHER DEBRIS FROM GRADING AREA. CLEAN OUT ROOTS 0.5 IN. IN DIAMETER AND LARGER TO A DEPTH OF 12 IN. BELOW EXISTING GROUND SURFACE OR SUBGRADE OF NEWLY GRADED SURFACE, WHICHEVER IS LOWER.
5. CONTRACTOR TO CLEAR UNDERGROWTH & DEAD WOOD MATERIALS WITHOUT DISTURBING THE SUBSOIL.
6. APPLY HERBICIDE TO REMAINING STUMPS INHIBITING GROWTH AS REQUIRED.
7. CONTRACTOR TO DISPOSE OF TOP SOIL, RUBBISH, DEBRIS, AND OTHER OBJECTIONABLE MATERIAL TO DESIGNATED DISPOSAL AREAS AS DIRECTED BY THE COMPANY.
8. UPON COMPLETION OF WORK, NO MATERIAL RESULTING FROM CLEARING AND GRUBBING OPERATIONS SHALL REMAIN WITHIN THE LIMITS OF THE SITE, EXCEPT IN THE DESIGNATED AREA.

D. SITE PREPARATION, EXCAVATION, SUBGRADE AND BACKFILL

1. CONTRACTOR SHALL EXCAVATE AND GRADE THE SITE AS DETAILED IN THE CONSTRUCTION DRAWINGS AND FOLLOW SPECIFICATIONS PER GEOTECHNICAL REPORT RECOMMENDATIONS.
2. EXPOSED SUBGRADE SHALL BE PROOF ROLLED IN ACCORDANCE WITH MASSACHUSETTS ITEM 170. WEAK OR SOFT ZONE MATERIALS SHALL BE REMOVED AND REPLACED/COMPACTED WITH APPROVED FILL MATERIAL.
3. UNLESS NOTED IN THE GEOTECHNICAL REPORT, ALL FILL MATERIAL SHALL:

    - BE COMPACTED IN LOOSE LIFTS 6 IN. OR LESS.
    - NOT EXCEED A SLOPE OF 1:10 BETWEEN DIFFERING TRANSITION FILL DEPTHS.
    - BE COMPACTED TO A MINIMUM OF 95% BUT NOT GREATER THAN 98% OF THE MAXIMUM DRY DENSITY AS DETERMINED BY THE STANDARD PROCTOR TEST (ASTM D-698).
    - HAVE MOISTURE CONTENT CONTROLLED AT THE TIME OF COMPACTION BETWEEN OPTIMUM AND 4% ABOVE OPTIMUM MOISTURE CONTENT.
    - THE CONTRACTOR SHALL IMPORT ALL FILL MATERIAL FROM AN APPROVED BORROW SITE, AND THIS MATERIAL SHALL MEET THE REQUIREMENTS OF THE PROJECT GEOTECHNICAL REPORT PREPARED BY GEOENGINEERS USA, PC. IMPORT MATERIAL SHALL BE APPROVED BY THE GEOTECHNICAL ENGINEER OF RECORD AND MEET THE REQUIREMENTS FOR LIQUID LIMIT (LL), PLASTIC LIMIT (PL) AND GRADATION.

4. PRIOR TO FILL PLACEMENT, THE TOP 12 IN. OF THE GROUND SURFACE IN FILL AREAS SHALL BE SCARIFIED, MOISTURE CONDITIONED AND RECOMPACTED PER GEOTECH RECOMMENDATIONS.
5. BACKFILL SHALL BE FREE FROM ORGANIC MATERIAL OR ANY OTHER DELETERIOUS MATTER.
6. PRIOR TO PERFORMING SOIL COMPACTION, MOISTURE CONDITION OR AERATE EACH LIFT AS NECESSARY TO PROVIDE THE REQUIRED MOISTURE CONTENT.
7. DO NOT PLACE BACKFILL OR FILL MATERIAL ON SURFACES THAT ARE MUDDY, FROZEN, OR CONTAIN FROST OR ICE.
8. MECHANICAL TAMPING OF BACKFILL AND FILL SHALL BE DONE WITH SUITABLE SIZED TAMPING FOOT SO AS TO PROVIDE UNIFORM COMPACTION.
9. INSPECTION AND FREQUENT TESTING BY QUALIFIED PERSONNEL DURING FILL COMPACTION IS NECESSARY TO ENSURE PROPER MOISTURE CONTENT AND DEGREE OF COMPACTION. CERTIFICATION SHALL BE OBTAINED FROM THE INSPECTING AGENCY THAT ALL FILL, BACKFILL AND SUBGRADE MATERIALS ARE IN COMPLIANCE WITH THE MOISTURE CONTENT AND COMPACTION RECOMMENDATIONS.
10. THE GEOTECHNICAL ENGINEER OR HIS DIRECT REPRESENTATIVE WILL MONITOR THE FILL OPERATION, IDENTIFY SOIL TYPES, AND MAKE RECOMMENDATIONS CONCERNING SELECTION AND PLACEMENT OF SOILS.
11. EXCESS EXCAVATION SHALL BE DISPOSED TO DESIGNATED DISPOSAL AREAS AS DIRECTED BY THE COMPANY.

E. WATER MANAGEMENT AND CONTROL

1. ADEQUATE DRAINAGE SHALL BE MAINTAINED AT ALL TIMES DURING CONSTRUCTION ACTIVITY. EARTHWORK SHALL BE ACCOMPLISHED IN SUCH A WAY TO ELIMINATE ACCUMULATION OF RAINWATER AND GROUNDWATER. THE CONTRACTOR SHALL INSTALL TEMPORARY MEASURES FOR MANAGING STORMWATER RUN-OFF FROM THE CUT OR FILL AREAS AS REQUIRED, MINIMIZING EROSION TO MEET NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) REQUIREMENTS.
2. CONTRACTOR SHALL PREVENT WATER FROM PONDING ON SITE AND SHALL NOT BLOCK DRAINAGE FROM OR DIRECT EXCESS DRAINAGE ONTO ADJACENT PROPERTY.
3. CONTRACTOR SHALL PROVIDE TEMPORARY PUMPING FACILITIES TO DRAIN THE WATER DURING CONSTRUCTION.
4. DEWATERING OF GROUNDWATER FOR EXCAVATIONS SHALL BE ACCOMPLISHED BY DEWATERING AT LEAST 3 FT BELOW THE BOTTOM OF THE EXCAVATION.
5. REMOVE ALL WATER, INCLUDING GROUNDWATER AND RAINWATER, TO A DESIGNATED LOCATION USING PUMPS, DRAINS OR OTHER APPROVED METHODS.
6. CONTRACTOR SHALL KEEP ALL EXCAVATIONS AND SITE CONSTRUCTION FREE FROM WATER. MAINTAIN TRENCH DRY AT ALL TIMES AND PROVIDE AUTOMATIC OR CONTINUOUS TRENCH PUMPS, AND WELL POINTS IF NECESSARY, TO OBTAIN DRY BEDDING CONDITIONS.

F. SURVEY BEARINGS & ELEVATION DATUM

1. ALL COORDINATES AND ELEVATIONS ARE REFERENCED TO NAD83 MASSACHUSETTS STATE PLANE COORDINATES, MAINLAND ZONE, US FOOT.

G. GEOTECHNICAL REPORT

1. THE GEOTECHNICAL ENGINEERING REPORT ENTITLED "CAPE CANAL BRIDGE RELOCATION PROJECT CAPE BOURNE METERING & REGULATING STATION" PREPARED BY GEOENGINEERS USA, PC. PROJECT NO. 15556-039-00, DATED MAY 15, 2025.

H. SOIL TYPES

ID #	DESCRIPTION
430B	BARNSTABLE SANDY LOAM, 3 TO 8 PERCENT SLOPES
431B	BARNSTABLE SANDY LOAM, 3 TO 8 PERCENT SLOPES, VERY STONY
431D	BARNSTABLE SANDY LOAM, 15 TO 25 PERCENT SLOPES, VERY STONY
485C	BARNSTABLE-PLYMOUTH COMPLEX, ROLLING
435B	PLYMOUTH LOAMY COARSE SAND, 3 TO 8 PERCENT SLOPES
435C	PLYMOUTH LOAMY COARSE SAND, 8 TO 15 PERCENT SLOPES
435D	PLYMOUTH LOAMY COARSE SAND, 15 TO 35 PERCENT SLOPES
436C	PLYMOUTH LOAMY COARSE SAND, 15 TO 35 PERCENT SLOPES
436D	PLYMOUTH LOAMY COARSE SAND, 15 TO 35 PERCENT SLOPES, VERY STONY
483C	PLYMOUTH-BARNSTABLE COMPLEX, ROLLING, VERY BOULDERY
483D	PLYMOUTH-BARNSTABLE COMPLEX, HILLY, VERY BOULDERY
484D	PLYMOUTH-BARNSTABLE COMPLEX, HILLY, EXTREMELY BOULDERY

THE ABOVE INFORMATION WAS OBTAINED FROM THE SOIL SURVEY GEOGRAPHIC (SSURGO) DATABASE FOR BARNSTABLE COUNTY, MASSACHUSETTS.

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
No. 58957
PROFESSIONAL ENGINEER

07/07/26

ISSUED FOR PERMIT
06/29/26

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		C	06/29/26	VN	DT	ISSUED FOR PERMIT
		B	05/15/26	VN	DT	ISSUED FOR BID
		A	05/15/26	VN	DT	ISSUED FOR PERMIT

audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

TITLE	INITIALS	DATE
DRAWN BY:	VN	05/15/26
DESIGN CHECKER:	CR	06/29/26
DESIGN ENGINEER:	PB	06/29/26
PROJECT MANAGER:	AC	06/29/26

CAPE COD CANAL PIPELINE RELOCATION PROJECT
BOURNE ROTARY METER STATION
M&R 00846
TITLE: EROSION & SEDIMENT GENERAL NOTES
LOC.: BARNSTABLE COUNTY, MASSACHUSETTS
YEAR: 2026 | W.O.: | SCALE: NO SCALE

ENBRIDGE
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400
DWG.: 00846-C.020-0001 | REV.: C

S:\AE\Projects\Enbridge\Mass\026356-001\200_civil_structural\170_drawings\e&s plans\bourne rotary\00846-C.020-0001.dwg - PLOT TIME: 6/29/2026 12:27 PM



PROPOSED BOURNE ROTARY METER STATION SITE

EXISTING CONDITIONS PLAN

SCALE: 1" = 200'

N 27.65°

STATION NORTH

0 200' 400'

Scale: 1" = 200'

NOTES:

1. ALL CONTOUR LABELS AND ELEVATION CALLOUTS ARE IN FEET.
2. PROPOSED SITE BOUNDARY WAS PROVIDED BY ENBRIDGE 3RD PARTY CONSULTANT.
3. SUPPLEMENTAL TAX PARCEL DATA IS SHOWN FOR REFERENCE ONLY AND WAS OBTAINED FROM THE CAPE COD COMMISSION OPEN GIS DATA HUB WEBSITE.
4. PROPERTY CONVEYED TO ALGONQUIN GAS TRANSMISSION, LLC.
5. TOPOGRAPHIC SURVEY INFORMATION WAS PROVIDED BY ALGONQUIN GAS TRANSMISSION, LLC. ADDITIONAL CONTOUR DATA WAS OBTAINED FROM 2022 USGS LIDAR POINT CLOUD DATA SETS. ALL COORDINATES AND DISTANCES SHOWN HEREON ARE REFERENCED TO THE MASSACHUSETTS STATE PLANE COORDINATE SYSTEM, US FEET.ELEVATIONS ARE REFERENCED TO NAVD 88.
6. THIS PROPERTY IS LOCATED IN ZONE X (AREA OF MINIMAL FLOOD HAZARD) AS DEPICTED ON FLOOD INSURANCE RATE MAP 25001C0318K DATED JULY 6, 2021.
7. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THE SITE THERE IS NOT A WETLAND WITHIN 100 FEET OF THE PROJECT LIMITS.
8. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THE SITE IS NOT LOCATED WITHIN AN AREA OF CRITICAL ENVIRONMENTAL CONCERN.
9. THIS PLAN SET IS PRELIMINARY. FOR PERMITTING PURPOSES ONLY. THIS PLAN IS NOT INTENDED FOR CONSTRUCTION PURPOSES.

LEGEND

- EXISTING MAJOR CONTOUR 70'
- EXISTING MINOR CONTOUR 72'
- EDGE OF GRAVEL
- PROPERTY LINE
- GIS TAX PARCELS
- PIPELINE EASMENT
- 100' WETLAND BUFFER

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
No. 58957
PROFESSIONAL ENGINEER

07/07/26

ISSUED FOR PERMIT
07/07/2026

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		D	07/07/26	VN	DT	REISSUED FOR PERMIT
		C	06/29/26	VN	DT	ISSUED FOR PERMIT
		B	05/15/26	VN	DT	ISSUED FOR BID
		A	05/15/26	VN	DT	ISSUED FOR REVIEW

audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

TITLE	INITIALS	DATE
DRAWN BY:	VN	05/15/26
DESIGN CHECKER:	CR	07/07/26
DESIGN ENGINEER:	PB	07/07/26
PROJECT MANAGER:	AC	07/07/26

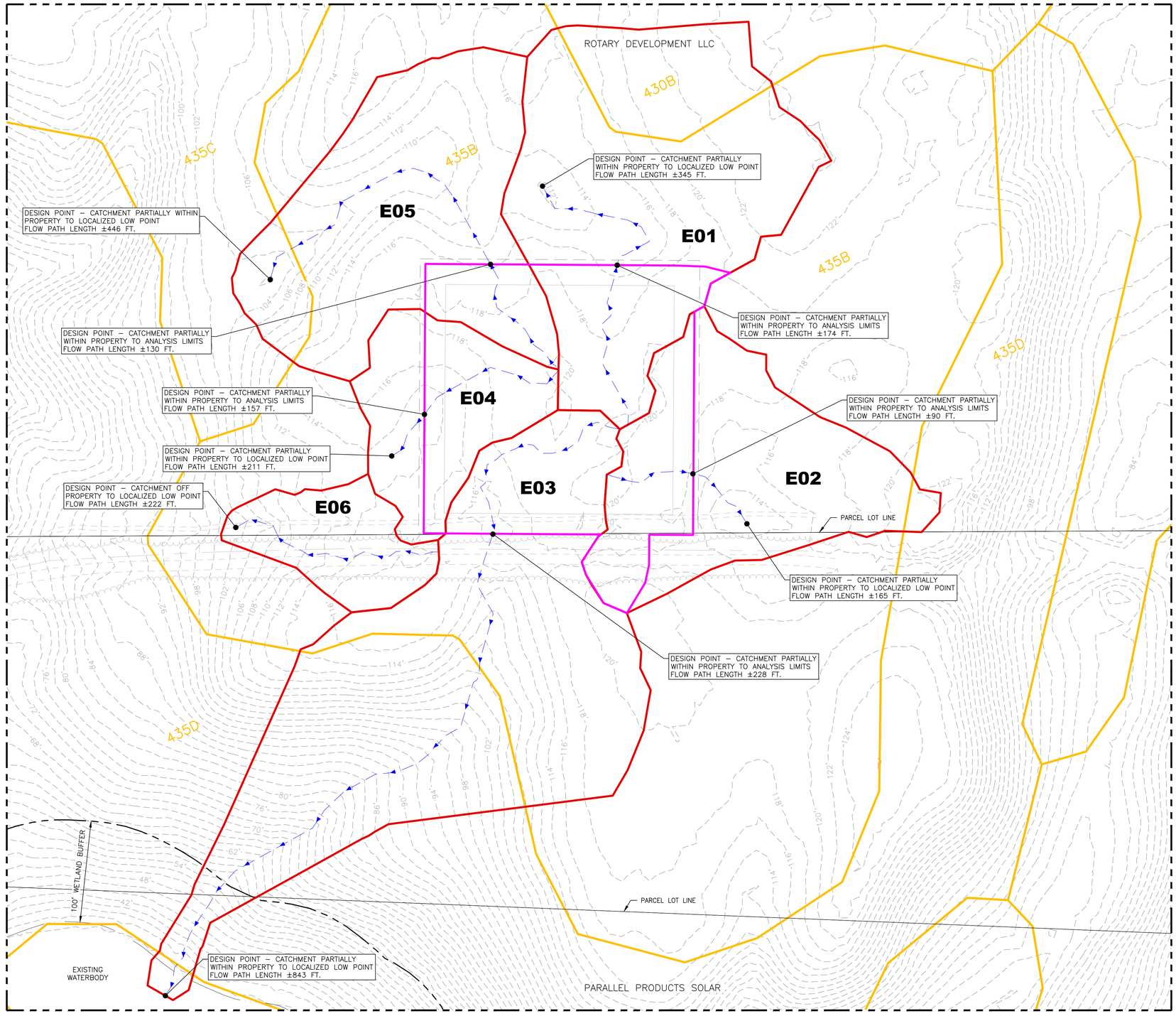
CAPE COD CANAL PIPELINE RELOCATION PROJECT
BOURNE ROTARY METER STATION
M&R 00846
TITLE: EXISTING CONDITIONS PLAN

LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

YEAR: 2026 | W.O.: | SCALE: 1"=200' | DWG.: 00846-C.320-0001 | REV.: D

ENBRIDGE
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

S:\AE\Projects\Enbridge\Mass\026356-001\200_Civil_Structural\170_Drawings\E&S Plans\Bourne Rotary\00846-C.320-0001.dwg - PLOT TIME: 7/6/2026 10:50 PM



PROPOSED BOURNE ROTARY METER STATION SITE

EXISTING SUBCATCHMENT AREAS PLAN

SCALE: 1" = 30'

0 50' 100'
Scale: 1" = 50'

N 27.65°
STATION NORTH

NOTES:

1. ALL CONTOUR LABELS AND ELEVATION CALLOUTS ARE IN FEET.
2. PROPOSED SITE BOUNDARY WAS PROVIDED BY ENBRIDGE 3RD PARTY CONSULTANT.
3. SUPPLEMENTAL TAX PARCEL DATA IS SHOWN FOR REFERENCE ONLY AND WAS OBTAINED FROM THE CAPE COD COMMISSION OPEN GIS DATA HUB WEBSITE.
4. PROPERTY CONVEYED TO ALGONQUIN GAS TRANSMISSION, LLC.
5. TOPOGRAPHIC SURVEY INFORMATION WAS PROVIDED BY ALGONQUIN GAS TRANSMISSION, LLC. ADDITIONAL CONTOUR DATA WAS OBTAINED FROM 2022 USGS LIDAR POINT CLOUD DATA SETS. ALL COORDINATES AND DISTANCES SHOWN HEREON ARE REFERENCED TO THE MASSACHUSETTS STATE PLANE COORDINATE SYSTEM, US FEET.ELEVATIONS ARE REFERENCED TO NAVD 88.
6. THIS PROPERTY IS LOCATED IN ZONE X (AREA OF MINIMAL FLOOD HAZARD) AS DEPICTED ON FLOOD INSURANCE RATE MAP 25001C0318K DATED JULY 6, 2021.
7. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT NATURAL RESOURCE STUDY THE SITE IS WITHIN THE NATURAL HERITAGE AND ENDANGERED SPECIES PROGRAM (NHESP), PRIORITY HABITATS OF RARE WILDLIFE, OR THE NHESP ESTIMATED HABITATS OF RARE WILDLIFE.
8. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THE SITE THERE IS NOT A WETLAND WITHIN 100 FEET OF THE PROJECT LIMITS.
9. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THE SITE IS NOT LOCATED WITHIN AN AREA OF CRITICAL ENVIRONMENTAL CONCERN.
10. THIS PLAN SET IS PRELIMINARY. FOR PERMITTING PURPOSES ONLY. THIS PLAN IS NOT INTENDED FOR CONSTRUCTION PURPOSES.
11. REFER TO THE "EROSION & SEDIMENT GENERAL NOTES" (DWG. 00846-C.020-0001) FOR SOIL TYPES INFORMATION.

LEGEND

PROPOSED FENCE	EXISTING MAJOR CONTOUR
PROPERTY LINE	EXISTING MINOR CONTOUR
GIS TAX PARCELS	PROPOSED MAJOR CONTOUR
SUBCATCHMENT AREA BOUNDARY	PROPOSED MINOR CONTOUR
ANALYSIS LIMITS BOUNDARY	PROPOSED DRAINAGE AREA BOUNDARY
NRCS SOIL BOUNDARY	TIME OF CONCENTRATION LINE
WORKSPACE LIMITS	
PROPOSED GRADE LIMITS	
EDGE OF ROAD	

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
No. 58957
PROFESSIONAL ENGINEER
07/07/26

ISSUED FOR PERMIT
07/07/2026

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		D	07/07/26	VN	DT	REISSUED FOR PERMIT
		C	06/29/26	VN	DT	ISSUED FOR PERMIT
		B	05/15/26	VN	DT	ISSUED FOR BID
		A	05/15/26	VN	DT	ISSUED FOR PERMIT

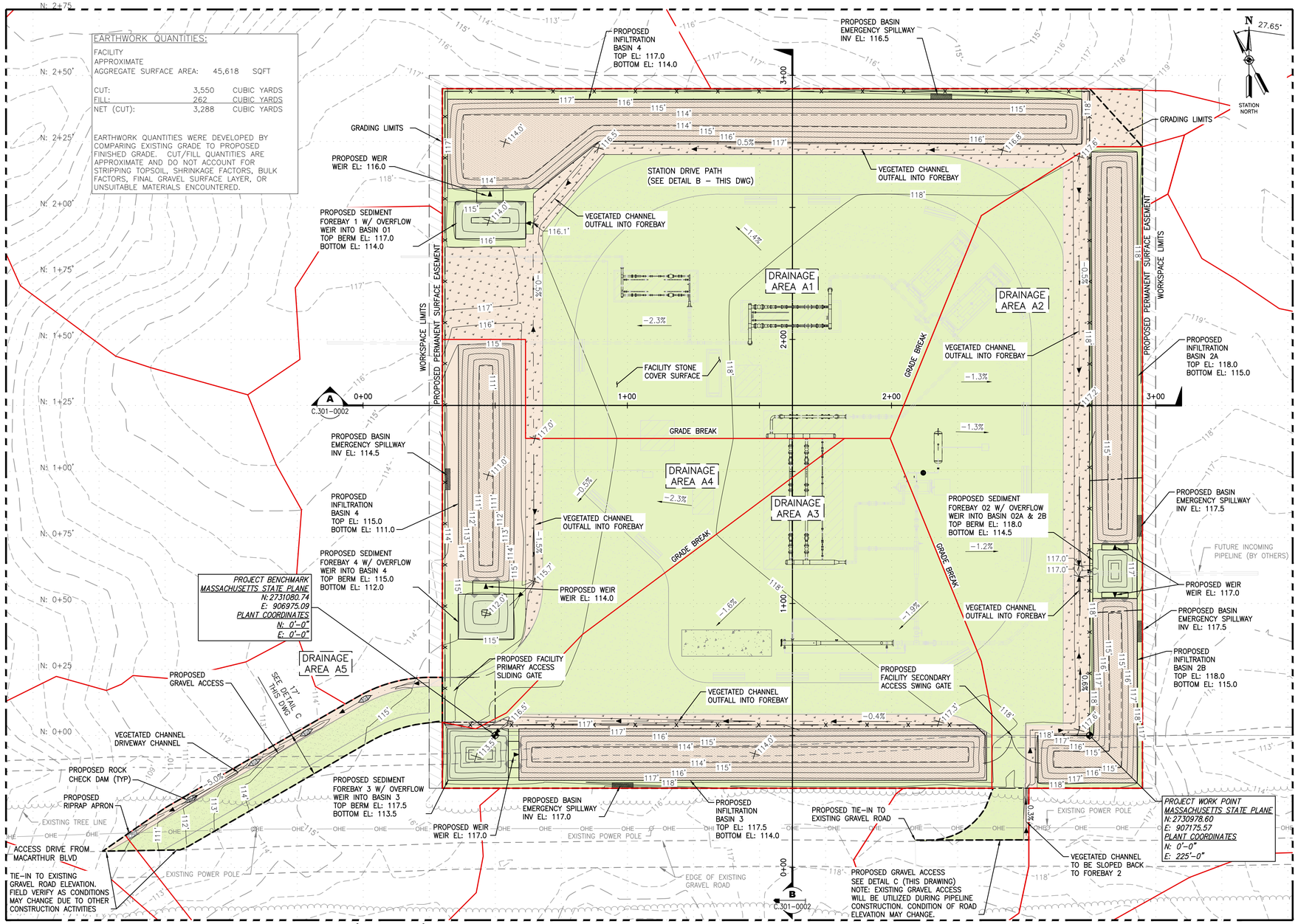
audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

DRAWN BY:	VN	05/15/26
DESIGN CHECKER:	CR	07/07/26
DESIGN ENGINEER:	PB	07/07/26
PROJECT MANAGER:	AC	07/07/26
TITLE	INITIALS	DATE

CAPE COD CANAL PIPELINE RELOCATION PROJECT
BOURNE ROTARY METER STATION
M&R 00846
TITLE: EXISTING SUBCATCHMENT AREAS PLAN
LOC.: BARNSTABLE COUNTY, MASSACHUSETTS
YEAR: 2026 | W.O.: | SCALE: 1"=50' | DWG.: 00846-C.320-0002 | REV.: D

ENBRIDGE
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

S:\AE\Projects\Enbridge\Mass\026356-001\200_Civil_Structural\170_Drawings\E&S Plans\Bourne Rotary\00846-C.320-0002.dwg - PLOT TIME: 7/6/2026 9:10 PM



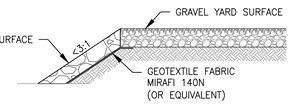
METER STATION
PLAN VIEW
SCALE: 1" = 20'–0"

NOTES:

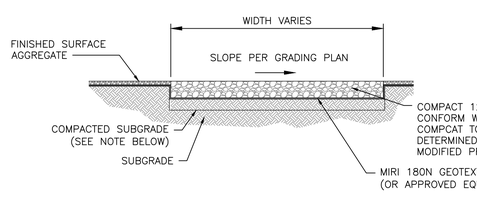
1. SITE PREPARATION METHODS SHALL FOLLOW RECOMMENDATIONS OUTLINED IN GEOTECHNICAL REPORT CAPE CANAL RELOCATION PROJECT CAPE BOURNE METERING & REGULATING STATION, BARNSTABLE COUNTY MASSACHUSETTS, PROVIDED BY GEOENGINEERS, DATED MAY 15, 2025.
2. ALL CONTOUR LABELS AND ELEVATION CALLOUTS ARE IN FEET AND REFERENCE TOP OF AGGREGATE ELEVATIONS (FINISHED GRADE).
3. CONTRACTOR SHALL PROVIDE AND INSTALL EROSION CONTROL DEVICES IN ACCORDANCE WITH LOCAL, STATE, AND FEDERAL REQUIREMENTS. ADDITIONAL EROSION CONTROL DEVICES NOT SHOWN MAY BE REQUIRED.
4. ALL SILTATION AND EROSION CONTROL DEVICES SHALL REMAIN IN PLACE UNTIL ADEQUATE VEGETATIVE GROWTH ENSURES NO FURTHER SOIL EROSION.
5. DEPENDING UPON EXISTING SOIL CONDITIONS, SOME AREAS OF THE SITE MAY BE SUSCEPTIBLE TO EROSION. CONTRACTOR SHALL INSTALL PERMANENT EROSION CONTROL DEVICES AS NECESSARY TO PREVENT EROSION.
6. FILL SLOPES SHALL BE OVERBUILT AND CUT BACK TO DEVELOP AN ADEQUATELY COMPACTED SLOPE FACE.
7. CONTRACTOR TO VERIFY ALL COORDINATES AND DIMENSIONS PRIOR TO CONSTRUCTION.
8. REFER TO GEOTECHNICAL RECOMMENDATIONS FOR BASE AGGREGATE AND FINISHING SURFACE AGGREGATE.
9. RIPRAP SHALL MEET THE REQUIREMENTS FOR MASSDOT ITEM M2.02.0 RIPRAP.
10. MIRAFI 140N, OR EQUIVALENT AND OVERLAIN WITH MIN. 18–INCHES OF RIPRAP SHALL BE PLACED IN FILL SLOPES 3.0H:1V TO 2.0H:V AND STEEPER.
11. CONTRACTOR TO PROVIDE ENGINEER OF RECORD GEOGRID AND GEOTEXTILE FABRIC SAMPLES, SPECIFICATIONS, AND INSTALLATION PROCEDURE PRIOR TO CONSTRUCTION.
12. ALL GEOGRID AND GEOTEXTILE FABRIC SHALL BE INSTALLED ACCORDING TO MANUFACTURER'S REQUIREMENTS AND RECOMMENDATIONS.
13. PROVIDE ENGINEER OF RECORD EQUIVALENT GEOTEXTILE FABRIC DATA SHEET AND SPECIFICATIONS.

SURVEY NOTES:

1. BACKGROUND INFORMATION IS BASED ON THE FOLLOWING:
   1.1. TOPOGRAPHIC SURVEY INFORMATION WAS PROVIDED BY ALGONQUIN GAS TRANSMISSION, LLC.
   1.2. ALL COORDINATES AND DISTANCES SHOWN HEREON ARE REFERENCED TO THE MASSACHUSETTS STATE PLANE COORDINATE SYSTEM, US FEET. ELEVATIONS ARE REFERENCED TO NAVD 88.
2. BEARING PLANT GRID LINES ARE AS FOLLOWS:
   2.1. N–S GRID LINE: N26°59'33.79"E
   2.2. E–W GRID LINE: S63°00'26.21"E

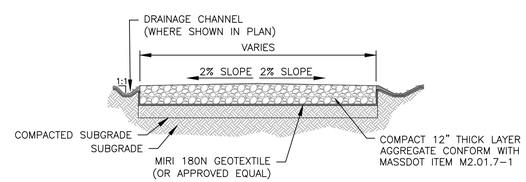


DETAIL A – TYPICAL RIPRAP SLOPE DETAIL
SCALE: NOT TO SCALE

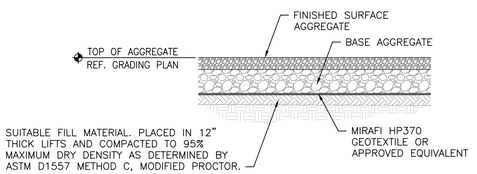


DETAIL B – TYPICAL AGGREGATE DRIVE AISLE
SCALE: NOT TO SCALE

NOTE: SITE PREPERATION SHALL CONFORM TO THE RECOMMENDATIONS OF THE GEOTECHNICAL REPORT REFERENCED.



DETAIL C – TYPICAL AGGREGATE ACCESS ROAD
SCALE: NOT TO SCALE



TYPICAL AGGREGATE YARD SURFACE SECTION
SCALE: NOT TO SCALE

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
No. 58957
PROFESSIONAL ENGINEER
07/07/26

ISSUED FOR PERMIT
07/07/2026

LEGEND

PROPOSED ACCESS ROAD	PROPOSED FENCE	PROPOSED VEGETATED	PROPOSED FLOW LLINE
PROPOSED CONCRETE	EXISTING CONTOUR LINE	PROPOSED INFILTRATION BASIN	PROPOSED EMERGENCY SPILLWAY
PROPOSED STRUCTURE	FINISH CONTOUR LINE	PROPOSED SEDIMENT FOREBAY	PROPOSED WEIR
PROPOSED ROCK (FACILITY)	DRAINAGE AREA BOUNDARY	PROPOSED ROCK	PROPOSED ROCK CHECK DAM
	WORKSPACE LIMITS	INFILTRATION >2.4"/HR	INFILTRATION <2.4"/HR
	LIMITS OF GRADING		

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		F	07/07/26	CR	DT	REISSUED FOR PERMIT
		E	06/29/26	CR	DT	ISSUED FOR PERMIT
		D	05/15/26	CR	DT	ISSUED FOR BID
00846–C.320–0007	DETAILS	C	05/15/26	CR	DT	ISSUED FOR PERMIT
00846–C.320–0006	DETAILS	B	03/31/26	CR	SP	ISSUED FOR REVIEW – 90% REVIEW
00846–C.301–0002	GRADING CROSS SECTIONS	A	06/26/25	CR	PB	ISSUED FOR REVIEW – 60% REVIEW

audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669–0590

TITLE	INITIALS	DATE
DRAWN BY:	CR	06/15/25
DESIGN CHECKER:	DT	07/07/26
DESIGN ENGINEER:	PB	07/07/26
PROJECT MANAGER:	AC	07/07/26

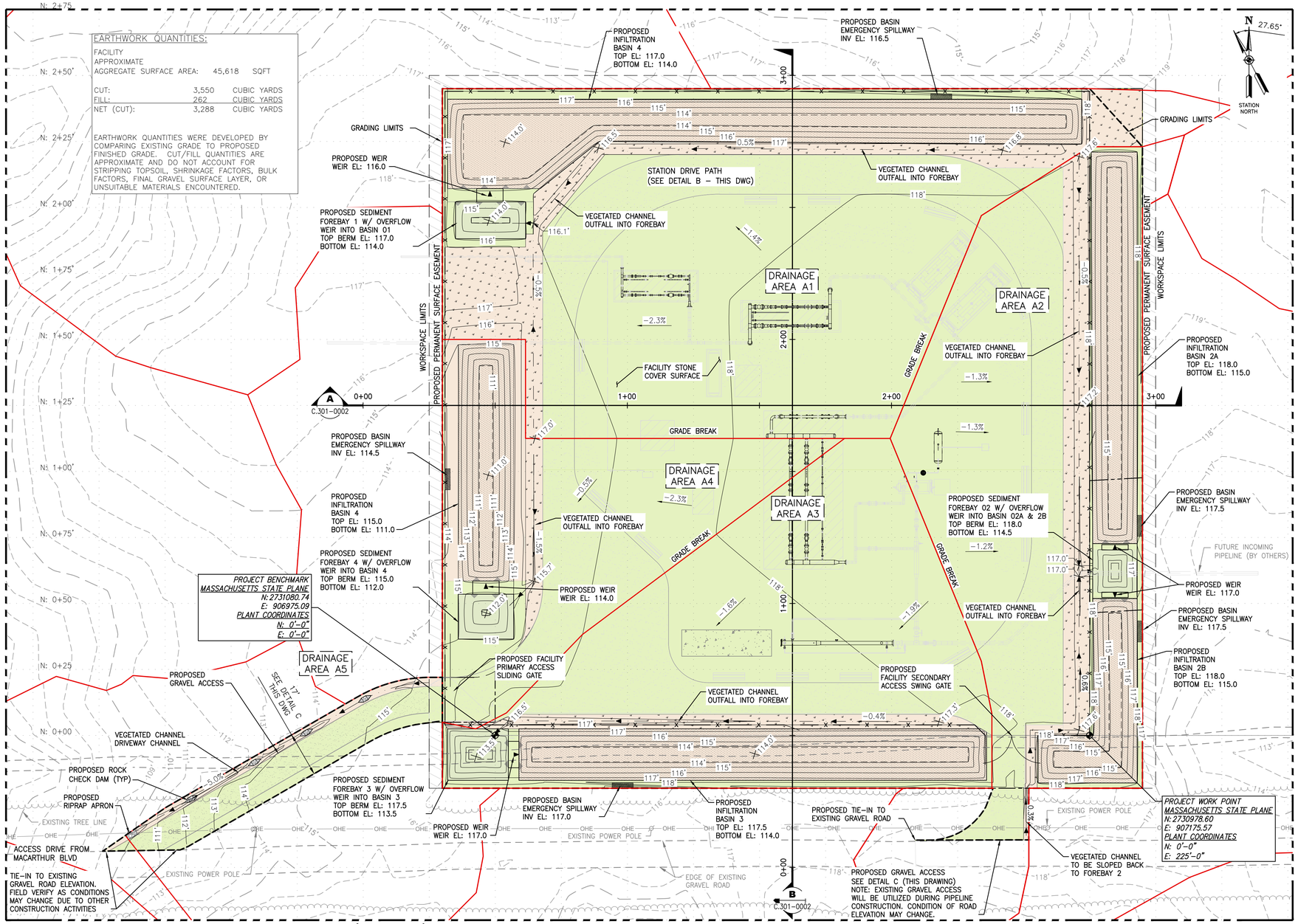
CAPE COD CANAL PIPELINE RELOCATION PROJECT
BOURNE ROTARY METER STATION
M&R 00846
TITLE: GRADING PLAN

LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

YEAR: 2026 | W.O.: | SCALE: AS NOTED | DWG.: 00846–C.301–0001 | REV.: F

ENBRIDGE
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

S:\AE\Projects\Enbridge\Mass\026356–001\200_Civil_Structural\170_Drawings\Grading\Cape Bourne\00846–C.301–0001.dwg – PLOT TIME: 7/6/2026 11:17 PM



METER STATION
PLAN VIEW
SCALE: 1" = 20'–0"

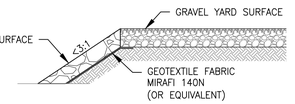
ISSUED FOR PERMIT
07/07/2026

NOTES:

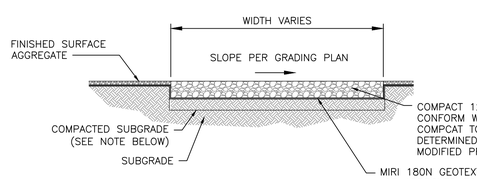
1. SITE PREPARATION METHODS SHALL FOLLOW RECOMMENDATIONS OUTLINED IN GEOTECHNICAL REPORT CAPE CANAL RELOCATION PROJECT CAPE BOURNE METERING & REGULATING STATION, BARNSTABLE COUNTY MASSACHUSETTS, PROVIDED BY GEOENGINEERS, DATED MAY 15, 2025.
2. ALL CONTOUR LABELS AND ELEVATION CALLOUTS ARE IN FEET AND REFERENCE TOP OF AGGREGATE ELEVATIONS (FINISHED GRADE).
3. CONTRACTOR SHALL PROVIDE AND INSTALL EROSION CONTROL DEVICES IN ACCORDANCE WITH LOCAL, STATE, AND FEDERAL REQUIREMENTS. ADDITIONAL EROSION CONTROL DEVICES NOT SHOWN MAY BE REQUIRED.
4. ALL SILTATION AND EROSION CONTROL DEVICES SHALL REMAIN IN PLACE UNTIL ADEQUATE VEGETATIVE GROWTH ENSURES NO FURTHER SOIL EROSION.
5. DEPENDING UPON EXISTING SOIL CONDITIONS, SOME AREAS OF THE SITE MAY BE SUSCEPTIBLE TO EROSION. CONTRACTOR SHALL INSTALL PERMANENT EROSION CONTROL DEVICES AS NECESSARY TO PREVENT EROSION.
6. FILL SLOPES SHALL BE OVERBUILT AND CUT BACK TO DEVELOP AN ADEQUATELY COMPACTED SLOPE FACE.
7. CONTRACTOR TO VERIFY ALL COORDINATES AND DIMENSIONS PRIOR TO CONSTRUCTION.
8. REFER TO GEOTECHNICAL RECOMMENDATIONS FOR BASE AGGREGATE AND FINISHING SURFACE AGGREGATE.
9. RIPRAP SHALL MEET THE REQUIREMENTS FOR MASSDOT ITEM M2.02.0 RIPRAP.
10. MIRAFI 140N, OR EQUIVALENT AND OVERLAIN WITH MIN. 18–INCHES OF RIPRAP SHALL BE PLACED IN FILL SLOPES 3.0H:1V TO 2.0H:V AND STEEPER.
11. CONTRACTOR TO PROVIDE ENGINEER OF RECORD GEOGRID AND GEOTEXTILE FABRIC SAMPLES, SPECIFICATIONS, AND INSTALLATION PROCEDURE PRIOR TO CONSTRUCTION.
12. ALL GEOGRID AND GEOTEXTILE FABRIC SHALL BE INSTALLED ACCORDING TO MANUFACTURER'S REQUIREMENTS AND RECOMMENDATIONS.
13. PROVIDE ENGINEER OF RECORD EQUIVALENT GEOTEXTILE FABRIC DATA SHEET AND SPECIFICATIONS.

SURVEY NOTES:

1. BACKGROUND INFORMATION IS BASED ON THE FOLLOWING:
   1.1. TOPOGRAPHIC SURVEY INFORMATION WAS PROVIDED BY ALGONQUIN GAS TRANSMISSION, LLC.
   1.2. ALL COORDINATES AND DISTANCES SHOWN HEREON ARE REFERENCED TO THE MASSACHUSETTS STATE PLANE COORDINATE SYSTEM, US FEET. ELEVATIONS ARE REFERENCED TO NAVD 88.
2. BEARING PLANT GRID LINES ARE AS FOLLOWS:
   2.1. N–S GRID LINE: N26°59'33.79"E
   2.2. E–W GRID LINE: S63°00'26.21"E

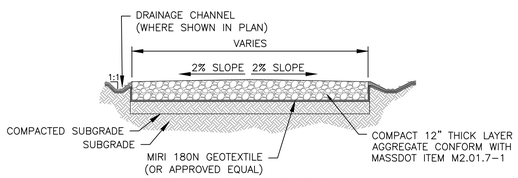


DETAIL A – TYPICAL RIPRAP SLOPE DETAIL
SCALE: NOT TO SCALE

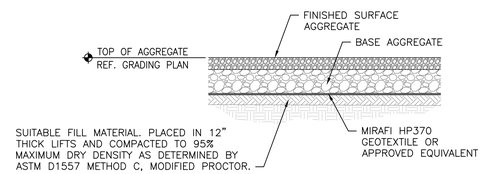


DETAIL B – TYPICAL AGGREGATE DRIVE AISLE
SCALE: NOT TO SCALE

NOTE: SITE PREPERATION SHALL CONFORM TO THE RECOMMENDATIONS OF THE GEOTECHNICAL REPORT REFERENCED.



DETAIL C – TYPICAL AGGREGATE ACCESS ROAD
SCALE: NOT TO SCALE



TYPICAL AGGREGATE YARD SURFACE SECTION
SCALE: NOT TO SCALE

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
No. 58957
PROFESSIONAL ENGINEER
07/07/26

LEGEND

PROPOSED ACCESS ROAD	PROPOSED FENCE	PROPOSED VEGETATED
PROPOSED CONCRETE	EXISTING CONTOUR LINE	PROPOSED INFILTRATION BASIN
PROPOSED STRUCTURE	FINISH CONTOUR LINE	PROPOSED SEDIMENT FOREBAY
PROPOSED ROCK (FACILITY)	DRAINAGE AREA BOUNDARY	PROPOSED ROCK
	WORKSPACE LIMITS	INFILTRATION >2.4"/HR
	LIMITS OF GRADING	INFILTRATION <2.4"/HR
		PROPOSED FLOW LLINE
		PROPOSED EMERGENCY SPILLWAY
		PROPOSED WEIR
		PROPOSED ROCK CHECK DAM

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		F	07/07/26	CR	DT	REISSUED FOR PERMIT
		E	06/29/26	CR	DT	ISSUED FOR PERMIT
		D	05/15/26	CR	DT	ISSUED FOR BID
00846–C.320–0007	DETAILS	C	05/15/26	CR	DT	ISSUED FOR PERMIT
00846–C.320–0006	DETAILS	B	03/31/26	CR	SP	ISSUED FOR REVIEW – 90% REVIEW
00846–C.301–0002	GRADING CROSS SECTIONS	A	06/26/25	CR	PB	ISSUED FOR REVIEW – 60% REVIEW

audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669–0590

TITLE	INITIALS	DATE
DRAWN BY:	CR	06/15/25
DESIGN CHECKER:	DT	07/07/26
DESIGN ENGINEER:	PB	07/07/26
PROJECT MANAGER:	AC	07/07/26

CAPE COD CANAL PIPELINE RELOCATION PROJECT
BOURNE ROTARY METER STATION
M&R 00846
TITLE: GRADING PLAN

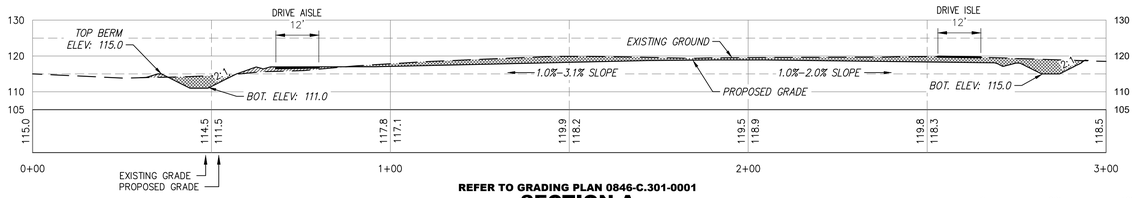
LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

YEAR: 2026 | W.O.: | SCALE: AS NOTED | DWG.: 00846–C.301–0001 | REV.: F

ENBRIDGE

Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

S:\AE\Projects\Enbridge\Mass\026356–001\200_Civil_Structural\170_Drawings\Grading\Cape Bourne\00846–C.301–0001.dwg – PLOT TIME: 7/6/2026 11:17 PM

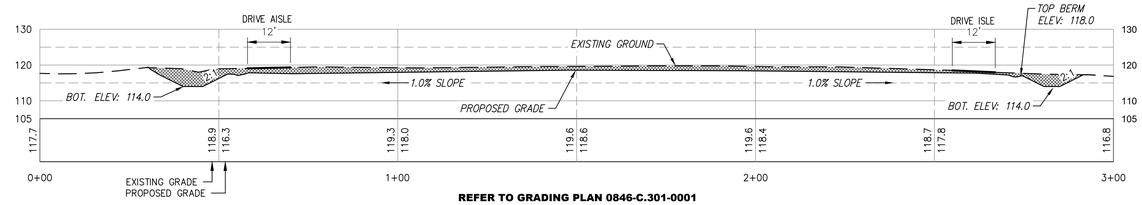


REFER TO GRADING PLAN 0846-C.301-0001

SECTION A

SCALE: 1" = 20'-0"

0 20' 40'
Scale: 1" = 20'

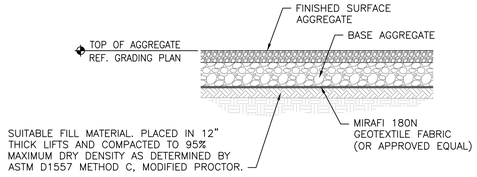


REFER TO GRADING PLAN 0846-C.301-0001

SECTION B

SCALE: 1" = 20'-0"

0 20' 40'
Scale: 1" = 20'



TYPICAL AGGREGATE YARD SURFACE SECTION

SCALE: NOT TO SCALE

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
No. 58957
PROFESSIONAL ENGINEER

07/07/26

ISSUED FOR PERMIT
07/07/26

SURVEY NOTES:

1. BACKGROUND INFORMATION IS BASED ON THE FOLLOWING:
   - 1.1. TOPOGRAPHIC SURVEY INFORMATION WAS PROVIDED BY ENBRIDGE.
   - 1.2. ALL COORDINATES AND DISTANCES SHOWN HEREON ARE REFERENCED TO THE MASSACHUSETTS STATE PLANE COORDINATE SYSTEM, US FEET. ELEVATIONS ARE REFERENCED TO NAVD 88.

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		F	07/07/26	CR	DT	REISSUED FOR PERMIT
		E	06/29/26	CR	DT	ISSUED FOR PERMIT
		D	05/15/26	CR	DT	ISSUED FOR BID
		C	05/15/26	CR	DT	ISSUED FOR PERMIT
00846-C.301-0001	CIVIL GRADING PLAN	B	03/31/26	CR	SP	ISSUED FOR REVIEW – 90% REVIEW
		A	06/26/25	CR	PB	ISSUED FOR REVIEW – 60% REVIEW

audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

DRAWN BY:	CR	06/20/25
DESIGN CHECKER:	DT	07/07/26
DESIGN ENGINEER:	PB	07/07/26
PROJECT MANAGER:	AC	07/07/26
TITLE	INITIALS	DATE

CAPE COD CANAL PIPELINE RELOCATION PROJECT
BOURNE ROTARY METER STATION
M&R 00846
TITLE: GRADING CROSS SECTIONS

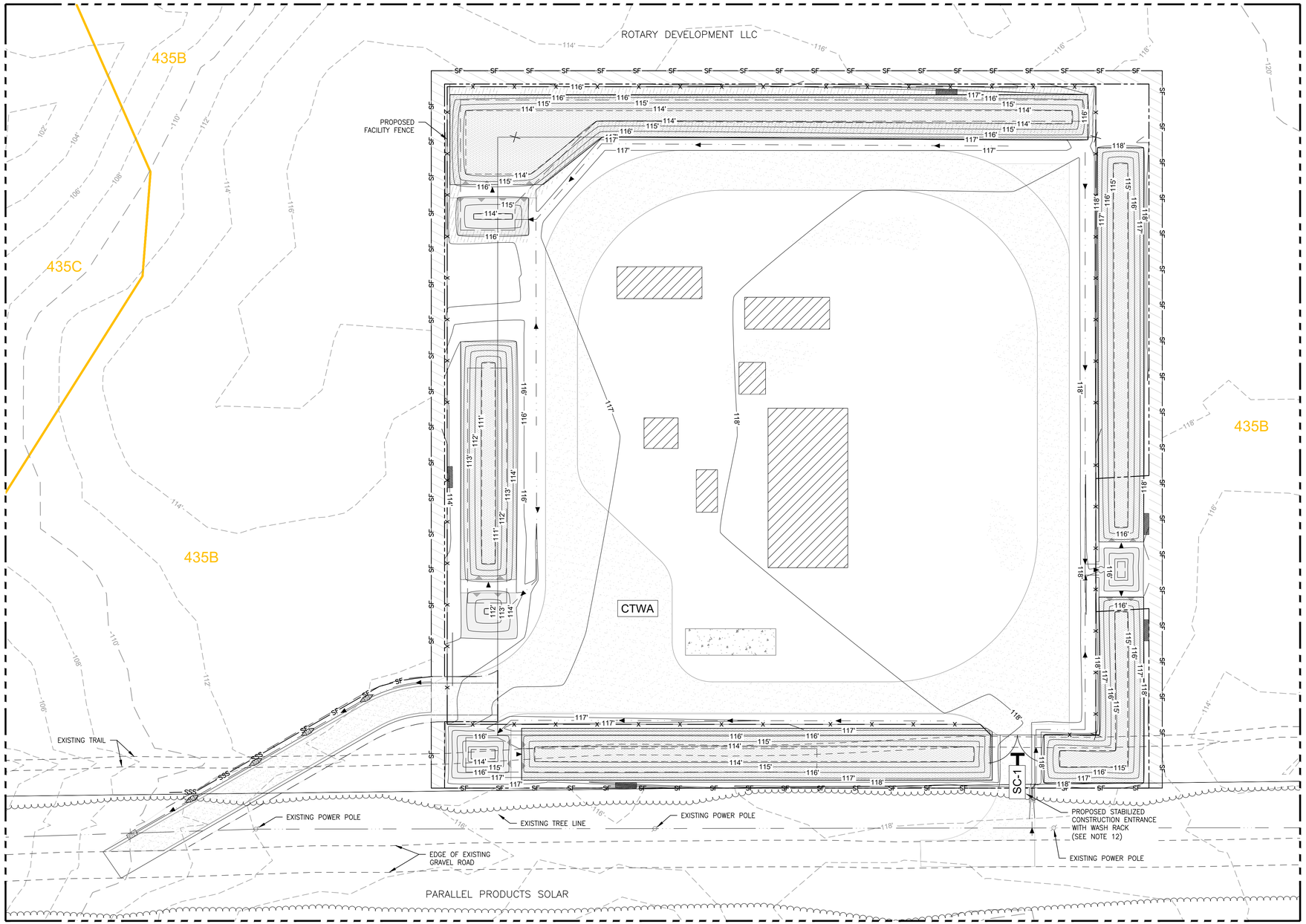
LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

YEAR: 2026 | W.O.: | SCALE: AS NOTED | DWG.: 00846-C.301-0002 | REV.: F

ENBRIDGE

Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

S:\AE\Projects\Enbridge\Mass\026356-001\200_Civil_Structural\170_Drawings\Grading\Cape Bourne\00846-C.301-0002.dwg – PLOT TIME: 7/6/2026 10:59 PM





NOTES:

1. ALL CONTOUR LABELS AND ELEVATION CALLOUTS ARE IN FEET.
2. PROPOSED SITE BOUNDARY WAS PROVIDED BY ENSBRIDGE 3RD PARTY CONSULTANT.
3. SUPPLEMENTAL TAX PARCEL DATA IS SHOWN FOR REFERENCE ONLY AND WAS OBTAINED FROM THE CAPE COD COMMISSION OPEN GIS DATA HUB WEBSITE.
4. PROPERTY CONVEYED TO ALGONQUIN GAS TRANSMISSION, LLC.
5. TOPOGRAPHIC SURVEY INFORMATION WAS PROVIDED BY ALGONQUIN GAS TRANSMISSION, LLC. ADDITIONAL CONTOUR DATA WAS OBTAINED FROM 2022 USGS LIDAR POINT CLOUD DATA SETS. ALL COORDINATES AND DISTANCES SHOWN HEREON ARE REFERENCED TO THE MASSACHUSETTS STATE PLANE COORDINATE SYSTEM, US FEET.ELEVATIONS ARE REFERENCED TO NAVD 88.
6. THIS PROPERTY IS LOCATED IN ZONE X (AREA OF MINIMAL FLOOD HAZARD) AS DEPICTED ON FLOOD INSURANCE RATE MAP 25001C0318K DATED JULY 6, 2021.
7. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THE SITE THERE IS NOT A WETLAND WITHIN 100 FEET OF THE PROJECT LIMITS.
8. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THE SITE IS NOT LOCATED WITHIN AN AREA OF CRITICAL ENVIRONMENTAL CONCERN.
9. THIS PLAN SET IS PRELIMINARY. FOR PERMITTING PURPOSES ONLY. PROPOSED GRADING MAY BE FURTHER OPTIMIZED TO ENSURE PROPER SHEET FLOW AROUND ASSUMED BUILDING LOCATIONS, FOUNDATIONS, AND MECHANICAL EQUIPMENT. THIS PLAN IS NOT INTENDED FOR CONSTRUCTION PURPOSES.
10. REFER TO DRAWINGS 00846-C.320-0006 THRU 0007 FOR BMP DETAILS.
11. REFER TO DRAWING 00846-C.020-0001 FOR CONSTRUCTION EROSION AND SEDIMENT CONTROL NOTES.
12. PROPOSED TEMPORARY WORKSPACE ACREAGE: 1.705 (74250.00 SQFT)
13. CONTRACTOR TO ENSURE ALL WORK TO BE CONDUCTED WITHIN THE WORK LIMITS SPECIFIED. WORK LIMITS SHALL BE CLEARLY MARKED.
14. TEMPORARY STOCK PILE LOCATIONS TO BE LOCATED WITHIN THE TEMPORARY WORKSPACE SHOWN ON THE PLANS AND COORDINATED WITH THE ON-SITE INSPECTOR. REFER TO DETAIL ON DRAWING 00846-C.320-0006.

LEGEND

- PROPOSED ACCESS ROAD
- PROPOSED CONCRETE
- PROPOSED STRUCTURE
- PROPOSED ROCK (FACILITY)
- PROPOSED VEGETATED
- PROPOSED INFILTRATION BASIN
- PROPOSED SEDIMENT FOREBAY
- PROPOSED ROCK
- PROPOSED BUILDING
- EXISTING PAVED AREA
- WETLAND
- EXISTING CATCH BASIN
- CONSTRUCTION TRUCK WASH AREA (TO BE FIELD LOCATED) — CTWA
- STABLIZED CONSTRUCTION ACCESS (TO BE FIELD LOCATED) — SC-1
- PROPOSED FENCE
- PROPERTY LINE
- GIS TAX PARCELS
- NRCS SOIL BOUNDARY
- WORKSPACE LIMITS
- PROPOSED GRADE LIMITS
- EDGE OF ROAD
- EDGE OF WATER
- EXISTING MAJOR CONTOUR 70'
- EXISTING MINOR CONTOUR 72'
- PROPOSED MAJOR CONTOUR 70'
- PROPOSED MINOR CONTOUR 72'
- PROPOSED SILT FENCE SF
- PROPOSED SILT SOCK SSS
- PROPOSED WIER
- PROPOSED EMERGENCY SPILLWAY

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
No. 58957
PROFESSIONAL ENGINEER
07/07/26

ISSUED FOR PERMIT
07/07/2026

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		D	07/07/26	VN	DT	REISSUED FOR PERMIT
00846-C320-0007	DETAILS	C	06/29/26	VN	DT	ISSUED FOR PERMIT
00846-C320-0006	DETAILS	B	05/15/26	VN	DT	ISSUED FOR BID
00846-C.020-0001	EROSION & SEDIMENT CONTROL GENERAL NOTES	A	05/15/26	VN	DT	ISSUED FOR PERMIT

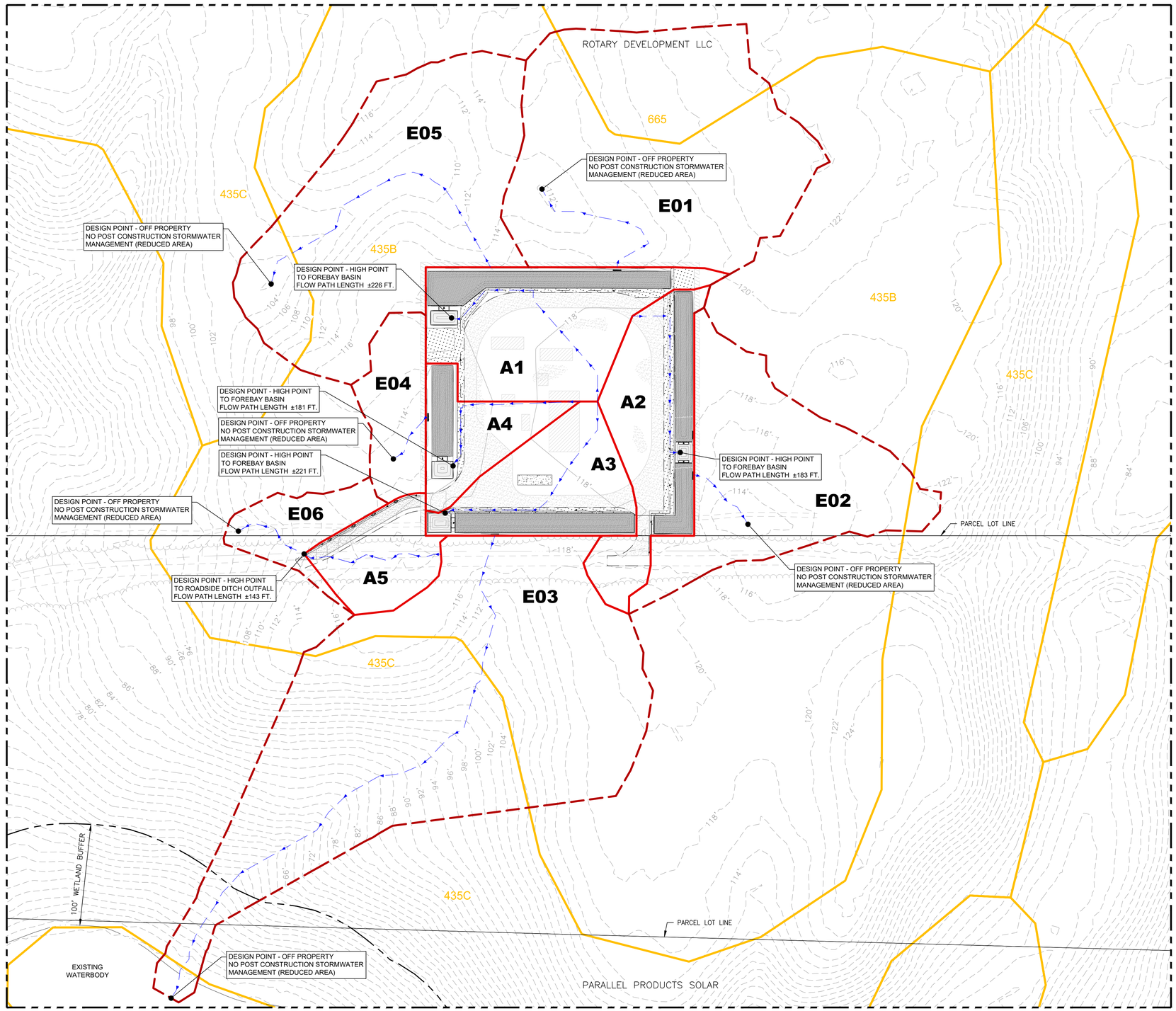
audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

DRAWN BY:	VN	05/15/26	CAPE COD CANAL PIPELINE RELOCATION PROJECT
DESIGN CHECKER:	CR	07/07/26	BOURNE ROTARY METER STATION
DESIGN ENGINEER:	PB	07/07/26	M&R 00846
PROJECT MANAGER:	AC	07/07/26	CONSTRUCTION EROSION AND SEDIMENT CONTROL PLAN

ENBRIDGE
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

TITLE	INITIALS	DATE	YEAR:	W.O.:	SCALE:	DWG.:	REV.:
			2026		1"=20'	00846-C.320-0004	D

S:\AE\Projects\Enbridge\Mass\026356-001\200_Civil_Structural\170_Drawings\E&S Plans\Bourne Rotary\00846-C.320-0004.dwg - PLOT TIME: 7/6/2026 10:15 PM



NOTES:

1. ALL CONTOUR LABELS AND ELEVATION CALLOUTS ARE IN FEET.
2. PROPOSED SITE BOUNDARY WAS PROVIDED BY ENSBRIDGE 3RD PARTY CONSULTANT.
3. SUPPLEMENTAL TAX PARCEL DATA IS SHOWN FOR REFERENCE ONLY AND WAS OBTAINED FROM THE CAPE COD COMMISSION OPEN GIS DATA HUB WEBSITE.
4. PROPERTY CONVEYED TO ALGONQUIN GAS TRANSMISSION, LLC.
5. TOPOGRAPHIC SURVEY INFORMATION WAS PROVIDED BY ALGONQUIN GAS TRANSMISSION, LLC. ADDITIONAL CONTOUR DATA WAS OBTAINED FROM 2022 USGS LIDAR POINT CLOUD DATA SETS. ALL COORDINATES AND DISTANCES SHOWN HEREON ARE REFERENCED TO THE MASSACHUSETTS STATE PLANE COORDINATE SYSTEM, US FEET.ELEVATIONS ARE REFERENCED TO NAVD 88.
6. THIS PROPERTY IS LOCATED IN ZONE X (AREA OF MINIMAL FLOOD HAZARD) AS DEPICTED ON FLOOD INSURANCE RATE MAP 25001C0318K DATED JULY 6, 2021.
7. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT NATURAL RESOURCE STUDY THE SITE IS WITHIN THE NATURAL HERITAGE AND ENDANGERED SPECIES PROGRAM (NHESP), PRIORITY HABITATS OF RARE WILDLIFE, OR THE NHESP ESTIMATED HABITATS OF RARE WILDLIFE.
8. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THE SITE THERE IS NOT A WETLAND WITHIN 100 FEET OF THE PROJECT LIMITS.
9. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THE SITE IS NOT LOCATED WITHIN AN AREA OF CRITICAL ENVIRONMENTAL CONCERN.
10. THIS PLAN SET IS PRELIMINARY. FOR PERMITTING PURPOSES ONLY. PROPOSED GRADING MAY BE FURTHER OPTIMIZED TO ENSURE PROPER SHEET FLOW AROUND ASSUMED BUILDING LOCATIONS, FOUNDATIONS, AND MECHANICAL EQUIPMENT. THIS PLAN IS NOT INTENDED FOR CONSTRUCTION PURPOSES.
11. REFER TO THE "EROSION & SEDIMENT GENERAL NOTES" (DWG. 00846-C.020-0001) FOR SOIL TYPES INFORMATION.

LEGEND

- PROPERTY LINE
- GIS TAX PARCELS
- PROPOSED DRAINAGE AREAS
- EXISTING DRAINAGE AREAS
- NRCS SOIL BOUNDARY
- WORKSPACE LIMITS
- PROPOSED GRADE LIMITS
- PROPOSED ACCESS ROAD
- EDGE OF ROAD
- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- PROPOSED DRAINAGE AREA BOUNDARY
- TIME OF CONCENTRATION LINE
- PROPOSED BUILDING
- PROPOSED INFILTRATION BASIN
- PROPOSED SEDIMENT FOREBAY

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
No. 58957
PROFESSIONAL ENGINEER
07/07/26

ISSUED FOR PERMIT
07/07/2026

PROPOSED BOURNE ROTARY METER STATION SITE
PROPOSED SUBCATCHMENT AREAS PLAN
SCALE: 1" = 30'

0 50' 100'
Scale: 1" = 50'

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		D	07/07/26	VN	DT	REISSUED FOR PERMIT
		C	06/29/26	VN	DT	ISSUED FOR PERMIT
		B	05/15/26	VN	DT	ISSUED FOR BID
		A	05/15/26	VN	DT	ISSUED FOR PERMIT

audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

DRAWN BY:	VN	05/15/26
DESIGN CHECKER:	CR	07/07/26
DESIGN ENGINEER:	PB	07/07/26
PROJECT MANAGER:	AC	07/07/26
TITLE	INITIALS	DATE

CAPE COD CANAL PIPELINE RELOCATION PROJECT
BOURNE ROTARY METER STATION
M&R 00846
TITLE: PROPOSED SUBCATCHMENT AREAS PLAN

YEAR: 2026 | W.O.: | SCALE: 1"=50'

ENBRIDGE
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

DWG.: 00846-C.320-0005 | REV.: D

S:\AE\Projects\Enbridge\Mass\026356-001\200_Civil_Structural\170_Drawings\E&S Plans\Bourne Rotary\00846-C.320-0005.dwg - PLOT TIME: 7/6/2026 10:29 PM

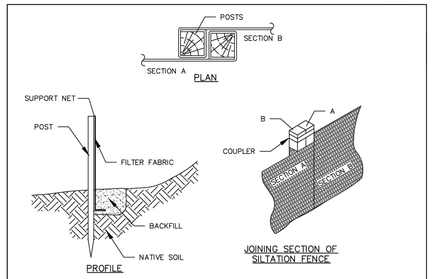
E&S CONSTRUCTION SEQUENCE AND MAINTENANCE

THE FOLLOWING CONSTRUCTION SEQUENCING AND EROSION AND SEDIMENTATION CONTROL MEASURES HAVE BEEN DEVELOPED TO MINIMIZE EROSION, SEDIMENT TRANSPORT, AND IMPACTS TO ADJACENT DRAINAGE SYSTEMS AND RESOURCE AREAS DURING ALL PHASES OF CONSTRUCTION. THE CONTRACTOR SHALL BE RESPONSIBLE FOR MAINTAINING ALL EROSION AND SEDIMENTATION CONTROLS THROUGHOUT CONSTRUCTION AND IMPLEMENTING ADDITIONAL MEASURES AS NECESSARY TO PREVENT OFF-SITE SEDIMENT TRANSPORT. THE SEQUENCE OF WORK SHALL GENERALLY PROCEED AS FOLLOWS:

- INSTALL CONSTRUCTION LIMIT SILT FENCING AND STABILIZED CONSTRUCTION ENTRANCES PRIOR TO THE COMMENCEMENT OF CLEARING OR EARTHWORK ACTIVITIES. CRUSHED STONE CONSTRUCTION ENTRANCE APRONS SHALL BE MAINTAINED TO MINIMIZE SEDIMENT TRACKING ONTO ADJACENT ROADWAYS.
- INSTALL PERIMETER EROSION AND SEDIMENTATION CONTROLS INCLUDING FIBER ROLLS AND SILT FENCE BARRIERS AT THE DOWNGRADIENT LIMITS OF DISTURBANCE AND AROUND SENSITIVE RESOURCE AREAS. IN AREAS SUBJECT TO CONCENTRATED RUNOFF OR HIGHER SEDIMENT LOADING, FIBER ROLLS SHALL BE SUPPLEMENTED WITH SILT FENCING FOR ADDITIONAL PROTECTION.
- INSTALL CATCH BASIN PROTECTION MEASURES, INCLUDING SILT SACKS WITHIN EXISTING AND NEWLY CONSTRUCTED CATCH BASINS, PRIOR TO NEARBY EARTH DISTURBANCE ACTIVITIES, IF APPLICABLE.
- ESTABLISH DESIGNATED CONCRETE WASHOUT AREAS IN APPROPRIATE UPLAND LOCATIONS TO CONTAIN CONCRETE WASH WATER AND SOLIDS GENERATED DURING CONSTRUCTION ACTIVITIES. CONCRETE WASHOUT FACILITIES SHALL BE LEAK PROOF AND MAINTAINED THROUGHOUT THE DURATION OF THE PROJECT.
- CONDUCT CLEARING AND GRUBBING OPERATIONS ONLY WITHIN APPROVED LIMITS OF DISTURBANCE. EXISTING VEGETATION OUTSIDE THE WORK LIMITS SHALL REMAIN PROTECTED TO THE MAXIMUM EXTENT PRACTICABLE.
- STRIP AND STOCKPILE TOPSOIL IN DESIGNATED STABILIZED AREAS UNTIL HAULED OFF. ANY STOCKPILED SOILS REMAINING INACTIVE SHALL BE COVERED OR TEMPORARILY STABILIZED TO MINIMIZE EROSION AND FUGITIVE DUST.
- TEMPORARY CHANNELS TO BE GRADED IN ONCE PERMANENT VEGETATED CHANNELS ARE INSTALLED.
- PERFORM EXCAVATION, GRADING, AND UTILITY INSTALLATION ACTIVITIES IN PHASES TO MINIMIZE THE EXTENT OF EXPOSED SOILS AT ANY ONE TIME.
- UTILIZE WATER TRUCKS OR OTHER DUST SUPPRESSION METHODS AS NECESSARY DURING EXCAVATION, GRADING, AND CONSTRUCTION OPERATIONS TO MINIMIZE DUST.
- INSTALL UNDERGROUND DRAINAGE INFRASTRUCTURE, STORMWATER MANAGEMENT SYSTEMS, AND ASSOCIATED DRAINAGE APPURTENANCES AS GRADING PROGRESSES.
- STABILIZE DISTURBED SOIL AREAS WITHIN FOURTEEN (14) DAYS AFTER CONSTRUCTION ACTIVITIES HAVE TEMPORARILY OR PERMANENTLY CEASED, UNLESS WEATHER CONDITIONS PROHIBIT STABILIZATION ACTIVITIES. TEMPORARY VEGETATIVE STABILIZATION SHALL INCLUDE HYDROSEEDING, TEMPORARY SEEDING, MULCH, OR EROSION CONTROL BLANKET APPLICATIONS AS APPROPRIATE.
- IMPLEMENT VEGETATIVE SLOPE STABILIZATION MEASURES ON SLOPES 2:1 OR FLATTER USING TEMPORARY ANNUAL GRASSES AND PERMANENT PERENNIAL SEED MIXES TO MINIMIZE EROSION AND PROMOTE LONG-TERM STABILIZATION.
- COMPLETE FINAL GRADING ACTIVITIES AND ESTABLISH PERMANENT STABILIZATION MEASURES INCLUDING PERMANENT SEEDING, LANDSCAPING, MULCH, EROSION CONTROL BLANKETS, AND OTHER APPROVED STABILIZATION METHODS.
- REMOVE ACCUMULATED SEDIMENT FROM TEMPORARY CONTROLS AND DRAINAGE STRUCTURES AS NECESSARY THROUGHOUT CONSTRUCTION.
- REMOVE TEMPORARY EROSION AND SEDIMENTATION CONTROLS ONLY AFTER ALL DISTURBED AREAS HAVE ACHIEVED PERMANENT STABILIZATION. DISTURBED AREAS RESULTING FROM REMOVAL ACTIVITIES SHALL BE REGRADED AND STABILIZED AS NECESSARY.

THE CONTRACTOR SHALL PERFORM ROUTINE INSPECTION AND MAINTENANCE OF ALL EROSION AND SEDIMENTATION CONTROL MEASURES THROUGHOUT CONSTRUCTION, INCLUDING BUT NOT LIMITED TO THE FOLLOWING:

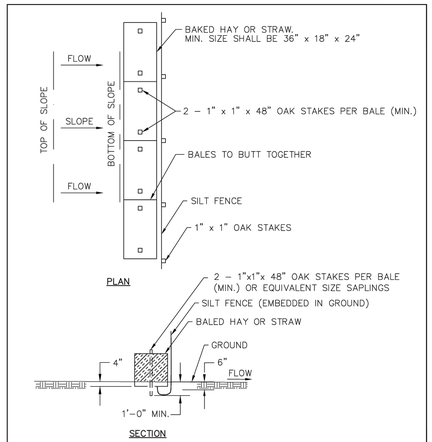
- INSPECT ALL EROSION AND SEDIMENTATION CONTROL MEASURES PERIODICALLY AND AFTER EACH RAINFALL EVENT. INSPECTION RECORDS SHALL BE MAINTAINED ONSITE BY THE CONTRACTOR.
- REPAIR OR REPLACE DAMAGED OR DETERIORATED EROSION CONTROL MEASURES IMMEDIATELY UPON IDENTIFICATION.
- REMOVE ACCUMULATED SEDIMENT FROM BEHIND SILT FENCE BARRIERS, STRAW WATTLES, AND OTHER SEDIMENT CONTROLS WHEN SEDIMENT REACHES APPROXIMATELY SIX INCHES IN DEPTH OR AS NECESSARY TO MAINTAIN FUNCTIONALITY.
- MAINTAIN STRAW WATTLES IN CONTINUOUS CONTACT WITH THE GROUND SURFACE AND RESET OR REPLACE AS NECESSARY.
- INSPECT AND MAINTAIN CATCH BASIN PROTECTION MEASURES REGULARLY AND REMOVE ACCUMULATED SEDIMENT AS REQUIRED.
- MAINTAIN STABILIZED CONSTRUCTION ENTRANCES AND REPLACE CRUSHED STONE AS SEDIMENT ACCUMULATES.
- INSPECT CONCRETE WASHOUT FACILITIES DAILY AND AFTER STORM EVENTS TO ENSURE ADEQUATE CONTAINMENT CAPACITY AND PREVENT LEAKAGE OR OVERFLOW. CONCRETE WASHOUT MATERIALS SHALL BE PROPERLY REMOVED AND RECYCLED OR DISPOSED OF IN ACCORDANCE WITH APPLICABLE REGULATIONS.
- MAINTAIN TEMPORARY AND PERMANENT VEGETATIVE STABILIZATION MEASURES, INCLUDING RESEEDING AND REPAIR OF ERODED AREAS AS NECESSARY.
- PROPERLY DISPOSE OF SEDIMENT AND DEBRIS REMOVED FROM EROSION CONTROL STRUCTURES AND COVER MATERIALS IF TEMPORARILY STORED ONSITE.
- MAINTAIN ALL EROSION AND SEDIMENTATION CONTROL MEASURES UNTIL FINAL SITE STABILIZATION HAS BEEN ACHIEVED.



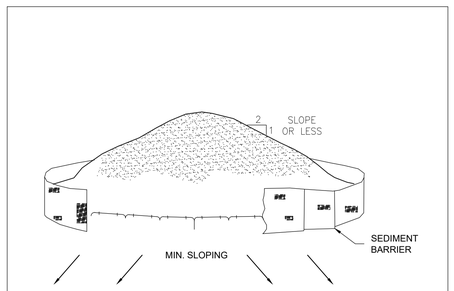
CONSTRUCTION NOTES

1. WOVEN WIRE FENCE TO BE FASTENED SECURELY TO FENCE POST WITH WIRE TIES OR STAPLES.
2. FILTER FABRIC TO BE FASTENED SECURELY TO WOVEN WIRE FENCE WITH TIES SPACED EVERY 24" AT TOP AND MID SECTION.
3. WHEN TWO SECTIONS OF FILTER FABRIC ADJOIN EACH OTHER, THEY SHALL BE OVERLAPPED BY 6 INCHES AND FOLDED.
4. MAINTENANCE SHALL BE PERFORMED AS NEEDED AND MATERIAL REMOVED WHEN "BULGES" DEVELOP IN THE SILT FENCE.
5. INSPECTION SHALL BE FREQUENT AND REPAIR REPLACEMENT SHALL BE MADE PROMPTLY AS NEEDED.
6. FENCES SHALL BE REMOVED WHEN THEY HAVE SERVED THEIR USEFULNESS SO AS NOT TO BLOCK OR IMPEDE STORM FLOW OR DRAINAGE.

SILTATION FENCE



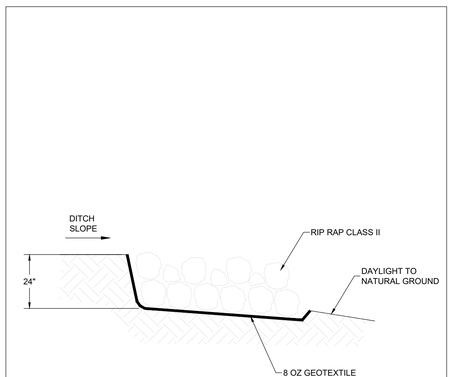
HAYBALES AND SILT FENCE



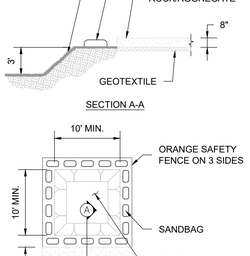
INSTALLATION NOTES:

1. AREA CHOSEN FOR STOCKPILING OPERATIONS SHALL BE DRY AND STABLE.
2. MAXIMUM SLOPE OF STOCKPILE SHALL BE 2:1.
3. UPON COMPLETION OF SOIL STOCKPILING, EACH PILE SHALL BE SURROUNDED WITH EITHER SILT FENCING.
4. COORDINATE WITH ON-SITE INSPECTOR FOR STOCKPILE LOCATIONS

TEMPORARY STOCKPILE DETAIL



RIP RAP PROTECTION DETAIL

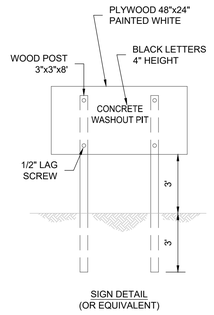


SECTION A-A

CTWA

SYMBOL

PLAN



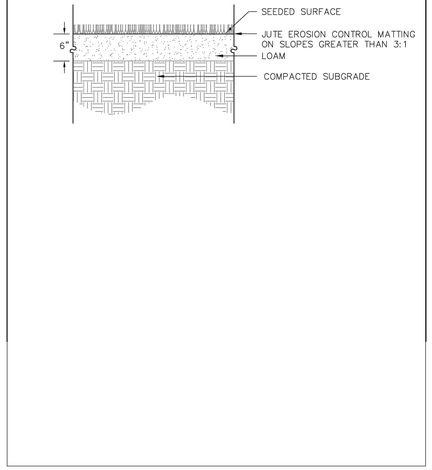
SIGN DETAIL
(OR EQUIVALENT)

GENERAL NOTES:

1. POST A SIGN READING "CONCRETE WASHOUT PIT" NEXT TO THE PIT.
2. VERBALLY INSTRUCT THE CONCRETE TRUCK DRIVERS WHERE THE PIT IS AND TO WASHOUT THEIR TRUCKS IN THE PIT AND NOWHERE ELSE.
3. UPON THE CONCRETE SETTING UP (CURING, DRYING OUT), THE CONCRETE WASTE SHALL BE REMOVED FROM THE PROJECT SITE AND DISPOSED OF PROPERLY BY THE CONTRACTOR. AFTER REMOVAL OF THE CONCRETE WASTE, THE WASHOUT PIT SHALL BE FILLED WITH CLEAN FILL MATERIAL AND COMPACTED TO IN-SITU CONDITIONS, OR AS DIRECTED BY THE PROJECT SPECIFICATIONS.
4. CONCRETE WASHOUT PITS SHALL NOT BE LOCATED DIRECTLY ADJACENT TO, NOR AT ANY TIME DRAIN INTO THE STORM SEWER SYSTEM OR ANY OTHER SWALE, DITCH, OR WATERWAY.
5. CONSTRUCT ENTRY ROAD AND BOTTOM OF WASHOUT AREA TO SUPPORT EXPECTED LOADINGS FROM TRUCKS EQUIPMENT.

CONCRETE TRUCK WASHOUT AREA

SCALE: N.T.S.



LOAM AND SEED DETAIL

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
No. 58957
PROFESSIONAL ENGINEER

07/07/26

ISSUED FOR PERMIT
07/07/26

NOTES:

1. SEE CONSTRUCTION EROSION AND SEDIMENT CONTROL PLAN DRAWING 00846-C.320-0004.
2. CONTRACTOR TO EVALUATE PROJECT AREA TO IMPLEMENT BMPS IN AREAS THAT BEST FIT FOR THE CURRENT CONDITIONS. CONSULT WITH THE ONSITE INSPECTOR FOR ANY ADJUSTMENTS AND/OR ADDITIONS TO THE CONSTRUCTION STORMWATER MANAGEMENT PLAN.

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		D	07/07/26	VN	DT	REISSUED FOR PERMIT
		C	06/29/26	VN	DT	ISSUED FOR PERMIT
		B	05/15/26	VN	DT	ISSUED FOR BID
		A	05/15/26	VN	DT	ISSUED FOR PERMIT

audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

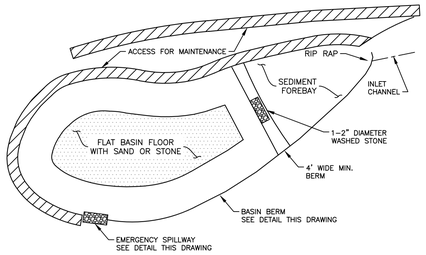
DRAWN BY:	VN	05/15/26	CAPE COD CANAL PIPELINE RELOCATION PROJECT
DESIGN CHECKER:	CR	07/07/26	BOURNE ROTARY METER STATION
DESIGN ENGINEER:	PB	07/07/26	M&R 00846
PROJECT MANAGER:	AC	07/07/26	TITLE: DETAILS

ENBRIDGE

Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

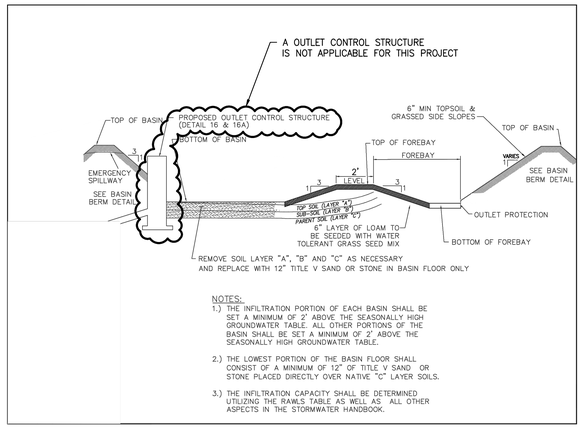
TITLE	INITIALS	DATE	YEAR: 2026	W.O.:	SCALE: N.T.S.	DWG.: 00846-C.320-0006	REV.: D

S:\AE\Projects\Enbridge\Mass\026356-001\200_Civil_Structural\170_Drawings\E&S Plans\Bourne Rotary\00846-C.320-0006.dwg - PLOT TIME: 7/6/2026 10:26 PM



NOTE:
THE INFILTRATION BASIN SHALL BE DESIGNED BY A PROFESSIONAL ENGINEER, AND SHALL COMPLY WITH ALL ASPECTS OF THE MA-DEP STORMWATER HANDBOOK.

INFILTRATION BASIN DETAIL

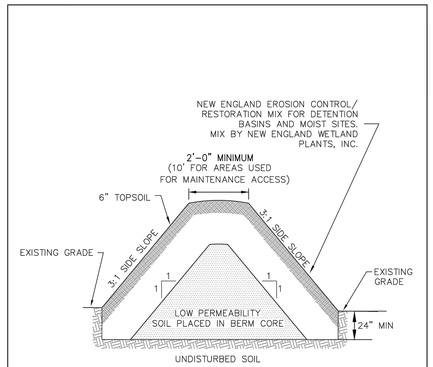


NOTES:
1.) THE INFILTRATION PORTION OF EACH BASIN SHALL BE SET A MINIMUM OF 2' ABOVE THE SEASONALLY HIGH GROUNDWATER TABLE. ALL OTHER PORTIONS OF THE BASIN SHALL BE SET A MINIMUM OF 2' ABOVE THE SEASONALLY HIGH GROUNDWATER TABLE.

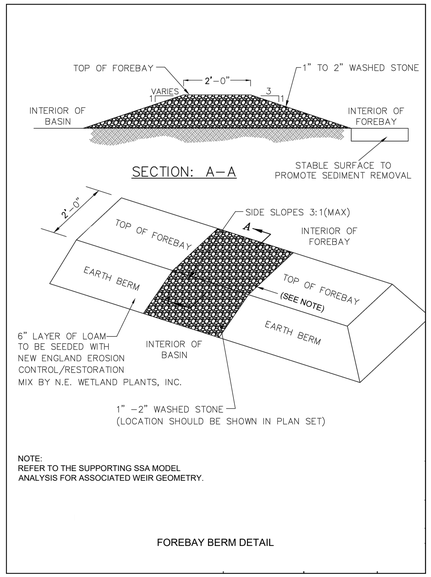
2.) THE LOWEST PORTION OF THE BASIN FLOOR SHALL CONSIST OF A MINIMUM OF 12" OF TITLE V SAND OR STONE PLACED DIRECTLY OVER NATIVE "C" LAYER SOILS.

3.) THE INFILTRATION CAPACITY SHALL BE DETERMINED UTILIZING THE RAWLS TABLE AS WELL AS ALL OTHER ASPECTS IN THE STORMWATER HANDBOOK.

INFILTRATION BASIN CROSS SECTION

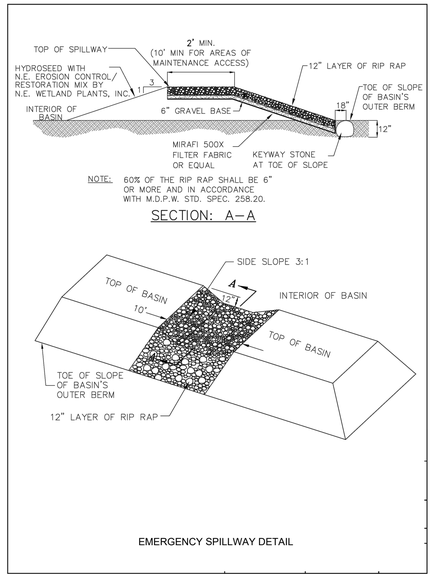


BASIN BERM DETAIL



NOTE:
REFER TO THE SUPPORTING SSA MODEL ANALYSIS FOR ASSOCIATED WEIR GEOMETRY.

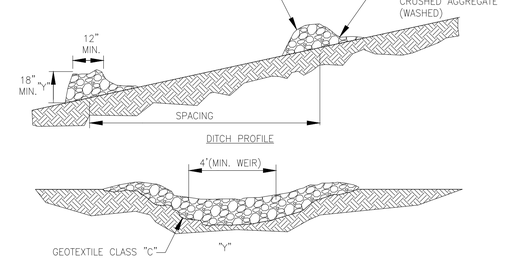
FOREBAY BERM DETAIL



NOTE: 60% OF THE RIP RAP SHALL BE 6" OR MORE AND IN ACCORDANCE WITH M.D.P.W. STD. SPEC. 258.20.

SECTION: A–A

EMERGENCY SPILLWAY DETAIL



DITCH PROFILE

CROSS SECTION

STANDARD SYMBOL

STANDARD STONE CHECK DAM DESIGN

SLOPE	SPACING
2% OR LESS	80'
2.1% TO 4%	40'
4.1% TO 7%	25'
7.1% TO 10%	15'
OVER 10%	USE LINED WATERWAY DESIGN

NOTES:
1. SWALES AND DITCHES SHALL BE PREPARED IN ACCORDANCE WITH THE CONSTRUCTION SPECIFICATIONS DESCRIBED IN SECTION A–2, STANDARDS AND SPECIFICATIONS FOR THE TEMPORARY SWALE.
2. THE CHECK DAM SHALL BE CONSTRUCTED OF 4"–7" STONE. THE STONE SHALL BE PLACED SO THAT IT COMPLETELY COVERS THE WIDTH OF THE CHANNEL AND KEYED INTO THE CHANNEL BANKS.
3. THE TOP OF THE CHECK DAM SHALL BE CONSTRUCTED SO THE CENTER IS APPROXIMATELY 6" LOWER THAN THE OUTER EDGES, FORMING A WEIR THAT WATER CAN FLOW ACROSS.
4. THE MAXIMUM HEIGHT OF THE CHECK DAM AT THE CENTER SHALL NOT EXCEED 2'.
5. THE UPSTREAM SIDE OF THE CHECK DAM SHALL BE LINED WITH APPROXIMATELY 1" OF 3/4" TO 1 1/2" CRUSHED AGGREGATE.

TYPICAL ROCK CHECK DAM DETAIL

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
No. 58957
PROFESSIONAL ENGINEER
07/07/26

ISSUED FOR PERMIT
07/07/2026

NOTES:
1. SEE CONSTRUCTION EROSION AND SEDIMENT CONTROL PLAN DRAWING 00846–C.320–0004.
2. CONTRACTOR TO EVALUATE PROJECT AREA TO IMPLEMENT BMPS IN AREAS THAT BEST FIT FOR THE CURRENT CONDITIONS. CONSULT WITH THE ONSITE INSPECTOR FOR ANY ADJUSTMENTS AND/OR ADDITIONS TO THE CONSTRUCTION STORM MANAGEMENT PLAN.

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		D	07/07/26	VN	DT	REISSUED FOR PERMIT
		C	06/29/26	VN	DT	ISSUED FOR PERMIT
		B	05/15/26	VN	DT	ISSUED FOR BID
		A	05/15/26	VN	DT	ISSUED FOR PERMIT

audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N, SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

TITLE	INITIALS	DATE
DRAWN BY:	VN	05/15/26
DESIGN CHECKER:	CR	07/07/26
DESIGN ENGINEER:	PB	07/07/26
PROJECT MANAGER:	AC	07/07/26

CAPE COD CANAL PIPELINE RELOCATION PROJECT
BOURNE ROTARY METER STATION
M&R 00846
TITLE: DETAILS

LOC.: BARNSTABLE COUNTY, MASSACHUSETTS
YEAR: 2026 | W.O.: | SCALE: N.T.S.

ENBRIDGE
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

DWG.: 00846–C.320–0007 | REV.: D

S:\AE\Projects\Enbridge\Mass\026356–001\200_Civil_Structural\170_Drawings\E&S Plans\Bourne Rotary\00846–C.320–0007.dwg – PLOT TIME: 7/6/2026 10:40 PM

Attachment G - Standard 9 Supporting Information

FEMA Flood Mapping

National Flood Hazard Layer FIRMette

FEMA

70°35'9"W 41°44'32"N



70°34'32"W 41°44'5"N

0 250 500 1,000 1,500 2,000 Feet

1:6,000

Basemap Imagery Source: USGS National Map 2023

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- 20.2 / 17.5 Cross Sections with 1% Annual Chance / Water Surface Elevation
- Coastal Transect
- Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 4/20/2026 at 8:55 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

JULY 2, 2026

CAPE COD CANAL PIPELINE REPLACEMENT PROJECT

STORMWATER REPORT FOR THE BOURNE METER STATION

BOURNE, MA

Prepared For: Algonquin Gas Transmission, LLC

Prepared By:

audubon

Audubon Companies, LC

3505 W. Sam Houston Pkwy N., Ste 150

Houston, TX 77043



07/02/26

BLANK PAGE LEFT INTENTIONALLY

Table of Contents

1 Checklist for Stormwater Report 1
2 Stormwater Report Narrative 8
2.1 Project Description 8
2.1.1 Site Description 8
2.1.2 Wetland Resources 8
2.1.3 Subsurface Soil Investigations 9
2.2 Existing Drainage Conditions 9
2.3 Proposed Drainage Conditions 10
3 Regulatory Compliance 15
3.1 Massachusetts Department of Environmental Protection (DEP) – Stormwater Management Standards 15
3.1.1 Standard 1: No New Untreated Discharges or Erosion to Wetlands 15
3.1.2 Standard 2: Peak Rate Attenuation 15
3.1.3 Standard 3: Stormwater Recharge 16
3.1.4 Standard 4: Water Quality 17
3.1.5 Standard 5: Land Uses and High Potential Pollutant Loads (LUHPPLs) 17
3.1.6 Standard 6: Critical Areas 18
3.1.7 Standard 7: Redevelopments and Other Projects Subject to the Standards only to the Maximum Extent Practicable 18
3.1.8 Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Controls 18
3.1.9 Standard 9: Operation and Maintenance Plan 18
3.1.10 Standard 10: Prohibition of Illicit Discharges 19
4 Local Municipal Rules and Regulations 19
5 FEMA Floodplain 20

Figure 1 - Site Location Map (Aerial)
Figure 2 - Site Location Map (Topo)

Table 1 - Existing Conditions Hydrologic Data
Table 2 - Proposed Conditions Hydrologic Data
Table 3 - NOAA Atlas 14 Volume 10 Design Depths for the 24 Hour Storm (inches)
Table 4 - Peak Discharge Rates
Table 5 - Summary of Recharge Calculations

Table 6 - Ditch Hydraulic Design Parameters
Table 7 - Culvert Hydraulic Design Parameters

Attachment A - Existing and Proposed Drainage Conditions 15
Attachment B - Standard 1 Supporting Information 20
Attachment C - Standard 2 Supporting Information 30
Attachment D - Standard 3 Supporting Information 36
Attachment E - Standard 4 Supporting Information 40
Attachment F - Standard 8 Supporting Information 52
Attachment G – Standard 9 Supporting Information 57

1 Checklist for Stormwater Report

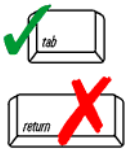
BLANK PAGE LEFT INTENTIONALLY

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

A. Introduction

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.



A Stormwater Report must be submitted with the Notice of Intent permit application to document compliance with the Stormwater Management Standards. The following checklist is NOT a substitute for the Stormwater Report (which should provide more substantive and detailed information) but is offered here as a tool to help the applicant organize their Stormwater Management documentation for their Report and for the reviewer to assess this information in a consistent format. As noted in the Checklist, the Stormwater Report must contain the engineering computations and supporting information set forth in Volume 3 of the Massachusetts Stormwater Handbook. The Stormwater Report must be prepared and certified by a Registered Professional Engineer (RPE) licensed in the Commonwealth.

The Stormwater Report must include:

- The Stormwater Checklist completed and stamped by a Registered Professional Engineer (see page 2) that certifies that the Stormwater Report contains all required submittals.[1] This Checklist is to be used as the cover for the completed Stormwater Report.
- Applicant/Project Name
- Project Address
- Name of Firm and Registered Professional Engineer that prepared the Report
- Long-Term Pollution Prevention Plan required by Standards 4-6
- Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan required by Standard 8[2]
- Operation and Maintenance Plan required by Standard 9

In addition to all plans and supporting information, the Stormwater Report must include a brief narrative describing stormwater management practices, including environmentally sensitive site design and LID techniques, along with a diagram depicting runoff through the proposed BMP treatment train. Plans are required to show existing and proposed conditions, identify all wetland resource areas, NRCS soil types, critical areas, Land Uses with Higher Potential Pollutant Loads (LUHPPL), and any areas on the site where infiltration rate is greater than 2.4 inches per hour. The Plans shall identify the drainage areas for both existing and proposed conditions at a scale that enables verification of supporting calculations.

As noted in the Checklist, the Stormwater Management Report shall document compliance with each of the Stormwater Management Standards as provided in the Massachusetts Stormwater Handbook. The soils evaluation and calculations shall be done using the methodologies set forth in Volume 3 of the Massachusetts Stormwater Handbook.

To ensure that the Stormwater Report is complete, applicants are required to fill in the Stormwater Report Checklist by checking the box to indicate that the specified information has been included in the Stormwater Report. If any of the information specified in the checklist has not been submitted, the applicant must provide an explanation. The completed Stormwater Report Checklist and Certification must be submitted with the Stormwater Report.

[1] The Stormwater Report may also include the Illicit Discharge Compliance Statement required by Standard 10. If not included in the Stormwater Report, the Illicit Discharge Compliance Statement must be submitted prior to the discharge of stormwater runoff to the post-construction best management practices.

[2] For some complex projects, it may not be possible to include the Construction Period Erosion and Sedimentation Control Plan in the Stormwater Report. In that event, the issuing authority has the discretion to issue an Order of Conditions that approves the project and includes a condition requiring the proponent to submit the Construction Period Erosion and Sedimentation Control Plan before commencing any land disturbance activity on the site.

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

B. Stormwater Checklist and Certification

The following checklist is intended to serve as a guide for applicants as to the elements that ordinarily need to be addressed in a complete Stormwater Report. The checklist is also intended to provide conservation commissions and other reviewing authorities with a summary of the components necessary for a comprehensive Stormwater Report that addresses the ten Stormwater Standards.

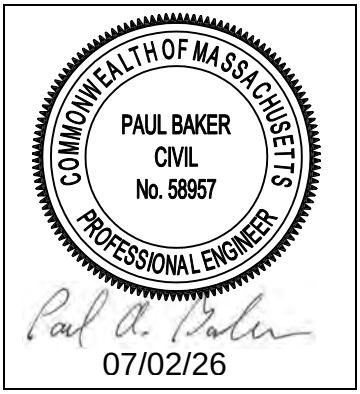
Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the item is not applicable (N.A.) and provide the reasons for that determination.

A complete checklist must include the Certification set forth below signed by the Registered Professional Engineer who prepared the Stormwater Report.

Registered Professional Engineer's Certification

I have reviewed the Stormwater Report, including the soil evaluation, computations, Long-term Pollution Prevention Plan, the Construction Period Erosion and Sedimentation Control Plan (if included), the Long-term Post-Construction Operation and Maintenance Plan, the Illicit Discharge Compliance Statement (if included) and the plans showing the stormwater management system, and have determined that they have been prepared in accordance with the requirements of the Stormwater Management Standards as further elaborated by the Massachusetts Stormwater Handbook. I have also determined that the information presented in the Stormwater Checklist is accurate and that the information presented in the Stormwater Report accurately reflects conditions at the site as of the date of this permit application.

Registered Professional Engineer Block and Signature



Paul Baker Digitally signed by Paul Baker DN: C=US, E=pbaker@audubooncompanies.com, O=Audubon Engineeriong, OU=Civil / Structural Engineer, CN=Paul Baker Reason: I am approving this document Date: 2026.07.02 21:04:05-05'00' 7/02/2026

Signature and Date

Checklist

Project Type: Is the application for new development, redevelopment, or a mix of new and redevelopment?

☒ New development

☐ Redevelopment

☐ Mix of New Development and Redevelopment

Checklist for Stormwater Report

Checklist (continued)

LID Measures: Stormwater Standards require LID measures to be considered. Document what environmentally sensitive design and LID Techniques were considered during the planning and design of the project:

- [X] No disturbance to any Wetland Resource Areas
- [ ] Site Design Practices (e.g. clustered development, reduced frontage setbacks)
- [ ] Reduced Impervious Area (Redevelopment Only)
- [ ] Minimizing disturbance to existing trees and shrubs
- [ ] LID Site Design Credit Requested:
  - [ ] Credit 1
  - [ ] Credit 2
  - [ ] Credit 3
- [ ] Use of "country drainage" versus curb and gutter conveyance and pipe
- [ ] Bioretention Cells (includes Rain Gardens)
- [ ] Constructed Stormwater Wetlands (includes Gravel Wetlands designs)
- [ ] Treebox Filter
- [ ] Water Quality Swale
- [X] Grass Channel
- [ ] Green Roof
- [X] Other (describe): Infiltration Basins

Standard 1: No New Untreated Discharges

- [X] No new untreated discharges
- [X] Outlets have been designed so there is no erosion or scour to wetlands and waters of the Commonwealth
- [X] Supporting calculations specified in Volume 3 of the Massachusetts Stormwater Handbook included.

Checklist for Stormwater Report

Checklist (continued)

Standard 2: Peak Rate Attenuation

☐ Standard 2 waiver requested because the project is located in land subject to coastal storm flowage and stormwater discharge is to a wetland subject to coastal flooding.

☐ Evaluation provided to determine whether off-site flooding increases during the 100-year 24-hour storm.

☒ Calculations provided to show that post-development peak discharge rates do not exceed pre-development rates for the 2-year and 10-year 24-hour storms. If evaluation shows that off-site flooding increases during the 100-year 24-hour storm, calculations are also provided to show that post-development peak discharge rates do not exceed pre-development rates for the 100-year 24-hour storm.

Standard 3: Recharge

☒ Soil Analysis provided.

☒ Required Recharge Volume calculation provided.

☐ Required Recharge volume reduced through use of the LID site Design Credits.

☒ Sizing the infiltration, BMPs is based on the following method: Check the method used.

☒ Static ☐ Simple Dynamic ☐ Dynamic Field[1]

☐ Runoff from all impervious areas at the site discharging to the infiltration BMP.

☒ Runoff from all impervious areas at the site is *not* discharging to the infiltration BMP and calculations are provided showing that the drainage area contributing runoff to the infiltration BMPs is sufficient to generate the required recharge volume.

☒ Recharge BMPs have been sized to infiltrate the Required Recharge Volume.

☐ Recharge BMPs have been sized to infiltrate the Required Recharge Volume *only* to the maximum extent practicable for the following reason:

- ☐ Site is comprised solely of C and D soils and/or bedrock at the land surface
- ☐ M.G.L. c. 21E sites pursuant to 310 CMR 40.0000
- ☐ Solid Waste Landfill pursuant to 310 CMR 19.000
- ☐ Project is otherwise subject to Stormwater Management Standards only to the maximum extent practicable.

☒ Calculations showing that the infiltration BMPs will drain in 72 hours are provided.

☐ Property includes a M.G.L. c. 21E site or a solid waste landfill and a mounding analysis is included.

[1] 80% TSS removal is required prior to discharge to infiltration BMP if Dynamic Field method is used.

Checklist for Stormwater Report

Checklist (continued)

Standard 3: Recharge (continued)

☐ The infiltration BMP is used to attenuate peak flows during storms greater than or equal to the 10-year 24-hour storm and separation to seasonal high groundwater is less than 4 feet and a mounding analysis is provided.

☐ Documentation is provided showing that infiltration BMPs do not adversely impact nearby wetland resource areas.

Standard 4: Water Quality

The Long-Term Pollution Prevention Plan typically includes the following:

- Good housekeeping practices;
- Provisions for storing materials and waste products inside or under cover;
- Vehicle washing controls;
- Requirements for routine inspections and maintenance of stormwater BMPs;
- Spill prevention and response plans;
- Provisions for maintenance of lawns, gardens, and other landscaped areas;
- Requirements for storage and use of fertilizers, herbicides, and pesticides;
- Pet waste management provisions;
- Provisions for operation and management of septic systems;
- Provisions for solid waste management;
- Snow disposal and plowing plans relative to Wetland Resource Areas;
- Winter Road Salt and/or Sand Use and Storage restrictions;
- Street sweeping schedules;
- Provisions for prevention of illicit discharges to the stormwater management system;
- Documentation that Stormwater BMPs are designed to provide for shutdown and containment in the event of a spill or discharges to or near critical areas or from LUHPPL;
- Training for staff or personnel involved with implementing Long-Term Pollution Prevention Plan;
- List of Emergency contacts for implementing Long-Term Pollution Prevention Plan.

☒ A Long-Term Pollution Prevention Plan is attached to Stormwater Report and is included as an attachment to the Wetlands Notice of Intent.

☒ Treatment BMPs subject to the 44% TSS removal pretreatment requirement and the one inch rule for calculating the water quality volume are included, and discharge:

- ☐ is within the Zone II or Interim Wellhead Protection Area
- ☐ is near or to other critical areas
- ☒ is within soils with a rapid infiltration rate (greater than 2.4 inches per hour)
- ☐ involves runoff from land uses with higher potential pollutant loads.

☐ The Required Water Quality Volume is reduced through use of the LID site Design Credits.

☒ Calculations documenting that the treatment train meets the 80% TSS removal requirement and, if applicable, the 44% TSS removal pretreatment requirement, are provided.

Checklist for Stormwater Report

Checklist (continued)

Standard 4: Water Quality (continued)

☒ The BMP is sized (and calculations provided) based on:

- ☒ The ½" or 1" Water Quality Volume or
- ☐ The equivalent flow rate associated with the Water Quality Volume and documentation is provided showing that the BMP treats the required water quality volume.

☐ The applicant proposes to use proprietary BMPs, and documentation supporting use of proprietary BMP and proposed TSS removal rate is provided. This documentation may be in the form of the propriety BMP checklist found in Volume 2, Chapter 4 of the Massachusetts Stormwater Handbook and submitting copies of the TARP Report, STEP Report, and/or other third party studies verifying performance of the proprietary BMPs.

☐ A TMDL exists that indicates a need to reduce pollutants other than TSS and documentation showing that the BMPs selected are consistent with the TMDL is provided.

Standard 5: Land Uses With Higher Potential Pollutant Loads (LUHPPLs)

☐ The NPDES Multi-Sector General Permit covers the land use and the Stormwater Pollution Prevention Plan (SWPPP) has been included with the Stormwater Report.

☐ The NPDES Multi-Sector General Permit covers the land use and the SWPPP will be submitted ***prior to*** the discharge of stormwater to the post-construction stormwater BMPs.

☒ The NPDES Multi-Sector General Permit does ***not*** cover the land use.

☐ LUHPPLs are located at the site and industry specific source control and pollution prevention measures have been proposed to reduce or eliminate the exposure of LUHPPLs to rain, snow, snow melt and runoff, and been included in the long term Pollution Prevention Plan.

☐ All exposure has been eliminated.

☐ All exposure has ***not*** been eliminated and all BMPs selected are on MassDEP LUHPPL list.

☐ The LUHPPL has the potential to generate runoff with moderate to higher concentrations of oil and grease (e.g. all parking lots with >1000 vehicle trips per day) and the treatment train includes an oil grit separator, a filtering bioretention area, a sand filter or equivalent.

Standard 6: Critical Areas

☐ The discharge is near or to a critical area and the treatment train includes only BMPs that MassDEP has approved for stormwater discharges to or near that particular class of critical area.

☐ Critical areas and BMPs are identified in the Stormwater Report.

Checklist for Stormwater Report

Checklist (continued)

Standard 7: Redevelopments and Other Projects Subject to the Standards only to the maximum extent practicable

☐ The project is subject to the Stormwater Management Standards only to the maximum Extent Practicable as a:

- ☐ Limited Project
- ☐ Small Residential Projects: 5-9 single family houses or 5-9 units in a multi-family development provided there is no discharge that may potentially affect a critical area.
- ☐ Small Residential Projects: 2-4 single family houses or 2-4 units in a multi-family development with a discharge to a critical area
- ☐ Marina and/or boatyard provided the hull painting, service and maintenance areas are protected from exposure to rain, snow, snow melt and runoff
- ☐ Bike Path and/or Foot Path
- ☐ Redevelopment Project
- ☐ Redevelopment portion of mix of new and redevelopment.

☐ Certain standards are not fully met (Standard No. 1, 8, 9, and 10 must always be fully met) and an explanation of why these standards are not met is contained in the Stormwater Report.

☐ The project involves redevelopment and a description of all measures that have been taken to improve existing conditions is provided in the Stormwater Report. The redevelopment checklist found in Volume 2 Chapter 3 of the Massachusetts Stormwater Handbook may be used to document that the proposed stormwater management system (a) complies with Standards 2, 3 and the pretreatment and structural BMP requirements of Standards 4-6 to the maximum extent practicable and (b) improves existing conditions.

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control

A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan must include the following information:

- Narrative;
- Construction Period Operation and Maintenance Plan;
- Names of Persons or Entity Responsible for Plan Compliance;
- Construction Period Pollution Prevention Measures;
- Erosion and Sedimentation Control Plan Drawings;
- Detail drawings and specifications for erosion control BMPs, including sizing calculations;
- Vegetation Planning;
- Site Development Plan;
- Construction Sequencing Plan;
- Sequencing of Erosion and Sedimentation Controls;
- Operation and Maintenance of Erosion and Sedimentation Controls;
- Inspection Schedule;
- Maintenance Schedule;
- Inspection and Maintenance Log Form.

☒ A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan containing the information set forth above has been included in the Stormwater Report.

Checklist for Stormwater Report

Checklist (continued)

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control (continued)

☐ The project is highly complex and information is included in the Stormwater Report that explains why it is not possible to submit the Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan with the application. A Construction Period Pollution Prevention and Erosion and Sedimentation Control has ***not*** been included in the Stormwater Report but will be submitted ***before*** land disturbance begins.

☒ The project is ***not*** covered by a NPDES Construction General Permit.

☐ The project is covered by a NPDES Construction General Permit and a copy of the SWPPP is in the Stormwater Report.

☐ The project is covered by a NPDES Construction General Permit but no SWPPP been submitted. The SWPPP will be submitted BEFORE land disturbance begins.

Standard 9: Operation and Maintenance Plan

☒ The Post Construction Operation and Maintenance Plan is included in the Stormwater Report and includes the following information:

- ☒ Name of the stormwater management system owners;
- ☒ Party responsible for operation and maintenance;
- ☒ Schedule for implementation of routine and non-routine maintenance tasks;
- ☒ Plan showing the location of all stormwater BMPs maintenance access areas;
- ☒ Description and delineation of public safety features;
- ☒ Estimated operation and maintenance budget; and
- ☒ Operation and Maintenance Log Form.

☐ The responsible party is ***not*** the owner of the parcel where the BMP is located and the Stormwater Report includes the following submissions:

- ☐ A copy of the legal instrument (deed, homeowner's association, utility trust or other legal entity) that establishes the terms of and legal responsibility for the operation and maintenance of the project site stormwater BMPs;
- ☐ A plan and easement deed that allows site access for the legal entity to operate and maintain BMP functions.

Standard 10: Prohibition of Illicit Discharges

☐ The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges;

☒ An Illicit Discharge Compliance Statement is attached;

☐ NO Illicit Discharge Compliance Statement is attached but will be submitted ***prior to*** the discharge of any stormwater to post-construction BMPs.

2 Stormwater Report Narrative

This stormwater report has been prepared to demonstrate compliance with the Massachusetts Stormwater Management Standards in accordance with the Massachusetts Wetland Protection Act Regulations (310 CMR 10.00). This report also demonstrates compliance with the Cape Cod Commission.

2.1 Project Description

The proposed project is part of the Massachusetts Department of Transportation (MassDOT) Cape Cod Canal Bridges Replacement Project and involves the construction of a new greenfield Metering and Regulating (M&R) Station on the mainland side of the Bourne Bridge in Bourne, Massachusetts.

The purpose of the project is to relocate existing gas infrastructure to maintain uninterrupted delivery of natural gas to National Grid and its customers during and after bridge replacement activities. The new facility will replace impacted infrastructure and support continued operation of the regional gas transmission system.

The proposed M&R station will include process and support equipment such as a filter separator, meter skids, regulator systems, water bath heaters, odorization systems, and associated electrical, control, and utility systems. The facility will also include pig receiver assemblies associated with the existing G-8C and G-8L pipelines. Site development will include clearing, grading, access roads, equipment pads, and stormwater management infrastructure designed to meet applicable regulatory requirements

2.1.1 Site Description

The project site is located on the mainland side of the Bourne Bridge along the east side of Route 25 in Bourne, Barnstable County, Massachusetts. The surrounding area consists primarily of undeveloped woodland, with nearby residential properties and roadway infrastructure.

The site is currently undeveloped and consists primarily of wooded land with existing dirt access roads located along portions of the site perimeter. Existing drainage is characterized by pervious grass- and woodland-covered areas with runoff conveyed via sheet flow generally toward the southern portion of the property.

Topography across the site consists of rolling terrain with multiple hills and localized elevation changes. Subsurface conditions generally consist of a thin layer of topsoil and subsoil underlain by native sand deposits with varying amounts of gravel, cobbles, and boulders.

Groundwater was not observed during subsurface investigations, although seasonal variations may occur.

2.1.2 Wetland Resources

On February 3, 2025, SWCA representatives conducted a wetland delineation on the subject property. Based on the results of the delineation, the proposed Bourne M&R Station site is not

located within, or in proximity to, any resource areas regulated under the Massachusetts Wetlands Protection Act.

2.1.3 Subsurface Soil Investigations

The Natural Resources Conservation Service (NRCS) identifies the soils at the Project Site as Plymouth loamy coarse sand (Map Unit #435C). Soil infiltration characteristics were evaluated using NRCS Web Soil Survey mapping and conservative design assumptions for infiltration BMP sizing.

In general, subsurface soil conditions at the Site consist of a thin organic surface layer underlain by loamy coarse sand, transitioning to coarse sand and gravelly sand deposits at depth, derived from glaciofluvial outwash materials.

The mapped soils are characterized as excessively drained with moderately high to very high permeability, and no restrictive layer was identified within at least 80 inches below ground surface.

Groundwater was not encountered within the mapped soil profile, and the NRCS data indicates a depth to water table greater than 80 inches. Groundwater conditions may vary seasonally and with precipitation and should be considered approximate.

Due to the Project not requiring sanitary sewer or septic system design, infiltration testing was not performed.

Due to the coarse-grained nature of the soils, low available water capacity, and site slopes (approximately 8 to 15 percent), disturbed areas may be susceptible to erosion and sediment transport during storm events, and appropriate erosion and sediment controls will be implemented in accordance with the SWPPP.

2.2 Existing Drainage Conditions

The project site encompasses approximately 4.1 acres and is currently heavily wooded and undeveloped, with the proposed facility occupying approximately 2.0 acres of the overall property. Site access is provided by an existing gravel private roadway located along the eastern portion of the property, which traverses varying terrain elevations as it approaches the proposed development area.

Based on available NRCS Web Soil Survey mapping, the site consists of Barnstable sandy loam, 3 to 8 percent slopes, very stony (431B); Plymouth loamy coarse sand, 3 to 8 percent slopes (435B); Plymouth loamy coarse sand, 8 to 15 percent slopes (435C); and Barnstable-Plymouth complex, rolling, very bouldery (489C). All mapped soils on the site are classified as Hydrologic Soil Group A, indicating relatively high infiltration potential and low runoff characteristics under existing conditions.

Existing site topography is characterized by rolling terrain with several prominent ridgelines and localized high points that create multiple distinct drainage patterns across the property. Within the proposed facility area, a prominent hill located along the northwestern portion of the site directs runoff toward the central portion of the property before continuing generally toward the northeast.

A secondary ridgeline located east of the proposed infiltration basin area further influences drainage patterns by directing runoff toward the proposed basin location under existing conditions. Several shallow depressions throughout the site provide minor temporary surface storage during runoff events but do not exhibit well-defined concentrated or channelized flow.

Due to the varied topography and multiple ridgeline features, the site was divided into fourteen existing drainage areas. The primary facility area is comprised of Drainage Areas E01 through E06. A hill in the northwestern corner of the proposed workspace limits serves as the drainage divide for Drainage Areas E01 through E05, while a second high point in the southeastern portion of the site forms a common drainage divide for Drainage Areas E04 and E06 through E08. Drainage Area E01 generally drains north away from the development, while Drainage Area E02 drains west. Drainage Area E03 drains northeast and serves as the primary analysis point for the existing drainage model, as it corresponds to the anticipated overflow discharge location of the proposed infiltration basin and associated overflow swale during larger storm events. Drainage Areas E04 through E06 drain toward localized shallow depressions within the proposed facility limits. Drainage Area E07 drains southwest to a localized depression. The remaining drainage areas, E08 through E14, are primarily associated with the existing access roadway corridor, with runoff conveyed generally to the north or south depending on localized roadway grades and surrounding topography.

No formal stormwater management facilities or drainage infrastructure currently exist on the site. Due to the undeveloped and densely vegetated nature of the property, stormwater runoff is conveyed primarily as shallow sheet flow through the wooded landscape, with no evidence of concentrated or channelized flow within the project limits.

A plan depicting the Existing Drainage Conditions is provided in Appendix A.

Table 1 - Existing Conditions Hydrologic Data

Drainage Area	Area (acres)	Curve Number	Time of Concentration (min)	Existing Outlet Discharge (cfs)
E03	0.48	43	23.8	0.59

2.3 Proposed Drainage Conditions

Under proposed conditions, approximately 2.0 acres of the 4.1-acre site will be developed with the construction of a gravel equipment pad, associated gravel access roadway improvements, and supporting stormwater management infrastructure. The proposed access drive will connect to the existing roadway located along the eastern portion of the property. The proposed stormwater management system has been designed to incorporate a treatment train approach consisting of vegetated swales, sediment forebays, infiltration practices, and rock check dams. These best management practices (BMPs) provide runoff attenuation, groundwater recharge, sediment removal, and water quality treatment while maintaining drainage patterns generally consistent with existing site conditions.

Proposed grading will selectively clear and regrade portions of the site to direct runoff toward defined collection, conveyance, and treatment systems. Stormwater runoff associated with the proposed facility area will generally be conveyed by a combination of sheet flow and vegetated swales to a sediment forebay prior to entering a proposed infiltration basin. The infiltration basin has been designed using the most conservative calculated infiltration rate based on mapped site soils and will provide temporary storage, groundwater recharge, peak flow attenuation, and water quality treatment. During larger storm events, runoff exceeding the storage capacity of the basin will discharge in a controlled manner while maintaining existing downgradient drainage patterns.

Under proposed conditions, the site is divided into seven primary drainage areas associated with the proposed improvements.

Drainage Area A01 encompasses the primary facility area and represents the principal stormwater management treatment system for the proposed development. Runoff from the gravel equipment pad and adjacent disturbed areas will generally sheet flow from west to east toward vegetated swales located along the downgradient side of the facility. Runoff collected within the swales will discharge to a sediment forebay prior to entering the proposed infiltration basin. The infiltration basin provides temporary storage, groundwater recharge, water quality treatment, and peak flow attenuation. During larger storm events, overflow from the basin will discharge in a controlled manner while maintaining drainage patterns generally consistent with existing site conditions.

Drainage Areas A02 through A07 are primarily associated with the proposed access roadway corridor. Due to the varying terrain and roadway grades, runoff from these drainage areas will be conveyed through vegetated roadside swales designed to reduce runoff velocities, promote infiltration, and minimize erosive conditions. A series of rock check dams will be incorporated within the swales to further dissipate flow energy and encourage infiltration.

Drainage Areas A02 and A03 convey runoff east along the proposed access roadway, where flows combine with runoff from Drainage Areas A04 and A05 at a common low point. The combined runoff is conveyed beneath the roadway through two 18-inch reinforced concrete pipe (RCP) culverts before discharging to a riprap outfall. The riprap outfall has been designed to dissipate flow energy and transition concentrated discharge into non-erosive sheet flow prior to entering the adjacent forested buffer, thereby maintaining existing downstream drainage characteristics. Hydraulic design parameters for the culverts are provided in Table 7.

Drainage Areas A06 and A07 drain west along the access roadway corridor to separate riprap outfalls. Runoff discharged from each outfall transitions to stabilized sheet flow and is conveyed along existing natural drainage pathways on either side of the roadway, maintaining pre-development drainage patterns while minimizing erosion potential. Hydraulic design parameters for the proposed roadside ditches are provided in.

Overall, the proposed stormwater management system formalizes existing drainage patterns while incorporating infiltration-based BMPs, vegetated conveyance systems, sediment forebays, infiltration practices, and rock check dams to improve groundwater recharge, provide water quality treatment, and reduce post-development peak discharge rates. No adverse impacts to downgradient properties or natural resource areas are anticipated. A plan depicting Proposed Drainage Conditions is provided in Appendix A.

Table 2 - Proposed Conditions Hydrologic Data

Drainage Area	Discharge Location	Design Event	Existing Area Distributions (acres)	Area (acres)	Curve Number	Time of Concentration (min)	Proposed Outlet Discharge (cfs)
A1	North	8.8 in, 50Year (2070)	E01(0.06) + E02(0.18) + E03(0.32) + E04(1.05) + E05(0.37) + E06(0.3) + E07(0.18) + E08(0.01)	2.47	61.66	7.4	0.59

Table 6 - Ditch Hydraulic Design Parameters

Ditch Location (Drainage area)	Peak flow (cfs) 2070 - 50 Year Event	Ditch Capacity (cfs)	Min depth (ft)	Slope (%)	Velocity(ft/s)	Section Geometry
A1NE	5.7	6.85	1.40	0.40	2.29	Triangular, side slope max 3:1
A1SE	1.6	8.54	1.00	1.51	4.27	Triangular, side slope max 2:1
A2	3.5	3.81	1.00	0.30	1.90	Triangular, side slope max 2:1
A3	10.2	11.23	1.50	0.30	2.49	Triangular, side slope max 2:1
A4	4.64	4.91	1.10	0.30	2.03	Triangular, side slope max 2:1
A5	5.82	6.19	1.20	0.30	2.15	Triangular, side slope max 2:1
A6	0.49	0.71	0.40	1.40	2.23	Triangular, side slope max 2:1
A7	1.37	2.11	0.60	1.40	2.92	Triangular, side slope max 2:1

Table 7 - Culvert Hydraulic Design Parameters

Parameters	Culverts
Quantity	2
Diameter	18 in
Length	16.5
Material	RCP
Inlet Invert Elevation	54.65
Outlet Invert Elevation	54.32
Slope	2.00%
Q(2070-50 year)	15.71 cfs
Headwater Elevation (2070-50 year)	56.30 ft
Outlet Velocity (2070-50 year)	7.64 ft/s



Name: WGS 1984 Web Mercator Auxiliary Sphere
PCS: WGS 1984 Web Mercator Auxiliary Sphere; Authority: EPSG; WKID: 3857

0 12.5 25 50 Miles

FIGURE 1		SITE LOCATION MAP	Rev. No: 2
Drawn By: MH	Approved By: SR	CAPE COD CANAL PIPELINE REPLACEMENT PROJECT BOURNE METER STATION BOURNE, MA	Rev. By:
Date: 6/24/26	Job No:	N	Rev. Date: 6/25/26
Sheet No: ___ of ___		audubon	Revision Description, Per OCM Request:



Name: WGS 1984 Web Mercator Auxiliary Sphere
PCS: WGS 1984 Web Mercator Auxiliary Sphere; Authority: EPSG; WKID: 3857

0 12.5 25 50 Miles

FIGURE 2	SITE LOCATION MAP	Rev. No: 2
Drawn By: MH / Approved By: SR	CAPE COD CANAL PIPELINE REPLACEMENT PROJECT BOURNE METER STATION BOURNE, MA	Rev. By:
Date: 6/24/26 / Job No:	N	Rev. Date: 6/25/26
Sheet No: ___ of ___	audubon	Revision Description, Per OCM Request:

3 Regulatory Compliance

3.1 Massachusetts Department of Environmental Protection (DEP) – Stormwater Management Standards

As demonstrated in the sections below, the proposed Project Complies with the DEP Stormwater Management Standards.

3.1.1 Standard 1: No New Untreated Discharges or Erosion to Wetlands

The Project has been designed to comply with Standard 1

The Best Management Practices (BMPs) included in the proposed stormwater management system have been designed in accordance with the Massachusetts Stormwater Handbook (MSH). Supporting information and computation demonstrating that no new untreated discharges will result from the Project are presented through compliance with Standards 4 through 6.

All proposed Project Stormwater Outlets and conveyances have been designed to not cause erosion or scour to wetlands or receiving waters.

Computations and supporting information for the sizing and selection of materials used to protect from scour and erosion are included in Appendix B.

3.1.2 Standard 2: Peak Rate Attenuation

The Project has been designed to comply with Standard 2. The project is not subject to coastal storm flowage; the Project is proposing to reduce peak flow rates from existing to proposed conditions. Future precipitation conditions were evaluated using projected 2070 rainfall depths in accordance with current guidance.

A hydrologic and hydraulic model was developed using Autodesk Storm and Sanitary Analysis (SSA) to evaluate the existing and proposed drainage conditions for the Site. The analysis utilizes the NRCS TR-20 hydrologic methodology, with time of concentration (Tc) calculated in accordance with NRCS TR-55 procedures, and a minimum Tc of 6 minutes applied across all subcatchments. Runoff hydrographs were generated using the NRCS dimensionless unit hydrograph approach, and hydraulic routing was performed using dynamic (hydrodynamic) wave routing within the SSA model. The results of the analyses indicate that there is no increase in peak discharge rates between pre- and post-development conditions at the evaluated design points for the 2-, 10-, 25-, 50- and 100-year storm events, as well as the 50-year (2070) climate-adjusted storm event. Rainfall distributions utilized in the analysis are based on the NRCS Type III storm distribution. Precipitation depths for each storm event were obtained from the NOAA Atlas 14, Volume 10. Runoff curve numbers (CNs) for both existing and proposed conditions, as summarized in Tables 1 and 2, were determined in accordance with NRCS TR-55 methodology. Detailed model input parameters, assumptions, and computational results are provided in Appendix C.

Table 3 - NOAA Atlas 14 Volume 10 Design Depths for the 24 Hour Storm (inches)

2-year	10-year	25-year	50-Year	100-year	50yr-2070
3.42	5.00	5.98	6.73	7.50	8.80

Table 4 - Peak Discharge Rates

Proposed Area	Storm Event	Design Point	Existing Areas (Acre)	Existing Peak Discharge (cfs)	Proposed Areas (Acre)	Proposed Peak Discharge (cfs)
A1	2-year	DP-1	(E03) - 0.48	0.00	A1-2.47	0.00
	10-year	DP-1	(E03) - 0.48	0.05	A1-2.47	0.02
	25-year	DP-1	(E03) - 0.48	0.14	A1-2.47	0.05
	50-year	DP-1	(E03) - 0.48	0.24	A1-2.47	0.08
	100-year	DP-1	(E03) - 0.48	0.35	A1-2.47	0.14
	50-year 2070	DP-1	(E03) - 0.48	0.59	A1-2.47	0.59

3.1.3 Standard 3: Stormwater Recharge

The Project has been designed to comply with Standard 3 of the Massachusetts Stormwater Management Standards. In accordance with the Massachusetts Stormwater Handbook, the required recharge volume for the site is 3,609.80 cubic feet. Recharge of stormwater is primarily provided through the proposed infiltration basin serving the main facility area, which has been designed to promote groundwater recharge while also providing water quality treatment and peak flow attenuation. The infiltration basin has been sized using the Static Method, with infiltration calculated based on the bottom area of the basin. The infiltration BMP has been designed to fully dewater within 72 hours. Supporting drawdown calculations are provided in Appendix D, and a summary of the proposed infiltration BMP is included in Table 5.

In the absence of site-specific geotechnical infiltration testing, design infiltration rates were estimated using published NRCS Web Soil Survey data. Based on available NRCS mapping, the site and access road consist of Barnstable sandy loam, 3 to 8 percent slopes, very stony (431B); Plymouth loamy coarse sand, 3 to 8 percent slopes (435B); Plymouth loamy coarse sand, 8 to 15 percent slopes (435C); and Barnstable-Plymouth complex, rolling, very bouldery (489C). Saturated hydraulic conductivity (Ksat) values were obtained for the representative mapped soil units and converted to inches per hour. A conservative factor of safety of 2 was applied to the published infiltration rates to account for variability and uncertainty associated with generalized soil mapping data.

Based on the published NRCS soil data and the applied factor of safety, calculated design infiltration rates ranged from approximately 4.899 inches per hour to 27.690 inches per hour, depending on the mapped soil unit. To provide a conservative design, the infiltration basin

drawdown analysis utilized the lowest calculated design infiltration rate of approximately 4.899 inches per hour, representing the most limiting anticipated soil conditions at the proposed infiltration interface. This assumed design infiltration rate was utilized in the project's drawdown analysis to evaluate dewatering performance and confirm compliance with required drawdown timeframes. Refer to the drawdown analysis in Appendix D for detailed calculations.

Table 5 - Summary of Recharge Calculations

Infiltration Basin	Provided Volume (cf)
1	24351.27
Total Provided Recharge	24351.27
Total Required Recharge	3609.80

3.1.4 Standard 4: Water Quality

The Project has been designed to comply with Standard 4.

During construction of the project a comprehensive stormwater management system that includes; fiber rolls and silt-fence for slope and parameter control, a stabilized construction entrance to minimize off-site transport of sediment on to local roadways, inlet protection to prevent sediment from entering the existing roadway stormwater management system, and a dedicated concrete washout and containment area.

Following construction, permanent stormwater BMPs will include Vegetative Swales to minimize sediment transport, Sediment Forebays as pre-treatment, Riprap Aprons for outlet protection, and Stabilized Riprap Slopes to prevent potential future erosion. To control stormwater along the permanent access roads, a series of stone check dams and level spreaders will be installed.

Treatment Train

Swales → Forebays → Infiltration Basins → Overflow

Roles:

- Vegetated swales provide conveyance and initial filtration.
- Sediment forebays provide pretreatment and sediment capture.
- Infiltration basins provide primary water quality treatment and recharge.

Pretreatment is provided upstream of infiltration BMPs through sediment forebays and vegetated conveyance systems in accordance with MassDEP Stormwater Handbook guidance.

The Massachusetts Stormwater Handbook assigns an 80% TSS removal credit to infiltration basins. Additional guidance and literature sources indicate that infiltration systems may achieve higher removal efficiencies under favorable site conditions.

Computations and supporting information, including the Long-Term Pollution Prevention Plan, are included in Appendix D.

3.1.5 Standard 5: Land Uses and High Potential Pollutant Loads (LUHPPLs)

The proposed facility does not include industrial process areas or outdoor pollutant handling activities that would constitute a LUHPPL under the Massachusetts Stormwater Handbook. Operational areas are limited and supported by spill prevention and maintenance procedures intended to minimize pollutant exposure to stormwater. While the Project is not considered a LUHPPL it has been designed with suitable BMPs sized to treat the 1-inch Water Quality Volume and 44% TSS pretreatment prior to infiltration.

For computations and supporting information regarding the sizing of BMPs suitable for treatment of runoff, see Appendix E.

3.1.6 Standard 6: Critical Areas

The Project will discharge treated storm water flow through a treatment train where all storm water will be contained within a properly scaled infiltration basin based on a 72-hour total infiltration rate. In case of an emergency, the infiltration basis has been designed with a spillway that will direct any potential overspill to an area identified as a relatively flat, vegetated area that would promote overland sheet flow. There are no critical or sensitive (i.e wetlands) with or adjacent to the Project Site.

Proposed source controls and pollution prevention measures have been identified in the Long-Term Pollution Prevention Plan included in Appendix E.

3.1.7 Standard 7: Redevelopments and Other Projects Subject to the Standards only to the Maximum Extent Practicable

The Project has been designed to comply with all ten of the Stormwater Management Standards. Refer directly to each Standard for applicable computations and supporting information demonstrating compliance with each.

3.1.8 Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Controls

The Project will disturb more than one acre of land; however, the Project is exempt from the Environmental Protection Agency (EPA) National Pollutant Discharge Elimination System (NPDES) Construction General Permit to being associated with an Oil and Gas Activity. Although, not required, a Site-Specific Erosion and Sediment Control Plan has been developed to prevent off-site transport of sediment during construction activities. During construction of the project a comprehensive stormwater management system that includes; fiber rolls and silt-fence for slope, parameter control, and stormwater inlet protection if applicable, and stabilized construction entrances to minimize off-site transport of sediment on to local roadways, and a dedicated concrete washout and containment area. Recommended construction period pollution prevention and erosion and sedimentation controls are included in Appendix E.

3.1.9 Standard 9: Operation and Maintenance Plan

In compliance with Standard 9, a Post-Construction Stormwater Operation and Maintenance (O&M) Plan has been developed for the Project to ensure the long-term functionality of the proposed stormwater management system. Following construction, permanent stormwater BMPs

will include vegetated swales for conveyance and sediment reduction, sediment forebays for pretreatment and sediment capture, infiltration basins for recharge and water quality treatment, riprap aprons for outlet protection, and stabilized riprap slopes to minimize the potential for future erosion.

The O&M Plan establishes inspection frequencies, maintenance procedures, and responsible parties for all stormwater BMPs. Vegetated swales, infiltration basins, and stabilized overflow areas will be inspected at least semi-annually and following major storm events to identify erosion, sediment accumulation, vegetation loss, debris buildup, or evidence of impaired drainage. Sediment forebays will be inspected quarterly and cleaned when sediment accumulation reaches approximately 50 percent of the forebay storage depth or otherwise impairs pretreatment performance. Infiltration basins will also be monitored for standing water, and if ponded water remains for greater than 72 hours following a storm event, the system will be evaluated for potential clogging and corrective maintenance performed as necessary.

Maintenance activities may include sediment and debris removal, stabilization of eroded areas, restoration of vegetative cover, and repair or replacement of damaged stabilization materials. Stabilized overflow and riprap outlet areas will be inspected following overflow-producing storm events to confirm that erosion, scour, or sediment transport has not occurred. Access to all stormwater BMPs will be maintained to facilitate inspection and maintenance activities throughout the operational life of the Project.

The O&M Plan is included in Appendix E as part of the Long-Term Pollution Prevention Plan.

3.1.10 Standard 10: Prohibition of Illicit Discharges

The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges. A copy of the Long-term Pollution Prevention Plan is included in Appendix E

4 Local Municipal Rules and Regulations

As a FERC-regulated interstate natural gas pipeline, Algonquin Gas Transmission LLC's proposed Project facilities are not subject to review under local ordinances and bylaws.

5 FEMA Floodplain

The project site, located within the Massachusetts Military Reservation in the Town of Bourne, Massachusetts, is situated within Zone X (Area of Minimal Flood Hazard) as defined by the Federal Emergency Management Agency (FEMA) National Flood Hazard Layer (NFHL) mapping.

Based on review of the FEMA FIRMette (page 1), the mapped project location lies entirely outside of the 1-percent-annual-chance floodplain (100-year floodplain) and outside all Special Flood Hazard Areas (SFHAs), including Zones AE, VE, AO, and other high-risk flood zones. The map explicitly identifies the site as an “Area of Minimal Flood Hazard (Zone X)” .

- Zone X represents areas outside both the 1-percent-annual-chance and 0.2-percent-annual-chance floodplains, indicating a low probability of flooding. No regulatory floodways, coastal high hazard areas, or shallow flooding zones are mapped within or adjacent to the project area.

As shown on the aerial mapping (page 1), the site is located inland within a predominantly upland, forested and is not hydraulically connected to nearby mapped flood hazard areas.

Given that the project is located entirely within Zone X, no portion of the site is expected to be inundated during the 1-percent-annual-chance storm event, and the proposed work will not result in impacts to flood storage capacity, flood elevations, or flood conveyance.

Attachment A - Existing and Proposed Drainage Conditions

Existing Conditions



NOTES:

1. ALL CONTOUR LABELS AND ELEVATION CALLOUTS ARE IN FEET.
2. PROPOSED SITE BOUNDARY WAS PROVIDED BY ALGONQUIN 3RD PARTY CONSULTANT.
3. SUPPLEMENTAL TAX PARCEL DATA IS SHOWN FOR REFERENCE ONLY AND WAS OBTAINED FROM THE CAPE COD COMMISSION OPEN GIS DATA HUB WEBSITE.
4. PROPERTY CONVEYED TO ALGONQUIN GAS TRANSMISSION, LLC.
5. TOPOGRAPHIC SURVEY INFORMATION WAS PROVIDED BY ALGONQUIN GAS TRANSMISSION, LLC. ALL COORDINATES AND DISTANCES SHOWN HEREON ARE REFERENCED TO THE MASSACHUSETTS STATE PLANE COORDINATE SYSTEM, US FEET.ELEVATIONS ARE REFERENCED TO NAVD 88.
6. ADDITIONAL CONTOUR DATA WAS OBTAINED FROM 2022 USGS LIDAR POINT CLOUD DATA SETS.
7. THIS PROPERTY IS LOCATED IN ZONE X (AREA OF MINIMAL FLOOD HAZARD) AS DEPICTED ON FLOOD INSURANCE RATE MAP 25001C0318K DATED JULY 6, 2021.
8. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT NATURAL RESOURCE STUDY THE SITE IS NOT WITHIN THE NATURAL HERITAGE AND ENDANGERED SPECIES PROGRAM (NHESP), PRIORITY HABITATS OF RARE WILDLIFE, OR THE NHESP ESTIMATED HABITATS OF RARE WILDLIFE.
9. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THE SITE THERE IS NOT A WETLAND WITHIN 100 FEET OF THE PROJECT LIMITS.
10. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THE SITE IS NOT LOCATED WITHIN AN AREA OF CRITICAL ENVIRONMENTAL CONCERN.
11. THIS PLAN SET IS PRELIMINARY. FOR PERMITTING PURPOSES ONLY. THIS PLAN IS NOT INTENDED FOR CONSTRUCTION PURPOSES.

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
No. 58957
PROFESSIONAL ENGINEER
07/02/26

EXISTING CONDITIONS PLAN
PLAN VIEW
SCALE: 1" = 60'-0"
0 60' 120'
Scale: 1" = 60'

ISSUED FOR PERMIT
07/02/26

LEGEND

EXISTING MAJOR CONTOUR 70	EXISTING EASEMENT LINE	EXISTING FIRE HYDRANT
EXISTING MINOR CONTOUR 72	EXISTING GRAVEL TRAIL	
PROPOSED FACILITY IMPACT	EXISTING NATURAL GAS LINE GAS	
GIS TAX PARCELS	EXISTING WATER LINE W	
FACILITY ACCESS EASEMENT	EXISTING CHAINLINK FENCE	

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		C	07/02/26	CR	DT	ISSUED FOR PERMIT
		B	05/15/26	CR	DT	ISSUED FOR BID
		A	05/15/26	CR	DT	ISSUED FOR PERMIT

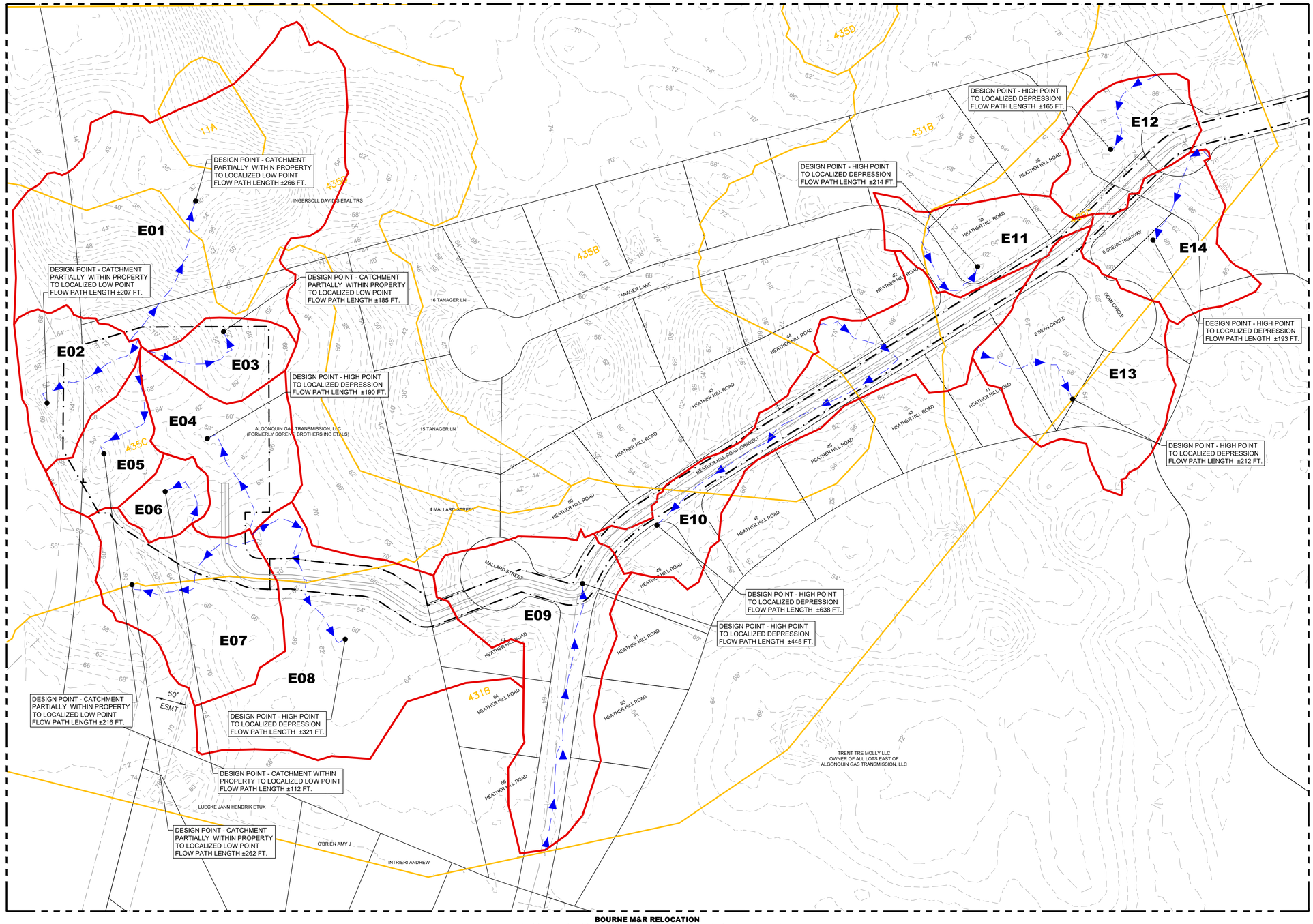
audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

DRAWN BY:	CR	05/15/26	CAPE COD CANAL PIPELINE RELOCATION PROJECT
DESIGN CHECKER:	AE	07/02/26	BOURNE M&R RELOCATION
DESIGN ENGINEER:	DT	07/02/26	M&R 00018
PROJECT MANAGER:	AC	07/02/26	TITLE: EXISTING CONDITIONS PLAN
TITLE	INITIALS	DATE	LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

ENBRIDGE
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

YEAR: 2026 | W.O.: | SCALE: AS NOTED | DWG.: 00018-C.320-0001 | REV.: C

S:\AE\Projects\Enbridge\Mass\026356-001\200_civil_structural\170_drawings\e&s plans\bourne m&r\00018-C.320-0001.dwg -- PLOT TIME: 7/2/2026 8:01 AM



N

23°6'42"

STATION NORTH

BOURNE M&R RELOCATION

EXISTING SUBCATCHMENT AREA PLAN

SCALE: 1" = 80'

0 80' 160'

Scale: 1" = 80'

NOTES:

1. ALL CONTOUR LABELS AND ELEVATION CALLOUTS ARE IN FEET.
2. PROPOSED SITE BOUNDARY WAS PROVIDED BY ALGONQUIN 3RD PARTY CONSULTANT.
3. SUPPLEMENTAL TAX PARCEL DATA IS SHOWN FOR REFERENCE ONLY AND WAS OBTAINED FROM THE CAPE COD COMMISSION OPEN GIS DATA HUB WEBSITE.
4. PROPERTY CONVEYED TO ALGONQUIN GAS TRANSMISSION, LLC.
5. TOPOGRAPHIC SURVEY INFORMATION WAS PROVIDED BY ALGONQUIN GAS TRANSMISSION, LLC. ALL COORDINATES AND DISTANCES SHOWN HEREON ARE REFERENCED TO THE MASSACHUSETTS STATE PLANE COORDINATE SYSTEM, US FEET.ELEVATIONS ARE REFERENCED TO NAVD 88.
6. ADDITIONAL CONTOUR DATA WAS OBTAINED FROM 2022 USGS LIDAR POINT CLOUD DATA SETS.
7. THIS PROPERTY IS LOCATED IN ZONE X (AREA OF MINIMAL FLOOD HAZARD) AS DEPICTED ON FLOOD INSURANCE RATE MAP 25001C0318K DATED JULY 6, 2021.
8. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT NATURAL RESOURCE STUDY THE SITE IS NOT WITHIN THE NATURAL HERITAGE AND ENDANGERED SPECIES PROGRAM (NHESP), PRIORITY HABITATS OF RARE WILDLIFE, OR THE NHESP ESTIMATED HABITATS OF RARE WILDLIFE.
9. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THE SITE THERE IS NOT A WETLAND WITHIN 100 FEET OF THE PROJECT LIMITS.
10. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THE SITE IS NOT LOCATED WITHIN AN AREA OF CRITICAL ENVIRONMENTAL CONCERN.
11. THIS PLAN SET IS PRELIMINARY. FOR PERMITTING PURPOSES ONLY. THIS PLAN IS NOT INTENDED FOR CONSTRUCTION PURPOSES.
12. TIME OF CONCENTRATION (TC) CALCULATIONS UTILIZED A 10-FOOT SHEET FLOW LENGTH FOR BOTH EXISTING AND PROPOSED CONDITIONS TO REPRESENT RUNOFF TRAVEL FROM THE ROADWAY CROWN TO THE ROADSIDE DITCH, AS THE PROPOSED IMPROVEMENTS ONLY MODIFY SURFACE CONDITIONS WITHIN THE IMMEDIATE ROADWAY CORRIDOR. FLOW WITHIN THE DITCH/SWALE SYSTEM WAS TREATED AS CONCENTRATED STORAGE FLOW RATHER THAN ADDITIONAL SHEET FLOW FOR TC CALCULATIONS.
13. REFER TO THE "EROSION & SEDIMENT GENERAL NOTES" (DWG. 00018-C.020-0001) FOR SOIL TYPES INFORMATION.

LEGEND

PROPOSED FENCE	EXISTING MAJOR CONTOUR
PROPERTY LINE	EXISTING MINOR CONTOUR
GIS TAX PARCELS	TIME OF CONCENTRATION LINE
SUBCATCHMENT AREA BOUNDARY	
NRCS SOIL BOUNDARY	
WORKSPACE LIMITS	
PROPOSED GRADE LIMITS	
EDGE OF ROAD	

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
No. 58957
PROFESSIONAL ENGINEER

07/02/26

ISSUED FOR PERMIT
07/02/26

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		C	07/02/26	CR	DT	ISSUED FOR PERMIT
		B	05/15/26	CR	DT	ISSUED FOR BID
		A	05/15/26	CR	DT	ISSUED FOR PERMIT

audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

DRAWN BY:	JA	05/15/26
DESIGN CHECKER:	AE	07/02/26
DESIGN ENGINEER:	DT	07/02/26
PROJECT MANAGER:	AC	07/02/26

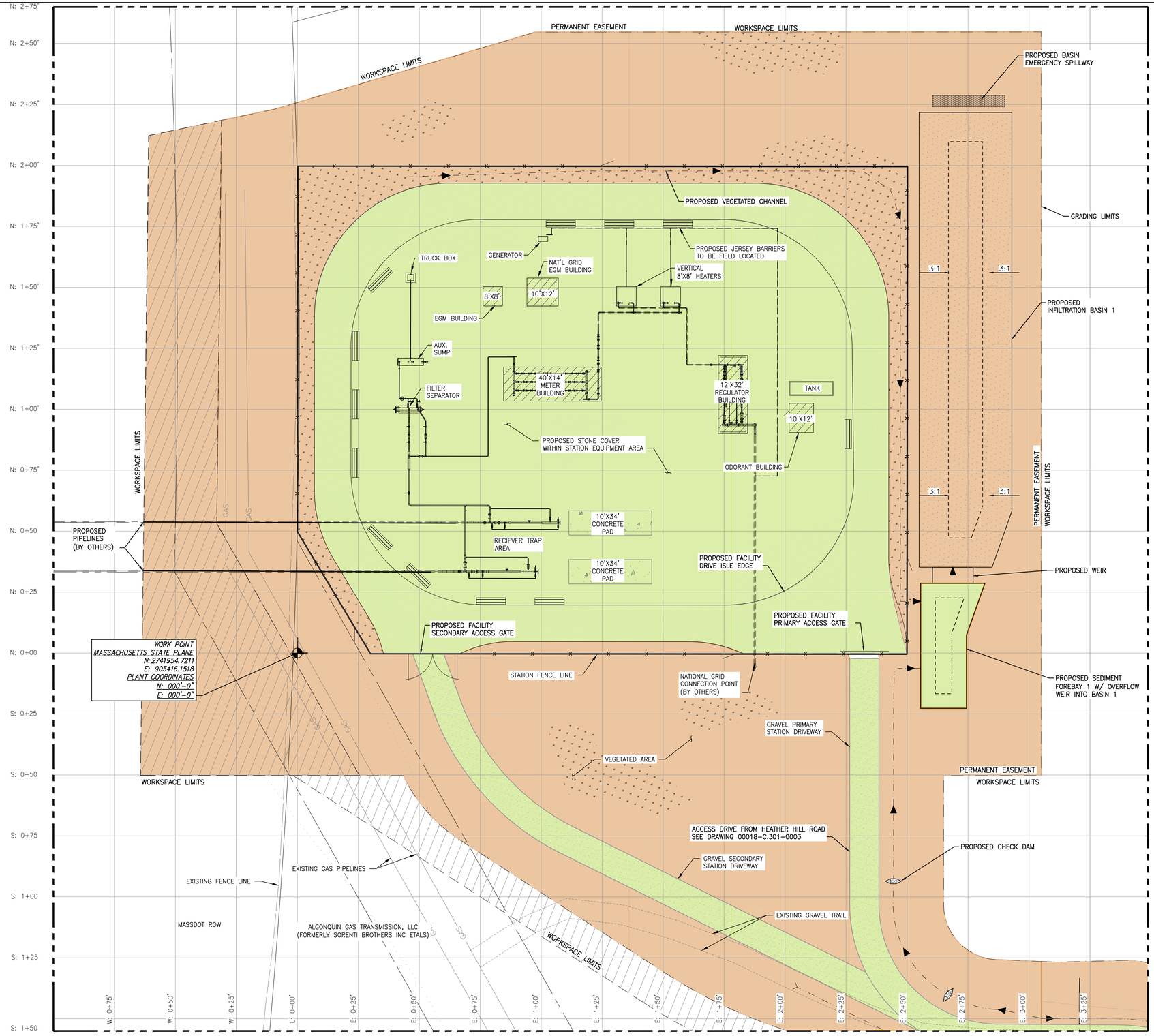
CAPE COD CANAL PIPELINE RELOCATION PROJECT
BOURNE M&R RELOCATION
M&R 00018
TITLE: EXISTING SUBCATCHMENT AREA PLAN
LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

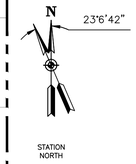
TITLE	INITIALS	DATE	YEAR:	W.O.:	SCALE:	DWG.:	REV.:
			2026		1"=80'	00018-C.320-0002	C

ENBRIDGE
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

S:\AE\Projects\Enbridge\Mass\026356-001\200_civil_structural\170_drawings\e&s plans\bourne m&r\00018-C.320-0002.dwg - PLOT TIME: 7/2/2026 8:14 AM

Proposed Conditions





NOTES:

1. ALL CONTOUR LABELS AND ELEVATION CALLOUTS ARE IN FEET.
2. PROPOSED SITE BOUNDARY WAS PROVIDED BY ALGONQUIN 3RD PARTY CONSULTANT.
3. SUPPLEMENTAL TAX PARCEL DATA IS SHOWN FOR REFERENCE ONLY AND WAS OBTAINED FROM THE CAPE COD COMMISSION OPEN GIS DATA HUB WEBSITE.
4. PROPERTY CONVEYED TO ALGONQUIN GAS TRANSMISSION, LLC.
5. TOPOGRAPHIC SURVEY INFORMATION WAS PROVIDED BY ALGONQUIN GAS TRANSMISSION, LLC. ALL COORDINATES AND DISTANCES SHOWN HEREON ARE REFERENCED TO THE MASSACHUSETTS STATE PLANE COORDINATE SYSTEM, US FEET. ELEVATIONS ARE REFERENCED TO NAVD 88.
6. ADDITIONAL CONTOUR DATA WAS OBTAINED FROM 2022 USGS LIDAR POINT CLOUD DATA SETS.
7. THIS PROPERTY IS LOCATED IN ZONE X (AREA OF MINIMAL FLOOD HAZARD) AS DEPICTED ON FLOOD INSURANCE RATE MAP 25001C0318K DATED JULY 6, 2021.
8. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT NATURAL RESOURCE STUDY THE SITE IS NOT WITHIN THE NATURAL HERITAGE AND ENDANGERED SPECIES PROGRAM (NHESP), PRIORITY HABITATS OF RARE WILDLIFE, OR THE NHESP ESTIMATED HABITATS OF RARE WILDLIFE.
9. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THE SITE THERE IS NOT A WETLAND WITHIN 100 FEET OF THE PROJECT LIMITS.
10. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THE SITE IS NOT LOCATED WITHIN AN AREA OF CRITICAL ENVIRONMENTAL CONCERN.
11. THIS PLAN SET IS PRELIMINARY. FOR PERMITTING PURPOSES ONLY. THIS PLAN IS NOT INTENDED FOR CONSTRUCTION PURPOSES.

PLANT GRID NOTES:

1. BEARING PLANT GRID LINES ARE AS FOLLOWS:
   - 1.1. N–S GRID LINE: N23°06'42.0"E
   - 1.2. E–W GRID LINE: S66°53'18.0"E

LEGEND

PROPOSED ACCESS ROAD
PROPOSED CONCRETE
PROPOSED STRUCTURE
PROPOSED ROCK (FACILITY)
EXISTING GAS LINE
PROPOSED FENCE
PERMANENT EASEMENT
LIMITS OF GRADING
EXISTING TRAIL
PROPOSED VEGETATED
PROPOSED INFILTRATION BASIN
PROPOSED SEDIMENT FOREBAY
WORKSPACE LIMITS
INFILTRATION >2.4"/HR
PROPOSED FLOW LLINE
PROPOSED EMERGENCY SPILLWAY
PROPOSED WEIR
PROPOSED ROCK CHECK DAM
TOP OF SLOPE
INFILTRATION <2.4"/HR

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
00018-C.301-0002	GRADING PLAN	C	07/02/26	CR	DT	ISSUED FOR PERMIT
00018-C.301-0003	CIVIL GRADING PLAN ACCESS ROAD	B	05/15/26	CR	DT	ISSUED FOR BID
00018-C.301-0004	CIVIL GRADING SECTIONS	A	05/15/26	CR	DT	ISSUED FOR PERMIT

audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

DRAWN BY:	CR	05/15/26	CAPE COD CANAL PIPELINE RELOCATION PROJECT
DESIGN CHECKER:	DT	07/02/26	BOURNE M&R RELOCATION
DESIGN ENGINEER:	PB	07/02/26	M&R 00018
PROJECT MANAGER:	AC	07/02/26	TITLE: PROPOSED SITE LAYOUT PLAN
TITLE	INITIALS	DATE	

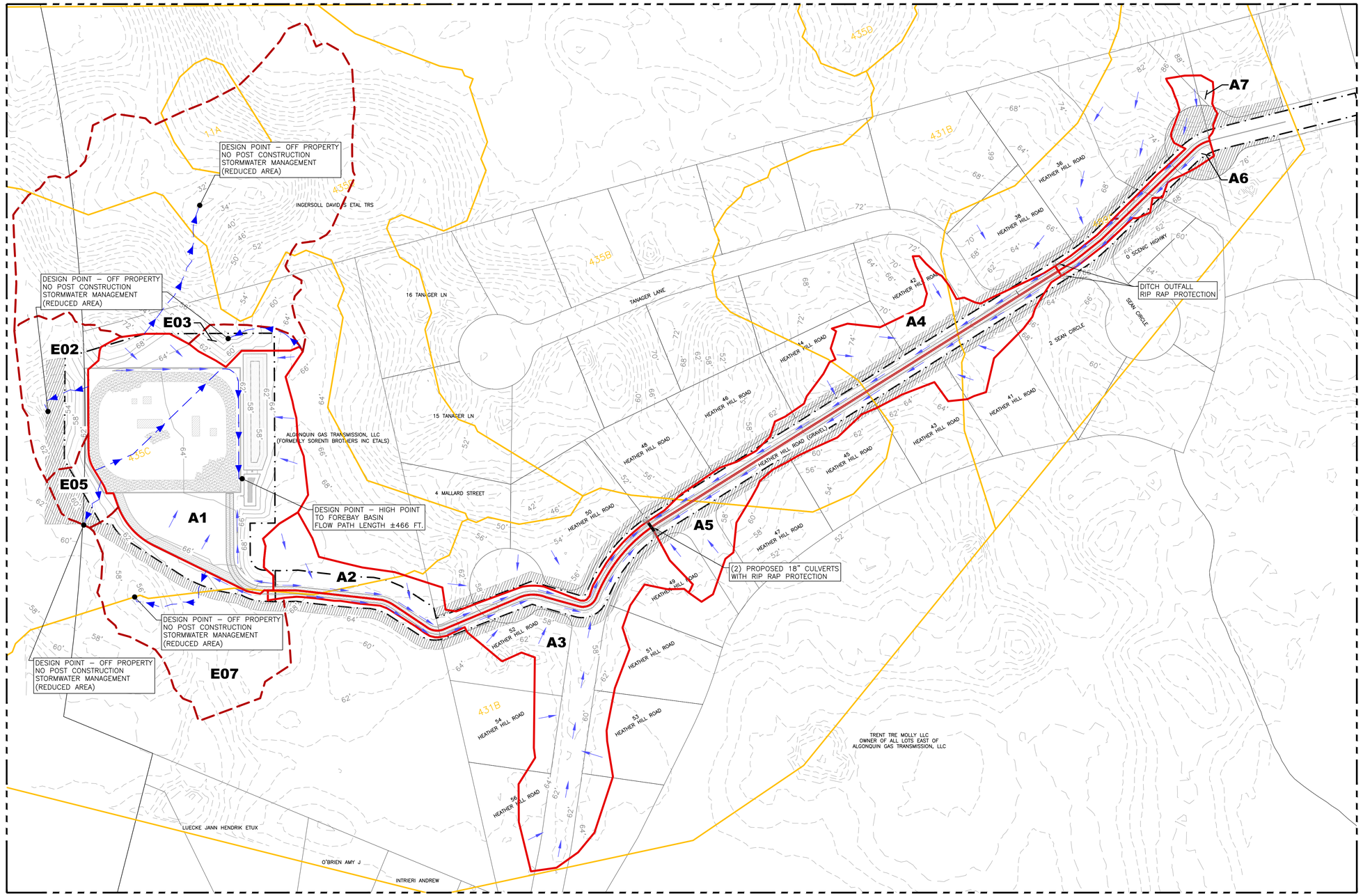
YEAR: 2026 | W.O.: | SCALE: AS NOTED | DWG.: 00018-C.320-0003 | REV.: C

ENBRIDGE
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
58957
PROFESSIONAL ENGINEER
07/02/26

ISSUED FOR PERMIT
07/02/26

S:\AE\Projects\Enbridge\Mass\026356-001\200_Civil_Structural\170_Drawings\E&S Plans\Bourne M&R\00018-C.320-0003.dwg – PLOT TIME: 7/2/2026 12:39 PM



N

23°6'42"

STATION NORTH

NOTES:

1. ALL CONTOUR LABELS AND ELEVATION CALLOUTS ARE IN FEET.
2. PROPOSED SITE BOUNDARY WAS PROVIDED BY ALGONQUIN 3RD PARTY CONSULTANT.
3. SUPPLEMENTAL TAX PARCEL DATA IS SHOWN FOR REFERENCE ONLY AND WAS OBTAINED FROM THE CAPE COD COMMISSION OPEN GIS DATA HUB WEBSITE.
4. PROPERTY CONVEYED TO ALGONQUIN GAS TRANSMISSION, LLC.
5. TOPOGRAPHIC SURVEY INFORMATION WAS PROVIDED BY ALGONQUIN GAS TRANSMISSION, LLC. ALL COORDINATES AND DISTANCES SHOWN HEREON ARE REFERENCED TO THE MASSACHUSETTS STATE PLANE COORDINATE SYSTEM, US FEET. ELEVATIONS ARE REFERENCED TO NAVD 88.
6. CONTOUR DATA SHOWN IS BASED ON THE TOPOGRAPHIC SURVEY REFERENCED ABOVE. ADDITIONAL CONTOUR DATA WAS OBTAINED FROM 2022 USGS LIDAR POINT CLOUD DATA SETS.
7. THIS PROPERTY IS LOCATED IN ZONE X (AREA OF MINIMAL FLOOD HAZARD) AS DEPICTED ON FLOOD INSURANCE RATE MAP 25001C0318K DATED JULY 6, 2021.
8. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT NATURAL RESOURCE STUDY THE SITE IS NOT WITHIN THE NATURAL HERITAGE AND ENDANGERED SPECIES PROGRAM (NHESP), PRIORITY HABITATS OF RARE WILDLIFE, OR THE NHESP ESTIMATED HABITATS OF RARE WILDLIFE.
9. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THE SITE THERE IS NOT A WETLAND WITHIN 100 FEET OF THE PROJECT LIMITS.
10. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THE SITE IS NOT LOCATED WITHIN AN AREA OF CRITICAL ENVIRONMENTAL CONCERN.
11. THIS PLAN SET IS PRELIMINARY. FOR PERMITTING PURPOSES ONLY. PROPOSED GRADING MAY BE FURTHER OPTIMIZED TO ENSURE PROPER SHEET FLOW AROUND ASSUMED BUILDING LOCATIONS, FOUNDATIONS, AND MECHANICAL EQUIPMENT. THIS PLAN IS NOT INTENDED FOR CONSTRUCTION PURPOSES.
12. REFER TO THE "EROSION & SEDIMENT GENERAL NOTES" (DWG. 00018–C.020–0001) FOR SOIL TYPES INFORMATION.

LEGEND

- PROPOSED ACCESS ROAD
- PROPOSED CONCRETE
- PROPOSED STRUCTURE
- PROPOSED ROCK (FACILITY)
- PROPOSED INFILTRATION BASIN
- PROPOSED SEDIMENT FOREBAY
- WORKSPACE
- PROPOSED BUILDING
- PROPOSED GRADE LIMITS
- EDGE OF ROAD
- PROPERTY LINE
- GIS TAX PARCELS
- NRCS SOIL BOUNDARY
- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- PROPOSED DRAINAGE AREAS
- DRAINAGE FLOW ARROW
- TIME OF CONCENTRATION LINE

BOURNE M&R RELOCATION

PROPOSED SUBCATCHMENT AREA PLAN

SCALE: 1" = 80'

0 80' 160'
Scale: 1" = 80'

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
No. 58957
PROFESSIONAL ENGINEER

07/02/26

ISSUED FOR PERMIT
07/02/26

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		C	07/02/26	CR	DT	ISSUED FOR PERMIT
		B	05/15/26	CR	DT	ISSUED FOR BID
		A	05/15/26	CR	PB	ISSUED FOR PERMIT

audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

DRAWN BY:	CR	05/15/26	CAPE COD CANAL PIPELINE RELOCATION PROJECT
DESIGN CHECKER:	AE	07/02/26	BOURNE M&R RELOCATION
DESIGN ENGINEER:	PB	07/02/26	M&R 00018
PROJECT MANAGER:	AC	07/02/26	TITLE: PROPOSED SUBCATCHMENT AREA PLAN
TITLE	INITIALS	DATE	LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

YEAR: 2026 | W.O.: | SCALE: 1"=80' | DWG.: 00018–C.320–0005 | REV.: C

ENBRIDGE
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

S:\AE\Projects\Enbridge\Mass\026356-001\200_Civil_Structural\170_Drawings\E&S Plans\Bourne M&R\00018-C.320-0005.dwg – PLOT TIME: 7/2/2026 9:16 AM

Attachment B - Standard 1 Supporting Information

Grass Swales

Sediment Forebays

Infiltration Basin

Level Spreader

Check Dam

Grassed Channel



Description

Grassed Channels are treatment systems with a longer hydraulic residence time than drainage channels. The removal mechanisms are sedimentation and gravity separation, rather than filtration. To receive TSS credit, a sediment forebay or equivalent must be provided for pretreatment. Note that the sediment forebay does not receive a separate TSS removal credit.

Ability to Meet Massachusetts Stormwater Management Standards

Standard	Description
2 - Peak Flow	N/A
3 - Recharge	No infiltration credit
4 - TSS Removal	50% TSS with adequate pretreatment
5 - Higher Pollutant Loading	N/A
6 - Discharges near or to Critical Areas	Not suitable for vernal pools or bathing beaches. At other critical areas, may be used as a pretreatment device.
7 - Redevelopment	Typically not suited for retrofits.

Advantages/Benefits

- Provides pretreatment if used as the first part of a treatment train.
- Open drainage system aids maintenance
- Accepts sheet or pipe flow
- Compatible with LID design measures.
- Little or no entrapment hazard for amphibians or other small animals
- Disadvantages/Limitations
- Short retention time does not allow for full gravity separation
- Limited biofiltration provided by grass lining.
- Cannot alone achieve 80% TSS removal
- Must be designed carefully to achieve low flow rates for Water Quality Volume purposes (<1.0 fps)
- Mosquito control considerations
- Pollutant Removal Efficiencies
- Total Suspended Solids (TSS) 50%[1] for Regulatory Purposes (47%)[2]
- Total phosphorus (TP) -121%[2]
- Total Nitrogen Insufficient Data
- Metals (copper, lead, zinc, cadmium) insufficient Data
- Pathogens (coliform, e. coli) Insufficient Data

Maintenance

Activity	Frequency
Remove sediment from forebay	Annually
Remove sediment from grass channel	Annually
Mow	Once a month during growing season
Repair areas of erosion and revegetate	As needed, but no less than once a year

Special Features

Reduces volume and rate of runoff.

Maintenance

Access

Maintenance access must be designed as part of the grass channel. If located adjacent to a roadway, make the maintenance access at least 15 feet wide, which can also be combined with a breakdown lane along a highway or on- street parking along a residential street. When combined

with on-street parking, post signs prohibiting parking when the swale is to be inspected and cleaned. Do not use travel lanes along highways and streets as the required maintenance access.

Mowing

Set the mower blades no lower than 3 to 4 inches above the ground. Do not mow beneath the depth of the design flow during the storm associated with the water quality event (e.g., if the design flow is no more than 4 inches, do not cut the grass shorter than 4 inches). Mow on an as-needed basis during the growing season so that the grass height does not exceed 6 inches. Inspection: Inspect semi-annually the first year, and at least once a year thereafter. Inspect the grass for growth and the side slopes for signs of erosion and formation of rills and gullies. Plant an alternative grass species if the original grass cover is not successfully established. If grass growth is impaired by winter road salt or other deicer use, re-establish the grass in the spring. Trash/Debris Removal: Remove accumulated trash and debris prior to mowing.

Sediment Removal

Check on a yearly basis and clean as needed. Use hand methods (i.e., a person with a shovel) when cleaning to minimize disturbance to vegetation and underlying soils. Sediment build-up in the grass channel reduces its capacity to treat and convey the water quality event, 2-year and 10-year 24-hour storm.

Sediment Forebays



Description

A sediment forebay is a post-construction practice consisting of an excavated pit, bermed area, or cast structure combined with a weir, designed to slow incoming stormwater runoff and facilitating the gravity separation of suspended solids. This practice is different from a sediment trap used as a construction period BMP.

Ability to Meet Massachusetts Stormwater Management Standards

Standard	Description
2 - Peak Flow	Provides no peak flow attenuation
3 - Recharge	Provides no groundwater recharge
4 - TSS Removal	MassDEP requires a sediment forebay as pretreatment before stormwater is discharged to an extended dry detention basin, wet basin, constructed stormwater wetland or infiltration basin. No separate credit is given for the sediment forebay. For example, extended dry detention basins with sediment forebays receive a credit for 50% TSS removal. Wet basins and constructed stormwater wetlands with sediment forebays receive a credit for 80% TSS removal. When they provide pretreatment for other BMPs, sediment forebays receive a 25% TSS removal credit.
5 - Higher Pollutant Loading	Recommended as a pretreatment BMP
6 - Discharges near or to Critical Areas	Recommended as a pretreatment BMP
7 - Redevelopment	Usually not suitable due to land use constraints

Advantages/Benefits

- Provides pretreatment of runoff before delivery to other BMPs.
- Slows velocities of incoming stormwater.
- Easily accessed for sediment removal.
- Longevity is high with proper maintenance.
- Relatively inexpensive compared to other BMPs.
- Greater detention time than proprietary separators.
- Disadvantages/Limitations
- Removes only coarse sediment fractions.
- No removal of soluble pollutants.
- Provides no recharge to groundwater.
- No control of the volume of runoff.
- Frequent maintenance is essential.
- Pollutant Removal Efficiencies
- Total Suspended Solids (TSS) - 25%.
- Nutrients (Nitrogen, phosphorus) - Insufficient data.
- Metals (copper, lead, zinc, cadmium) - Insufficient data.
- Pathogens (coliform, e coli) - Insufficient data

Maintenance

Sediments and associated pollutants are removed only when sediment forebays are actually cleaned out, so regular maintenance is essential. Frequently removing accumulated sediments will make it less likely that sediments will be resuspended. At a minimum, inspect sediment forebays monthly and clean them out at least four times per year. Stabilize the floor and sidewalls of the sediment forebay before making it operational, otherwise the practice will discharge excess amounts of suspended sediments. When mowing grasses, keep the grass height no greater than 6 inches. Set mower blades no lower than 3 to 4 inches. Check for signs of rilling and gullying and repair as needed. After removing the sediment, replace any vegetation damaged during the clean-out by either reseeding or re-sodding. When reseeding, incorporate practices such as hydroseeding with a tackifier, blanket, or similar practice to ensure that no scour occurs in the forebay, while the seeds germinate and develop roots.

Activity	Frequency
Inspect sediment forebays	Monthly
Clean sediment forebays	Four times per year and when sediment depth is between 3 to 6 feet.

Infiltration-Recharge Basins

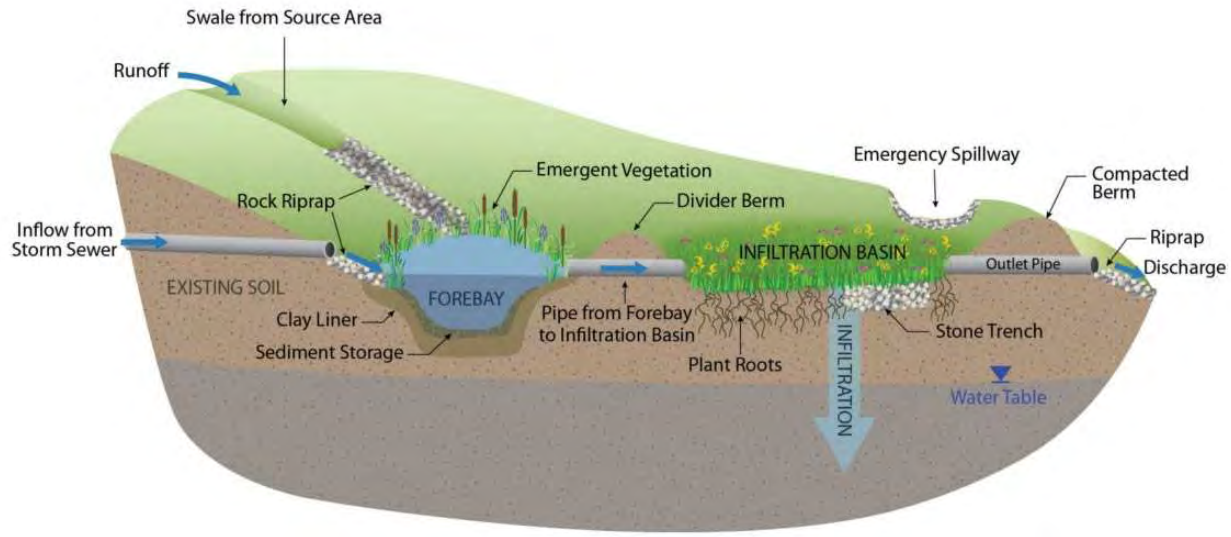


Illustration by Geosyntec Consultants, Inc.

Description

Recharge basins temporarily store runoff, but release at least a portion of that runoff by infiltrating the water into the ground. The recharge volume is stored and allowed to infiltrate into the underlying soils over a period of time following a storm event. The storage volume above this level may be released by an outlet structure designed to bypass all excess flows. Recharge Basins may be designed on-line or off-line. To maintain proper function of an infiltration-recharge basin, it is important to avoid soil compaction.

General Information		
Applicable DEP Stormwater Management Policy Performance Standards	Standards #3 and #4.	
TSS Removal	DEP Credit:	80% (for infiltration basin)
	Estimated Range from Literature:	>90%
Relative Cost	Construction: Moderate to high; varies depending on types soils of contributing drainage area, soils at site of system, storage depth, and type of outlet structure	

	Maintenance: Moderate to high
Potential Constraints to Use	Depth to groundwater Depth to bedrock or other impermeable stratum Suitability of site soils for infiltration
Other Considerations	Pre-treatment must be provided, to prevent clogging of soils surface by sediments in the influent storm water. Frequent maintenance may be required, to remove accumulated sediment and restore infiltrative capacity. Recharge systems can provide high levels of treatment of other pollutants, in addition to TSS removal.
Maintenance Requirements	Inspect a minimum of twice annually. Periodic mowing of embankments Removal of woody vegetation from embankments Removal of debris from outlet structures Clean forebay as required. Clean basin of accumulated sediment as required. Clean flow control structures at least once annually, or as indicated by inspection. Maintain vegetation in healthy condition.

Several of the design criteria regarding setbacks from slopes, foundations, and other site features have been adapted from the requirements for on-site sewage disposal systems described in Massachusetts Title 5 (310 CMR 15.000). However, storm water quantities and flow durations differ markedly from the hydraulic loadings to septic systems. The design engineer should be aware of these differences and may need to consider additional setbacks to provide for slope stability, protect structures, and provide for the satisfactory performance of the recharge system.

LEVEL SPREADER

A level spreader is an excavated depression constructed at zero percent grade across a slope. The level spreader changes concentrated flow into sheet flow and then outlets it onto stable areas without causing erosion. It allows concentrated runoff to be discharged at non-erosive velocities onto natural or man-made areas that have existing vegetation capable of preventing erosion. An example would be at the outlet of a diversion or a waterway.



Where Practice Applies

- Where it can be constructed on undisturbed soils and a level lip can be installed without filling.
- Where the area directly below the spreader is stabilized by existing vegetation.
- Where water will not re-concentrate immediately below the spreader, and water can be released in sheet flow down a stabilized slope without causing erosion.
- Where there is at least 100 feet of vegetated area between the spreader and surface waters.
- Where the area below the spreader lip is uniform with a slope of 10 percent or less and is stable for anticipated flow conditions.
- Where there will be no traffic over the spreader.

Advantages

Level spreaders are relatively low cost structures designed to release small volumes of water safely. Level spreaders disperse the energy of concentrated flows, reducing erosion potential and encouraging sedimentation.

Maintenance

- The level spreader should be checked periodically and after every major storm.
- Any detrimental sediment accumulation should be removed.
- If rilling has taken place on the lip, the damage should be repaired and re-vegetated.
- Vegetation should be mowed occasionally to control weeds and encroachment of woody vegetation. Clippings should be removed and disposed of outside the spreader and away from the outlet area.
- Fertilization should be done as necessary to keep the vegetation healthy and dense.
- The spreader should be inspected after every runoff event to ensure that it is functioning correctly.

Check Dam



A check dam is a small dam constructed across a drainage ditch, swale, or channel to lower the velocity of flow. Reduced runoff velocity reduces erosion and gullying in the channel and allows sediments to settle out. A check dam may be built from stone, sandbags filled with pea gravel, or logs.

Applicability

Check dams can be used where temporary channels or permanent channels are not yet vegetated, channel lining is infeasible and velocity checks are required. This practice may be used as a temporary or emergency measure to limit erosion by reducing flow in small open channels. This practice should be used with drainage areas of 2 acres or less. Check dams may be used:

- To reduce flow in small temporary channels that are presently undergoing degradation,
- Where permanent stabilization is impractical due to the temporary nature of the problem,
- To reduce flow in small eroding channels where construction delays or weather conditions prevent timely installation of non-erosive liners.

Advantages

- Inexpensive and easy to install.
- Reduce velocity and may provide aeration of the water.
- Check dams prevent gully erosion from occurring before vegetation is established, and also cause a high proportion of the sediment load in runoff to settle out.
- In some cases, if carefully located and designed, these check dams can remain as permanent installations with very minor regrading, etc.
- They may be left as either spillways, in which case accumulated sediment would be graded and seeded, or as check dams to capture sediment coming off that site.

Maintenance

- Inspect after each rainfall event.
- Remove sediment accumulations.

Check structure and abutments for erosion, piping, or rock displacement. Repair immediately

Attachment C - Standard 2 Supporting Information

NOAA Altas Rainfall Data

SSA Analysis: Existing and Proposed Conditions – Drainage Area A1

SSA Analysis: Existing and Proposed Conditions – Drainage Area A2

SSA Analysis: Existing and Proposed Conditions – Drainage Area A3

SSA Analysis: Existing and Proposed Conditions – Drainage Area A4

NOAA ATLAS RAINFALL DATA

NOAA Atlas 14, Volume 10, Version 3
Location name: Buzzards Bay, Massachusetts, USA*
Latitude: 41.7685°, Longitude: -70.5859°
Elevation: 62 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sandra Pavlovic, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Orlan Wilhite

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.291** (0.237-0.355)	**0.362** (0.295-0.442)	**0.478** (0.388-0.585)	**0.574** (0.462-0.705)	**0.707** (0.552-0.902)	**0.806** (0.617-1.05)	**0.912** (0.679-1.22)	**1.04** (0.725-1.40)	**1.22** (0.822-1.69)	**1.38** (0.906-1.94)
10-min	**0.412** (0.336-0.502)	**0.513** (0.417-0.626)	**0.678** (0.551-0.830)	**0.814** (0.656-1.00)	**1.00** (0.783-1.28)	**1.14** (0.874-1.48)	**1.29** (0.963-1.73)	**1.47** (1.03-1.98)	**1.73** (1.16-2.40)	**1.96** (1.28-2.74)
15-min	**0.485** (0.395-0.591)	**0.603** (0.491-0.736)	**0.797** (0.647-0.975)	**0.958** (0.772-1.18)	**1.18** (0.921-1.50)	**1.34** (1.03-1.74)	**1.52** (1.13-2.04)	**1.73** (1.21-2.33)	**2.04** (1.37-2.82)	**2.30** (1.51-3.23)
30-min	**0.698** (0.569-0.851)	**0.868** (0.706-1.06)	**1.14** (0.929-1.40)	**1.37** (1.11-1.69)	**1.69** (1.32-2.16)	**1.92** (1.47-2.50)	**2.18** (1.62-2.92)	**2.48** (1.73-3.34)	**2.92** (1.96-4.04)	**3.30** (2.16-4.63)
60-min	**0.912** (0.743-1.11)	**1.13** (0.921-1.38)	**1.49** (1.21-1.82)	**1.79** (1.44-2.20)	**2.20** (1.72-2.81)	**2.51** (1.92-3.25)	**2.84** (2.11-3.80)	**3.22** (2.25-4.34)	**3.81** (2.56-5.26)	**4.30** (2.82-6.03)
2-hr	**1.23** (1.01-1.49)	**1.53** (1.26-1.86)	**2.02** (1.65-2.45)	**2.43** (1.97-2.96)	**2.99** (2.35-3.78)	**3.40** (2.63-4.39)	**3.85** (2.90-5.13)	**4.39** (3.09-5.86)	**5.21** (3.54-7.14)	**5.92** (3.92-8.22)
3-hr	**1.45** (1.20-1.75)	**1.80** (1.48-2.17)	**2.36** (1.94-2.86)	**2.83** (2.31-3.44)	**3.48** (2.75-4.39)	**3.96** (3.08-5.08)	**4.48** (3.39-5.94)	**5.10** (3.62-6.78)	**6.06** (4.13-8.24)	**6.87** (4.58-9.49)
6-hr	**1.90** (1.57-2.27)	**2.31** (1.92-2.77)	**2.99** (2.47-3.59)	**3.55** (2.92-4.28)	**4.33** (3.45-5.41)	**4.90** (3.83-6.23)	**5.52** (4.21-7.24)	**6.26** (4.48-8.23)	**7.36** (5.07-9.92)	**8.29** (5.59-11.3)
12-hr	**2.40** (2.01-2.86)	**2.87** (2.40-3.42)	**3.63** (3.02-4.33)	**4.26** (3.53-5.11)	**5.13** (4.12-6.35)	**5.79** (4.55-7.26)	**6.47** (4.95-8.36)	**7.26** (5.25-9.46)	**8.40** (5.85-11.2)	**9.33** (6.36-12.6)
24-hr	**2.90** (2.44-3.42)	**3.42** (2.88-4.05)	**4.29** (3.59-5.08)	**5.00** (4.16-5.94)	**5.98** (4.83-7.33)	**6.73** (5.32-8.35)	**7.50** (5.76-9.55)	**8.35** (6.11-10.8)	**9.55** (6.73-12.6)	**10.5** (7.24-14.1)
2-day	**3.34** (2.83-3.92)	**3.95** (3.35-4.64)	**4.95** (4.18-5.82)	**5.78** (4.85-6.82)	**6.92** (5.63-8.40)	**7.78** (6.20-9.58)	**8.67** (6.72-10.9)	**9.65** (7.13-12.3)	**11.0** (7.85-14.4)	**12.1** (8.44-16.1)
3-day	**3.67** (3.12-4.29)	**4.31** (3.66-5.04)	**5.36** (4.54-6.28)	**6.23** (5.24-7.32)	**7.42** (6.06-8.96)	**8.33** (6.67-10.2)	**9.26** (7.21-11.6)	**10.3** (7.64-13.1)	**11.7** (8.38-15.2)	**12.8** (8.98-16.9)
4-day	**3.96** (3.38-4.61)	**4.61** (3.93-5.37)	**5.68** (4.82-6.63)	**6.57** (5.55-7.70)	**7.79** (6.38-9.37)	**8.72** (7.00-10.6)	**9.67** (7.54-12.1)	**10.7** (7.98-13.5)	**12.1** (8.71-15.7)	**13.2** (9.30-17.4)
7-day	**4.70** (4.04-5.45)	**5.38** (4.61-6.24)	**6.49** (5.55-7.54)	**7.41** (6.30-8.64)	**8.68** (7.15-10.4)	**9.65** (7.80-11.7)	**10.6** (8.33-13.1)	**11.6** (8.77-14.6)	**13.0** (9.46-16.7)	**14.1** (9.98-18.3)
10-day	**5.40** (4.64-6.22)	**6.10** (5.25-7.04)	**7.25** (6.22-8.38)	**8.20** (7.00-9.52)	**9.52** (7.87-11.3)	**10.5** (8.54-12.6)	**11.5** (9.07-14.1)	**12.6** (9.51-15.7)	**13.9** (10.2-17.8)	**14.9** (10.6-19.3)
20-day	**7.44** (6.46-8.52)	**8.24** (7.14-9.44)	**9.54** (8.24-11.0)	**10.6** (9.13-12.2)	**12.1** (10.1-14.2)	**13.3** (10.8-15.8)	**14.4** (11.4-17.4)	**15.5** (11.9-19.2)	**16.8** (12.4-21.3)	**17.8** (12.8-22.8)
30-day	**9.17** (7.98-10.5)	**10.0** (8.74-11.5)	**11.5** (9.96-13.1)	**12.7** (10.9-14.5)	**14.3** (12.0-16.7)	**15.6** (12.8-18.4)	**16.8** (13.4-20.2)	**18.0** (13.9-22.1)	**19.4** (14.4-24.3)	**20.3** (14.8-25.9)
45-day	**11.3** (9.93-12.9)	**12.3** (10.8-14.0)	**13.9** (12.1-15.9)	**15.3** (13.2-17.4)	**17.1** (14.4-19.8)	**18.5** (15.3-21.7)	**19.9** (15.9-23.7)	**21.1** (16.4-25.8)	**22.5** (16.9-28.2)	**23.5** (17.2-29.7)
60-day	**13.2** (11.6-14.9)	**14.3** (12.5-16.2)	**16.0** (14.0-18.2)	**17.4** (15.2-19.9)	**19.4** (16.4-22.5)	**21.0** (17.4-24.5)	**22.5** (18.0-26.6)	**23.7** (18.5-28.9)	**25.2** (19.0-31.4)	**26.1** (19.2-33.0)

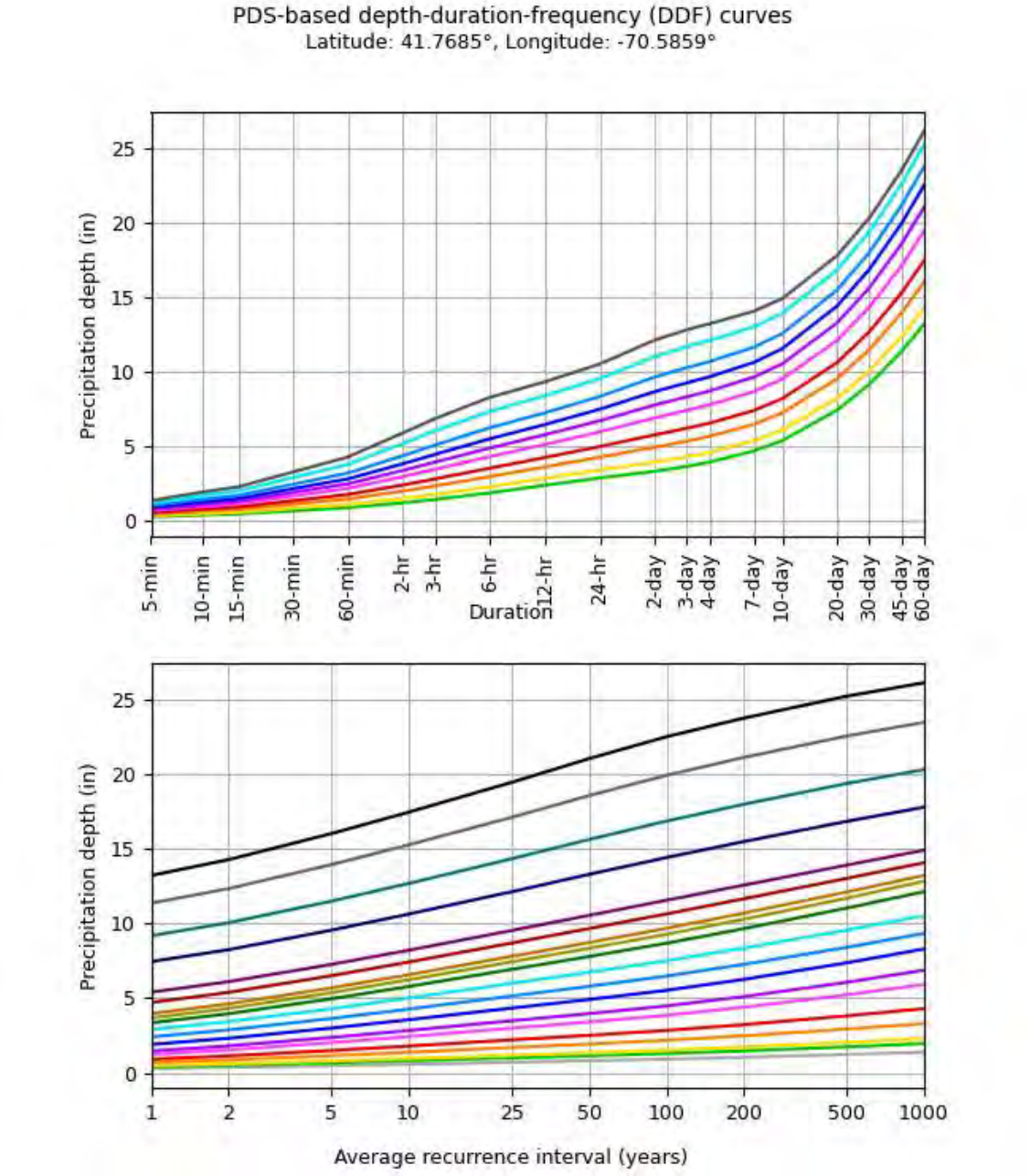
[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

Back to Top

PF graphical



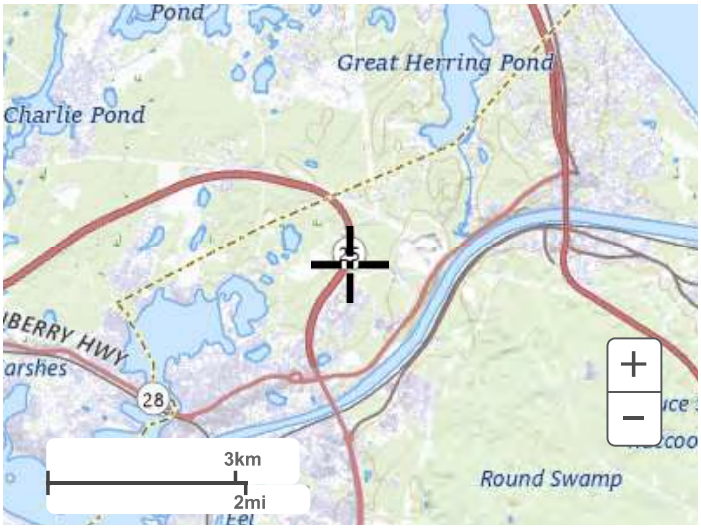
NOAA Atlas 14, Volume 10, Version 3

Created (GMT): Tue Apr 21 16:26:15 2026

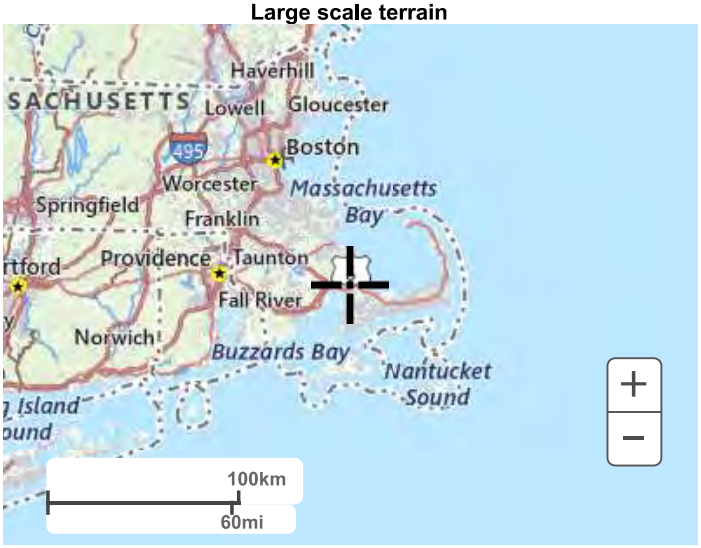
Back to Top

Maps & aerials

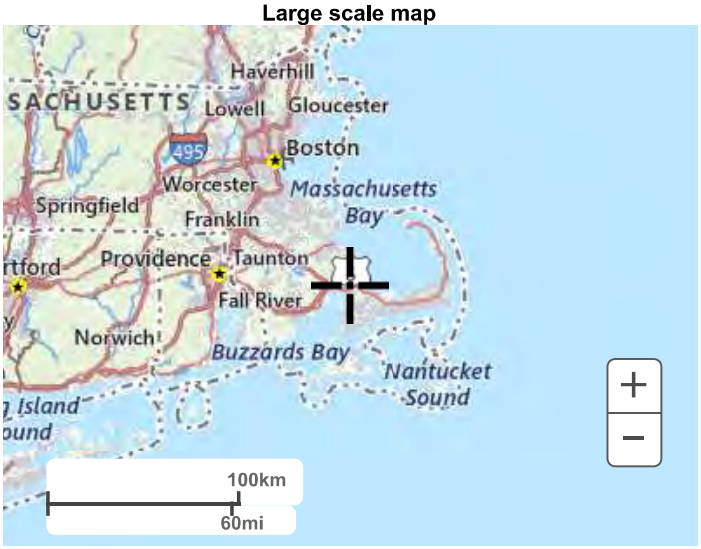
Small scale terrain



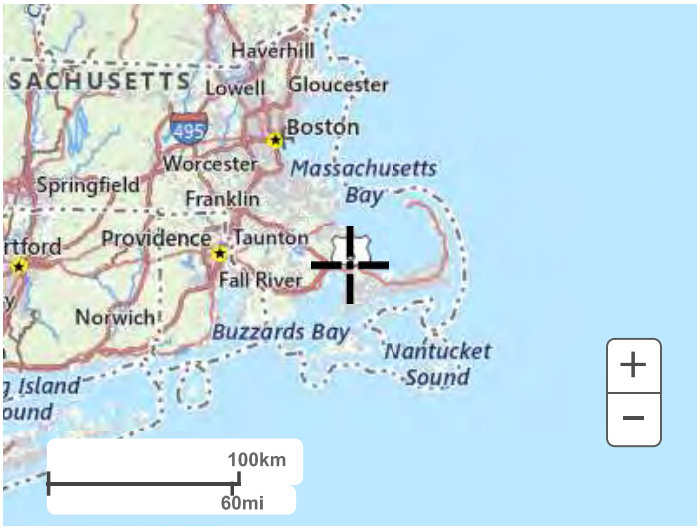
Large scale terrain



Large scale map



Large scale aerial



Back to Top

US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer

SSA Analysis – Drainage Area A1 – Existing and Proposed

Project Description

File Name ..... Bourne MyR_A1.SPF

Project Options

Flow Units ..... CFS
Elevation Type ..... Elevation
Hydrology Method ..... SCS TR-20
Time of Concentration (TOC) Method ..... SCS TR-55
Link Routing Method ..... Hydrodynamic
Enable Overflow Ponding at Nodes ..... YES
Skip Steady State Analysis Time Periods ..... NO

Analysis Options

Start Analysis On ..... oct. 14, 2021 0:00:00
End Analysis On ..... oct. 17, 2021 0:00:00
Start Reporting On ..... oct. 14, 2021 0:00:00
Antecedent Dry Days ..... 0 days
Runoff (Dry Weather) Time Step ..... 0 01:00:00 days hh:mm:ss
Runoff (Wet Weather) Time Step ..... 0 00:05:00 days hh:mm:ss
Reporting Time Step ..... 0 00:05:00 days hh:mm:ss
Routing Time Step ..... 30 seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	3
Nodes	4
Junctions	0
Outfalls	2
Flow Diversions	0
Inlets	0
Storage Nodes	2
Links	2
Channels	0
Pipes	0
Pumps	0
Orifices	0
Weirs	2
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	2 years	Intensity	inches	Massachusetts	None	2.00	3.42	SCS Type III 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Sub-03.1	0.16	484.00	43.00	3.42	0.00	0.00	0.00	0 00:23:46
2	Sub-A1	2.47	484.00	61.66	3.42	0.56	1.39	1.11	0 00:07:21
3	Sub-E03	0.48	484.00	43.00	3.42	0.04	0.02	0.00	0 00:23:49

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Out-A1	Outfall	62.00					0.00	62.00					
2	Out-E03	Outfall	62.00					0.00	62.00					
3	Basin-A1	Storage Node	57.50	63.20	57.50		0.00	0.33	58.94				0.00	0.00
4	Forebay-A1	Storage Node	59.20	63.20	59.20		0.00	1.07	62.08				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(ft)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
1	Weir-BA1	Weir	Basin-A1	Out-A1		57.50	62.00				0.00							
2	Weir-FA1	Weir	Forebay-A1	Basin-A1		59.20	57.50				0.33							

Subbasin Hydrology

Subbasin : Sub-03.1

Input Data

Area (ac) 0.16
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.16	A	43
Composite Area & Weighted CN	0.16		43

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft^2)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	130.15	0	0
Slope (%) :	10	0	0
2 yr, 24 hr Rainfall (in) :	3.42	0	0
Velocity (ft/sec) :	0.09	0	0
Computed Flow Time (min) :	23.46	0	0

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	42	0	0
Slope (%) :	10	0	0
Surface Type :	Grass pasture	Unpaved	Unpaved
Velocity (ft/sec) :	2.21	0	0
Computed Flow Time (min) :	0.32	0	0

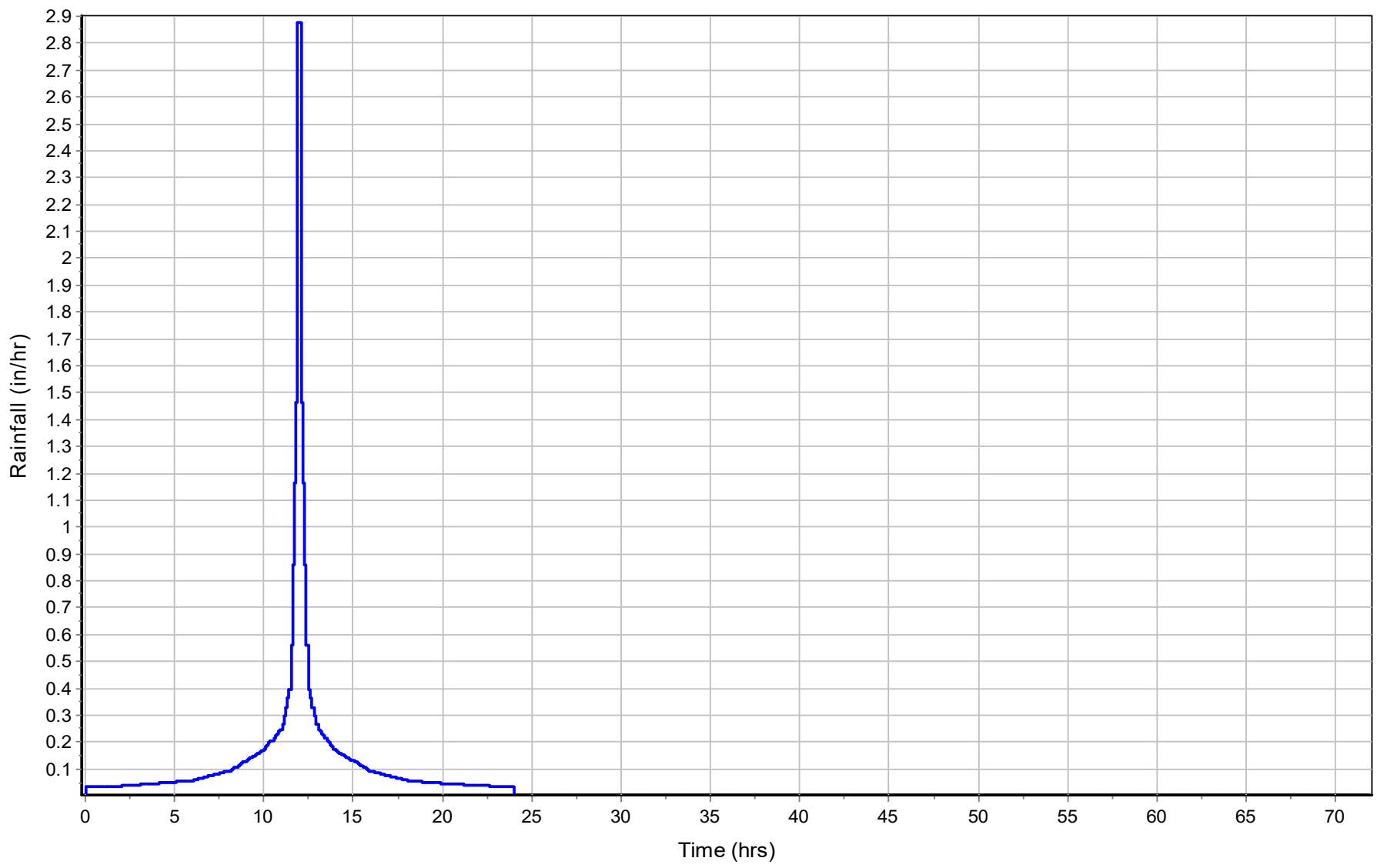
Total TOC (min) 23.77

Subbasin Runoff Results

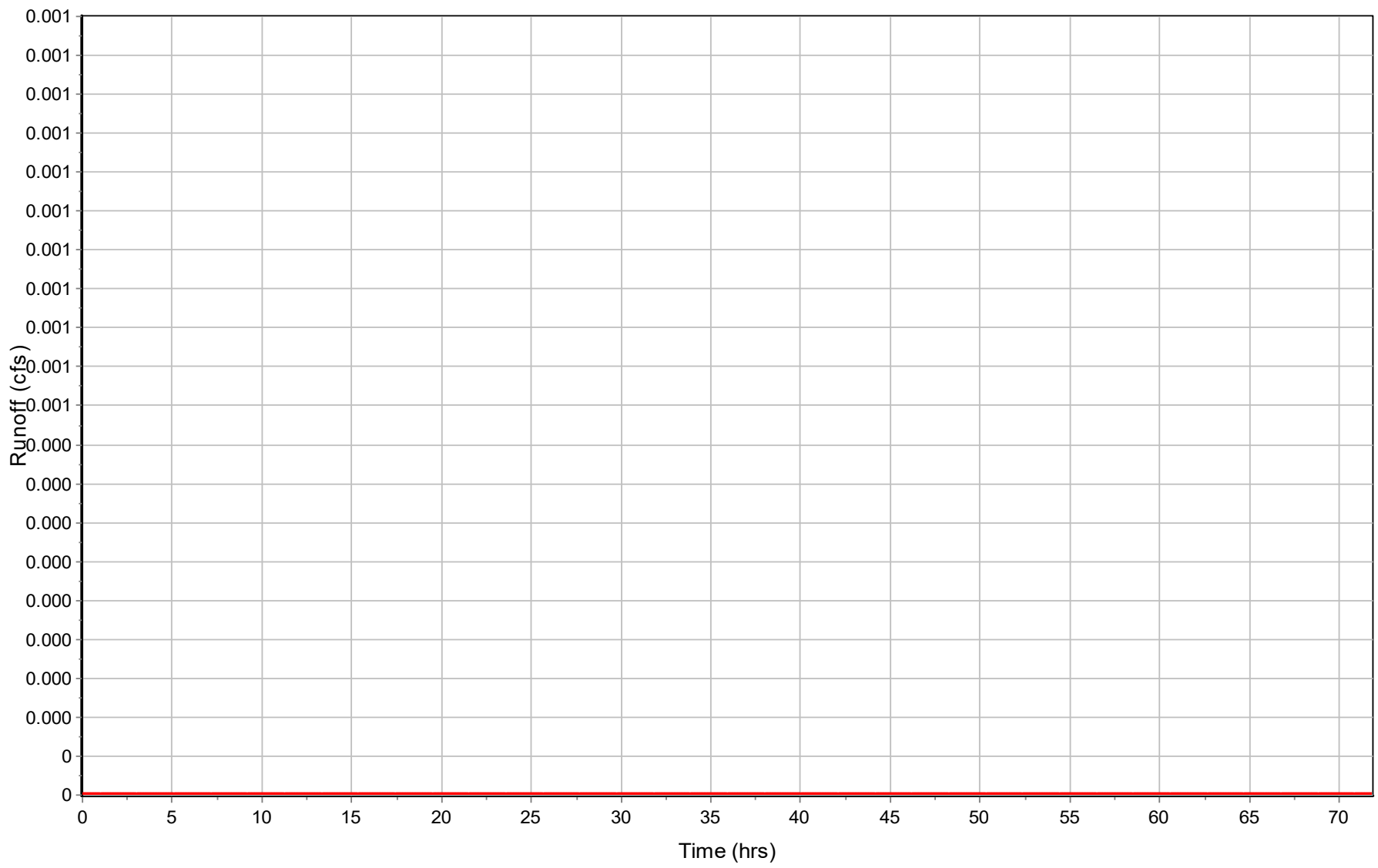
Total Rainfall (in)	3.42
Total Runoff (in)	0
Peak Runoff (cfs)	0
Weighted Curve Number	43
Time of Concentration (days hh:mm:ss)	0 00:23:46

Subbasin : Sub-03.1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-A1

Input Data

Area (ac) 2.47
Peak Rate Factor 484
Weighted Curve Number 61.66
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
50 - 75% grass cover, Fair	1.31	A	49
Gravel roads	1.16	A	76
Composite Area & Weighted CN	2.47		61.66

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	263.43	0	0
Slope (%) :	0.52	0	0
2 yr, 24 hr Rainfall (in) :	3.42	0	0
Velocity (ft/sec) :	0.79	0	0
Computed Flow Time (min) :	5.59	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	202.09	0	0
Channel Slope (%) :	0.4	0	0
Cross Section Area (ft^2) :	3	0	0
Wetted Perimeter (ft) :	6.32	0	0
Velocity (ft/sec) :	1.91	0	0
Computed Flow Time (min) :	1.76	0	0

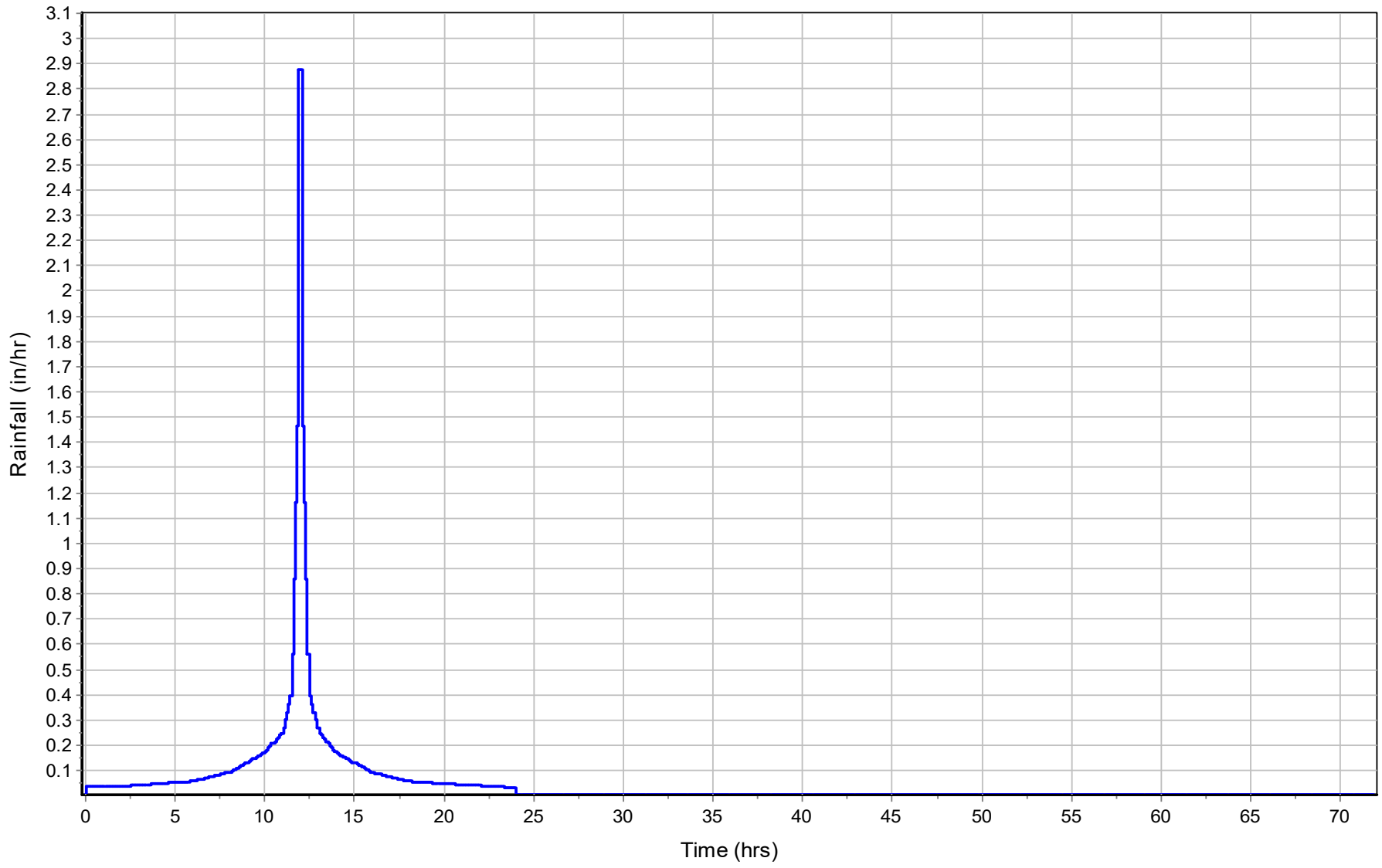
Total TOC (min) 7.35

Subbasin Runoff Results

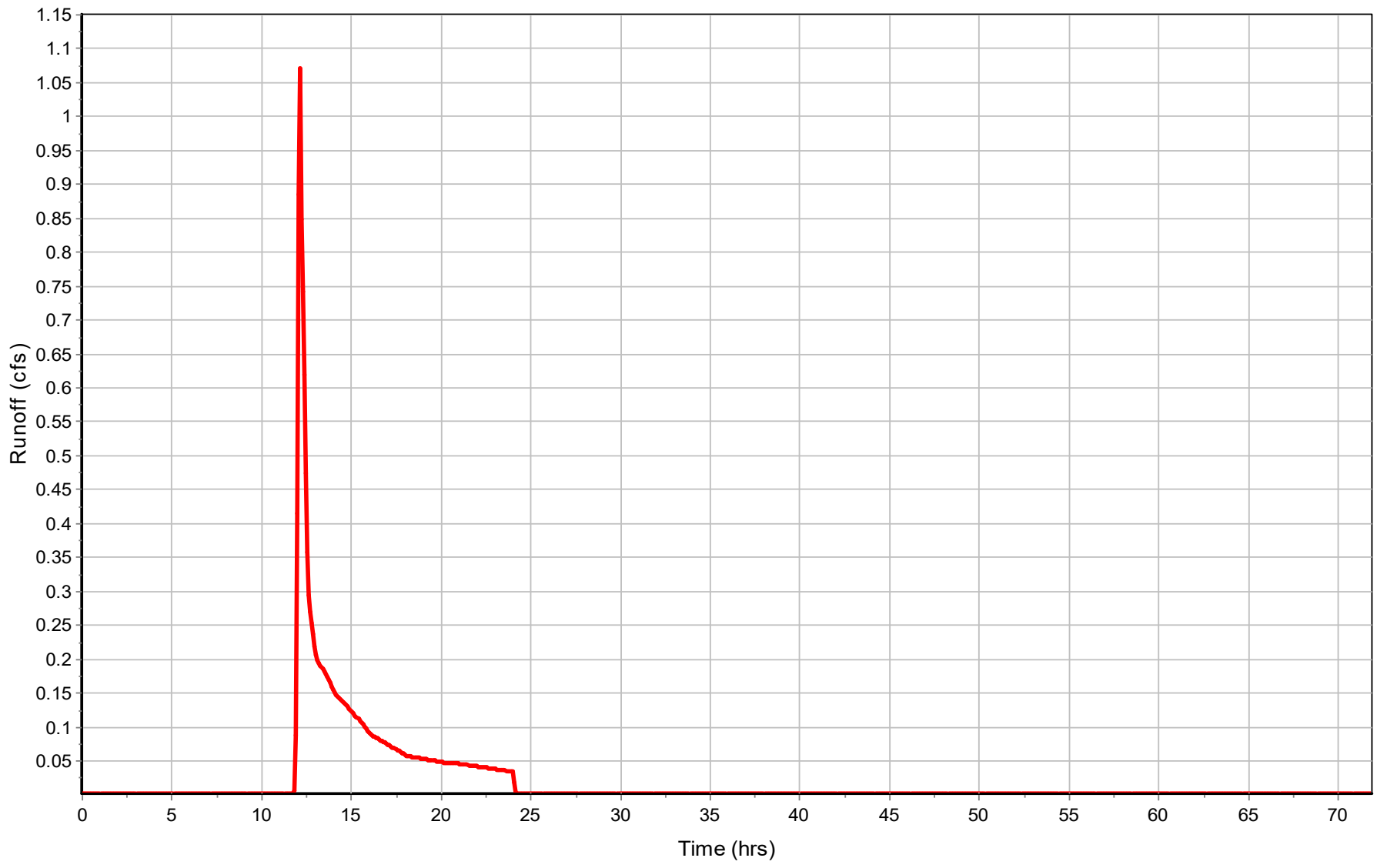
Total Rainfall (in) 3.42
Total Runoff (in) 0.56
Peak Runoff (cfs) 1.11
Weighted Curve Number 61.66
Time of Concentration (days hh:mm:ss) 0 00:07:21

Subbasin : Sub-A1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E03

Input Data

Area (ac) 0.48
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.48	A	43
Composite Area & Weighted CN	0.48		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	184.51	0	0
Slope (%) :	20	0	0
2 yr, 24 hr Rainfall (in) :	3.42	0	0
Velocity (ft/sec) :	0.13	0	0
Computed Flow Time (min) :	23.5	0	0

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	42	0	0
Slope (%) :	10	0	0
Surface Type :	Grass pasture	Unpaved	Unpaved
Velocity (ft/sec) :	2.21	0	0
Computed Flow Time (min) :	0.32	0	0

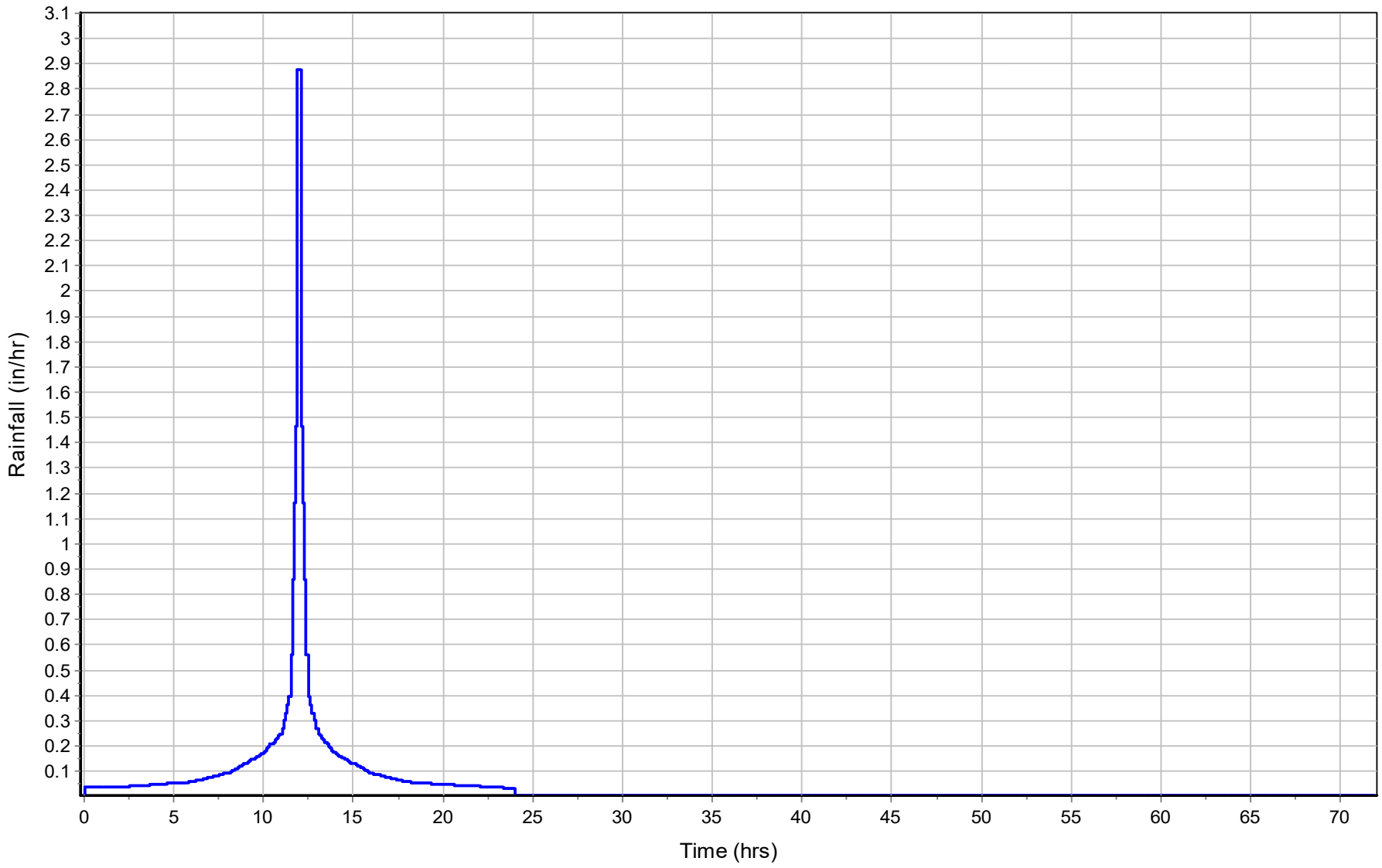
Total TOC (min) 23.82

Subbasin Runoff Results

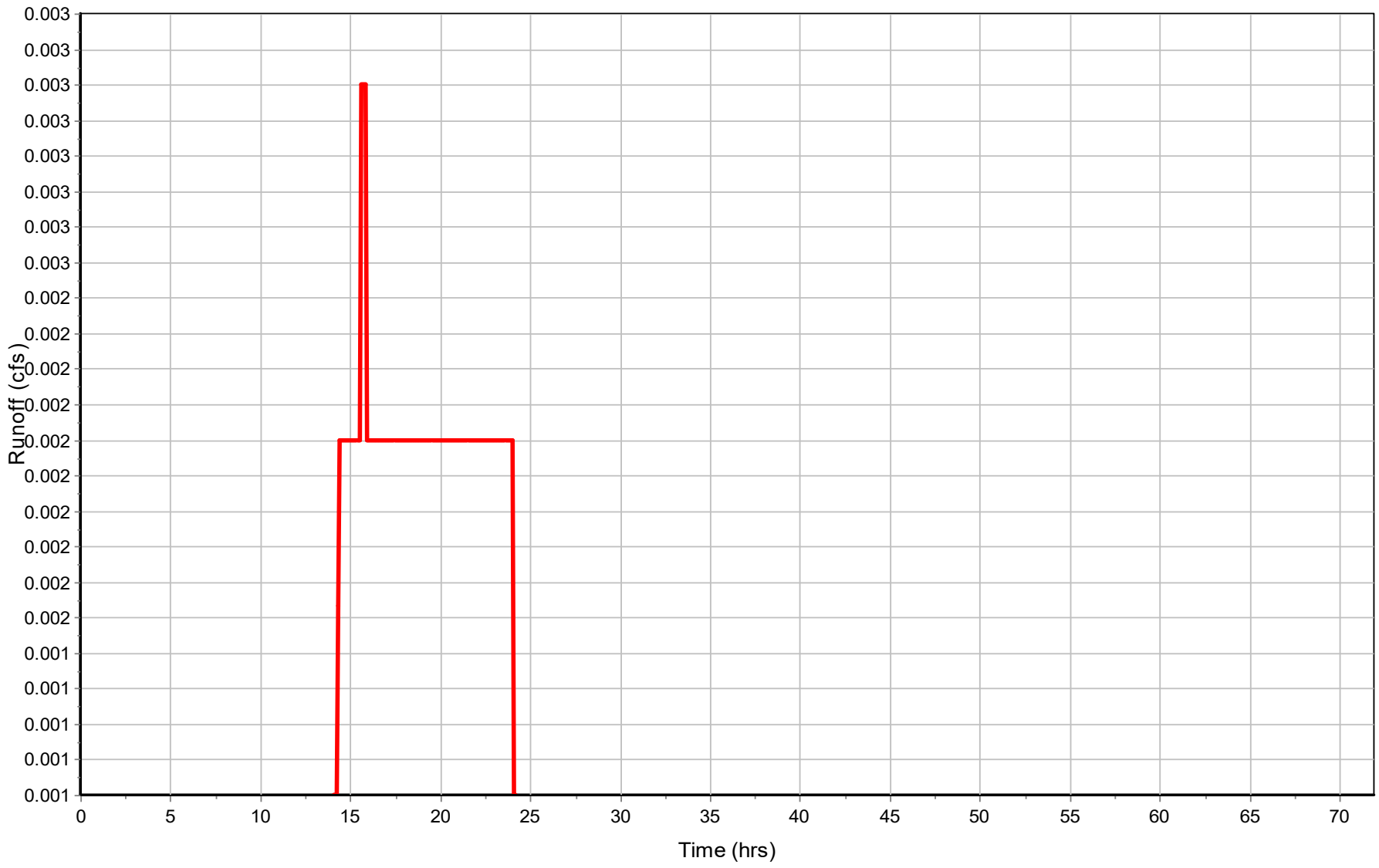
Total Rainfall (in) 3.42
Total Runoff (in) 0.04
Peak Runoff (cfs) 0
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:23:49

Subbasin : Sub-E03

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A1

Input Data

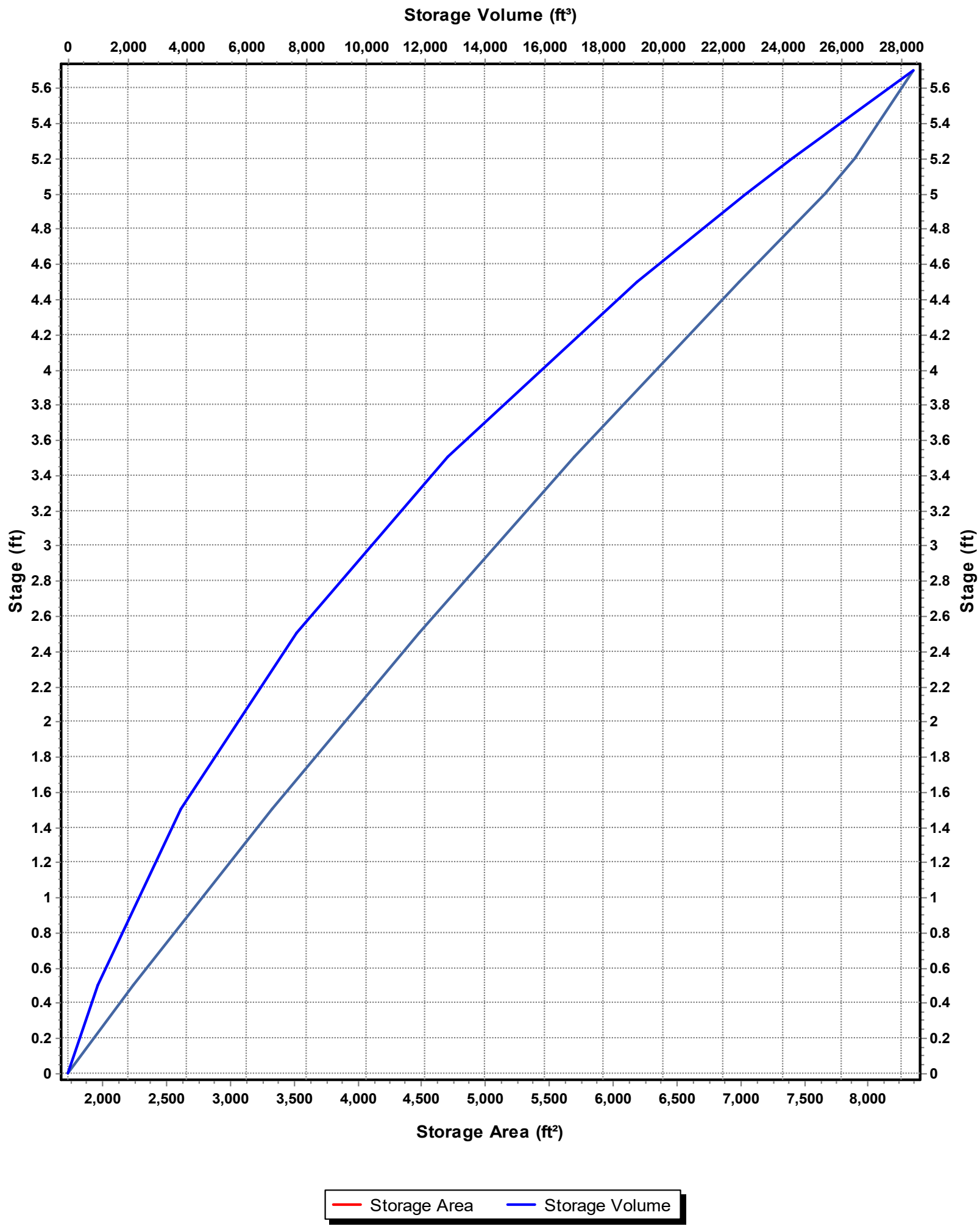
Invert Elevation (ft)	57.50
Max (Rim) Elevation (ft)	63.20
Max (Rim) Offset (ft)	5.70
Initial Water Elevation (ft)	57.50
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Basin-01

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	1730.97	0
0.5	2246.13	994.28
1.5	3328.81	3781.75
2.5	4481.3	7686.81
3.5	5703.61	12779.27
4.5	6995.74	19128.95
5	7667.99	22794.88
5.2	7895.95	24351.27
5.7	8357.69	28414.68

Storage Area Volume Curves



Storage Node : Basin-A1 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-BA1	Trapezoidal	No	62.70	5.20	5.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	0.33
Peak Lateral Inflow (cfs)	0
Peak Outflow (cfs)	0
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	58.94
Max HGL Depth Attained (ft)	1.44
Average HGL Elevation Attained (ft)	58.62
Average HGL Depth Attained (ft)	1.12
Time of Max HGL Occurrence (days hh:mm)	1 04:13
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Forebay-A1

Input Data

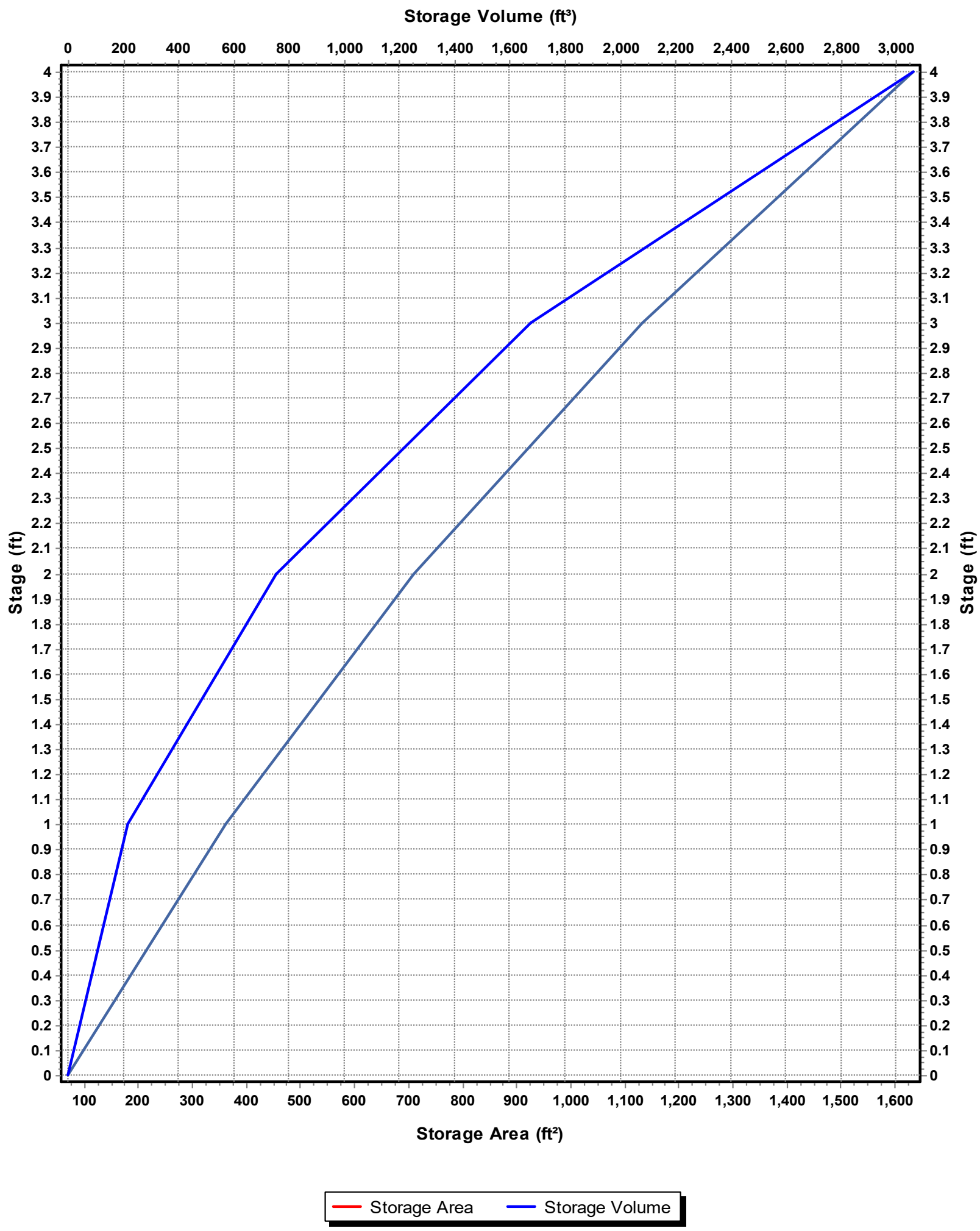
Invert Elevation (ft)	59.20
Max (Rim) Elevation (ft)	63.20
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	59.20
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Forebay-01

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	70.72	0
1	363.35	217.04
2	710.9	754.17
3	1134.81	1677.03
4	1635.08	3061.98

Storage Area Volume Curves



Storage Node : Forebay-A1 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-FA1	Trapezoidal	No	62.00	2.80	4.00	1.20	3.33

Output Summary Results

Peak Inflow (cfs)	1.07
Peak Lateral Inflow (cfs)	1.07
Peak Outflow (cfs)	0.33
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	62.08
Max HGL Depth Attained (ft)	2.88
Average HGL Elevation Attained (ft)	61.53
Average HGL Depth Attained (ft)	2.33
Time of Max HGL Occurrence (days hh:mm)	0 12:42
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Project Description

File Name ..... Bourne MyR_A1.SPF

Project Options

Flow Units ..... CFS
Elevation Type ..... Elevation
Hydrology Method ..... SCS TR-20
Time of Concentration (TOC) Method ..... SCS TR-55
Link Routing Method ..... Hydrodynamic
Enable Overflow Ponding at Nodes ..... YES
Skip Steady State Analysis Time Periods ..... NO

Analysis Options

Start Analysis On ..... oct. 14, 2021 0:00:00
End Analysis On ..... oct. 17, 2021 0:00:00
Start Reporting On ..... oct. 14, 2021 0:00:00
Antecedent Dry Days ..... 0 days
Runoff (Dry Weather) Time Step ..... 0 01:00:00 days hh:mm:ss
Runoff (Wet Weather) Time Step ..... 0 00:05:00 days hh:mm:ss
Reporting Time Step ..... 0 00:05:00 days hh:mm:ss
Routing Time Step ..... 30 seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	3
Nodes	4
Junctions	0
Outfalls	2
Flow Diversions	0
Inlets	0
Storage Nodes	2
Links	2
Channels	0
Pipes	0
Pumps	0
Orifices	0
Weirs	2
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	10 years	Intensity	inches	Massachusetts	None	10.00	5.00	SCS Type III 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Sub-03.1	0.16	484.00	43.00	5.00	0.35	0.06	0.02	0 00:23:46
2	Sub-A1	2.47	484.00	61.66	5.00	1.42	3.49	3.35	0 00:07:21
3	Sub-E03	0.48	484.00	43.00	5.00	0.35	0.17	0.05	0 00:23:49

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Out-A1	Outfall	62.00					0.02	62.00					
2	Out-E03	Outfall	62.00					0.05	62.00					
3	Basin-A1	Storage Node	57.50	63.20	57.50		0.00	3.08	60.71				0.00	0.00
4	Forebay-A1	Storage Node	59.20	63.20	59.20		0.00	3.11	62.33				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(ft)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
1	Weir-BA1	Weir	Basin-A1	Out-A1		57.50	62.00				0.00							
2	Weir-FA1	Weir	Forebay-A1	Basin-A1		59.20	57.50				3.08							

Subbasin Hydrology

Subbasin : Sub-03.1

Input Data

Area (ac) 0.16
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.16	A	43
Composite Area & Weighted CN	0.16		43

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft^2)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	130.15	0	0
Slope (%) :	10	0	0
2 yr, 24 hr Rainfall (in) :	3.42	0	0
Velocity (ft/sec) :	0.09	0	0
Computed Flow Time (min) :	23.46	0	0

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	42	0	0
Slope (%) :	10	0	0
Surface Type :	Grass pasture	Unpaved	Unpaved
Velocity (ft/sec) :	2.21	0	0
Computed Flow Time (min) :	0.32	0	0

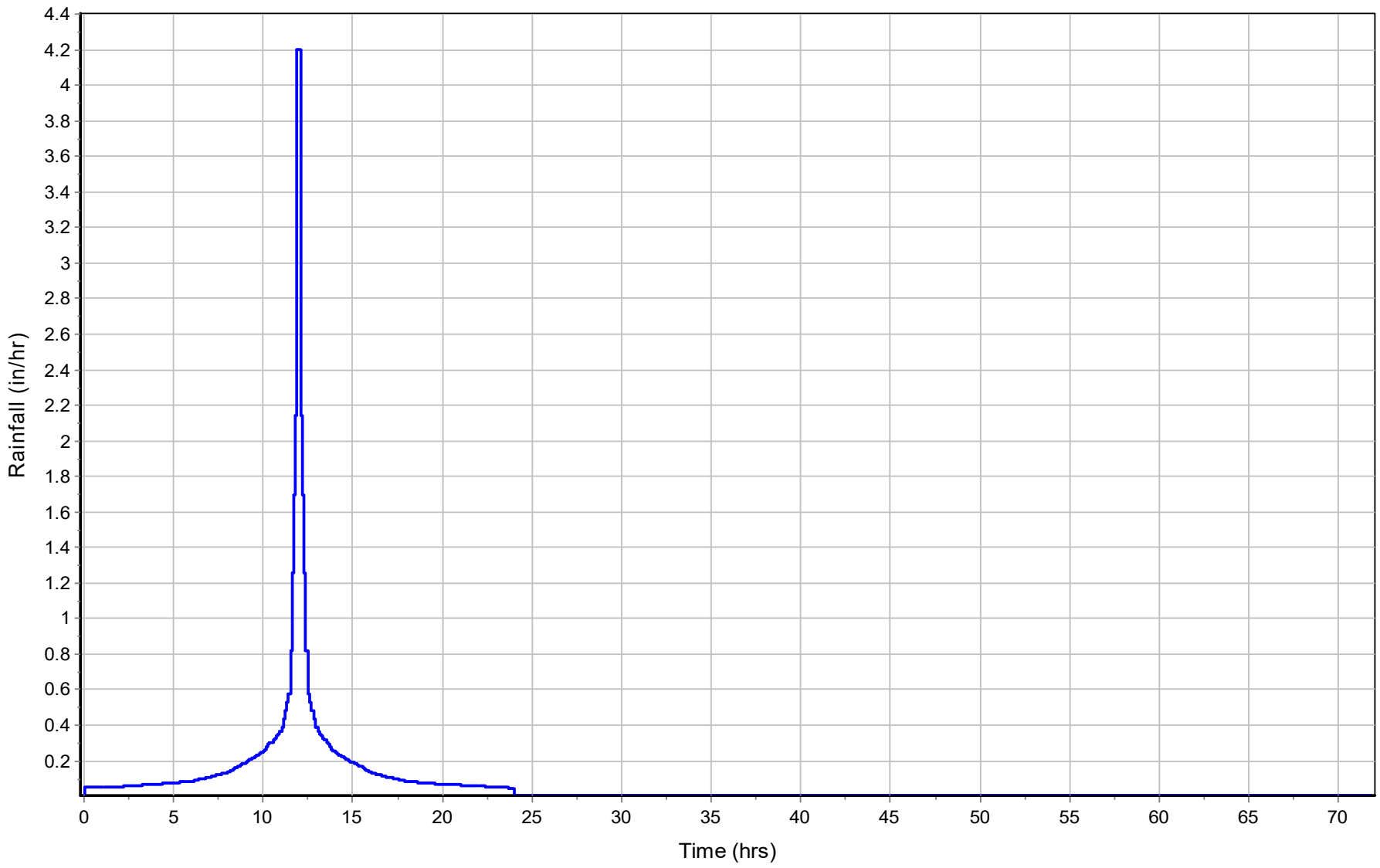
Total TOC (min) 23.77

Subbasin Runoff Results

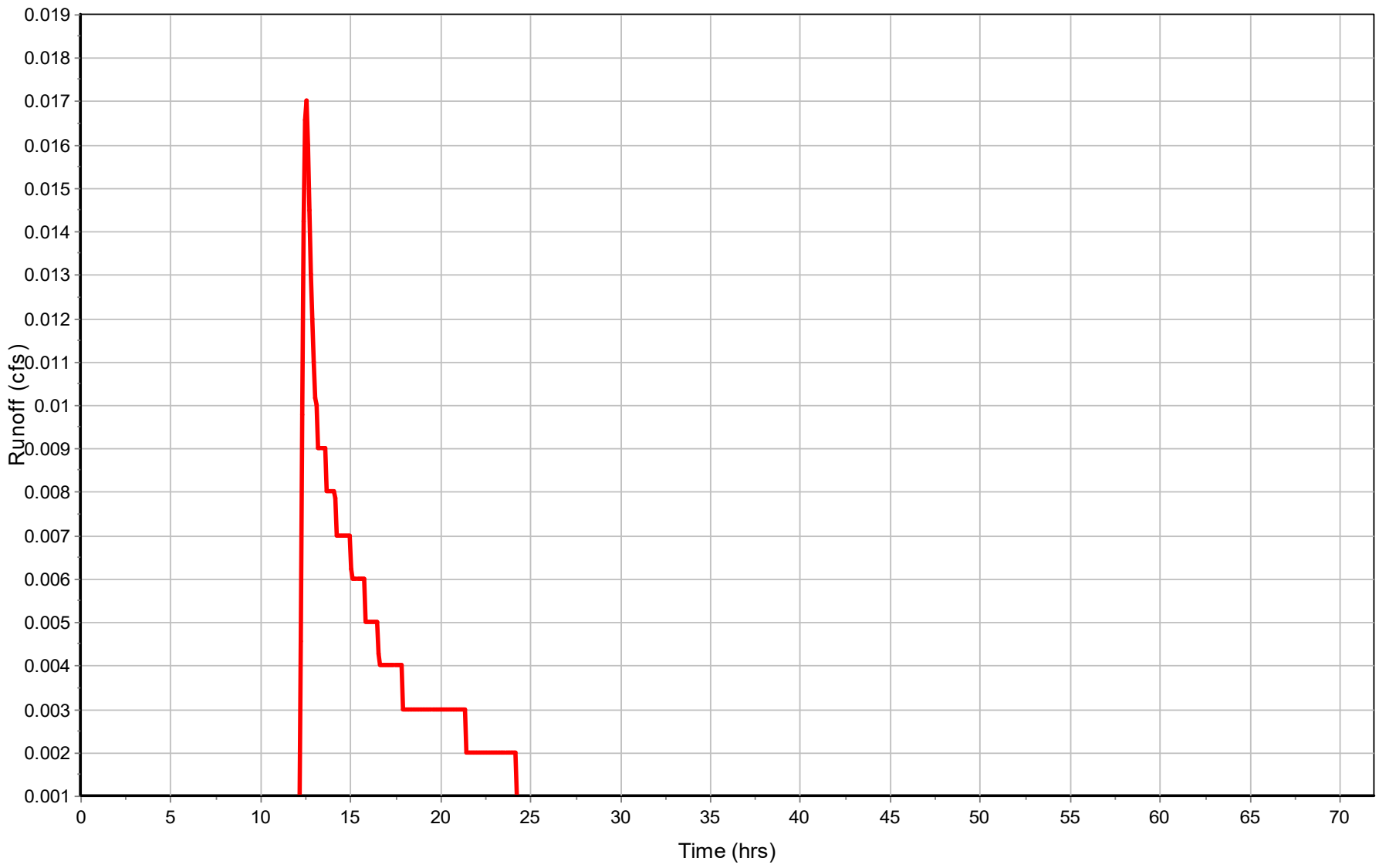
Total Rainfall (in)	5
Total Runoff (in)	0.35
Peak Runoff (cfs)	0.02
Weighted Curve Number	43
Time of Concentration (days hh:mm:ss)	0 00:23:46

Subbasin : Sub-03.1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-A1

Input Data

Area (ac) 2.47
Peak Rate Factor 484
Weighted Curve Number 61.66
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
50 - 75% grass cover, Fair	1.31	A	49
Gravel roads	1.16	A	76
Composite Area & Weighted CN	2.47		61.66

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	263.43	0	0
Slope (%) :	0.52	0	0
2 yr, 24 hr Rainfall (in) :	3.42	0	0
Velocity (ft/sec) :	0.79	0	0
Computed Flow Time (min) :	5.59	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	202.09	0	0
Channel Slope (%) :	0.4	0	0
Cross Section Area (ft^2) :	3	0	0
Wetted Perimeter (ft) :	6.32	0	0
Velocity (ft/sec) :	1.91	0	0
Computed Flow Time (min) :	1.76	0	0

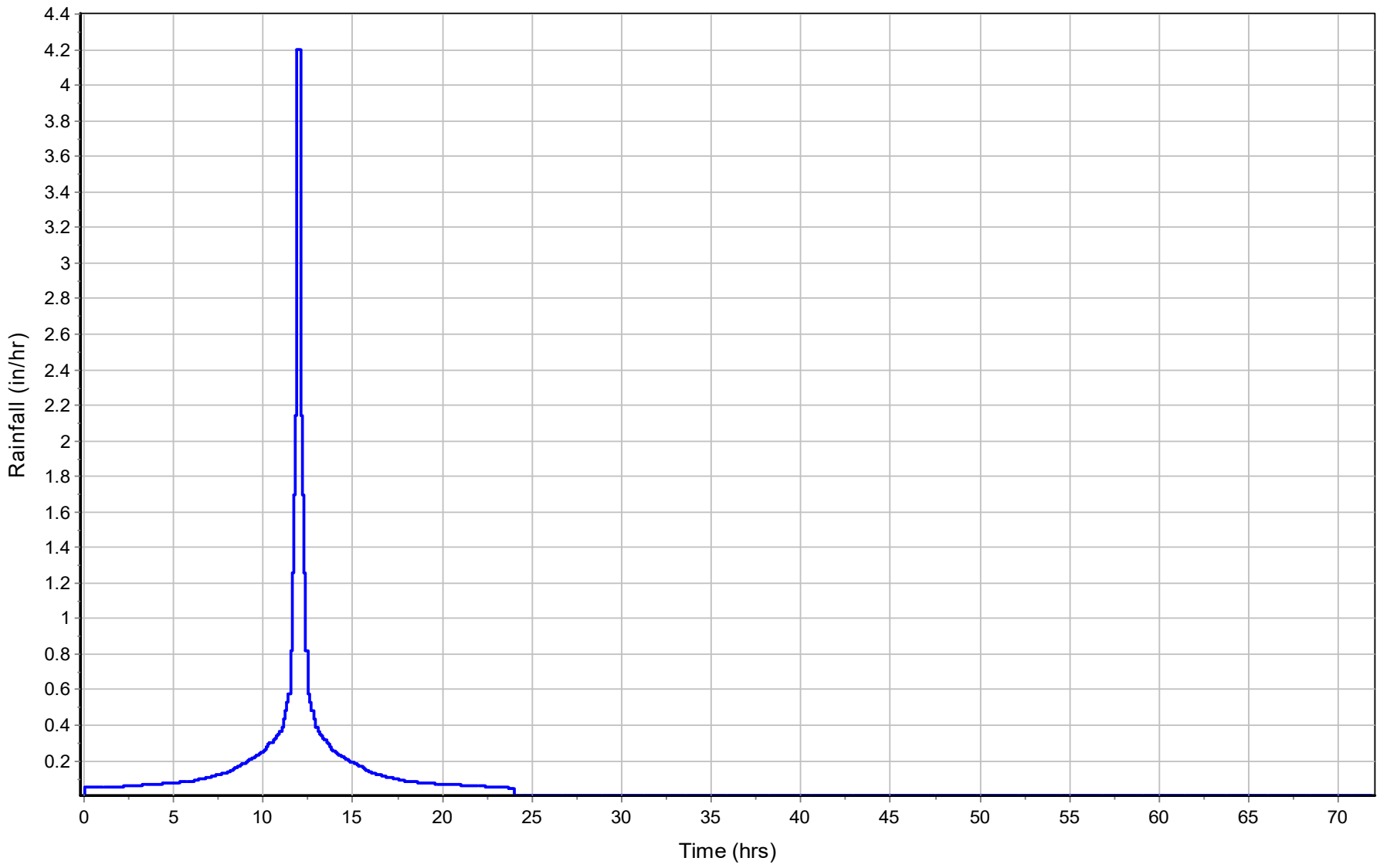
Total TOC (min) 7.35

Subbasin Runoff Results

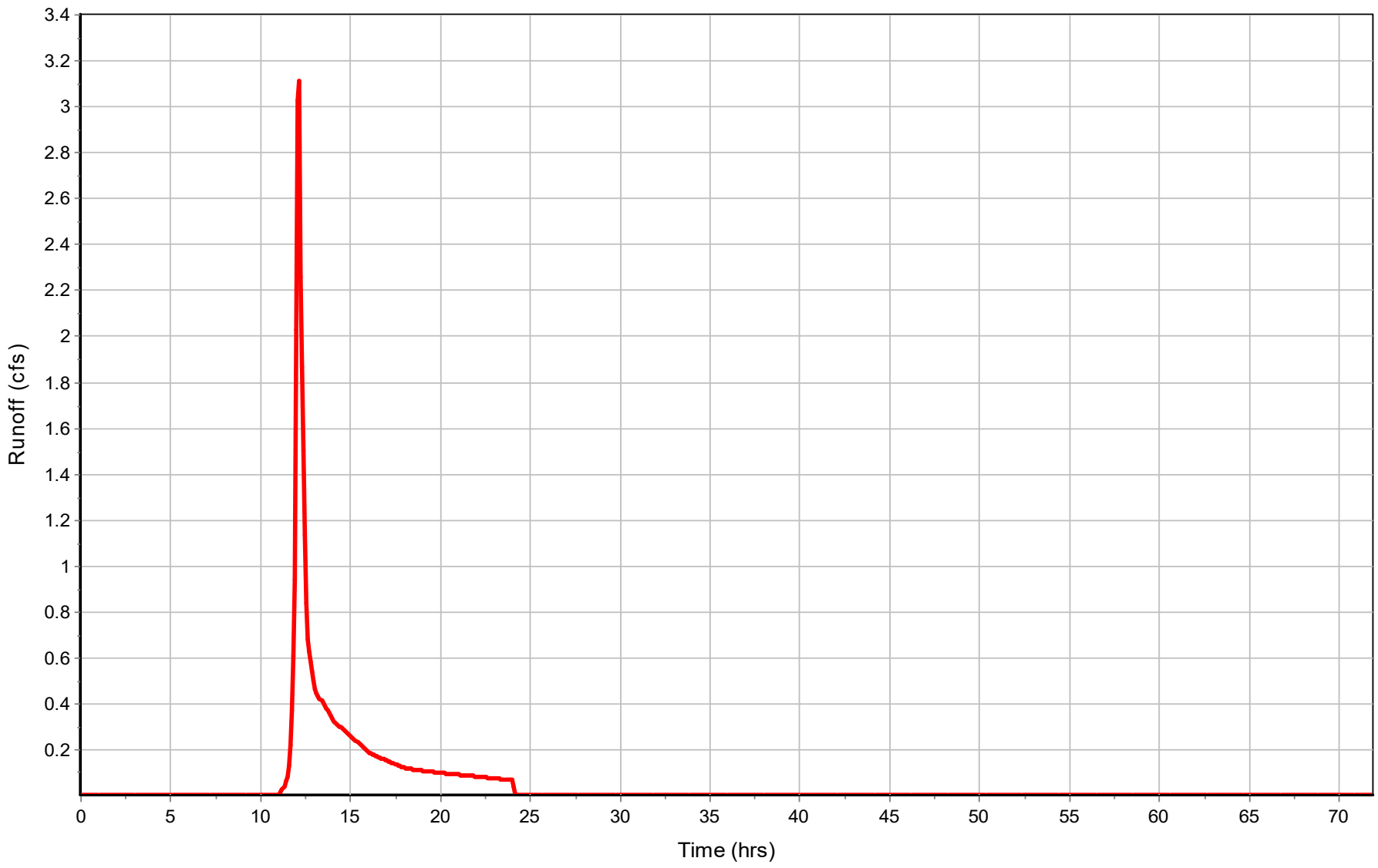
Total Rainfall (in) 5
Total Runoff (in) 1.42
Peak Runoff (cfs) 3.35
Weighted Curve Number 61.66
Time of Concentration (days hh:mm:ss) 0 00:07:21

Subbasin : Sub-A1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E03

Input Data

Area (ac) 0.48
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.48	A	43
Composite Area & Weighted CN	0.48		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	184.51	0	0
Slope (%) :	20	0	0
2 yr, 24 hr Rainfall (in) :	3.42	0	0
Velocity (ft/sec) :	0.13	0	0
Computed Flow Time (min) :	23.5	0	0

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	42	0	0
Slope (%) :	10	0	0
Surface Type :	Grass pasture	Unpaved	Unpaved
Velocity (ft/sec) :	2.21	0	0
Computed Flow Time (min) :	0.32	0	0

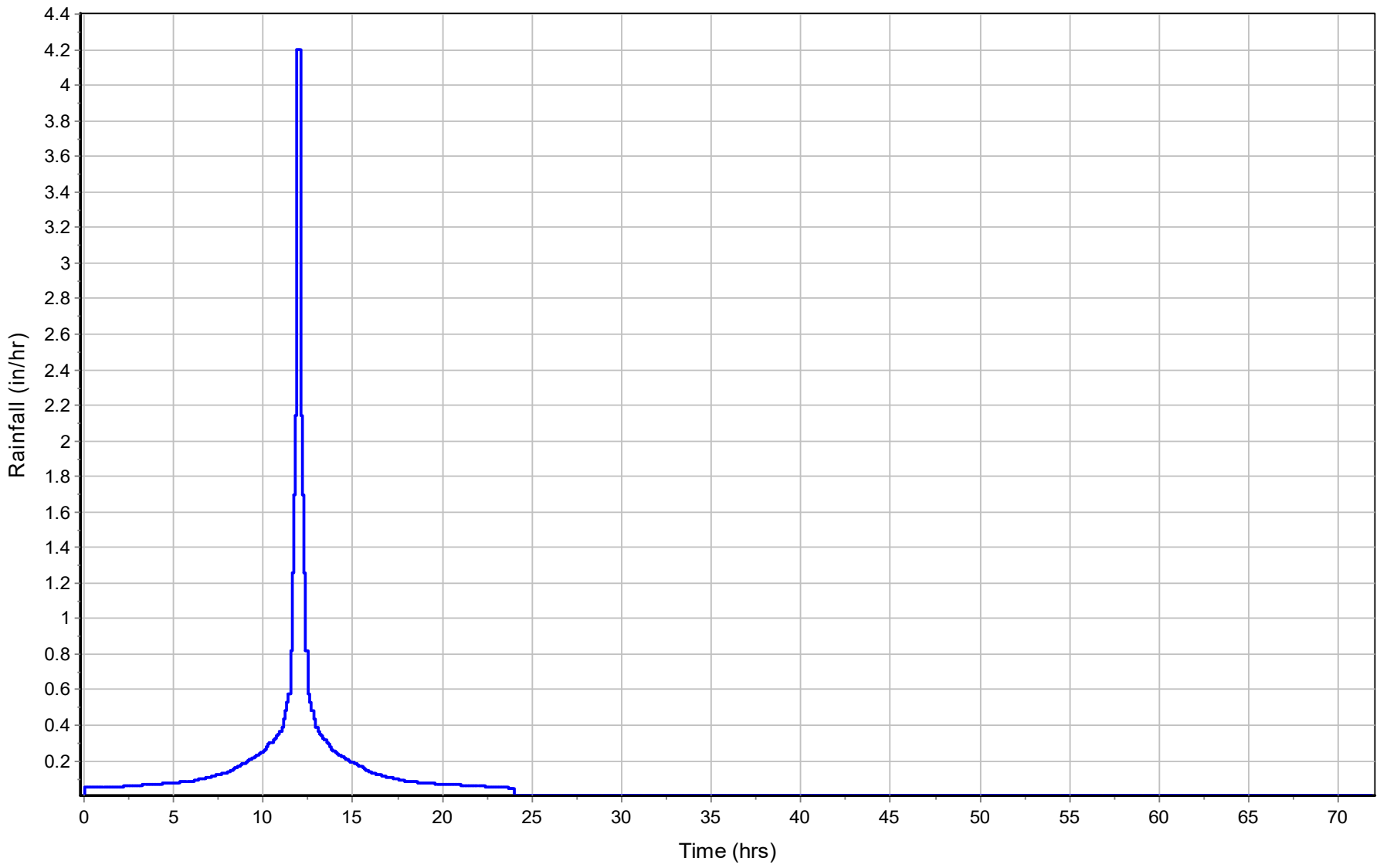
Total TOC (min) 23.82

Subbasin Runoff Results

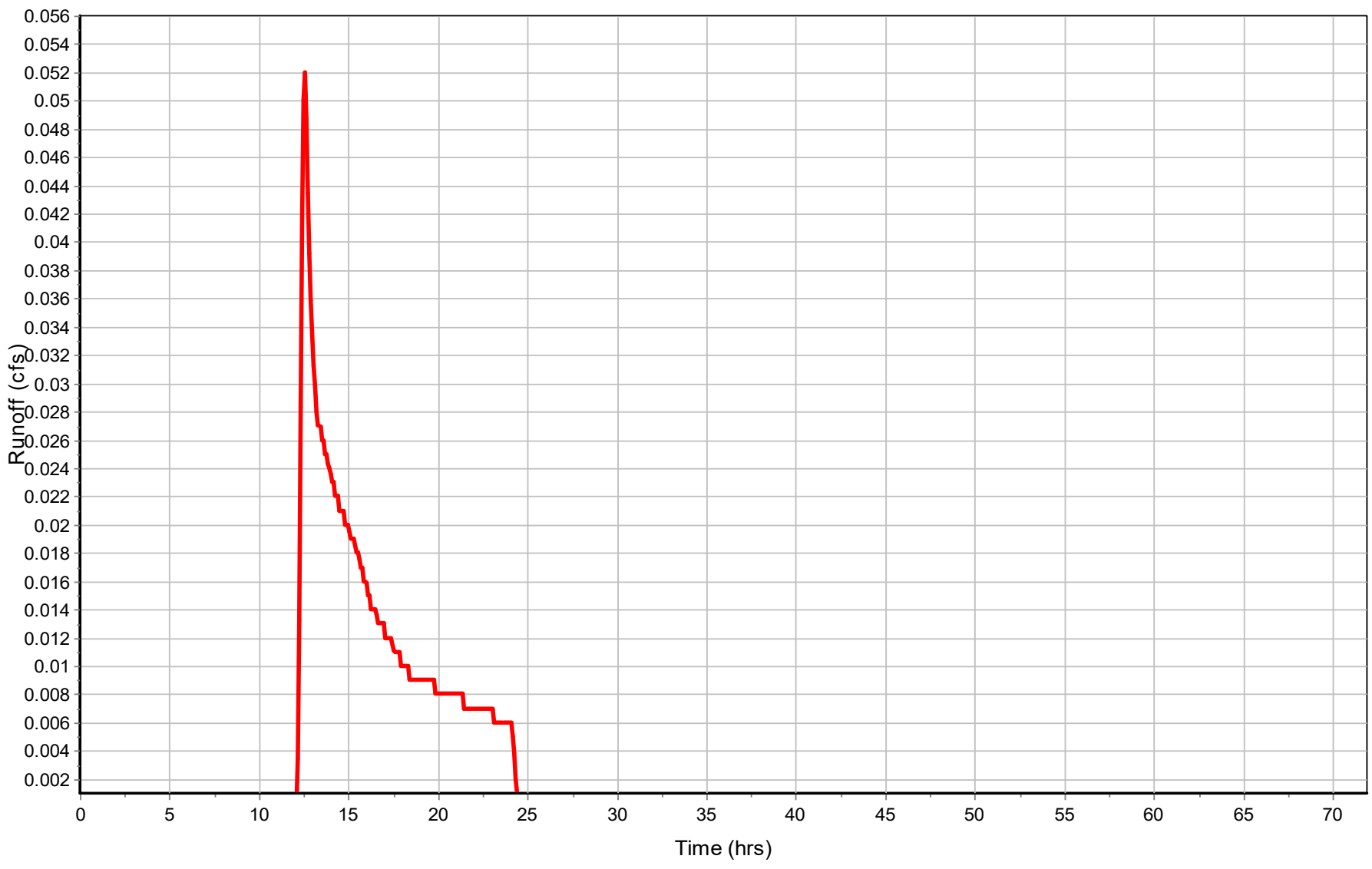
Total Rainfall (in) 5
Total Runoff (in) 0.35
Peak Runoff (cfs) 0.05
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:23:49

Subbasin : Sub-E03

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A1

Input Data

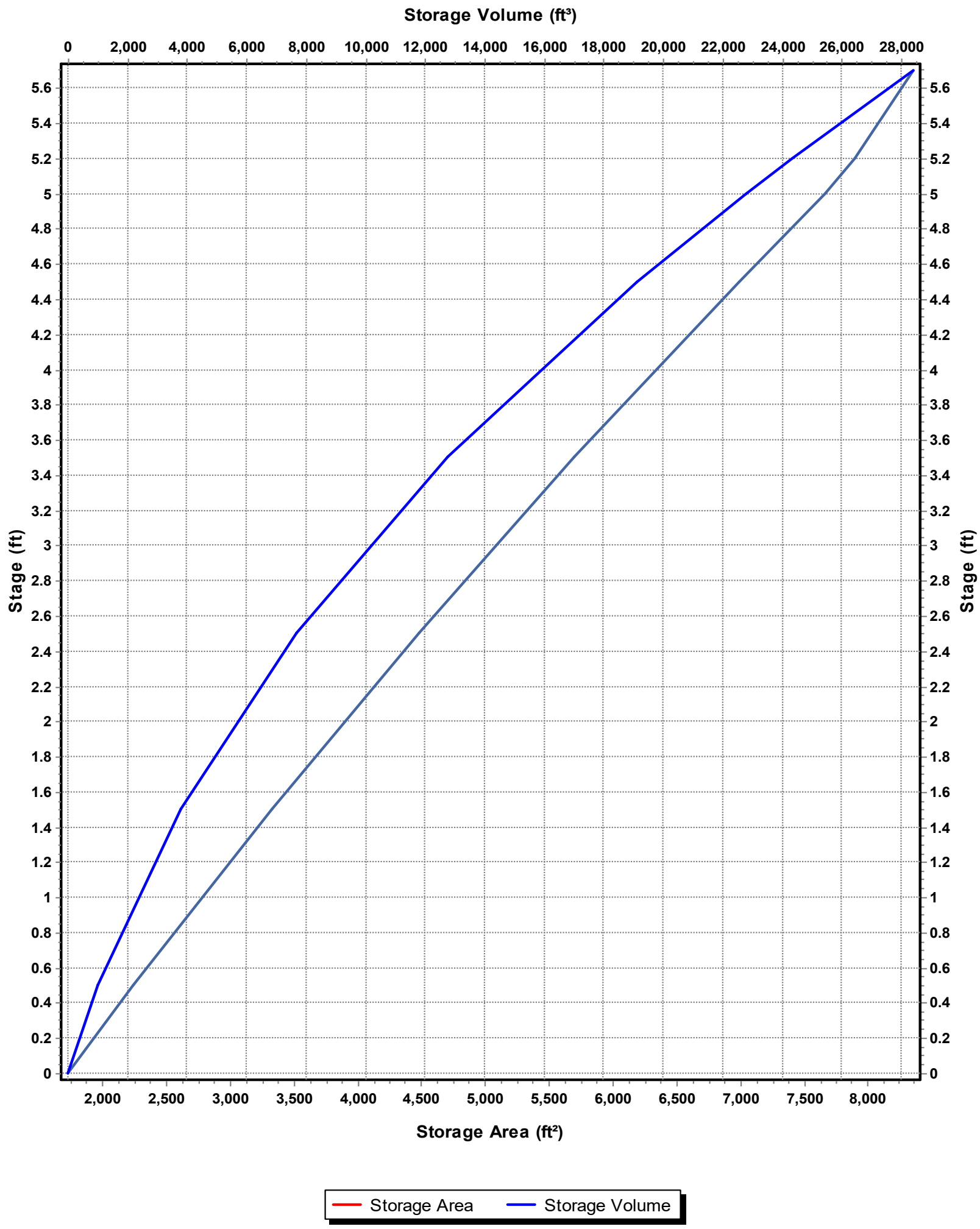
Invert Elevation (ft)	57.50
Max (Rim) Elevation (ft)	63.20
Max (Rim) Offset (ft)	5.70
Initial Water Elevation (ft)	57.50
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Basin-01

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	1730.97	0
0.5	2246.13	994.28
1.5	3328.81	3781.75
2.5	4481.3	7686.81
3.5	5703.61	12779.27
4.5	6995.74	19128.95
5	7667.99	22794.88
5.2	7895.95	24351.27
5.7	8357.69	28414.68

Storage Area Volume Curves



Storage Node : Basin-A1 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-BA1	Trapezoidal	No	62.70	5.20	5.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	3.08
Peak Lateral Inflow (cfs)	0
Peak Outflow (cfs)	0
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	60.71
Max HGL Depth Attained (ft)	3.21
Average HGL Elevation Attained (ft)	60.08
Average HGL Depth Attained (ft)	2.58
Time of Max HGL Occurrence (days hh:mm)	1 04:17
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Forebay-A1

Input Data

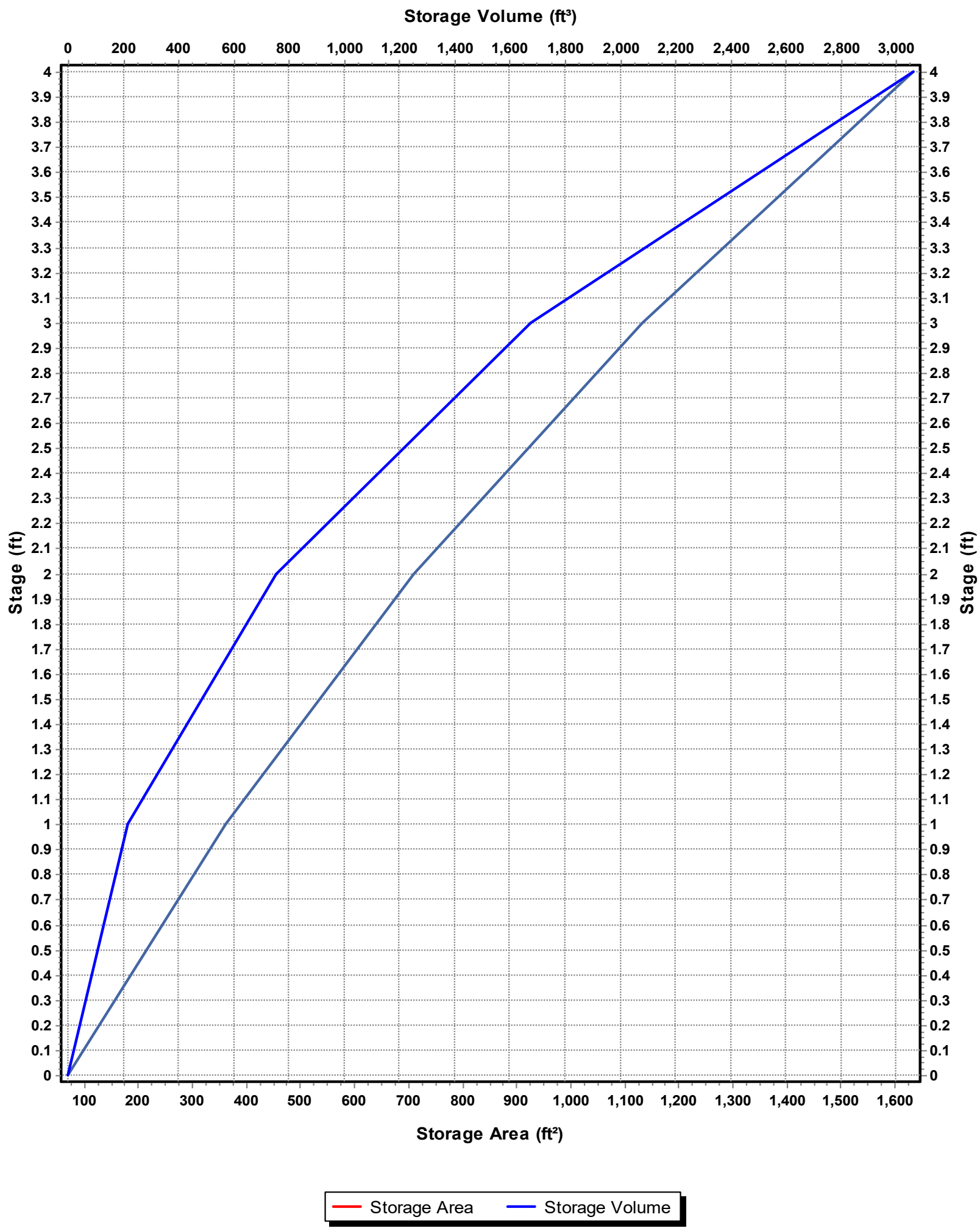
Invert Elevation (ft)	59.20
Max (Rim) Elevation (ft)	63.20
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	59.20
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Forebay-01

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	70.72	0
1	363.35	217.04
2	710.9	754.17
3	1134.81	1677.03
4	1635.08	3061.98

Storage Area Volume Curves



Storage Node : Forebay-A1 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-FA1	Trapezoidal	No	62.00	2.80	4.00	1.20	3.33

Output Summary Results

Peak Inflow (cfs)	3.11
Peak Lateral Inflow (cfs)	3.11
Peak Outflow (cfs)	3.08
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	62.33
Max HGL Depth Attained (ft)	3.13
Average HGL Elevation Attained (ft)	61.55
Average HGL Depth Attained (ft)	2.35
Time of Max HGL Occurrence (days hh:mm)	0 12:15
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Project Description

File Name ..... Bourne MyR_A1.SPF

Project Options

Flow Units ..... CFS
Elevation Type ..... Elevation
Hydrology Method ..... SCS TR-20
Time of Concentration (TOC) Method ..... SCS TR-55
Link Routing Method ..... Hydrodynamic
Enable Overflow Ponding at Nodes ..... YES
Skip Steady State Analysis Time Periods ..... NO

Analysis Options

Start Analysis On ..... oct. 14, 2021 0:00:00
End Analysis On ..... oct. 17, 2021 0:00:00
Start Reporting On ..... oct. 14, 2021 0:00:00
Antecedent Dry Days ..... 0 days
Runoff (Dry Weather) Time Step ..... 0 01:00:00 days hh:mm:ss
Runoff (Wet Weather) Time Step ..... 0 00:05:00 days hh:mm:ss
Reporting Time Step ..... 0 00:05:00 days hh:mm:ss
Routing Time Step ..... 30 seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	3
Nodes	4
Junctions	0
Outfalls	2
Flow Diversions	0
Inlets	0
Storage Nodes	2
Links	2
Channels	0
Pipes	0
Pumps	0
Orifices	0
Weirs	2
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	25 years	Intensity	inches	Massachusetts	None	25.00	5.98	SCS Type III 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Sub-03.1	0.16	484.00	43.00	5.98	0.67	0.11	0.05	0 00:23:46
2	Sub-A1	2.47	484.00	61.66	5.98	2.05	5.05	5.00	0 00:07:21
3	Sub-E03	0.48	484.00	43.00	5.98	0.67	0.32	0.14	0 00:23:49

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Out-A1	Outfall	62.00					0.05	62.00					
2	Out-E03	Outfall	62.00					0.14	62.00					
3	Basin-A1	Storage Node	57.50	63.20	57.50		0.00	4.60	61.66				0.00	0.00
4	Forebay-A1	Storage Node	59.20	63.20	59.20		0.00	4.62	62.42				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(ft)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
1	Weir-BA1	Weir	Basin-A1	Out-A1		57.50	62.00				0.00							
2	Weir-FA1	Weir	Forebay-A1	Basin-A1		59.20	57.50				4.60							

Subbasin Hydrology

Subbasin : Sub-03.1

Input Data

Area (ac) 0.16
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.16	A	43
Composite Area & Weighted CN	0.16		43

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft^2)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	130.15	0	0
Slope (%) :	10	0	0
2 yr, 24 hr Rainfall (in) :	3.42	0	0
Velocity (ft/sec) :	0.09	0	0
Computed Flow Time (min) :	23.46	0	0

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	42	0	0
Slope (%) :	10	0	0
Surface Type :	Grass pasture	Unpaved	Unpaved
Velocity (ft/sec) :	2.21	0	0
Computed Flow Time (min) :	0.32	0	0

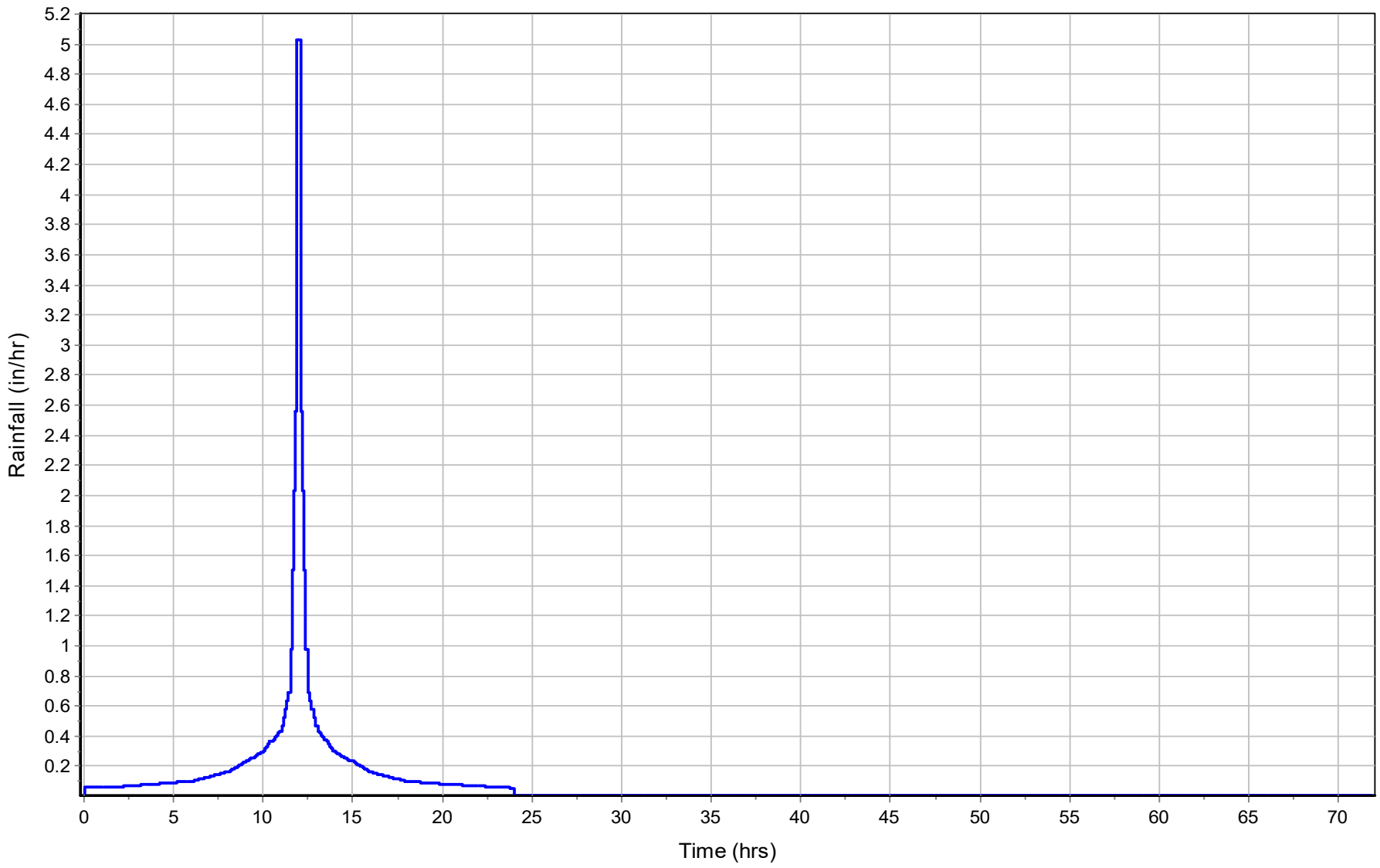
Total TOC (min) 23.77

Subbasin Runoff Results

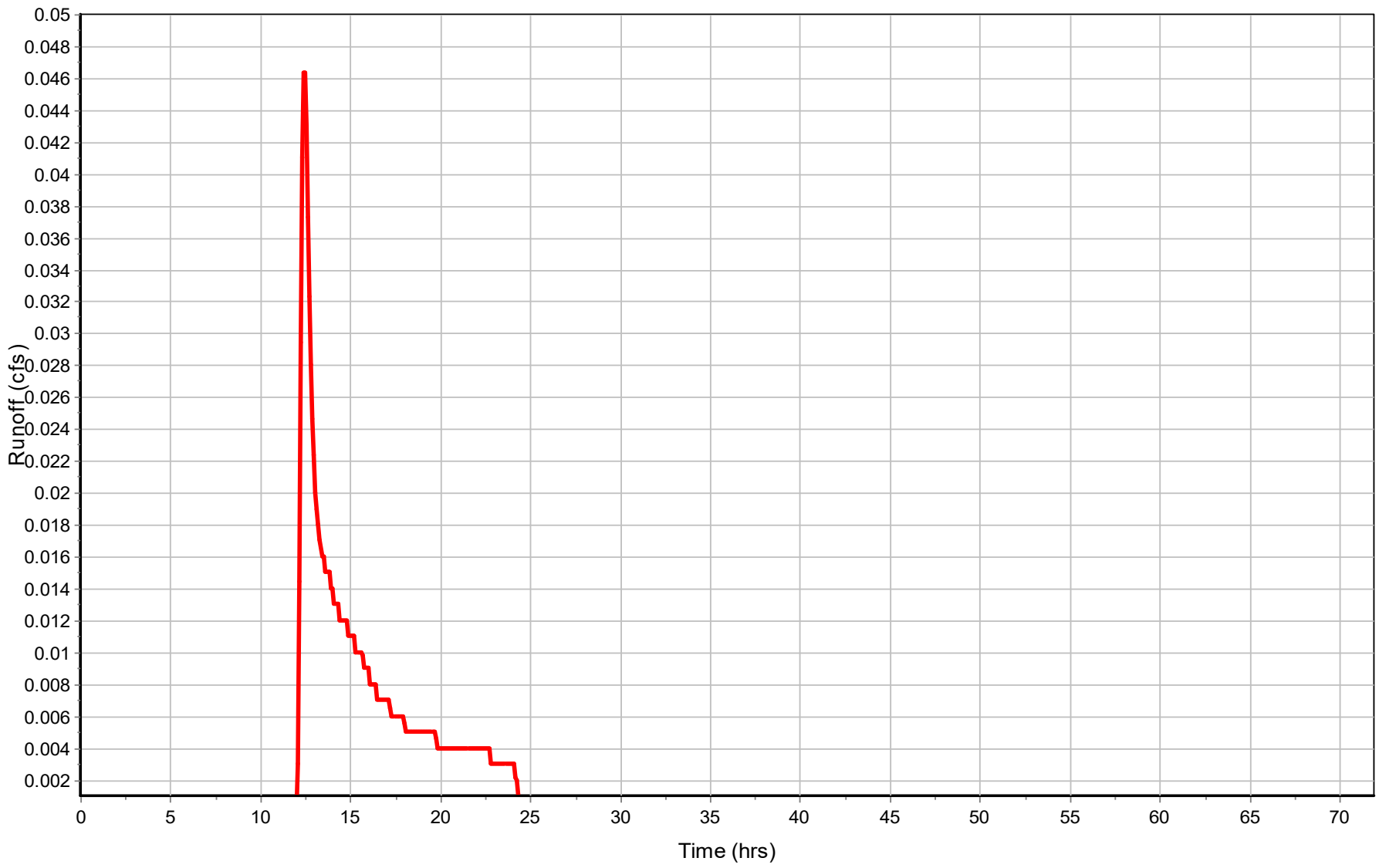
Total Rainfall (in)	5.98
Total Runoff (in)	0.67
Peak Runoff (cfs)	0.05
Weighted Curve Number	43
Time of Concentration (days hh:mm:ss)	0 00:23:46

Subbasin : Sub-03.1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-A1

Input Data

Area (ac) 2.47
Peak Rate Factor 484
Weighted Curve Number 61.66
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
50 - 75% grass cover, Fair	1.31	A	49
Gravel roads	1.16	A	76
Composite Area & Weighted CN	2.47		61.66

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	263.43	0	0
Slope (%) :	0.52	0	0
2 yr, 24 hr Rainfall (in) :	3.42	0	0
Velocity (ft/sec) :	0.79	0	0
Computed Flow Time (min) :	5.59	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	202.09	0	0
Channel Slope (%) :	0.4	0	0
Cross Section Area (ft^2) :	3	0	0
Wetted Perimeter (ft) :	6.32	0	0
Velocity (ft/sec) :	1.91	0	0
Computed Flow Time (min) :	1.76	0	0

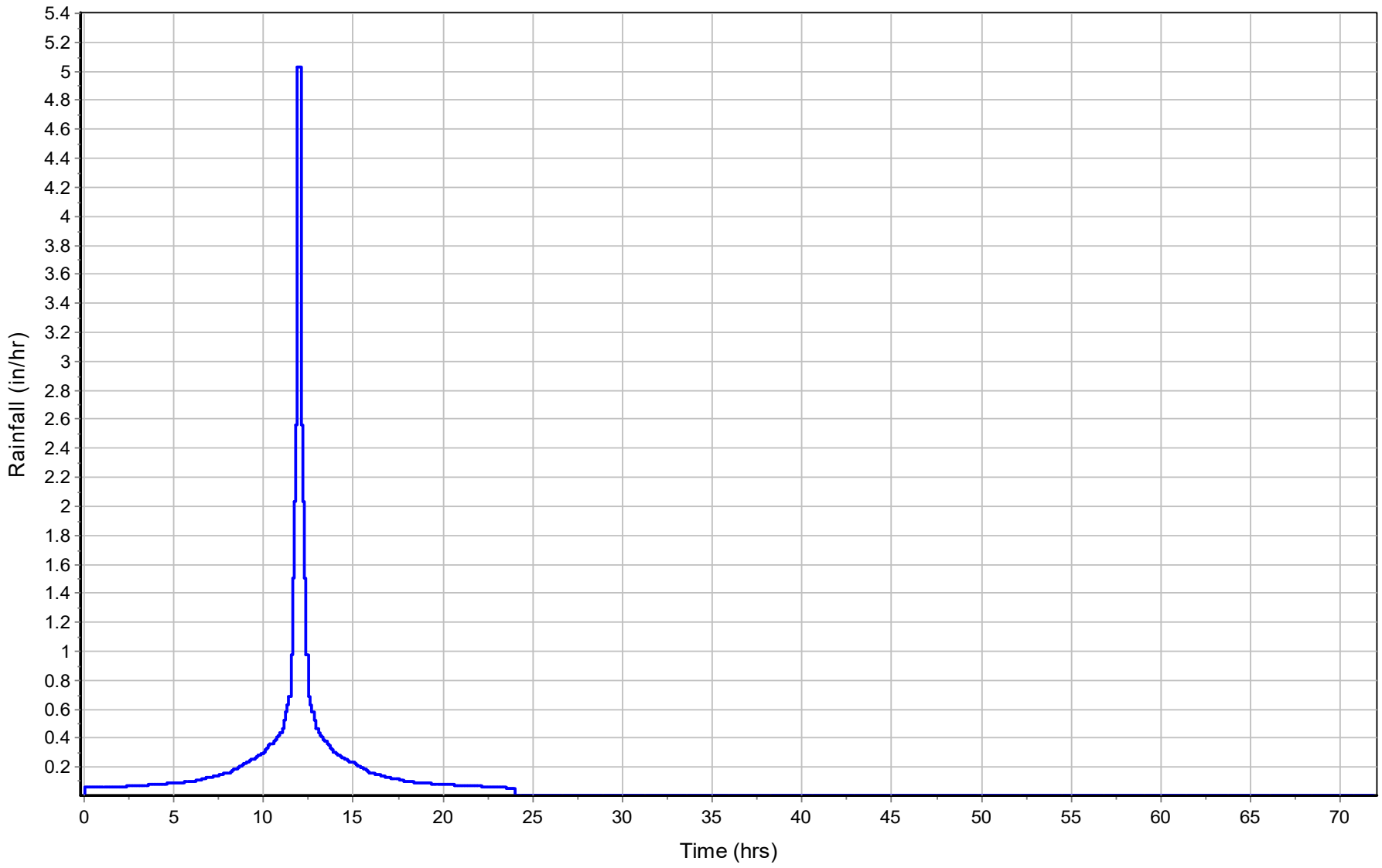
Total TOC (min) 7.35

Subbasin Runoff Results

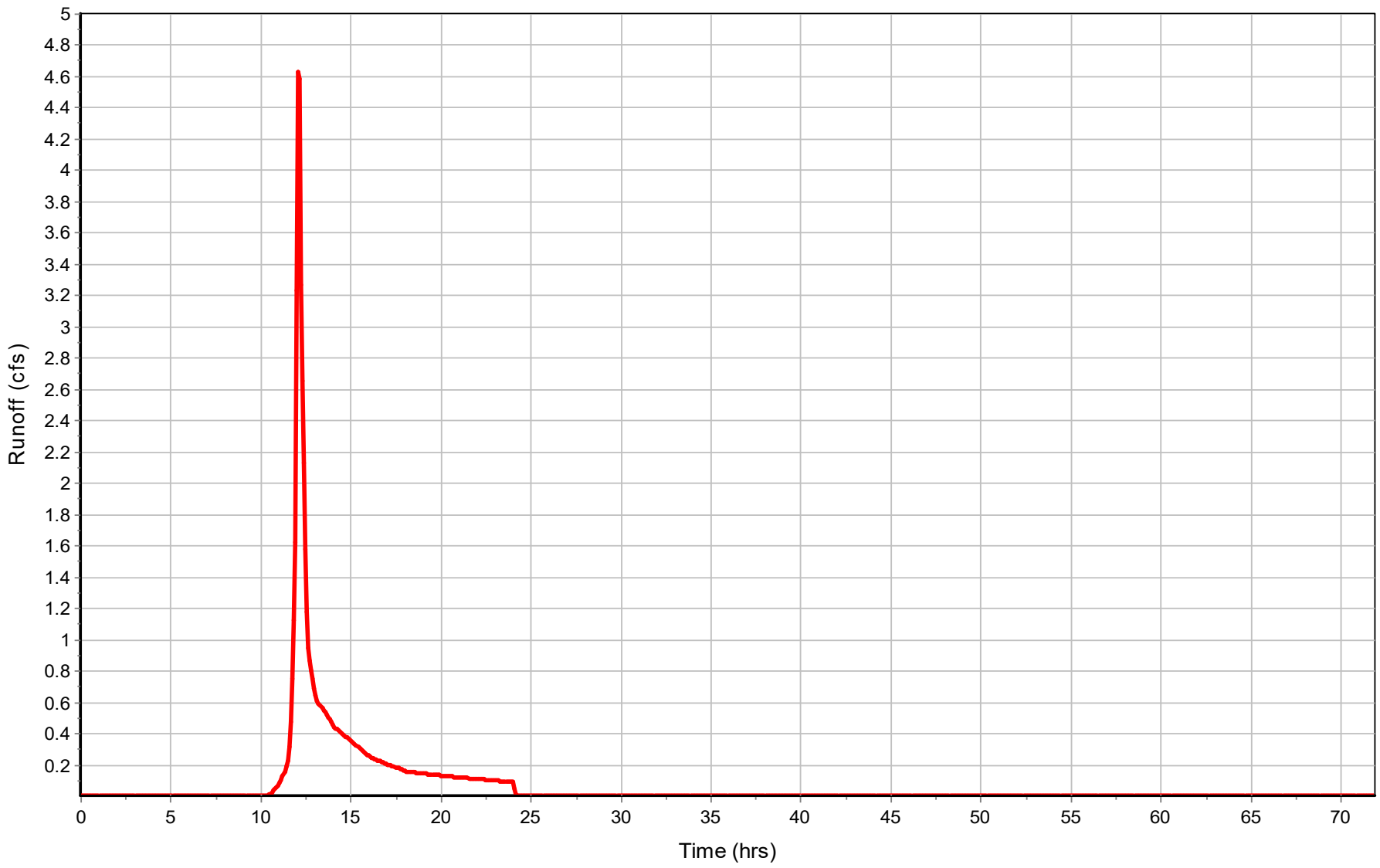
Total Rainfall (in) 5.98
Total Runoff (in) 2.05
Peak Runoff (cfs) 5
Weighted Curve Number 61.66
Time of Concentration (days hh:mm:ss) 0 00:07:21

Subbasin : Sub-A1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E03

Input Data

Area (ac) 0.48
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.48	A	43
Composite Area & Weighted CN	0.48		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	184.51	0	0
Slope (%) :	20	0	0
2 yr, 24 hr Rainfall (in) :	3.42	0	0
Velocity (ft/sec) :	0.13	0	0
Computed Flow Time (min) :	23.5	0	0

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	42	0	0
Slope (%) :	10	0	0
Surface Type :	Grass pasture	Unpaved	Unpaved
Velocity (ft/sec) :	2.21	0	0
Computed Flow Time (min) :	0.32	0	0

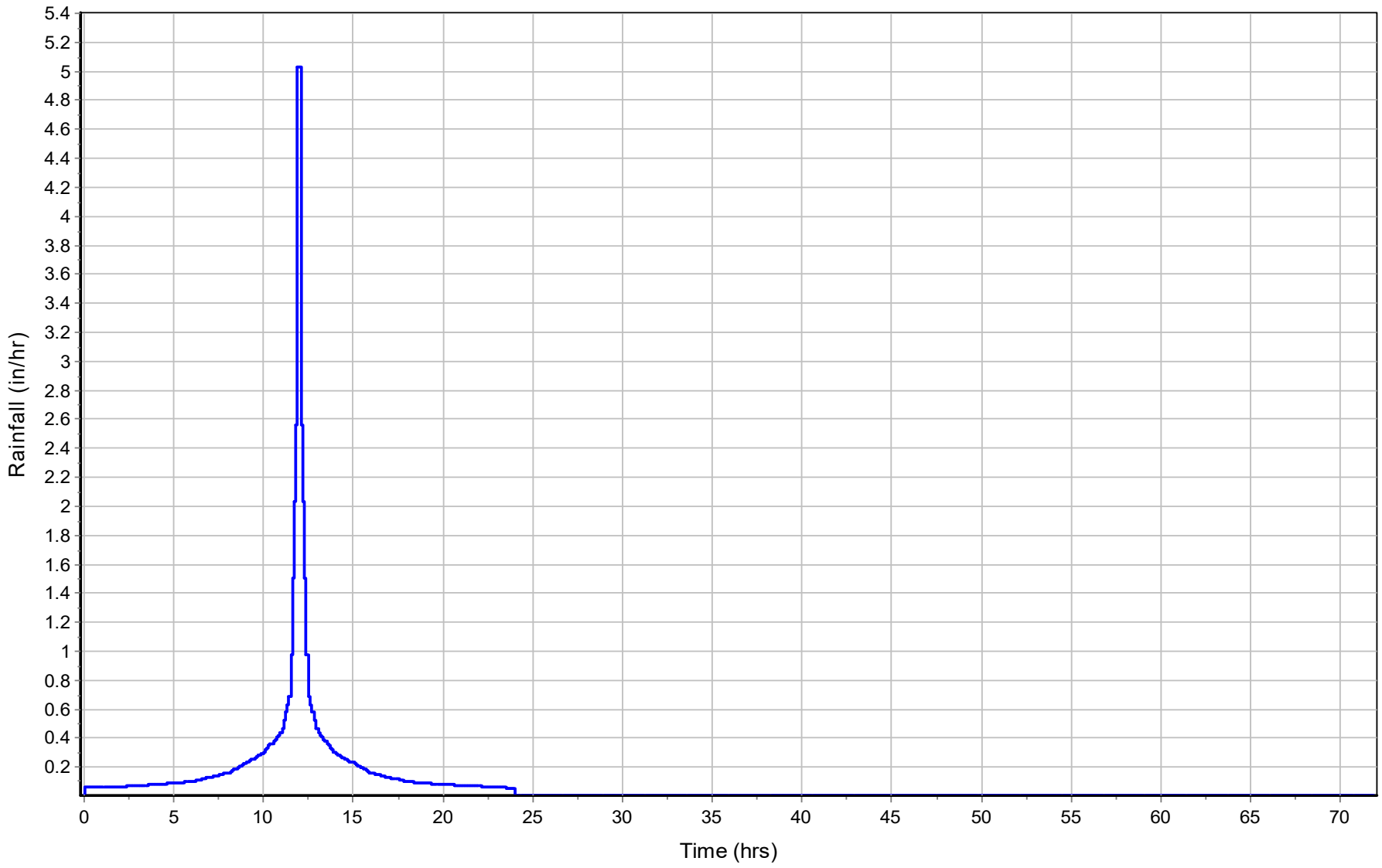
Total TOC (min) 23.82

Subbasin Runoff Results

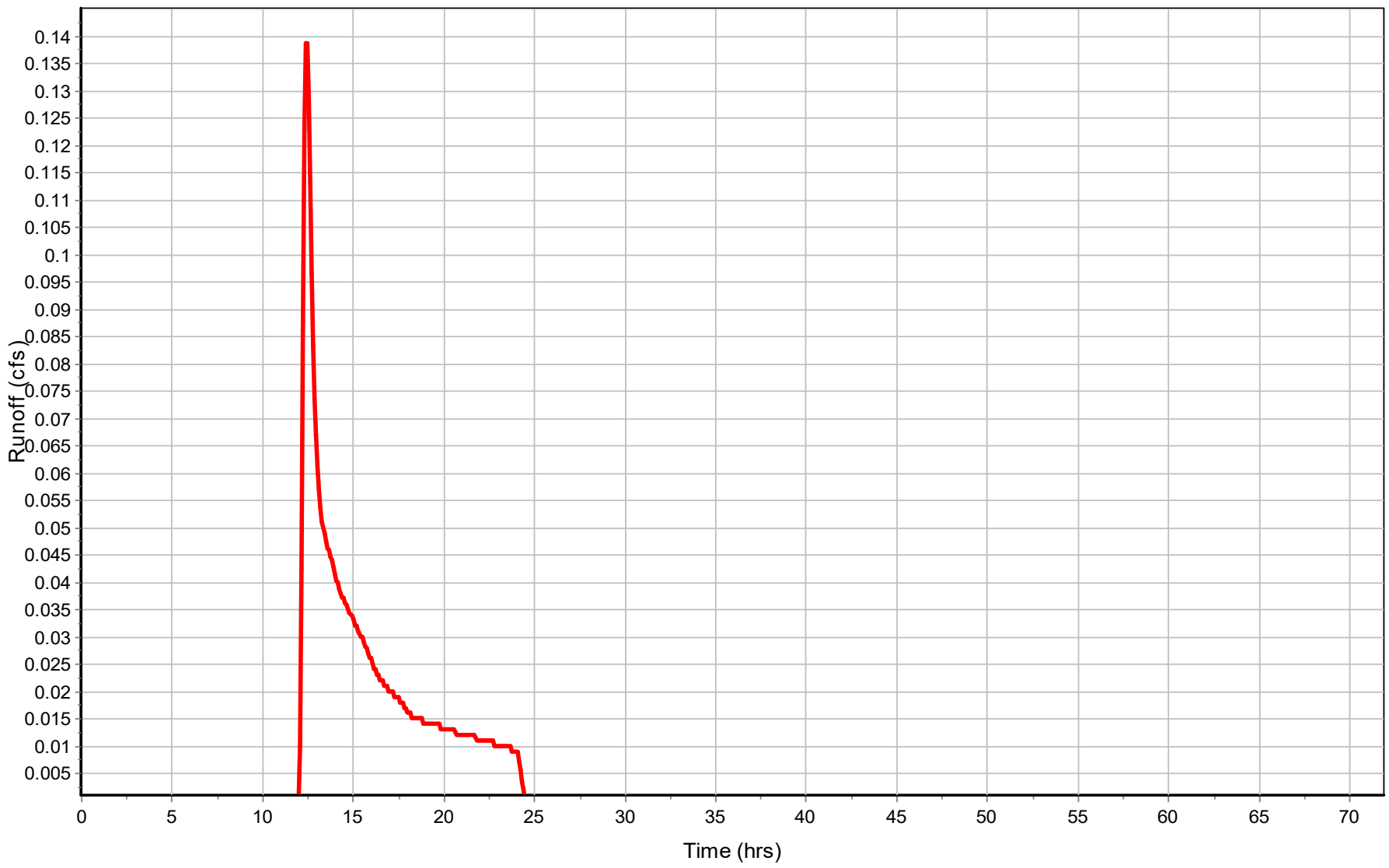
Total Rainfall (in) 5.98
Total Runoff (in) 0.67
Peak Runoff (cfs) 0.14
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:23:49

Subbasin : Sub-E03

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A1

Input Data

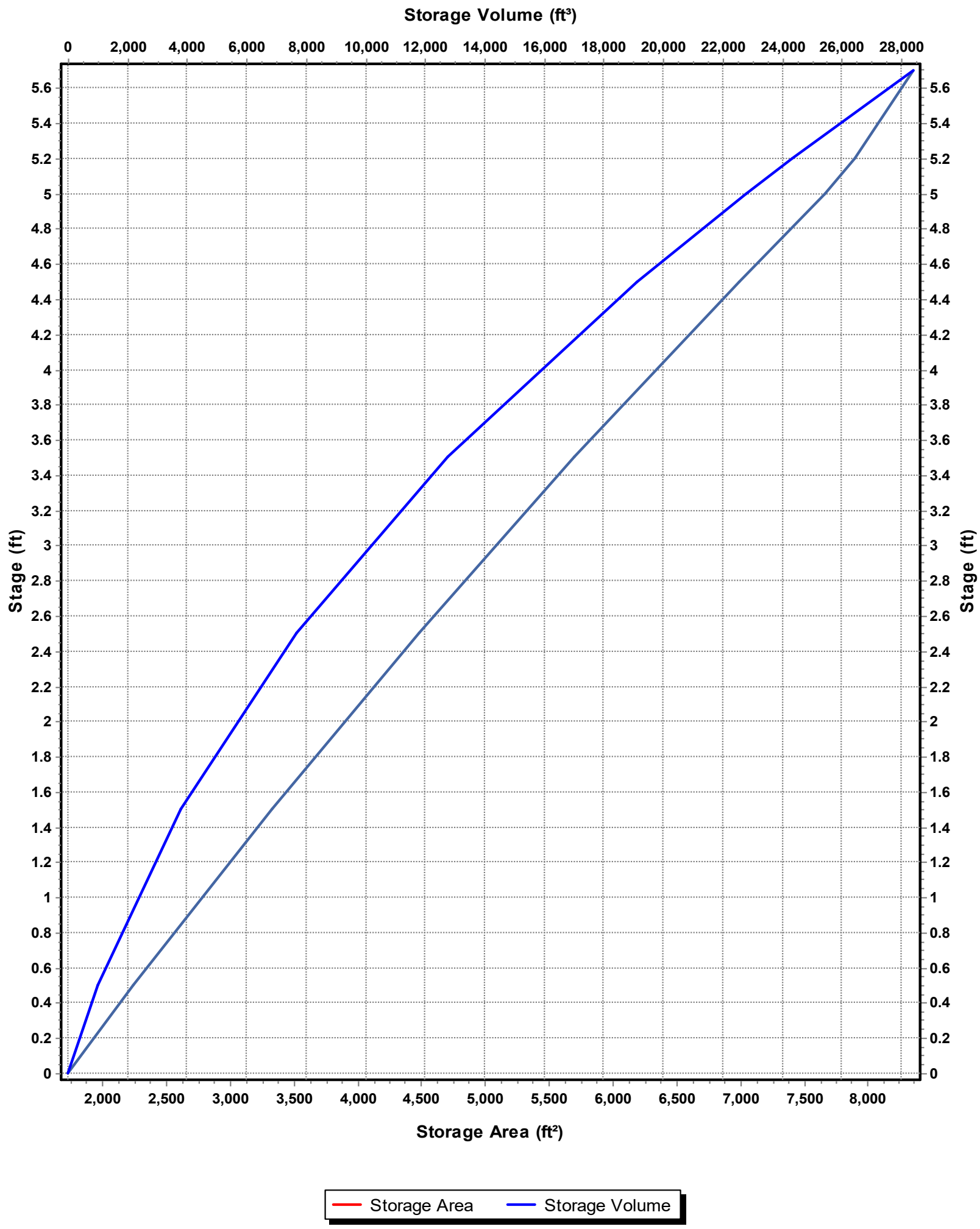
Invert Elevation (ft)	57.50
Max (Rim) Elevation (ft)	63.20
Max (Rim) Offset (ft)	5.70
Initial Water Elevation (ft)	57.50
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Basin-01

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	1730.97	0
0.5	2246.13	994.28
1.5	3328.81	3781.75
2.5	4481.3	7686.81
3.5	5703.61	12779.27
4.5	6995.74	19128.95
5	7667.99	22794.88
5.2	7895.95	24351.27
5.7	8357.69	28414.68

Storage Area Volume Curves



Storage Node : Basin-A1 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-BA1	Trapezoidal	No	62.70	5.20	5.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs) 4.6
Peak Lateral Inflow (cfs) 0
Peak Outflow (cfs) 0
Peak Exfiltration Flow Rate (cfm) 0
Max HGL Elevation Attained (ft) 61.66
Max HGL Depth Attained (ft) 4.16
Average HGL Elevation Attained (ft) 60.86
Average HGL Depth Attained (ft) 3.36
Time of Max HGL Occurrence (days hh:mm) 1 04:19
Total Exfiltration Volume (1000-ft^3) 0
Total Flooded Volume (ac-in) 0
Total Time Flooded (min) 0
Total Retention Time (sec) 0

Storage Node : Forebay-A1

Input Data

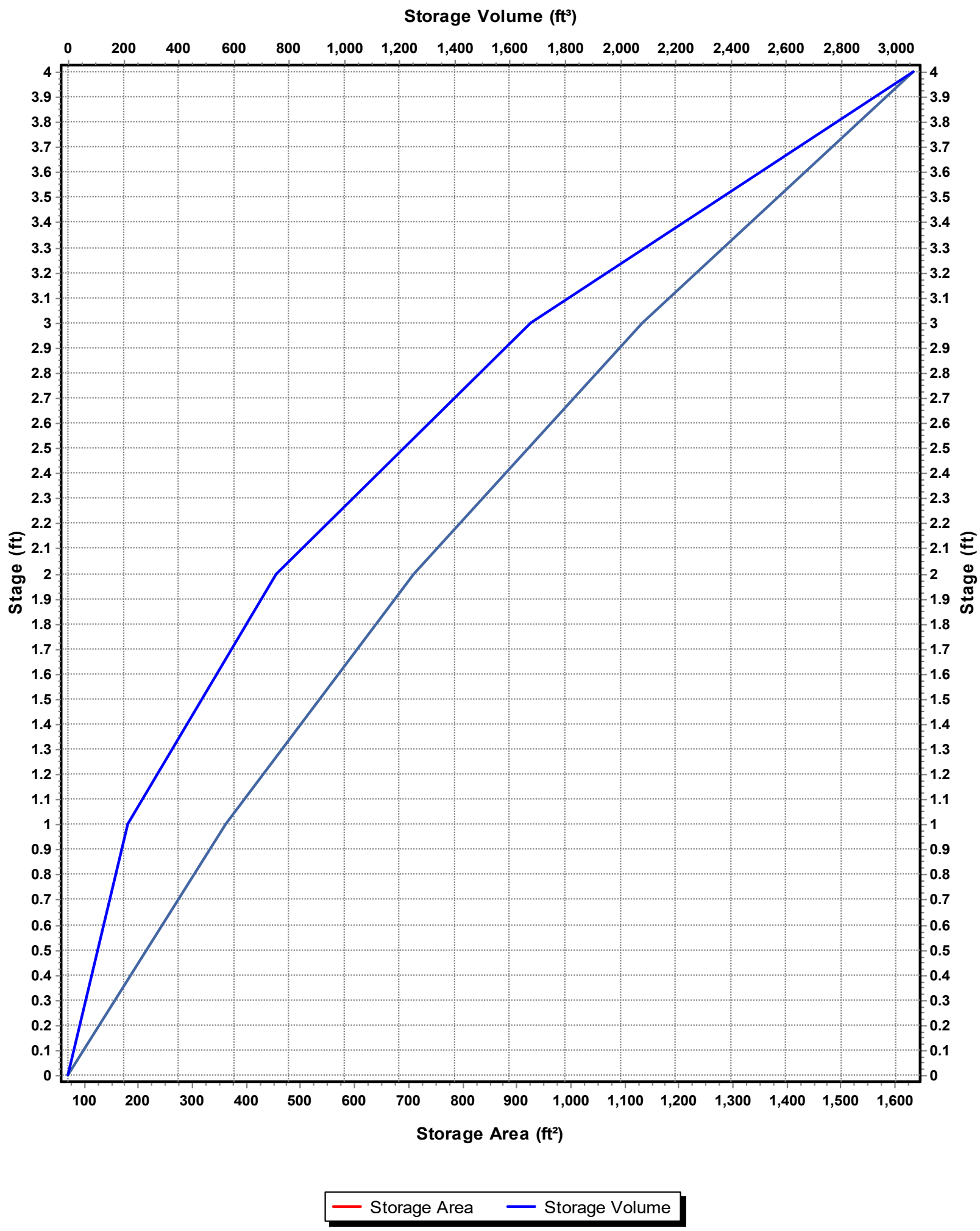
Invert Elevation (ft)	59.20
Max (Rim) Elevation (ft)	63.20
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	59.20
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Forebay-01

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	70.72	0
1	363.35	217.04
2	710.9	754.17
3	1134.81	1677.03
4	1635.08	3061.98

Storage Area Volume Curves



Storage Node : Forebay-A1 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-FA1	Trapezoidal	No	62.00	2.80	4.00	1.20	3.33

Output Summary Results

Peak Inflow (cfs)	4.62
Peak Lateral Inflow (cfs)	4.62
Peak Outflow (cfs)	4.6
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	62.42
Max HGL Depth Attained (ft)	3.22
Average HGL Elevation Attained (ft)	61.56
Average HGL Depth Attained (ft)	2.36
Time of Max HGL Occurrence (days hh:mm)	0 12:13
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Project Description

File Name ..... Bourne MyR_A1.SPF

Project Options

Flow Units ..... CFS
Elevation Type ..... Elevation
Hydrology Method ..... SCS TR-20
Time of Concentration (TOC) Method ..... SCS TR-55
Link Routing Method ..... Hydrodynamic
Enable Overflow Ponding at Nodes ..... YES
Skip Steady State Analysis Time Periods ..... NO

Analysis Options

Start Analysis On ..... oct. 14, 2021 0:00:00
End Analysis On ..... oct. 17, 2021 0:00:00
Start Reporting On ..... oct. 14, 2021 0:00:00
Antecedent Dry Days ..... 0 days
Runoff (Dry Weather) Time Step ..... 0 01:00:00 days hh:mm:ss
Runoff (Wet Weather) Time Step ..... 0 00:05:00 days hh:mm:ss
Reporting Time Step ..... 0 00:05:00 days hh:mm:ss
Routing Time Step ..... 30 seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	3
Nodes	4
Junctions	0
Outfalls	2
Flow Diversions	0
Inlets	0
Storage Nodes	2
Links	2
Channels	0
Pipes	0
Pumps	0
Orifices	0
Weirs	2
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	50 years	Intensity	inches	Massachusetts	None	50.00	6.73	SCS Type III 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Sub-03.1	0.16	484.00	43.00	6.73	0.96	0.15	0.08	0 00:23:46
2	Sub-A1	2.47	484.00	61.66	6.73	2.57	6.34	6.35	0 00:07:21
3	Sub-E03	0.48	484.00	43.00	6.73	0.96	0.46	0.24	0 00:23:49

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Out-A1	Outfall	62.00					0.08	62.00					
2	Out-E03	Outfall	62.00					0.23	62.00					
3	Basin-A1	Storage Node	57.50	63.20	57.50		0.00	5.87	62.29				0.00	0.00
4	Forebay-A1	Storage Node	59.20	63.20	59.20		0.00	5.92	62.49				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(ft)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
1	Weir-BA1	Weir	Basin-A1	Out-A1		57.50	62.00				0.00							
2	Weir-FA1	Weir	Forebay-A1	Basin-A1		59.20	57.50				5.87							

Subbasin Hydrology

Subbasin : Sub-03.1

Input Data

Area (ac) 0.16
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.16	A	43
Composite Area & Weighted CN	0.16		43

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft^2)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	130.15	0	0
Slope (%) :	10	0	0
2 yr, 24 hr Rainfall (in) :	3.42	0	0
Velocity (ft/sec) :	0.09	0	0
Computed Flow Time (min) :	23.46	0	0

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	42	0	0
Slope (%) :	10	0	0
Surface Type :	Grass pasture	Unpaved	Unpaved
Velocity (ft/sec) :	2.21	0	0
Computed Flow Time (min) :	0.32	0	0

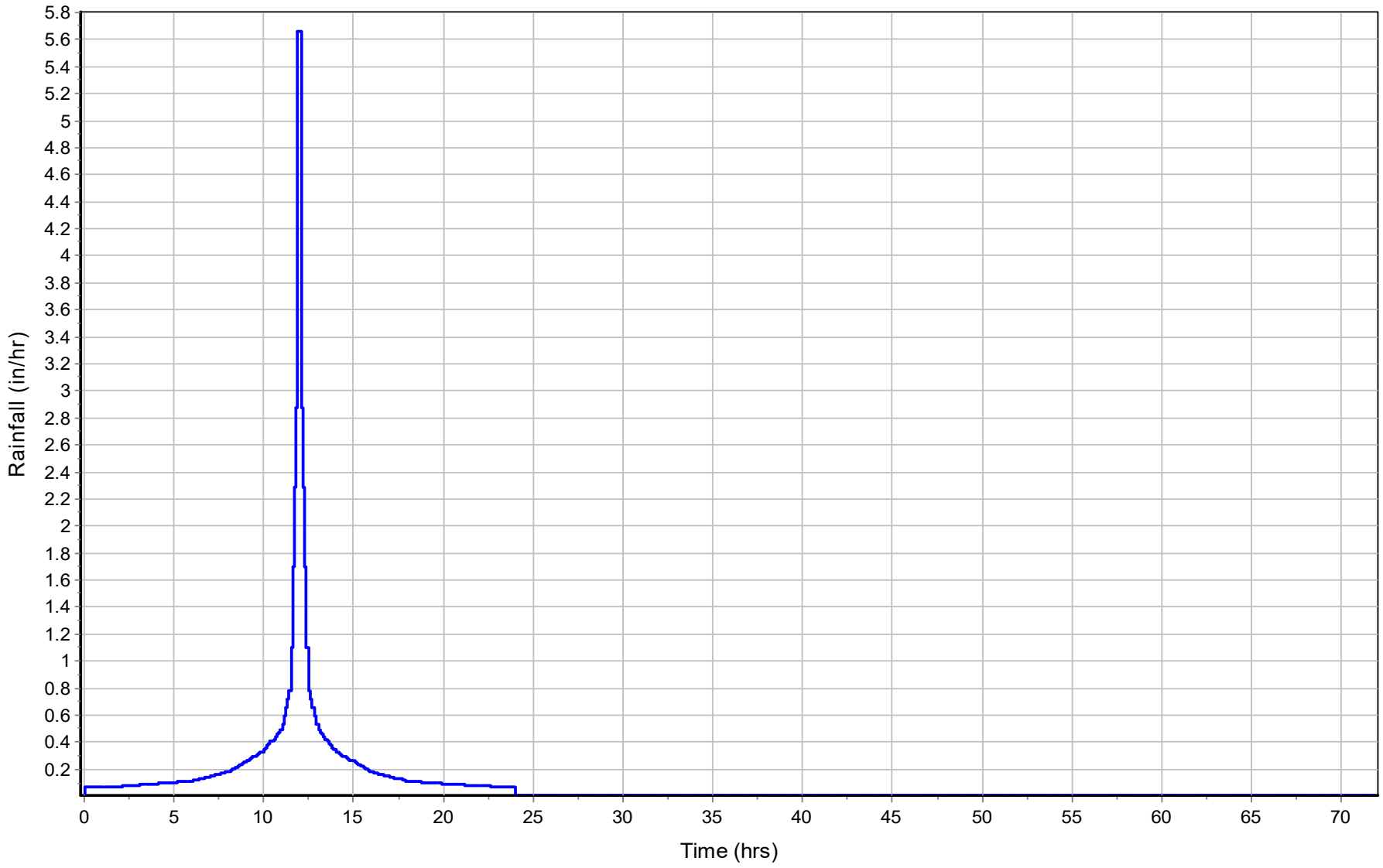
Total TOC (min) 23.77

Subbasin Runoff Results

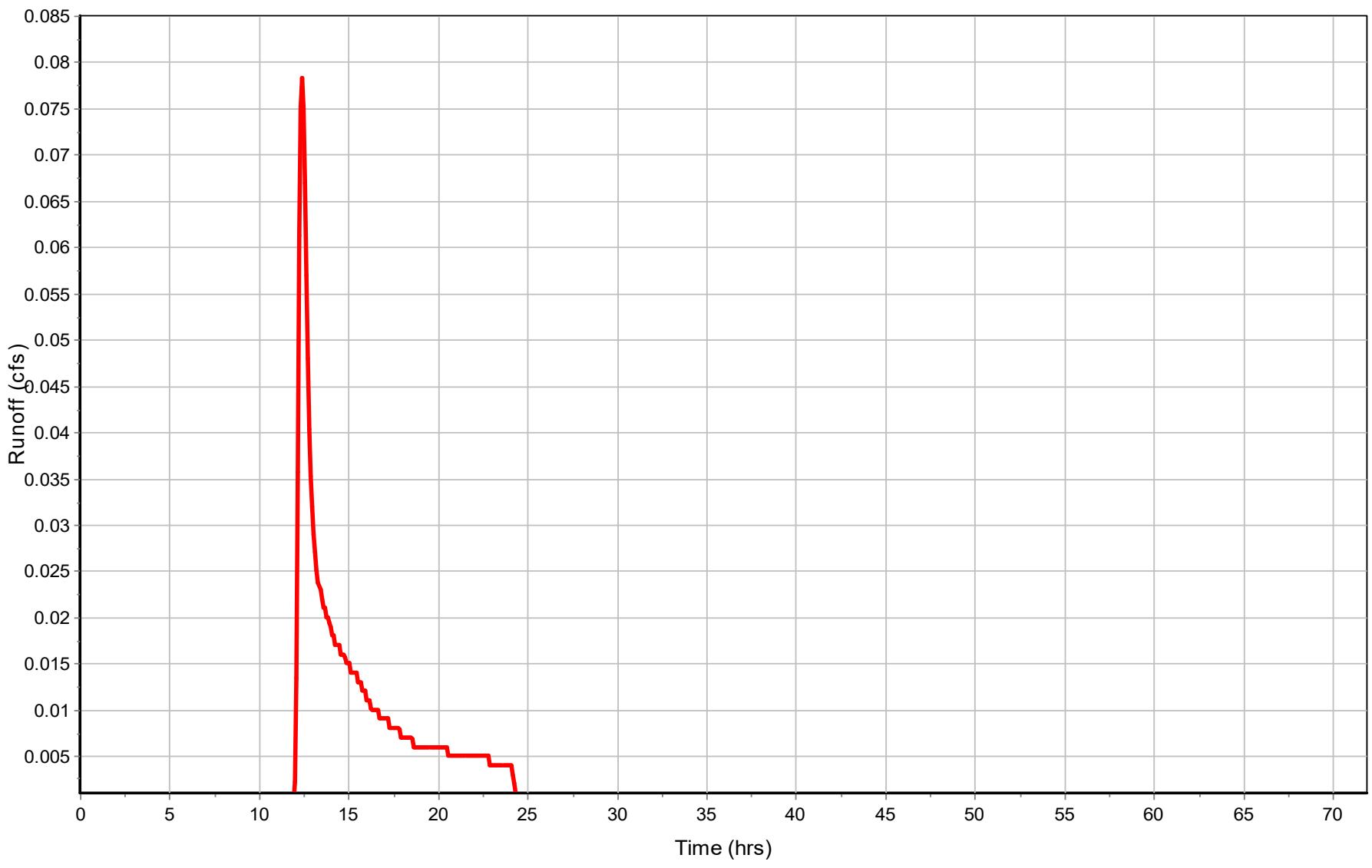
Total Rainfall (in)	6.73
Total Runoff (in)	0.96
Peak Runoff (cfs)	0.08
Weighted Curve Number	43
Time of Concentration (days hh:mm:ss)	0 00:23:46

Subbasin : Sub-03.1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-A1

Input Data

Area (ac) 2.47
Peak Rate Factor 484
Weighted Curve Number 61.66
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
50 - 75% grass cover, Fair	1.31	A	49
Gravel roads	1.16	A	76
Composite Area & Weighted CN	2.47		61.66

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	263.43	0	0
Slope (%) :	0.52	0	0
2 yr, 24 hr Rainfall (in) :	3.42	0	0
Velocity (ft/sec) :	0.79	0	0
Computed Flow Time (min) :	5.59	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	202.09	0	0
Channel Slope (%) :	0.4	0	0
Cross Section Area (ft^2) :	3	0	0
Wetted Perimeter (ft) :	6.32	0	0
Velocity (ft/sec) :	1.91	0	0
Computed Flow Time (min) :	1.76	0	0

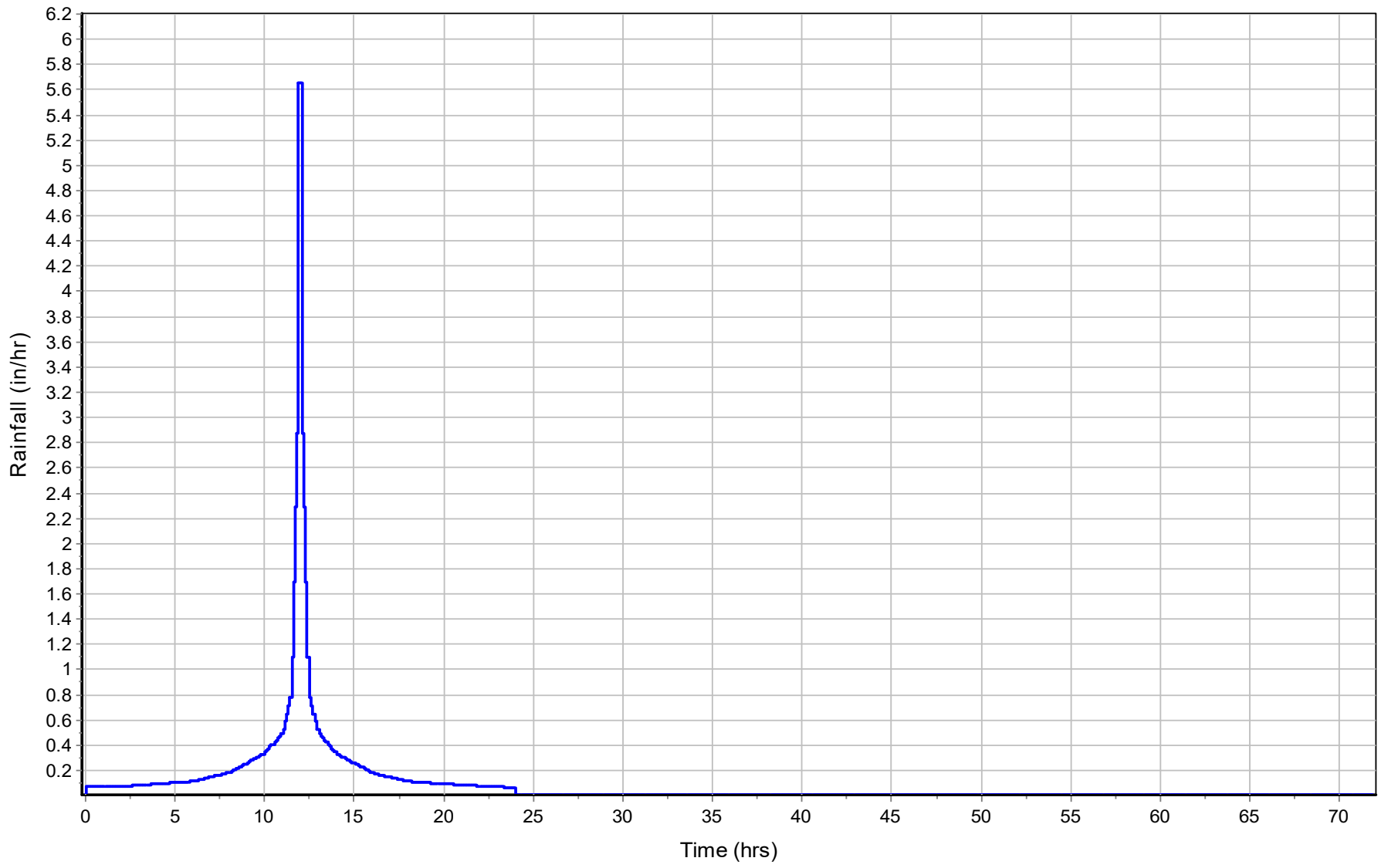
Total TOC (min) 7.35

Subbasin Runoff Results

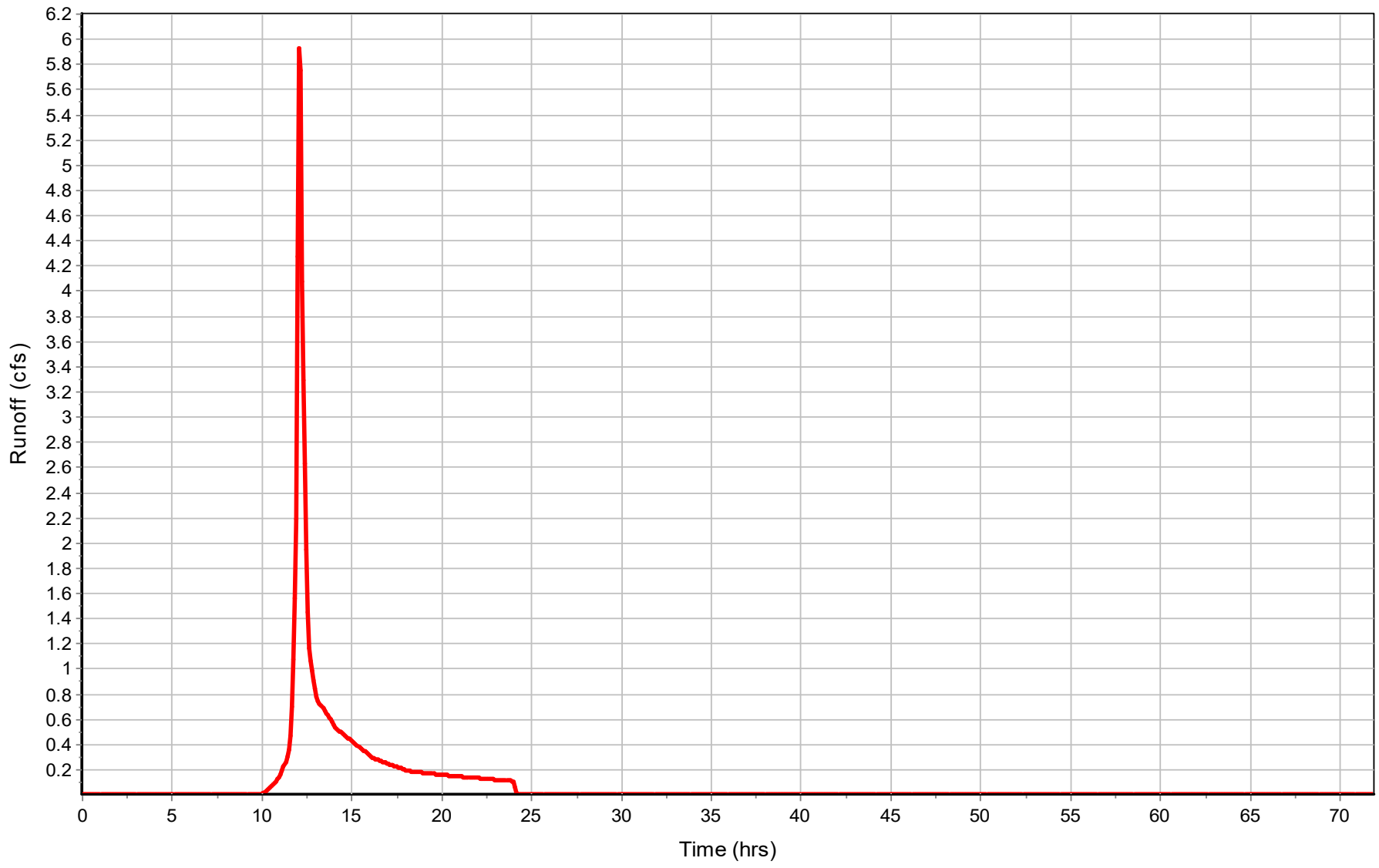
Total Rainfall (in) 6.73
Total Runoff (in) 2.57
Peak Runoff (cfs) 6.35
Weighted Curve Number 61.66
Time of Concentration (days hh:mm:ss) 0 00:07:21

Subbasin : Sub-A1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E03

Input Data

Area (ac) 0.48
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.48	A	43
Composite Area & Weighted CN	0.48		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	184.51	0	0
Slope (%) :	20	0	0
2 yr, 24 hr Rainfall (in) :	3.42	0	0
Velocity (ft/sec) :	0.13	0	0
Computed Flow Time (min) :	23.5	0	0

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	42	0	0
Slope (%) :	10	0	0
Surface Type :	Grass pasture	Unpaved	Unpaved
Velocity (ft/sec) :	2.21	0	0
Computed Flow Time (min) :	0.32	0	0

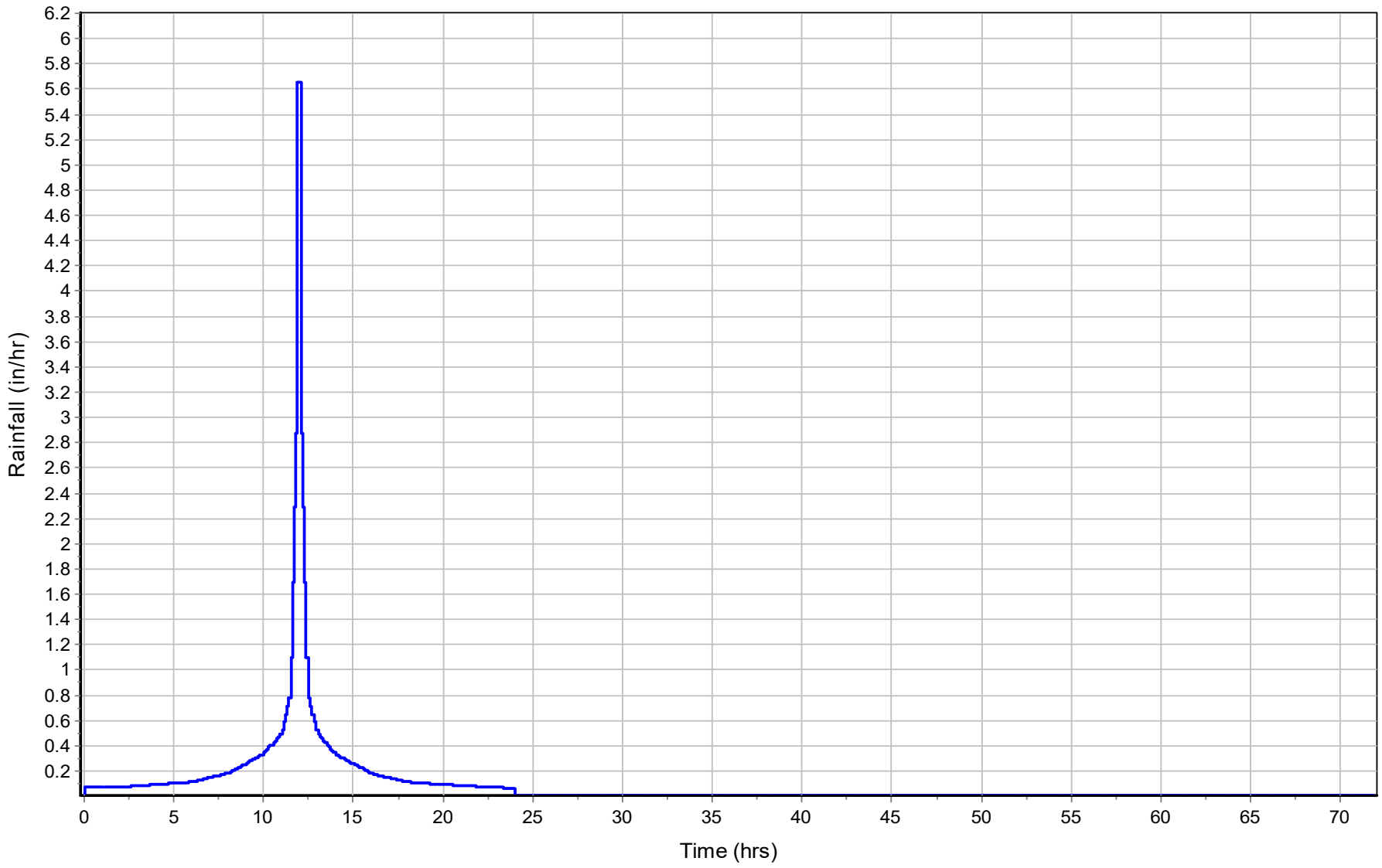
Total TOC (min) 23.82

Subbasin Runoff Results

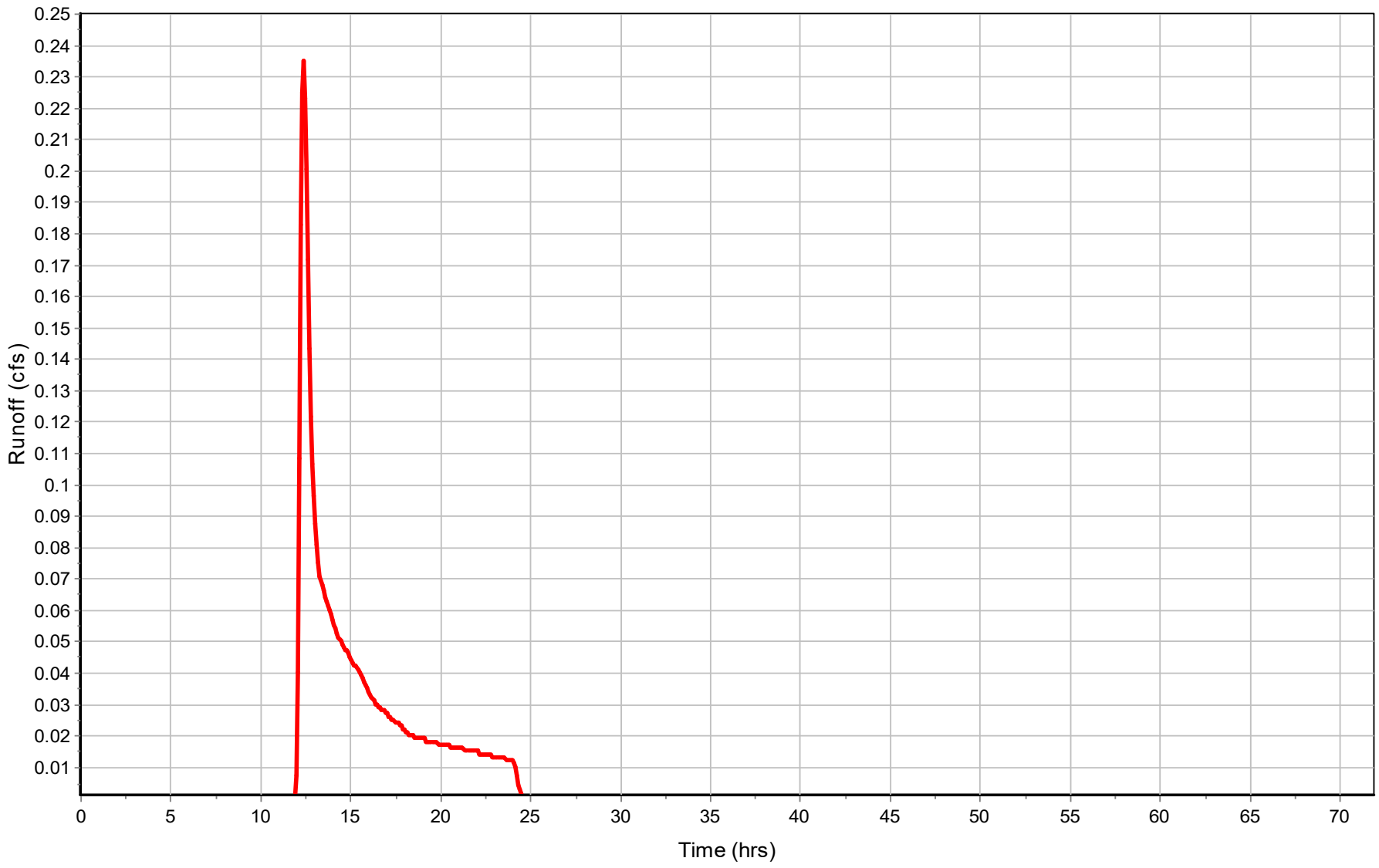
Total Rainfall (in) 6.73
Total Runoff (in) 0.96
Peak Runoff (cfs) 0.24
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:23:49

Subbasin : Sub-E03

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A1

Input Data

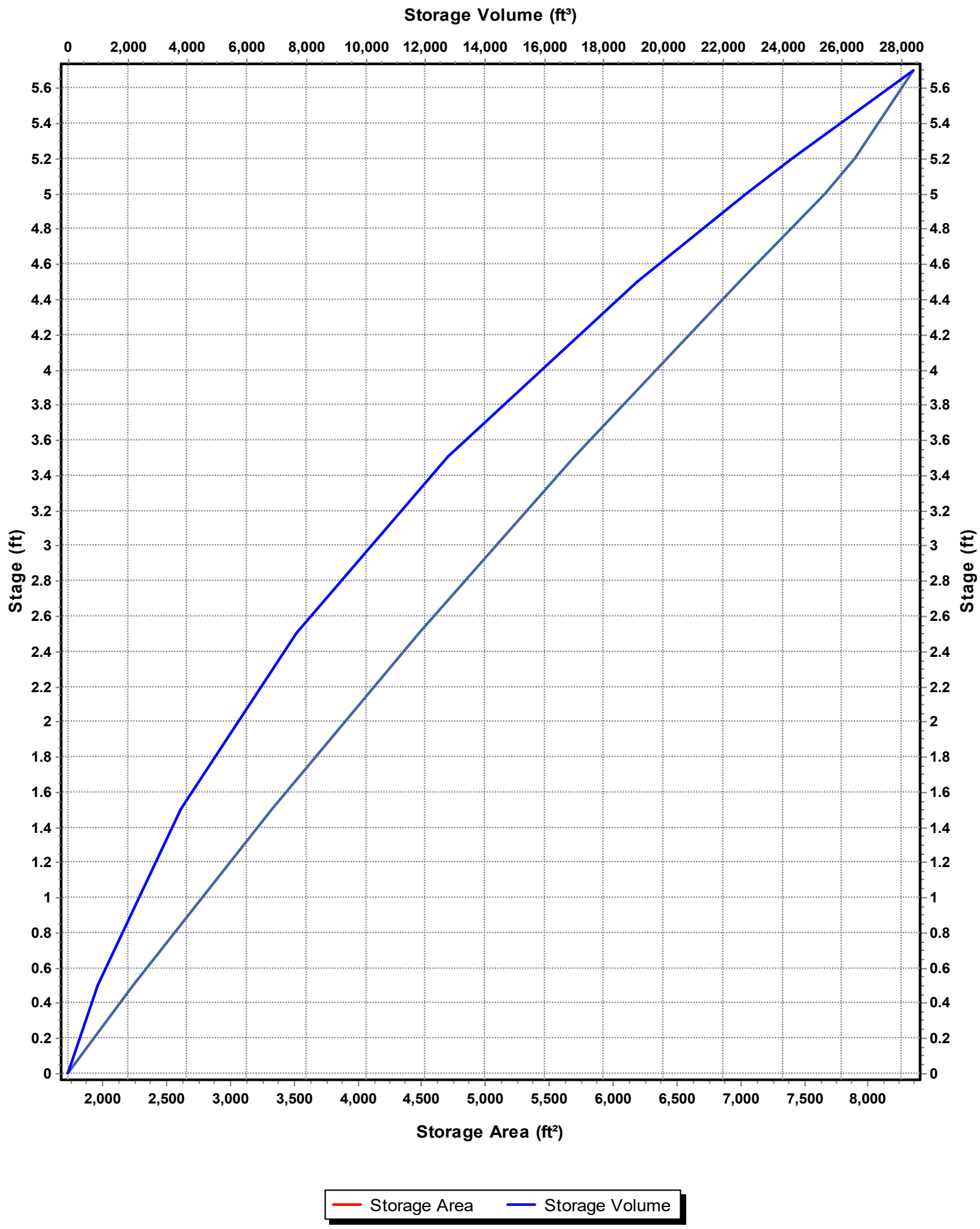
Invert Elevation (ft)	57.50
Max (Rim) Elevation (ft)	63.20
Max (Rim) Offset (ft)	5.70
Initial Water Elevation (ft)	57.50
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Basin-01

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	1730.97	0
0.5	2246.13	994.28
1.5	3328.81	3781.75
2.5	4481.3	7686.81
3.5	5703.61	12779.27
4.5	6995.74	19128.95
5	7667.99	22794.88
5.2	7895.95	24351.27
5.7	8357.69	28414.68

Storage Area Volume Curves



Storage Node : Basin-A1 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-BA1	Trapezoidal	No	62.70	5.20	5.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs) 5.87
Peak Lateral Inflow (cfs) 0
Peak Outflow (cfs) 0
Peak Exfiltration Flow Rate (cfm) 0
Max HGL Elevation Attained (ft) 62.29
Max HGL Depth Attained (ft) 4.79
Average HGL Elevation Attained (ft) 61.38
Average HGL Depth Attained (ft) 3.88
Time of Max HGL Occurrence (days hh:mm) 3 00:00
Total Exfiltration Volume (1000-ft^3) 0
Total Flooded Volume (ac-in) 0
Total Time Flooded (min) 0
Total Retention Time (sec) 0

Storage Node : Forebay-A1

Input Data

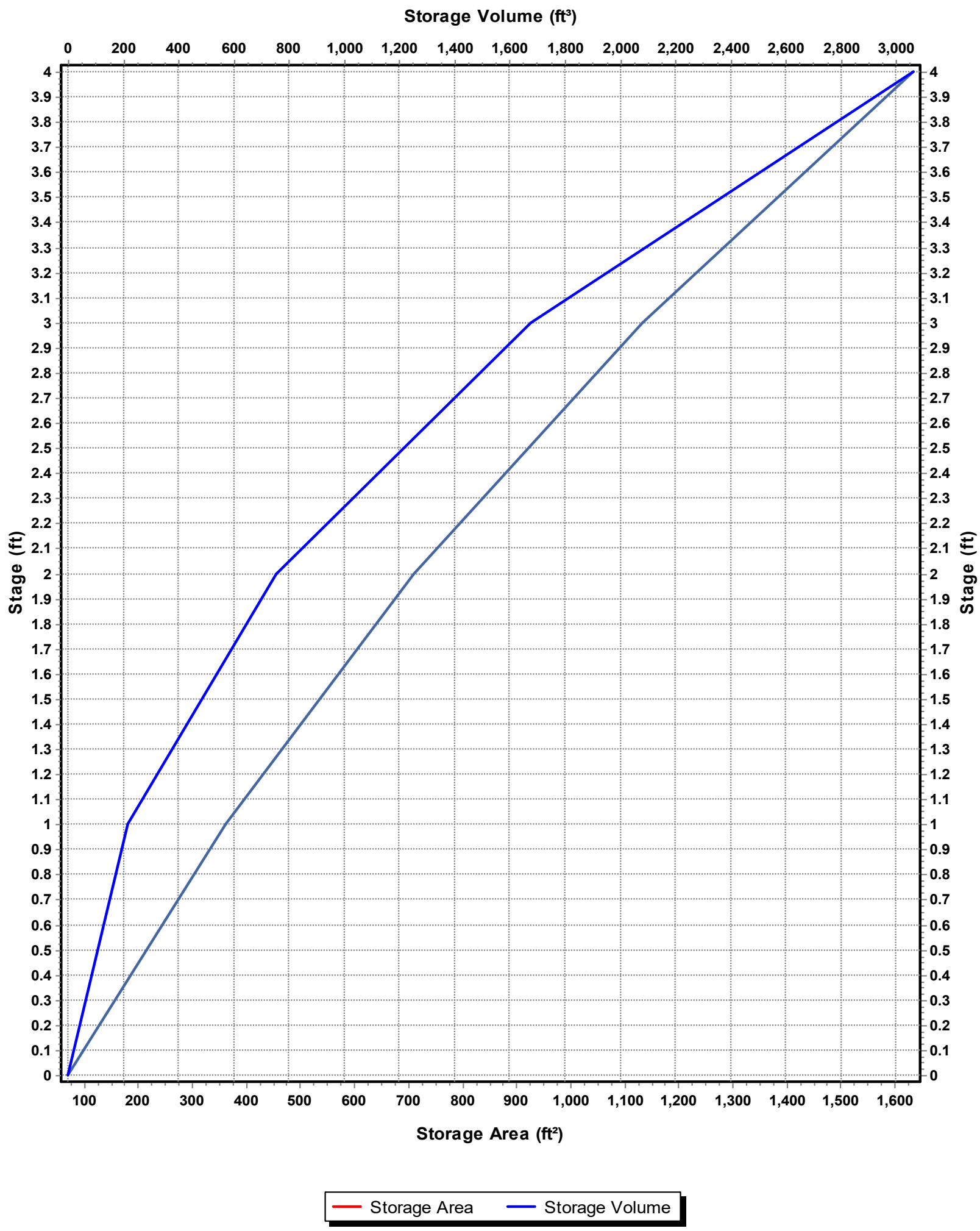
Invert Elevation (ft)	59.20
Max (Rim) Elevation (ft)	63.20
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	59.20
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Forebay-01

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	70.72	0
1	363.35	217.04
2	710.9	754.17
3	1134.81	1677.03
4	1635.08	3061.98

Storage Area Volume Curves



Storage Node : Forebay-A1 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-FA1	Trapezoidal	No	62.00	2.80	4.00	1.20	3.33

Output Summary Results

Peak Inflow (cfs)	5.92
Peak Lateral Inflow (cfs)	5.92
Peak Outflow (cfs)	5.87
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	62.49
Max HGL Depth Attained (ft)	3.29
Average HGL Elevation Attained (ft)	61.78
Average HGL Depth Attained (ft)	2.58
Time of Max HGL Occurrence (days hh:mm)	0 12:11
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Project Description

File Name ..... Bourne MyR_A1.SPF

Project Options

Flow Units ..... CFS
Elevation Type ..... Elevation
Hydrology Method ..... SCS TR-20
Time of Concentration (TOC) Method ..... SCS TR-55
Link Routing Method ..... Hydrodynamic
Enable Overflow Ponding at Nodes ..... YES
Skip Steady State Analysis Time Periods ..... NO

Analysis Options

Start Analysis On ..... oct. 14, 2021 0:00:00
End Analysis On ..... oct. 17, 2021 0:00:00
Start Reporting On ..... oct. 14, 2021 0:00:00
Antecedent Dry Days ..... 0 days
Runoff (Dry Weather) Time Step ..... 0 01:00:00 days hh:mm:ss
Runoff (Wet Weather) Time Step ..... 0 00:05:00 days hh:mm:ss
Reporting Time Step ..... 0 00:05:00 days hh:mm:ss
Routing Time Step ..... 30 seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	3
Nodes	4
Junctions	0
Outfalls	2
Flow Diversions	0
Inlets	0
Storage Nodes	2
Links	2
Channels	0
Pipes	0
Pumps	0
Orifices	0
Weirs	2
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	100 years	Intensity	inches	Massachusetts	None	100.00	7.50	SCS Type III 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Sub-03.1	0.16	484.00	43.00	7.50	1.30	0.21	0.12	0 00:23:46
2	Sub-A1	2.47	484.00	61.66	7.50	3.14	7.74	7.79	0 00:07:21
3	Sub-E03	0.48	484.00	43.00	7.50	1.30	0.62	0.35	0 00:23:49

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Out-A1	Outfall	62.00					0.14	62.00					
2	Out-E03	Outfall	62.00					0.35	62.00					
3	Basin-A1	Storage Node	57.50	63.20	57.50		0.00	7.28	62.74				0.00	0.00
4	Forebay-A1	Storage Node	59.20	63.20	59.20		0.00	7.34	62.76				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(ft)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
1	Weir-BA1	Weir	Basin-A1	Out-A1		57.50	62.00				0.13							
2	Weir-FA1	Weir	Forebay-A1	Basin-A1		59.20	57.50				7.28							

Subbasin Hydrology

Subbasin : Sub-03.1

Input Data

Area (ac) 0.16
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.16	A	43
Composite Area & Weighted CN	0.16		43

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft^2)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	130.15	0	0
Slope (%) :	10	0	0
2 yr, 24 hr Rainfall (in) :	3.42	0	0
Velocity (ft/sec) :	0.09	0	0
Computed Flow Time (min) :	23.46	0	0

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	42	0	0
Slope (%) :	10	0	0
Surface Type :	Grass pasture	Unpaved	Unpaved
Velocity (ft/sec) :	2.21	0	0
Computed Flow Time (min) :	0.32	0	0

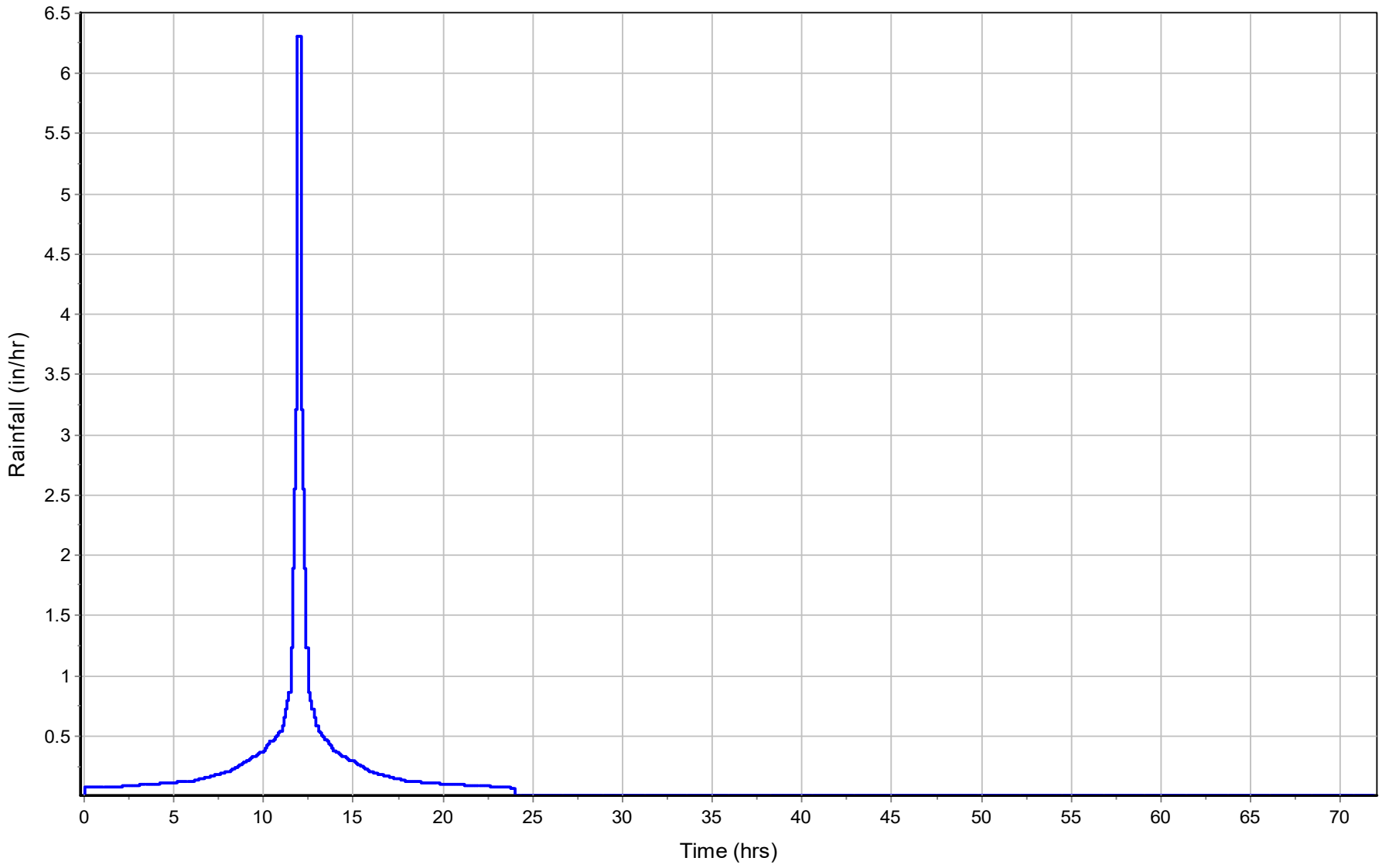
Total TOC (min) 23.77

Subbasin Runoff Results

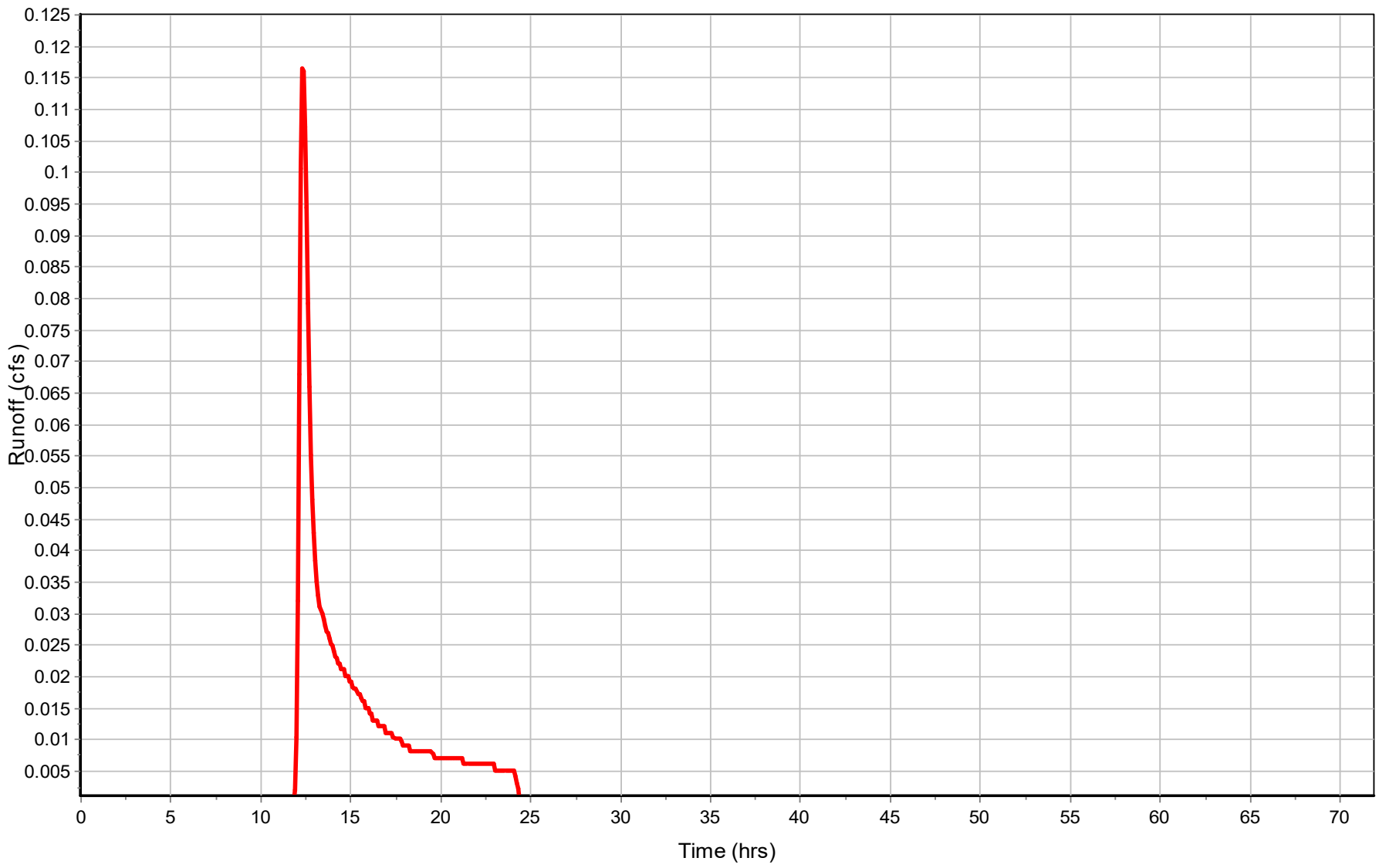
Total Rainfall (in)	7.5
Total Runoff (in)	1.3
Peak Runoff (cfs)	0.12
Weighted Curve Number	43
Time of Concentration (days hh:mm:ss)	0 00:23:46

Subbasin : Sub-03.1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-A1

Input Data

Area (ac) 2.47
Peak Rate Factor 484
Weighted Curve Number 61.66
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
50 - 75% grass cover, Fair	1.31	A	49
Gravel roads	1.16	A	76
Composite Area & Weighted CN	2.47		61.66

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	263.43	0	0
Slope (%) :	0.52	0	0
2 yr, 24 hr Rainfall (in) :	3.42	0	0
Velocity (ft/sec) :	0.79	0	0
Computed Flow Time (min) :	5.59	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	202.09	0	0
Channel Slope (%) :	0.4	0	0
Cross Section Area (ft^2) :	3	0	0
Wetted Perimeter (ft) :	6.32	0	0
Velocity (ft/sec) :	1.91	0	0
Computed Flow Time (min) :	1.76	0	0

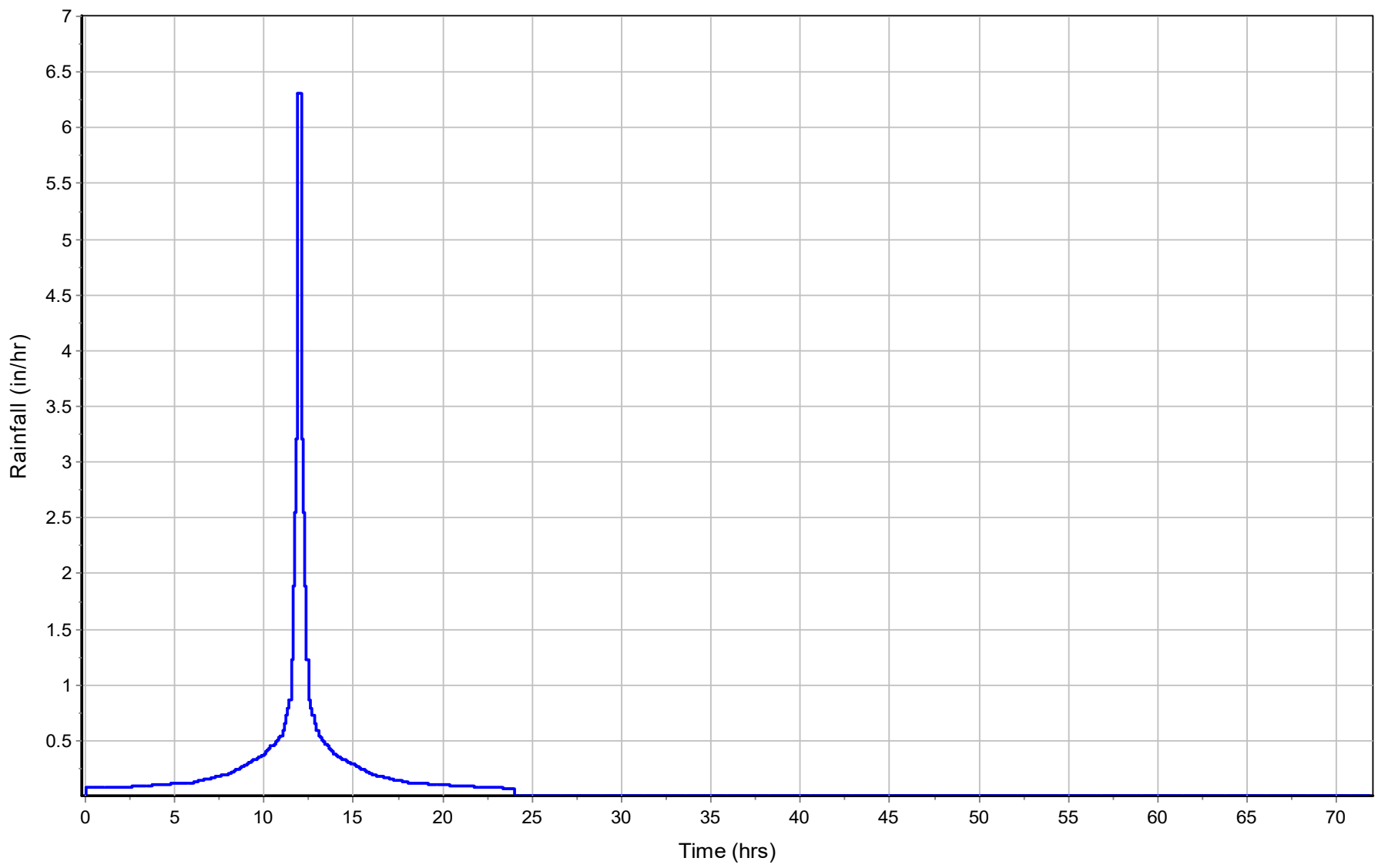
Total TOC (min) 7.35

Subbasin Runoff Results

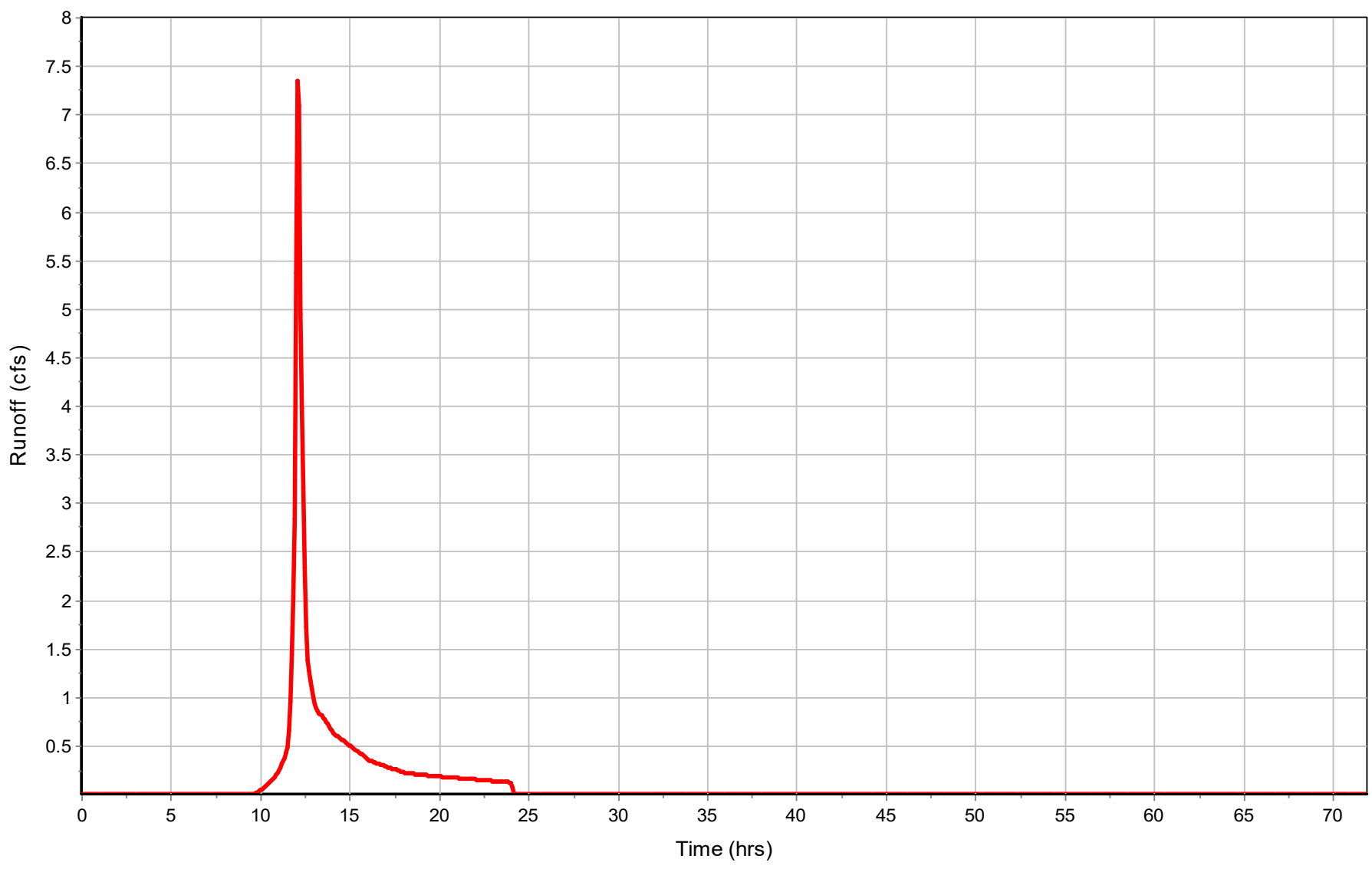
Total Rainfall (in) 7.5
Total Runoff (in) 3.14
Peak Runoff (cfs) 7.79
Weighted Curve Number 61.66
Time of Concentration (days hh:mm:ss) 0 00:07:21

Subbasin : Sub-A1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E03

Input Data

Area (ac) 0.48
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.48	A	43
Composite Area & Weighted CN	0.48		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	184.51	0	0
Slope (%) :	20	0	0
2 yr, 24 hr Rainfall (in) :	3.42	0	0
Velocity (ft/sec) :	0.13	0	0
Computed Flow Time (min) :	23.5	0	0

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	42	0	0
Slope (%) :	10	0	0
Surface Type :	Grass pasture	Unpaved	Unpaved
Velocity (ft/sec) :	2.21	0	0
Computed Flow Time (min) :	0.32	0	0

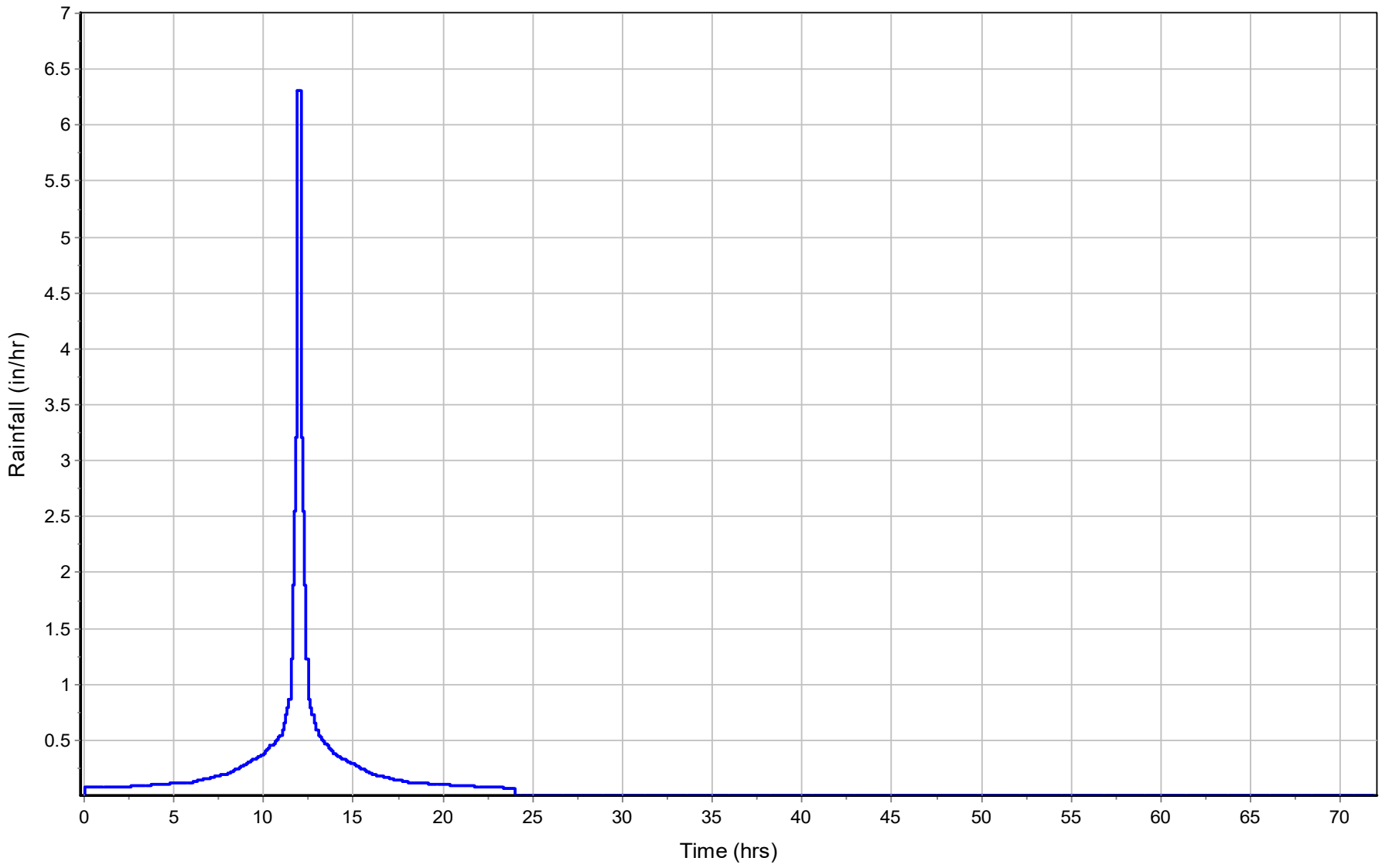
Total TOC (min) 23.82

Subbasin Runoff Results

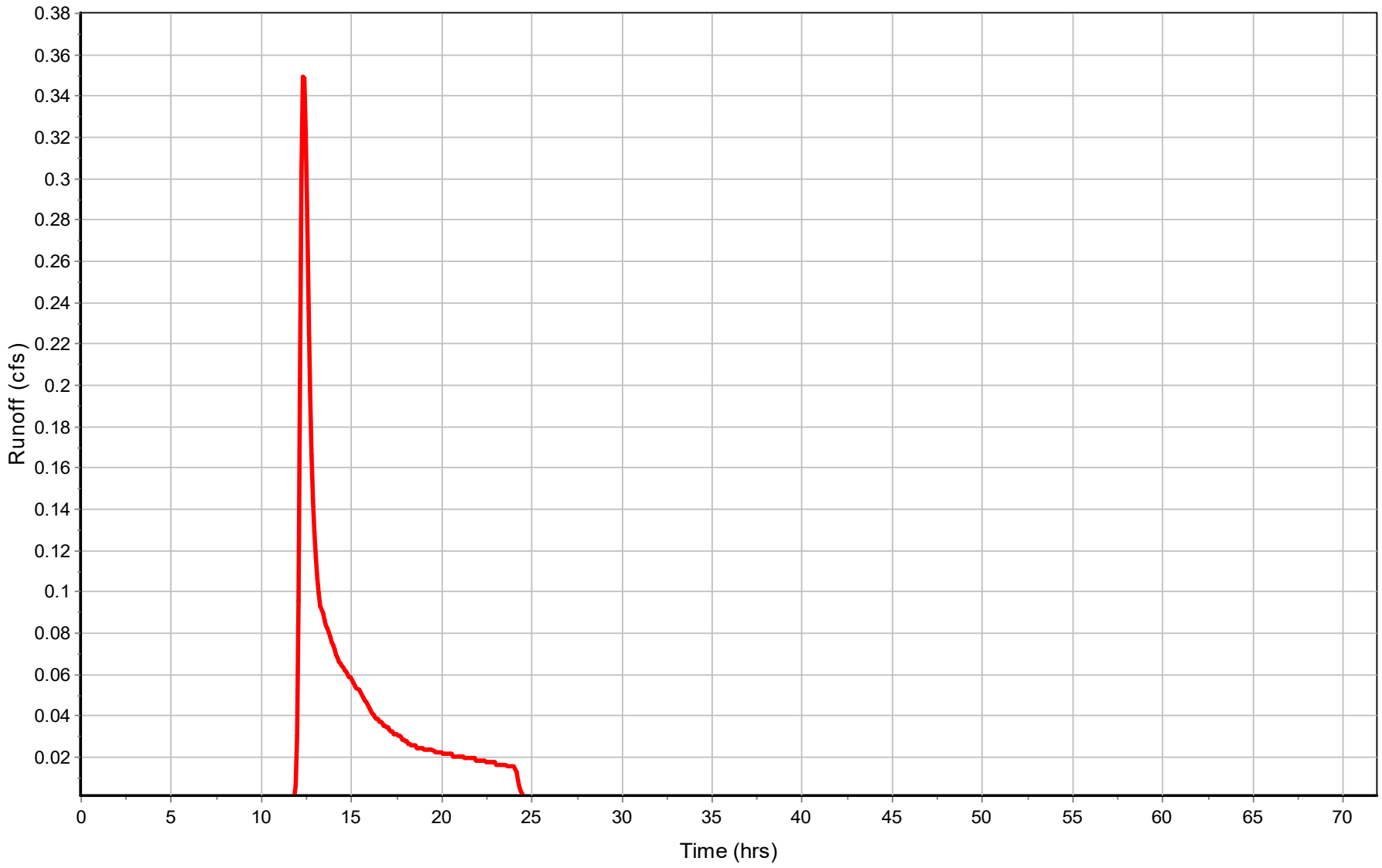
Total Rainfall (in) 7.5
Total Runoff (in) 1.3
Peak Runoff (cfs) 0.35
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:23:49

Subbasin : Sub-E03

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A1

Input Data

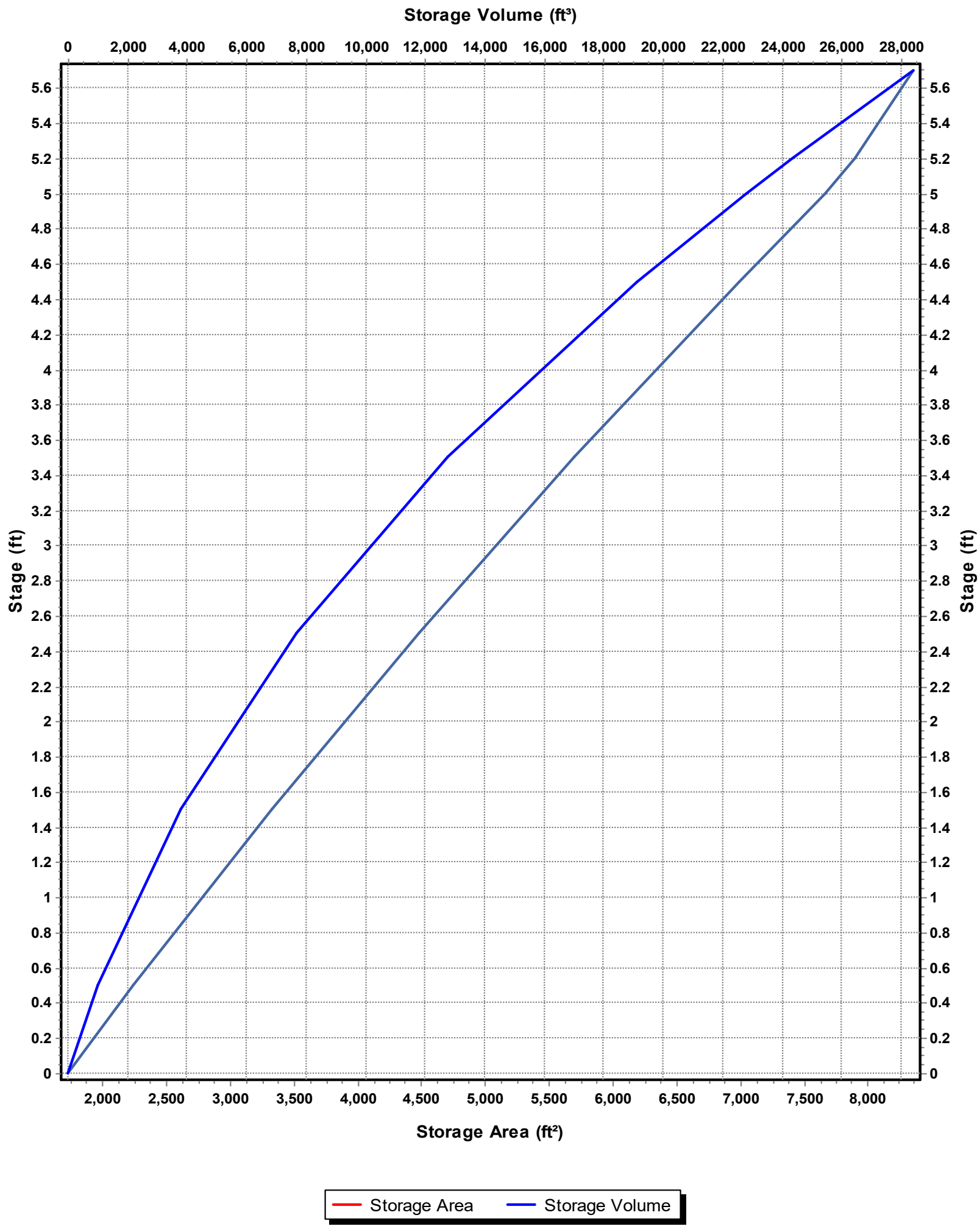
Invert Elevation (ft)	57.50
Max (Rim) Elevation (ft)	63.20
Max (Rim) Offset (ft)	5.70
Initial Water Elevation (ft)	57.50
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Basin-01

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	1730.97	0
0.5	2246.13	994.28
1.5	3328.81	3781.75
2.5	4481.3	7686.81
3.5	5703.61	12779.27
4.5	6995.74	19128.95
5	7667.99	22794.88
5.2	7895.95	24351.27
5.7	8357.69	28414.68

Storage Area Volume Curves



Storage Node : Basin-A1 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-BA1	Trapezoidal	No	62.70	5.20	5.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	7.28
Peak Lateral Inflow (cfs)	0
Peak Outflow (cfs)	1.07
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	62.74
Max HGL Depth Attained (ft)	5.24
Average HGL Elevation Attained (ft)	61.75
Average HGL Depth Attained (ft)	4.25
Time of Max HGL Occurrence (days hh:mm)	0 23:13
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Forebay-A1

Input Data

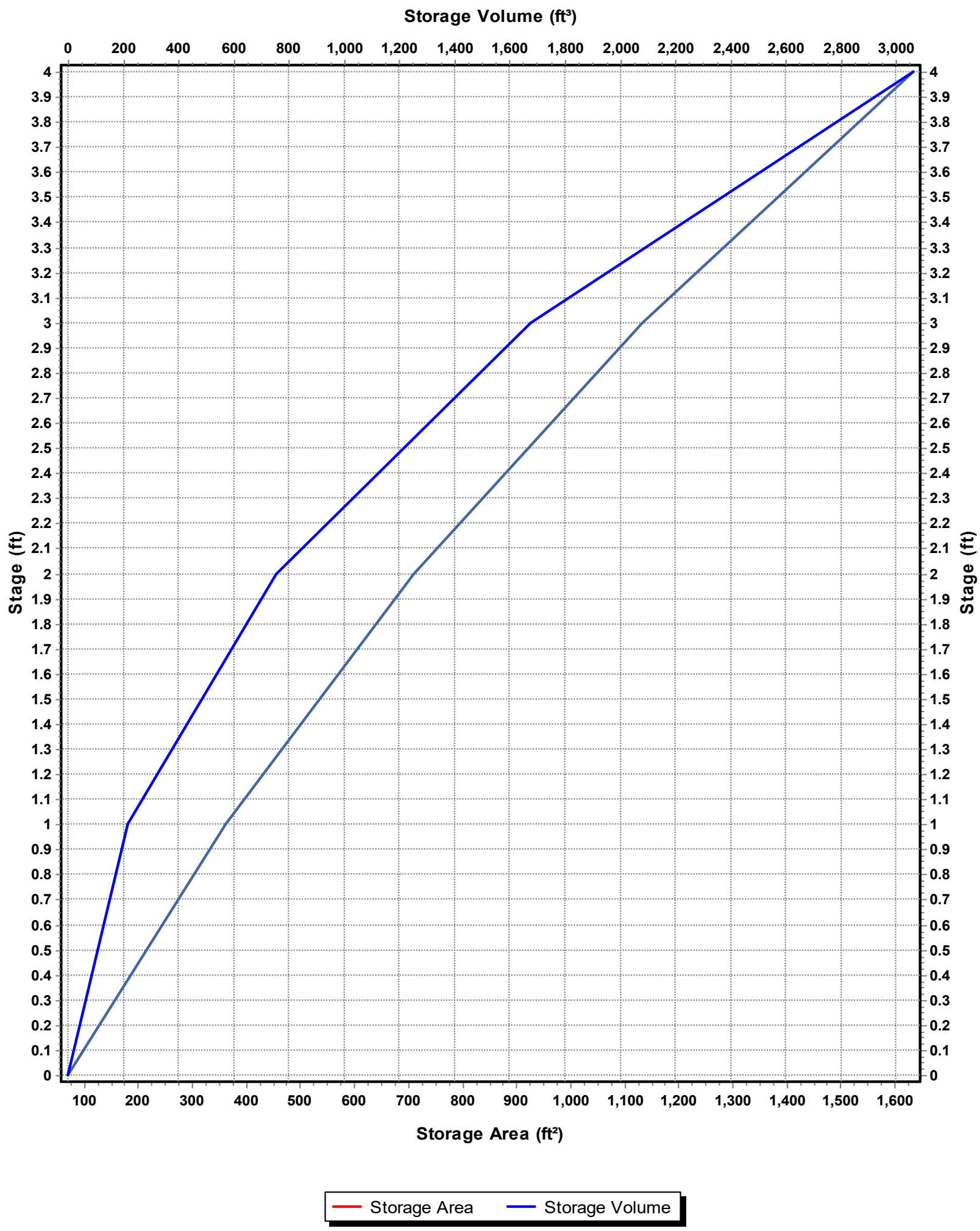
Invert Elevation (ft)	59.20
Max (Rim) Elevation (ft)	63.20
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	59.20
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Forebay-01

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	70.72	0
1	363.35	217.04
2	710.9	754.17
3	1134.81	1677.03
4	1635.08	3061.98

Storage Area Volume Curves



Storage Node : Forebay-A1 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-FA1	Trapezoidal	No	62.00	2.80	4.00	1.20	3.33

Output Summary Results

Peak Inflow (cfs)	7.34
Peak Lateral Inflow (cfs)	7.34
Peak Outflow (cfs)	7.28
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	62.76
Max HGL Depth Attained (ft)	3.56
Average HGL Elevation Attained (ft)	62.12
Average HGL Depth Attained (ft)	2.92
Time of Max HGL Occurrence (days hh:mm)	0 23:08
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Project Description

File Name ..... Bourne MyR_A1.SPF

Project Options

Flow Units ..... CFS
Elevation Type ..... Elevation
Hydrology Method ..... SCS TR-20
Time of Concentration (TOC) Method ..... SCS TR-55
Link Routing Method ..... Hydrodynamic
Enable Overflow Ponding at Nodes ..... YES
Skip Steady State Analysis Time Periods ..... NO

Analysis Options

Start Analysis On	oct. 14, 2021	0:00:00
End Analysis On	oct. 17, 2021	0:00:00
Start Reporting On	oct. 14, 2021	0:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins.....	3
Nodes.....	4
Junctions	0
Outfalls	2
Flow Diversions	0
Inlets	0
Storage Nodes	2
Links.....	2
Channels	0
Pipes	0
Pumps	0
Orifices	0
Weirs	2
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	50 Years 2070	Intensity	inches	Massachusetts	None	50.00	8.80	SCS Type III 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Sub-03.1	0.16	484.00	43.00	8.80	1.95	0.31	0.20	0 00:23:46
2	Sub-A1	2.47	484.00	61.66	8.80	4.15	10.22	10.33	0 00:07:21
3	Sub-E03	0.48	484.00	43.00	8.80	1.95	0.94	0.59	0 00:23:49

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Out-A1	Outfall	62.00					0.59	62.00					
2	Out-E03	Outfall	62.00					0.59	62.00					
3	Basin-A1	Storage Node	57.50	63.20	57.50		0.00	9.73	62.80				0.00	0.00
4	Forebay-A1	Storage Node	59.20	63.20	59.20		0.00	9.81	62.82				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(ft)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
1	Weir-BA1	Weir	Basin-A1	Out-A1		57.50	62.00				0.57							
2	Weir-FA1	Weir	Forebay-A1	Basin-A1		59.20	57.50				9.73							

Subbasin Hydrology

Subbasin : Sub-03.1

Input Data

Area (ac) 0.16
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.16	A	43
Composite Area & Weighted CN	0.16		43

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft^2)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	130.15	0	0
Slope (%) :	10	0	0
2 yr, 24 hr Rainfall (in) :	3.42	0	0
Velocity (ft/sec) :	0.09	0	0
Computed Flow Time (min) :	23.46	0	0

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	42	0	0
Slope (%) :	10	0	0
Surface Type :	Grass pasture	Unpaved	Unpaved
Velocity (ft/sec) :	2.21	0	0
Computed Flow Time (min) :	0.32	0	0

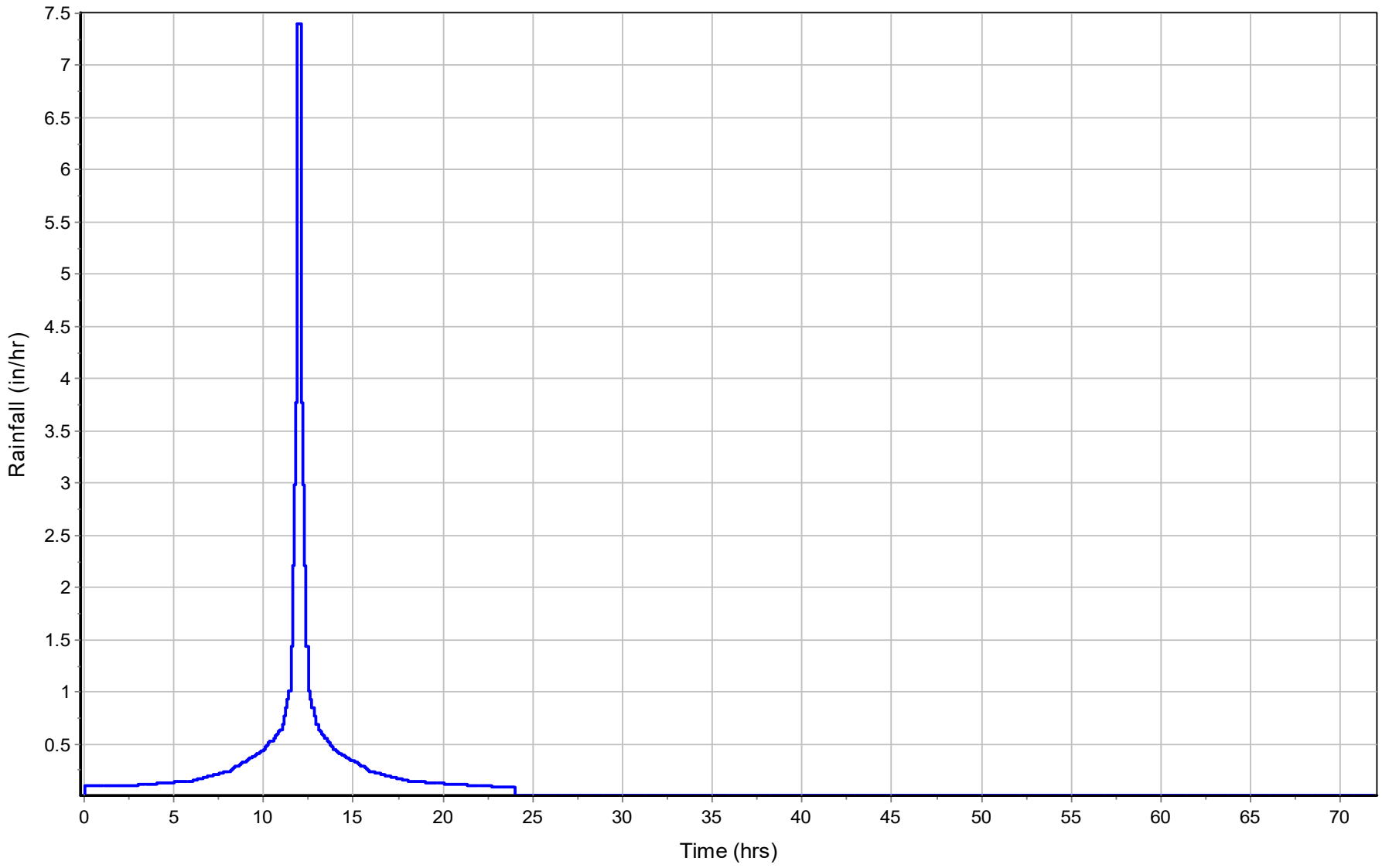
Total TOC (min) 23.77

Subbasin Runoff Results

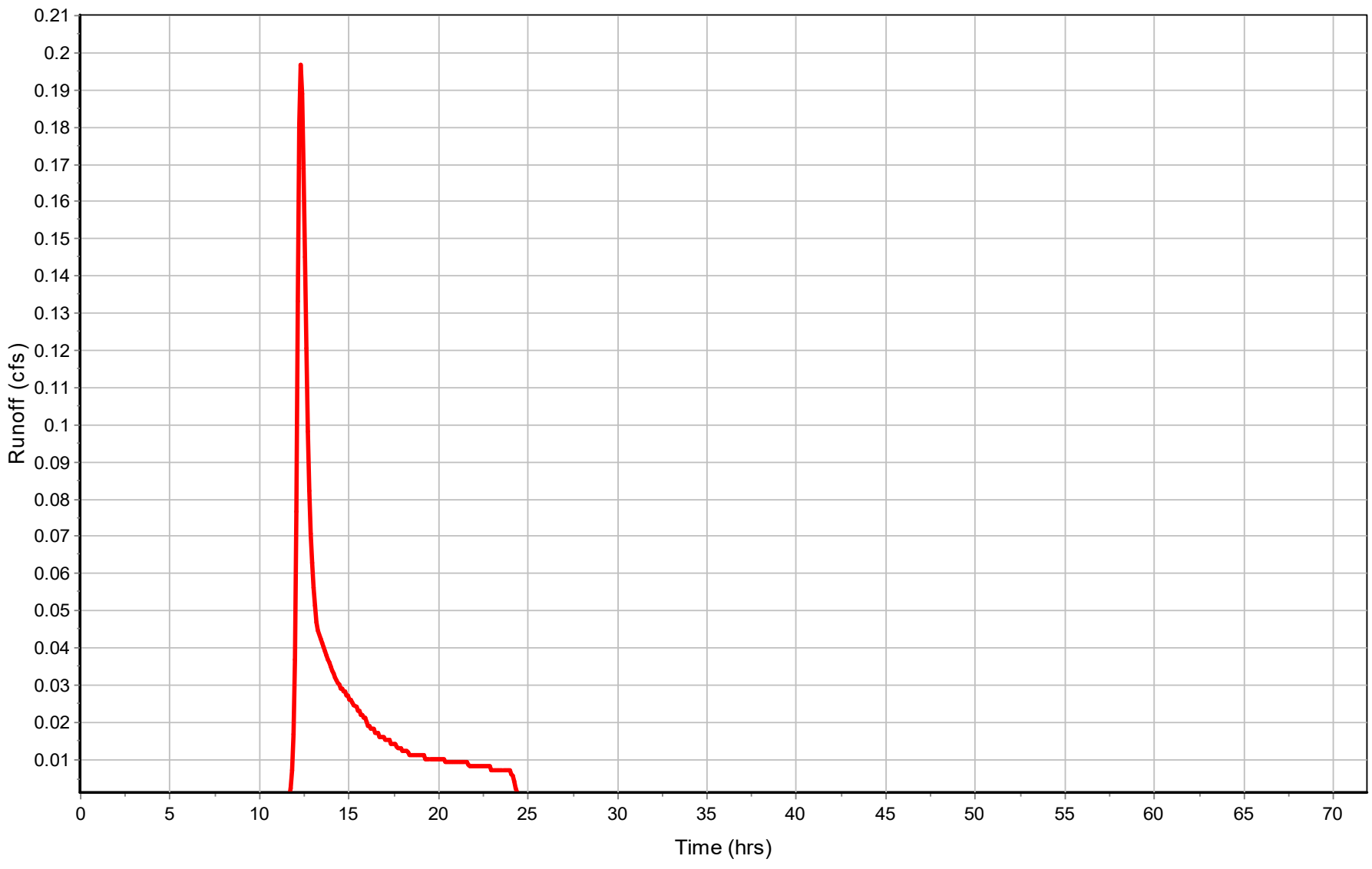
Total Rainfall (in)	8.8
Total Runoff (in)	1.95
Peak Runoff (cfs)	0.2
Weighted Curve Number	43
Time of Concentration (days hh:mm:ss)	0 00:23:46

Subbasin : Sub-03.1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-A1

Input Data

Area (ac) 2.47
Peak Rate Factor 484
Weighted Curve Number 61.66
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
50 - 75% grass cover, Fair	1.31	A	49
Gravel roads	1.16	A	76
Composite Area & Weighted CN	2.47		61.66

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	263.43	0	0
Slope (%) :	0.52	0	0
2 yr, 24 hr Rainfall (in) :	3.42	0	0
Velocity (ft/sec) :	0.79	0	0
Computed Flow Time (min) :	5.59	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	202.09	0	0
Channel Slope (%) :	0.4	0	0
Cross Section Area (ft^2) :	3	0	0
Wetted Perimeter (ft) :	6.32	0	0
Velocity (ft/sec) :	1.91	0	0
Computed Flow Time (min) :	1.76	0	0

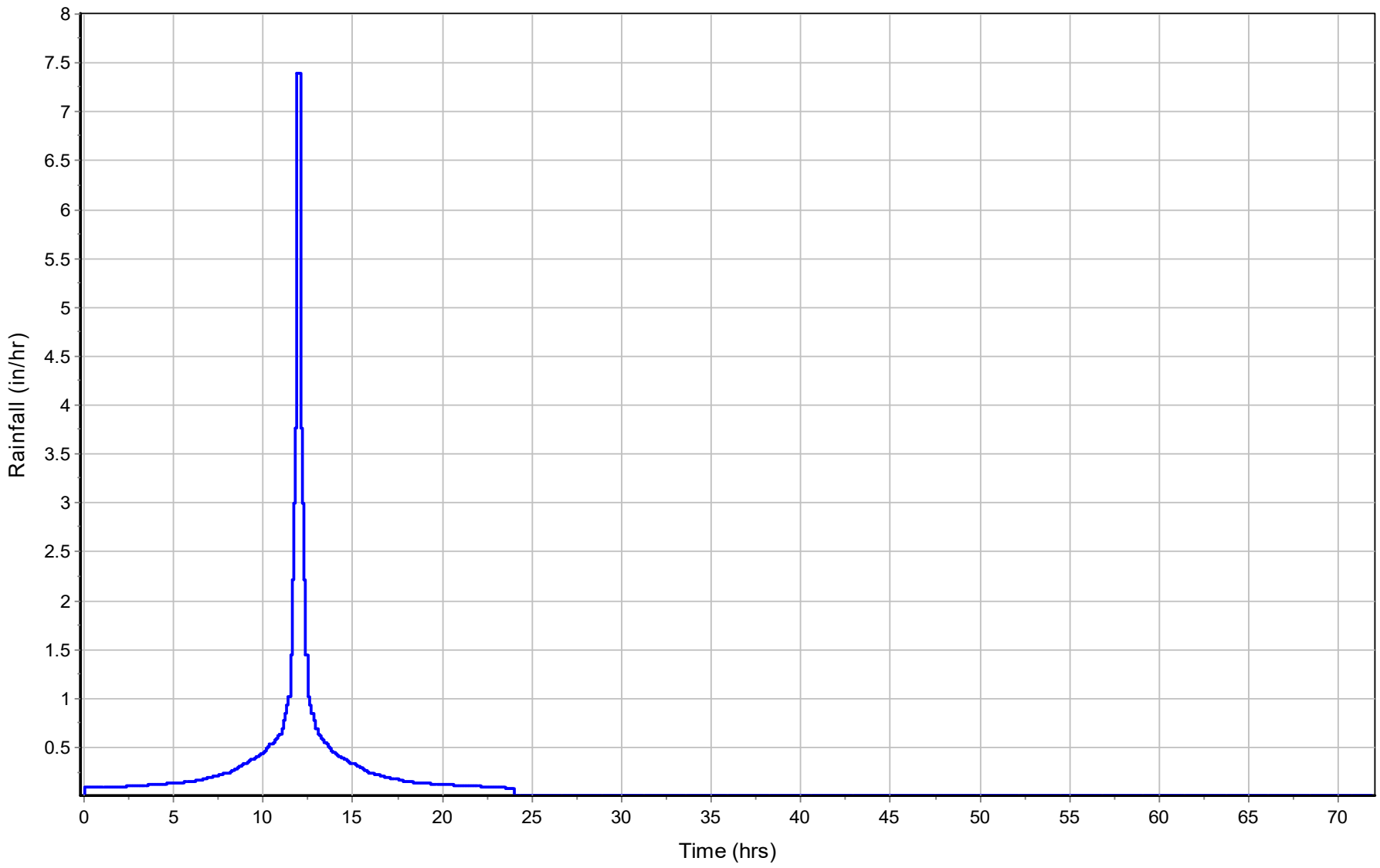
Total TOC (min) 7.35

Subbasin Runoff Results

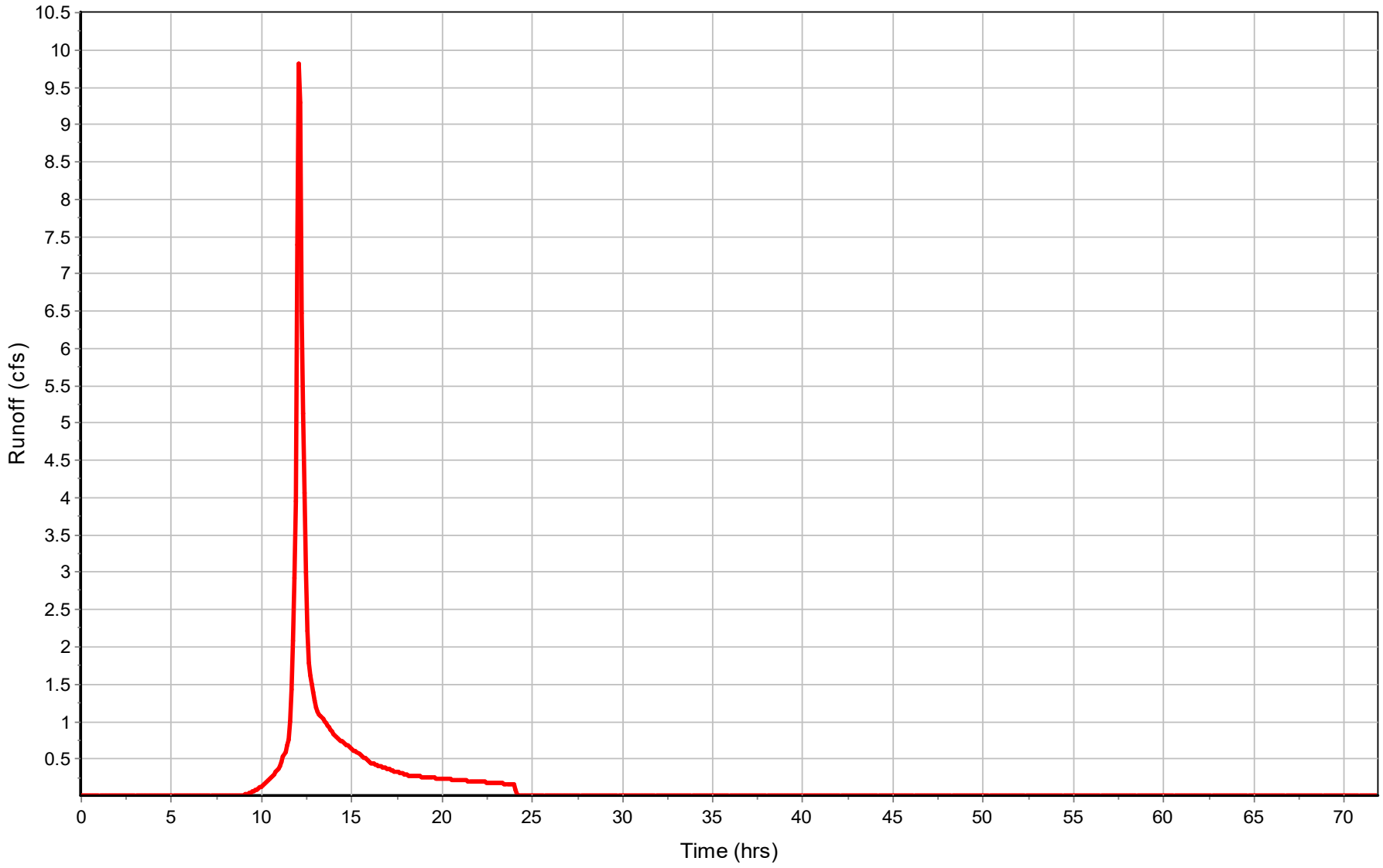
Total Rainfall (in) 8.8
Total Runoff (in) 4.15
Peak Runoff (cfs) 10.33
Weighted Curve Number 61.66
Time of Concentration (days hh:mm:ss) 0 00:07:21

Subbasin : Sub-A1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-E03

Input Data

Area (ac) 0.48
Peak Rate Factor 484
Weighted Curve Number 43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Fair	0.48	A	43
Composite Area & Weighted CN	0.48		43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.8	0	0
Flow Length (ft) :	184.51	0	0
Slope (%) :	20	0	0
2 yr, 24 hr Rainfall (in) :	3.42	0	0
Velocity (ft/sec) :	0.13	0	0
Computed Flow Time (min) :	23.5	0	0

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	42	0	0
Slope (%) :	10	0	0
Surface Type :	Grass pasture	Unpaved	Unpaved
Velocity (ft/sec) :	2.21	0	0
Computed Flow Time (min) :	0.32	0	0

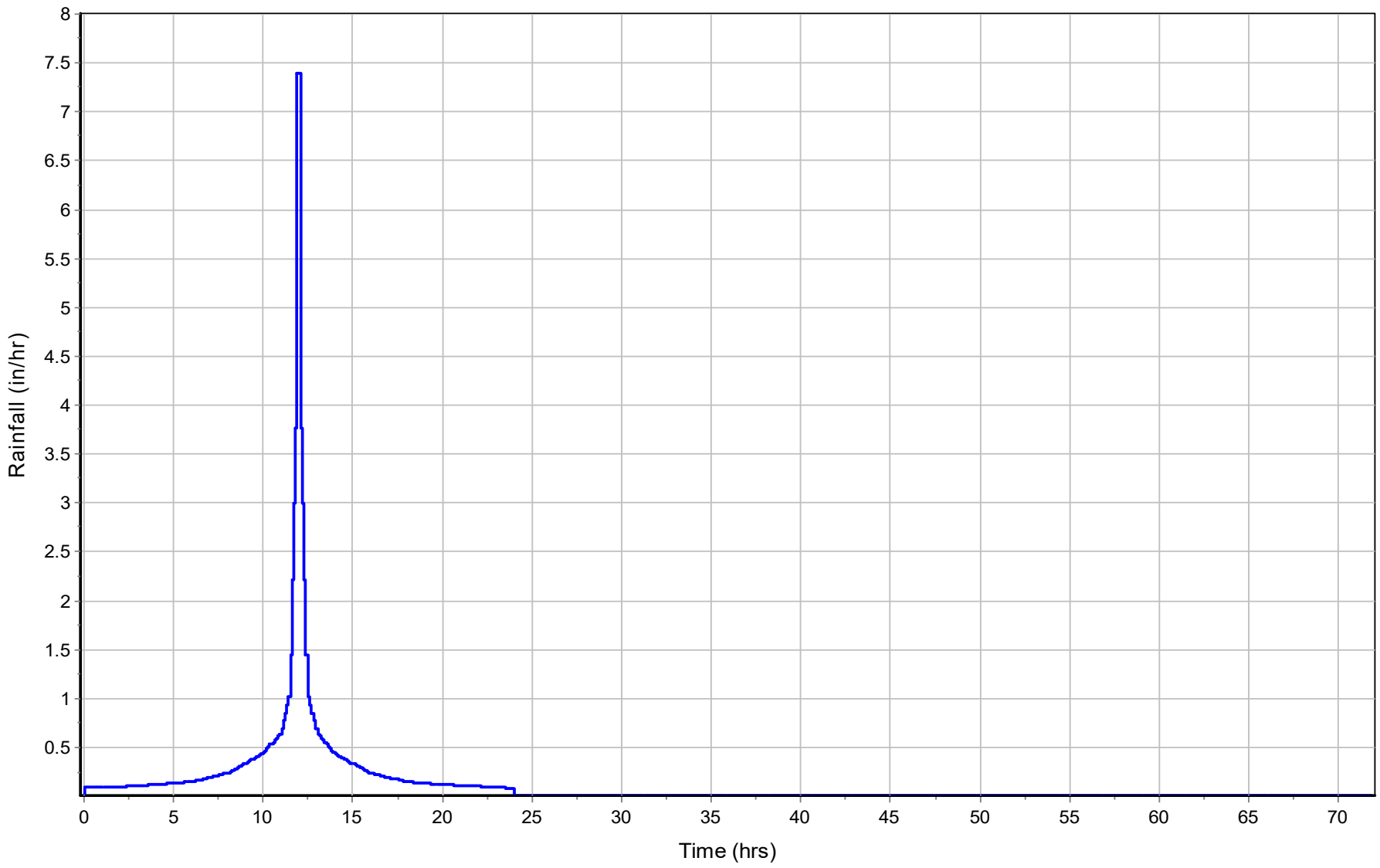
Total TOC (min) 23.82

Subbasin Runoff Results

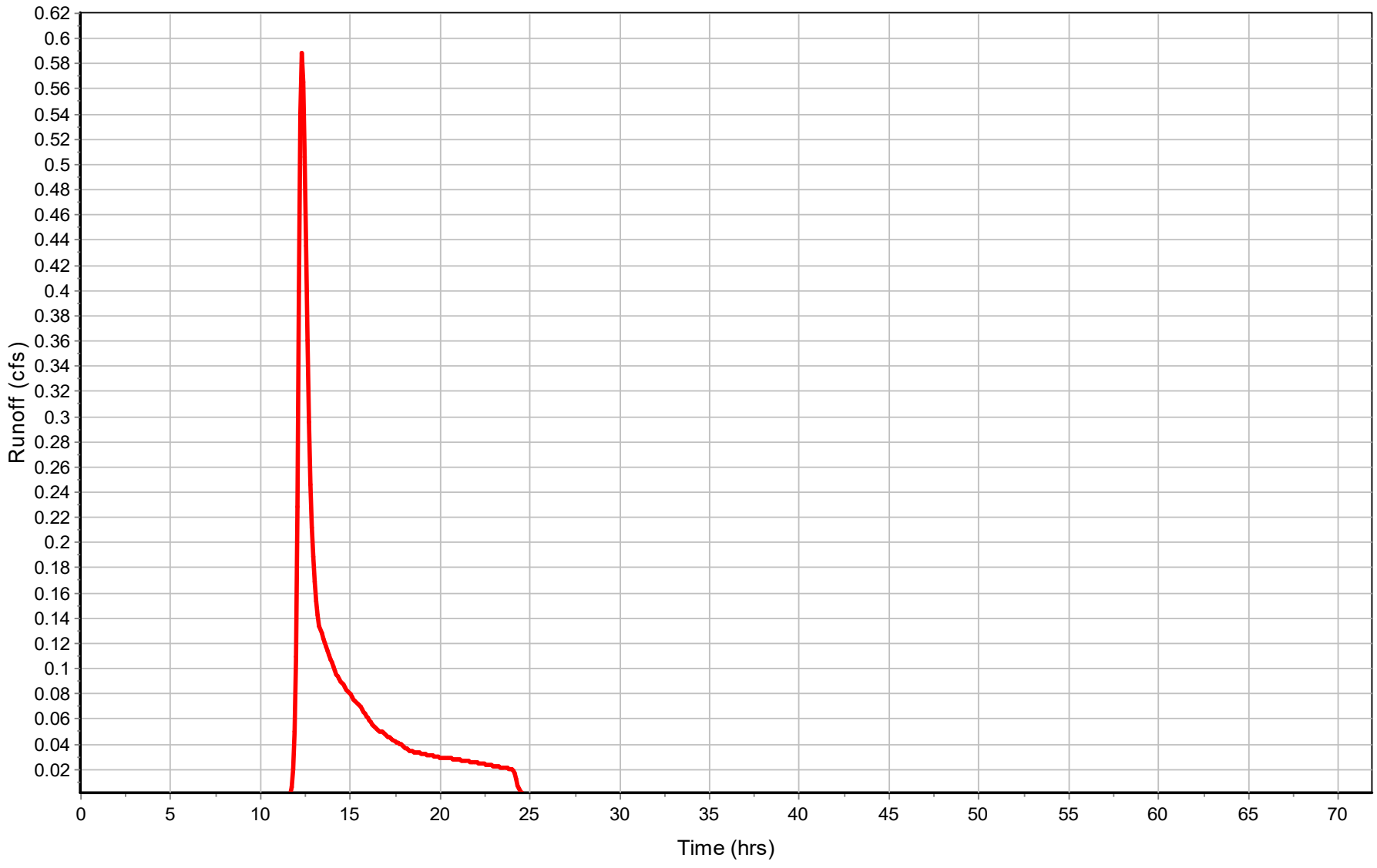
Total Rainfall (in) 8.8
Total Runoff (in) 1.95
Peak Runoff (cfs) 0.59
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:23:49

Subbasin : Sub-E03

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A1

Input Data

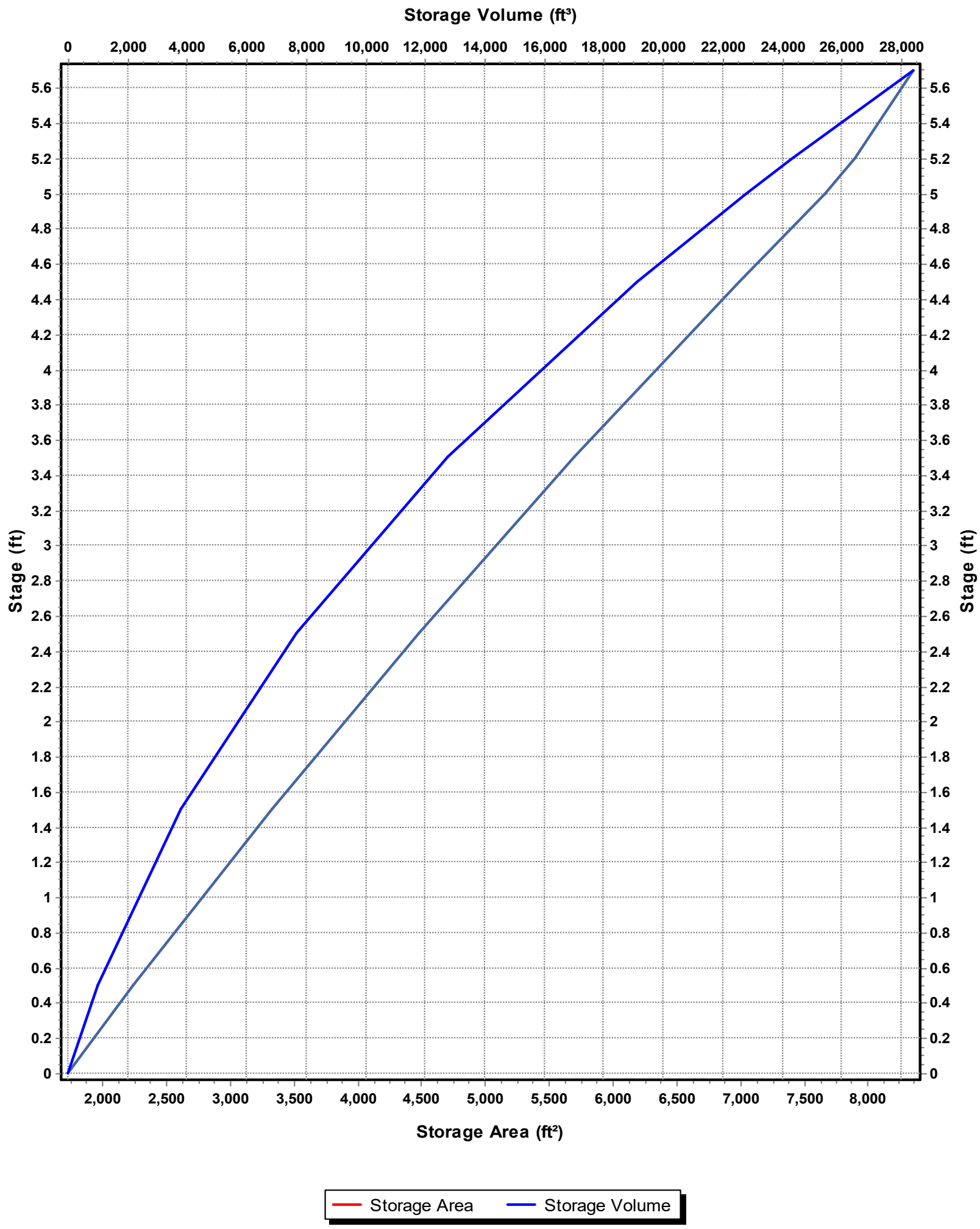
Invert Elevation (ft)	57.50
Max (Rim) Elevation (ft)	63.20
Max (Rim) Offset (ft)	5.70
Initial Water Elevation (ft)	57.50
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Basin-01

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	1730.97	0
0.5	2246.13	994.28
1.5	3328.81	3781.75
2.5	4481.3	7686.81
3.5	5703.61	12779.27
4.5	6995.74	19128.95
5	7667.99	22794.88
5.2	7895.95	24351.27
5.7	8357.69	28414.68

Storage Area Volume Curves



Storage Node : Basin-A1 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-BA1	Trapezoidal	No	62.70	5.20	5.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	9.73
Peak Lateral Inflow (cfs)	0
Peak Outflow (cfs)	2.12
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	62.8
Max HGL Depth Attained (ft)	5.3
Average HGL Elevation Attained (ft)	61.82
Average HGL Depth Attained (ft)	4.32
Time of Max HGL Occurrence (days hh:mm)	0 15:31
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Forebay-A1

Input Data

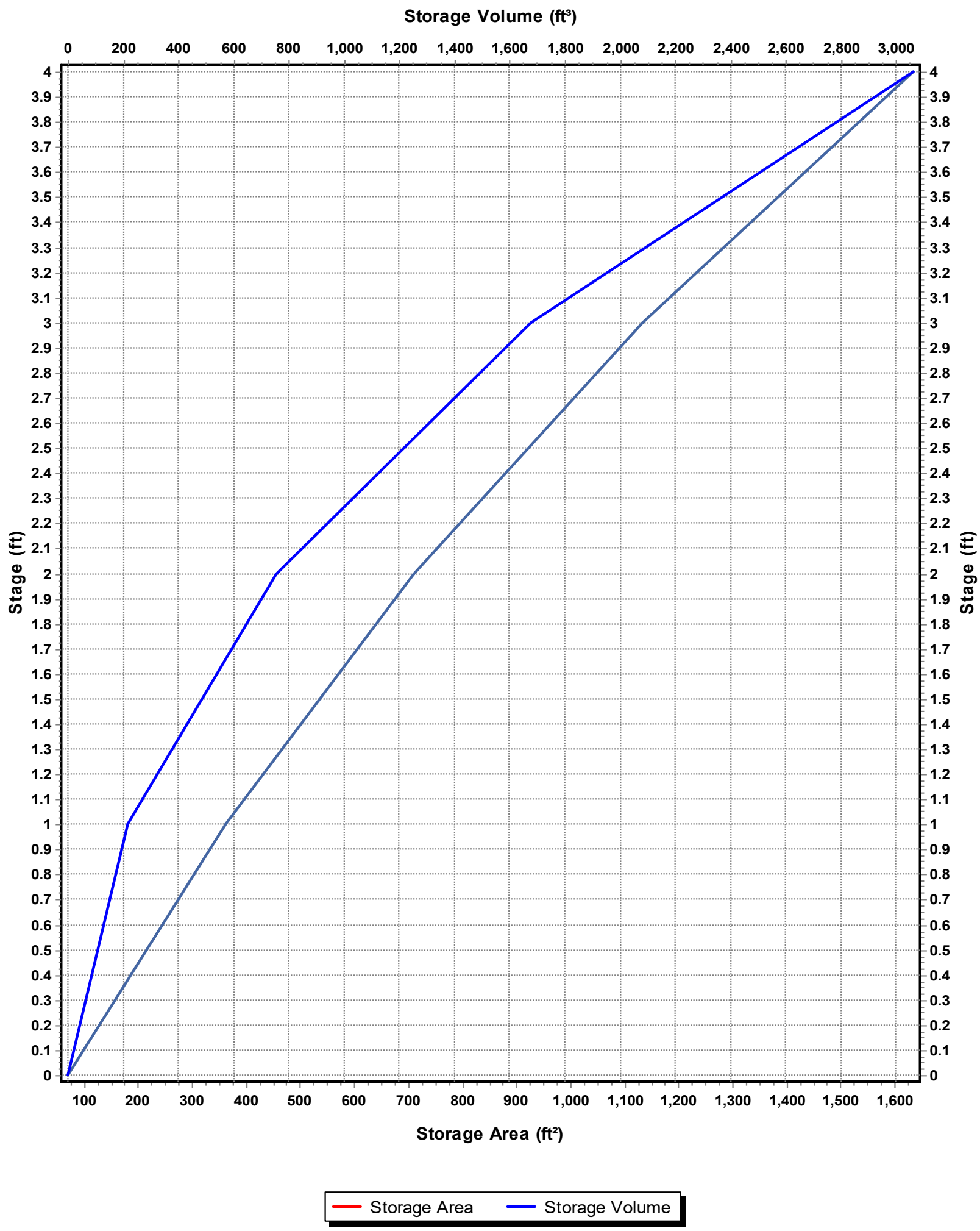
Invert Elevation (ft)	59.20
Max (Rim) Elevation (ft)	63.20
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	59.20
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Forebay-01

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	70.72	0
1	363.35	217.04
2	710.9	754.17
3	1134.81	1677.03
4	1635.08	3061.98

Storage Area Volume Curves



Storage Node : Forebay-A1 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-FA1	Trapezoidal	No	62.00	2.80	4.00	1.20	3.33

Output Summary Results

Peak Inflow (cfs)	9.81
Peak Lateral Inflow (cfs)	9.81
Peak Outflow (cfs)	9.73
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	62.82
Max HGL Depth Attained (ft)	3.62
Average HGL Elevation Attained (ft)	62.19
Average HGL Depth Attained (ft)	2.99
Time of Max HGL Occurrence (days hh:mm)	0 15:35
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Attachment D - Standard 3 Supporting Information

NRCS Soil Report

Site Specific Geotechnical Engineering Report

Drawdown Analysis

Recharge Volume

NRCS Soils Report

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Barnstable County, Massachusetts



April 20, 2026

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require

alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

Contents

Preface.....2
How Soil Surveys Are Made.....5
Soil Map.....8
Soil Map.....9
Legend.....10
Map Unit Legend.....11
Map Unit Descriptions.....11
Barnstable County, Massachusetts.....13
435C—Plymouth loamy coarse sand, 8 to 15 percent slopes.....13
References.....15

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map



Map Scale: 1:1,000 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 10 20 40 60

Feet
0 45 90 180 270

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 19N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:25,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Barnstable County, Massachusetts
Survey Area Data: Version 24, Sep 5, 2025

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jun 10, 2022—Jun 30, 2022

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
435C	Plymouth loamy coarse sand, 8 to 15 percent slopes	2.5	100.0%
Totals for Area of Interest		**2.5**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Barnstable County, Massachusetts

435C—Plymouth loamy coarse sand, 8 to 15 percent slopes

Map Unit Setting

National map unit symbol: 2yldy
Landscape: Uplands
Elevation: 0 to 310 feet
Mean annual precipitation: 40 to 52 inches
Mean annual air temperature: 52 to 59 degrees F
Frost-free period: 190 to 250 days
Farmland classification: Not prime farmland

Map Unit Composition

Plymouth, loamy coarse sand, and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Plymouth, Loamy Coarse Sand

Setting

Landscape: Uplands
Landform: Outwash plains, Hills, Moraines
Landform position (two-dimensional): Summit, shoulder, backslope, footslope
Landform position (three-dimensional): Head slope, side slope, crest, tread
Down-slope shape: Linear, concave, convex
Across-slope shape: Linear, concave, convex
Parent material: Siliceous sandy and gravelly glaciofluvial deposits and/or sandy and gravelly supraglacial meltout till

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
Oe - 1 to 2 inches: moderately decomposed plant material
A - 2 to 3 inches: loamy coarse sand
E - 3 to 5 inches: coarse sand
Bhs - 5 to 7 inches: cobbly loamy coarse sand
Bw1 - 7 to 11 inches: cobbly loamy coarse sand
Bw2 - 11 to 22 inches: gravelly coarse sand
BC - 22 to 31 inches: gravelly coarse sand
C1 - 31 to 43 inches: gravelly coarse sand
C2 - 43 to 66 inches: coarse sand

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Excessively drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to very high (1.42 to 14.17 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 1.9 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 5.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: A
Ecological site: F149BY005MA - Dry Outwash
Hydric soil rating: No

Minor Components

Montauk, sandy variant

Percent of map unit: 5 percent
Landscape: Uplands
Landform: Moraines
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Convex
Ecological site: F149BY009MA - Well Drained Dense Till Uplands
Hydric soil rating: No

Barnstable

Percent of map unit: 5 percent
Landscape: Coastal lowlands, uplands
Landform: Moraines on outwash plains
Landform position (two-dimensional): Summit, shoulder, backslope, footslope
Landform position (three-dimensional): Head slope, side slope, crest, tread
Down-slope shape: Linear, concave, convex
Across-slope shape: Linear, concave, convex
Hydric soil rating: No

Riverhead

Percent of map unit: 5 percent
Landscape: Uplands, coastal lowlands
Landform: Outwash plains, Moraines
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Side slope, crest, tread
Down-slope shape: Linear, convex
Across-slope shape: Linear
Hydric soil rating: No

Carver

Percent of map unit: 5 percent
Landscape: Uplands
Landform: Disected outwash plains, Moraines
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Side slope, crest, tread
Down-slope shape: Linear, convex
Across-slope shape: Linear
Ecological site: F149BY005MA - Dry Outwash
Hydric soil rating: No

References

American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deep-water habitats of the United States. U.S. Fish and Wildlife Service FWS/OBS-79/31.

Federal Register. July 13, 1994. Changes in hydric soils of the United States.

Federal Register. September 18, 2002. Hydric soils of the United States.

Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.

National Research Council. 1995. Wetlands: Characteristics and boundaries.

Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_054262

Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service, U.S. Department of Agriculture Handbook 436. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053577

Soil Survey Staff. 2010. Keys to soil taxonomy. 11th edition. U.S. Department of Agriculture, Natural Resources Conservation Service. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053580

Tiner, R.W., Jr. 1985. Wetlands of Delaware. U.S. Fish and Wildlife Service and Delaware Department of Natural Resources and Environmental Control, Wetlands Section.

United States Army Corps of Engineers, Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Waterways Experiment Station Technical Report Y-87-1.

United States Department of Agriculture, Natural Resources Conservation Service. National forestry manual. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2_053374

United States Department of Agriculture, Natural Resources Conservation Service. National range and pasture handbook. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/landuse/rangepasture/?cid=stelprdb1043084

United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053624

United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf

Boring Logs

GeoEngineers performed a geotechnical subsurface exploration program on April 15 and April 16, 2025. The exploration program consisted of two (2) borings (designated MR-09, and MR-10) both advanced to a depth of 32 feet below the ground surface (bgs) by Geologic Earth Exploration, Inc. (Geologic) of Norfolk, Massachusetts. The borings were advanced using hollow-stem auger drilling methods with a track mounted CME 55 drill rig. The borings were continuously monitored by a representative from our firm who logged and classified the soils encountered, obtained representative soil samples, observed groundwater conditions, and prepared logs for the explorations.

Soils encountered in the borings were visually classified in general accordance with the classification system described in Figure A-1. A key to the boring log symbols is also presented in Figure A-1. The logs of the borings are presented in Figures A-2 through A-3 within Appendix A. The boring logs are based on our interpretation of the field and laboratory data and indicate the various types of soils and groundwater conditions encountered. The logs also indicate the depths at which these soils or their characteristics change, although the change may be gradual. If the change occurred between samples, it was interpreted. The densities noted in the boring logs are based on the blow count data obtained in the borings and judgment based on the conditions encountered.

The soils encountered within the borings were generally sampled starting at the surface continuously until 10 feet bgs, then at 5-foot vertical intervals thereafter with a 2-inch outside-diameter split-barrel standard penetration test (SPT) sampler. The disturbed samples were obtained by driving the sampler 24 inches into the soil with a 140-pound automatic hammer free-falling 30 inches. The number of blows required for each 6 inches of penetration was recorded. The blow count (“N-value”) of the soil was calculated as the number of blows required for the middle 12 inches of penetration. This resistance, or N-value, provides a measure of the relative density of granular soils and the relative consistency of cohesive soils. Where very dense soil conditions precluded driving the full 24 inches, the penetration resistance for the partial penetration was entered on the logs. The blow counts are shown in the boring logs at the respective sample depths. Where no sample recovery occurred, a 3-inch outside-diameter split-barrel SPT sampler was re-driven to collect additional soil for classification.

Observations of groundwater conditions were made during drilling. The groundwater conditions encountered during drilling are presented in the boring logs. Groundwater conditions observed during drilling represent a short-term condition and may or may not be representative of the long-term groundwater conditions at the Site. Groundwater conditions observed during drilling should be considered approximate.

Logs of the test borings are provided in Appendix A, Subsurface Exploration and Laboratory Testing.

Site Specific Geotechnical Report

Geotechnical Engineering Report

Cape Canal Bridge Relocation Project
Mainland Bourne Metering & Regulating Station
Barnstable County, Massachusetts

for
Enbridge, Inc.

May 19, 2025

239 Causeway Street, Suite 400
Boston, Massachusetts 02114
617.749.9220

GeoEngineers USA

Geotechnical Engineering Report

Cape Canal Bridge Relocation Project
Mainland Bourne Metering & Regulating Station
Barnstable County, Massachusetts

File No. 15556-039-00
May 19, 2025

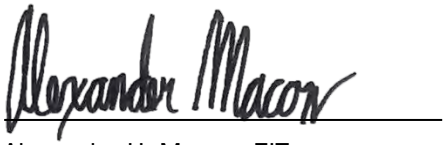
Prepared for:

Enbridge, Inc.
915 North Eldrige Parkway, Suite 1100
Houston, Texas 77079

Attention: Cindy Dilber

Prepared by:

GeoEngineers USA, PC
239 Causeway Street, Suite 400
Boston, Massachusetts 02114
617.749.9220



Alexander H. Macon, EIT
Staff Geotechnical Engineer 2



Heidi P. Cashman, PE
Associate Geotechnical Engineer

AHM:HPC:kjb

Disclaimer: Any electronic form, facsimile, or hard copy of the original document (email, text, table, and/or figure), if provided, and any attachments are only a copy of the original document. The original document is stored by GeoEngineers USA, PC and will serve as the official document of record.

Table of Contents

Executive Summary ES-1
1.0 Introduction 1
2.0 Site Location and Project Understanding 1
3.0 Subsurface Exploration Program 1
3.1. Subsurface Exploration 1
3.2. Laboratory Testing 2
4.0 Site Conditions 3
4.1. Subsurface Conditions 3
4.2. Available Subsurface Information 3
4.2.1. Surficial Material 3
4.2.2. Bedrock Geology 3
4.3. Subsurface Conditions 4
4.3.1. Soil Conditions 4
4.3.2. Groundwater Conditions 4
5.0 Geotechnical Recommendations 4
5.1. Seismic Design Parameters 5
5.1.1. Seismic Site Class and Design Parameters 5
5.1.2. Liquefaction Potential 5
5.2. Foundation Design recommendations 6
5.2.1. Allowable Bearing Pressure 6
5.2.2. Foundation Dimensions 6
5.2.3. Settlement 6
5.3. Slab-on-grade 7
5.4. Gravel Roads 7
5.4.1. Drive Isles 7
5.4.2. Embankments and Slopes 7
5.5. Earthwork and Subgrade Preparation 8
5.5.1. Boulder Removal 9
5.5.2. Structural Fill 9
5.5.3. Structural Fill Placement and Compaction 10
5.5.4. Weather Conditions 10
5.6. Material Reuse 11
5.6.1. Onsite Soil Reuse 11
5.7. Temporary Construction Dewatering 11
6.0 Limitations 11
7.0 References 12

List of Figures

Figure 1. Vicinity Map
Figure 2. Exploration Location Plan

Appendices

Appendix A. Subsurface Explorations and Laboratory Testing
Figure A-1. Key to Exploration Logs
Figures A-2 and A-3. Logs of Borings
Laboratory Test Results
Appendix B. Report Limitations and Guidelines for Use

Executive Summary

The proposed Site development involves the construction of a Metering and Regulation (M&R) facility on the mainland side of the Bourne Bridge to facilitate a new horizontal directional drilling (HDD) gas line crossing the Cape Cod Canal. The proposed Site development is a part of the overall larger Cape Canal Bridge Replacement Project. The Site is currently unimproved woodland with dirt roads along the south, east, and west edge of the Site.

Based on our understanding of the Site concepts and our review of the subsurface conditions, we recommend that the M&R station be supported by conventional spread footings and a slab-on-grade bearing on natural inorganic natural soils (i.e. natural sand deposits).

Boulders were encountered during our exploration program and should be anticipated to be encountered during construction. Localized boulder removal should be anticipated to facilitate foundation and slab construction.

Additional design considerations and recommendations are provided in Section 5.0 of this report.

1.0 Introduction

This report presents the results of GeoEngineers USA, PC (GeoEngineers) geotechnical engineering services for the proposed Metering and Regulating (M&R) Station development at the mainland side of the Bourne Bridge along the east side of Route 25 in Bourne, Massachusetts (the Site). The Site is shown relative to surrounding physical features in Figure 1, Vicinity Map, and Figure 2, Exploration Location Plan.

The purpose of this report is to provide geotechnical engineering recommendations for the design and construction of the planned M&R station development on the mainland side of the Bourne Bridge. Our services have been completed in general accordance with our signed agreement dated October 31, 2023, and revised April 4, 2025. This report is subject to the attached limitations.

2.0 Site Location and Project Understanding

The Site consists of undeveloped woodland and is bounded by undeveloped woodland on all directions. Dirt roads (Leaf Lane, Tanager Lane, and Heather Hill Road) are present to the east, residential properties and Mirasol Drive to the south, and a dirt road for utility easement access then Route 25 to the west. Existing noteworthy features beyond the Site boundaries include the Cape Cod Canal, which is generally further southeast of the site, and the existing Bourne Bridge which is generally south of the Site.

Project concepts are still in development; however, we understand Site improvements will consist of removal of woodland and construction of a single-story at grade M&R facility and associated equipment.

Building/structure loads are unavailable at this time, however based on discussions with the project team, and experience with similar structures of this type, we anticipate individual column loads of less than 50 kips and wall loads of less than 4 kips/linear-foot. Building/structure loads once available should be provided to GeoEngineers to confirm our recommendations herein.

3.0 Subsurface Exploration Program

3.1. SUBSURFACE EXPLORATION

GeoEngineers performed a geotechnical subsurface exploration program on April 15 and April 16, 2025. The exploration program consisted of two (2) borings (designated MR-09, and MR-10) both advanced to a depth of 32 feet below the ground surface (bgs) by Geologic Earth Exploration, Inc. (Geologic) of Norfolk, Massachusetts. The borings were advanced using hollow-stem auger drilling methods with a track mounted CME 55 drill rig. The borings were continuously monitored by a representative from our firm who logged and classified the soils encountered, obtained representative soil samples, observed groundwater conditions, and prepared logs for the explorations.

Soils encountered in the borings were visually classified in general accordance with the classification system described in Figure A-1. A key to the boring log symbols is also presented in Figure A-1. The logs of the borings are presented in Figures A-2 through A-3 within Appendix A. The boring logs are based on our

interpretation of the field and laboratory data and indicate the various types of soils and groundwater conditions encountered. The logs also indicate the depths at which these soils or their characteristics change, although the change may be gradual. If the change occurred between samples, it was interpreted. The densities noted in the boring logs are based on the blow count data obtained in the borings and judgment based on the conditions encountered.

The soils encountered within the borings were generally sampled starting at the surface continuously until 10 feet bgs, then at 5-foot vertical intervals thereafter with a 2-inch outside-diameter split-barrel standard penetration test (SPT) sampler. The disturbed samples were obtained by driving the sampler 24 inches into the soil with a 140-pound automatic hammer free-falling 30 inches. The number of blows required for each 6 inches of penetration was recorded. The blow count ("N-value") of the soil was calculated as the number of blows required for the middle 12 inches of penetration. This resistance, or N-value, provides a measure of the relative density of granular soils and the relative consistency of cohesive soils. Where very dense soil conditions precluded driving the full 24 inches, the penetration resistance for the partial penetration was entered on the logs. The blow counts are shown in the boring logs at the respective sample depths. Where no sample recovery occurred, a 3-inch outside-diameter split-barrel SPT sampler was re-driven to collect additional soil for classification.

Observations of groundwater conditions were made during drilling. The groundwater conditions encountered during drilling are presented in the boring logs. Groundwater conditions observed during drilling represent a short-term condition and may or may not be representative of the long-term groundwater conditions at the Site. Groundwater conditions observed during drilling should be considered approximate.

Logs of the test borings are provided in Appendix A, Subsurface Exploration and Laboratory Testing.

3.2. LABORATORY TESTING

Six (6) soil samples were submitted to Geotesting Express of Acton, Massachusetts for geotechnical laboratory testing in accordance with the standards provided in ASTM International (ASTM) and American Association of State Highway and Transportation Officials (AASHTO) procedures. One representative composite sample was created of representative soil samples from MR-09 and MR-10 and the following laboratory tests were conducted.

- Two (2) Standard Classification, per ASTM D2488
- Four (4) grain-size analysis (sieve only), per ASTM D6913.
- Four (4) moisture content determinations, per ASTM D2216.
- Two (2) unit weight determination, per ASTM D7263.
- One (1) soil electric resistivity test on the composite sample, per AASHTO T288 and ASTM G 57.
- One (1) sulfate determination on the composite sample, per ASTM D516.
- One (1) chloride determination on the composite sample, per ASTM D512.
- One (1) pH determination on the composite sample, per ASTM D4972.

Laboratory test results are provided in Appendix A, Subsurface Exploration and Laboratory Testing.

4.0 Site Conditions

4.1. SUBSURFACE CONDITIONS

Site survey information is unavailable at this time. The site generally consists of multiple hills, the largest of which crests towards the center of the site. The hills generally slope down from the center of the Site towards the Site perimeter. Surficial glacial erratic boulders, 3- to 5-foot wide, were observed at residential properties adjacent to the Site.

4.2. AVAILABLE SUBSURFACE INFORMATION

4.2.1. Surficial Material

Surficial geologic mapping indicates that late Wisconsin Age (75,000 to 11,000 years ago) glacial stratified coarse deposits of gravel and sand are the predominant surficial materials present across the majority of the Site, with areas of thin glacial till deposits along the south perimeter of the Site.

The mapped areas of coarse glacial deposits are typically composed of at least 50 percent gravel-size clasts; cobbles and boulders predominate; with minor amounts of sand within gravel layers, and minor layers of sand. The gravel layers are generally poorly sorted, and bedding is commonly distorted and faulted due to post-depositional collapse related to the melting of ice. The sand and gravel deposits occur as mixtures of gravel and sand within individual layers and as layers of sand alternating with layers of gravel. The sand and gravel layers generally range between 25 and 50 percent gravel particles and between 50 and 75 percent sand particles. Sand deposits are composed mainly of very coarse to fine sand, commonly in well-sorted layers and may contain up to 25 percent gravel. Finer layers may contain some very fine sand, silt, and clay.

The mapped areas of thin glacial till deposits typically consist of a nonsorted, nonstratified, matrix of sand, some silt, and little clay containing scattered pebble, cobble, and boulder clasts where large surface boulders are common. Thin glacial till deposits predominantly consists of upper till of the last glaciation, which is loose to moderately compact, generally sandy, and commonly stony. Two facies are present in some places: a looser, coarser grained ablation facies, melted out from supraglacial position; and an underlying more compact, finer grained lodgement facies deposited subglacially. In general, both ablation and lodgement facies of the upper till are derived from fine-grained bedrock, and generally are finer grained, more compact, less stony and have fewer surface boulders than upper till derived from coarse-grained crystalline rocks. Across Massachusetts, fine-grained bedrock sources include the red Mesozoic sedimentary rocks of the Connecticut Valley lowland areas, marble of the western river valley areas, and fine-grained schists of the upland areas.

The thickness of the coarse glacial deposits is expected to be over 100 feet, and the thickness of the thin glacial till deposits are generally less than 10 to 15 ft thick, both overlying the bedrock described below (Stone, et al, 2019), (Hartshorn, et al, 1991).

4.2.2. Bedrock Geology

Geologic mapping indicates the primary bedrock present at the Site is Proterozoic Age (2,500 to 542 million years ago) plutonic and metamorphic rocks consisting primarily of granite, gneiss, and schist (undivided) (Zen, et al, 1983).

4.3. SUBSURFACE CONDITIONS

4.3.1. Soil Conditions

In general, the soil conditions observed at the Site consist of topsoil, underlain by subsoil, and natural sand deposits. Details of the subsurface strata from the explorations by GeoEngineers are summarized below from the ground surface down:

- **Topsoil:** A topsoil layer was encountered at both boring locations and was observed at ground surface across the Site. The topsoil was observed to be approximately 4-inches thick. The topsoil layer primarily consists of silty fine-grained sand with trace amounts of organic matter (roots and leaves). The N-values in the topsoil material generally indicated a very loose condition.
- **Subsoil:** A layer of subsoil was observed beneath the topsoil layer at both boring locations. The bottom of subsoil was observed approximately 2 feet bgs at all boring locations. The subsoil layer primarily consists of silty fine to medium-grained sand with trace amounts of gravel and organic matter (roots). The N-values in the subsoil material generally indicated a very loose condition.
- **Natural Sand Deposits:** Natural sand deposits were observed underlying the subsoil, within both borings, and extended to the depths explored. Borings were terminated within the natural sand deposits, therefore the natural sand deposits depths are likely deeper than reported herein.

  The natural sand deposits primarily consist of fine to medium-grained sand with varying amounts of gravel and silt. The N-values in the natural sand material indicate a condition ranging from generally loose to medium dense within the upper 20 feet and ranging from generally medium dense to dense within the lower 20 to 30 feet. The gravel content in the natural sand samples selected for grain-size analysis ranged from about 0 to 16 percent. The fines content in the natural sand samples selected for grain-size analysis ranged from about 1 to 14 percent. The moisture content in the natural sand samples selected for analysis ranged from about 3 to 5 percent. The unit weight of the natural sand samples selected for analysis ranged from about 102 to 106 pounds per cubic foot (pcf). Drill rig chatter was noted while drilling occasionally within the upper 10 feet of the natural sand deposits, and consistently within the lower 20 to 30 feet of the natural sand deposits, which likely indicates the presence of gravel, cobbles, and/or boulders within this layer.

4.3.2. Groundwater Conditions

Groundwater was not observed during drilling of the test borings. However, it should be noted that groundwater levels will vary depending on tidal action, seasonal variations in temperature and precipitation, and can also be influenced by subsurface utilities, construction activities and other factors.

5.0 Geotechnical Recommendations

Below is a summary of the geotechnical considerations associated with design and development of the Site. Additional details are provided in subsequent sections of this report.

- The proposed building/structures can be supported by conventional shallow spread footings and a slab-on-grade following removal of topsoil and subsoil containing roots. Foundations should bear directly on natural sand deposits or compacted structural fill placed over natural sand deposits. Foundations should not bear on topsoil or subsoil.

- The subsoil (both organic and inorganic) is not suitable for foundation support; however, the existing inorganic subsoil (i.e. subsoil free of roots) can remain in place below the slab provided the subgrade is prepared as specified herein.
- Localized boulders are anticipated within the natural sand deposits, as evidenced from observations of surficial erratic boulders adjacent to the site, and drilling action at depth during our field exploration program. Localized boulder removal should be anticipated at the proposed foundation, slab, and utility areas. We anticipate that boulders could be removed using large excavators or by mechanical means (i.e. hoe-ramming). We recommend that boulders (if encountered) should be removed to at least 12 inches below footings and sub-slab utilities.
- Inorganic granular soils (i.e., inorganic subsoil and natural sand deposits) from cut/fill activities can be re-used as backfill provided it is placed and compacted as specified herein.

5.1. SEISMIC DESIGN PARAMETERS

5.1.1. Seismic Site Class and Design Parameters

The Massachusetts State Building Code 10th edition (MSBC10) incorporates the 2021 International Building Code (2021 IBC) by reference with state specific amendments. We have considered the soil conditions encountered in the borings to be consistent and representative of the soil conditions in the top 100 feet of soil at this Site. Given this, it is GeoEngineers' opinion that the Site is best characterized as Site Class D. The 2021 IBC seismic design parameters are presented in Table 1.

TABLE 1. 2021 IBC SEISMIC DESIGN PARAMETERS

2021 IBC PARAMETER	RECOMMENDED VALUE
Mapped Spectral Acceleration for short periods, (S_S):	0.180
Mapped Spectral Acceleration for 1-sec period, (S_1):	0.052
Site Class:	D
Site Coefficient, (F_a):	1.6
Site Coefficient, (F_v):	2.4
5% damped design spectral response acceleration at short periods, (S_{DS}):	0.192
5% damped design spectral response acceleration at 1-sec periods, (S_{D1}):	0.083
Anticipated Risk Category:	IV
Seismic Design Category:	C

Note:

The anticipated risk category is based on the assumption that the M&R stations are critical to national defense and would be part of the gas line supplying the military base Joint Base Cape Cod. Should a lower anticipated risk category of III be permitted, a seismic design category of B can be justified.

5.1.2. Liquefaction Potential

The soils encountered at the Site are not considered susceptible to liquefaction based on the criteria set forth in section 1806.4 of MSBC10.

5.2. FOUNDATION DESIGN RECOMMENDATIONS

We recommend the proposed structures be supported on conventional shallow spread footings. Footings should bear directly on inorganic, natural, granular soil (i.e. natural sand deposits), or structural fill placed over the natural sand deposits.

Foundations should not bear directly on topsoil, subsoil, or boulders. Some over-excavation of the existing topsoil and subsoil may be necessary to expose the top of the natural sand deposits suitable for footing bearing. The existing topsoil and subsoil material (both organic and inorganic), where present, should be excavated from within the zone of influence (ZOI) of the footings. The ZOI is defined as a one (1) horizontal to one (1) vertical (1H:1V) line projecting outward and downward from the outside edge of the foundation element. Additional construction recommendations for subgrade preparation are provided in Section 5.5 Earthwork and Subgrade Preparation.

Where boulder removal is required to achieve the bottom of footing elevation, the boulder should be removed to allow placement of 12 inches of Gravel Fill to provide a soil cushion between the bottom of footing and boulder surface to minimize the potential for hard spots below the footing and the potential for differential settlement.

5.2.1. Allowable Bearing Pressure

For foundations constructed as recommended in this report, we recommend using a net allowable bearing pressure of 3 kips per square foot (ksf). The allowable bearing pressure applies to the total of dead and long-term live loads. Building/structure loads are unavailable at this time and the allowable soil bearing pressure is based upon assumed building/structure loads. Based on our experience with similar building/structures of this type we assume that individual column loads will likely be less than 50 kips and wall loads will likely be less than 4 kips/linear-foot. Building/structure loads once available should be provided to GeoEngineers to confirm our recommendations herein.

5.2.2. Foundation Dimensions

The minimum recommended lateral dimension for isolated spread footings is 36 inches, while continuous wall footings should be at least 18 inches wide. Footings in areas exposed to freezing temperatures should be founded at least 4 feet below exterior finished grade for frost protection. Interior footings, in areas not exposed to freezing temperatures, should be at least 24 inches below finished floor grade, or a depth that provides at least 12 inches between the top of footing and finished floor elevation, whichever is deeper. A minimum 12-inch soil cushion should be provided between the bottom of the footing and top of boulders.

5.2.3. Settlement

Provided that topsoil and subsoils (both organic and inorganic) are removed, and that the subgrade is prepared as recommended herein, we estimate that the total post-construction settlement, based on assumed column loads, will be less than 1 inch. Post-construction, differential settlements are estimated to be less than 0.5 inches between adjacent columns but will vary based on live load distribution and column spacing.

5.3. SLAB-ON-GRADE

The slab-on-grade should bear on a minimum of 12 inches of base course (Gravel Fill). For slabs designed as a beam on an elastic foundation, a modulus of subgrade reaction of 150 pounds per cubic inch (pci) may be used for subgrade soils prepared as recommended.

5.4. GRAVEL ROADS

5.4.1. Drive Isles

All surficial topsoil and subsoil containing roots should be removed from proposed gravel road subgrades and embankments. Exposed natural subgrades (i.e. the natural sand deposits) should be proofrolled, and soft or loose areas identified should be over-excavated and replaced with Gravel Fill as specified in Section 5.5 Earthwork and Subgrade Preparation.

Geogrid such as Tensar NX750, or equivalent, should be placed over the prepared subgrade materials (i.e. the natural sand deposits), and overlain with a minimum of 12-inches of Gravel Fill material. The Gravel Fill material will bind together better than the natural on-site soils, and (in combination with the geogrid) is expected to distribute vehicular loads and minimize settlement over time. The Gravel Fill material should conform with MassDOT Item M2.01.7-1, dense-graded crushed stone, see Section 5.5.2 Structural Fill. If settlement control is not considered critical, the geogrid can be omitted and a filter fabric placed over the prepared subgrade materials (i.e. the natural sand deposits). The filter fabric would then be overlain with a minimum of 12-inches of Gravel Fill material.

It should be noted that the gravel road will require regular maintenance, with additional gravel placement and regrading, following potential rutting and long-term settlement, to maintain access to the site.

5.4.2. Embankments and Slopes

The following recommendations are effective for the construction of gravel roadway embankment slopes, and for general site slopes required to facilitate site/road grades.

- For slopes with angles flatter than 3H:1V, the slope face should be established with vegetative cover as quickly as practical to prevent erosion. We recommend that the topsoil layer be limited to 4 to 6 inches thick and a jute mat be placed along the slope face. The contractor is responsible for maintaining the slope face (i.e., stability) until vegetation is fully established.
- For slopes with angles between 3H:1V and 2H:1V, we recommend the slope face be protected with a non-woven geotextile fabric such as Mirafi 140N, or equivalent, and overlain with a minimum of 18-inches of Riprap meeting the requirements for MassDOT Item M2.02.0, Riprap.
- Fill slopes should be constructed with Structural Fill as described herein.

Slopes with angles steeper than 2H:1V are not recommended. Should slopes with angles steeper than 2H:1V be required they should be coordinated with GeoEngineers and will require an evaluation for slope stability (i.e., performance of a slope stability analysis).

5.5. EARTHWORK AND SUBGRADE PREPARATION

The following paragraphs describe the recommended earthwork procedures for preparation of the building/structure areas.

- Unsuitable materials (topsoil and subsoil containing roots) should be removed in their entirety from the proposed building/structures footprint and 5 feet beyond.
- The existing topsoil and subsoil (both organic and inorganic) should be over-excavated below proposed footings, and perimeter foundation walls down to a subgrade consisting of inorganic, granular, natural soil (i.e. natural sand deposits). Over-excavation should extend to the ZOI of the footings as previously defined herein. Footings should not bear on subsoil; however, subsoil free of roots may remain below the proposed slab-on-grade.
- Following removal of the unsuitable materials noted above and prior to placing raise-in-grade fill, the exposed subgrade within the building/structures footprint, and 5 feet beyond the exterior walls, should be proof-compacted with at least eight (8) passes of a 20-ton smooth-drum, vibratory roller until visibly firm and stable as observed by the Geotechnical Engineer or their qualified representative. Any soft or loose areas identified during proof-compaction should be over-excavated and replaced with Gravel Fill as specified herein.
- Footing subgrades should be excavated with a smooth-edge bucket to limit disturbance to the underlying subgrade. If footings are excavated with a toothed bucket, the subgrade should be compacted with at least six (6) passes of a 1,000-pound vibratory plate compactor, or equivalent effort, until the subgrade is visibly firm and stable as observed by the Geotechnical Engineer or his/her qualified representative. Footings should bear directly on the natural, inorganic, granular soil (i.e. natural sand deposits) or Gravel Fill placed directly over the natural sand deposits.
- Localized areas of boulders are anticipated below within the proposed building and structures, and should be removed using large excavators or mechanical means (i.e. hoe-ramming) to at least 12 inches below the base course for slabs and 12 inches below the bottom of footing in the building areas.
- Where boulders are present at the footing subgrade, the boulders should be removed 12 inches below the bottom of footing and replaced with a soil cushion of compacted Gravel Fill. Footings should bear directly on soil, to avoid the potential for differential settlement due to hard spots below the footing.
- Raise-in-grade fill placed within the building pad and structure areas to achieve Site grades should consist of Structural Fill, as specified herein. Structural Fill should be placed in 12-inch-thick, loose lifts and compacted to at least 95 percent of its maximum dry density as determined by ASTM D1557, Method C (modified proctor).
- For the slab-on-grade, the exposed subgrade (for base course) should be proof-compacted with at least eight (8) passes of a 20-ton smooth-drum, vibratory roller until visibly firm and stable as observed by the Geotechnical Engineer or their qualified representative. The final 12 inches of soil directly below the slab-on-grade should consist of Gravel Fill as defined herein and compacted to at least 95 percent of its maximum dry density as determined by ASTM D1557 Method C (Modified Proctor).
- The excavated on-site soils may be re-used as raise-in-grade fill, provided they meet the requirements for Structural Fill provided herein. Raise-in-grade fill and backfill should be placed and compacted in maximum 12-inch-thick loose lifts and compacted as specified herein.

- Temporary cut slopes of natural material below proposed footings for building and structure foundations should be conducted at a 1.5H:1V slope angle (or shallower) to maintain a safe excavation.

5.5.1. Boulder Removal

Boulders were observed adjacent to the site and encountered at depth within the natural sand deposits during drilling, as such localized boulders are expected to be present at subgrades elevations. It is recommended that boulders, if encountered, be removed to at least 12 inches below the bottom of utility corridors, foundations, and slabs so that they are supported by a cushion of compacted soil to limit the potential for differential settlement due to hard spots. If boulders are encountered in areas where there are building/structures, boulders should be removed to allow construction of the base course layer below the slabs.

5.5.2. Structural Fill

Raise-in-grade fill placed within the building pad/structures and site areas should consist of Structural Fill as described below:

- Gravel Fill to serve as the base course for the building slab should consist of hard, inert, durable gravel and sand. The material should be free from organics, clay, loam, sticks, snow/ice, debris and other deleterious materials. Gravel Fill should be processed to meet the gradation requirements for MassDOT Item M2.01.7-1, dense-graded crushed stone.
- Soil material generated from on-site cut areas, free of organics and other deleterious material, may be used as raise-in-grade fill below the base course layer. On-site fill should have a maximum particle size of 6 inches. On-site fill meeting the gradation requirements below and free from roots and organics, may be used as general raise-in-grade fill below building, structure, and Site areas.

SIEVE SIZE	PERCENT PASSING BY WEIGHT
6-inch	100
1-inch	85-100
No. 4	20-90
No. 40	10-75
No. 200	0-40*

Note:

Silt content of the subsoil may vary. The on-site inorganic material is intended to be re-used as backfill below the base course layer provided it is placed and compacted as specified herein.

- Structural Fill imported from off-site sources and used as backfill within the building/structure areas, and as general raise in grade fill in non-building areas (below base course) should consist of the following:

SIEVE SIZE	PERCENT PASSING BY WEIGHT
4-inch	100
1-inch	70-100
No. 40	30-60
No. 200	0-10

- Structural Fill placed within irregularly shaped utility trenches or trenches not accessible to compaction equipment should consist of Controlled Density Fill (CDF) consisting of high slump Portland Cement Concrete (PCC) with a compressive strength less than 150 pci at 28 days; otherwise, the trench should be backfilled in accordance with the project specifications.

5.5.3. Structural Fill Placement and Compaction

Structural Fill should be mechanically compacted to a firm, non-yielding (stable) condition. Structural Fill should be placed in loose lifts approximately 12 inches thick. Each lift should be conditioned to the proper moisture content and compacted as specified herein before placing subsequent lifts. Structural Fill should be compacted to the following criteria:

- Structural Fill should be compacted to at least 95 percent of its maximum dry density as determined by ASTM D1557 Method C, Modified Proctor.

5.5.4. Weather Conditions

The subsoil contains a sufficient percentage of fines and should be considered sensitive to moisture and frost susceptible. When the moisture content of these soils is more than a few percent above the optimum moisture content, these soils become unstable, and operation of equipment on these soils and compaction of these soils is difficult. Additionally, disturbance of near-surface soils should be expected if earthwork is completed during periods of wet weather. During wet weather, we recommend the following:

- The ground surface in and around the work area should be graded so that surface water is directed away from the work area. The ground surface should be graded such that areas of ponded water do not develop. The contractor should take measures to prevent surface water from collecting in excavations and trenches. Measures should be implemented to remove surface water from the work area, and it should not be directed towards downslope structures, unless properly collected and conveyed to appropriate catch basins.
- Earthwork activities should not take place during periods of moderate to heavy precipitation.
- Slopes with exposed soils should be covered with plastic sheeting or similar means.
- The contractor should take necessary measures to prevent on-site soils, and soils to be used as fill, from becoming wet or unstable. These measures may include temporary construction dewatering, the use of plastic sheeting, sumps with pumps, and grading. The Site soils should not be left uncompacted and exposed to moisture. Sealing the surficial soils by rolling with a smooth-drum roller prior to periods of precipitation will reduce the extent to which these soils become wet or unstable.
- The contractor should cover all soil stockpiles that will be used as structural fill with plastic sheeting.
- Construction traffic should be restricted to specific areas of the Site, preferably areas that are surfaced with materials not susceptible to wet weather disturbance.
- Construction activities should be scheduled so that the length of time that soils are left exposed to moisture is reduced to the extent practicable.
- Footings and backfill should not be placed over a subgrade with standing water or that is frozen.

In the event that standing water is present on the subgrade, the water should be removed from the surface and any soft and yielding soils should be removed or allowed to dry prior to the placement of backfill. In the

event that the subgrade is frozen, the soil that is frozen should be removed, or thawed and re compacted prior to placement of backfill.

5.6. MATERIAL REUSE

5.6.1. Onsite Soil Reuse

Based on available data, we anticipate that the natural soils (inorganic subsoil and natural sand deposits, free of organics and other deleterious materials) may be suitable for reuse below building/structures and Site areas provided they can be placed and compacted in accordance with the project specifications and recommendations herein. Subsoil may be sensitive to excess moisture as described herein.

Subsoil containing organics could be screened of organics and reused in Site. Natural on-site soil (i.e., subsoil or natural sand deposits) containing organics are suitable for re-use in landscaped areas. Stripped on-site topsoil can be reused as topsoil within landscaped areas provided it meets project environmental and landscape architecture requirements.

5.7. TEMPORARY CONSTRUCTION DEWATERING

Groundwater, while generally not encountered at the Site, may still impact Site construction activities during the wet seasons due to surficial runoff and ponding. As such localized dewatering may be necessary for deep construction activities (i.e., deep excavations). We anticipate that dewatering can be achieved by installing sumps at low points in the excavation. Sumps should be constructed with crushed stone wrapped in a geotextile fabric. Groundwater is anticipated to be recharged on Site to the ground surface, and should be performed in accordance with local, State, and Federal regulations.

6.0 Limitations

We have prepared this report for Enbridge, Inc., who may distribute copies of this report to their authorized agents and regulatory agencies as may be required for the project.

Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices in the field of geotechnical engineering in this area at the time this report was prepared. The conclusions, recommendations, and opinions presented in this report are based on our professional knowledge, judgment, and experience. No warranty or other conditions, express or implied, should be understood.

Any electronic form, facsimile or hard copy of the original document (email, text, table and/or figure), if provided, and any attachments should be considered a copy of the original document. The original document is stored by GeoEngineers USA, PC and will serve as the official document of record.

Please refer to Appendix B entitled “Report Limitations and Guidelines for Use” for additional information pertaining to use of this report.

7.0 References

ASCE 7-16, 2017. “Minimum Design Loads for Buildings and Other Structures,” American Society of Civil Engineers.

ASTM D-1557, 2012. “Standard Testing Method for Laboratory Compaction Characteristics of Soil Using Modified Effort,” ASTM International.

Commonwealth of Massachusetts Department of Transportation (MassDOT), 2022, “Standard Specifications for Highways and Bridges.”

Hartshorn, J.H., Thompson, W.B., Chapman, W.F., Black, R.F., Richmond, G.M., Grant, D.R., and Fullerton, D.S., 1991, Quaternary Geologic Map of the Boston 4 Degrees x 6 Degrees Quadrangle, United States and Canada, U.S. Geological Survey, Miscellaneous Investigations Series Map I-1420 (Nk-19), Scale 1:1,000,000.

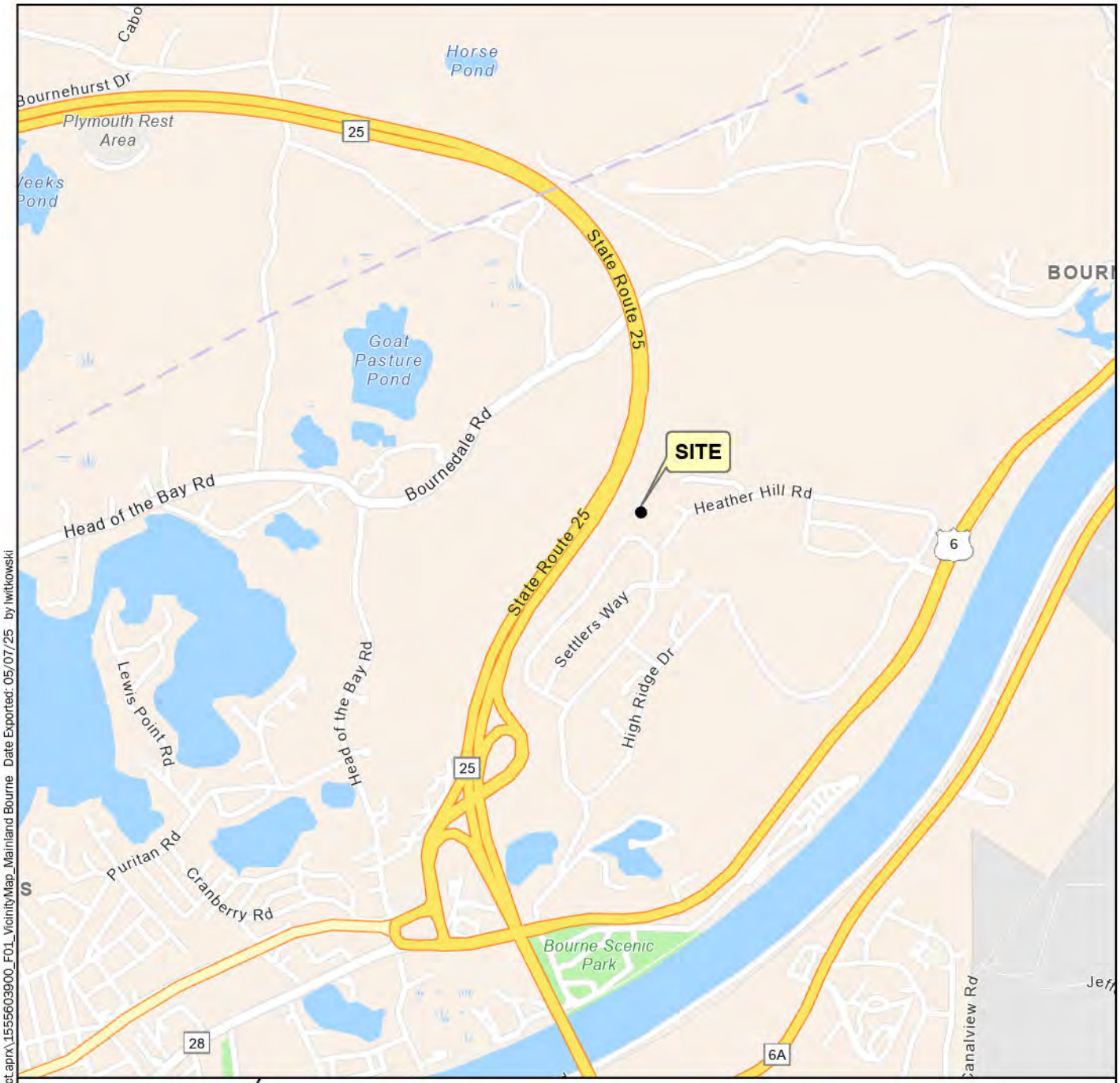
International Code Council, 2021, “International Building Code.”

Massachusetts State Building Code, 2021, “780 CMR Tenth Edition.”

Stone, J.R., Stone, B.D., Digiacomo-Cohen, M.L., and Mabee, S.B., 2019, Surficial Materials of Massachusetts—A 1:24,000-Scale Geologic Map Database, U.S. Geological Survey, Scientific Investigations Map Sim-3402, Scale 1: 24,000.

Een, E-An, Goldsmith, Richard, Ratcliffe, N.M., Robinson, Peter, Stanley, R.S., Hatch, N.L., Shride, A.F., Weed, E.G.A., and Wones, D.R., 1983, Bedrock Geologic Map of Massachusetts, U.S. Geological Survey, Scale 1:250,000.

Figures





N

0 2,000

Feet

Source(s):
- ESRI

Coordinate System: NAD 1983 2011 StatePlane Massachusetts Mnld FIPS 2001 FtUS

Disclaimer: This figure was created for a specific purpose and project. Any use of this figure for any other project or purpose shall be at the user's sole risk and without liability to GeoEngineers. The locations of features shown may be approximate. GeoEngineers makes no warranty or representation as to the accuracy, completeness, or suitability of the figure, or data contained therein. The file containing this figure is a copy of a master document, the original of which is retained by GeoEngineers and is the official document of record.

Vicinity Map

Cape Canal Bridge Replacement Project
Mainland Bourne- M&R Station
Barnstable County, Massachusetts

GeoEngineers USA

Figure 1

P:\15\15556039\GIS\15556039_Project\15556039_Project\15556039_Project.aprx\1555603900_F01_VicinityMap_Mainland Bourne Date Exported: 05/07/25 by lwitkowski



Note:

1. GeoEngineers, USA, P.C. has not verified the field location of the existing utilities.

Source: Aerial from Google Earth Pro, 05/27/2023

Coordinate System: Massachusetts State Plane, Mainland Zone, NAD83, US Foot

Disclaimer: This figure was created for a specific purpose and project. Any use of this figure for any other project or purpose shall be at the user's sole risk and without liability to GeoEngineers. The locations of features shown may be approximate. GeoEngineers makes no warranty or representation as to the accuracy, completeness, or suitability of the figure, or data contained therein. The file containing this figure is a copy of a master document, the original of which is retained by GeoEngineers and is the official document of record.

Legend

MR-09 Boring Location

Site Boundary

N

0 200

Feet

Exploration Location Plan

Cape Canal Bridge Replacement Project
Mainland Bourne M & R Station
Barnstable County Massachusetts

GeoEngineers USA

Figure 2

P:\15\15556039\CAD\00\HDD\Mainland Bourne - Geotech\15556039900_F02_ELP.dwg 2 Date Exported:5/7/2025 10:47 AM - by Lisa Witkowski

Appendices

Appendix A
Subsurface Exploration and Laboratory Testing

Appendix A
Field Explorations and Laboratory Testing

FIELD EXPLORATIONS

We explored subsurface conditions at the site on April 15 and April 16, 2025 by drilling two (2) geotechnical borings (MR-09, and MR-10). The geotechnical borings were drilled to a depth of up to approximately 32 feet below ground surface (bgs) and utilized a track-mounted drill rig. The locations of the borings are shown in the attached Exploration Location Plan, Figure 2. The Massachusetts DigSafe utility locating agency was contacted to locate utilities in the project area prior to the start of the exploratory borings.

A GeoEngineers representative observed field activities, classified the soil encountered, obtained representative samples, and prepared a log of each exploration. The soils encountered were classified visually in general accordance with American Society for Testing and Materials (ASTM) D2487, which is described in Figure A-1.

In general, soil samples were obtained from the borings continuously to a depth of 10-feet and then at 5-foot-depth intervals using 2-inch I.D. split-spoon samplers. The split-spoon samplers were driven 24 inches during Standard Penetration Tests (SPT), using a 140-pound automatic hammer with a 30-inch drop. The number of hammer blows required to drive the sampler the middle 12-inches was recorded on field logs. If no sample recovery occurred, a 3-inch I.D. split-spoon sampler was re-driven at the same depth of the 2-inch split-spoon sampler to retrieve additional soil for classification. Each boring was backfilled upon completion with soil cuttings.

The relative density of the SPT samples recovered at each interval was evaluated based on correlations with lab and field observations in general accordance with the values outlined in Table A-1 below.

TABLE A-1 CORRELATION BETWEEN BLOW COUNTS AND RELATIVE DENSITY[1]

COHESIVE SOILS (CLAY/SILT)						
Parameter	Very Soft	Soft	Medium Stiff	Stiff	Very Stiff	Hard
Blows, N	< 2	2 – 4	4 – 8	8 – 16	16 – 32	> 32
COHESIONLESS SOILS (GRAVEL/SAND/SILTY SAND)[2]						
Parameter	Very Loose	Loose	Medium Dense		Dense	Very Dense
Blows, N	0 – 4	4 – 10	10 – 30		30 – 50	> 50

Notes:

[1]After Terzaghi, K and Peck, R.B., "Soil Mechanics in Engineering Practice," John Wiley & Sons, Inc., 1962.

[2]Classification applies to soils containing additional constituents; that is, organic clay, silty or clayey sand, etc.

The exploration logs are presented in Figures A-2 and A-3. The logs are based on our interpretation of the field data and indicate the various types of soil encountered while indicating the approximate depths at which the subsurface conditions change. Unless noted on the boring logs, the lines between soil units represent approximate boundaries. The transition between materials may be gradual or may occur between

recovered samples. Additionally, the boring logs represent conditions observed at the time of drilling and have been edited to incorporate results of the laboratory tests performed as appropriate.

LABORATORY TESTING

General

Soil samples obtained from the borings were transported to Geocomp Corporation's GeoTesting Express' laboratory in Acton, Massachusetts and examined to confirm or modify field classifications. Representative soil samples were selected for laboratory testing consisting of standard classification, sieve analyses, moisture content determination, unit weight determination, resistivity testing, sulfate determination, chloride determination, and pH determination. The laboratory testing procedures are discussed in more detail below. A summary of the lab results is shown in the attached Laboratory Test Results.

Standard Classification of Soils

Standard classification of soils was performed on selected coarse-grained samples in general accordance with ASTM D2488. The results of the of the classification are in general accordance with the Unified Soil Classification System (USCS) and are presented in the attached Laboratory Test Results.

Sieve Analysis

Sieve analyses were performed on selected coarse-grained samples in general accordance with ASTM D6913. The results of the sieve analyses were plotted and classified in general accordance with the Unified Soil Classification System (USCS) and are presented in the attached Laboratory Test Results. The percentage passing the U.S. No. 200 sieve is shown on the boring logs at the respective sample depths.

Moisture Content

Moisture content determinations were performed on selected coarse-grained samples in general accordance with ASTM D2216. The results of the moisture content determinations are shown on the boring logs at the respective sample depths and presented in the attached Laboratory Test Results.

Unit Weight Determination

Unit weight determinations were performed on selected coarse-grained samples in general accordance with ASTM D7263. The results of the unit weight determinations are presented in the attached Laboratory Test Results.

Soil Resistivity

Laboratory measurements of soil resistivity in general accordance with AASHTO T288 and ASTM G 57 were performed on selected samples. The results of the soil resistivity testing are shown are presented in the attached Laboratory Test Results.

Sulfate Determination

Sulfate determinations were performed on selected coarse-grained samples in general accordance with ASTM D516. The results of the sulfate content determinations are presented in the attached Laboratory Test Results.

Chloride Determination

Chloride determinations were performed on selected coarse-grained samples in general accordance with ASTM D512. The results of the chloride content determinations are presented in the attached Laboratory Test Results.

pH Determination

pH determinations were performed on selected coarse-grained samples in general accordance with ASTM D4972. The results of the pH determinations are presented in the attached Laboratory Test Results.

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES
	MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
MORE THAN 50% RETAINED ON NO. 200 SIEVE	SAND AND SANDY SOILS	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS
				SP	POORLY-GRADED SANDS, GRAVELLY SAND
	MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS, ROCK FLOUR, CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
MORE THAN 50% PASSING NO. 200 SIEVE	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS AND SILTS OF MEDIUM TO HIGH PLASTICITY
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: Multiple symbols are used to indicate borderline or dual soil classifications

ADDITIONAL MATERIAL SYMBOLS

SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
	AC	Asphalt Concrete
	CC	Cement Concrete
	CR	Crushed Rock/ Quarry Spalls
	SOD	Sod/Forest Duff
	TS	Topsoil

Groundwater Contact

Measured groundwater level in exploration, well, or piezometer

Measured free product in well or piezometer

Graphic Log Contact

Distinct contact between soil strata

Approximate contact between soil strata

Material Description Contact

Contact between geologic units

Contact between soil of the same geologic unit

Sampler Symbol Descriptions

Modified California Sampler (6-inch sleeve) or Dames & Moore

Standard Penetration Test (SPT)

Shelby tube

Piston

Direct-Push

Bulk or grab

Continuous Coring

Blowcount is recorded for driven samplers as the number of blows required to advance sampler 12 inches (or distance noted). See exploration log for hammer weight and drop.

"P" indicates sampler pushed using the weight of the drill rig.

"WOH" indicates sampler pushed using the weight of the hammer.

Laboratory / Field Tests

%F	Percent fines
%G	Percent gravel
AL	Atterberg limits
CA	Chemical analysis
CP	Laboratory compaction test
CS	Consolidation test
DD	Dry density
DS	Direct shear
HA	Hydrometer analysis
MC	Moisture content
MD	Moisture content and dry density
Mohs	Mohs hardness scale
OC	Organic content
PM	Permeability or hydraulic conductivity
PI	Plasticity index
PL	Point load test
PP	Pocket penetrometer
SA	Sieve analysis
TX	Triaxial compression
UC	Unconfined compression
UU	Unconsolidated undrained triaxial compression
VS	Vane shear

Sheen Classification

NS	No Visible Sheen
SS	Slight Sheen
MS	Moderate Sheen
HS	Heavy Sheen

NOTE: The reader must refer to the discussion in the report text and the logs of explorations for a proper understanding of subsurface conditions. Descriptions on the logs apply only at the specific exploration locations and at the time the explorations were made; they are not warranted to be representative of subsurface conditions at other locations or times.

Key to Exploration Logs

GeoEngineers USA

Figure A-1

Drilled: Start 4/15/2025 End 4/15/2025	Total Depth (ft): 32	Logged By: AM Checked By: HPC	Driller: Geologic Earth Exploration, Inc.	Drilling Method: Hollow-stem Auger	
Surface Elevation (ft): 71.972 Vertical Datum: NAVD88		Hammer Data: Autohammer 140 (lbs) / 30 (in) Drop		Drilling Equipment: CME 55	
Easting (X): 905570.311 Northing (Y): 2742095.73		System Datum: Mass State Plane Mainland NAD83 (feet)		Groundwater not observed at time of exploration	

Notes:

Elevation (feet)	Depth (feet)	Interval	Recovered (in)	Blows/foot	Sample Name Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
70	0		9	WOH-WOH-1-2 (1)	S-1		TS	Dark brown silty fine sand with organic matter (roots, leaves) (very loose, moist) (topsoil)			
							SM				
			5	2-3-4-7 (7)	S-2		SP-SM	Orange-brown silty fine to medium sand with trace organic matter (roots) (very loose, moist) (subsoil)			
								Light brown fine to medium sand with silt and trace gravel (loose, moist)			
65	5		14	3-5-5-6 (10)	S-3 MC, SA, DD		SP	Light brown fine to coarse sand with trace silt and gravel (loose, moist)	3.4	1.4	Light rig chatter from 3½ to 4 feet % Gravel = 12.0; Dry density = 101.9 pcf Grab sample G-1 of cuttings from 4 to 8 feet
			17	7-4-6-5 (10)	S-4			Becomes fine to medium sand			
			10	3-3-3-5 (6)	S-5			Becomes without gravel			
60	10										
55	15		19	3-4-7-9 (11)	S-6 MC, SA			Becomes medium dense	2.5	1.3	% Gravel = 0.3
50	20		18	6-6-6-10 (12)	S-7			Becomes fine to medium			
45	25		14	10-9-10-12 (19)	S-8			Becomes fine to coarse and with gravel			Intermittent rig chatter from 27 to 28½ feet
40	30		0	34-25-22-19 (47)	S-9			Becomes dense			

Boring terminated at 32 feet below ground surface due to target depth achieved. Backfilled to grade with drilling cuttings.

Note: See Figure A-1 for explanation of symbols.
Coordinates Data Source: Horizontal approximated based on survey data completed by Enbridge. Vertical approximated based on survey data completed by Enbridge.

Date:5/19/25 Path:P:\15\155556039\GINT\155560390O.GPJ DBLibrary/Library:GEOUSA_DF_STD_US.GLB/GEI8_GEOTECH_STANDARD_%F_NO_GW_4BC

Log of Boring MR-9

GeoEngineers USA

Project: Cape Canal Bridge Relocation - M&R Stations
Project Location: Barnstable County, Massachusetts
Project Number: 15556-039-00

Figure A-2
Sheet 1 of 1

Drilled Start 4/16/2025 End 4/16/2025	Total Depth (ft) 32	Logged By AM Checked By HPC	Driller Geologic Earth Exploration, Inc.	Drilling Method Hollow-stem Auger	
Surface Elevation (ft) 62.827 Vertical Datum NAVD88		Hammer Data Autohammer 140 (lbs) / 30 (in) Drop		Drilling Equipment CME 55	
Easting (X) 905538.31 Northing (Y) 2741986.562		System Datum Mass State Plane Mainland NAD83 (feet)		Groundwater not observed at time of exploration	

Notes:

Elevation (feet)	Depth (feet)	FIELD DATA: Interval	Recovered (in)	Blows/foot	Sample Name Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
60	0		21	WOH-WOH-1-2 (1)	S-1		TS	Dark brown silty fine sand with organic matter (roots) (very loose, moist) (topsoil)			
							SM				
			9	1-3-3-3 (6)	S-2		SP-SM	Orange-brown silty fine to medium sand with trace fine gravel and trace organic matter (roots) (very loose, moist) (subsoil)			
			15	2-2-2-4 (4)	S-3 MC, SA, DD		SP	Light brown fine to medium sand with silt and trace fine gravel (loose, moist)	5.2	3.8	% Gravel = 14.0; Dry density = 105.6 pcf Grab sample G-1 of cuttings from 4 to 8 feet
55	5							Light brown fine to medium sand with trace silt and gravel (loose, moist)			
			16	3-3-2-3 (5)	S-4						
			14	2-2-3-3 (5)	S-5			Becomes fine to coarse			
50	10										
	15		15	2-3-3-3 (6)	S-6			Becomes fine to medium and without gravel			
45											
	20		10	2-5-3-4 (8)	S-7			Becomes with trace fine gravel			
40											Light rig chatter from 23 to 25 feet
	25		16	12-14-13-12 (27)	S-8 MC, SA		SM	Light brown silty fine to medium sand with gravel (medium dense, moist)	3.3	14.4	% Gravel = 16.0
35											Moderate rig chatter at 27 feet
	30		0	12-16-18-14 (34)	S-9		SP	Light brown fine to medium sand with trace silt and trace fine gravel (dense, moist)			Cobble in tip of 2-inch split spoon and no recovery. Re-sample with 3-inch split spoon to collect soil sample from 30 to 32 feet.

Boring terminated at 32 feet below ground surface due to target depth achieved. Backfilled to grade with drilling cuttings.

Note: See Figure A-1 for explanation of symbols.
Coordinates Data Source: Horizontal approximated based on survey data completed by Enbridge. Vertical approximated based on survey data completed by Enbridge.

Log of Boring MR-10

GeoEngineers USA

Project: Cape Canal Bridge Relocation - M&R Stations
Project Location: Barnstable County, Massachusetts
Project Number: 15556-039-00

Figure A-3
Sheet 1 of 1

Date:5/19/25 Path:P:\15\15556039\GINT\1555603900.GPJ DBLibrary/Library:GEOUSA_DF_STD_US.GLB/GEI8_GEOTECH_STANDARD_%F_NO_GW_4BC

Client:	GeoEngineers, Inc.				
Project:	Cape Cod - Enbridge				
Location:	Bourne, MA			Project No:	GTX-320928
Boring ID:	---	Sample Type:	---	Tested By:	ajl
Sample ID:	---	Test Date:	04/28/25	Checked By:	ank
Depth :	---	Test Id:	812857		

Moisture Content of Soil and Rock - ASTM D2216

Boring ID	Sample ID	Depth	Description	Moisture Content,%
MR-09	S- 6A	15-17'	Moist, very pale brown sand	2.5
MR-09	S- 3	4-6'	Moist, yellowish brown sand	3.4
MR-10	S- 8	25-27'	Moist, pale brown silty sand with gravel	3.3
MR-10	S- 3	4-6'	Moist, yellowish brown sand	5.2

Notes: Temperature of Drying : 110º Celsius

Client:	GeoEngineers, Inc.				
Project:	Cape Cod - Enbridge				
Location:	Bourne, MA			Project No:	GTX-320928
Boring ID:	MR-09 / MR-10	Sample Type:	Bag	Tested By:	ajl
Sample ID:	S-3, G-1 / S-3, G1	Test Date:	04/25/25	Checked By:	ank
Depth :	Composite	Test Id:	812876		
Test Comment:	---				
Visual Description:	Moist, yellowish brown sand				
Sample Comment:	---				

Description and Classification of Soils (Visual-Manual) - ASTM D2488

Parameter	Result
Group Name	Sand
Group Symbol	SP
% Cobbles/Boulders	0
% Gravel	5
% Sand	94
% Fines	1
Angularity (coarse grained)	SUBANGULAR
Shape (coarse grained)	N/A
Maximum Particle Size (mm)	12.7
Hardness (coarse grained)	HARD
Plasticity (fine grained)	NONPLASTIC
Dry Strength (fine grained)	---
Dilatancy (fine grained)	---
Toughness (fine grained)	---
Color	Light yellowish brown
Odor	NONE
Moisture	MOIST
Reaction with HCL	NONE
Consistency (intact,fine grained)	---
Structure (intact)	---
Cementation (intact, coarse grained)	---

Client:	GeoEngineers, Inc.				
Project:	Cape Cod - Enbridge				
Location:	Bourne, MA			Project No:	GTX-320928
Boring ID:	MR-09 / MR-10	Sample Type:	Bag	Tested By:	ajl
Sample ID:	S-3, G-1 / S-3, G1	Test Date:	05/07/25	Checked By:	ank
Depth :	Composite	Test Id:	812871		
Test Comment:	---				
Visual Description:	Moist, yellowish brown sand				
Sample Comment:	---				

pH of Soil by ASTM D4972

Boring ID	Sample ID	Depth	Visual Description	pH of Soil in Distilled Water	pH of Soil in Calcium Chloride
MR-09 / MR-10	S-3, G-1 / S-3, G1	Composite	Moist, yellowish brown sand	5.5	4.6

Notes: Sample Preparation: screened through #10 sieve

Method A, pH meter used

Client:	GeoEngineers, Inc.				
Project:	Cape Cod - Enbridge				
Location:	Bourne, MA			Project No:	GTX-320928
Boring ID:	---	Sample Type:	---	Tested By:	ajl
Sample ID:	---	Test Date:	04/25/25	Checked By:	ank
Depth :	---	Test Id:	812861		

Laboratory Determination of Density (Unit Weight) of Soil Specimens by ASTM D7263

Boring ID	Sample ID	Depth	Visual Description	Bulk Density pcf	Moisture Content %	Dry Density pcf	*
MR-09	S- 3	4-6'	Moist, yellowish brown sand	105.4	3.428	101.9	(1)
MR-10	S- 3	4-6'	Moist, yellowish brown sand	111.1	5.159	105.6	(2)

* Sample Comments

(1): One 1.5" rock removed

Method B-Volumetric, Reconstituted (compacted)

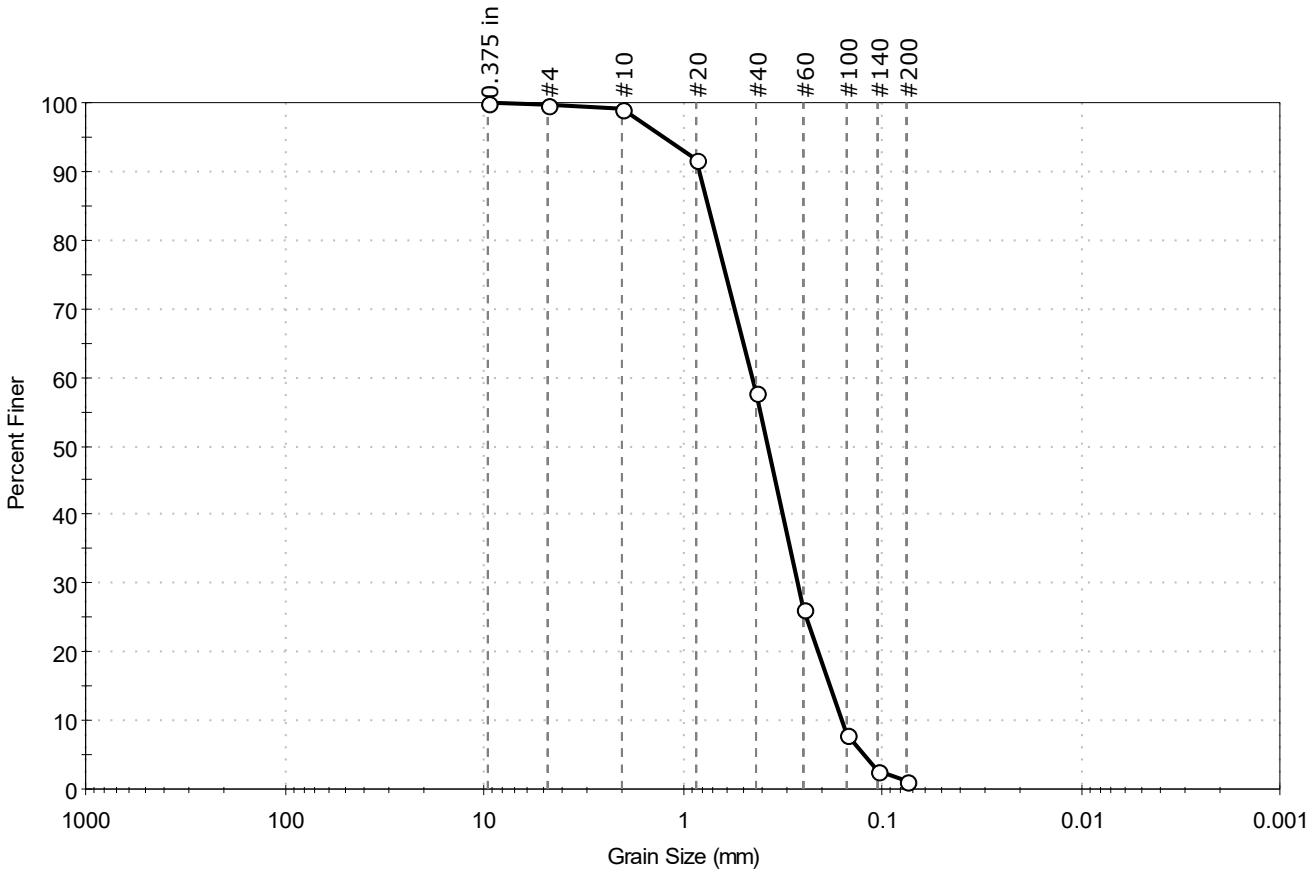
(2): Method B-Volumetric, Reconstituted (compacted)

Notes: Moisture Content determined by ASTM D2216.

Client:	GeoEngineers, Inc.				
Project:	Cape Cod - Enbridge				
Location:	Bourne, MA			Project No:	GTX-320928
Boring ID:	MR-09	Sample Type:	Unspecified	Tested By:	ajl
Sample ID:	S-6A	Test Date:	05/02/25	Checked By:	ank
Depth :	15-17'	Test Id:	812856		

Test Comment: ---
Visual Description: Moist, very pale brown sand
Sample Comment: ---

Particle Size Analysis - ASTM D6913



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.3	98.4	1.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	100		
#10	2.00	99		
#20	0.85	92		
#40	0.42	58		
#60	0.25	26		
#100	0.15	8		
#140	0.11	3		
#200	0.075	1.3		

Coefficients

D_{85} = 0.7411 mm	D_{30} = 0.2664 mm
D_{60} = 0.4451 mm	D_{15} = 0.1829 mm
D_{50} = 0.3731 mm	D_{10} = 0.1592 mm
C_u = 2.796	C_c = 1.002

Classification

ASTM Poorly graded SAND (SP)

AASHTO Fine Sand (A-3 (1))

Sample/Test Description

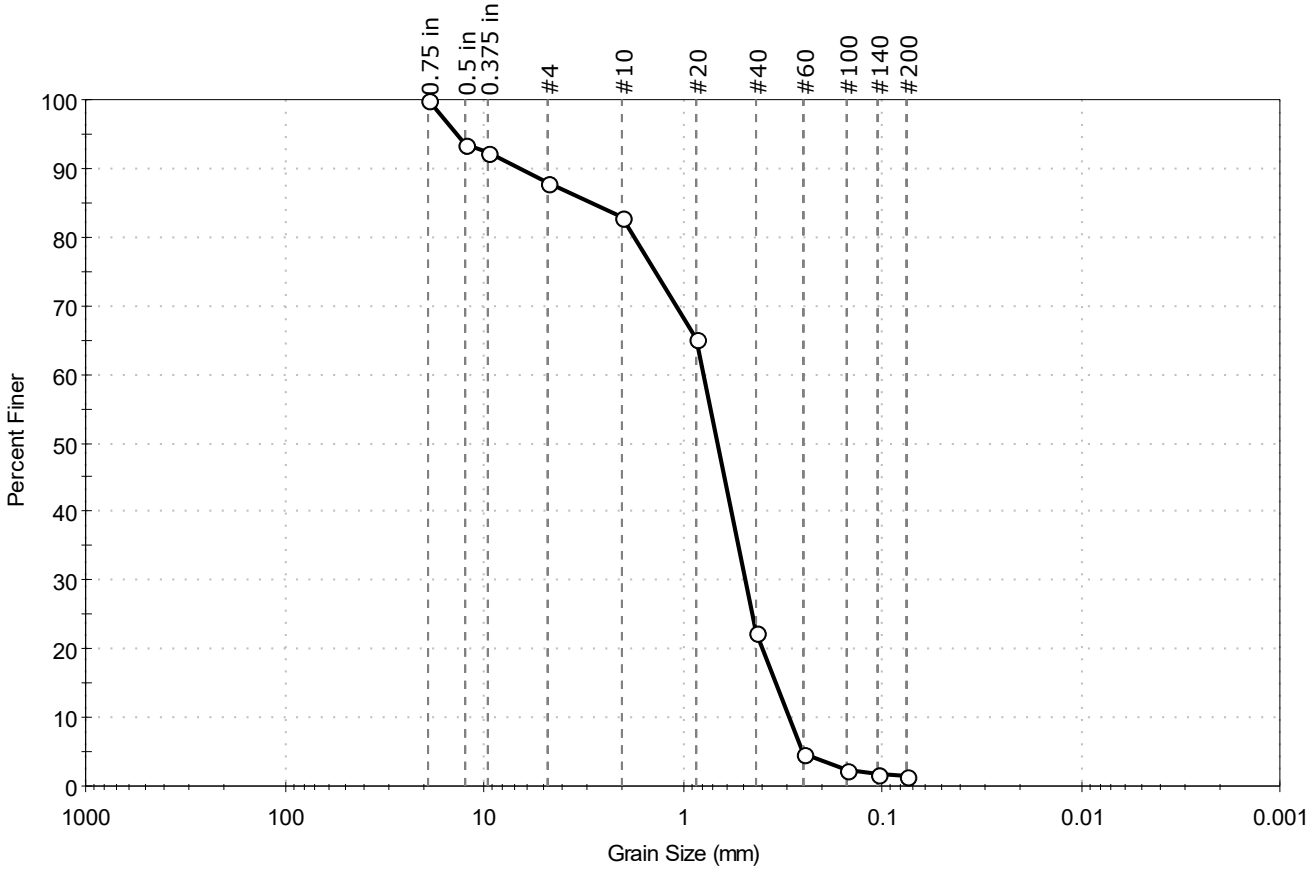
Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

Client:	GeoEngineers, Inc.				
Project:	Cape Cod - Enbridge				
Location:	Bourne, MA			Project No:	GTX-320928
Boring ID:	MR-09	Sample Type:	Unspecified	Tested By:	ajl
Sample ID:	S-3	Test Date:	05/02/25	Checked By:	ank
Depth :	4-6'	Test Id:	812855		

Test Comment: ---
Visual Description: Moist, yellowish brown sand
Sample Comment: ---

Particle Size Analysis - ASTM D6913



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	12.0	86.6	1.4

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.75 in	19.00	100		
0.5 in	12.50	94		
0.375 in	9.50	92		
#4	4.75	88		
#10	2.00	83		
#20	0.85	65		
#40	0.42	22		
#60	0.25	5		
#100	0.15	2		
#140	0.11	2		
#200	0.075	1.4		

Coefficients

D_{85} = 2.8866 mm
D_{30} = 0.4802 mm
D_{60} = 0.7815 mm
D_{15} = 0.3397 mm
D_{50} = 0.6644 mm
D_{10} = 0.2924 mm
C_u = 2.673
C_c = 1.009

Classification

ASTM: Poorly graded SAND (SP)

AASHTO: Stone Fragments, Gravel and Sand (A-1-b (1))

Sample/Test Description

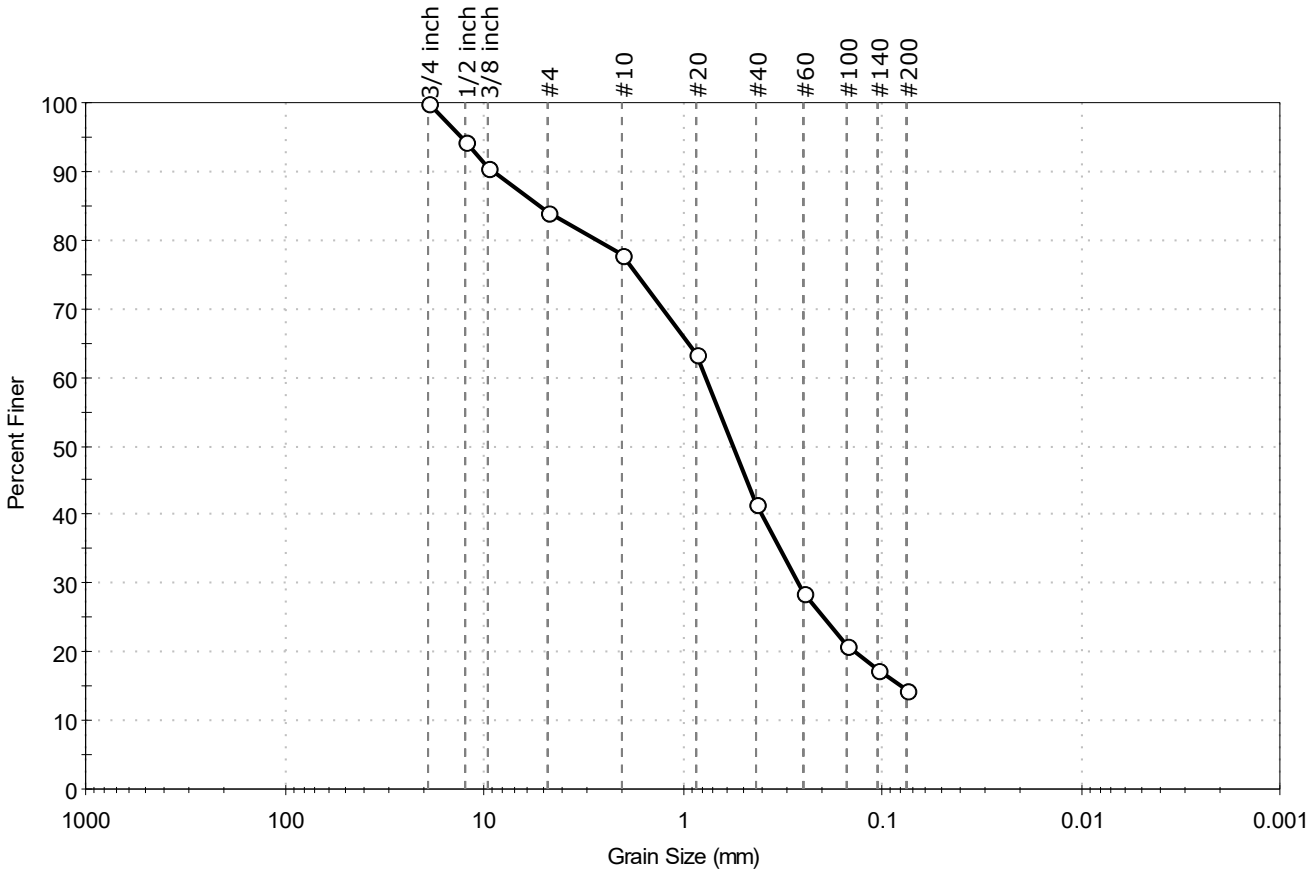
Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

Client:	GeoEngineers, Inc.				
Project:	Cape Cod - Enbridge				
Location:	Bourne, MA			Project No:	GTX-320928
Boring ID:	MR-10	Sample Type:	Unspecified	Tested By:	ajl
Sample ID:	S-8	Test Date:	05/03/25	Checked By:	ank
Depth :	25-27'	Test Id:	812854		

Test Comment: ---
Visual Description: Moist, pale brown silty sand with gravel
Sample Comment: ---

Particle Size Analysis - ASTM D6913



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	16.0	69.6	14.4

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
3/4 inch	19.00	100		
1/2 inch	12.50	94		
3/8 inch	9.50	91		
#4	4.75	84		
#10	2.00	78		
#20	0.85	63		
#40	0.42	42		
#60	0.25	29		
#100	0.15	21		
#140	0.11	17		
#200	0.075	14		

Coefficients

D_{85} = 5.2917 mm
D_{30} = 0.2636 mm
D_{60} = 0.7625 mm
D_{15} = 0.0806 mm
D_{50} = 0.5541 mm
D_{10} = N/A
C_u = N/A
C_c = N/A

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

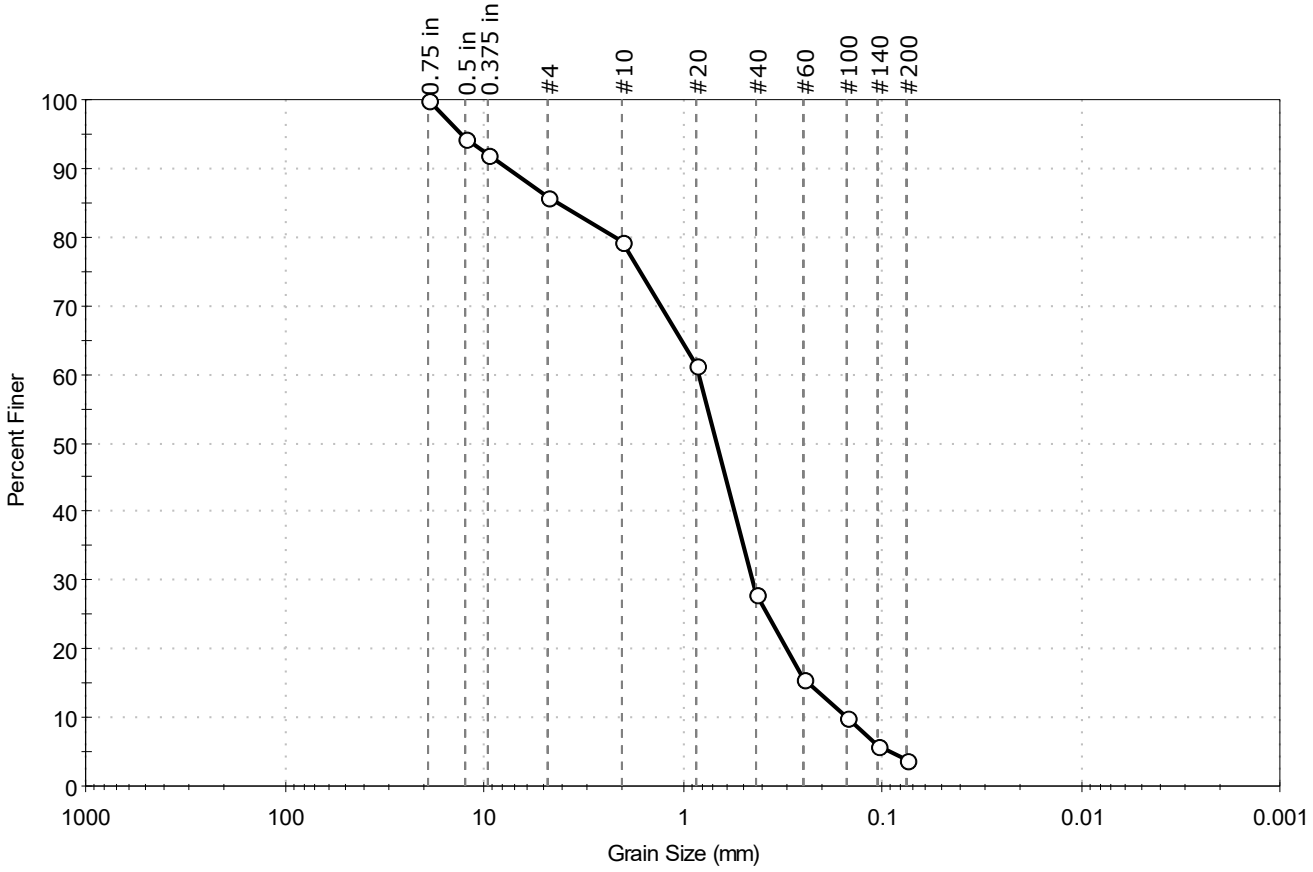
Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

printed 5/7/2025 11:52:39 AM

Client:	GeoEngineers, Inc.				
Project:	Cape Cod - Enbridge				
Location:	Bourne, MA			Project No:	GTX-320928
Boring ID:	MR-10	Sample Type:	Unspecified	Tested By:	ajl
Sample ID:	S-3	Test Date:	05/02/25	Checked By:	ank
Depth :	4-6'	Test Id:	812853		
Test Comment:	---				
Visual Description:	Moist, yellowish brown sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D6913



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	14.0	82.2	3.8

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.75 in	19.00	100		
0.5 in	12.50	94		
0.375 in	9.50	92		
#4	4.75	86		
#10	2.00	79		
#20	0.85	61		
#40	0.42	28		
#60	0.25	16		
#100	0.15	10		
#140	0.11	6		
#200	0.075	3.8		

Coefficients

D_{85} =4.1923 mm	D_{30} =0.4435 mm
D_{60} =0.8251 mm	D_{15} =0.2345 mm
D_{50} =0.6708 mm	D_{10} =0.1493 mm
C_u =5.526	C_c =1.597

Classification

ASTM — Poorly graded SAND (SP)

AASHTO — Stone Fragments, Gravel and Sand (A-1-b (1))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

Client:	GeoEngineers, Inc.
Project:	Cape Cod-Enbridge
Location:	Bourne, MA
GTX#:	320928
Test Date:	05/06/25
Due Date:	05/07/25
Tested By:	NMK
Checked By:	ank

Laboratory Measurement of Soil Resistivity Using the Wenner Four-Electrode Method by ASTM G57 (Laboratory Measurement)

Boring ID	Sample ID	Depth, ft.	Sample Description	Electrical Resistivity, ohm-cm	Electrical Conductivity, $(ohm\text{-}cm)^{-1}$
MR-09/MR-10	S-3, G-1/S-3, G1	Composite	Moist, yellowish brown sand	79,645	1.26E-05

Notes: Test Equipment: Nilsson Model 400 Soil Resistance Meter, MC Miller Soil Box
Water added to sample to create a thick slurry prior to testing (saturated condition).
Electrical Conductivity is calculated as inverse of Electrical Resistivity (per ASTM G57)
Test conducted in standard laboratory atmosphere: 68-73 F

Client:	GeoEngineers, Inc.
Project:	Cape Cod- Enbridge
Location:	Bourne, MA
GTX#:	320928
Test Date:	05/07/25
Due Date:	05/07/25
Tested By:	NMK
Checked By:	ank

Minimum Laboratory Soil Resistivity by AASHTO T 288

Boring ID	Sample ID	Depth, ft.	Sample Description	Electrical Resistivity, ohm-cm	Electrical Conductivity, $(ohm\text{-}cm)^{-1}$
MR-09/MR-10	S-3, G-1/S-3, G1	Composite	Moist, yellowish brown sand	72,100	1.39E-05

Notes: Test Equipment: Nilsson Model 400 Soil Resistance Meter, MC Miller Soil Box
Water added to sample to create a thick slurry prior to testing (saturated condition).
Electrical Conductivity is calculated as inverse of Electrical Resistivity (per ASTM G57)
Test conducted in standard laboratory atmosphere: 68-73 F



PO Box 572455 / Salt Lake City UT 84157-2455 / USA
TEL +1 801 262 2448 · FAX +1 801 262 9870 · www.TEi-TS.com

GEOTESTING EXPRESS INCORPORATED
125 NAGOG PARK
ACTON MA 01720-3451
USA

Analysis No.	TS-A2512668
Report Date	05 May 2025
Date Sampled	29 April 2025
Date Received	01 May 2025
Where Sampled	Acton, MA USA
Sampled By	Client

This is to attest that we have examined: Soil: Project: Cape Cod - Enbridge; Site Location: – — –; Job Number: GTX-320928

When examined to the applicable requirements of:

ASTM D 512-12* "Standard Test Methods for Chloride Ion in Water" Method B

ASTM D 516-22 "Standard Test Method for Sulfate Ion in Water"

Results:

ASTM D 512 - Chloride Method B

Sample		Results		Minimum Detection Limit
		ppm (mg/kg)	%[1]	
MR-09/MR-10		12.	0.0012	10.
S-3, G-1 / S-3, G-1	Composite			

NOTE: [1]Percent by weight after drying and prepared as per the Standard. *Withdrawn 2021 without Replacement

ASTM D 516 - Sulfates (Soluble)

Sample		Results		Minimum Detection Limit
		ppm (mg/kg)	%[1]	
MR-09/MR-10		< 10.	< 0.0010	10.
S-3, G-1 / S-3, G-1	Composite			

NOTE: [1]Percent by weight after drying and prepared as per the Standard.

END OF ANALYSIS

USEPA Laboratory ID UT00930

Merrill Gee P.E. – Engineer in Charge

© 2025 by Testing Engineers International, Inc. CAVEAT: This certificate may not be reproduced except in full, without the expressed written consent of TEi-Testing Services, LLC. Note: The values in this certificate are the values obtained under standard test conditions as reported in the appropriate Report of Test and thus may be used for purposes of demonstrating compliance or for comparison with other units tested under the same standard. The results do not indicate the function of the sample(s) under nonstandard or field conditions. Statement of Risk: Client understands and agrees that declarations of conformity are made by directly comparing the measurement results against the test limits given in the standard without consideration to factors that may contribute to measurement uncertainty and accepts the shared risk that arises from this approach. This certificate gives the characteristics of the sample(s) submitted for testing only. It does not and may not be used to certify the characteristics of the product, nor to imply that the product in general meets the requirements of any standard, nor its acceptability in the marketplace. TEi stylized lettering and logo are registered trademarks, and use is by contract and/or written permission only. USEPA Laboratory ID UT00930 TEi-Testing Services is a wholly owned LLC of Testing Engineers International, Inc.

Appendix B
Report Limitations and Guidelines for Use

Appendix B
Report Limitations and Guidelines For Use[1]

This appendix provides information to help you manage your risks with respect to the use of this report.

READ THESE PROVISIONS CLOSELY

It is important to recognize that the geoscience practices (geotechnical engineering, geology, and environmental science) rely on professional judgment and opinion to a greater extent than other engineering and natural science disciplines, where more precise and/or readily observable data may exist. To help clients better understand how this difference pertains to our services, GeoEngineers includes the following explanatory "limitations" provisions in its reports. Please confer with GeoEngineers if you need to know more how these "Report Limitations and Guidelines for Use" apply to your project or site.

GEOTECHNICAL SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES, PERSONS, AND PROJECTS

This report has been prepared for Enbridge, Inc. and for the Project specifically identified in the report. The information contained herein is not applicable to other sites or projects.

GeoEngineers structures its services to meet the specific needs of its clients. No party other than the party to whom this report is addressed may rely on the product of our services unless we agree to such reliance in advance and in writing. Within the limitations of the agreed scope of services for the Project, and its schedule and budget, our services have been executed in accordance with our Agreement with Enbridge, Inc. dated October 31, 2023, and revised April 4, 2025 and generally accepted geotechnical practices in this area at the time this report was prepared. We do not authorize, and will not be responsible for, the use of this report for any purposes or projects other than those identified in the report.

A GEOTECHNICAL ENGINEERING OR GEOLOGIC REPORT IS BASED ON A UNIQUE SET OF PROJECT-SPECIFIC FACTORS

This report has been prepared for Enbridge Inc. for the proposed Mainland Bourne M&R Station Site, in Bourne, Massachusetts. GeoEngineers considered a number of unique, project-specific factors when establishing the scope of services for this project and report. Unless GeoEngineers specifically indicates otherwise, it is important not to rely on this report if it was:

- Not prepared for you,
- Not prepared for your project,
- Not prepared for the specific site explored, or
- Completed before important project changes were made.

1 Developed based on material provided by GBA, GeoProfessional Business Association; www.geoprofessional.org.

For example, changes that can affect the applicability of this report include those that affect:

- The function of the proposed structure;
- Elevation, configuration, location, orientation, or weight of the proposed structure;
- Composition of the design team; or
- Project ownership.

If changes occur after the date of this report, GeoEngineers cannot be responsible for any consequences of such changes in relation to this report unless we have been given the opportunity to review our interpretations and recommendations. Based on that review, we can provide written modifications or confirmation, as appropriate.

ENVIRONMENTAL CONCERNS ARE NOT COVERED

Unless environmental services were specifically included in our scope of services, this report does not provide any environmental findings, conclusions, or recommendations, including but not limited to, the likelihood of encountering underground storage tanks or regulated contaminants.

SUBSURFACE CONDITIONS CAN CHANGE

This geotechnical or geologic report is based on conditions that existed at the time the study was performed. The findings and conclusions of this report may be affected by the passage of time, by man-made events such as construction on or adjacent to the site, new information or technology that becomes available subsequent to the report date, or by natural events such as floods, earthquakes, slope instability or groundwater fluctuations. If more than a few months have passed since issuance of our report or work product, or if any of the described events may have occurred, please contact GeoEngineers before applying this report for its intended purpose so that we may evaluate whether changed conditions affect the continued reliability or applicability of our conclusions and recommendations.

TOPSOIL

For the purposes of this report, we consider topsoil to consist of generally fine-grained soil with an appreciable amount of organic matter based on visual examination and to be unsuitable for direct support of the proposed improvements. However, the organic content and other mineralogical and gradational characteristics used to evaluate the suitability of soil for use in landscaping and agricultural purposes was not determined, nor considered in our analyses. Therefore, the information and recommendations in this report and our logs and descriptions should not be used as a basis for estimating the volume of topsoil available for such purposes.

GEOTECHNICAL AND GEOLOGIC FINDINGS ARE PROFESSIONAL OPINIONS

Our interpretations of subsurface conditions are based on field observations from widely spaced sampling locations at the site. Site exploration identifies the specific subsurface conditions only at those points where subsurface tests are conducted or samples are taken. GeoEngineers reviewed field and laboratory data and then applied its professional judgment to render an informed opinion about subsurface conditions at other locations. Actual subsurface conditions may differ, sometimes significantly, from the opinions

presented in this report. Our report, conclusions and interpretations are not a warranty of the actual subsurface conditions.

GEOTECHNICAL ENGINEERING REPORT RECOMMENDATIONS ARE NOT FINAL

We have developed the following recommendations based on data gathered from subsurface investigation(s). These investigations sample just a small percentage of a site to create a snapshot of the subsurface conditions elsewhere on the site. Such sampling on its own cannot provide a complete and accurate view of subsurface conditions for the entire site. Therefore, the recommendations included in this report are preliminary and should not be considered final. GeoEngineers' recommendations can be finalized only by observing actual subsurface conditions revealed during construction. GeoEngineers cannot assume responsibility or liability for the recommendations in this report if we do not perform construction observation.

We recommend that you allow sufficient monitoring, testing and consultation during construction by GeoEngineers to confirm that the conditions encountered are consistent with those indicated by the explorations, to provide recommendations for design changes if the conditions revealed during the work differ from those anticipated, and to evaluate whether earthwork activities are completed in accordance with our recommendations. Retaining GeoEngineers for construction observation for this project is the most effective means of managing the risks associated with unanticipated conditions. If another party performs field observation and confirms our expectations, the other party must take full responsibility for both the observations and recommendations. Please note, however, that another party would lack our project-specific knowledge and resources.

A GEOTECHNICAL ENGINEERING OR GEOLOGIC REPORT COULD BE SUBJECT TO MISINTERPRETATION

Misinterpretation of this report by members of the design team or by contractors can result in costly problems. GeoEngineers can help reduce the risks of misinterpretation by conferring with appropriate members of the design team after submitting the report, reviewing pertinent elements of the design team's plans and specifications, participating in pre-bid and preconstruction conferences, and providing construction observation.

DO NOT REDRAW THE EXPLORATION LOGS

Geotechnical engineers and geologists prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. The logs included in a geotechnical engineering or geologic report should never be redrawn for inclusion in architectural or other design drawings. Photographic or electronic reproduction is acceptable, but separating logs from the report can create a risk of misinterpretation.

GIVE CONTRACTORS A COMPLETE REPORT AND GUIDANCE

To help reduce the risk of problems associated with unanticipated subsurface conditions, GeoEngineers recommends giving contractors the complete geotechnical engineering or geologic report, including these "Report Limitations and Guidelines for Use." When providing the report, you should preface it with a clearly written letter of transmittal that:

- Advises contractors that the report was not prepared for purposes of bid development and that its accuracy is limited; and
- Encourages contractors to conduct additional study to obtain the specific types of information they need or prefer.

CONTRACTORS ARE RESPONSIBLE FOR SITE SAFETY ON THEIR OWN CONSTRUCTION PROJECTS

Our geotechnical recommendations are not intended to direct the contractor's procedures, methods, schedule, or management of the work site. The contractor is solely responsible for job site safety and for managing construction operations to minimize risks to on-site personnel and adjacent properties.

BIOLOGICAL POLLUTANTS

GeoEngineers' Scope of Work specifically excludes the investigation, detection, prevention, or assessment of the presence of Biological Pollutants. Accordingly, this report does not include any interpretations, recommendations, findings, or conclusions regarding the detecting, assessing, preventing or abating of Biological Pollutants, and no conclusions or inferences should be drawn regarding Biological Pollutants as they may relate to this project. The term "Biological Pollutants" includes, but is not limited to, molds, fungi, spores, bacteria, and viruses, and/or any of their byproducts.

A Client that desires these specialized services is advised to obtain them from a consultant who offers services in this specialized field.

INFORMATION PROVIDED BY OTHERS

GeoEngineers has relied upon certain data or information provided or compiled by others in the performance of our services. Although we use sources that we reasonably believe to be trustworthy, GeoEngineers cannot warrant or guarantee the accuracy or completeness of information provided or compiled by others.

Drawdown Analysis

Drawdown Analysis

Required Drawdown Time

Infiltration Basin	Bottom Area (sf)	Recharge Volume (cf)	Infiltration Rate (in/hr)	Drawdown Time (hr)
1	1730.97	24351.27	4.899	34.5

NRCS Web Soil Infiltration Data

NRCS Web Soil Map Symbol and Soil Name	Ksat rv (micro m/sec)	Ksat rv (in/hr)	Safety Factor (0.5)	Design Infitlration Rate
Barnstable sandy loam, 3 to 8 percent slopes, very stony				
431B	69.1414	9.80	0.5	4.899
Plymouth loamy coarse sand, 3 to 8 percent slopes				
435B	390.8036	55.38	0.5	27.688
Plymouth loamy coarse sand, 8 to 15 percent slopes				
435C	390.8036	55.38	0.5	27.688
Barnstable-Plymouth complex, rolling, very bouldery				
489C	69.1414	9.80	0.5	4.899

Design Infiltration Rate = 4.899 in/hr

Recharge Volume

Recharge Volume Calculations

Proposed Impervious Surface Summary

Basin	Drainage Area	HSG	Impervious Area (sf)	Recharge Depth (in)	Required Volume (cf)	Provided Volume (cf)
1	1	A	50529.60	0.60	2526.48	24351.27
N/A	2	A	4116.00	0.60	205.80	0.00
N/A	3	A	4138.44	0.60	206.92	0.00
N/A	4	A	3600.00	0.60	180.00	0.00
N/A	5	A	3576.24	0.60	178.81	0.00
N/A	6	A	406.74	0.60	20.34	0.00
N/A	7	A	383.40	0.60	19.17	0.00
N/A	8	A	2710.98	0.60	135.55	0.00
N/A	9	A	2734.68	0.60	136.73	0.00

Total Required Recharge Volume = 3609.80 cf
Total Provided Recharge Volume = 24351.27 cf

Provided Storage Volumes

	Depth (ft)	Area (sf)	Cumulative Volume (cf)
Forebay 1	0	70.72	0.000
	1	363.35	217.04
	2	710.9	754.17
	3	1134.81	1677.03
	4	1635.08	3061.98

	Depth (ft)	Area (sf)	Cumulative Volume (cf)
Infiltration Basin 1	0	1730.97	0.000
	.5	2246.13	994.28
	1.5	3328.81	3781.75
	2.5	4481.3	7686.81
	3.5	5703.61	12779.27
	4.5	6995.74	19128.95
	5	7667.99	22794.88
	5.2	7895.95	24351.27
	5.7	8357.69	28414.68

Attachment E - Standard 4 Supporting Information

Long-Term Pollution Prevention Plan

Water Quality Volume Calculations

TSS Removal Work Sheet

Nitrogen Loading Calculations

Long – Term Pollution Prevention Plan

This Long-Term Pollution Prevention Plan has been developed to establish site management practices that improve the quality of stormwater discharges from the Project.

Pollutant Control Approach

Maintenance of Impervious Areas

Standard Gravel Areas

Gravel area maintenance involves regular raking to redistribute stones, removing debris with a leaf blower, and replenishing aggregate every 2–4 years to fix sinking or bare spots. For longevity, ensure proper drainage with a crown, clean debris from edges, and remove sediment to prevent clogging. Maintain Proper Grading on roads with a 3% grade to shed water and reduce erosion and sediment runoff.

Key Maintenance Activities:

- **Raking & Leveling:** Regularly rake in ruts and maintain a level surface, especially in high-traffic areas.
- **Debris Removal:** Use a leaf blower or rake to remove leaves and debris, preventing decomposition that creates soil for weeds.
- **Replenishing:** Top off gravel every 2-4 years as it settles or sinks into the ground.
- **Weed Management:** Pull weeds regularly and apply mulch glue or similar products to help keep gravel in place and reduce weed growth.
- **Drainage & Erosion Control:** Ensure the area has a slight slope (crown) to prevent standing water. Inspect for erosion and fill in low spots with clean, washed stone.
- **Edge Maintenance:** Clean edges to maintain a clear boundary.

O&M for Specific Gravel Uses:

- **Gravel Driveways:** Use a rake or land plane to keep the surface level and remove potholes. Maintain 3% grade to promote sheet flow and avoid erosion and sedimentation.
- **Pervious Gravel Areas:** Remove sediment that clogs voids to maintain infiltration. If clogged, remove the top layer of rock to wash or replace it.

Maintenance of Vegetated Areas

Proper maintenance of vegetated areas can prevent the pollution of stormwater runoff by controlling the source of pollutants such as suspended sediments, excess nutrients, and chemicals from landscape care products. Practices that should be followed under the regular maintenance of the vegetated landscape include:

- Inspect vegetated areas on a semi-annual basis and remove any litter.

- Maintain vegetated areas adjacent to pavement to prevent soil washout.
- Immediately clean any soil deposited on pavement.
- Re-seed bare areas; install appropriate erosion control measures when native soil is exposed or erosion channels are forming.

Management of Snow and Ice

Storage and Disposal

Snow shall be stockpiled on standard pavement surfaces so sand and salt may be swept in the spring or removed as snow melts and drains through the stormwater management system. Key practices for the safe storage and disposal of snow include:

- Under no circumstances shall snow be disposed or stored in wetland resource areas.
- Under no circumstances shall snow be disposed or stored in stormwater basins, ponds, rain gardens, swales, channels, or trenches.

Salt and Deicing Chemicals

The amount of salt and deicing chemicals to be used on the site shall be reduced to the minimum amount needed to provide safe pedestrian and vehicle travel. The following practices should be followed to control the amount of salt and deicing

materials that come into contact with stormwater runoff:

- Devices used for spreading salt and deicing chemicals should be capable of varying the rate of application based on the site specific conditions.
- Sand and salt should be stockpiled under covered storage facilities that prevent precipitation and adjacent runoff from coming in contact with the deicing materials

Spill Prevention and Response Plan

Initial Notification

In the event of a spill the facility and/or construction manager or supervisor will be notified immediately.

Facility Manager: Joseph Bruno (Jpseph.Bruno@enbridge.com)

Construction Manager: Williams Rogers (William.Rodger@enbridge.com)

The designated Site Representative shall promptly notify emergency response personnel, including the Fire Department, as appropriate based on the nature and severity of the incident. Additional notifications to local authorities, including the Police Department, Health Department, and Conservation Commission, shall be made as necessary and in accordance with applicable regulatory requirements.

Emergency contact information for facility personnel, contractors, and response agencies shall be maintained on-site and updated prior to construction and facility operation

Further Notification

Based on the nature, size, and potential environmental impact of the spill or release, additional notifications may be made to appropriate local, state, and federal agencies, as well as qualified cleanup contractors and emergency response personnel.

Applicable regulatory notifications may include the Massachusetts Department of Environmental Protection (MassDEP), the National Response Center (NRC), and other agencies as required by law or permit conditions. Emergency response personnel and the designated Site Representative shall coordinate response actions and determine appropriate cleanup and reporting measures based on site conditions and regulatory requirements.

Emergency contact information shall be maintained at the site office and made readily accessible to project personnel during construction and facility operations. Spill incidents and corrective actions shall be documented and maintained as part of the project records, and spill reporting forms shall be completed as necessary.

Emergency Notification Phone Numbers

1. FACILITY MANAGER NAME: Joseph Bruno ALERNATE CONTACT: William Rogers	PHONE: _____ BEEPER/CELL: _____ HOME PHONE: _____ PHONE: _____ BEEPER/CELL: _____ HOME PHONE: _____
2. FIRE AND POLICE DEPARTMENT	EMERGENCY: 911
3. CLEANUP CONTRACTOR: TBD ADDRESS: _____ _____	PHONE: TO BE DETERMINED
4. STATE DEPARTMENT OF ENVIRONMENTAL PROTECTION (DEP)/ DEPARTMENT OF ENVIRONMENTAL SERVICES (DES)	EMERGENCY PHONE: 508-946-2700
5. NATIONAL RESPONSE CENTER U.S ENVIORNMENTAL PROTECTION AGENCY	PHONE: (800) 424-8802 PHONE: 1-888-372-7341
6. BARNSTABLE HEATH DEPARTMENT CAPE COD CONSERVATION COMISSION:	PHONE: 508-862-4644 PHONE: 508-362-3828

Hazardous Waste / Oil Spill Report

Date: ____/____/_____ Time: _____ AM / PM

Exact location _____

Type of equipment:_____ Make:_____ Size:_____

License or S/N:_____ Weather Conditions:_____

On or near water ☐ Yes If yes, name of body of water:_____

☐ No

Type of chemical / oil spilled: _____

Amount of chemical / oil spilled: _____

Cause of spill: _____

_____

_____

Measures taken to contain or clean up spill: _____

_____

_____

Amount of chemical / oil recovered: _____ Method:_____

Material collected as a result of clean up

_____ drums containing: _____

_____ drums containing: _____

_____ drums containing: _____

Location and method of debris disposal:_____

Name and address of any person, firm, or corporation suffering damages:_____

_____

Procedures, method, and precautions instituted to prevent a similar occurrence from recurring: :_____

_____

Spill reported to General Office by:_____Time: _____AM / PM

Spill reported to DEP / National Response Center by:_____

DEP Date: ____/____/_____ Time:_____AM / PM Inspector:_____

NRC Date: ____/____/_____ Time:_____AM / PM Inspector: _____

Additional comments: _____

_____

Assessment – Initial Containment

- The supervisor or manager will assess the incident and initiate containment
- control measures with the appropriate spill containment equipment included in the spill kit kept on-site. A list of recommended spill equipment to be kept on site is included on the following page.
- Fire / Police Department: 911
- Municipality Health Department: (508) 862-4644
- Municipality Conservation Commission: (508) 362-3828

Stormwater Operation and Maintenance Plan

Project Information

Cape Cod Canal Pipeine Replacement Project

Site

Bourne M&R Station

Owner

TBD

Site Supervisor

Name: Joseph Bruno

Telephone: _____

Cell phone: _____

Email: Joseph.bruno@enbridge.com

Description of Stormwater Maintenance Measures

The following Operation and Maintenance (O&M) program is proposed to ensure the continued effectiveness of the stormwater management system. Attached to this plan are a Stormwater Best Management Practices Checklist and Maintenance Figure for use during the long term operation and maintenance of the stormwater management system.

The long term O&M of the stormwater management system is estimated to cost approximately $20,000 annually.

Grass Swales

Grass swales shall be inspected semi-annually and after storm events exceeding 1 inch of rainfall. Swales shall be maintained to ensure proper flow conveyance without erosion or standing water. Sediment and debris shall be removed as needed to maintain design capacity. Vegetation shall be mowed and maintained to promote uniform flow and infiltration. Eroded areas shall be repaired and stabilized.

Sediment Forebays

Sediment forebays shall be inspected semi-annually and after major storm events. Accumulated sediment shall be removed when it reaches 50% of the design storage capacity or as needed to maintain function. Inlet and outlet structures shall be checked for blockages or damage. Removed sediment shall be disposed of in accordance with applicable regulations.

Infiltration Basin

The infiltration basin shall be inspected semi-annually and after storm events exceeding 1 inch of rainfall. The basin shall be maintained to ensure proper infiltration, including removal of accumulated sediment, trash, and debris. Sediment shall be removed when accumulation exceeds 3 inches. The basin shall be evaluated if standing water persists longer than 72 hours, and corrective actions shall be implemented as needed. Vegetation shall be maintained to ensure proper function.

Inspections and Cleaning

A routine inspection and maintenance program shall be implemented in accordance with the Massachusetts Stormwater Management Standards (310 CMR 10.00). Inspection records shall include the date, inspector name, observations, and corrective actions taken. Maintenance activities, including sediment removal and repairs, shall be documented and retained on-site or made available upon request. Any deficiencies identified during inspections shall be corrected in a timely manner to ensure continued compliance.

Long Term Best Management Practices – Maintenance / Evaluation Checklist

Best Management Practices	Inspection Frequency	Date	Inspector	Minimum Maintenance and Key items to check	Cleaning/Repair needed	Date of Cleaning/ Repair	Preformed by:

Stormwater Control Manager: _____

Water Quality Volume Calculations

Water Quality Volume Calculations

Storage Volume Summary

Forebay	Drainage Area	Treatment Depth (in)	Impervious Area (Acres)	Required Volume (cf)	Provided Volume (cf)
1	A1	0.1	1.09	395.67	1677.03
N/A	A2	0.1	0.105	38.12	0.00
N/A	A3	0.1	0.107	38.84	0.00
N/A	A4	0.1	0.093	33.76	0.00
N/A	A5	0.1	0.094	34.12	0.00
N/A	A6	0.1	0.01	3.63	0.00
N/A	A7	0.1	0.01	3.63	0.00
N/A	A8	0.1	0.087	31.58	0.00
N/A	A9	0.1	0.071	25.77	0.00

Min. Storage Volume = 0.1-inch per impervious acre tributary to BMP (per Volume 2, Chapter 2, p.13 of the 2008 MA DEP Stormwater Management Handbook)

Basin	Drainage Area	Treatment Depth (in)	Impervious Area (Acres)	Required Volume (cf)	Provided Volume (cf)
1	A1	1.00	1.16	4210.82	24351.27
N/A	A2	1.00	0.09	343.00	0.00
N/A	A3	1.00	0.10	344.87	0.00
N/A	A4	1.00	0.08	300.00	0.00
N/A	A5	1.00	0.08	298.02	0.00
N/A	A6	1.00	0.01	33.90	0.00
N/A	A7	1.00	0.01	31.95	0.00
N/A	A8	1.00	0.06	225.92	0.00
N/A	A9	1.00	0.06	227.89	0.00

Provided Storage Volumes

	Depth (ft)	Area (sf)	Cumulative Volume (cf)
Forebay 1	0	70.72	0.000
	1	363.35	217.04
	2	710.9	754.17
	3	1134.81	1677.03
	4	1635.08	3061.98

	Depth (ft)	Area (sf)	Cumulative Volume (cf)
Infiltration Basin 1	0	1730.97	0.000
	.5	2246.13	994.28
	1.5	3328.81	3781.75
	2.5	4481.3	7686.81
	3.5	5703.61	12779.27
	4.5	6995.74	19128.95
	5	7667.99	22794.88
	5.2	7895.95	24351.27
	5.7	8357.69	28414.68

TSS Removal Worksheets

INSTRUCTIONS:
1. In BMP Column, click on Blue Cell to Activate Drop Down Menu
2. Select BMP from Drop Down Menu
3. After BMP is selected, TSS Removal and other Columns are automatically completed.

Version 1, Automated: Mar. 4, 2008

Location: Barnstable County - Drainage Area 1

TSS Removal Calculation Worksheet

B BMP[1]	C TSS Removal Rate[1]	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
Grass Channel	0.50	1.00	0.50	0.50
Sediment Forebay	0.25	0.50	0.13	0.38
Infiltration Basin	0.80	0.38	0.30	0.08
	0.00	0.08	0.00	0.08
	0.00	0.08	0.00	0.08

Total TSS Removal = 93%

Separate Form Needs to be Completed for Each Outlet or BMP Train

Project: MASS DOT Canal Bridges Relocation
Prepared By: Drake Trawhon
Date: 6/30/2026

*Equals remaining load from previous BMP (E) which enters the BMP

Non-automated TSS Calculation Sheet must be used if Proprietary BMP Proposed
1. From MassDEP Stormwater Handbook Vol. 1

INSTRUCTIONS:
1. In BMP Column, click on Blue Cell to Activate Drop Down Menu
2. Select BMP from Drop Down Menu
3. After BMP is selected, TSS Removal and other Columns are automatically completed.

Version 1, Automated: Mar. 4, 2008

Location: Barnstable County - Drainage Area 2

TSS Removal Calculation Worksheet

B BMP[1]	C TSS Removal Rate[1]	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
Grass Channel	0.50	1.00	0.50	0.50
	0.00	0.50	0.00	0.50
	0.00	0.50	0.00	0.50
	0.00	0.50	0.00	0.50
	0.00	0.50	0.00	0.50

Total TSS Removal = 50%

Separate Form Needs to be Completed for Each Outlet or BMP Train

Project: MASS DOT Canal Bridges Relocation
Prepared By: Drake Trawhon
Date: 6/30/2026

*Equals remaining load from previous BMP (E) which enters the BMP

Non-automated TSS Calculation Sheet must be used if Proprietary BMP Proposed
1. From MassDEP Stormwater Handbook Vol. 1

INSTRUCTIONS:
1. In BMP Column, click on Blue Cell to Activate Drop Down Menu
2. Select BMP from Drop Down Menu
3. After BMP is selected, TSS Removal and other Columns are automatically completed.

Version 1, Automated: Mar. 4, 2008

Location: Barnstable County - Drainage Area 3

TSS Removal Calculation Worksheet

B BMP[1]	C TSS Removal Rate[1]	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
Grass Channel	0.50	1.00	0.50	0.50
	0.00	0.50	0.00	0.50
	0.00	0.50	0.00	0.50
	0.00	0.50	0.00	0.50
	0.00	0.50	0.00	0.50

Total TSS Removal = 50%

Separate Form Needs to be Completed for Each Outlet or BMP Train

Project: MASS DOT Canal Bridges Relocation
Prepared By: Drake Trawhon
Date: 6/30/2026

*Equals remaining load from previous BMP (E) which enters the BMP

Non-automated TSS Calculation Sheet must be used if Proprietary BMP Proposed
1. From MassDEP Stormwater Handbook Vol. 1

INSTRUCTIONS:
1. In BMP Column, click on Blue Cell to Activate Drop Down Menu
2. Select BMP from Drop Down Menu
3. After BMP is selected, TSS Removal and other Columns are automatically completed.

Version 1, Automated: Mar. 4, 2008

Location: Barnstable County - Drainage Area 4

TSS Removal Calculation Worksheet

B BMP[1]	C TSS Removal Rate[1]	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
Grass Channel	0.50	1.00	0.50	0.50
	0.00	0.50	0.00	0.50
	0.00	0.50	0.00	0.50
	0.00	0.50	0.00	0.50
	0.00	0.50	0.00	0.50

Total TSS Removal = 50%

Separate Form Needs to be Completed for Each Outlet or BMP Train

Project: MASS DOT Canal Bridges Relocation
Prepared By: Drake Trawhon
Date: 6/30/2026

*Equals remaining load from previous BMP (E) which enters the BMP

Non-automated TSS Calculation Sheet must be used if Proprietary BMP Proposed
1. From MassDEP Stormwater Handbook Vol. 1

INSTRUCTIONS:
1. In BMP Column, click on Blue Cell to Activate Drop Down Menu
2. Select BMP from Drop Down Menu
3. After BMP is selected, TSS Removal and other Columns are automatically completed.

Version 1, Automated: Mar. 4, 2008

Location: Barnstable County - Drainage Area 5

TSS Removal Calculation Worksheet

B BMP[1]	C TSS Removal Rate[1]	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
Grass Channel	0.50	1.00	0.50	0.50
	0.00	0.50	0.00	0.50
	0.00	0.50	0.00	0.50
	0.00	0.50	0.00	0.50
	0.00	0.50	0.00	0.50

Total TSS Removal = 50%

Separate Form Needs to be Completed for Each Outlet or BMP Train

Project: MASS DOT Canal Bridges Relocation
Prepared By: Drake Trawhon
Date: 6/30/2026

*Equals remaining load from previous BMP (E) which enters the BMP

Non-automated TSS Calculation Sheet must be used if Proprietary BMP Proposed
1. From MassDEP Stormwater Handbook Vol. 1

INSTRUCTIONS:
1. In BMP Column, click on Blue Cell to Activate Drop Down Menu
2. Select BMP from Drop Down Menu
3. After BMP is selected, TSS Removal and other Columns are automatically completed.

Version 1, Automated: Mar. 4, 2008

Location: Barnstable County - Drainage Area 6

TSS Removal Calculation Worksheet

B BMP[1]	C TSS Removal Rate[1]	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
Grass Channel	0.50	1.00	0.50	0.50
	0.00	0.50	0.00	0.50
	0.00	0.50	0.00	0.50
	0.00	0.50	0.00	0.50
	0.00	0.50	0.00	0.50

Total TSS Removal = 50%

Separate Form Needs to be Completed for Each Outlet or BMP Train

Project: MASS DOT Canal Bridges Relocation
Prepared By: Drake Trawhon
Date: 6/30/2026

*Equals remaining load from previous BMP (E) which enters the BMP

Non-automated TSS Calculation Sheet must be used if Proprietary BMP Proposed
1. From MassDEP Stormwater Handbook Vol. 1

INSTRUCTIONS:

Version 1, Automated: Mar. 4, 2008

1. In BMP Column, click on Blue Cell to Activate Drop Down Menu
2. Select BMP from Drop Down Menu
3. After BMP is selected, TSS Removal and other Columns are automatically completed.

Location: Barnstable County - Drainage Area 7

TSS Removal Calculation Worksheet

B BMP[1]	C TSS Removal Rate[1]	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
Grass Channel	0.50	1.00	0.50	0.50
	0.00	0.50	0.00	0.50
	0.00	0.50	0.00	0.50
	0.00	0.50	0.00	0.50
	0.00	0.50	0.00	0.50

Total TSS Removal = 50%

Separate Form Needs to be Completed for Each Outlet or BMP Train

Project: MASS DOT Canal Bridges Relocation

Prepared By: Drake Trawhon

Date: 6/30/2026

*Equals remaining load from previous BMP (E) which enters the BMP

Non-automated TSS Calculation Sheet must be used if Proprietary BMP Proposed

1. From MassDEP Stormwater Handbook Vol. 1

Nitrogen Loading Calculations

NITROGEN LOADING CALCULATION

Based on Cape Cod Commission Technical Bulletin 91-001 (April 1992)

SECTION 1 — INPUT DATA

Property Information

Parameter	Description	Value	Units		Source / Notes	
Property Name	Project ID	Bourne M&R	—		Source: Project data	
Town / Municipality	Cape Cod Commission town	Bourne	—		TB 91-001 Table 1	
Target NO_3-N Conc.	Max allowable concentration	5	ppm		TB 91-001, Section B.1	

Site Areas (Editable Inputs — Blue)

Surface Type	Description	Area (ft²)	Area (acres)		Notes	
Gravel Area	Impervious — site runoff	72,392	1.662		Source: Site plan	
Paved Area	Impervious — road runoff	0	0.000		Source: Site plan	
Pervious Area	Natural — recharge only	108,782	2.497		Source: Site plan	
Roof Area	Impervious — roof runoff	888	0.020		Enter if applicable	
Lawn Area	Fertilized turf	0	0.000		Enter if applicable	
TOTAL SITE AREA		**182,062**	**4.180**		**ft²**	

CCC Standard Parameters (per Technical Bulletin 91-001)

Parameter	Value	Units			Source	
Recharge — Impervious surfaces	40	in/yr			TB 91-001, Section B.5	
Recharge — Natural (Bourne)	21	in/yr			TB 91-001, Table 1	
NO_3-N conc. — Road/Gravel runoff	1.5	ppm			TB 91-001, Section B.5	
NO_3-N conc. — Roof runoff	0.75	ppm			TB 91-001, Section B.5	
NO_3-N conc. — Wastewater	35	ppm			TB 91-001, Section B.2	
Fertilizer application rate	3	lbs N/1000 ft²/yr			TB 91-001, Section B.4	
Fertilizer leaching rate	0.25	%			TB 91-001, Section B.4	
Unit conversion — L per ft³	28.32	L/ft³			Standard conversion	
Unit conversion — days per year	365	d/yr			Standard	
Unit conversion — ft per inch	0.083333333	ft/in			Standard	
mg per lb	454000	mg/lb			Standard	

SECTION 2 — MASS BALANCE CALCULATIONS

Surface / Source	Area or Flow	Units	Flow (L/d)	Conc. (mg/L)	Load (mg/d)	Notes
A. Impervious Surfaces						
Gravel Area	72392	ft²	18,722.75	1.50	28,084.13	Road runoff @ 1.5 ppm
Paved Area	0	ft²	0.00	1.50	0.00	Road runoff @ 1.5 ppm
Roof Area	888	ft²	229.66	0.75	172.25	Roof runoff @ 0.75 ppm
Subtotal — Impervious			**18,952.42**	**—**	**28,256.38**	
B. Natural / Pervious Area (contributes to denominator only — N load = 0)						
Natural Area	108782	ft²	14,770.51	0.00	0.00	N load ignored per TB 91-001 B.5
C. Lawn Areas						
Lawn Area	0	ft²	0.00	N/A	0.00	3 lbs/1000ft²/yr × 25% leaching
D. Wastewater						
Wastewater Flow	0	L/d	0.00	35.00	0.00	Enter Title 5 flow (L/d) in col B

SECTION 3 — SUMMARY & RESULT

Component		Flow (L/d)		Load (mg/d)		
Impervious Surfaces (Gravel + Paved + Roof)		18,952.42		28,256.38		
Natural / Pervious Areas		14,770.51		0.00		
Lawn Areas		0.00		0.00		
Wastewater		0.00		0.00		
TOTAL		**33,722.93**		**28,256.38**		

Calculated NO_3-N Concentration	**0.838 ppm**	**ppm NO_3-N**
Target Concentration	**5.0 ppm**	**ppm NO_3-N (max)**
COMPLIANCE STATUS		**✓ COMPLIES — Below Target**

Note: Per TB 91-001, natural recharge nitrogen load is negligible and excluded from numerator. Gravel treated as road runoff (1.5 ppm). Lawn N load adds to numerator only (no dilution volume).

Attachment F - Standard 8 Supporting Information

Algonquin Standard Erosion and Sediment Control Plan Narrative

Site Specific Erosion and Sediment Control Plan

Enbridge Stands Erosion and Sediment Control Narrative

Erosion and Sedimentation Control Measures

The following erosion and sedimentation controls were selected based on existing and proposed site conditions for use during the earthwork and construction phases of the project. In addition to those outlined below, additional practices are included in Algonquin's Standard Erosion and Sediment Control Manual.

Silt Fence/Straw Wattle

Straw wattle barriers will be placed to trap sediment transported by runoff before it reaches the drainage system or leaves the construction site. In areas where high runoff velocities or high sediment loads are expected, straw wattles will be backed up with silt fencing. This semi-permeable barrier made of a synthetic porous fabric will provide additional protection. The silt fence and straw wattle barrier will be replaced as determined by periodic field inspections.

Catch Basin Protection

Newly constructed and existing nearby catch basins will be protected with silt sacks throughout construction.

Concrete Wash Area

The best management practice objectives for concrete washout are to (a) collect and retain all the concrete washout water and solids in leak proof containers, so that this caustic material does not reach the soil surface and then migrate to surface waters or into the ground water, and (b) recycle 100 percent of the collected concrete washout water and solids. Another objective is to support the diversion of recyclable materials from landfills.

Concrete washout facilities should be inspected daily and after heavy rains to check for leaks, identify any plastic linings and sidewalls have been damaged by construction activities, and determine whether they have been filled to over 75 percent capacity. When the washout container is filled to over 75 percent of its capacity, the washwater should be vacuumed off or allowed to evaporate to avoid overflows. Then when the remaining cementitious solids have hardened, they should be removed and recycled. Damages to the container should be repaired promptly. Before heavy rains, the washout container's liquid level should be lowered or the container should be covered to avoid an overflow during the rain storm.

Temporary Diversion Channels

Diversion channels will be used to collect runoff from construction areas and discharge to either sedimentation basins or protected catch basin inlets.

Vegetative Slope Stabilization

Stabilization of open soil surfaces will be implemented within 14 days after grading or construction activities have temporarily or permanently ceased, unless there is sufficient snow cover to prohibit implementation. Vegetative slope stabilization will be used to minimize erosion on slopes of 3:1 or flatter. Annual grasses, such as annual rye, will be used to ensure rapid germination and production of root mass. Permanent stabilization will be completed with the planting of perennial grasses or legumes. Establishment of temporary and permanent vegetative cover may be established by hydro-seeding or sodding. A suitable topsoil, good seedbed preparation, and

adequate lime, fertilizer and water will be provided for effective establishment of these vegetative stabilization methods. Mulch will also be used after permanent seeding to protect soil from the impact of falling rain and to increase the capacity of the soil

Maintenance

- The contractor or subcontractor will be responsible for implementing each control shown on the Sedimentation and Erosion Control Plan. In accordance with EPA regulations, the contractor must sign a copy of a certification to verify that a plan has been prepared and that permit regulations are understood.
- The on-site contractor will inspect all sediment and erosion control structures periodically and after each rainfall event. Records of the inspections will be prepared and maintained on-site by the contractor.
- Silt shall be removed from behind barriers if greater than 6-inches deep or as needed.
- Damaged or deteriorated items will be repaired immediately after
- identification.
- The underside of straw wattles should be kept in close contact with the earth and reset as necessary.
- Sediment that is collected in structures shall be disposed of properly and covered if stored on-site.
- Erosion control structures shall remain in place until all disturbed earth has been securely stabilized. After removal of structures, disturbed areas shall be regraded and stabilized as necessary.

Construction Best Management Practices - Maintenance/Evaluation Checklist

Best Management Practice	Inspection Frequency	Date Inspected	Inspector	Minimum Maintenance and Key Items to Check	Cleaning/Repair Needed ☐ yes ☐ no	Date of Cleaning/Repair	Performed by:
					☐ yes ☐ no		
					☐ yes ☐ no		
					☐ yes ☐ no		
					☐ yes ☐ no		
					☐ yes ☐ no		
					☐ yes ☐ no		
					☐ yes ☐ no		

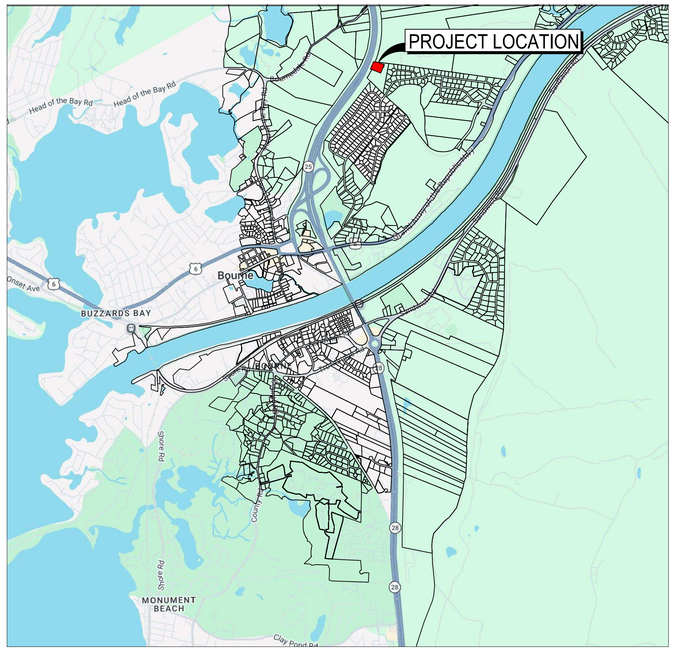
Stormwater Control Manager _____

Site Specific Erosion and Sediment Control Plan

CAPE COD CANAL PIPELINE RELOCATION PROJECT
BOURNE M&R RELOCATION
STATION RELOCATION PROJECT
M&R 00018
BARNSTABLE COUNTY, MASSACHUSETTS
2026

DATE	ISSUE	LEAD DFRS.	SECT. SUPV.	PROJ. ENG./ DESIGN ENG.	PROJ. MGR./ DESIGN MGR.	PROJECT DIRECTOR
		APPROVALS				
07/02/26	☒ ISSUED FOR PERMIT	CR	DT	PB	AC	
05/15/26	☒ ISSUED FOR BID	CR	DT	PB	AC	

DWG. NO.	DRAWING TITLE
	CIVIL DRAWINGS
00018-C.015-0002	EROSION & SEDIMENT CONTROL COVER SHEET
00018-C.020-0001	EROSION AND SEDIMENT GENERAL NOTES
00018-C.320-0001	EXISTING CONDITIONS PLAN
00018-C.320-0002	EXISTING SUBCATCHMENT AREA PLAN
00018-C.320-0003	PROPOSED SITE LAYOUT PLAN
00018-C.301-0002	GRADING PLAN
00018-C.301-0003	CIVIL ACCESS ROAD GRADING PLAN
00018-C.301-0004	CIVIL GRADE PROFILE AND SECTIONS
00018-C.320-0004	CONSTRUCTION EROSION AND SEDIMENT CONTROL PLAN
00018-C.320-0005	PROPOSED SUBCATCHMENT AREA PLAN
00018-C.320-0006	DETAILS
00018-C.320-0007	DETAILS



VICINITY MAP

EXHIBIT A

SRO NO. XXXX

PLANT W.O. NO.

PIPELINE W.B.S. NO. 30002835

YEAR 2026

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
No. 59957
PROFESSIONAL ENGINEER
07/02/26

ENBRIDGE®

Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

ISSUED FOR PERMIT
07/02/2026

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		C	07/02/26	CR	DT	ISSUED FOR PERMIT
		B	05/15/26	CR	DT	ISSUED FOR BID
		A	05/15/26	CR	DT	ISSUED FOR PERMIT

audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

TITLE	INITIALS	DATE
DRAWN BY:	CR	05/15/26
DESIGN CHECKER:	AE	07/02/26
DESIGN ENGINEER:	DT	07/02/26
PROJECT MANAGER:	AC	07/02/26

CAPE COD CANAL PIPELINE RELOCATION PROJECT
BOURNE M&R RELOCATION
M&R 00018
TITLE: EROSION & SEDIMENT CONTROL COVER SHEET

LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

YEAR: 2026 | W.O.: | SCALE: N.T.S.

ENBRIDGE
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

DWG.: 00018-C.015-0002 | REV.: C

S:\AE\Projects\Enbridge\Mass\026356-001\200_civil_structural\170_drawings\e&s plans\bourne m&r\00018-C.015-0002.dwg — PLOT TIME: 7/2/2026 7:47 AM

SEDIMENTATION AND EROSION CONTROL NOTES

IT IS THE INTENT OF THE CONTRACT PLANS AND DETAILS TO CONTROL EROSION AND SEDIMENTATION IN ALL PORTIONS OF THE SITE. THE CONTRACTOR IS TO IMPLEMENT THE EROSION AND SEDIMENTATION CONTROLS INDICATED ON THE PLANS, IN ACCORDANCE WITH THE FOLLOWING NOTES, BUT IS ALERTED TO THE FACT THAT ADDITIONAL MEASURES MAY BE REQUIRED TO COMPLY WITH THIS INTENT, AS FIELD CONDITIONS MAY WARRANT. SHOULD SUCH MEASURES BE DETERMINED TO BE REQUIRED OR ORDERED BY THE ENGINEER, THEY ARE TO BE IMPLEMENTED IMMEDIATELY. IN ADDITION, THE CONTRACTOR SHALL PREPARE AND SUBMIT FOR ENGINEER'S REVIEW A STORMWATER POLLUTION PREVENTION PLAN (SWPPP) AND FILE A NOTICE OF INTENT WITH THE U.S. EPA AS REQUIRED UNDER THE NPDES CONSTRUCTION GENERAL PERMIT PROGRAM. A COPY OF THE SWPPP SHALL BE KEPT ON-SITE AT ALL TIMES AND UPDATED AS REQUIRED.

1. THE CONTRACTOR SHALL BE RESPONSIBLE FOR IMPLEMENTING EROSION CONTROL MEASURES IN ORDER TO PREVENT THE OFF-SITE TRACKING OF EARTH, SEDIMENT, AND DEBRIS; AND FOR GENERALLY CONTROLLING THE EROSION AND SEDIMENT TRANSPORT DURING THE CONSTRUCTION PROCESS. SITE SPECIFIC CONDITIONS MAY REQUIRE MODIFICATIONS IN THE FIELD, BUT THE CONTRACTOR MUST ENSURE THAT THAT MEASURES IMPLEMENTED IN THE FIELD MEET THE MINIMUM REQUIREMENTS OF THESE PLANS.

2. ALL WORK SHALL BE IN ACCORDANCE WITH THE CONTRACT DOCUMENTS, THE PROVISIONS OF ALL APPLICABLE PERMITS AND APPROVALS ISSUED BY LOCAL, STATE, AND FEDERAL REGULATION FOR ACTIVITIES INVOLVING WETLANDS, WATERCOURSES AND/OR EROSION CONTROLS. ALL EROSION AND SEDIMENTATION CONTROL MEASURES SHALL BE CONSTRUCTED IN ACCORDANCE WITH THE MASSACHUSETTS EROSION AND SEDIMENT CONTROL GUIDELINES FOR URBAN AND SUBURBAN AREAS, FEBRUARY 2008 AND THE MASSACHUSETTS STORMWATER HANDBOOK VOLUME 1, AS AMENDED.

3. THE CONTRACTOR IS RESPONSIBLE FOR THE INSTALLATION OF SILT FENCES, CHECK DAMS AND TEMPORARY SEDIMENT BASINS. SUCH PRACTICES DIVERT FLOWS FROM EXPOSED SOILS, LIMIT RUNOFF AND THE DISCHARGE OF POLLUTANTS FROM EXPOSED AREAS OF THE SITE TO THE DEGREE ATTAINABLE. TEMPORARY EROSION AND SEDIMENTATION CONTROL MEASURES SHALL BE INSTALLED PRIOR TO THE COMMENCEMENT OF ANY SITE WORK, SHALL BE MAINTAINED DURING CONSTRUCTION, AND SHALL REMAIN IN PLACE UNTIL ALL SITE WORK IS COMPLETED AND GROUND COVER IS ESTABLISHED BY NEW SEEDLINGS). (AT LEAST 751 UNIFORM COVERAGE BY NEW SEEDLINGS).

4. IN GENERAL, WORK REQUIRING EROSION CONTROL INCLUDES EXCAVATIONS, FILLS, RETAINING WALLS, DRAINAGE, ROUGH AND FINISH GRADING, AND STOCKPILING OF EARTH.

5. AREAS SUBJECT TO EROSION SHALL BE MINIMIZED IN TERMS OF TIME AND AREA. DO NOT DISTURB VEGETATION AND TOPSOIL BEYOND THE PROPOSED LIMIT OF SILT FENCE ACTIVITIES.

6. A STABILIZED CONSTRUCTION ENTRANCE SHALL BE INSTALLED AT ALL POINTS OF ACCESS TO THE SITE TO MINIMIZE TRACKING OF SEDIMENT ONTO PUBLIC ROADWAY.

7. EROSION CONTROL MEASURE SHALL BE INCORPORATED IN THE SEQUENCE OF CONSTRUCTION TO PREVENT SEDIMENT LADEN WATER FROM LEAVING THE SITE.

8. EARTHWORK ACTIVITY SHALL BE PERFORMED IN A MANNER SUCH THAT RUNOFF IS DIRECTED TO PERIMETER CONTROLS. IN NO CASE SHALL RUNOFF FROM ROADWAYS OR OTHER AREAS, UPGRADIENT FROM EMBANKMENTS, BE ALLOWED TO RUN DOWN ANY CUT OR FILL SLOPE, WITHOUT THE APPROVAL OF THE ENGINEER.

9. THE CONTRACTOR SHALL, AT ALL TIMES, HAVE A STOCKPILE OF HAY BALES, SILT FENCE, CRUSHED STONE, AND CATCH BASIN FILTER BAGS ADEQUATE TO REINFORCE/REPLACE EROSION AND SEDIMENT CONTROLS AS NEEDED.

10. ALL EROSION AND SEDIMENTATION CONTROL MEASURES SHALL BE MAINTAINED IN EFFECTIVE CONDITION THROUGHOUT THE CONSTRUCTION PERIOD SO THAT ALL AREAS ARE STABILIZED TO PREVENT THE MOVEMENT OF SOIL, SILT, SEDIMENT AND DEBRIS INTO DRAINAGE SYSTEMS OR WATERWAYS ON AND NEAR CONSTRUCTION ACTIVITY. THE CONTRACTOR SHALL INSPECT THE EROSION CONTROLS DAILY AND CLEAN ACCUMULATED MATERIALS FROM BEHIND THEM, AS NECESSARY. ALL EROSION AND SEDIMENTATION CONTROL MEASURES FOUND TO BE IN NEED OF REPAIR OR REPLACEMENT SHALL BE IMMEDIATELY CORRECTED, SO AS TO MAINTAIN THE INTEGRITY OF THE EROSION AND SEDIMENTATION CONTROL SYSTEM.

11. IN ORDER TO MINIMIZE EROSION AND SEDIMENT RUNOFF FROM THE SITE, THE CONTRACTOR SHOULD MAINTAIN EXISTING VEGETATION WHERE POSSIBLE AND STABILIZE THE DISTURBED PORTIONS OF THE SITE AS QUICKLY AS POSSIBLE. THE CONTRACTOR SHALL PHASE CONSTRUCTION TO MINIMIZE THE AREA OF DISTURBED EARTH OPEN TO THE ELEMENTS AT ANY GIVEN TIME. THIS SHALL BE ACHIEVED BY THE FOLLOWING METHODS OR OTHER BEST MANAGEMENT PRACTICES (BMP's):

    A. LOAMING AND SEEDING CUT SLOPES IMMEDIATELY UPON COMPLETION OF SUBGRADE PREPARATION, AND SECURING SUCH NEWLY ESTABLISHED SLOPES WITH EROSION CONTROL NETTING AND/OR MULCH.
    B. PLACING AND COMPACTING PAVEMENT GRAVEL BASE AND SUB- BASE IMMEDIATELY UPON COMPLETION OF SUBGRADE PREPARATION.
    C. LIMITING STRIPPING AND STOCKPILING OF LOAM TO AREAS SLATED FOR IMMEDIATE CONSTRUCTION AND STABILIZATION (I.E. PLACEMENT OF GRAVELS, LOAM AND SEED, EROSION CONTROL MATTING).

12. THE CONTRACTOR MUST ALSO ANTICIPATE INCREASED RUNOFF FROM STEEPER SLOPES AND DURING HIGH GROUNDWATER CONDITIONS.THIS MAY OCCUR DURING THE WET SEASON (TYPICALLY MARCH THROUGH APRIL) OR AFTER SIGNIFICANT PRECIPITATION EVENTS.

13. SEDIMENT REMOVED FROM CONTROL STRUCTURES SHALL BE DISPOSED OF LEGALLY OFF SITE. NO EQUIPMENT OR MATERIAL OF ANY KIND SHALL BE STOCKPILED OR DEPOSITED IN ANY REGULATED AREA, UNLESS SPECIFICALLY SHOWN ON THE CONTRACT PLANS OR AUTHORIZED BY PROJECT PERMITS/APPROVALS.

14. STOCKPILED SOIL SHALL BE SURROUNDED WITH SILTATION FENCES TO PREVENT AND CONTROL SILTATION AND EROSION. STOCKPILES THAT WILL REMAIN EXPOSED FOR MORE THAN 30 DAYS, SHALL BE STABILIZED WITH MULCH OR SEEDED FOR TEMPORARY VEGETATIVE COVER.

15. TEMPORARY STORAGE OF MATERIALS ON-SITE SHALL BE LOCATED GREATER THAN 10O-FEET FROM WETLAND AREAS, AND AS APPROVED BY THE ENGINEER. EROSION CONTROLS INSTALLED ALONG WETLAND RESOURCE AREAS SHALL DEFINE THE LIMIT OF WORK AND SHALL NOT BE CROSSED. THERE SHALL BE NO LONG-TERM STORAGE OF MATERIAL ON-SITE OR ON-ROUTE. MATERIAL NOT USED ON-SITE OR ON-ROUTE SHALL BE TRUCKED TO AN ACCEPTABLE OFF-SITE DISPOSAL LOCATION.

16. ALL DISTURBED SURFACES SHALL BE STABILIZED WITHIN 14 DAYS AFTER CONSTRUCTION IN ANY PORTION OF THE SITE THAT HAS BEEN COMPLETED OR WHERE CONSTRUCTION HAS TEMPORARILY CEASED.

17. ALL AREAS OF DISTURBANCE MUST HAVE TEMPORARY OR FINAL STABILIZATION WITH MULCH OR MULCH NETTING, OR SEEDED FOR TEMPORARY VEGETATIVE COVER, WITHIN 14 DAYS OF THE INITIAL DISTURBANCE. AFTER THIS TIME, ANY DISTURBANCE IN THE AREA MUST BE STABILIZED AT THE END OF EACH WORK DAY. THE FOLLOWING EXCEPTIONS APPLY:

    A. STABILIZATION IS NOT REQUIRED IF WORK IS TO CONTINUE IN THE AREA WITHIN THE NEXT 24 HOURS AND THERE IS NO PRECIPITATION FORECAST FOR THE NEXT 24 HOURS.
    B. STABILIZATION IS NOT REQUIRED IF THE WORK IS OCCURRING IN A SELF-CONTAINED EXCAVATION WITH A DEPTH OF 2 FEET OR GREATER.

18. THERE SHALL BE NO DIRECT DISCHARGE FROM ANY REQUIRED DEWATERING OPERATIONS INTO ANY WETLAND, WATERCOURSE, OR DRAINAGE SYSTEM AND THEN ONLY AS ALLOWED BY REGULATORY PERMITS. ANY DEWATERING DISCHARGE CONTAINING SETTLEABLE SOLIDS (SEDIMENTS) SHALL BE PASSED THROUGH A SEDIMENTATION CONTROL BASIN, FRACTIONATION TANK OR SIMILAR TREATMENT, APPROVED BY THE ENGINEER, TO REMOVE THESE SOLIDS. CONTRACTOR SHALL MAINTAIN SAID SEDIMENT CONTROL DEVICES THROUGHOUT THE ENTIRE DEWATERING OPERATION AND SHALL CEASE DEWATERING, IF DEFICIENCIES ARE NOTED, UNTIL THE DEFICIENCIES ARE CORRECTED.

19. THE CONTRACTOR SHALL INSPECT ALL PORTIONS OF THE SITE IN ANTICIPATION OF RAINFALL EVENTS TO DETERMINE IF SITE GRADING IS SUFFICIENT TO PREVENT EROSION OF SLOPES AND/OR THE TRANSPORTATION OF SEDIMENTS TO WETLANDS OR WATERCOURSES, WITHIN THE PROJECT LIMITS. SHOULD ADDITIONAL MEASURES BE REQUIRED, THEY ARE TO BE IMPLEMENTED IMMEDIATELY. IN NO CASE SHALL THE INSTALLATION OF ADDITIONAL MEASURES, NECESSARY TO PROTECT SLOPES WITHIN THE PROJECT LIMITS, BE DELAYED BEYOND THE COMMENCEMENT OF PRECIPITATION.

20. EROSION CONTROL MEASURES SHALL BE INSPECTED EVERY WEEK, AND WITHIN 24-HOUR OF AN EVENT GREATER THAN 0.25 INCHES. ANY NECESSARY REPLACEMENT OF REPAIR SHALL BE PERFORMED PROMPTLY BY THE CONTRACTOR

21. ALL DISTURBED EARTH SLOPES SHALL BE STABILIZED WITH PERMANENT VEGETATIVE COVER AS SOON AS POSSIBLE. DISTURBED AREAS, THAT ARE NOT SUBJECT TO CONSTRUCTION TRAFFIC, SHALL RECEIVE A PERMANENT OR TEMPORARY VEGETATIVE COVER AS SOON AS FINAL CONTOURS ARE ESTABLISHED. IF THE SEASON PREVENTS THE ESTABLISHMENT OF A VEGETATIVE COVER, DISTURBED AREAS SHALL BE THOROUGHLY MULCHED. MULCHED AREAS SHALL BE SEEDED AS SOON AS WEATHER CONDITIONS ALLOW.

22. ALL SLOPES STEEPER THAN 2H:1V SHALL BE COVERED WITH MODIFIED ROCKFILL AND AN APPROVED EROSION CONTROL MATTING.

23. CONTRACTOR SHALL REMOVE ALL SEDIMENTATION CONTROL SYSTEMS, REMOVE ALL ACCUMULATED SEDIMENTS, AND SEED THE DISTURBED AREAS, WHEN THE CONTROL SYSTEMS ARE NO LONGER REQUIRED. CONTRACTOR SHALL REQUEST AND RECEIVE PERMISSION FROM THE ENGINEER PRIOR TO REMOVING ANY CONTROL SYSTEM.

24. THE CONTRACTOR SHALL REMOVE AND DISPOSE OF ALL SILT AND DEBRIS RESULTING FROM CONSTRUCTION OPERATIONS FROM EACH DRAINAGE STRUCTURE UPON COMPLETION OF THE PROJECT.

25. OBJECTS AND/OR AREAS DAMAGED BY THE CONTRACTOR'S OPERATIONS SHALL BE RESTORED TO THEIR ORIGINAL CONDITION AND ELEVATION.

26. ALL DISTURBED AREAS NOT OCCUPIED BY PAVEMENT, SIDEWALK OR RIPRAP SHALL BE COVERED WITH 4" (MIN.) OF LOAM AND SEED.

27. PERMANENT SEEDING SHALL OCCUR BETWEEN MARCH 1 AND JUNE 15, OR BETWEEN AUGUST 15 AND OCTOBER 15.

28. THE CONTRACTOR SHALL MODIFY, REPAIR, OR INSTALL ADDITIONAL EROSION AND SEDIMENTATION CONTROL MEASURES AS NECESSARY TO PREVENT SEDIMENT FROM LEAVING THE SITE AT NO ADDITIONAL COST.

A. GENERAL CONSTRUCTION NOTES

1. SITE PREPARATION, GRADING AND DRAINAGE SHALL BE IN ACCORDANCE WITH THESE GENERAL NOTES, APPROVED CONSTRUCTION DRAWINGS AND PROJECT SPECIFICATIONS. FOR EARTHWORK REQUIREMENTS AND THE CONSTRUCTION OF STRUCTURAL SUBGRADES, IF IN CONFLICT WITH THESE GENERAL NOTES, THE GEOTECHNICAL REPORT SHALL GOVERN IN DETAILS.
2. CONTRACTOR SHALL COMPLY WITH OSHA REGULATIONS, STATE SPECIFIC LAWS AND COMPANY SAFETY STANDARDS AT ALL TIMES.
3. CONTRACTOR SHALL OBTAIN ALL REQUIRED PERMITS PRIOR TO STARTING CONSTRUCTION. CONTRACTOR SHALL HAVE A COPY OF ALL DRIVEWAY PERMITS ON SITE AT ALL TIMES DURING CONSTRUCTION OF DRIVES AND DRIVEWAY CULVERTS.
4. CONTRACTOR TO PROVIDE ALL MATERIAL NECESSARY FOR INSTALLATION.
5. ALL PROJECT MATERIALS OR FOR THE REPAIR OF EXISTING ELEMENTS SHALL BE NEW PRODUCTS AND FREE FROM DEFECTS PER PROJECT SPECIFICATIONS.
6. PRIOR TO BACKFILLING PONDS, CREEKS, DITCHES, OR OTHER RUNOFF CHANNELS, ALL ACCUMULATED SEDIMENT, ORGANIC MATERIAL, AND DEBRIS SHALL BE REMOVED AND DISPOSED OF AS DIRECTED BY THE COMPANY.
7. WASTE MATERIALS INCLUDING PAVEMENT REMOVED DURING CONSTRUCTION, WASTE PIPING AND SUPPLIES AND CONSTRUCTION DEBRIS SHALL BECOME THE PROPERTY OF THE CONTRACTOR AND SHALL BE REMOVED FROM THE PROJECT SITE AND DISPOSED OF PROPERLY BY THE CONTRACTOR.
8. EARTHWORK QUANTITIES SHOWN ARE APPROXIMATE AND ARE PROVIDED FOR INFORMATION PURPOSES ONLY. QUANTITIES DO NOT ACCOUNT FOR SHRINKAGE, SWELL (BULK) FACTORS, LOSS OF MATERIAL, OR REMOVAL/REPLACEMENT OF UNSUITABLE MATERIALS ENCOUNTERED IN THE FIELD. FOUNDATION AREAS WERE NOT ACCOUNTED FOR IN THE EARTHWORK ANALYSIS CALCULATION. THE CONTRACTOR SHALL VERIFY ALL QUANTITIES AND CONDITIONS PRIOR TO CONSTRUCTION.

B. UTILITIES, RIGHT-OF-WAY AND EASEMENTS

1. THE CONTRACTOR SHALL VERIFY THE LOCATIONS, ELEVATIONS AND DIMENSIONS OF ALL EXISTING UTILITIES, STRUCTURES, ETC. AFFECTING HIS WORK PRIOR TO CONSTRUCTION.
2. CONTRACTOR SHALL NOTIFY THE LOCAL JURISDICTIONAL AUTHORITY BEFORE ANY WORK IS WITHIN THE STREET RIGHT-OF-WAY OR EASEMENTS.
3. CONTRACTOR SHALL GIVE NOTICE TO ALL AUTHORIZED INSPECTORS, SUPERINTENDENTS AND PERSONS IN CHARGE OF PUBLIC AND PRIVATE UTILITIES AFFECTED BY HIS OPERATIONS PRIOR TO STARTING WORK.
4. CONTRACTOR SHALL VERIFY THE LOCATIONS OF EXISTING UNDERGROUND UTILITIES PRIOR TO COMMENCING CONSTRUCTION AND SHALL REPORT DISCREPANCIES TO THE COMPANY REPRESENTATIVE IMMEDIATELY.
5. CONTRACTOR TO PROTECT ACTIVE UTILITY LINES OR ELECTRICAL CONDUITS SHOWN ON THE DRAWINGS OR OTHERWISE MADE KNOWN TO THE CONSTRUCTION MANAGEMENT PRIOR TO COMMENCING WORK.
6. ALL UTILITIES SHALL BE KEPT IN OPERATION EXCEPT WITH THE EXPRESS WRITTEN CONSENT OF THE UTILITY OWNER. IT SHALL BE THE CONTRACTOR'S RESPONSIBILITY TO PRESERVE EXISTING UTILITIES.
7. CONTRACTOR SHALL LOCATE ALL UNDERGROUND PIPELINES AND PROTECT THEM DURING CONSTRUCTION FROM IMPOSING HEAVY LOADS FROM SITE PREPARATION ACTIVITIES, MACHINERY AND ANY OTHER EQUIPMENT THAT MAY DAMAGE EXISTING FACILITIES. CONTRACTOR SHALL BE FULLY RESPONSIBLE FOR ANY DAMAGES DURING CONTRUCTION AND REPAIR IN ACCORDANCE WITH THE OWNING AUTHORITIES WITH NO COST TO THE OWNER.
8. ALL GRADING EXCAVATION WORK TO BE PERFORMED WITHIN PIPELINE RIGHT-OF-WAY OR EASEMENTS OR WITHIN 25 FT, MEASURED AT RIGHT ANGLES, OF PIPELINES, SHALL BE IN THE PRESENCE OF COMPANY REPRESENTATIVE.
9. WORK SHALL BE STOPPED IF ANY UNDERGROUND UTILITIES ARE ENCOUNTERED DURING EARTHWORK OPERATIONS AND THE COMPANY REPRESENTATIVE SHALL BE NOTIFIED FOR SPECIFIC DIRECTION.
10. CONTRACTOR SHALL LOCATE ALL OVERHEAD ELECTRICAL POWER LINES IN THE PROPERTY PRIOR TO BEGINNING ANY CONSTRUCTION. FEDERAL AND STATE REGULATIONS RELATED TO HEALTH AND SAFETY SHALL BE FOLLOWED FOR ANY WORK RELATED TO OVERHEAD ELECTRICAL POWER LINES.
11. CONTRACTOR SHALL BE FULLY RESPONSIBLE FOR ANY AND ALL DAMAGE TO FACILITIES, PROPERTY, UNDERGROUND UTILITIES AND TO EXISTING PUBLIC OR PRIVATE UTILITY LINES, INCLUDING BUT NOT LIMITED TO PIPELINES, WATER LINES, WASTEWATER COLLECTION SYSTEMS AND STORM SEWERS, DURING CONSTRUCTION. ALL DAMAGE SHALL BE REPAIRED IN ACCORDANCE WITH THE OWNING AUTHORITY, WITH NO COST TO THE OWNER.
12. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ANY REPAIR OR REPLACEMENT TO MEET THE STANDARDS OF THE APPROPRIATE REGULATORY AGENCY FOR ANY PAVEMENT, DRIVEWAYS, SIDEWALKS, CURBS AND OTHER EXISTING STRUCTURE THAT SUBJECTED TO MODIFICATION OR DAMAGED DURING OR AS A RESULT OF CONSTRUCTION.
13. THE CONTRACTOR SHALL BE RESPONSIBLE FOR CONTACTING THE APPROPRIATE UTILITY COMPANY OR OWNER AS APPLICABLE TO STABILIZE UTILITY POLES AND REMOVE AND REPLACE EXISTING GUY WIRES AS NECESSARY FOR CONSTRUCTION. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ALL COST ASSOCIATED WITH THE WORK.

C. CLEARING AND GRUBBING

1. CONTRACTOR SHALL BE RESPONSIBLE FOR CLEARING AND GRUBBING TO THE GRADING AREA LIMITS SHOWN ON THE CONSTRUCTION DRAWINGS AND FURTHER DESCRIBED BELOW. CONTRACTOR TO SPREAD ORGANIC SOILS FROM VEGETATION STRIP IN AREAS DESIGNATED BY THE OWNER REPRESENTATIVE.
2. UNLESS NOTED IN THE GEOTECHNICAL REPORT, STRIPPING OF TOP SOIL SHALL BE AT A MINIMUM DEPTH OF 12 IN. OR AS DIRECTED BY THE GEOTECHNICAL ENGINEER OR HIS DIRECT REPRESENTATIVE.
3. IN AREAS WHERE TREES, SHRUBS, GROWTH OR OTHER ITEMS ARE DESIGNATED TO REMAIN BY CONSTRUCTION MANAGEMENT, SELECTED CLEARING SHALL BE DONE AND ADEQUATELY PROTECTED FROM CONSTRUCTION EQUIPMENT WITHIN THE SURROUNDING AREAS.
4. CONTRACTOR SHALL STRIP ALL TREES, SHRUBS, VEGETATION, ORGANICS, LOOSE TOPSOIL AND OTHER DEBRIS FROM GRADING AREA. CLEAN OUT ROOTS 0.5 IN. IN DIAMETER AND LARGER TO A DEPTH OF 12 IN. BELOW EXISTING GROUND SURFACE OR SUBGRADE OF NEWLY GRADED SURFACE, WHICHEVER IS LOWER.
5. CONTRACTOR TO CLEAR UNDERGROWTH & DEAD WOOD MATERIALS WITHOUT DISTURBING THE SUBSOIL.
6. APPLY HERBICIDE TO REMAINING STUMPS INHIBITING GROWTH AS REQUIRED.
7. CONTRACTOR TO DISPOSE OF TOP SOIL, RUBBISH, DEBRIS, AND OTHER OBJECTIONABLE MATERIAL TO DESIGNATED DISPOSAL AREAS AS DIRECTED BY THE COMPANY.
8. UPON COMPLETION OF WORK, NO MATERIAL RESULTING FROM CLEARING AND GRUBBING OPERATIONS SHALL REMAIN WITHIN THE LIMITS OF THE SITE, EXCEPT IN THE DESIGNATED AREA.

D. SITE PREPARATION, EXCAVATION, SUBGRADE AND BACKFILL

1. CONTRACTOR SHALL EXCAVATE AND GRADE THE SITE AS DETAILED IN THE CONSTRUCTION DRAWINGS AND FOLLOW SPECIFICATIONS PER GEOTECHNICAL REPORT RECOMMENDATIONS.
2. EXPOSED SUBGRADE SHALL BE PROOF ROLLED IN ACCORDANCE WITH MASSACHUSETTS ITEM 170. WEAK OR SOFT ZONE MATERIALS SHALL BE REMOVED AND REPLACED/COMPACTED WITH APPROVED FILL MATERIAL.
3. UNLESS NOTED IN THE GEOTECHNICAL REPORT, ALL FILL MATERIAL SHALL:

    - BE COMPACTED IN LOOSE LIFTS 6 IN. OR LESS.
    - NOT EXCEED A SLOPE OF 1:10 BETWEEN DIFFERING TRANSITION FILL DEPTHS.
    - BE COMPACTED TO A MINIMUM OF 95% BUT NOT GREATER THAN 98% OF THE MAXIMUM DRY DENSITY AS DETERMINED BY THE STANDARD PROCTOR TEST (ASTM D-698).
    - HAVE MOISTURE CONTENT CONTROLLED AT THE TIME OF COMPACTION BETWEEN OPTIMUM AND 4% ABOVE OPTIMUM MOISTURE CONTENT.
    - THE CONTRACTOR SHALL IMPORT ALL FILL MATERIAL FROM AN APPROVED BORROW SITE, AND THIS MATERIAL SHALL MEET THE REQUIREMENTS OF THE PROJECT GEOTECHNICAL REPORT PREPARED BY GEOENGINEERS USA, PC. IMPORT MATERIAL SHALL BE APPROVED BY THE GEOTECHNICAL ENGINEER OF RECORD AND MEET THE REQUIREMENTS FOR LIQUID LIMIT (LL), PLASTIC LIMIT (PL) AND GRADATION.

4. PRIOR TO FILL PLACEMENT, THE TOP 12 IN. OF THE GROUND SURFACE IN FILL AREAS SHALL BE SCARIFIED, MOISTURE CONDITIONED AND RECOMPACTED PER GEOTECH RECOMMENDATIONS.
5. BACKFILL SHALL BE FREE FROM ORGANIC MATERIAL OR ANY OTHER DELETERIOUS MATTER.
6. PRIOR TO PERFORMING SOIL COMPACTION, MOISTURE CONDITION OR AERATE EACH LIFT AS NECESSARY TO PROVIDE THE REQUIRED MOISTURE CONTENT.
7. DO NOT PLACE BACKFILL OR FILL MATERIAL ON SURFACES THAT ARE MUDDY, FROZEN, OR CONTAIN FROST OR ICE.
8. MECHANICAL TAMPING OF BACKFILL AND FILL SHALL BE DONE WITH SUITABLE SIZED TAMPING FOOT SO AS TO PROVIDE UNIFORM COMPACTION.
9. INSPECTION AND FREQUENT TESTING BY QUALIFIED PERSONNEL DURING FILL COMPACTION IS NECESSARY TO ENSURE PROPER MOISTURE CONTENT AND DEGREE OF COMPACTION. CERTIFICATION SHALL BE OBTAINED FROM THE INSPECTING AGENCY THAT ALL FILL, BACKFILL AND SUBGRADE MATERIALS ARE IN COMPLIANCE WITH THE MOISTURE CONTENT AND COMPACTION RECOMMENDATIONS.
10. THE GEOTECHNICAL ENGINEER OR HIS DIRECT REPRESENTATIVE WILL MONITOR THE FILL OPERATION, IDENTIFY SOIL TYPES, AND MAKE RECOMMENDATIONS CONCERNING SELECTION AND PLACEMENT OF SOILS.
11. EXCESS EXCAVATION SHALL BE DISPOSED TO DESIGNATED DISPOSAL AREAS AS DIRECTED BY THE COMPANY.

E. WATER MANAGEMENT AND CONTROL

1. ADEQUATE DRAINAGE SHALL BE MAINTAINED AT ALL TIMES DURING CONSTRUCTION ACTIVITY. EARTHWORK SHALL BE ACCOMPLISHED IN SUCH A WAY TO ELIMINATE ACCUMULATION OF RAINWATER AND GROUNDWATER. THE CONTRACTOR SHALL INSTALL TEMPORARY MEASURES FOR MANAGING STORMWATER RUN-OFF FROM THE CUT OR FILL AREAS AS REQUIRED, MINIMIZING EROSION TO MEET NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) REQUIREMENTS.
2. CONTRACTOR SHALL PREVENT WATER FROM PONDING ON SITE AND SHALL NOT BLOCK DRAINAGE FROM OR DIRECT EXCESS DRAINAGE ONTO ADJACENT PROPERTY.
3. CONTRACTOR SHALL PROVIDE TEMPORARY PUMPING FACILITIES TO DRAIN THE WATER DURING CONSTRUCTION.
4. DEWATERING OF GROUNDWATER FOR EXCAVATIONS SHALL BE ACCOMPLISHED BY DEWATERING AT LEAST 3 FT BELOW THE BOTTOM OF THE EXCAVATION.
5. REMOVE ALL WATER, INCLUDING GROUNDWATER AND RAINWATER, TO A DESIGNATED LOCATION USING PUMPS, DRAINS OR OTHER APPROVED METHODS.
6. CONTRACTOR SHALL KEEP ALL EXCAVATIONS AND SITE CONSTRUCTION FREE FROM WATER. MAINTAIN TRENCH DRY AT ALL TIMES AND PROVIDE AUTOMATIC OR CONTINUOUS TRENCH PUMPS, AND WELL POINTS IF NECESSARY, TO OBTAIN DRY BEDDING CONDITIONS.

F. SURVEY BEARINGS & ELEVATION DATUM

1. ALL COORDINATES AND ELEVATIONS ARE REFERENCED TO NAD83 MASSACHUSETTS STATE PLANE COORDINATES, MAINLAND ZONE, US FOOT.

G. GEOTECHNICAL REPORT

1. THE GEOTECHNICAL ENGINEERING REPORT ENTITLED "CAPE CANAL BRIDGE RELOCATION PROJECT CAPE BOURNE METERING & REGULATING STATION" PREPARED BY GEOENGINEERS USA, PC. PROJECT NO. 15556-039-00, DATED MAY 19, 2025.

H. SOIL TYPES

ID #	DESCRIPTION
431B	BARNSTABLE SANDY LOAM, 3 TO 8 PERCENT SLOPES, VERY STONY
489C	BARNSTABLE-PLYMOUTH COMPLEX, ROLLING, VERY BOULDERY
435B	PLYMOUTH LOAMY COARSE SAND, 3 TO 8 PERCENT SLOPES
435C	PLYMOUTH LOAMY COARSE SAND, 8 TO 15 PERCENT SLOPES

THE ABOVE INFORMATION WAS OBTAINED FROM THE SOIL SURVEY GEOGRAPHIC (SSURGO) DATABASE FOR BARNSTABLE COUNTY, MASSACHUSETTS.

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
No. 58957
PROFESSIONAL ENGINEER

07/02/26

ISSUED FOR PERMIT
07/02/26

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		C	07/02/26	CR	DT	ISSUED FOR PERMIT
		B	05/15/26	CR	DT	ISSUED FOR BID
		A	05/15/26	CR	DT	ISSUED FOR PERMIT

audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N, SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

DRAWN BY:	CR	05/15/26	CAPE COD CANAL PIPELINE RELOCATION PROJECT
DESIGN CHECKER:	AE	07/02/26	BOURNE M&R RELOCATION
DESIGN ENGINEER:	DT	07/02/26	M&R 00845
PROJECT MANAGER:	AC	07/02/26	TITLE: EROSION AND SEDIMENT GENERAL NOTES
TITLE	INITIALS	DATE	LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

YEAR: 2026 | W.O.: | SCALE: NONE | DWG.: 00018-C.020-0001 | REV.: C

ENBRIDGE
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

S:\AE\Projects\Enbridge\Mass\026356-001\200_civil_structural\170_drawings\e&s plans\bourne m&r\00018-C.020-0001.dwg — PLOT TIME: 7/2/2026 6:29 AM



NOTES:

1. ALL CONTOUR LABELS AND ELEVATION CALLOUTS ARE IN FEET.
2. PROPOSED SITE BOUNDARY WAS PROVIDED BY ALGONQUIN 3RD PARTY CONSULTANT.
3. SUPPLEMENTAL TAX PARCEL DATA IS SHOWN FOR REFERENCE ONLY AND WAS OBTAINED FROM THE CAPE COD COMMISSION OPEN GIS DATA HUB WEBSITE.
4. PROPERTY CONVEYED TO ALGONQUIN GAS TRANSMISSION, LLC.
5. TOPOGRAPHIC SURVEY INFORMATION WAS PROVIDED BY ALGONQUIN GAS TRANSMISSION, LLC. ALL COORDINATES AND DISTANCES SHOWN HEREON ARE REFERENCED TO THE MASSACHUSETTS STATE PLANE COORDINATE SYSTEM, US FEET.ELEVATIONS ARE REFERENCED TO NAVD 88.
6. ADDITIONAL CONTOUR DATA WAS OBTAINED FROM 2022 USGS LIDAR POINT CLOUD DATA SETS.
7. THIS PROPERTY IS LOCATED IN ZONE X (AREA OF MINIMAL FLOOD HAZARD) AS DEPICTED ON FLOOD INSURANCE RATE MAP 25001C0318K DATED JULY 6, 2021.
8. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT NATURAL RESOURCE STUDY THE SITE IS NOT WITHIN THE NATURAL HERITAGE AND ENDANGERED SPECIES PROGRAM (NHESP), PRIORITY HABITATS OF RARE WILDLIFE, OR THE NHESP ESTIMATED HABITATS OF RARE WILDLIFE.
9. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THE SITE THERE IS NOT A WETLAND WITHIN 100 FEET OF THE PROJECT LIMITS.
10. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THE SITE IS NOT LOCATED WITHIN AN AREA OF CRITICAL ENVIRONMENTAL CONCERN.
11. THIS PLAN SET IS PRELIMINARY. FOR PERMITTING PURPOSES ONLY. THIS PLAN IS NOT INTENDED FOR CONSTRUCTION PURPOSES.

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
No. 58957
PROFESSIONAL ENGINEER
07/02/26

EXISTING CONDITIONS PLAN
PLAN VIEW
SCALE: 1" = 60'-0"
0 60' 120'
Scale: 1" = 60'

ISSUED FOR PERMIT
07/02/26

LEGEND

EXISTING MAJOR CONTOUR 70	EXISTING EASEMENT LINE	EXISTING FIRE HYDRANT
EXISTING MINOR CONTOUR 72	EXISTING GRAVEL TRAIL	
PROPOSED FACILITY IMPACT	EXISTING NATURAL GAS LINE GAS	
GIS TAX PARCELS	EXISTING WATER LINE W	
FACILITY ACCESS EASEMENT	EXISTING CHAINLINK FENCE	

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		C	07/02/26	CR	DT	ISSUED FOR PERMIT
		B	05/15/26	CR	DT	ISSUED FOR BID
		A	05/15/26	CR	DT	ISSUED FOR PERMIT

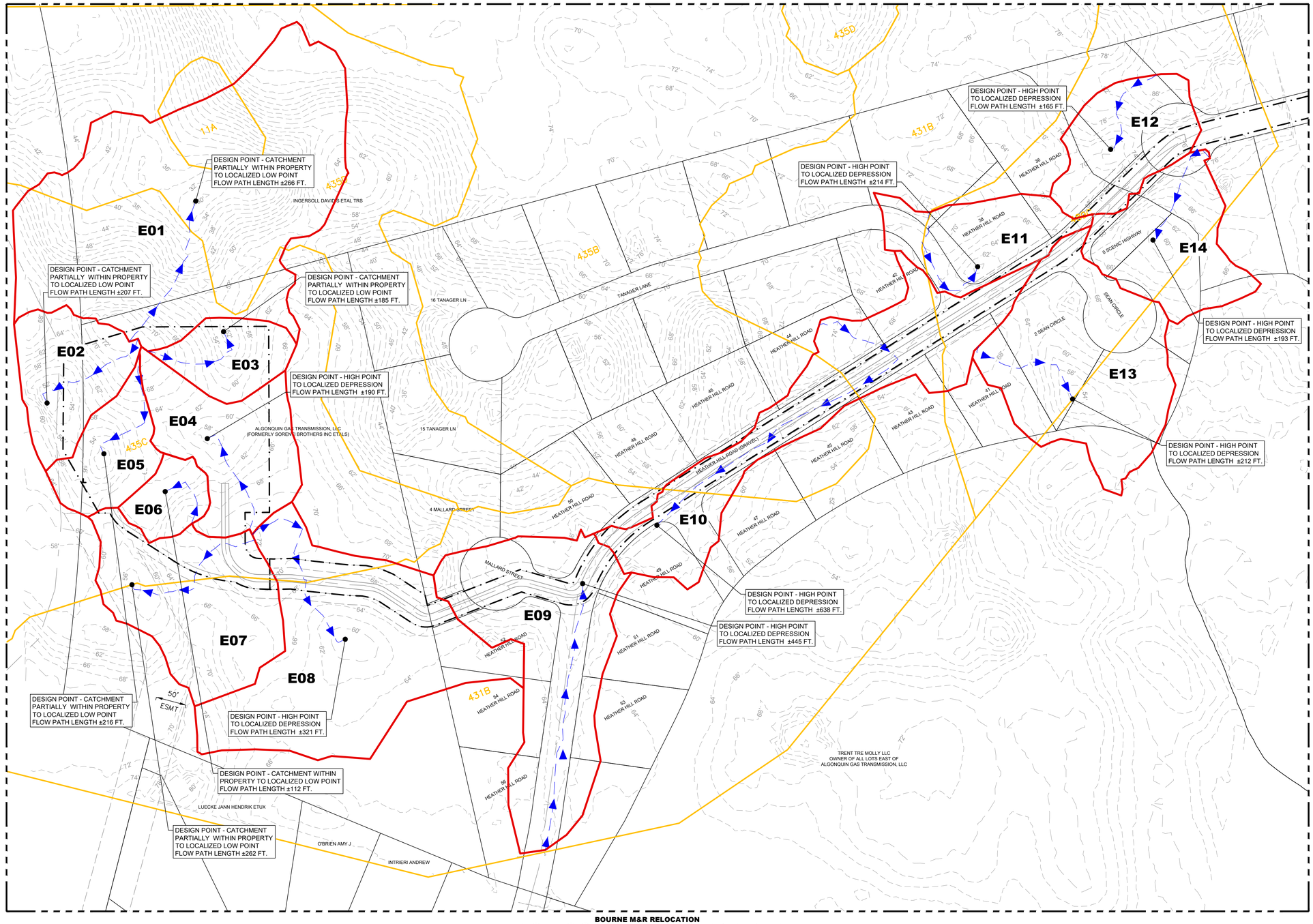
audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

DRAWN BY:	CR	05/15/26	CAPE COD CANAL PIPELINE RELOCATION PROJECT
DESIGN CHECKER:	AE	07/02/26	BOURNE M&R RELOCATION
DESIGN ENGINEER:	DT	07/02/26	M&R 00018
PROJECT MANAGER:	AC	07/02/26	TITLE: EXISTING CONDITIONS PLAN
TITLE	INITIALS	DATE	LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

ENBRIDGE
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

YEAR: 2026 | W.O.: | SCALE: AS NOTED | DWG.: 00018-C.320-0001 | REV.: C

S:\AE\Projects\Enbridge\Mass\026356-001\200_civil_structural\170_drawings\e&s plans\bourne m&r\00018-C.320-0001.dwg -- PLOT TIME: 7/2/2026 8:01 AM



N

23°6'42"

STATION NORTH

BOURNE M&R RELOCATION

EXISTING SUBCATCHMENT AREA PLAN

SCALE: 1" = 80'

0 80' 160'

Scale: 1" = 80'

NOTES:

1. ALL CONTOUR LABELS AND ELEVATION CALLOUTS ARE IN FEET.
2. PROPOSED SITE BOUNDARY WAS PROVIDED BY ALGONQUIN 3RD PARTY CONSULTANT.
3. SUPPLEMENTAL TAX PARCEL DATA IS SHOWN FOR REFERENCE ONLY AND WAS OBTAINED FROM THE CAPE COD COMMISSION OPEN GIS DATA HUB WEBSITE.
4. PROPERTY CONVEYED TO ALGONQUIN GAS TRANSMISSION, LLC.
5. TOPOGRAPHIC SURVEY INFORMATION WAS PROVIDED BY ALGONQUIN GAS TRANSMISSION, LLC. ALL COORDINATES AND DISTANCES SHOWN HEREON ARE REFERENCED TO THE MASSACHUSETTS STATE PLANE COORDINATE SYSTEM, US FEET.ELEVATIONS ARE REFERENCED TO NAVD 88.
6. ADDITIONAL CONTOUR DATA WAS OBTAINED FROM 2022 USGS LIDAR POINT CLOUD DATA SETS.
7. THIS PROPERTY IS LOCATED IN ZONE X (AREA OF MINIMAL FLOOD HAZARD) AS DEPICTED ON FLOOD INSURANCE RATE MAP 25001C0318K DATED JULY 6, 2021.
8. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT NATURAL RESOURCE STUDY THE SITE IS NOT WITHIN THE NATURAL HERITAGE AND ENDANGERED SPECIES PROGRAM (NHESP), PRIORITY HABITATS OF RARE WILDLIFE, OR THE NHESP ESTIMATED HABITATS OF RARE WILDLIFE.
9. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THE SITE THERE IS NOT A WETLAND WITHIN 100 FEET OF THE PROJECT LIMITS.
10. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THE SITE IS NOT LOCATED WITHIN AN AREA OF CRITICAL ENVIRONMENTAL CONCERN.
11. THIS PLAN SET IS PRELIMINARY. FOR PERMITTING PURPOSES ONLY. THIS PLAN IS NOT INTENDED FOR CONSTRUCTION PURPOSES.
12. TIME OF CONCENTRATION (TC) CALCULATIONS UTILIZED A 10-FOOT SHEET FLOW LENGTH FOR BOTH EXISTING AND PROPOSED CONDITIONS TO REPRESENT RUNOFF TRAVEL FROM THE ROADWAY CROWN TO THE ROADSIDE DITCH, AS THE PROPOSED IMPROVEMENTS ONLY MODIFY SURFACE CONDITIONS WITHIN THE IMMEDIATE ROADWAY CORRIDOR. FLOW WITHIN THE DITCH/SWALE SYSTEM WAS TREATED AS CONCENTRATED STORAGE FLOW RATHER THAN ADDITIONAL SHEET FLOW FOR TC CALCULATIONS.
13. REFER TO THE "EROSION & SEDIMENT GENERAL NOTES" (DWG. 00018-C.020-0001) FOR SOIL TYPES INFORMATION.

LEGEND

PROPOSED FENCE	EXISTING MAJOR CONTOUR
PROPERTY LINE	EXISTING MINOR CONTOUR
GIS TAX PARCELS	TIME OF CONCENTRATION LINE
SUBCATCHMENT AREA BOUNDARY	
NRCS SOIL BOUNDARY	
WORKSPACE LIMITS	
PROPOSED GRADE LIMITS	
EDGE OF ROAD	

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
No. 58957
PROFESSIONAL ENGINEER

07/02/26

ISSUED FOR PERMIT
07/02/26

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		C	07/02/26	CR	DT	ISSUED FOR PERMIT
		B	05/15/26	CR	DT	ISSUED FOR BID
		A	05/15/26	CR	DT	ISSUED FOR PERMIT

audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

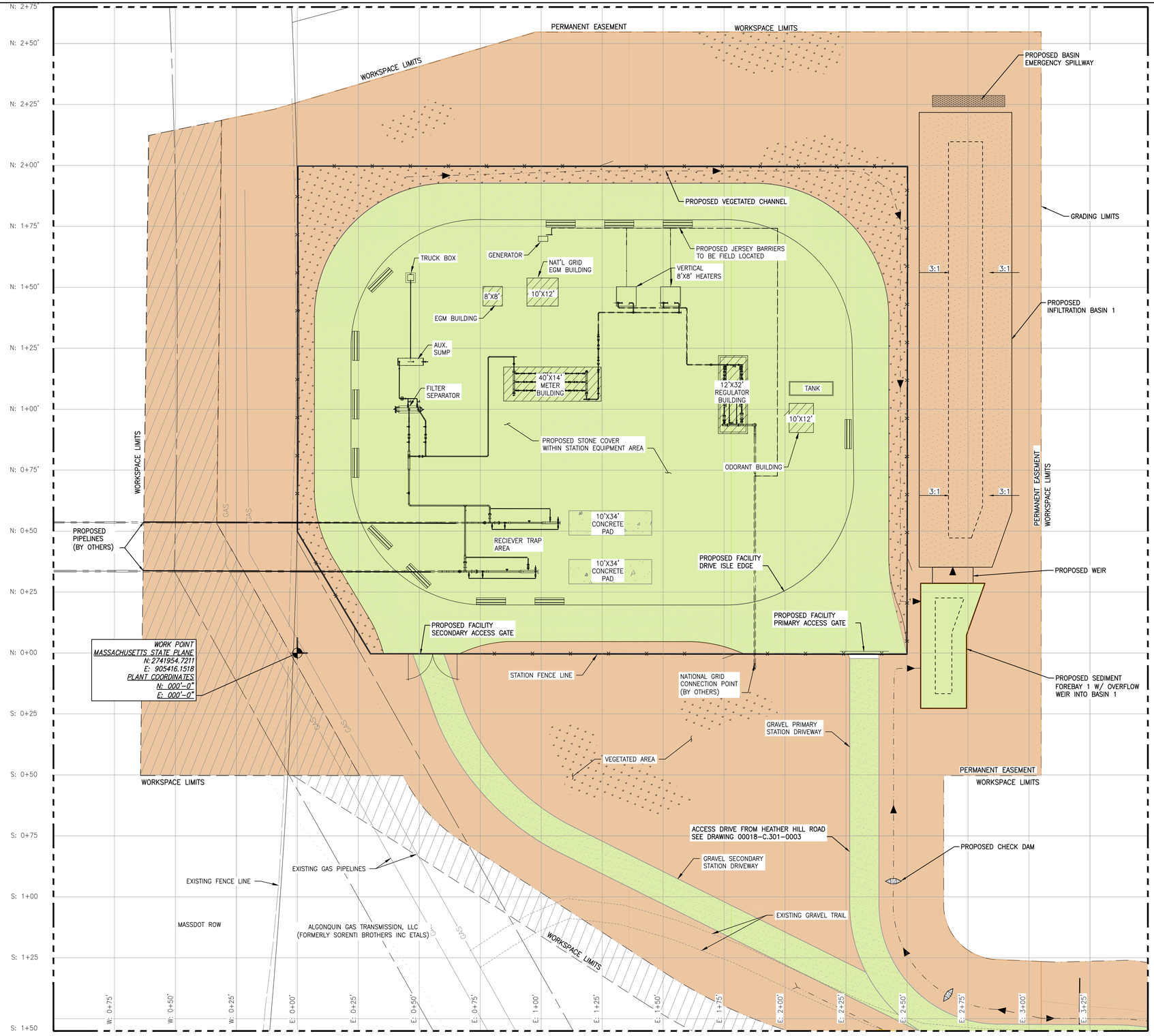
DRAWN BY:	JA	05/15/26
DESIGN CHECKER:	AE	07/02/26
DESIGN ENGINEER:	DT	07/02/26
PROJECT MANAGER:	AC	07/02/26

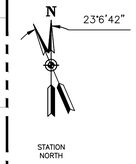
CAPE COD CANAL PIPELINE RELOCATION PROJECT
BOURNE M&R RELOCATION
M&R 00018
TITLE: EXISTING SUBCATCHMENT AREA PLAN
LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

TITLE	INITIALS	DATE	YEAR:	W.O.:	SCALE:	DWG.:	REV.:
			2026		1"=80'	00018-C.320-0002	C

ENBRIDGE
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

S:\AE\Projects\Enbridge\Mass\026356-001\200_civil_structural\170_drawings\e&s plans\bourne m&r\00018-C.320-0002.dwg - PLOT TIME: 7/2/2026 8:14 AM





NOTES:

1. ALL CONTOUR LABELS AND ELEVATION CALLOUTS ARE IN FEET.
2. PROPOSED SITE BOUNDARY WAS PROVIDED BY ALGONQUIN 3RD PARTY CONSULTANT.
3. SUPPLEMENTAL TAX PARCEL DATA IS SHOWN FOR REFERENCE ONLY AND WAS OBTAINED FROM THE CAPE COD COMMISSION OPEN GIS DATA HUB WEBSITE.
4. PROPERTY CONVEYED TO ALGONQUIN GAS TRANSMISSION, LLC.
5. TOPOGRAPHIC SURVEY INFORMATION WAS PROVIDED BY ALGONQUIN GAS TRANSMISSION, LLC. ALL COORDINATES AND DISTANCES SHOWN HEREON ARE REFERENCED TO THE MASSACHUSETTS STATE PLANE COORDINATE SYSTEM, US FEET. ELEVATIONS ARE REFERENCED TO NAVD 88.
6. ADDITIONAL CONTOUR DATA WAS OBTAINED FROM 2022 USGS LIDAR POINT CLOUD DATA SETS.
7. THIS PROPERTY IS LOCATED IN ZONE X (AREA OF MINIMAL FLOOD HAZARD) AS DEPICTED ON FLOOD INSURANCE RATE MAP 25001C0318K DATED JULY 6, 2021.
8. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT NATURAL RESOURCE STUDY THE SITE IS NOT WITHIN THE NATURAL HERITAGE AND ENDANGERED SPECIES PROGRAM (NHESP), PRIORITY HABITATS OF RARE WILDLIFE, OR THE NHESP ESTIMATED HABITATS OF RARE WILDLIFE.
9. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THE SITE THERE IS NOT A WETLAND WITHIN 100 FEET OF THE PROJECT LIMITS.
10. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THE SITE IS NOT LOCATED WITHIN AN AREA OF CRITICAL ENVIRONMENTAL CONCERN.
11. THIS PLAN SET IS PRELIMINARY. FOR PERMITTING PURPOSES ONLY. THIS PLAN IS NOT INTENDED FOR CONSTRUCTION PURPOSES.

PLANT GRID NOTES:

1. BEARING PLANT GRID LINES ARE AS FOLLOWS:
   - 1.1. N–S GRID LINE: N23°06'42.0"E
   - 1.2. E–W GRID LINE: S66°53'18.0"E

LEGEND

PROPOSED ACCESS ROAD
PROPOSED CONCRETE
PROPOSED STRUCTURE
PROPOSED ROCK (FACILITY)
EXISTING GAS LINE
PROPOSED FENCE
PERMANENT EASEMENT
LIMITS OF GRADING
EXISTING TRAIL
PROPOSED VEGETATED
PROPOSED INFILTRATION BASIN
PROPOSED SEDIMENT FOREBAY
WORKSPACE LIMITS
INFILTRATION >2.4"/HR
PROPOSED FLOW LLINE
PROPOSED EMERGENCY SPILLWAY
PROPOSED WEIR
PROPOSED ROCK CHECK DAM
TOP OF SLOPE
INFILTRATION <2.4"/HR

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
00018-C.301-0002	GRADING PLAN	C	07/02/26	CR	DT	ISSUED FOR PERMIT
00018-C.301-0003	CIVIL GRADING PLAN ACCESS ROAD	B	05/15/26	CR	DT	ISSUED FOR BID
00018-C.301-0004	CIVIL GRADING SECTIONS	A	05/15/26	CR	DT	ISSUED FOR PERMIT

audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

DRAWN BY:	CR	05/15/26	CAPE COD CANAL PIPELINE RELOCATION PROJECT
DESIGN CHECKER:	DT	07/02/26	BOURNE M&R RELOCATION
DESIGN ENGINEER:	PB	07/02/26	M&R 00018
PROJECT MANAGER:	AC	07/02/26	TITLE: PROPOSED SITE LAYOUT PLAN
TITLE	INITIALS	DATE	

YEAR: 2026 | W.O.: | SCALE: AS NOTED | DWG.: 00018-C.320-0003 | REV.: C

ENBRIDGE
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
58957
PROFESSIONAL ENGINEER
07/02/26

ISSUED FOR PERMIT
07/02/26

S:\AE\Projects\Enbridge\Mass\026356-001\200_Civil_Structural\170_Drawings\E&S Plans\Bourne M&R\00018-C.320-0003.dwg – PLOT TIME: 7/2/2026 12:39 PM

S:\AE\Projects\Enbridge\Mass\026356-001\200_civil_structural\170_drawings\Grading\Mainland Bourne\00018-C.301-0002.dwg – PLOT TIME: 7/2/2026 1:31 PM

PERMANENT SURFACE EASEMENT
WORKSPACE LIMITS
WORKSPACE LIMITS
PROPOSED BASIN EMERGENCY SPILLWAY INV EL: 62.7
GRADE BREAK
PROPOSED VEGETATED CHANNEL
GRADING LIMITS
435C
PROPOSED INFILTRATION BASIN 1 TOP BERM EL: 63.2 BOTTOM EL: 57.5
GRADING LIMITS
3:1 MAX
3:1 MAX
A C.301-0004
DRAINAGE AREA A1
435C
WORKSPACE LIMITS
PROPOSED PIPELINES (BY OTHERS)
PROPOSED FACILITY ROAD SEE DETAIL B THIS DWG
PROPOSED WEIR WEIR INV EL: 62.0
PROPOSED FACILITY SECONDARY ACCESS GATE
PROPOSED FACILITY PRIMARY ACCESS GATE
PROPOSED SEDIMENT FOREBAY 1 W/ OVERFLOW WEIR INTO BASIN 1 TOP BERM EL: 63.2 BOTTOM EL: 59.2
WORK POINT
MASSACHUSETTS STATE PLANE
N:2741954.7211
E: 905416.1518
PLANT COORDINATES
N: 000'-0"
E: 000'-0"
PROPOSED ROCK CHECK DAM (SEE REFERANCE DWGS)
WORKSPACE LIMITS
PERMANENT SURFACE EASEMENT
WORKSPACE LIMITS
B C.301-0004
ACCESS DRIVE FROM HEATHER HILL ROAD SEE DRAWING 00018-C.301-0003
PERMANENT SURFACE EASEMENT
WORKSPACE LIMITS
N: 2+75'
N: 2+50'
N: 2+25'
N: 2+00'
N: 1+75'
N: 1+50'
N: 1+25'
N: 1+00'
N: 0+75'
N: 0+50
N: 0+25
N: 0+00'
S: 0+25
S: 0+50
S: 0+75
S: 1+00
S: 1+25
S: 1+50
W: 0+75'
W: 0+50'
W: 0+25'
E: 0+00'
E: 0+25'
E: 0+50'
E: 0+75'
E: 1+00'
E: 1+25'
E: 1+50'
E: 1+75'
E: 2+00'
E: 2+25'
E: 2+50'
E: 2+75'
E: 3+00'
E: 3+25'
0+00
1+00
2+00
3+00
3+25
-0.90%
-0.20%
-1.24%
-0.40%
-0.55%
-0.32%
-0.50%
-0.61%
-0.40%
-1.92%
-2.13%
-1.60%
4:1
3:1
23°6'42"
STATION NORTH

EARTHWORK QUANTITIES:

FACILITY SITE
CUT: 5261 CUBIC YARDS
FILL: 9193 CUBIC YARDS
NET (FILL): 3932 CUBIC YARDS

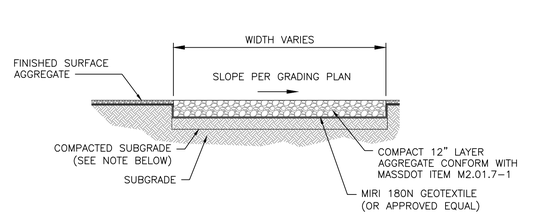
EARTHWORK QUANTITIES WERE DEVELOPED BY COMPARING EXISTING GROUND WITH PROPOSED FINISHED GRADE. CUT/FILL QUANTITIES ARE APPROXIMATE AND DO NOT ACCOUNT FOR STRIPPING TOPSOIL, FINAL GRAVEL SURFACE LAYER, SHRINKAGE FACTORS, BULK FACTORS, OR UNSUITABLE MATERIALS ENCOUNTERED.

NOTES:

1. SITE PREPARATION METHODS SHALL FOLLOW RECOMMENDATIONS OUTLINED IN GEOTECHNICAL REPORT CAPE CANAL BRIDGE RELOCATION PROJECT MAINLAND BOURNE METERING & REGULATION STATION, DATED MAY 19, 2025, PROVIDED BY GEOENGINEERS.
2. ALL CONTOUR LABELS AND ELEVATION CALLOUTS ARE IN FEET AND REFERENCE TOP OF AGGREGATE ELEVATIONS (FINISHED GRADE).
3. CONTRACTOR SHALL PROVIDE AND INSTALL EROSION CONTROL DEVICES IN ACCORDANCE WITH LOCAL, STATE, AND FEDERAL REQUIREMENTS. ADDITIONAL EROSION CONTROL DEVICES NOT SHOWN MAY BE REQUIRED.
4. ALL SILTATION AND EROSION CONTROL DEVICES SHALL REMAIN IN PLACE UNTIL ADEQUATE VEGETATIVE GROWTH ENSURES NO FURTHER SOIL EROSION.
5. DEPENDING UPON EXISTING SOIL CONDITIONS, SOME AREAS OF THE SITE MAY BE SUSCEPTIBLE TO EROSION. CONTRACTOR SHALL INSTALL PERMANENT EROSION CONTROL DEVICES AS NECESSARY TO PREVENT EROSION.
6. FILL SLOPES SHALL BE OVERBUILT AND CUT BACK TO DEVELOP AN ADEQUATELY COMPACTED SLOPE FACE.
7. CONTRACTOR TO VERIFY ALL COORDINATES AND DIMENSIONS PRIOR TO CONSTRUCTION.
8. REFER TO GEOTECHNICAL RECOMMENDATIONS FOR BASE AGGREGATE.
9. RIPRAP SHALL MEET THE REQUIREMENTS OF MASSDOT ITEM M2.02.0 RIPRAP
10. MIRAFI 140N, OR EQUIVALENT AND OVERLAIN WITH MIN. 18–INCHES OF RIPRAP SHALL BE PLACED IN FILL SLOPES 3.0H:1V TO 2.0H:1V AND STEEPER.
11. CONTRACTOR TO PROVIDE ENGINEER OF RECORD GEOGRID AND GEOTEXTILE FABRIC SAMPLES, SPECIFICATIONS, AND INSTALLATION PROCEDURE PRIOR TO CONSTRUCTION.
12. ALL GEOGRID AND GEOTEXTILE FABRIC SHALL BE INSTALLED ACCORDING TO MANUFACTURER'S REQUIREMENTS AND RECOMMENDATIONS.
13. REFER TO GEOTECHNICAL REPORT FOR DRIVE ISLE AND GRAVEL ROAD EARTHWORK AND SUBGRADE PREPARATIONS.

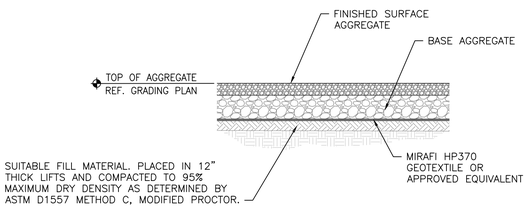
SURVEY NOTES:

1. BACKGROUND INFORMATION IS BASED ON THE FOLLOWING:
   - 1.1. TOPOGRAPHIC SURVEY INFORMATION WAS PROVIDED BY ALGONQUIN GAS TRANSMISSION LLC.
   - 1.2. ALL COORDINATES AND DISTANCES SHOWN HEREON ARE REFERENCED TO THE MASSACHUSETTS STATE PLANE COORDINATE SYSTEM, US FEET. ELEVATIONS ARE REFERENCED TO NAVD 88.
2. BEARING PLANT GRID LINES ARE AS FOLLOWS:
   - 2.1. N–S GRID LINE: N23°06'42.0"E
   - 2.2. E–W GRID LINE: S66°53'18.0"E



DETAIL B – TYPICAL AGGREGATE DRIVE AISLE
SCALE: NOT TO SCALE

NOTE: SITE PREPARATION SHALL CONFORM TO THE RECOMMENDATIONS OF THE GEOTECHNICAL REPORT REFERENCED



TYPICAL AGGREGATE YARD SURFACE SECTION
SCALE: NOT TO SCALE

METER STATION
PLAN VIEW
SCALE: 1" = 20'–0"
0 20' 40'
Scale: 1" = 20'

ISSUED FOR PERMIT
07/02/26

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
39957
PROFESSIONAL ENGINEER
07/02/26

LEGEND

PROPOSED ACCESS ROAD
PROPOSED CONCRETE
PROPOSED STRUCTURE
PROPOSED ROCK (FACILITY)
EXISTING GAS LINE
PROPOSED FENCE
EXISTING CONTOUR LINE
FINISH CONTOUR LINE
DRAINAGE AREA BOUNDARY
PERMANENT EASEMENT
LIMITS OF GRADING
PROPOSED VEGETATED
PROPOSED INFILTRATION BASIN
PROPOSED SEDIMENT FOREBAY
WORKSPACE LIMITS
INFILTRATION >2.4"/HR
PROPOSED FLOW LLINE
PROPOSED EMERGENCY SPILLWAY
PROPOSED WEIR
PROPOSED ROCK CHECK DAM
INFILTRATION <2.4"/HR

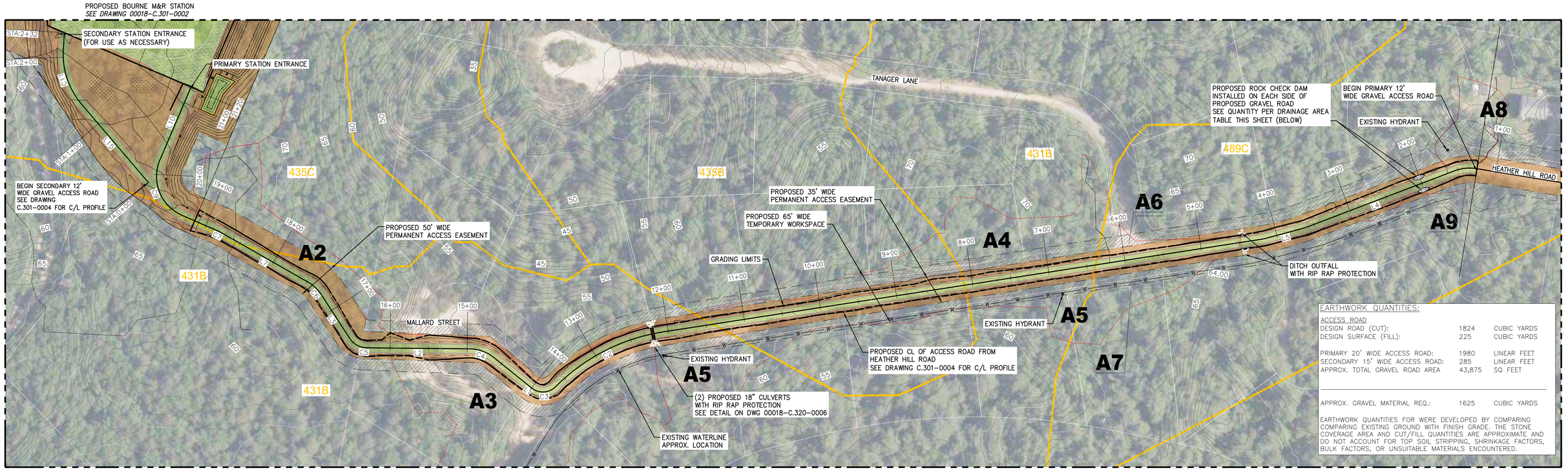
DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		E	07/02/26	CR	DT	ISSUED FOR PERMIT
00018-C.320-0007	DETAILS	D	05/15/26	CR	DT	ISSUED FOR BID
00018-C.320-0006	DETAILS	C	05/15/26	CR	DT	ISSUED FOR PERMIT
00018-C.301-0003	CIVIL GRADING PLAN ACCESS ROAD	B	03/17/26	CR	SP	ISSUED FOR REVIEW – 90% REVIEW
00018-C.301-0004	CIVIL GRADING SECTIONS	A	06/12/25	CR	PB	ISSUED FOR REVIEW – 60% REVIEW

audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

DRAWN BY:	CR	04/20/25	CAPE COD CANAL PIPELINE RELOCATION PROJECT
DESIGN CHECKER:	DT	07/02/26	BOURNE M&R RELOCATION
DESIGN ENGINEER:	PB	07/02/26	M&R 00018
PROJECT MANAGER:	AC	07/02/26	TITLE: GRADING PLAN
LOC.: BARNSTABLE COUNTY, MASSACHUSETTS			

ENBRIDGE
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713.627.5400

TITLE	INITIALS	DATE	YEAR: 2026	W.O.:	SCALE: AS NOTED	DWG.: 00018–C.301–0002	REV.: E



EARTHWORK QUANTITIES:

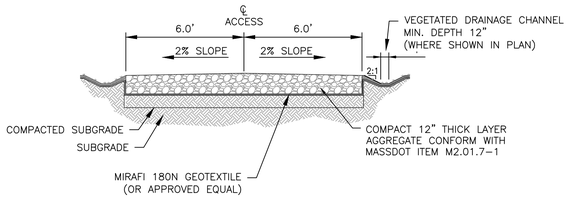
ACCESS ROAD		
DESIGN ROAD (CUT):	1824	CUBIC YARDS
DESIGN SURFACE (FILL):	225	CUBIC YARDS
PRIMARY 20' WIDE ACCESS ROAD:	1980	LINEAR FEET
SECONDARY 15' WIDE ACCESS ROAD:	285	LINEAR FEET
APPROX. TOTAL GRAVEL ROAD AREA	43,875	SQ FEET
APPROX. GRAVEL MATERIAL REQ.:	1625	CUBIC YARDS

EARTHWORK QUANTITIES FOR WERE DEVELOPED BY COMPARING COMPARING EXISTING GROUND WITH FINISH GRADE. THE STONE COVERAGE AREA AND CUT/FILL QUANTITIES ARE APPROXIMATE AND DO NOT ACCOUNT FOR TOP SOIL STRIPPING, SHRINKAGE FACTORS, BULK FACTORS, OR UNSUITABLE MATERIALS ENCOUNTERED.

ACCESS ROAD C/L PLAN

SCALE: HORIZ. 1" = 60'-0

0 60' 120'
Scale: 1" = 60'

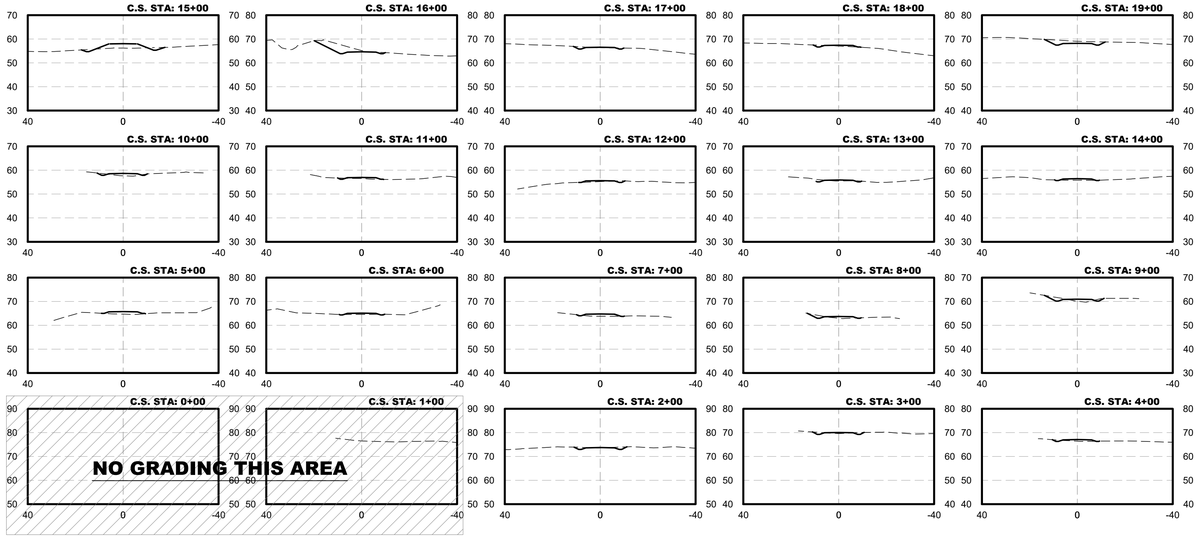


DETAIL B – TYPICAL AGGREGATE ACCESS ROAD

SCALE: NOT TO SCALE

BOURNE METER STATION ACCESS ROAD			
NUMBER	RADIUS	LENGTH	LINE/CHORD DIRECTION
L4		190.84	S69° 08' 48.73"W
L5		55.24	S74° 53' 13.98"W
C2	250.46	160.78	S63° 09' 42.77"W
C3	23.10	33.87	S86° 46' 26.75"W
L1		63.68	N51° 13' 22.89"W
C4	50.00	33.33	N70° 19' 15.11"W
L2		133.68	N89° 25' 07.32"W
C5	26.82	26.43	N61° 11' 21.35"W
L3		66.15	N32° 57' 35.38"W
C6	59.46	21.22	N43° 10' 57.10"W
L7		133.64	N60° 18' 09.57"W
C7	55.00	5.98	N63° 24' 54.68"W
C9	55.00	86.05	N21° 42' 28.89"W
L10		100.95	N23° 06' 42.00"E

BOURNE METER STATION SECONDARY ROAD			
NUMBER	RADIUS	LENGTH	LINE/CHORD DIRECTION
L15		133.42	N40° 27' 04.99"W
C11	100.00	76.60	N18° 30' 25.79"W



ACCESS ROAD C/L CROSS SECTIONS

HORZ. & VERT. SCALE: 1" = 30'-0

NOTES:

1. BACKGROUND INFORMATION IS BASED ON THE FOLLOWING:
   - 1.1. TOPOGRAPHIC SURVEY INFORMATION WAS PROVIDED BY ALGONQUIN GAS TRANSMISSION, LLC.
   - 1.2. ADDITIONAL CONTOUR DATA WAS OBTAINED FROM 2022 USGS LIDAR POINT CLOUD DATA SETS.
   - 1.3. ALL COORDINATES AND DISTANCES SHOWN HEREON ARE REFERENCED TO THE MASSACHUSETTS STATE PLANE COORDINATE SYSTEM, US FEET. ELEVATIONS ARE REFERENCED TO NAVD 88.
   - 1.4. REFER TO THE "EROSION & SEDIMENT GENERAL NOTES" (DWG. 00018-C.020-0001) FOR SOIL TYPES INFORMATION.

PROPOSED ROCK CHECK DAM QUANTITY PER DRAINAGE AREA	
DRAINAGE AREA	TOTAL DAMS/DRAINAGE
A2	14
A3	14
A4	8
A5	8
A6	1
A7	1
A8	12
A9	9

REFER TO DETAIL DRAWING 00018-C.301-0007 FOR ROCK CHECK DAM TYPICAL AND STANDARD SPACING TABLE.

PRELIMINARY
07/02/26

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
59957
PROFESSIONAL ENGINEER
07/02/26

LEGEND

PROPOSED ACCESS ROAD
PROPOSED CONCRETE
PROPOSED STRUCTURE
PROPOSED ROCK (FACILITY)
NRCS SOIL BOUNDARY
PROPOSED FENCE
EXISTING CONTOUR LINE
FINISH CONTOUR LINE
DRAINAGE AREA BOUNDARY
PERMANENT EASEMENT
LIMITS OF GRADING
PROPOSED VEGETATED
PROPOSED INFILTRATION BASIN
PROPOSED SEDIMENT FOREBAY
WORKSPACE LIMITS
INFILTRATION >2.4"/HR
PROPOSED FLOW LLINE
PROPOSED EMERGENCY SPILLWAY
PROPOSED WEIR
PROPOSED ROCK CHECK DAM
EXISTING WATER LINE
INFILTRATION <2.4"/HR

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		E	07/02/26	CR	DT	ISSUED FOR PERMIT
00018-C.320-0007	DETAILS	D	05/15/26	CR	DT	ISSUED FOR BID
00018-C.320-0006	DETAILS	C	05/15/26	CR	DT	ISSUED FOR PERMIT
00018-C.301-0004	CIVIL – PROFILE AND SECTIONS	B	03/17/26	CR	PB	ISSUED FOR REVIEW – 90% REVIEW
00018-C.301-0002	CIVIL GRADING PLAN	A	06/12/25	CR	PB	ISSUED FOR REVIEW – 60% REVIEW

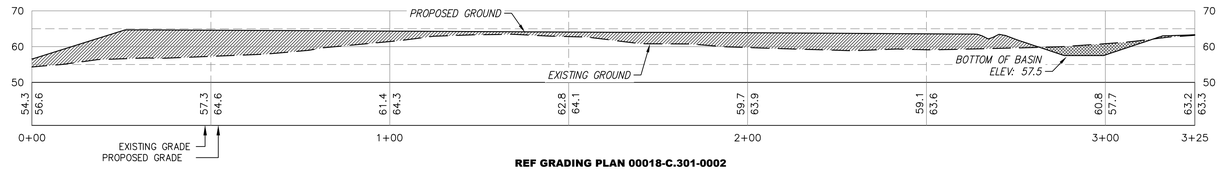
audubon Engineering
3505 W. SAM HOUSTON PKWY. N., SUITE 100
HOUSTON, TX 77043
PHONE: (281) 669-0590

TITLE	INITIALS	DATE
DRAWN BY:	CR	05/15/26
DESIGN CHECKER:	AE	07/02/26
DESIGN ENGINEER:	PB	07/02/26
PROJECT MANAGER:	AC	07/02/26

CAPE COD CANAL PIPELINE RELOCATION PROJECT
BOURNE M&R RELOCATION
M&R 00018
TITLE: CIVIL ACCESS ROAD GRADE PLAN AND SECTIONS
LOC.: BARNSTABLE COUNTY, MASSACHUSETTS
YEAR: 2026 | W.O.: | SCALE: AS NOTED | DWG.: 00018-C.301-0003 | REV.: E

ENBRIDGE
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

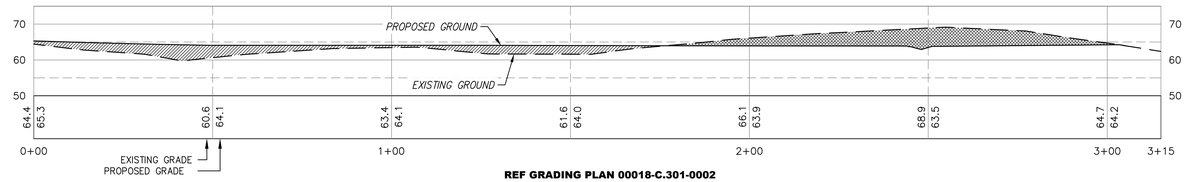
S:\AE\Projects\Enbridge\Mass\026356-001\200_Civil_Structural\170_Drawings\Grading\Mainland Bourne\00018-C.301-0003.dwg – PLOT TIME: 7/2/2026 1:45 PM



REF GRADING PLAN 00018-C.301-0002

SECTION A

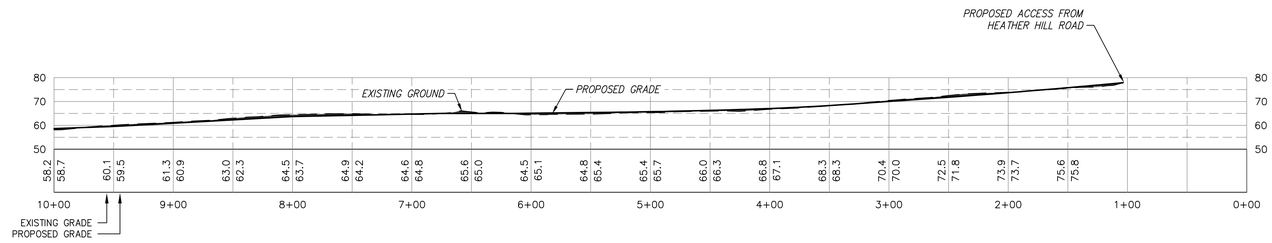
SCALES: HORIZ. 1" = 20'-0"



REF GRADING PLAN 00018-C.301-0002

SECTION B

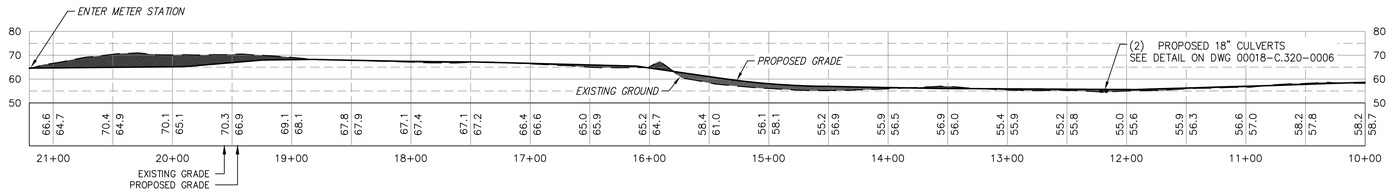
SCALES: HORIZ. 1" = 20'-0"



CL STA: 0+00 THRU 10+00 / REF GRADING PLAN 00018-C-301-0003

ACCESS ROAD C/L PROFILE

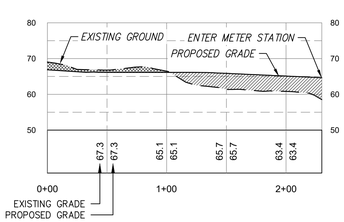
SCALES: HORIZ. 1" = 60'-0" / VERT. 1" = 30'-0"



CL STA: 10+00 THRU 20+45 / REF GRADING PLAN 00018-C-301-0003

ACCESS ROAD C/L PROFILE

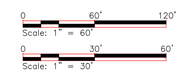
SCALES: HORIZ. 1" = 60'-0" / VERT. 1" = 30'-0"



CL STA: 0+00 THRU 2+32 / REF GRADING PLAN 00018-C-301-0003

SECONDARY ACCESS ROAD C/L PROFILE

SCALES: HORIZ. 1" = 60'-0" / VERT. 1" = 30'-0"



LEGEND

PROPOSED CUT

PROPOSED FILL

SURVEY NOTES:

1. BACKGROUND INFORMATION IS BASED ON THE FOLLOWING:
   - 1.1. TOPOGRAPHIC SURVEY INFORMATION WAS PROVIDED BY ALGONQUIN GAS TRANSMISSION, LLC.
   - 1.2. ALL COORDINATES AND DISTANCES SHOWN HEREON ARE REFERENCED TO THE MASSACHUSETTS STATE PLANE COORDINATE SYSTEM, US FEET. ELEVATIONS ARE REFERENCED TO NAVD 88.

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
58957
PROFESSIONAL ENGINEER

07/02/26

ISSUED FOR PERMIT
07/02/26

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		E	07/02/26	CR	DT	ISSUED FOR PERMIT
		D	05/15/26	CR	DT	ISSUED FOR BID
00018-C.301-0003	CIVIL ACCESS ROAD GRADING PLAN	C	05/15/26	CR	DT	ISSUED FOR PERMIT
00018-C.301-0002	CIVIL GRADING PLAN	B	03/17/26	CR	PB	ISSUED FOR REVIEW – 90% REVIEW
		A	06/12/25	CR	PB	ISSUED FOR REVIEW – 60% REVIEW

audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

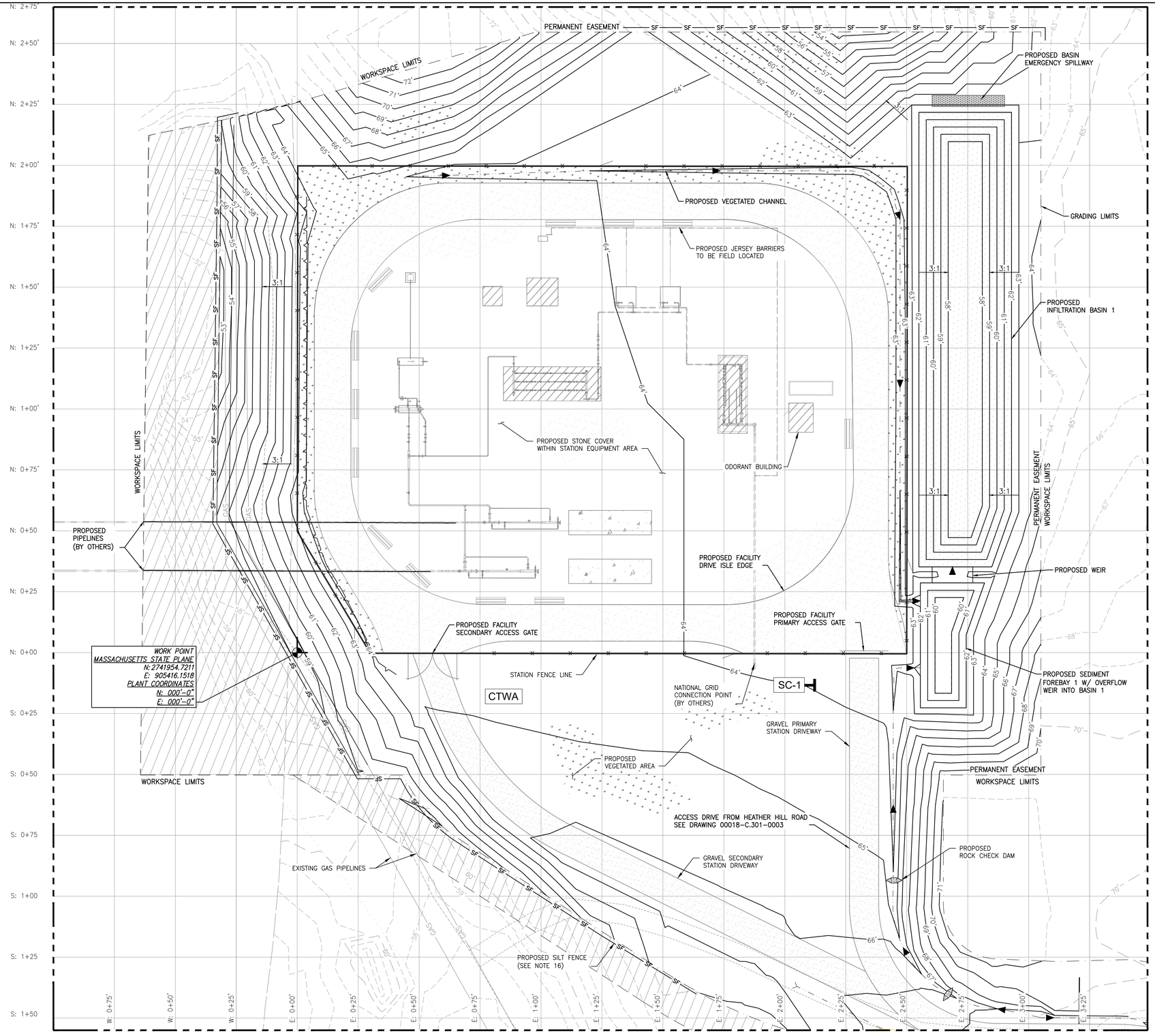
DRAWN BY:	CR	05/08/25	CAPE COD CANAL PIPELINE RELOCATION PROJECT
DESIGN CHECKER:	DT	07/02/26	BOURNE M&R RELOCATION
DESIGN ENGINEER:	PB	07/02/26	M&R 00018
PROJECT MANAGER:	AC	07/02/26	TITLE: CIVIL GRADE PROFILE AND SECTIONS

ENBRIDGE

Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

TITLE	INITIALS	DATE	YEAR: 2026	W.O.:	SCALE: AS NOTED	DWG.: 00018-C.301-0004	REV.: E

S:\AE\Projects\Enbridge\Mass\026356-001\200_Civil_Structural\170_Drawings\Grading\Mainland Bourne\00018-C.301-0004.dwg – PLOT TIME: 7/2/2026 1:40 PM



N

23°6'42"

STATION NORTH

NOTES:

1. ALL CONTOUR LABELS AND ELEVATION CALLOUTS ARE IN FEET.
2. PROPOSED SITE BOUNDARY WAS PROVIDED BY ALGONQUIN 3RD PARTY CONSULTANT.
3. SUPPLEMENTAL TAX PARCEL DATA IS SHOWN FOR REFERENCE ONLY AND WAS OBTAINED FROM THE CAPE COD COMMISSION OPEN GIS DATA HUB WEBSITE.
4. PROPERTY CONVEYED TO ALGONQUIN GAS TRANSMISSION, LLC.
5. TOPOGRAPHIC SURVEY INFORMATION WAS PROVIDED BY ALGONQUIN GAS TRANSMISSION, LLC. ALL COORDINATES AND DISTANCES SHOWN HEREON ARE REFERENCED TO THE MASSACHUSETTS STATE PLANE COORDINATE SYSTEM, US FEET. ELEVATIONS ARE REFERENCED TO NAVD 88.
6. ADDITIONAL CONTOUR DATA WAS OBTAINED FROM 2022 USGS LIDAR POINT CLOUD DATA SETS.
7. THIS PROPERTY IS LOCATED IN ZONE X (AREA OF MINIMAL FLOOD HAZARD) AS DEPICTED ON FLOOD INSURANCE RATE MAP 25001C0318K DATED JULY 6, 2021.
8. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT NATURAL RESOURCE STUDY THE SITE IS NOT WITHIN THE NATURAL HERITAGE AND ENDANGERED SPECIES PROGRAM (NHESP), PRIORITY HABITATS OF RARE WILDLIFE, OR THE NHESP ESTIMATED HABITATS OF RARE WILDLIFE.
9. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THE SITE THERE IS NOT A WETLAND WITHIN 100 FEET OF THE PROJECT LIMITS.
10. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THE SITE IS NOT LOCATED WITHIN AN AREA OF CRITICAL ENVIRONMENTAL CONCERN.
11. THIS PLAN SET IS PRELIMINARY. FOR PERMITTING PURPOSES ONLY. THIS PLAN IS NOT INTENDED FOR CONSTRUCTION PURPOSES.
12. REFER TO DRAWINGS 00844-C.320-0006 THRU 0007 FOR BMP DETAILS.
13. REFER TO DRAWING 00844-C.020-0001 FOR CONSTRUCTION EROSION AND SEDIMENT CONTROL NOTES.
14. PROPOSED FACILITY PERMANENT WORK AREA ACREAGE: 2.669 AC.
15. PROPOSED TEMPORARY WORKSPACE ACREAGE: 0.254 AC.
16. FOR CLARITY, THE SILT FENCE IS SHOWN OFFSET FROM THE PROPERTY LINE/WORKSPACE LIMITS, BUT IN REALITY THEY ARE SYNONYMOUS.
17. CONTRACTOR TO ENSURE ALL WORK TO BE CONDUCTED WITHIN THE WORK LIMITS SPECIFIED. WORK LIMITS SHALL BE CLEARLY MARKED.
18. TEMOPORARY STOCK PILE LOCATIONS TO BE LOCATED WITHIN THE TEMPORARY WORKSPACE SHOWN ON THE PLANS AND COORDINATED WITH THE ON-SITE INSPECTOR. REFERE TO DETAIL ON DRAWING 00018-C.320-0006.

SURVEY NOTES:

1. BACKGROUND INFORMATION IS BASED ON THE FOLLOWING:
   - 1.1. TOPOGRAPHIC SURVEY INFORMATION WAS PROVIDED BY ALGONQUIN.
   - 1.2. ALL COORDINATES AND DISTANCES SHOWN HEREON ARE REFERENCED TO THE MASSACHUSETTS STATE PLANE COORDINATE SYSTEM, US FEET. ELEVATIONS ARE REFERENCED TO NAVD 88.
2. BEARING PLANT GRID LINES ARE AS FOLLOWS:
   - 2.1. N-S GRID LINE: N23°06'42.0"E
   - 2.2. E-W GRID LINE: S66°53'18.0"E

LEGEND

- PROPOSED ACCESS ROAD
- PROPOSED CONCRETE
- PROPOSED STRUCTURE
- PROPOSED ROCK (FACILITY)
- PROPOSED VEGETATED
- PROPOSED INFILTRATION BASIN
- PROPOSED SEDIMENT FOREBAY
- PROPOSED ROCK
- EXISTING PAVED AREA
- WETLAND
- CONSTRUCTION TRUCK WASH AREA (TO BE FIELD LOCATED) — CTWA
- STABLIZED CONSTRUCTION ACCESS (TO BE FIELD LOCATED) — SC-1
- PROPOSED FLOW LINE
- PROPOSED FENCE
- PERMANENT EASEMENT
- GIS TAX PARCELS
- WORKSPACE LIMITS
- PROPOSED GRADE LIMITS
- EDGE OF ROAD
- EDGE OF WATER
- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- PROPOSED SILT FENCE — SF
- PROPOSED SILT SOCK — SSF
- PROPOSED WIER
- PROPOSED EMERGENCY SPILLWAY
- TEMPORARY WORK SPACE
- PROPOSED ROCK CHECK DAM

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
No. 58957
PROFESSIONAL ENGINEER

07/02/26

ISSUED FOR PERMIT
07/02/26

LEGEND

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		C	07/02/26	CR	DT	ISSUED FOR PERMIT
00018-C.301-0003	CIVIL GRADING PLAN ACCESS ROAD	B	05/15/26	CR	DT	ISSUED FOR BID
00018-C.301-0004	CIVIL GRADING SECTIONS	A	05/14/26	CR	PB	ISSUED FOR PERMIT

audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

DRAWN BY:	CR	05/15/25	
DESIGN CHECKER:	DT	07/02/26	
DESIGN ENGINEER:	PB	07/02/26	
PROJECT MANAGER:	AC	07/02/26	
TITLE	INITIALS	DATE	

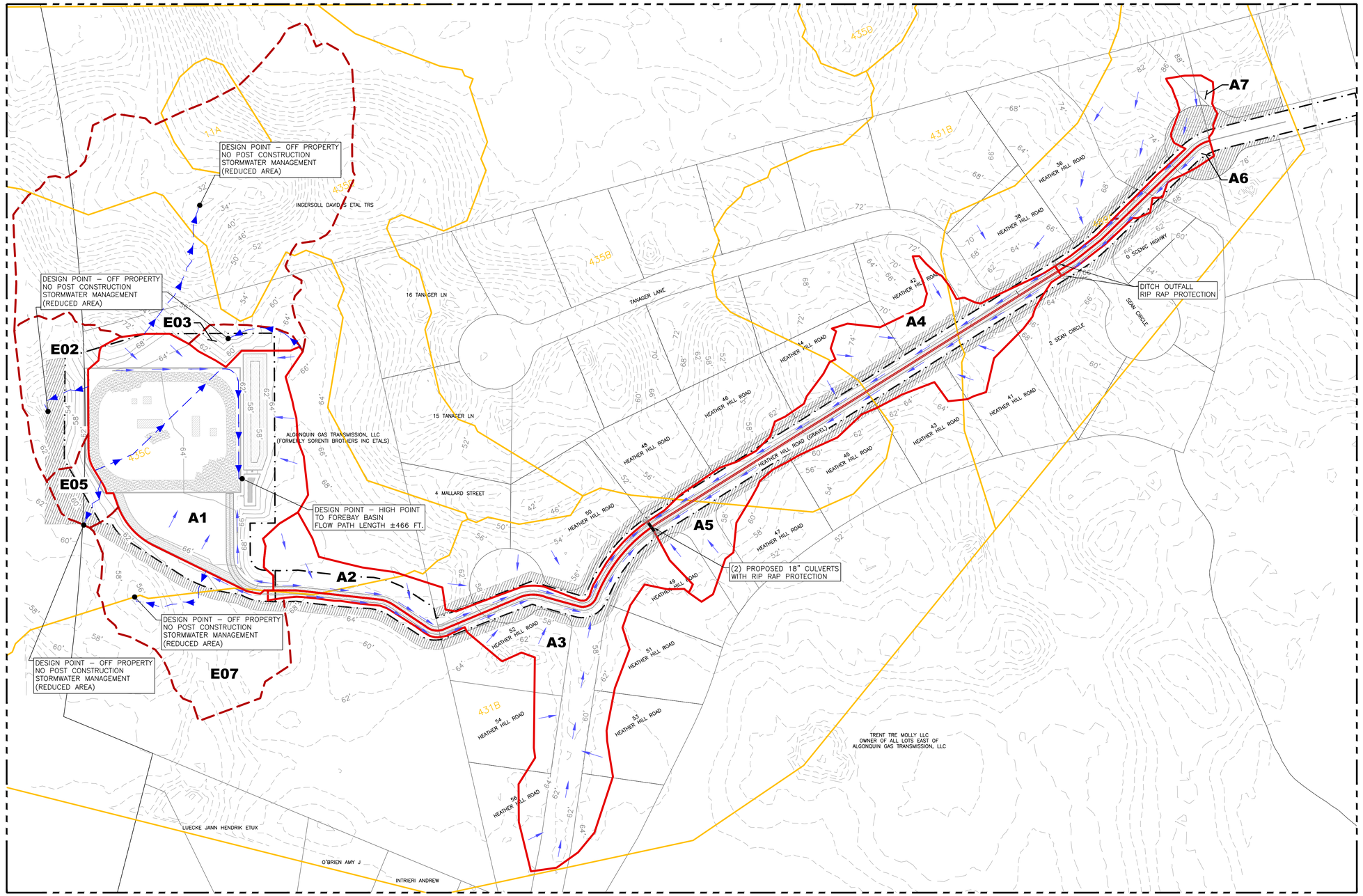
CAPE COD CANAL PIPELINE RELOCATION PROJECT
BOURNE M&R RELOCATION
M&R 00018
TITLE: CONSTRUCTION EROSION AND SEDIMENT CONTROL PLAN

LOC.: BARNSTABLE COUNTY, MASSACHUSETTS
YEAR: 2026 | W.O.: | SCALE: AS NOTED

ENBRIDGE
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

DWG.: 00018-C.320-0004 | REV.: C

S:\AE\Projects\Enbridge\Mass\026356-001\200_Civil_Structural\170_Drawings\E&S Plans\Bourne M&R\00018-C.320-0004.dwg - PLOT TIME: 7/2/2026 2:04 PM



N

23°6'42"

STATION NORTH

NOTES:

1. ALL CONTOUR LABELS AND ELEVATION CALLOUTS ARE IN FEET.
2. PROPOSED SITE BOUNDARY WAS PROVIDED BY ALGONQUIN 3RD PARTY CONSULTANT.
3. SUPPLEMENTAL TAX PARCEL DATA IS SHOWN FOR REFERENCE ONLY AND WAS OBTAINED FROM THE CAPE COD COMMISSION OPEN GIS DATA HUB WEBSITE.
4. PROPERTY CONVEYED TO ALGONQUIN GAS TRANSMISSION, LLC.
5. TOPOGRAPHIC SURVEY INFORMATION WAS PROVIDED BY ALGONQUIN GAS TRANSMISSION, LLC. ALL COORDINATES AND DISTANCES SHOWN HEREON ARE REFERENCED TO THE MASSACHUSETTS STATE PLANE COORDINATE SYSTEM, US FEET. ELEVATIONS ARE REFERENCED TO NAVD 88.
6. CONTOUR DATA SHOWN IS BASED ON THE TOPOGRAPHIC SURVEY REFERENCED ABOVE. ADDITIONAL CONTOUR DATA WAS OBTAINED FROM 2022 USGS LIDAR POINT CLOUD DATA SETS.
7. THIS PROPERTY IS LOCATED IN ZONE X (AREA OF MINIMAL FLOOD HAZARD) AS DEPICTED ON FLOOD INSURANCE RATE MAP 25001C0318K DATED JULY 6, 2021.
8. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT NATURAL RESOURCE STUDY THE SITE IS NOT WITHIN THE NATURAL HERITAGE AND ENDANGERED SPECIES PROGRAM (NHESP), PRIORITY HABITATS OF RARE WILDLIFE, OR THE NHESP ESTIMATED HABITATS OF RARE WILDLIFE.
9. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THE SITE THERE IS NOT A WETLAND WITHIN 100 FEET OF THE PROJECT LIMITS.
10. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THE SITE IS NOT LOCATED WITHIN AN AREA OF CRITICAL ENVIRONMENTAL CONCERN.
11. THIS PLAN SET IS PRELIMINARY. FOR PERMITTING PURPOSES ONLY. PROPOSED GRADING MAY BE FURTHER OPTIMIZED TO ENSURE PROPER SHEET FLOW AROUND ASSUMED BUILDING LOCATIONS, FOUNDATIONS, AND MECHANICAL EQUIPMENT. THIS PLAN IS NOT INTENDED FOR CONSTRUCTION PURPOSES.
12. REFER TO THE "EROSION & SEDIMENT GENERAL NOTES" (DWG. 00018–C.020–0001) FOR SOIL TYPES INFORMATION.

LEGEND

- PROPOSED ACCESS ROAD
- PROPOSED CONCRETE
- PROPOSED STRUCTURE
- PROPOSED ROCK (FACILITY)
- PROPOSED INFILTRATION BASIN
- PROPOSED SEDIMENT FOREBAY
- WORKSPACE
- PROPOSED BUILDING
- PROPOSED GRADE LIMITS
- EDGE OF ROAD
- PROPERTY LINE
- GIS TAX PARCELS
- NRCS SOIL BOUNDARY
- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- PROPOSED DRAINAGE AREAS
- DRAINAGE FLOW ARROW
- TIME OF CONCENTRATION LINE

BOURNE M&R RELOCATION

PROPOSED SUBCATCHMENT AREA PLAN

SCALE: 1" = 80'

0 80' 160'
Scale: 1" = 80'

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
No. 58957
PROFESSIONAL ENGINEER

07/02/26

ISSUED FOR PERMIT
07/02/26

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		C	07/02/26	CR	DT	ISSUED FOR PERMIT
		B	05/15/26	CR	DT	ISSUED FOR BID
		A	05/15/26	CR	PB	ISSUED FOR PERMIT

audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

DRAWN BY:	CR	05/15/26	CAPE COD CANAL PIPELINE RELOCATION PROJECT
DESIGN CHECKER:	AE	07/02/26	BOURNE M&R RELOCATION
DESIGN ENGINEER:	PB	07/02/26	M&R 00018
PROJECT MANAGER:	AC	07/02/26	TITLE: PROPOSED SUBCATCHMENT AREA PLAN
TITLE	INITIALS	DATE	LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

YEAR: 2026 | W.O.: | SCALE: 1"=80' | DWG.: 00018–C.320–0005 | REV.: C

ENBRIDGE
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

S:\AE\Projects\Enbridge\Mass\026356-001\200_Civil_Structural\170_Drawings\E&S Plans\Bourne M&R\00018-C.320-0005.dwg – PLOT TIME: 7/2/2026 9:16 AM

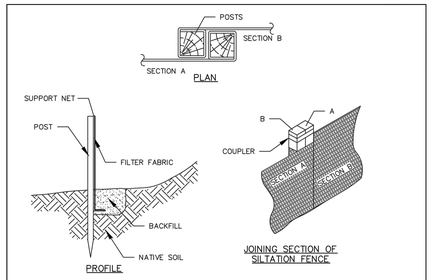
E&S CONSTRUCTION SEQUENCE AND MAINTENANCE

THE FOLLOWING CONSTRUCTION SEQUENCING AND EROSION AND SEDIMENTATION CONTROL MEASURES HAVE BEEN DEVELOPED TO MINIMIZE EROSION, SEDIMENT TRANSPORT, AND IMPACTS TO ADJACENT DRAINAGE SYSTEMS AND RESOURCE AREAS DURING ALL PHASES OF CONSTRUCTION. THE CONTRACTOR SHALL BE RESPONSIBLE FOR MAINTAINING ALL EROSION AND SEDIMENTATION CONTROLS THROUGHOUT CONSTRUCTION AND IMPLEMENTING ADDITIONAL MEASURES AS NECESSARY TO PREVENT OFF-SITE SEDIMENT TRANSPORT. THE SEQUENCE OF WORK SHALL GENERALLY PROCEED AS FOLLOWS:

- INSTALL CONSTRUCTION LIMIT SILT FENCING AND STABILIZED CONSTRUCTION ENTRANCES PRIOR TO THE COMMENCEMENT OF CLEARING OR EARTHWORK ACTIVITIES. CRUSHED STONE CONSTRUCTION ENTRANCE APRONS SHALL BE MAINTAINED TO MINIMIZE SEDIMENT TRACKING ONTO ADJACENT ROADWAYS.
- INSTALL PERIMETER EROSION AND SEDIMENTATION CONTROLS INCLUDING FIBER ROLLS AND SILT FENCE BARRIERS AT THE DOWNGRADIENT LIMITS OF DISTURBANCE AND AROUND SENSITIVE RESOURCE AREAS. IN AREAS SUBJECT TO CONCENTRATED RUNOFF OR HIGHER SEDIMENT LOADING, FIBER ROLLS SHALL BE SUPPLEMENTED WITH SILT FENCING FOR ADDITIONAL PROTECTION.
- INSTALL CATCH BASIN PROTECTION MEASURES, INCLUDING SILT SACKS WITHIN EXISTING AND NEWLY CONSTRUCTED CATCH BASINS, PRIOR TO NEARBY EARTH DISTURBANCE ACTIVITIES, IF APPLICABLE.
- ESTABLISH DESIGNATED CONCRETE WASHOUT AREAS IN APPROPRIATE UPLAND LOCATIONS TO CONTAIN CONCRETE WASH WATER AND SOLIDS GENERATED DURING CONSTRUCTION ACTIVITIES. CONCRETE WASHOUT FACILITIES SHALL BE LEAK PROOF AND MAINTAINED THROUGHOUT THE DURATION OF THE PROJECT.
- CONDUCT CLEARING AND GRUBBING OPERATIONS ONLY WITHIN APPROVED LIMITS OF DISTURBANCE. EXISTING VEGETATION OUTSIDE THE WORK LIMITS SHALL REMAIN PROTECTED TO THE MAXIMUM EXTENT PRACTICABLE.
- STRIP AND STOCKPILE TOPSOIL IN DESIGNATED STABILIZED AREAS UNTIL HAULED OFF. ANY STOCKPILED SOILS REMAINING INACTIVE SHALL BE COVERED OR TEMPORARILY STABILIZED TO MINIMIZE EROSION AND FUGITIVE DUST.
- TEMPORARY CHANNELS TO BE GRADED IN ONCE PERMANENT VEGETATED CHANNELS ARE INSTALLED.
- PERFORM EXCAVATION, GRADING, AND UTILITY INSTALLATION ACTIVITIES IN PHASES TO MINIMIZE THE EXTENT OF EXPOSED SOILS AT ANY ONE TIME.
- UTILIZE WATER TRUCKS OR OTHER DUST SUPPRESSION METHODS AS NECESSARY DURING EXCAVATION, GRADING, AND CONSTRUCTION OPERATIONS TO MINIMIZE DUST.
- INSTALL UNDERGROUND DRAINAGE INFRASTRUCTURE, STORMWATER MANAGEMENT SYSTEMS, AND ASSOCIATED DRAINAGE APPURTENANCES AS GRADING PROGRESSES.
- STABILIZE DISTURBED SOIL AREAS WITHIN FOURTEEN (14) DAYS AFTER CONSTRUCTION ACTIVITIES HAVE TEMPORARILY OR PERMANENTLY CEASED, UNLESS WEATHER CONDITIONS PROHIBIT STABILIZATION ACTIVITIES. TEMPORARY VEGETATIVE STABILIZATION SHALL INCLUDE HYDROSEEDING, TEMPORARY SEEDING, MULCH, OR EROSION CONTROL BLANKET APPLICATIONS AS APPROPRIATE.
- IMPLEMENT VEGETATIVE SLOPE STABILIZATION MEASURES ON SLOPES 2:1 OR FLATTER USING TEMPORARY ANNUAL GRASSES AND PERMANENT PERENNIAL SEED MIXES TO MINIMIZE EROSION AND PROMOTE LONG-TERM STABILIZATION.
- COMPLETE FINAL GRADING ACTIVITIES AND ESTABLISH PERMANENT STABILIZATION MEASURES INCLUDING PERMANENT SEEDING, LANDSCAPING, MULCH, EROSION CONTROL BLANKETS, AND OTHER APPROVED STABILIZATION METHODS.
- REMOVE ACCUMULATED SEDIMENT FROM TEMPORARY CONTROLS AND DRAINAGE STRUCTURES AS NECESSARY THROUGHOUT CONSTRUCTION.
- REMOVE TEMPORARY EROSION AND SEDIMENTATION CONTROLS ONLY AFTER ALL DISTURBED AREAS HAVE ACHIEVED PERMANENT STABILIZATION. DISTURBED AREAS RESULTING FROM REMOVAL ACTIVITIES SHALL BE REGRADED AND STABILIZED AS NECESSARY.

THE CONTRACTOR SHALL PERFORM ROUTINE INSPECTION AND MAINTENANCE OF ALL EROSION AND SEDIMENTATION CONTROL MEASURES THROUGHOUT CONSTRUCTION, INCLUDING BUT NOT LIMITED TO THE FOLLOWING:

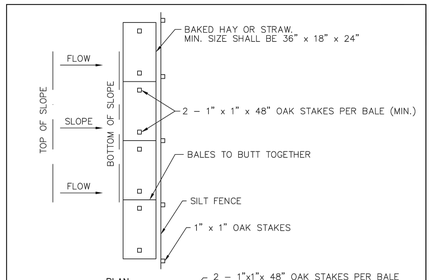
- INSPECT ALL EROSION AND SEDIMENTATION CONTROL MEASURES PERIODICALLY AND AFTER EACH RAINFALL EVENT. INSPECTION RECORDS SHALL BE MAINTAINED ONSITE BY THE CONTRACTOR.
- REPAIR OR REPLACE DAMAGED OR DETERIORATED EROSION CONTROL MEASURES IMMEDIATELY UPON IDENTIFICATION.
- REMOVE ACCUMULATED SEDIMENT FROM BEHIND SILT FENCE BARRIERS, STRAW WATTLES, AND OTHER SEDIMENT CONTROLS WHEN SEDIMENT REACHES APPROXIMATELY SIX INCHES IN DEPTH OR AS NECESSARY TO MAINTAIN FUNCTIONALITY.
- MAINTAIN STRAW WATTLES IN CONTINUOUS CONTACT WITH THE GROUND SURFACE AND RESET OR REPLACE AS NECESSARY.
- INSPECT AND MAINTAIN CATCH BASIN PROTECTION MEASURES REGULARLY AND REMOVE ACCUMULATED SEDIMENT AS REQUIRED.
- MAINTAIN STABILIZED CONSTRUCTION ENTRANCES AND REPLACE CRUSHED STONE AS SEDIMENT ACCUMULATES.
- INSPECT CONCRETE WASHOUT FACILITIES DAILY AND AFTER STORM EVENTS TO ENSURE ADEQUATE CONTAINMENT CAPACITY AND PREVENT LEAKAGE OR OVERFLOW. CONCRETE WASHOUT MATERIALS SHALL BE PROPERLY REMOVED AND RECYCLED OR DISPOSED OF IN ACCORDANCE WITH APPLICABLE REGULATIONS.
- MAINTAIN TEMPORARY AND PERMANENT VEGETATIVE STABILIZATION MEASURES, INCLUDING RESEEDING AND REPAIR OF ERODED AREAS AS NECESSARY.
- PROPERLY DISPOSE OF SEDIMENT AND DEBRIS REMOVED FROM EROSION CONTROL STRUCTURES AND COVER MATERIALS IF TEMPORARILY STORED ONSITE.
- MAINTAIN ALL EROSION AND SEDIMENTATION CONTROL MEASURES UNTIL FINAL SITE STABILIZATION HAS BEEN ACHIEVED.



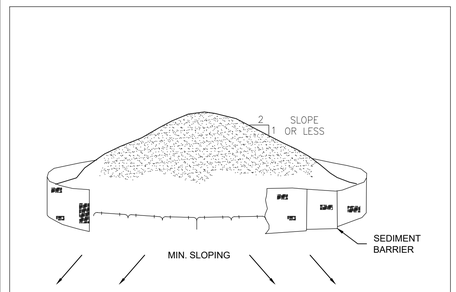
CONSTRUCTION NOTES

1. WOVEN WIRE FENCE TO BE FASTENED SECURELY TO FENCE POST WITH WIRE TIES OR STAPLES.
2. FILTER FABRIC TO BE FASTENED SECURELY TO WOVEN WIRE FENCE WITH TIES SPACED EVERY 24" AT TOP AND MID SECTION.
3. WHEN TWO SECTIONS OF FILTER FABRIC ADJOIN EACH OTHER, THEY SHALL BE OVERLAPPED BY 6 INCHES AND FOLDED.
4. MAINTENANCE SHALL BE PERFORMED AS NEEDED AND MATERIAL REMOVED WHEN "BULGES" DEVELOP IN THE SILT FENCE.
5. INSPECTION SHALL BE FREQUENT AND REPAIR REPLACEMENT SHALL BE MADE PROMPTLY AS NEEDED.
6. FENCES SHALL BE REMOVED WHEN THEY HAVE SERVED THEIR USEFULNESS SO AS NOT TO BLOCK OR IMPEDE STORM FLOW OR DRAINAGE.

SILTATION FENCE



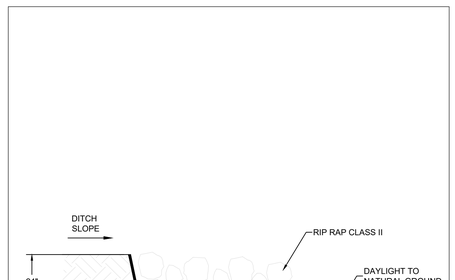
HAYBALES AND SILT FENCE



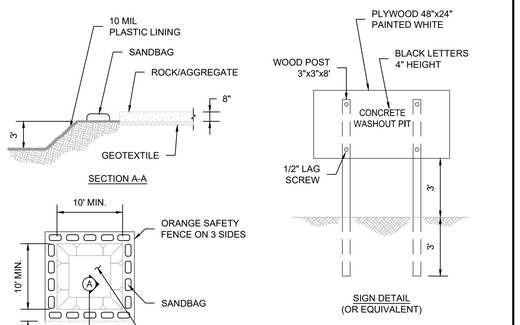
INSTALLATION NOTES:

1. AREA CHOSEN FOR STOCKPILING OPERATIONS SHALL BE DRY AND STABLE.
2. MAXIMUM SLOPE OF STOCKPILE SHALL BE 2:1.
3. UPON COMPLETION OF SOIL STOCKPILING, EACH PILE SHALL BE SURROUNDED WITH EITHER SILT FENCING.
4. COORDINATE WITH ON–SITE INSPECTOR FOR STOCKPILE LOCATIONS

TEMPORARY STOCKPILE DETAIL



RIP RAP PROTECTION DETAIL



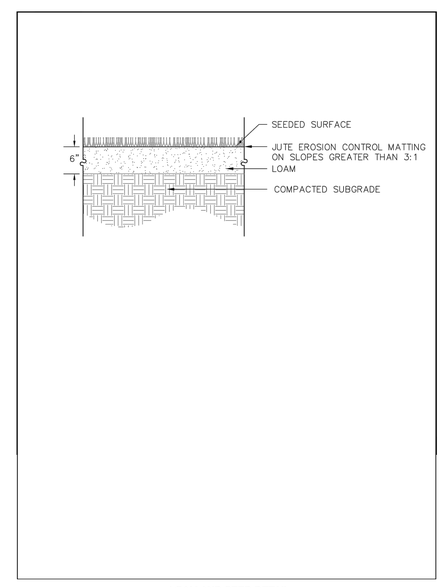
CONCRETE TRUCK WASHOUT AREA

SCALE: N.T.S.

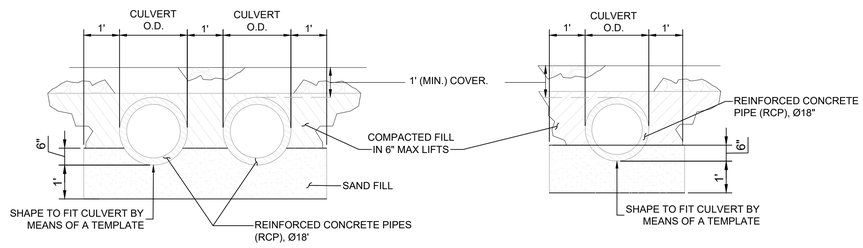
SIGN DETAIL
(OR EQUIVALENT)

GENERAL NOTES:

1. POST A SIGN READING "CONCRETE WASHOUT PIT" NEXT TO THE PIT.
2. VERBALLY INSTRUCT THE CONCRETE TRUCK DRIVERS WHERE THE PIT IS AND TO WASHOUT THEIR TRUCKS IN THE PIT AND NOWHERE ELSE.
3. UPON THE CONCRETE SETTING UP (CURING, DRYING OUT), THE CONCRETE WASTE SHALL BE REMOVED FROM THE PROJECT SITE AND DISPOSED OF PROPERLY BY THE CONTRACTOR. AFTER REMOVAL OF THE CONCRETE WASTE, THE WASHOUT PIT SHALL BE FILLED WITH CLEAN FILL MATERIAL AND COMPACTED TO IN–SITU CONDITIONS, OR AS DIRECTED BY THE PROJECT SPECIFICATIONS.
4. CONCRETE WASHOUT PITS SHALL NOT BE LOCATED DIRECTLY ADJACENT TO, NOR AT ANY TIME DRAIN INTO THE STORM SEWER SYSTEM OR ANY OTHER SWALE, DITCH, OR WATERWAY.
5. CONSTRUCT ENTRY ROAD AND BOTTOM OF WASHOUT AREA TO SUPPORT EXPECTED LOADINGS FROM TRUCKS EQUIPMENT.

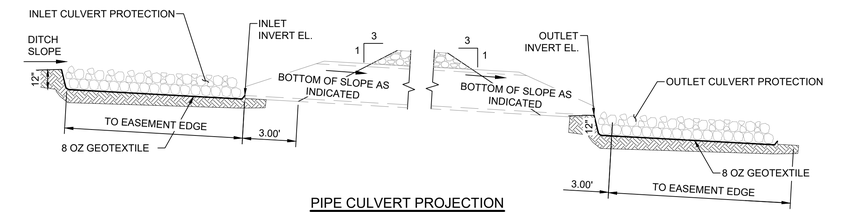


LOAM AND SEED DETAIL



DOUBLE CULVERT PIPE
REINFORCED CONCRETE PIPE (RCP) INSTALLATION

SCALE: N.T.S.



PIPE CULVERT PROJECTION

SCALE: N.T.S.

PAUL BAKER
CIVIL
No. 58957
COMMONWEALTH OF MASSACHUSETTS
PROFESSIONAL ENGINEER

07/02/26

ISSUED FOR PERMIT
07/02/26

NOTES:

1. SEE CONSTRUCTION EROSION AND SEDIMENT CONTROL PLAN DRAWING 00018–C.320–0004.
2. CONTRACTOR TO EVALUATE PROJECT AREA TO IMPLEMENT BMPS IN AREAS THAT BEST FIT FOR THE CURRENT CONDITIONS. CONSULT WITH THE ONSITE INSPECTOR FOR ANY ADJUSTMENTS AND/OR ADDITIONS TO THE CONSTRUCTION STORMWATER MANAGEMENT PLAN.

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		C	07/02/26	CR	DT	ISSUED FOR PERMIT
		B	05/15/26	CR	DT	ISSUED FOR BID
		A	05/15/26	CR	PB	ISSUED FOR PERMIT

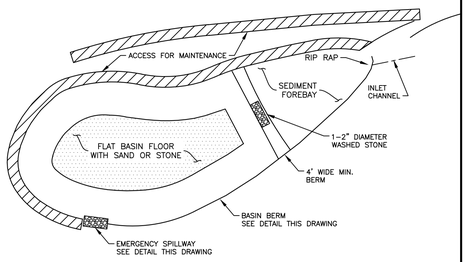
audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669–0590

DRAWN BY:	CR	05/15/26	CAPE COD CANAL PIPELINE RELOCATION PROJECT
DESIGN CHECKER:	AE	07/02/26	BOURNE M&R RELOCATION
DESIGN ENGINEER:	PB	07/02/26	M&R 00018
PROJECT MANAGER:	AC	07/02/26	TITLE: DETAILS
LOC.: BARNSTABLE COUNTY, MASSACHUSETTS			

ENBRIDGE

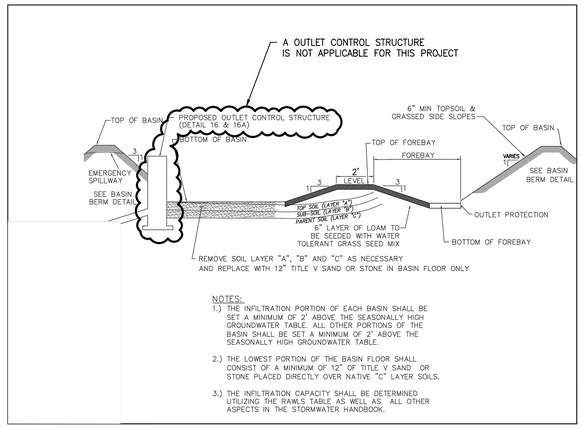
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 7134275400

TITLE	INITIALS	DATE	YEAR: 2026	W.O.:	SCALE: N.T.S.	DWG.: 00018–C.320–0006	REV.: C



NOTE:
THE INFILTRATION BASIN SHALL BE DESIGNED BY A PROFESSIONAL ENGINEER, AND SHALL COMPLY WITH ALL ASPECTS OF THE MA-DEP STORMWATER HANDBOOK.

INFILTRATION BASIN DETAIL

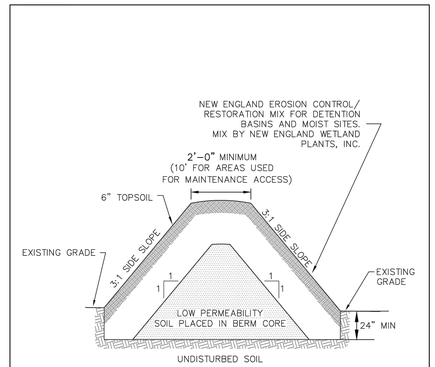


NOTES:
1.) THE INFILTRATION PORTION OF EACH BASIN SHALL BE SET A MINIMUM OF 2' ABOVE THE SEASONALLY HIGH GROUNDWATER TABLE. ALL OTHER PORTIONS OF THE BASIN SHALL BE SET A MINIMUM OF 2' ABOVE THE SEASONALLY HIGH GROUNDWATER TABLE.

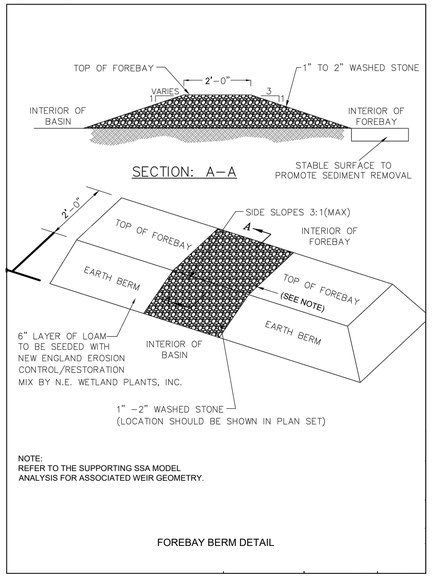
2.) THE LOWEST PORTION OF THE BASIN FLOOR SHALL CONSIST OF A MINIMUM OF 12" OF TITLE V SAND OR STONE PLACED DIRECTLY OVER NATIVE "C" LAYER SOILS.

3.) THE INFILTRATION CAPACITY SHALL BE DETERMINED UTILIZING THE RAWLS TABLE AS WELL AS ALL OTHER ASPECTS IN THE STORMWATER HANDBOOK.

INFILTRATION BASIN CROSS SECTION

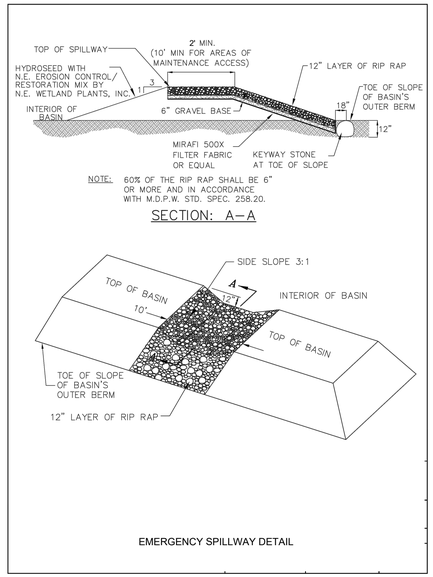


BASIN BERM DETAIL



NOTE:
REFER TO THE SUPPORTING SSA MODEL ANALYSIS FOR ASSOCIATED WEIR GEOMETRY.

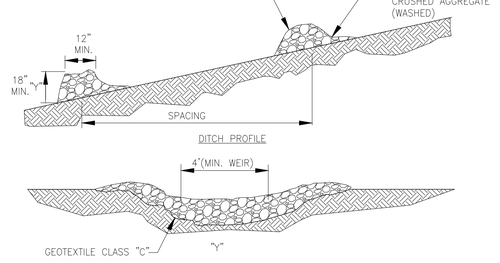
FOREBAY BERM DETAIL



NOTE: 60% OF THE RIP RAP SHALL BE 6" OR MORE AND IN ACCORDANCE WITH M.D.P.W. STD. SPEC. 258.20.

SECTION: A–A

EMERGENCY SPILLWAY DETAIL



STANDARD SYMBOL

STANDARD STONE CHECK DAM DESIGN

SLOPE	SPACING
2% OR LESS	80'
2.1% TO 4%	40'
4.1% TO 7%	25'
7.1% TO 10%	15'
OVER 10%	USE LINED WATERWAY DESIGN

NOTES:
1. SWALES AND DITCHES SHALL BE PREPARED IN ACCORDANCE WITH THE CONSTRUCTION SPECIFICATIONS DESCRIBED IN SECTION A–2, STANDARDS AND SPECIFICATIONS FOR THE TEMPORARY SWALE.
2. THE CHECK DAM SHALL BE CONSTRUCTED OF 4"–7" STONE. THE STONE SHALL BE PLACED SO THAT IT COMPLETELY COVERS THE WIDTH OF THE CHANNEL AND KEYED INTO THE CHANNEL BANKS.
3. THE TOP OF THE CHECK DAM SHALL BE CONSTRUCTED SO THE CENTER IS APPROXIMATELY 6" LOWER THAN THE OUTER EDGES, FORMING A WEIR THAT WATER CAN FLOW ACROSS.
4. THE MAXIMUM HEIGHT OF THE CHECK DAM AT THE CENTER SHALL NOT EXCEED 2'.
5. THE UPSTREAM SIDE OF THE CHECK DAM SHALL BE LINED WITH APPROXIMATELY 1" OF 3/4" TO 1 1/2" CRUSHED AGGREGATE.

TYPICAL ROCK CHECK DAM DETAIL

COMMONWEALTH OF MASS
PAUL BAKER
CIVIL
No. 58957
PROFESSIONAL ENG
07/02/26

ISSUED FOR PERMIT
07/02/2026

NOTES:
1. SEE CONSTRUCTION EROSION AND SEDIMENT CONTROL PLAN DRAWING 00018–C.320–0004.
2. CONTRACTOR TO EVALUATE PROJECT AREA TO IMPLEMENT BMPS IN AREAS THAT BEST FIT FOR THE CURRENT CONDITIONS. CONSULT WITH THE ONSITE INSPECTOR FOR ANY ADJUSTMENTS AND/OR ADDITIONS TO THE CONSTRUCTION STORMWATER MANAGEMENT PLAN.

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		C	07/02/26	CR	DT	ISSUED FOR PERMIT
		B	05/15/26	CR	DT	ISSUED FOR BID
		A	05/15/26	CR	PB	ISSUED FOR PERMIT

audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

DRAWN BY:	CR	05/15/26	CAPE COD CANAL PIPELINE RELOCATION PROJECT
DESIGN CHECKER:	AE	07/02/26	BOURNE M&R RELOCATION
DESIGN ENGINEER:	PB	07/02/26	M&R 00018
PROJECT MANAGER:	AC	07/02/26	TITLE: DETAILS
TITLE	INITIALS	DATE	LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

ENBRIDGE
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

YEAR: 2026 | W.O.: | SCALE: N.T.S. | DWG.: 00018–C.320–0007 | REV.: C

S:\AE\Projects\Enbridge\Mass\026356-001\200_civil_structural\170_drawings\e&s plans\bourne m&r\00018-C.320-0007.dwg - PLOT TIME: 7/2/2026 7:55 AM

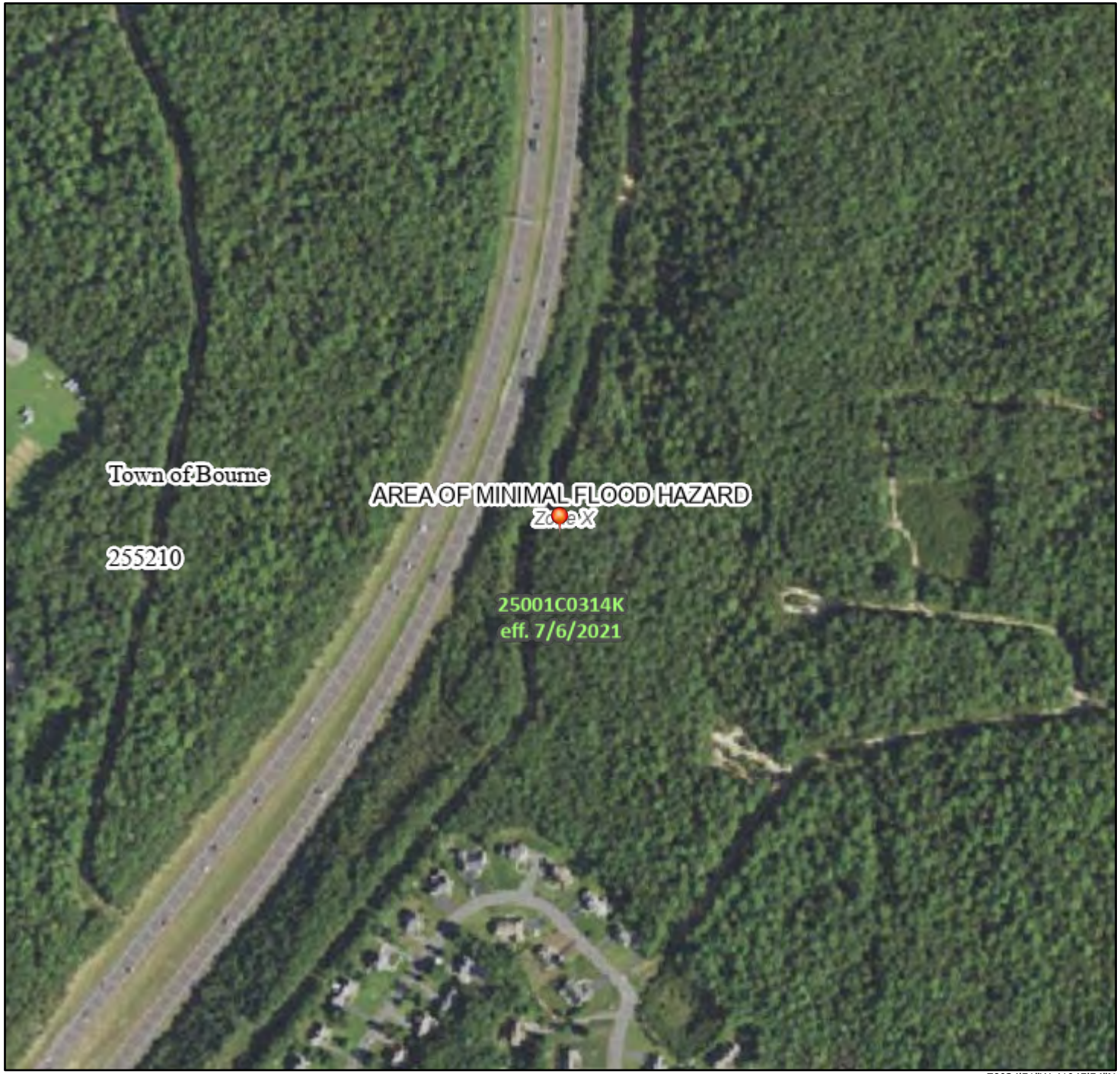
Attachment G – Standard 9 Supporting Information

FEMA Floodway Mapping

National Flood Hazard Layer FIRMette

FEMA

70°35'28"W 41°46'21"N



70°34'51"W 41°45'54"N

0 250 500 1,000 1,500 2,000 Feet

1:6,000

Basemap Imagery Source: USGS National Map 2023

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- 20.2 Cross Sections with 1% Annual Chance
- 17.5 Water Surface Elevation
- Coastal Transect
- Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 4/20/2026 at 8:57 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

June 24, 2026

CAPE COD CANAL BRIDGE REPLACEMENT PROJECT

STORMWATER REPORT FOR THE MAINLAND SAGAMORE METER STATION

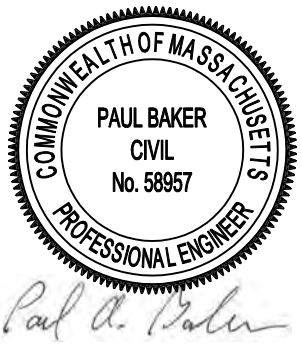
Prepared For: Algonquin Gas Transmission, LLC

Prepared By:

Audubon Companies, LC

3505 W. Sam Houston Pkwy N., Ste 150

Houston, TX 77043



06/24/26

Table of Contents

1 Checklist for Stormwater Report 1
2 Stormwater Report Narrative 8
2.1 Project Description 8
2.1.1 Site Description 8
2.2.1 Wetland Resources 8
2.2.2 Subsurface Soil Investigations 9
2.2 Existing Drainage Conditions 9
2.3 Proposed Drainage Conditions 10
3 Regulatory Compliance 14
3.1 Massachusetts Department of Environmental Protection (DEP) – Stormwater Management Standards 14
3.1.1 Standard 1: No New Untreated Discharges or Erosion to Wetlands 14
3.1.2 Standard 2: Peak Rate Attenuation 14
3.1.3 Standard 3: Stormwater Recharge 16
3.1.4 Standard 4: Water Quality 17
3.1.5 Standard 5: Land Uses and High Potential Pollutant Loads (LUHPPLs) 18
3.1.6 Standard 6: Critical Areas 18
3.1.7 Standard 7: Redevelopments and Other Projects Subject to the Standards only to the Maximum Extent Practicable 18
3.1.8 Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Controls 18
3.1.9 Standard 9: Operation and Maintenance Plan 19
3.1.10 Standard 10: Prohibition of Illicit Discharges 19
4 Local Municipal Rules and Regulations 19
5 FEMA Floodplain 20

Figure 1 - Site Location Map (Aerial)
Figure 2 - Site Location Map (Topo)

Table 1 - Existing Conditions Hydrologic Data
Table 2 - Proposed Conditions Hydrologic Data
Table 3 - NOAA Atlas 14 Volume 10 Design Depths for the 24 Hour Storm (inches)
Table 4 - Peak Discharge Rates
Table 5 - Summary of Recharge Calculations

Attachment A - Existing and Proposed Drainage Conditions 15
Attachment B - Standard 1 Supporting Information 20
Attachment C - Standard 2 Supporting Information 30
Attachment D - Standard 3 Supporting Information 33
Attachment E - Standard 4 Supporting Information 19
Attachment F - Standard 8 Supporting Information 31
Attachment G - Standard 9 Supporting Documentation 45

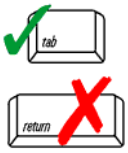
1 Checklist for Stormwater Report

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

A. Introduction

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.



A Stormwater Report must be submitted with the Notice of Intent permit application to document compliance with the Stormwater Management Standards. The following checklist is NOT a substitute for the Stormwater Report (which should provide more substantive and detailed information) but is offered here as a tool to help the applicant organize their Stormwater Management documentation for their Report and for the reviewer to assess this information in a consistent format. As noted in the Checklist, the Stormwater Report must contain the engineering computations and supporting information set forth in Volume 3 of the Massachusetts Stormwater Handbook. The Stormwater Report must be prepared and certified by a Registered Professional Engineer (RPE) licensed in the Commonwealth.

The Stormwater Report must include:

- The Stormwater Checklist completed and stamped by a Registered Professional Engineer (see page 2) that certifies that the Stormwater Report contains all required submittals.[1] This Checklist is to be used as the cover for the completed Stormwater Report.
- Applicant/Project Name
- Project Address
- Name of Firm and Registered Professional Engineer that prepared the Report
- Long-Term Pollution Prevention Plan required by Standards 4-6
- Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan required by Standard 8[2]
- Operation and Maintenance Plan required by Standard 9

In addition to all plans and supporting information, the Stormwater Report must include a brief narrative describing stormwater management practices, including environmentally sensitive site design and LID techniques, along with a diagram depicting runoff through the proposed BMP treatment train. Plans are required to show existing and proposed conditions, identify all wetland resource areas, NRCS soil types, critical areas, Land Uses with Higher Potential Pollutant Loads (LUHPPL), and any areas on the site where infiltration rate is greater than 2.4 inches per hour. The Plans shall identify the drainage areas for both existing and proposed conditions at a scale that enables verification of supporting calculations.

As noted in the Checklist, the Stormwater Management Report shall document compliance with each of the Stormwater Management Standards as provided in the Massachusetts Stormwater Handbook. The soils evaluation and calculations shall be done using the methodologies set forth in Volume 3 of the Massachusetts Stormwater Handbook.

To ensure that the Stormwater Report is complete, applicants are required to fill in the Stormwater Report Checklist by checking the box to indicate that the specified information has been included in the Stormwater Report. If any of the information specified in the checklist has not been submitted, the applicant must provide an explanation. The completed Stormwater Report Checklist and Certification must be submitted with the Stormwater Report.

---

[1] The Stormwater Report may also include the Illicit Discharge Compliance Statement required by Standard 10. If not included in the Stormwater Report, the Illicit Discharge Compliance Statement must be submitted prior to the discharge of stormwater runoff to the post-construction best management practices.

[2] For some complex projects, it may not be possible to include the Construction Period Erosion and Sedimentation Control Plan in the Stormwater Report. In that event, the issuing authority has the discretion to issue an Order of Conditions that approves the project and includes a condition requiring the proponent to submit the Construction Period Erosion and Sedimentation Control Plan before commencing any land disturbance activity on the site.

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

B. Stormwater Checklist and Certification

The following checklist is intended to serve as a guide for applicants as to the elements that ordinarily need to be addressed in a complete Stormwater Report. The checklist is also intended to provide conservation commissions and other reviewing authorities with a summary of the components necessary for a comprehensive Stormwater Report that addresses the ten Stormwater Standards.

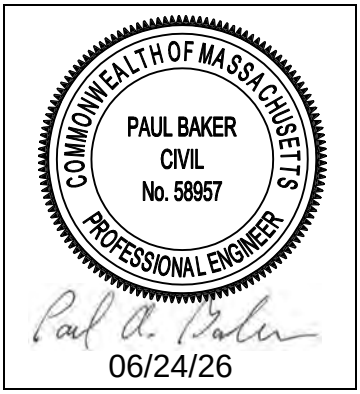
Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the item is not applicable (N.A.) and provide the reasons for that determination.

A complete checklist must include the Certification set forth below signed by the Registered Professional Engineer who prepared the Stormwater Report.

Registered Professional Engineer's Certification

I have reviewed the Stormwater Report, including the soil evaluation, computations, Long-term Pollution Prevention Plan, the Construction Period Erosion and Sedimentation Control Plan (if included), the Long-term Post-Construction Operation and Maintenance Plan, the Illicit Discharge Compliance Statement (if included) and the plans showing the stormwater management system, and have determined that they have been prepared in accordance with the requirements of the Stormwater Management Standards as further elaborated by the Massachusetts Stormwater Handbook. I have also determined that the information presented in the Stormwater Checklist is accurate and that the information presented in the Stormwater Report accurately reflects conditions at the site as of the date of this permit application.

Registered Professional Engineer Block and Signature



Paul Baker Digitally signed by Paul Baker DN: C=US, E=pbaker@auduboncompanies.com, O=Audubon Engineering, OU=Civil / Structural Engineer, CN=Paul Baker Reason: I am approving this document Date: 2026.06.24 12:30:08-05'00' 06/24/2026

Signature and Date

Checklist

Project Type: Is the application for new development, redevelopment, or a mix of new and redevelopment?

☒ New development

☐ Redevelopment

☐ Mix of New Development and Redevelopment

Checklist for Stormwater Report

Checklist (continued)

LID Measures: Stormwater Standards require LID measures to be considered. Document what environmentally sensitive design and LID Techniques were considered during the planning and design of the project:

- [X] No disturbance to any Wetland Resource Areas
- [ ] Site Design Practices (e.g. clustered development, reduced frontage setbacks)
- [ ] Reduced Impervious Area (Redevelopment Only)
- [ ] Minimizing disturbance to existing trees and shrubs
- [ ] LID Site Design Credit Requested:
  - [ ] Credit 1
  - [ ] Credit 2
  - [ ] Credit 3
- [ ] Use of "country drainage" versus curb and gutter conveyance and pipe
- [ ] Bioretention Cells (includes Rain Gardens)
- [ ] Constructed Stormwater Wetlands (includes Gravel Wetlands designs)
- [ ] Treebox Filter
- [ ] Water Quality Swale
- [X] Grass Channel
- [ ] Green Roof
- [X] Other (describe): Infiltration Basins

Standard 1: No New Untreated Discharges

- [X] No new untreated discharges
- [X] Outlets have been designed so there is no erosion or scour to wetlands and waters of the Commonwealth
- [X] Supporting calculations specified in Volume 3 of the Massachusetts Stormwater Handbook included.

Checklist for Stormwater Report

Checklist (continued)

Standard 2: Peak Rate Attenuation

☐ Standard 2 waiver requested because the project is located in land subject to coastal storm flowage and stormwater discharge is to a wetland subject to coastal flooding.

☐ Evaluation provided to determine whether off-site flooding increases during the 100-year 24-hour storm.

☒ Calculations provided to show that post-development peak discharge rates do not exceed pre-development rates for the 2-year and 10-year 24-hour storms. If evaluation shows that off-site flooding increases during the 100-year 24-hour storm, calculations are also provided to show that post-development peak discharge rates do not exceed pre-development rates for the 100-year 24-hour storm.

Standard 3: Recharge

☒ Soil Analysis provided.

☒ Required Recharge Volume calculation provided.

☐ Required Recharge volume reduced through use of the LID site Design Credits.

☒ Sizing the infiltration, BMPs is based on the following method: Check the method used.

☒ Static ☐ Simple Dynamic ☐ Dynamic Field[1]

☐ Runoff from all impervious areas at the site discharging to the infiltration BMP.

☒ Runoff from all impervious areas at the site is *not* discharging to the infiltration BMP and calculations are provided showing that the drainage area contributing runoff to the infiltration BMPs is sufficient to generate the required recharge volume.

☒ Recharge BMPs have been sized to infiltrate the Required Recharge Volume.

☐ Recharge BMPs have been sized to infiltrate the Required Recharge Volume *only* to the maximum extent practicable for the following reason:

- ☐ Site is comprised solely of C and D soils and/or bedrock at the land surface
- ☐ M.G.L. c. 21E sites pursuant to 310 CMR 40.0000
- ☐ Solid Waste Landfill pursuant to 310 CMR 19.000
- ☐ Project is otherwise subject to Stormwater Management Standards only to the maximum extent practicable.

☒ Calculations showing that the infiltration BMPs will drain in 72 hours are provided.

☐ Property includes a M.G.L. c. 21E site or a solid waste landfill and a mounding analysis is included.

[1] 80% TSS removal is required prior to discharge to infiltration BMP if Dynamic Field method is used.

Checklist for Stormwater Report

Checklist (continued)

Standard 3: Recharge (continued)

☐ The infiltration BMP is used to attenuate peak flows during storms greater than or equal to the 10-year 24-hour storm and separation to seasonal high groundwater is less than 4 feet and a mounding analysis is provided.

☐ Documentation is provided showing that infiltration BMPs do not adversely impact nearby wetland resource areas.

Standard 4: Water Quality

The Long-Term Pollution Prevention Plan typically includes the following:

- Good housekeeping practices;
- Provisions for storing materials and waste products inside or under cover;
- Vehicle washing controls;
- Requirements for routine inspections and maintenance of stormwater BMPs;
- Spill prevention and response plans;
- Provisions for maintenance of lawns, gardens, and other landscaped areas;
- Requirements for storage and use of fertilizers, herbicides, and pesticides;
- Pet waste management provisions;
- Provisions for operation and management of septic systems;
- Provisions for solid waste management;
- Snow disposal and plowing plans relative to Wetland Resource Areas;
- Winter Road Salt and/or Sand Use and Storage restrictions;
- Street sweeping schedules;
- Provisions for prevention of illicit discharges to the stormwater management system;
- Documentation that Stormwater BMPs are designed to provide for shutdown and containment in the event of a spill or discharges to or near critical areas or from LUHPPL;
- Training for staff or personnel involved with implementing Long-Term Pollution Prevention Plan;
- List of Emergency contacts for implementing Long-Term Pollution Prevention Plan.

☒ A Long-Term Pollution Prevention Plan is attached to Stormwater Report and is included as an attachment to the Wetlands Notice of Intent.

☒ Treatment BMPs subject to the 44% TSS removal pretreatment requirement and the one inch rule for calculating the water quality volume are included, and discharge:

- ☐ is within the Zone II or Interim Wellhead Protection Area
- ☐ is near or to other critical areas
- ☒ is within soils with a rapid infiltration rate (greater than 2.4 inches per hour)
- ☐ involves runoff from land uses with higher potential pollutant loads.

☐ The Required Water Quality Volume is reduced through use of the LID site Design Credits.

☒ Calculations documenting that the treatment train meets the 80% TSS removal requirement and, if applicable, the 44% TSS removal pretreatment requirement, are provided.

Checklist for Stormwater Report

Checklist (continued)

Standard 4: Water Quality (continued)

☒ The BMP is sized (and calculations provided) based on:

- ☒ The ½" or 1" Water Quality Volume or
- ☐ The equivalent flow rate associated with the Water Quality Volume and documentation is provided showing that the BMP treats the required water quality volume.

☐ The applicant proposes to use proprietary BMPs, and documentation supporting use of proprietary BMP and proposed TSS removal rate is provided. This documentation may be in the form of the propriety BMP checklist found in Volume 2, Chapter 4 of the Massachusetts Stormwater Handbook and submitting copies of the TARP Report, STEP Report, and/or other third party studies verifying performance of the proprietary BMPs.

☐ A TMDL exists that indicates a need to reduce pollutants other than TSS and documentation showing that the BMPs selected are consistent with the TMDL is provided.

Standard 5: Land Uses With Higher Potential Pollutant Loads (LUHPPLs)

☐ The NPDES Multi-Sector General Permit covers the land use and the Stormwater Pollution Prevention Plan (SWPPP) has been included with the Stormwater Report.

☐ The NPDES Multi-Sector General Permit covers the land use and the SWPPP will be submitted ***prior to*** the discharge of stormwater to the post-construction stormwater BMPs.

☒ The NPDES Multi-Sector General Permit does ***not*** cover the land use.

☐ LUHPPLs are located at the site and industry specific source control and pollution prevention measures have been proposed to reduce or eliminate the exposure of LUHPPLs to rain, snow, snow melt and runoff, and been included in the long term Pollution Prevention Plan.

☐ All exposure has been eliminated.

☐ All exposure has ***not*** been eliminated and all BMPs selected are on MassDEP LUHPPL list.

☐ The LUHPPL has the potential to generate runoff with moderate to higher concentrations of oil and grease (e.g. all parking lots with >1000 vehicle trips per day) and the treatment train includes an oil grit separator, a filtering bioretention area, a sand filter or equivalent.

Standard 6: Critical Areas

☐ The discharge is near or to a critical area and the treatment train includes only BMPs that MassDEP has approved for stormwater discharges to or near that particular class of critical area.

☐ Critical areas and BMPs are identified in the Stormwater Report.

Checklist for Stormwater Report

Checklist (continued)

Standard 7: Redevelopments and Other Projects Subject to the Standards only to the maximum extent practicable

☐ The project is subject to the Stormwater Management Standards only to the maximum Extent Practicable as a:

- ☐ Limited Project
- ☐ Small Residential Projects: 5-9 single family houses or 5-9 units in a multi-family development provided there is no discharge that may potentially affect a critical area.
- ☐ Small Residential Projects: 2-4 single family houses or 2-4 units in a multi-family development with a discharge to a critical area
- ☐ Marina and/or boatyard provided the hull painting, service and maintenance areas are protected from exposure to rain, snow, snow melt and runoff
- ☐ Bike Path and/or Foot Path
- ☐ Redevelopment Project
- ☐ Redevelopment portion of mix of new and redevelopment.

☐ Certain standards are not fully met (Standard No. 1, 8, 9, and 10 must always be fully met) and an explanation of why these standards are not met is contained in the Stormwater Report.

☐ The project involves redevelopment and a description of all measures that have been taken to improve existing conditions is provided in the Stormwater Report. The redevelopment checklist found in Volume 2 Chapter 3 of the Massachusetts Stormwater Handbook may be used to document that the proposed stormwater management system (a) complies with Standards 2, 3 and the pretreatment and structural BMP requirements of Standards 4-6 to the maximum extent practicable and (b) improves existing conditions.

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control

A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan must include the following information:

- Narrative;
- Construction Period Operation and Maintenance Plan;
- Names of Persons or Entity Responsible for Plan Compliance;
- Construction Period Pollution Prevention Measures;
- Erosion and Sedimentation Control Plan Drawings;
- Detail drawings and specifications for erosion control BMPs, including sizing calculations;
- Vegetation Planning;
- Site Development Plan;
- Construction Sequencing Plan;
- Sequencing of Erosion and Sedimentation Controls;
- Operation and Maintenance of Erosion and Sedimentation Controls;
- Inspection Schedule;
- Maintenance Schedule;
- Inspection and Maintenance Log Form.

☒ A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan containing the information set forth above has been included in the Stormwater Report.

Checklist for Stormwater Report

Checklist (continued)

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control (continued)

☐ The project is highly complex and information is included in the Stormwater Report that explains why it is not possible to submit the Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan with the application. A Construction Period Pollution Prevention and Erosion and Sedimentation Control has ***not*** been included in the Stormwater Report but will be submitted ***before*** land disturbance begins.

☒ The project is ***not*** covered by a NPDES Construction General Permit.

☐ The project is covered by a NPDES Construction General Permit and a copy of the SWPPP is in the Stormwater Report.

☐ The project is covered by a NPDES Construction General Permit but no SWPPP been submitted. The SWPPP will be submitted BEFORE land disturbance begins.

Standard 9: Operation and Maintenance Plan

☒ The Post Construction Operation and Maintenance Plan is included in the Stormwater Report and includes the following information:

- ☒ Name of the stormwater management system owners;
- ☒ Party responsible for operation and maintenance;
- ☒ Schedule for implementation of routine and non-routine maintenance tasks;
- ☒ Plan showing the location of all stormwater BMPs maintenance access areas;
- ☒ Description and delineation of public safety features;
- ☒ Estimated operation and maintenance budget; and
- ☒ Operation and Maintenance Log Form.

☐ The responsible party is ***not*** the owner of the parcel where the BMP is located and the Stormwater Report includes the following submissions:

- ☐ A copy of the legal instrument (deed, homeowner's association, utility trust or other legal entity) that establishes the terms of and legal responsibility for the operation and maintenance of the project site stormwater BMPs;
- ☐ A plan and easement deed that allows site access for the legal entity to operate and maintain BMP functions.

Standard 10: Prohibition of Illicit Discharges

☐ The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges;

☒ An Illicit Discharge Compliance Statement is attached;

☐ NO Illicit Discharge Compliance Statement is attached but will be submitted ***prior to*** the discharge of any stormwater to post-construction BMPs.

2 Stormwater Report Narrative

This stormwater report has been prepared to demonstrate compliance with the Massachusetts Stormwater Management Standards in accordance with the Massachusetts Wetland Protection Act Regulations (310 CMR 10.00). This report also demonstrates compliance with the Cape Cod Commission.

2.1 Project Description

The Project includes modifications to Algonquin's existing interstate natural gas pipeline system facilities within the Town of Bourne, Barnstable County, Massachusetts, to accommodate the planned replacement of the Bourne Bridge and Sagamore Bridge by the Cape Cod Bridges Program ("CCBP"). The Massachusetts Department of Transportation ("MassDOT") and the United States ("U.S.") Army Corps of Engineers ("USACE") are jointly implementing the CCBP. The USACE owns and operates the Bourne and Sagamore Bridges as well as the Cape Cod Canal.

The Project will remove, abandon, and relocate segments of Algonquin's existing pipeline and metering and regulating ("M&R") stations to accommodate the requirements of the CCBP and to continue providing uninterrupted natural gas service to National Grid by replacing National Grid's two existing pipelines, one located on the Bourne Bridge and one on the Sagamore Bridge, with new natural gas infrastructure designed to meet the same natural gas capacity requirements.

One of the M&R Stations slated for relocation is the Sagamore M&R Station. The existing site is located immediately adjacent to the Sagamore Bridge, currently associated with the existing G-24 and G-11 pipelines, and must be relocated to avoid conflict with the CCBP facilities. The relocated M&R station site is located northeast of the Sagamore Bridge on an empty, previously developed parcel between Meetinghouse Lane and Canal Street.

2.1.1 Site Description

Algonquin's relocated Sagamore M&R Station site is a previously developed parcel located near the intersection of Commerce Way and Canal Street in Bourne, Massachusetts, within a commercial area zoned Business (B-2). The property will serve as the HDD entry workspace for the G-24 pipeline and will later be developed as the relocated Sagamore M&R Station. A short segment of connector pipeline will extend from the station to a tie-in with the existing G-24 pipeline at the intersection of Canal Street and Hunters Brook Road.

2.2.1 Wetland Resources

On February 3, 2025, representative from SWCA conducted an wetland delineation on the subject property. In their findings, the Sagamore M&R Station site lies within the 100-foot buffer zone of a Bordering Vegetated Wetland regulated by the Massachusetts Wetlands Protection Act. It is located to the east of Canal Street and south of the station site. This wetland is a red maple swamp with a shrub layer of coastal sweet pepperbush. The wetland lies at the base of a steep slope that forms the southern edge of the M&R station site. There will be no direct impacts to this wetland as a result of the Project.

2.2.2 Subsurface Soil Investigations

The Natural Resource Conservation Service (NCRS) identifies the land cover of the site Project Site as Merrimac (Map Unit # 254) and Barnstable (Map Unit # 431). Between March 3 and March 7, 2025, GeoEngineers performed a geotechnical subsurface exploration program consisting of five (5) borings advanced to depths between 14 and 121 feet below ground surface. The USDA NRCS soil report along with the Site Geotechnical Report are included in Appendix C.

In general, the soil conditions observed at the Site consist of topsoil, underlain by fill and natural sand and gravel deposits. Details of the subsurface strata from the explorations by GeoEngineers are summarized below from the ground surface down:

- The soil at the M&R station site consists of fill material comprised of course-gravely sands.
- Observations of groundwater conditions were made during geotech drilling. Groundwater was observed during drilling at approximately 75 feet bgs at boring MR-6. The groundwater conditions encountered during drilling are presented in the boring logs. Groundwater conditions observed during drilling represent short-term condition and may or may not be representative of the long-term groundwater conditions at the site.

2.2 Existing Drainage Conditions

The project site consists of approximately 5.99 acres and was previously developed as a parking lot. All pavement and associated infrastructure have since been removed, and the site is now predominantly covered with native grass. Remnants of previous drainage infrastructure and erosion and sedimentation control features remain throughout the property. Access to the site is currently provided by an existing roadway located along the eastern side of the property. Based on available NRCS Soil Survey mapping, the site contains Merrimac fine sandy loam and Barnstable sandy loam soils with varying slope classifications and stony characteristics. These soils are classified as Hydrologic Soil Group A.

Site topography generally slopes toward the south and southeast, with runoff conveyed across broad overland flow paths toward the downgradient portions of the site. Several natural high points and subtle ridgelines create localized drainage divides across the property. The drainage areas intersected by the access roadway do not exhibit well-defined concentrated flow paths and are not hydraulically restricted. Runoff from these areas primarily occurs as shallow sheet flow across the existing vegetated surfaces and over the improved riprap berm located along the southern property boundary before discharging to adjacent downgradient properties and wetland areas. Minor localized depressions and previously developed drainage features remain throughout the site and provide temporary storage during runoff events prior to overflowing and continuing to drain along the natural topographic gradient.

Under existing conditions, the site is divided into seven drainage areas. Drainage area E01 is located along the western portion of the site and drains south over the existing riprap berm toward the wetlands located at the bottom of the slope. Drainage area E02 extends from the existing access roadway southward into a localized depression adjacent to the wetland system at the base of the southern slope.

Drainage area E03 and E03.1 encompasses a large central portion of the site and drains southeast toward an existing basin located within the southeastern corner of the property that previously served the former parking lot development. Drainage area E04 receives runoff from the northeastern developed portion of the adjacent site as well as roadway runoff from the north and drains toward an existing catch basin. Drainage area E05 and E05.1 consists of areas located southeast of the proposed facility that continue offsite and drain toward localized low areas at the base of the southern berm. Drainage Area E06 is located in the northeastern corner of the property and generally drains east toward the existing roadway corridor, where runoff is collected by an existing roadside grate inlet. Drainage Area E07 is located along the eastern edge of the property and drains south across the existing gravel roadway before continuing offsite along the existing roadside drainage system. Existing times of concentration were developed to correspond with the proposed drainage configurations and anticipated runoff flow paths.

The only notable existing stormwater management features on or adjacent to the site include the riprap slope stabilization along the southern boundary, the existing drainage basin located in the southeastern corner of the property, and the existing basin adjacent to the developed property to the north. No formal stormwater quality treatment systems are known to be present on site. A drawing depicting existing drainage conditions is provided in Appendix A.

Table 1 - Existing Contributing Hydrologic Data

Drainage Area	Area (acres)	Curve Number	Time of Concentration (min)	Existing Outlet Discharge (cfs)
E03.1 (A1)	0.89	49	34.8	1.38
E03 (A1-2)	3.20	49	42.9	4.47
E05.1 (A2)	0.26	49	14.5	0.57
E07 (A3)	0.39	51.7	36.5	0.68

2.3 Proposed Drainage Conditions

Under proposed conditions, approximately 2.0 acres of the 5.99-acre site will be developed with the construction of a gravel pad and associated access improvements. Two access points are proposed, including a new northern access entrance and improvements to the existing access roadway along the eastern side of the property, which will be reconditioned with gravel and extended to the proposed pad. The proposed stormwater management system has been designed in accordance with applicable local and state stormwater management standards and incorporates a treatment train approach consisting of vegetated swales, sediment forebays, infiltration basins, and detention features. These BMPs are intended to provide runoff attenuation, groundwater recharge, sediment removal, and water quality treatment while maintaining existing drainage patterns and minimizing downstream impacts.

The proposed grading plan formalizes existing drainage patterns by directing runoff to defined collection, conveyance, and treatment systems. Under proposed conditions, the site is divided into three primary drainage areas associated with the proposed improvements.

Drainage Area A1 consists of four interconnected subareas (A1, A1-1, A1-2, and A1-3) that ultimately discharge to the existing basin and catch basin system located in the southeastern corner of the property. Drainage Area A1 primarily encompasses the proposed gravel pad. Runoff from this area is directed eastward by surface grading into a vegetated swale located between the two facility entrances. The swale is designed to reduce flow velocities, promote sediment deposition, and convey runoff to a sediment forebay. The forebay provides pretreatment by capturing coarse sediments prior to discharge into the proposed stormwater management basin.

The proposed infiltration basin 1 has been sized to provide storage, infiltration, and peak flow attenuation for runoff generated from the contributing drainage area. In addition to treating runoff generated within Drainage Area A1, the basin has been designed to receive runoff from Drainage Area A1-1 through a proposed 12-inch reinforced concrete pipe culvert located beneath the northern access road. The culvert provides hydraulic connectivity between the upstream drainage area and the proposed basin system. The culvert system is only expected to receive flow during larger design events. Culvert design information is provided in Table 7. Additionally, hydraulic modeling indicates that runoff from Drainage Areas A1 and A1-1 remains contained within basin 1 during smaller and more frequent storm events. However, controlled overflow is expected through the emergency spillway during a (2070) 50-year design event. This overflow is conveyed toward the existing catch basin through sheet flow. As a result, Drainage Areas A1 and A1-1 remain

hydraulically connected to Drainage Areas A1-2 and A1-3 during extreme storm events, and all four subareas ultimately discharge through the existing catch basin.

Drainage Area A1-2 consists primarily of the improved access roadway corridor extending eastward from the facility entrance. A vegetated roadside swale located along the south side of the roadway captures runoff from the gravel roadway surface while also intercepting a portion of existing offsite runoff entering the site from the north. The swale provides both conveyance and pretreatment functions by reducing runoff velocities and promoting sediment deposition prior to discharge into a proposed sediment basin located north of the existing catch basin in the southeastern corner of the site. An overflow weir and riprap-lined discharge channel are provided to safely convey runoff from larger storm events while minimizing erosion potential and protecting downstream receiving areas.

Drainage Area A1-3 consists primarily of the undisturbed portion of existing Drainage Area E03 that remains outside the proposed limits of disturbance. Existing drainage patterns within this area remain unchanged, and runoff continues to discharge to the existing catch basin located in the southeastern corner of the site. Because no grading, clearing, or impervious surface modifications are proposed within this drainage area, no additional stormwater management practices are required. This drainage area was nevertheless included in the hydrologic and hydraulic analyses because it contributes runoff to the same downstream basin system and remains hydraulically connected to the overall site drainage network.

Drainage Area A2 is located along the southern portion of the proposed facility and drains southward to a vegetated swale designed to intercept and convey runoff to a sediment forebay adjacent to the southern facility entrance. The forebay provides pretreatment through sediment capture and flow dissipation prior to discharge into proposed infiltration basin 2 located immediately east of the forebay. The infiltration basin has been designed to promote groundwater recharge, reduce runoff volumes, and attenuate peak discharge rates associated with the contributing drainage area.

Drainage Area A3 is located along the eastern portion of the property and generally follows the existing roadway corridor. No stormwater management practices are proposed within this drainage area because the roadway's impervious cover and runoff characteristics remain substantially unchanged from existing conditions. In addition, the proposed vegetated swale provides supplemental drainage relief and reduces the area contributing runoff to downstream discharge locations. As a result, post-development runoff from this area is anticipated to be less than existing conditions.

No post-construction stormwater management practices are proposed for existing Drainage Areas E01, E02, and E05 because these areas are located outside the proposed limits of disturbance and experience a reduction in drainage area under proposed conditions. Existing Drainage Area E06 also remains unchanged, as no grading modifications or drainage alterations are proposed within that portion of the site.

Overall, the proposed stormwater management system formalizes existing drainage patterns while incorporating infiltration-based BMPs, vegetated conveyance systems, sediment forebays, and detention storage features to improve runoff attenuation, groundwater recharge, and water quality treatment relative to existing conditions. A drawing depicting proposed drainage conditions is provided in Appendix A. Supporting ditch capacity calculations are included in Table 6, and culvert hydraulic calculations are provided in Table 7.

Table 2- Proposed Hydrologic Data

Drainage Area	Discharge Location	Design Event	Existing Area Distributions (acres)	Area (acres)	Curve Number	Time of Concentration (min)	Proposed Outlet Discharge (cfs)
A1	East	8.8 in, 50Year (2070)	E02 (0.09 ac) + E03 (0.88 ac) + E04 (0.21 ac)+E05 (0.02 ac)	1.2	76	6.0	0.4
A1, A1-1, A1-2 & A1-3	South	8.8 in, 50Year (2070)	E02 (0.09 ac) + E03 (3.09 ac) + E04 (0.60 ac)+E05 (0.02 ac)+E07 (0.15 ac)	3.95	76	6.0	0.00
A2	South	8.8 in, 50Year (2070)	E01 (0.22 ac) + E02 (0.36ac) + E03 (0.13 ac) + E05 (0.21ac)	0.92	76	6.0	0.12
A3	East	8.8 in, 50Year (2070)	E07 (0.25 ac)	0.25	51.7	6.0	0.43

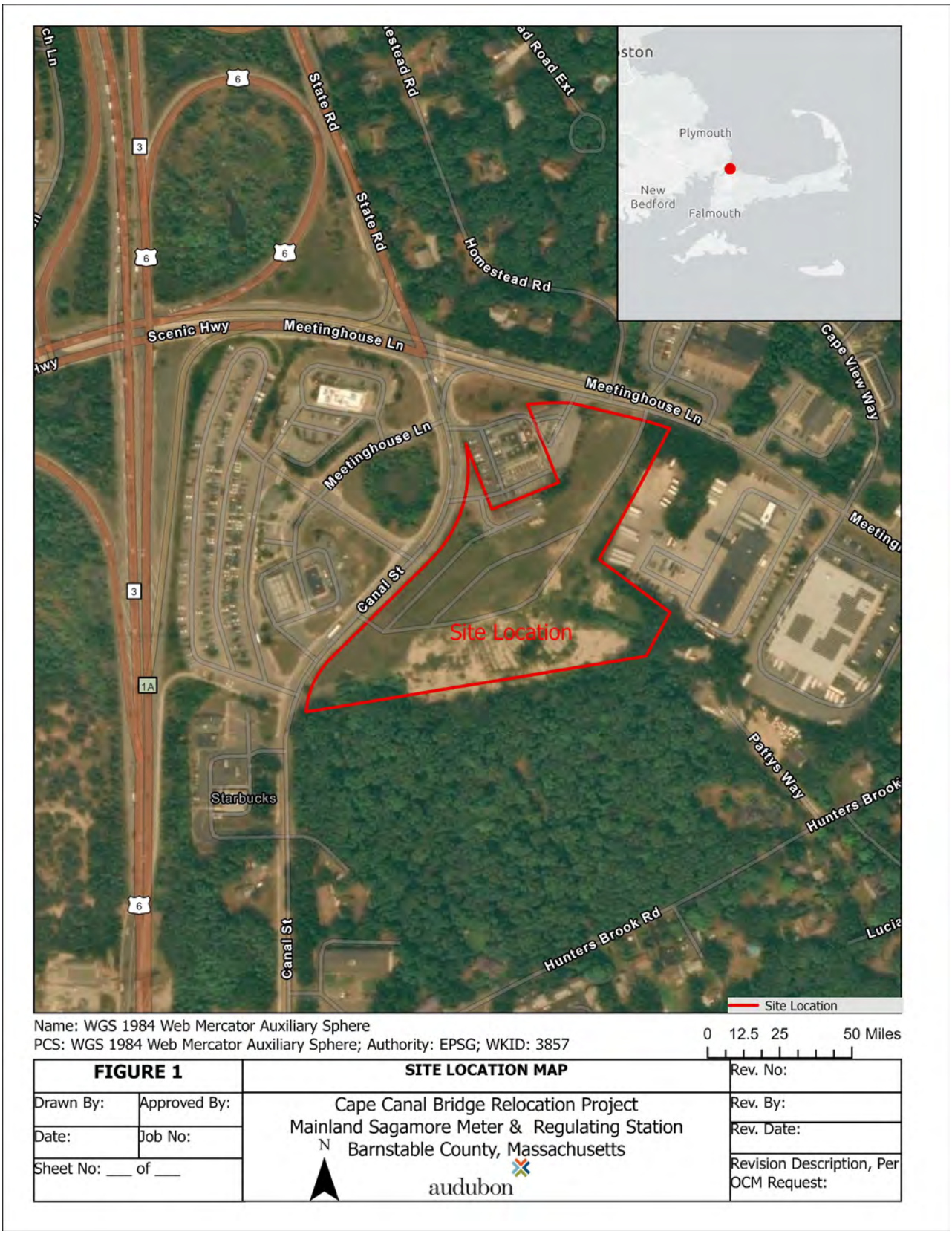


Figure A - Site Location Map (Aerial)



Figure B - Site Location Map (Topo)

3 Regulatory Compliance

3.1 Massachusetts Department of Environmental Protection (DEP) – Stormwater Management Standards

As demonstrated in the sections below, the proposed Project Complies with the DEP Stormwater Management Standards.

3.1.1 Standard 1: No New Untreated Discharges or Erosion to Wetlands

The Project has been designed to comply with Standard 1

The Best Management Practices (BMPs) included in the proposed stormwater management system have been designed in accordance with the Massachusetts Stormwater Handbook (MSH). Supporting information and computation demonstrating that no new untreated discharges will result from the Project are presented through compliance with Standards 4 through 6.

All proposed Project Stormwater Outlets and conveyances have been designed to not cause erosion or scour to wetlands or receiving waters.

Computations and supporting information for the sizing and selection of materials used to protect from scour and erosion are included in Appendix B.

3.1.2 Standard 2: Peak Rate Attenuation

The Project has been designed to comply with Standard 2. The project is not subject to coastal storm flowage; the Project is proposing to reduce peak flow rates from existing to proposed conditions.

A hydrologic and hydraulic model was developed using Autodesk Storm and Sanitary Analysis (SSA) to evaluate the existing and proposed drainage conditions for the Site. The analysis utilizes the NRCS TR-20 hydrologic methodology, with time of cocentration (Tc) calculated in accordance with NRCS TR-55 procedures, and a minimum Tc of 6 minutes applied across all subcatchments. Runoff hydrographs were generated using the NRCS dimensionless unit hydrograph approach, and hydraulic routing was performed using dynamic (hydrodynamic) wave routing within the SSA model. The results of the analyses indicate that there is no increase in peak discharge rates between pre- and post-development conditions at the evaluated design points for the 2-, 10-, 25-, 50-, and 100-year storm events, as well as the 50-year (2070) climate-adjusted storm event. Rainfall distributions utilized in the analysis are based on the NRCS Type III storm distribution. Precipitation depths for each storm event were obtained from the NOAA Atlas 14, Volume 10. Runoff curve numbers (CNs) for both existing and proposed conditions, as summarized in Tables 1 and 2, were determined in accordance with NRCS TR-55 methodology. Detailed model input parameters, assumptions, and computational results are provided in Appendix C.

Table 3 - NOAA Atlas 14 Volume 10 Design Depths for the 24 Hour Storm (inches)

2-year	10-year	25-year	50-year	100-year	50-year (2070)
3.41	4.98	5.96	6.7	7.47	8.8

Table 4 - Peak Discharge Rates

Proposed Area	Storm Event	Design Point	Existing Areas (Acre)	Existing Peak Discharge (cfs)	Proposed Areas (Acre)	Proposed Peak Discharge (cfs)
A1	2-year	DP-1	(Partial Area -E03.1) - 0.89	0.02	A1-1.20	0
	10-year	DP-1	(Partial Area -E03.1) - 0.89	0.23	A1-1.20	0
	25-year	DP-1	(Partial Area -E03.1) - 0.89	0.46	A1-1.20	0
	50-year	DP-1	(Partial Area -E03.1) - 0.89	0.67	A1-1.20	0
	100-year	DP-1	(Partial Area -E03.1) - 0.89	0.91	A1-1.20	0.03
	50-year 2070	DP-1	(Partial Area -E03.1) - 0.89	1.38	A1-1.20	0.4

Proposed Area	Storm Event	Design Point	Existing Areas (Acre)	Existing Peak Discharge (cfs)	Proposed Areas	Proposed Peak Discharge (cfs)
A1, A1-1, A1-2 & A1-3	2-year	DP-3	(Area - E03) - 3.20	0.07	A3-3.97	0.00
	10-year	DP-3	(Area - E03) - 3.20	0.76	A3-3.97	0.00
	25-year	DP-3	(Area - E03) - 3.20	1.5	A3-3.97	0.00
	50-year	DP-3	(Area - E03) - 3.20	2.18	A3-3.97	0.00
	100-year	DP-3	(Area - E03) - 3.20	2.96	A3-3.97	0.00
	50-year 2070	DP-3	(Area - E03) - 3.20	4.47	A3-3.97	0.00

Proposed Area	Storm Event	Design Point	Existing Areas (Acre)	Existing Peak Discharge (cfs)	Proposed Areas	Proposed Peak Discharge (cfs)
A2	2-year	DP-2	(Partial Area- E05.1) - 0.26	0.01	A2-0.92	0
	10-year	DP-2	(Partial Area- E05.1) - 0.26	0.09	A2-0.92	0
	25-year	DP-2	(Partial Area- E05.1) - 0.26	0.19	A2-0.92	0
	50-year	DP-2	(Partial Area- E05.1) - 0.26	0.27	A2-0.92	0
	100-year	DP-2	(Partial Area- E05.1) - 0.26	0.38	A2-0.92	0
	50-year 2070	DP-2	(Partial Area- E05.1) - 0.26	0.57	A2-0.92	0.12

Proposed Area	Storm Event	Design Point	Existing Areas (Acre)	Existing Peak Discharge (cfs)	Proposed Areas	Proposed Peak Discharge (cfs)
A3	2-year	DP-4	(Area - E07) - 0.39	0.02	A3-0.25	0.01
	10-year	DP-4	(Area - E07) - 0.39	0.14	A3-0.25	0.09
	25-year	DP-4	(Area - E07) - 0.39	0.25	A3-0.25	0.16
	50-year	DP-4	(Area - E07) - 0.39	0.35	A3-0.25	0.22
	100-year	DP-4	(Area - E07) - 0.39	0.46	A3-0.25	0.30
	50-year 2070	DP-4	(Area - E07) - 0.39	0.68	A3-0.25	0.43

3.1.3 Standard 3: Stormwater Recharge

TThe Project has been designed to comply with Standard 3 of the Massachusetts Stormwater Management Standards. In accordance with the Massachusetts Stormwater Handbook, the required recharge volume for the site is 3604.59 cubic feet. Recharge of stormwater is provided through infiltration-based best management practices, including the proposed infiltration basins associated with the facility and access improvements. The infiltration systems have been sized using the Static Method, with infiltration calculated based on the bottom area of each basin. Each infiltration BMP has been designed to fully dewater within 72 hours. Supporting drawdown calculations are provided in Appendix D, and a summary of the provided recharge volumes is included in Table 5.

In the absence of site-specific geotechnical infiltration testing, design infiltration rates were estimated using published NRCS Web Soil Survey data for the mapped on-site soil units, including Merrimac fine sandy loam (254B) and Barnstable sandy loam soils (430B and 431C), all classified as Hydrologic Soil Group A. Saturated hydraulic conductivity (Ksat) values were obtained for representative soil horizons and converted to inches per hour. A conservative safety factor of 0.5 was applied to account for variability and uncertainty associated with generalized soild mapping data.

The resulting design infiltration rate utilized for the project is 2.0 inches per hour. This value reflects the most limiting anticipated soil conditions at the proposed infiltration interfaces and is intended to provide reliable long-term infiltration performance in the absence of field verification testing. The assumed design infiltration rate was utilized in the project drawdown analysis to evaluate dewatering performance and confirm compliance with the required 72-hour drawdown timeframe. Refer to the drawdown analysis for detailed calculations.

Table 5 - Summary of Recharge Calculations

Drainage Area	Provided Volume (cf)
A1	25382.74
A2	13126.86
A3	0.00
Total Provided Recharge	38509.60
Total Required Recharge	3604.59

Table 6 - Drainage Swale Design Summary

Drainage area	Peak flow (cfs) 2070 - 50 Year Event	Capacity	Max depth (ft)	Slope (%)	Velocity(ft/s)	Section Geometry
Ditch A1	8.02	131.20	2.90	0.50	5.20	Triangular, side slope max 3:1
Ditch A1-2	7.68	43.84	2.50	0.30	3.51	Triangular, side slope max 2:1
Ditch A2	3.99	8.75	0.80	1.17	3.42	Triangular, side slope max 4:1

Table 7 - Culvert Design Summary

Parameters	Culverts
Quantity	1
Diameter	12 in
Length	36 ft
Material	RCP
Inlet Invert Elevation	68.00
Outlet Invert Elevation	67.75
Slope	0.70%
Q(2070-50 year)	1.67 cfs
Headwater Elevation (2070-50 year)	68.72 ft
Outlet Velocity (2070-50 year)	4.18 ft/s

3.1.4 Standard 4: Water Quality

The Project has been designed to comply with Standard 4.

During construction of the project a comprehensive stormwater management system that includes; fiber rolls and silt-fence for slope and parameter control, a stabilized construction entrance to minimize off-site transport of sediment on to local roadways, inlet protection to prevent sediment from entering the existing roadway stormwater management system, and a dedicated concrete washout and containment area.

Following construction, permanent stormwater BMPs will include Vegetative Swales to minimize sediment transport, Sediment Forebays as pre-treatment, Riprap Aprons for outlet protection.

Treatment Train

Swales → Forebays → Infiltration Basins → Overflow

Roles:

- Vegetated swales provide conveyance and initial filtration.
- Sediment forebays provide pretreatment and sediment capture.
- Infiltration basins provide primary water quality treatment and recharge.

Pretreatment is provided upstream of infiltration BMPs through sediment forebays and vegetated conveyance systems in accordance with MassDEP Stormwater Handbook guidance.

The Massachusetts Stormwater Handbook assigns an 80% TSS removal credit to infiltration basins. Additional guidance and literature sources indicate that infiltration systems may achieve higher removal efficiencies under favorable site conditions.

Computations and supporting information, including the Long-Term Pollution Prevention Plan, are included in Appendix D

3.1.5 Standard 5: Land Uses and High Potential Pollutant Loads (LUHPPLs)

The proposed facility does not include industrial process areas or outdoor pollutant handling activities that not would constitute a LUHPPL under the Massachusetts Stormwater Handbook. Operational areas are limited and supported by spill prevention and maintenance procedures intended to minimize pollutant exposure to stormwater. While the Project is not considered a LUHPPL it has been designed with suitable BMPs sized to treat the 1-inch Water Quality Volume and 44% TSS pretreatment prior to infiltration.

For computations and supporting information regarding the sizing of BMPs suitable for treatment of runoff, see Appendix E

3.1.6 Standard 6: Critical Areas

The Project will discharge treated storm water flow through a treatment train where all storm water will be contained within a properly scaled infiltration basin based on a 72-hour total infiltration rate. In case of an emergency, the infiltration basis has been designed with a spillway that will direct any potential overspill to an area identified as a relatively flat, vegetated area that would promote overland sheet flow. Although not considered a “critical area” by the MADEP, there is an existing wetland located approximately 75-feet south from the discharge location. A steep bank leading to the wetland has existing riprap and natural vegetation that would protect the wetland from potential sedimentation and/or scour associated emergency spillway discharge.

Proposed source controls and pollution prevention measures have been identified in the Long-Term Pollution Prevention Plan included in Appendix E.

3.1.7 Standard 7: Redevelopments and Other Projects Subject to the Standards only to the Maximum Extent Practicable

The Project has been designed to comply with all ten of the Stormwater Management Standards. Refer directly to each Standard for applicable computations and supporting information demonstrating compliance with each.

3.1.8 Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Controls

The Project will disturb more than one acre of land, however, the Project is exempt from the Environmental Protection Agency (EPA) National Pollutant Discharge Elimination System (NPDES) Construction General Permit to being associated with an Oil and Gas Activity. Although, not required, a site specific Erosion and Sediment Control Plan has been developed to prevent off-site transport of sediment during construction activities. During construction of the project a comprehensive stormwater management system that includes; fiber rolls and silt-fence for slope, parameter control, and stormwater inlet protection if applicable, and stabilized construction entrances to minimize off-site transport of sediment on to local roadways, and a dedicated concrete washout and containment area. Recommended construction period pollution prevention and erosion and sedimentation controls are included in Appendix E.

3.1.9 Standard 9: Operation and Maintenance Plan

In compliance with Standard 9, a Post-Construction Stormwater Operation and Maintenance (O&M) Plan has been developed for the Project to ensure the long-term functionality of the proposed stormwater management system. Following construction, permanent stormwater BMPs will include vegetated swales for conveyance and sediment reduction, sediment forebays for pretreatment and sediment capture, infiltration basins for recharge and water quality treatment, riprap aprons for outlet protection, and stabilized riprap slopes to minimize the potential for future erosion.

The O&M Plan establishes inspection frequencies, maintenance procedures, and responsible parties for all stormwater BMPs. Vegetated swales, infiltration basins, and stabilized overflow areas will be inspected at least semi-annually and following major storm events to identify erosion, sediment accumulation, vegetation loss, debris buildup, or evidence of impaired drainage. Sediment forebays will be inspected quarterly and cleaned when sediment accumulation reaches approximately 50 percent of the forebay storage depth or otherwise impairs pretreatment performance. Infiltration basins will also be monitored for standing water, and if ponded water remains for greater than 72 hours following a storm event, the system will be evaluated for potential clogging and corrective maintenance performed as necessary.

Maintenance activities may include sediment and debris removal, stabilization of eroded areas, restoration of vegetative cover, and repair or replacement of damaged stabilization materials. Stabilized overflow and riprap outlet areas will be inspected following overflow-producing storm events to confirm that erosion, scour, or sediment transport has not occurred. Access to all stormwater BMPs will be maintained to facilitate inspection and maintenance activities throughout the operational life of the Project.

The O&M Plan is included in Appendix E as part of the Long-Term Pollution Prevention Plan.

3.1.10 Standard 10: Prohibition of Illicit Discharges

The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges. A copy of the Long-term Pollution Prevention Plan is included in Appendix E

4 Local Municipal Rules and Regulations

As a FERC-regulated interstate natural gas pipeline, Algonquin Gas Transmission, LLC's proposed Project facilities are not subject to review under local ordinances and bylaws.

5 FEMA Floodplain

The project site, located off Meetinghouse Lane in the Town of Barnstable, Massachusetts, is situated within Zone X (Area of Minimal Flood Hazard) as defined by the FEMA Flood Insurance Rate Maps (FIRMs), Panel 25001C0317J, effective July 16, 2014.

Based on review of FEMA mapping and site location, the project lies entirely outside of the 1-percent-annual-chance floodplain (100-year floodplain) and outside all Special Flood Hazard Areas (SFHAs), including Zones AE, VE, and AO.

The nearest mapped flood zones are associated with the Cape Cod Canal and coastal areas to the south of the site, and are separated from the project area by both distance and higher ground elevations. These flood zones are described as follows:

- Zone AE is mapped along the Cape Cod Canal shoreline and represents areas subject to inundation by the 1-percent-annual-chance flood event with established Base Flood Elevations (BFEs). This zone is located south of Canal Service Road and does not extend into the project site.
- Zone VE is mapped in more exposed coastal areas further from the site and represents areas subject to wave action during coastal storm events. This zone is not present within or adjacent to the project area.
- Zone AO (shallow flooding areas) is not mapped within or near the project site.

Given that the project is located entirely within Zone X, no portion of the site is subject to flooding during the 1-percent-annual-chance storm event, and the proposed work will not result in impacts to flood storage capacity, flood elevations, or flood conveyance.

Attachment A - Existing and Proposed Drainage Conditions

Existing Conditions



PROPOSED SAGAMORE METER STATION SITE

EXISTING CONDITIONS PLAN

SCALE: 1" = 40'-0"

0 40' 80'
Scale: 1" = 40'

N
10.03°
STATION NORTH

NOTES:

1. ALL CONTOUR LABELS AND ELEVATION CALLOUTS ARE IN FEET.
2. PROPOSED SITE BOUNDARY IS BASED ON GROUND SURVEY CONDUCTED BY BRADY CONSULTING, L.L.C. ON OCTOBER 2, 2025
3. SUPPLEMENTAL TAX PARCEL DATA IS SHOWN FOR REFERENCE ONLY AND WAS OBTAINED FROM THE CAPE COD COMMISION OPEN GIS DATA HUB WEBSITE. PROJECT AREA IS WITHIN THE COMMONWEALTH OF MASSACHUSETTS PROPERTY.
4. PROPERTY CONVEYED TO ALGONQUIN GAS TRANSMISSION, LLC.
5. TOPOGRAPHIC SURVEY INFORMATION WAS PROVIDED BY ALGONQUIN GAS TRANSMISSION, LLC. ALL COORDINATES AND DISTANCES SHOWN HEREON ARE REFERENCED TO THE MASSACHUSETTS STATE PLANE COORDINATE SYSTEM, US FEET.ELEVATIONS ARE REFERENCED TO NAVD 88.
6. ADDITIONAL CONTOUR DATA WAS OBTAINED FROM 2022 USGS LIDAR POINT CLOUD DATA SETS.
7. THIS PROPERTY IS LOCATED IN ZONE X (AREA OF MINIMAL FLOOD HAZARD) AS DEPICTED ON FLOOD INSURANCE RATE MAP 25001C0318K DATED JULY 6, 2021.
8. ACCORDING TO MASSGIS THE SITE AND 3RD PARTY CONSULTANT NATURAL RESOURCE STUDY IS NOT WITHIN THE NATURAL HERITAGE AND ENDANGERED SPECIES PROGRAM (NHESP), PRIORITY HABITATS OF RARE WILDLIFE, OR THE NHESP ESTIMATED HABITATS OF RARE WILDLIFE.
9. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT NATURAL RESOURCE STUDY THE SITE THERE IS A WETLAND WITHIN 100 FEET OF THE PROJECT LIMITS. SEE SITE LAYOUT FOR BMPS.
10. SUBJECT SITE IS IN THE BUSINESS 2 (B2) DISTRICT AS DEPICTED ON THE TOWN OF BOURNE ZONING MAP.
11. THIS PLAN SET IS PRELIMINARY. FOR PERMITTING PURPOSES ONLY. THIS PLAN IS NOT INTENDED FOR CONSTRUCTION PURPOSES.

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
No. 58957
PROFESSIONAL ENGINEER
06/24/26

ISSUED FOR PERMIT
06/18/2026

LEGEND

EDGE OF GRAVEL	MAJOR CONTOUR	PROPERTY LINE
EXISTING OVERHEAD ELECTRIC	MINOR CONTOUR	GIS PARCEL LINES
EXISTING UG ELECTRIC	BOTTOM OF SLOPE	EXISTING RIP RAP
EDGE OF ROAD	EDGE OF WATER	DIRT MOUND (DEPOSITED)
WETLAND	100 FT WETLAND BUFFER	EXISTING STRUCTURE

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		C	06/18/26	CR	DT	ISSUED FOR PERMIT
		B	05/15/26	CR	DT	ISSUED FOR BID
		A	05/15/26	CR	DT	ISSUED FOR PERMIT

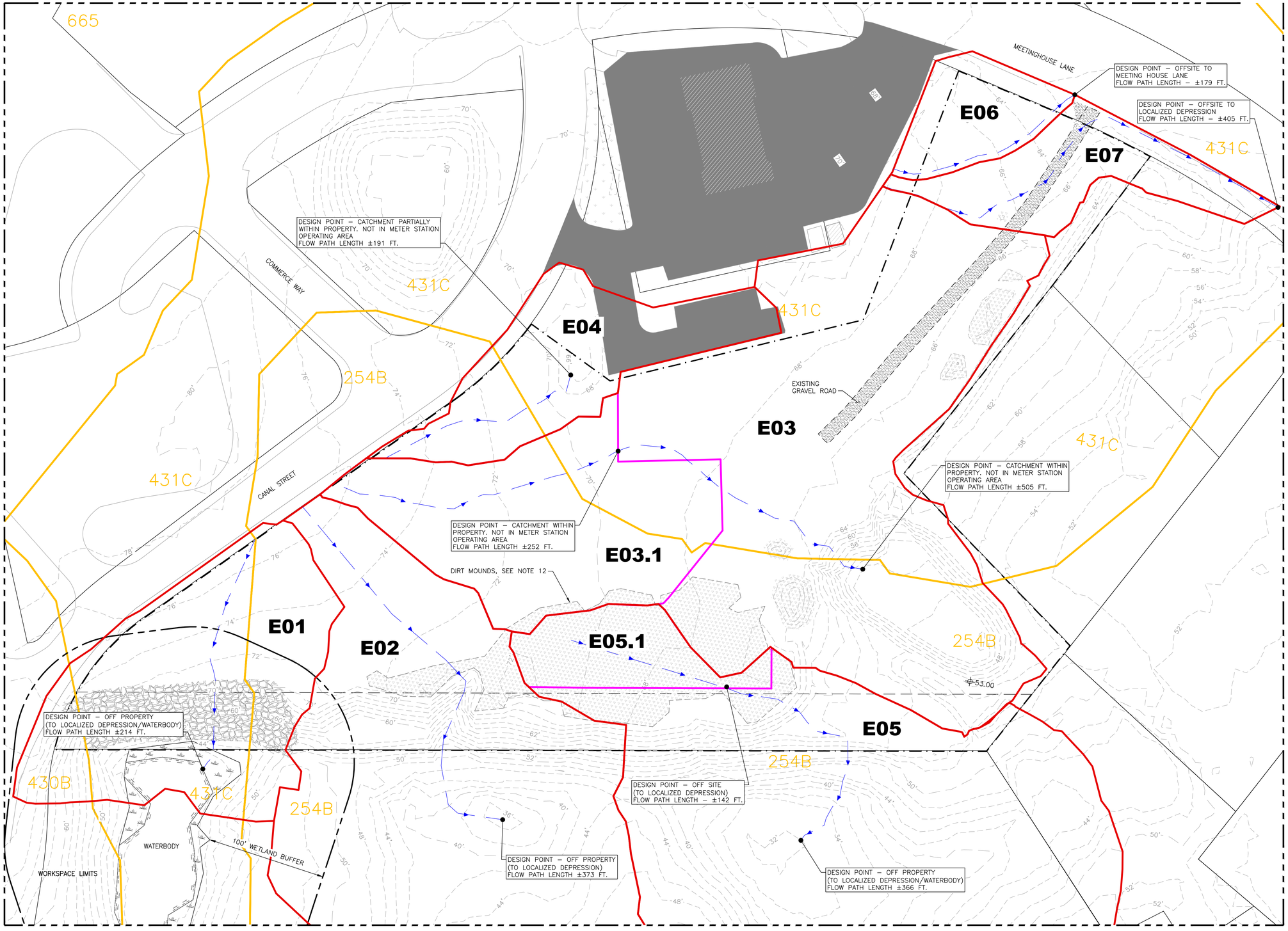
audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

TITLE	INITIALS	DATE
DRAWN BY:	CR	05/08/26
DESIGN CHECKER:	AE	06/18/26
DESIGN ENGINEER:	DT	06/18/26
PROJECT MANAGER:	AC	06/18/26

CAPE COD CANAL PIPELINE RELOCATION PROJECT
SAGAMORE M&R RELOCATION
M&R 00051
TITLE: EXISTING CONDITIONS PLAN
LOC.: BARNSTABLE COUNTY, MASSACHUSETTS
YEAR: 2026 | W.O.: | SCALE: AS NOTED | DWG.: 00051-C.320-0001 | REV.: C

ENBRIDGE
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

S:\AE\Projects\Enbridge\Mass\026356-001\200_Civil_Structural\170_Drawings\E&S Plans\Sagamore M&R\00051-C.320-0001.dwg – PLOT TIME: 6/23/2026 9:20 PM



PROPOSED SAGAMORE METER STATION SITE

EXISTING SUBCATCHMENT AREAS PLAN

SCALE: 1" = 40'

0 40' 80'
Scale: 1" = 40'

N

10.03°

STATION NORTH

NOTES:

1. ALL CONTOUR LABELS AND ELEVATION CALLOUTS ARE IN FEET.
2. PROPOSED SITE BOUNDARY IS BASED ON GROUND SURVEY CONDUCTED BY BRADY CONSULTING, L.L.C. ON OCTOBER 2, 2025
3. SUPPLEMENTAL TAX PARCEL DATA IS SHOWN FOR REFERENCE ONLY AND WAS OBTAINED FROM THE CAPE COD COMMISSION OPEN GIS DATA HUB WEBSITE.
4. PROPERTY CONVEYED TO ALGONQUIN GAS TRANSMISSION, LLC.
5. TOPOGRAPHIC SURVEY INFORMATION WAS PROVIDED BY ALGONQUIN GAS TRANSMISSION, LLC. ALL COORDINATES AND DISTANCES SHOWN HEREON ARE REFERENCED TO THE MASSACHUSETTS STATE PLANE COORDINATE SYSTEM, US FEET.ELEVATIONS ARE REFERENCED TO NAVD 88.
6. ADDITIONAL CONTOUR DATA WAS OBTAINED FROM 2022 USGS LIDAR POINT CLOUD DATA SETS.
7. THIS PROPERTY IS LOCATED IN ZONE X (AREA OF MINIMAL FLOOD HAZARD) AS DEPICTED ON FLOOD INSURANCE RATE MAP 25001C0318K DATED JULY 6, 2021.
8. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT NATURAL RESOURCE STUDY THE SITE IS NOT WITHIN THE NATURAL HERITAGE AND ENDANGERED SPECIES PROGRAM (NHESP), PRIORITY HABITATS OF RARE WILDLIFE, OR THE NHESP ESTIMATED HABITATS OF RARE WILDLIFE.
9. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THE SITE THERE IS A WETLAND WITHIN 100 FEET OF THE PROJECT LIMITS. SEE SITE LAYOUT FOR BMPS.
10. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THE SITE IS NOT LOCATED WITHIN AN AREA OF CRITICAL ENVIRONMENTAL CONCERN.
11. THIS PLAN SET IS PRELIMINARY. FOR PERMITTING PURPOSES ONLY. THIS PLAN IS NOT INTENDED FOR CONSTRUCTION PURPOSES.
12. THE EXISTING DRAINAGE AREAS AND FLOW PATHS ACCOUNTS FOR THE PRESENCE OF EXCESS FILL (DIRT) MOUNDS THAT EXIST ON THIS SITE.
13. REFER TO THE "EROSION & SEDIMENT GENERAL NOTES" (DWG. 00051–C.020–0001) FOR SOIL TYPES INFORMATION.

LEGEND

- PROPERTY LINE
- MAJOR CONTOUR — 70' —
- MINOR CONTOUR — 72' —
- TIME OF CONCENTRATION LINE
- SUBCATCHMENT AREA BOUNDARY
- ANALYSIS AREA BOUNDARY
- NRCS SOIL BOUNDARY
- GIS PARCEL LINES
- EXISTING BUILDING
- EXISTING PAVED AREA
- EXISTING DIRT MOUNDS
- EXISTING GRAVEL
- WETLAND
- 100 FT WETLAND BUFFER

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
No. 58557
PROFESSIONAL ENGINEER

06/24/26

ISSUED FOR PERMIT
06/18/2026

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		C	06/18/26	CR	DT	ISSUED FOR PERMIT
		B	05/15/26	CR	DT	ISSUED FOR BID
		A	05/15/26	CR	DT	ISSUED FOR PERMIT

audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

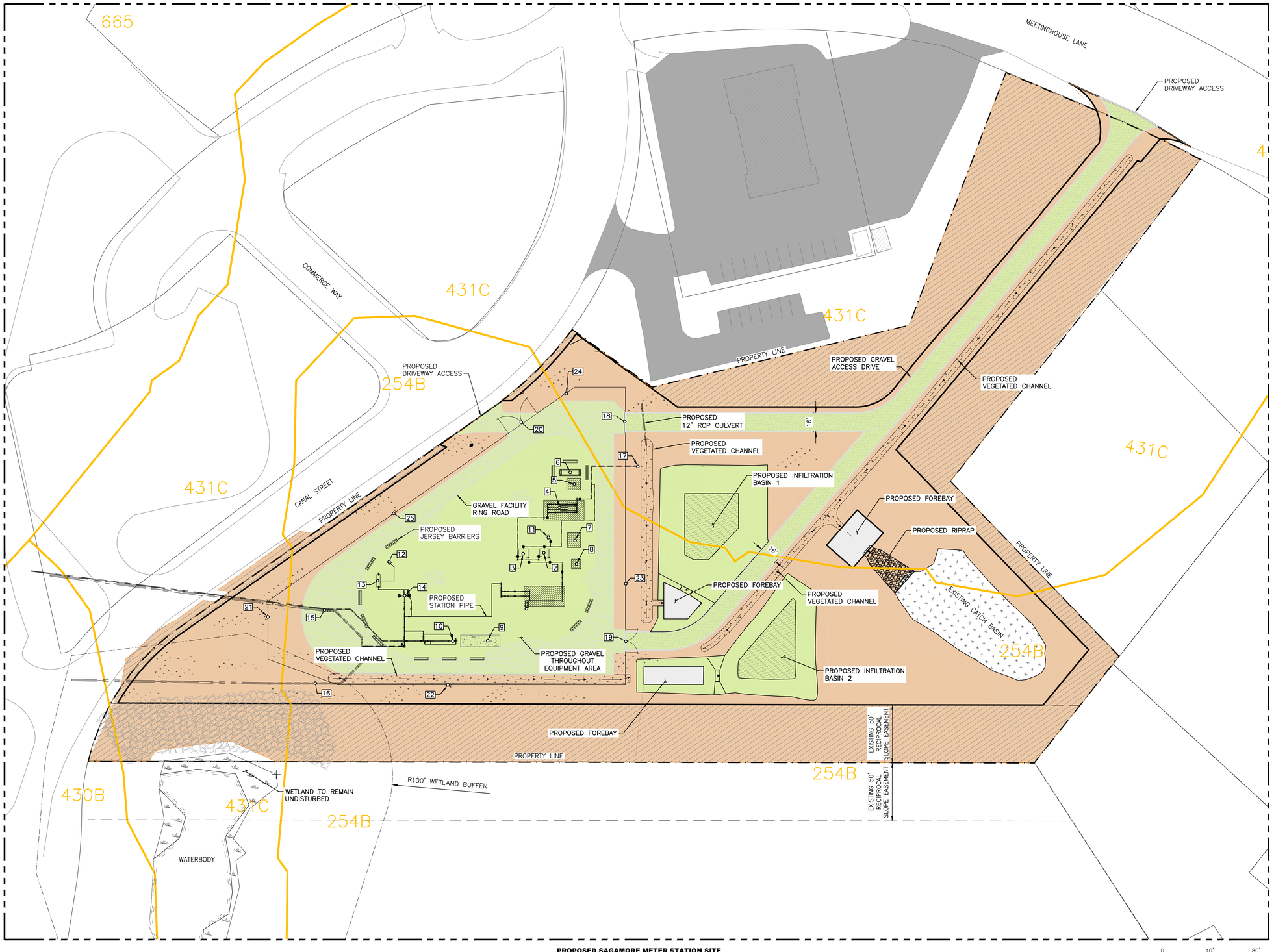
DRAWN BY:	CR	05/15/26	CAPE COD CANAL PIPELINE RELOCATION PROJECT
DESIGN CHECKER:	DT	06/18/26	SAGAMORE M&R RELOCATION
DESIGN ENGINEER:	PB	06/18/26	M&R 00051
PROJECT MANAGER:	AC	06/18/26	TITLE: EXISTING SUBCATCHMENT AREAS PLAN
TITLE	INITIALS	DATE	LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

YEAR: 2026 | W.O.: | SCALE: 1"=40' | DWG.: 00051–C.320–0002 | REV.: C

ENBRIDGE
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

S:\AE\Projects\Enbridge\Mass\026356-001\200_Civil_Structural\170_Drawings\E&S Plans\Sagamore M&R\00051-C.320-0002.dwg – PLOT TIME: 6/18/2026 10:54 AM

Proposed Conditions



NOTES:

1. ALL CONTOUR LABELS AND ELEVATION CALLOUTS ARE IN FEET.
2. PROPOSED SITE BOUNDARY IS BASED ON GROUND SURVEY CONDUCTED BY BRADY CONSULTING, L.L.C. ON OCTOBER 2, 2025
3. SUPPLEMENTAL TAX PARCEL DATA IS SHOWN FOR REFERENCE ONLY AND WAS OBTAINED FROM THE CAPE COD COMMISSION OPEN GIS DATA HUB WEBSITE. PROJECT AREA IS WITHIN THE COMMONWEALTH OF MASSACHUSETTS PROPERTY.
4. PROPERTY CONVEYED TO ALGONQUIN GAS TRANSMISSION, LLC.
5. TOPOGRAPHIC SURVEY INFORMATION WAS PROVIDED BY ALGONQUIN GAS TRANSMISSION, LLC. ALL COORDINATES AND DISTANCES SHOWN HEREON ARE REFERENCED TO THE MASSACHUSETTS STATE PLANE COORDINATE SYSTEM, US FEET. ELEVATIONS ARE REFERENCED TO NAVD 88.
6. CONTOUR DATA WAS OBTAINED FROM 2022 USGS LIDAR POINT CLOUD DATA SETS.
7. THIS PROPERTY IS LOCATED IN ZONE X (AREA OF MINIMAL FLOOD HAZARD) AS DEPICTED ON FLOOD INSURANCE RATE MAP 25001C0318K DATED JULY 6, 2021.
8. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT NATURAL RESOURCE STUDY THE SITE IS NOT WITHIN THE NATURAL HERITAGE AND ENDANGERED SPECIES PROGRAM (NHESP), PRIORITY HABITATS OF RARE WILDLIFE, OR THE NHESP ESTIMATED HABITATS OF RARE WILDLIFE.
9. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT, THERE IS A WETLAND WITHIN 100 FEET OF THE PROJECT LIMITS. SEE SITE LAYOUT FOR BMPS.
10. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THE SITE IS NOT LOCATED WITHIN AN AREA OF CRITICAL ENVIRONMENTAL CONCERN.
11. THIS PLAN SET IS PRELIMINARY. FOR PERMITTING PURPOSES ONLY. THIS PLAN IS NOT INTENDED FOR CONSTRUCTION PURPOSES.
12. SEE GRADING PLAN DRAWING 00051-C.301-0001 FOR DETAILS ON SITE GRADING AND STORM WATER MANAGEMENT.
13. REFER TO THE "EROSION & SEDIMENT GENERAL NOTE" (DWG. 00051-C.020-0001) FOR SOIL TYPES INFORMATION.

KEY NOTE ID	
POINT #	DESCRIPTION
1	32'x12' METER BUILDING
2	VERTICAL HEATER
3	VERTICAL HEATER
4	32'x12' REGULATOR BUILDING
5	12'x10' ODORIZIER BUILDING
6	TANK
7	10'x12' N.G. EGM BUILDING
8	8'x8' ENBRIDGE EGM BUILDING
9	34'x10' MAINTANANCE SLAB
10	PIPELINE TRAP
11	NG GENERATOR
12	TRUCK BOX
13	AUXILIARY SUMP
14	FILTER SEPARATOR
15	INCOMING HDD BUNDLE

KEY NOTE ID	
POINT #	DESCRIPTION
16	INCOMING G024 PIPELINE
17	FUTURE NG PIPELINE
18	SLIDING GATE
19	SECONDARY SWING GATE
20	SECONDARY DRIVE GATE*
21	EGRESS GATE
22	EGRESS GATE
23	EGRESS GATE
24	EGRESS GATE
25	EGRESS GATE

* SLIDE GATE OPTIONAL

LEGEND

- PROPOSED ACCESS ROAD
- PROPOSED CONCRETE
- PROPOSED STRUCTURE
- PROPOSED ROCK (FACILITY)
- PROPOSED VEGETATED
- PROPOSED INFILTRATION BASIN
- PROPOSED SEDIMENT FOREBAY
- EXISTING BASIN
- EXISTING BUILDING
- EXISTING PAVED AREA
- WETLAND
- WORKSPACE
- INFILTRATION >2.4"/HR
- INFILTRATION <2.4"/HR
- VENDOR SUPPLIED EQUIPMENT
- PROPOSED FENCE
- PROPOSED UG PIPING
- PROPERTY LINE
- GIS TAX PARCELS
- NRCS SOIL BOUNDARY
- WORKSPACE LIMITS
- PROPOSED GRADE LIMITS
- EDGE OF ROAD
- EDGE OF WATER
- EXISTING MAJOR CONTOUR 70
- EXISTING MINOR CONTOUR 72
- PROPOSED MAJOR CONTOUR 70
- PROPOSED MINOR CONTOUR 72
- PROPOSED FLOW LINE
- PROPOSED WIER

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
No. 58957
PROFESSIONAL ENGINEER
06/24/26

ISSUED FOR PERMIT
06/18/2026

0 40' 80'
Scale: 1" = 40'

PROPOSED SAGAMORE METER STATION SITE
PROPOSED SITE LAYOUT PLAN
SCALE: 1" = 40'-0"

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		C	06/18/26	CR	DT	ISSUED FOR PERMIT
		B	05/15/26	CR	DT	ISSUED FOR BID
		A	05/15/26	CR	DT	ISSUED FOR PERMIT

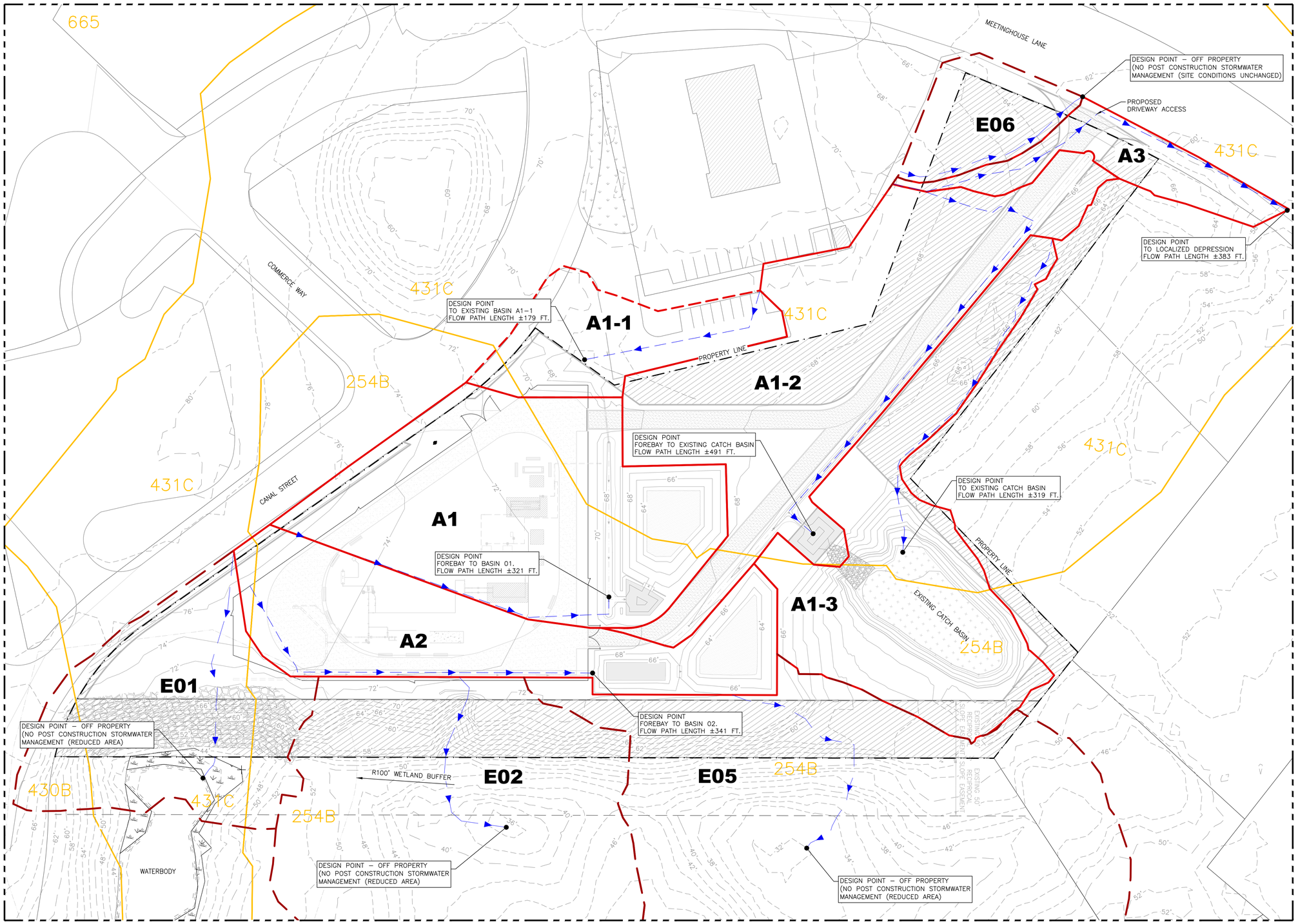
audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

DRAWN BY:	CR	05/15/26	CAPE COD CANAL PIPELINE RELOCATION PROJECT
DESIGN CHECKER:	DT	06/18/26	SAGAMORE M&R RELOCATION
DESIGN ENGINEER:	PB	06/18/26	M&R 00051
PROJECT MANAGER:	AC	06/18/26	TITLE: PROPOSED SITE LAYOUT PLAN
TITLE	INITIALS	DATE	LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

YEAR: 2026 | W.O.: | SCALE: AS NOTED | DWG.: 00051-C.320-0003 | REV.: C

ENBRIDGE
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

S:\AE\Projects\Enbridge\Mass\026356-001\200_Civil_Structural\170_Drawings\E&S Plans\Sagamore M&R\00051-C.320-0003.dwg – PLOT TIME: 6/24/2026 10:44 AM



N

10.03°

STATION NORTH

NOTES:

1. ALL CONTOUR LABELS AND ELEVATION CALLOUTS ARE IN FEET.
2. PROPOSED SITE BOUNDARY IS BASED ON GROUND SURVEY CONDUCTED BY BRADY CONSULTING, L.L.C. ON OCTOBER 2, 2025
3. SUPPLEMENTAL TAX PARCEL DATA IS SHOWN FOR REFERENCE ONLY AND WAS OBTAINED FROM THE CAPE COD COMMISSION OPEN GIS DATA HUB WEBSITE.
4. PROPERTY CONVEYED TO ALGONQUIN GAS TRANSMISSON, LLC.
5. TOPOGRAPHIC SURVEY INFORMATION WAS PROVIDED BY ALGONQUIN GAS TRANSMISSION, LLC. ALL COORDINATES AND DISTANCES SHOWN HEREON ARE REFERENCED TO THE MASSACHUSETTS STATE PLANE COORDINATE SYSTEM, US FEET. ELEVATIONS ARE REFERENCED TO NAVD 88.
6. ADDITIONAL CONTOUR DATA WAS OBTAINED FROM 2022 USGS LIDAR POINT CLOUD DATA SETS.
7. THIS PROPERTY IS LOCATED IN ZONE X (AREA OF MINIMAL FLOOD HAZARD) AS DEPICTED ON FLOOD INSURANCE RATE MAP 25001C0318K DATED JULY 6, 2021.
8. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT NATURAL RESOURCE STUDY THE SITE IS NOT WITHIN THE NATURAL HERITAGE AND ENDANGERED SPECIES PROGRAM (NHESP), PRIORITY HABITATS OF RARE WILDLIFE, OR THE NHESP ESTIMATED HABITATS OF RARE WILDLIFE.
9. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THE SITE THERE IS A WETLAND WITHIN 100 FEET OF THE PROJECT LIMITS. SEE SITE LAYOUT FOR BMPS.
10. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THE SITE IS NOT LOCATED WITHIN AN AREA OF CRITICAL ENVIRONMENTAL CONCERN.
11. THIS PLAN SET IS PRELIMINARY. FOR PERMITTING PURPOSES ONLY. PROPOSED GRADING MAY BE FURTHER OPTIMIZED TO ENSURE PROPER SHEET FLOW AROUND ASSUMED BUILDING LOCATIONS, FOUNDATIONS, AND MECHANICAL EQUIPMENT. THIS PLAN IS NOT INTENDED FOR CONSTRUCTION PURPOSES.
13. REFER TO THE "EROSION & SEDIMENT GENERAL NOTES" (DWG. 00051–C.020–0001) FOR SOIL TYPES INFORMATION.

LEGEND

- PROPOSED ACCESS ROAD
- PROPOSED CONCRETE
- PROPOSED STRUCTURE
- PROPOSED ROCK (FACILITY)
- PROPOSED VEGETATED
- PROPOSED INFILTRATION BASIN
- PROPOSED SEDIMENT FOREBAY
- EXISTING BASIN
- PROPOSED ROCK
- EXISTING BUILDING
- EXISTING PAVED AREA
- WETLAND
- PROPERTY LINE
- GIS TAX PARCELS
- NRCS SOIL BOUNDARY
- WORKSPACE LIMITS
- PROPOSED GRADE LIMITS
- EDGE OF ROAD
- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- SUBCATCHMENT AREA BOUNDARY (PROP)
- SUBCATCHMENT AREA BOUNDARY (EXIST)
- TIME OF CONCENTRATION LINE
- PROPOSED WIER

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
No. 58957
PROFESSIONAL ENGINEER

06/24/26

ISSUED FOR PERMIT
06/18/2026

PROPOSED SAGAMORE METER STATION SITE

PROPOSED SUBCATCHMENT AREAS PLAN

SCALE: 1" = 40'

0 40' 80'
Scale: 1" = 40'

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		C	06/18/26	CR	DT	ISSUED FOR PERMIT
		B	05/15/26	CR	DT	ISSUED FOR BID
		A	05/15/26	CR	DT	ISSUED FOR PERMIT

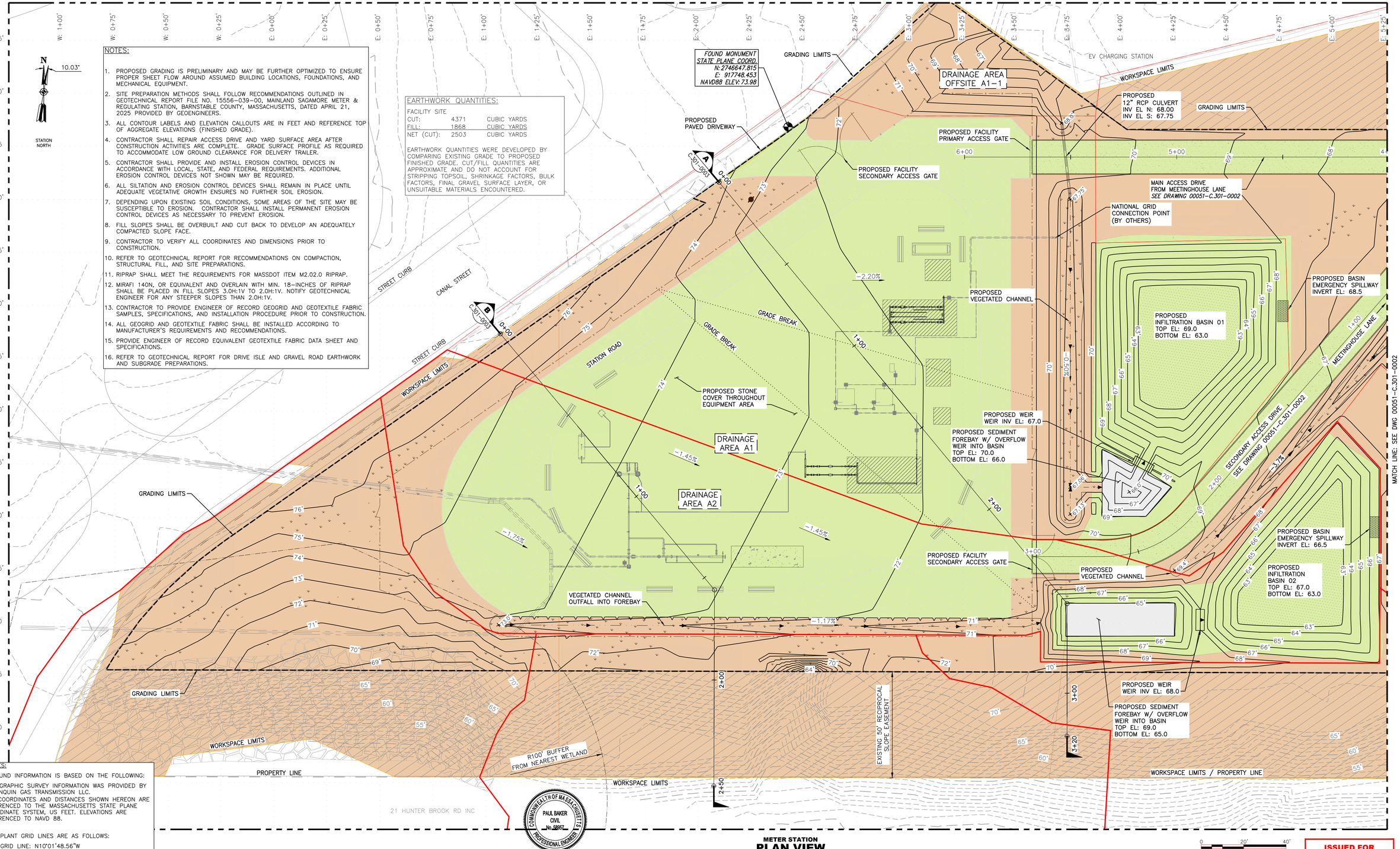
audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

DRAWN BY:	CR	05/15/26	CAPE COD CANAL PIPELINE RELOCATION PROJECT
DESIGN CHECKER:	AE	06/18/26	SAGAMORE M&R RELOCATION
DESIGN ENGINEER:	DT	06/18/26	M&R 00051
PROJECT MANAGER:	AC	06/18/26	TITLE: PROPOSED SUBCATCHMENT AREAS PLAN
TITLE	INITIALS	DATE	LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

ENBRIDGE
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

YEAR: 2026 | W.O.: | SCALE: 1"=40' | DWG.: 00051–C.320–0004 | REV.: C

S:\AE\Projects\Enbridge\Mass\026356-001\200_Civil_Structural\170_Drawings\E&S Plans\Sagamore M&R\00051-C.320-0004.dwg – PLOT TIME: 6/24/2026 10:27 AM



SURVEY NOTES:

1. BACKGROUND INFORMATION IS BASED ON THE FOLLOWING:
   - 1.1. TOPOGRAPHIC SURVEY INFORMATION WAS PROVIDED BY ALGONQUIN GAS TRANSMISSION LLC.
   - 1.2. ALL COORDINATES AND DISTANCES SHOWN HEREON ARE REFERENCED TO THE MASSACHUSETTS STATE PLANE COORDINATE SYSTEM, US FEET. ELEVATIONS ARE REFERENCED TO NAVD 88.
2. BEARING PLANT GRID LINES ARE AS FOLLOWS:
   - 2.1. N-S GRID LINE: N10°01'48.56"W
   - 2.2. E-W GRID LINE: S66°53'18.0"E

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
No. 58957
PROFESSIONAL ENGINEER
06/24/26

METER STATION
PLAN VIEW
SCALE: 1" = 20'-0"

0 20' 40'
Scale: 1" = 20'

ISSUED FOR PERMIT
06/18/2026

LEGEND

PROPOSED ACCESS ROAD
PROPOSED CONCRETE
PROPOSED STRUCTURE
PROPOSED ROCK (FACILITY)
EXISTING GAS LINE GAS GAS
PROPOSED FENCE
EXISTING CONTOUR LINE
FINISH CONTOUR LINE 70
DRAINAGE AREA BOUNDARY
PERMANENT EASEMENT
LIMITS OF GRADING
PROPOSED VEGETATED
PROPOSED INFILTRATION BASIN
PROPOSED SEDIMENT FOREBAY
WORKSPACE LIMITS
INFILTRATION >2.4"/HR
PROPOSED FLOW LLINE
PROPOSED EMERGENCY SPILLWAY
PROPOSED WEIR
TOP OF SLOPE
INFILTRATION <2.4"/HR

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		E	06/18/26	CR	DT	ISSUED FOR PERMIT
		D	05/15/26	CR	DT	ISSUED FOR BID
00051-C.320-0007	DETAILS	C	05/15/26	CR	DT	ISSUED FOR PERMIT
00051-C.320-0006	DETAILS	B	03/03/26	CR	PB	ISSUED FOR REVIEW – 90% REVIEW
00051-C.301-0002	CIVIL ACCESS ROAD PLAN	A	05/29/25	CR	PB	ISSUED FOR REVIEW – 60% REVIEW

audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

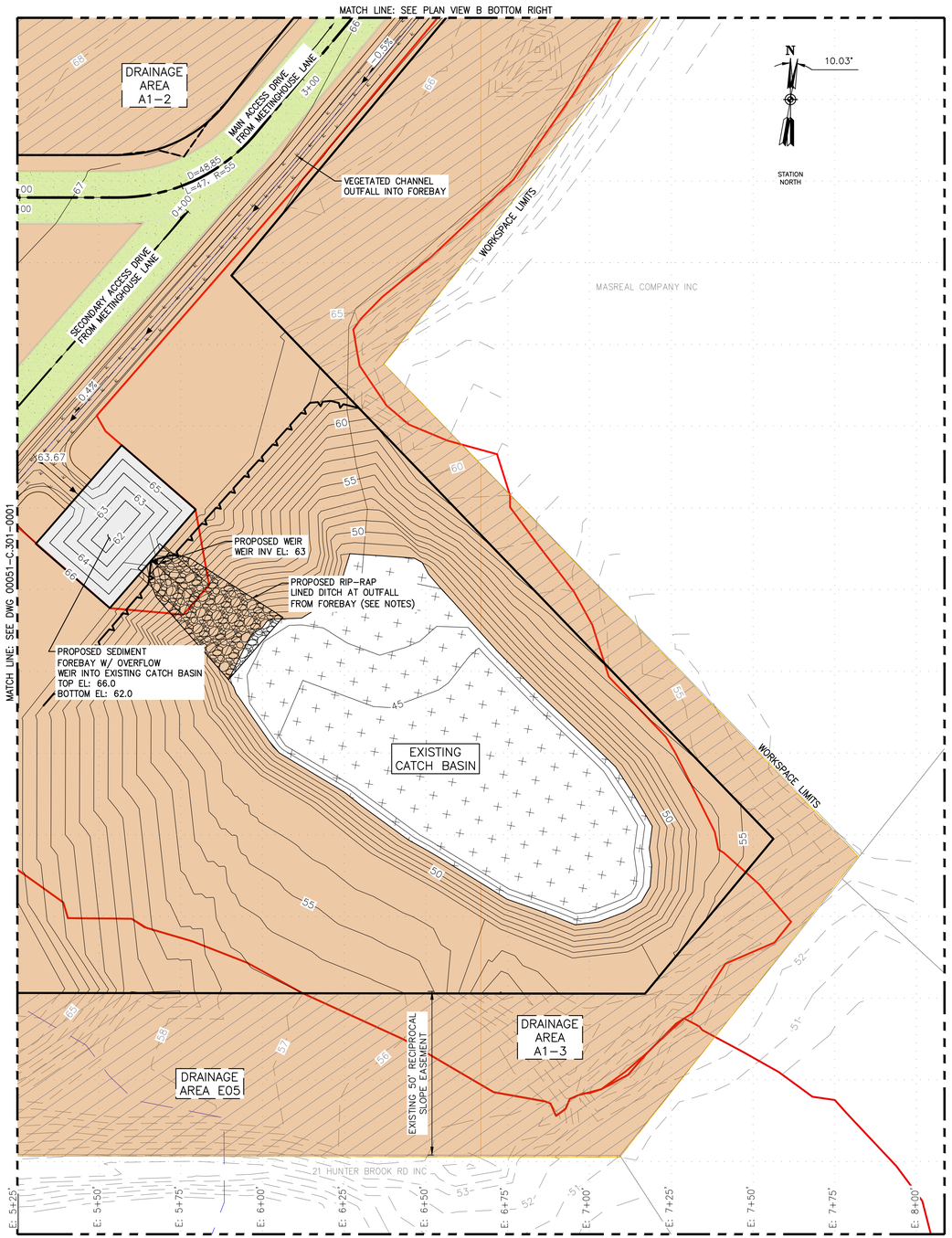
DRAWN BY:	CR	04/20/25	
DESIGN CHECKER:	AE	06/18/26	
DESIGN ENGINEER:	PB	06/18/26	
PROJECT MANAGER:	AC	06/18/26	
TITLE	INITIALS	DATE	

CAPE COD CANAL PIPELINE RELOCATION PROJECT
SAGAMORE M&R RELOCATION
M&R 00051
TITLE: GRADING PLAN
LOC.: BARNSTABLE COUNTY, MASSACHUSETTS
YEAR: 2026 W.O.: SCALE: AS NOTED

ENBRIDGE
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400
DWG.: 00051-C.301-0001 REV.: E

S:\AE\Projects\Enbridge\Mass\026356-001\200_Civil_Structural\170_Drawings\Grading\Mainland Sagamore\00051-C.301-0001.dwg - PLOT TIME: 6/24/2026 10:21 AM

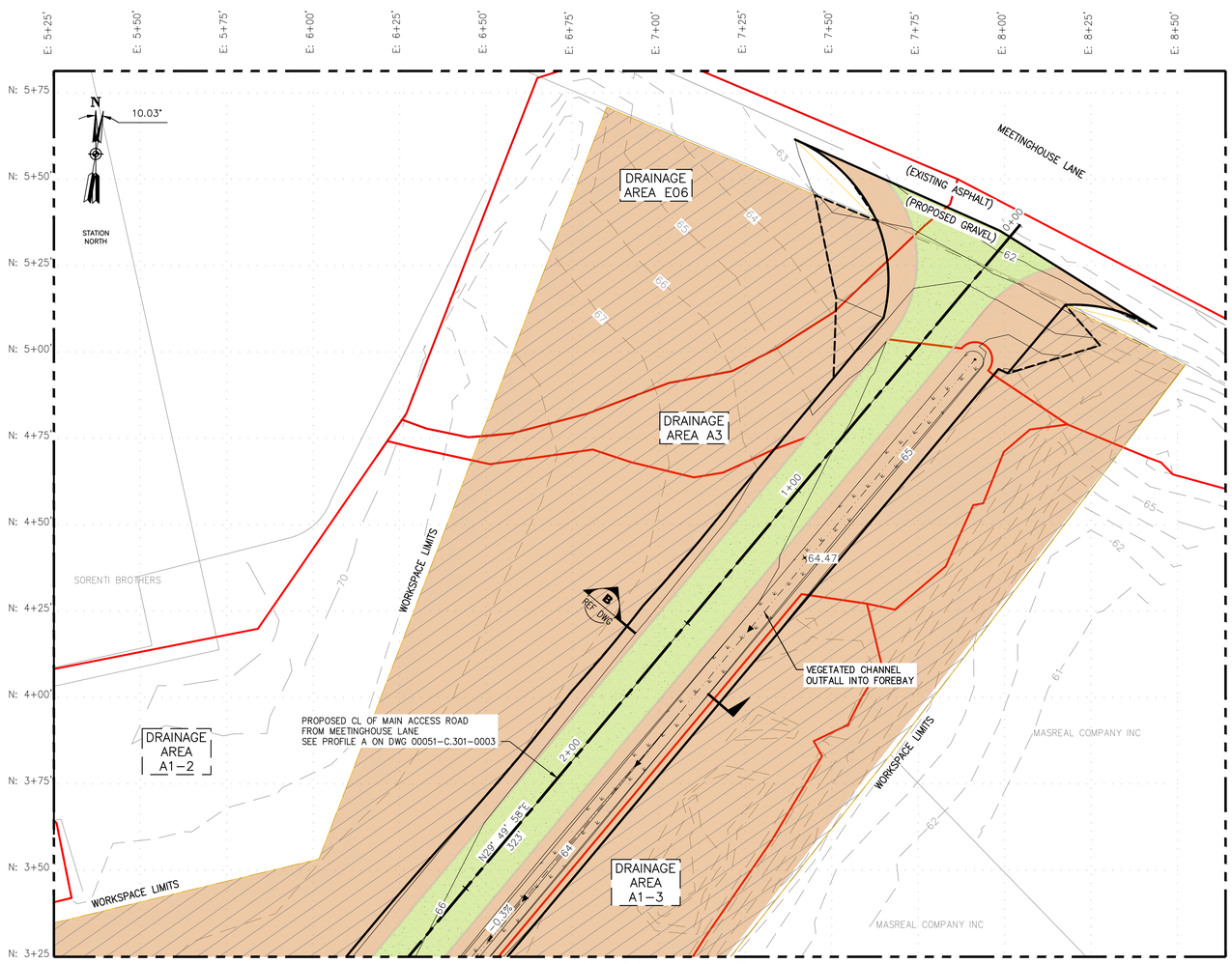
S:\AE\Projects\Enbridge\Mass\026356-001\200_Civil_Structural\170_Drawings\Grading\Mainland Sagamore\00051-C.301-0002.dwg — PLOT TIME: 6/24/2026 12:49 AM



PLAN VIEW A

SCALE: 1" = 20'-0"

Scale: 1" = 20'



PLAN VIEW B

SCALE: 1" = 20'-0"

Scale: 1" = 20'

NOTES:

1. PROPOSED GRADING IS PRELIMINARY AND MAY BE FURTHER OPTIMIZED TO ENSURE PROPER SHEET FLOW AROUND ASSUMED BUILDING LOCATIONS, FOUNDATIONS, AND MECHANICAL EQUIPMENT.
2. SITE PREPARATION METHODS SHALL FOLLOW RECOMMENDATIONS OUTLINED IN GEOTECHNICAL REPORT FILE NO. 15556-039-00, MAINLAND SAGAMORE METER & REGULATING STATION, BARNSTABLE COUNTY, MASSACHUSETTS, DATED APRIL 21, 2025 PROVIDED BY GEOENGINEERS.
3. ALL CONTOUR LABELS AND ELEVATION CALLOUTS ARE IN FEET AND REFERENCE TOP OF AGGREGATE ELEVATIONS (FINISHED GRADE).
4. CONTRACTOR SHALL REPAIR ACCESS DRIVE AND YARD SURFACE AREA AFTER CONSTRUCTION ACTIVITIES ARE COMPLETE. GRADE SURFACE PROFILE AS REQUIRED TO ACCOMMODATE LOW GROUND CLEARANCE FOR DELIVERY TRAILER.
5. CONTRACTOR SHALL PROVIDE AND INSTALL EROSION CONTROL DEVICES IN ACCORDANCE WITH LOCAL, STATE, AND FEDERAL REQUIREMENTS. ADDITIONAL EROSION CONTROL DEVICES NOT SHOWN MAY BE REQUIRED.
6. ALL SILTATION AND EROSION CONTROL DEVICES SHALL REMAIN IN PLACE UNTIL ADEQUATE VEGETATIVE GROWTH ENSURES NO FURTHER SOIL EROSION.
7. DEPENDING UPON EXISTING SOIL CONDITIONS, SOME AREAS OF THE SITE MAY BE SUSCEPTIBLE TO EROSION. CONTRACTOR SHALL INSTALL PERMANENT EROSION CONTROL DEVICES AS NECESSARY TO PREVENT EROSION.
8. FILL SLOPES SHALL BE OVERBUILT AND CUT BACK TO DEVELOP AN ADEQUATELY COMPACTED SLOPE FACE.
9. CONTRACTOR TO VERIFY ALL COORDINATES AND DIMENSIONS PRIOR TO CONSTRUCTION.
10. REFER TO GEOTECHNICAL REPORT FOR RECOMMENDATIONS ON COMPACTION, STRUCTURAL FILL, AND SITE PREPARATIONS.
11. RIPRAP SHALL MEET THE REQUIREMENTS FOR MASSDOT ITEM M2.02.0 RIPRAP.
12. MIRAFI 140N, OR EQUIVALENT AND OVERLAIN WITH MIN. 18-INCHES OF RIPRAP SHALL BE PLACED IN FILL SLOPES 3.0H:1V TO 2.0H:1V. NOTIFY GEOTECHNICAL ENGINEER FOR ANY STEEPER SLOPES THAN 2.0H:1V.
13. CONTRACTOR TO PROVIDE ENGINEER OF RECORD GEOGRID AND GEOTEXTILE FABRIC SAMPLES, SPECIFICATIONS, AND INSTALLATION PROCEDURE PRIOR TO CONSTRUCTION.
14. ALL GEOGRID AND GEOTEXTILE FABRIC SHALL BE INSTALLED ACCORDING TO MANUFACTURER'S REQUIREMENTS AND RECOMMENDATIONS.
15. PROVIDE ENGINEER OF RECORD EQUIVALENT GEOTEXTILE FABRIC DATA SHEET AND SPECIFICATIONS.
16. REFER TO GEOTECHNICAL REPORT FOR DRIVE ISLE AND GRAVEL ROAD EARTHWORK AND SUBGRADE PREPARATIONS.

EARTHWORK QUANTITIES:

ACCESS ROAD

STRIPPED MATERIAL (CUT):	677.0 CUBIC YARDS
6" ROCK SURFACE FILL:	270.8 CUBIC YARDS
9" SUBBASE FILL:	406.2 CUBIC YARDS
NET (FILL):	677.0 CUBIC YARDS

EARTHWORK QUANTITIES WERE DEVELOPED BY COMPARING EXISTING GRADE TO PROPOSED FINISHED GRADE. STONE COVERAGE AND CUT/FILL QUANTITIES ARE APPROXIMATE AND DO NOT ACCOUNT FOR STRIPPING TOPSOIL, SHRINKAGE FACTORS, BULK FACTORS, FINAL GRAVEL SURFACE LAYER, OR UNSUITABLE MATERIALS ENCOUNTERED.

SURVEY NOTES:

1. BACKGROUND INFORMATION IS BASED ON THE FOLLOWING:
   - 1.1. TOPOGRAPHIC SURVEY INFORMATION WAS PROVIDED BY ALGONQUIN GAS TRANSMISSION LLC.
   - 1.2. ALL COORDINATES AND DISTANCES SHOWN HEREON ARE REFERENCED TO THE MASSACHUSETTS STATE PLANE COORDINATE SYSTEM, US FEET. ELEVATIONS ARE REFERENCED TO NAVD 88.
2. BEARING PLANT GRID LINES ARE AS FOLLOWS:
   - 2.1. N-S GRID LINE: N10°01'48.56"W
   - 2.2. E-W GRID LINE: S66°53'18.0"E

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
No. 59957
PROFESSIONAL ENGINEER
06/24/26

ISSUED FOR PERMIT
06/18/2026

LEGEND

PROPOSED ACCESS ROAD	PROPOSED FENCE	PROPOSED VEGETATED	PROPOSED FLOW LLINE
PROPOSED CONCRETE	EXISTING CONTOUR LINE	PROPOSED INFILTRATION BASIN	PROPOSED EMERGENCY SPILLWAY
PROPOSED STRUCTURE	FINISH CONTOUR LINE	PROPOSED SEDIMENT FOREBAY	PROPOSED WEIR
PROPOSED ROCK (FACILITY)	DRAINAGE AREA BOUNDARY	WORKSPACE LIMITS	TOP OF SLOPE
	PROPERTY LINE	INFILTRATION >2.4"/HR	INFILTRATION <2.4"/HR
	LIMITS OF GRADING		

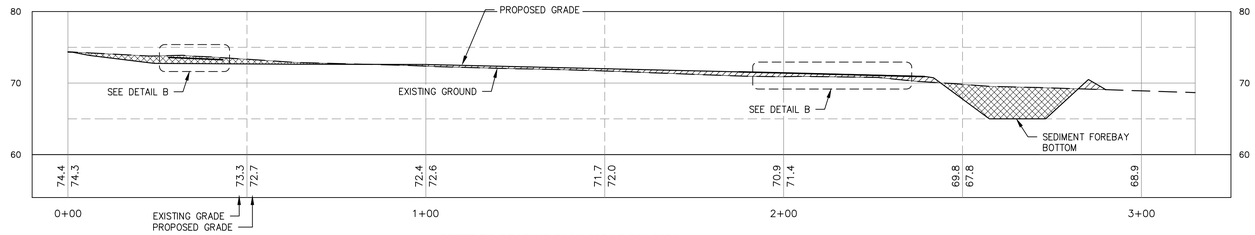
DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		E	06/18/26	CR	DT	ISSUED FOR PERMIT
		D	05/15/26	CR	DT	ISSUED FOR BID
		C	05/15/26	CR	DT	ISSUED FOR PERMIT
00051-C.301-0003	CIVIL GRADING SECTIONS AND DETAILS	B	03/03/26	CR	PB	ISSUED FOR REVIEW – 90% REVIEW
00051-C.301-0001	CIVIL GRADING PLAN	A	05/29/25	CR	PB	ISSUED FOR REVIEW – 60% REVIEW

audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

DRAWN BY:	CR	05/08/25	CAPE COD CANAL PIPELINE RELOCATION PROJECT
DESIGN CHECKER:	DT	06/18/26	SAGAMORE M&R RELOCATION
DESIGN ENGINEER:	PB	06/18/26	M&R 00051
PROJECT MANAGER:	AC	06/18/26	TITLE: CIVIL ACCESS ROAD PLAN
TITLE	INITIALS	DATE	LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

YEAR: 2026 | W.O.: | SCALE: AS NOTED | DWG.: 00051-C.301-0002 | REV.: E

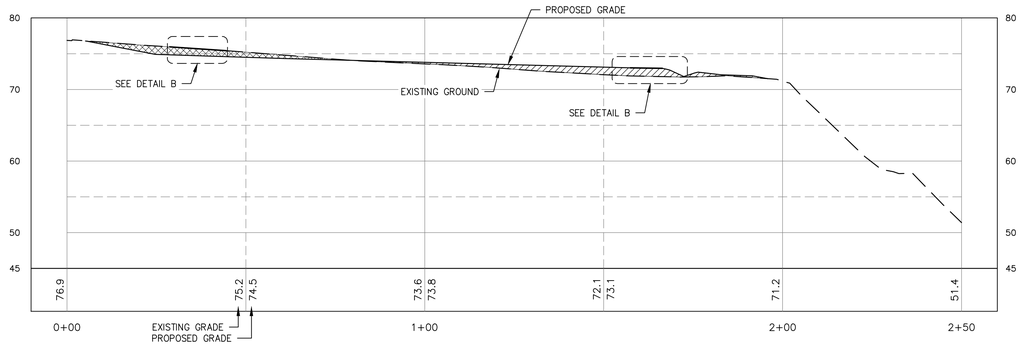
ENBRIDGE
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713.627.5400



REFER TO GRADING PLAN 0051-C.301-0001

SECTION A

SCALES: HORIZ. 1" = 20'-0" / VERT. 1" = 10'-0"



REFER TO GRADING PLAN 0051-C.301-0001

SECTION B

SCALES: HORIZ. 1" = 20'-0" / VERT. 1" = 10'-0"

```
BEGIN SAGAMORE M&R CL OF PRIMARY DRIVEWAY
   N 2,746,994.2540   E 918,257.6723                    0+00.00

LINE (1)
   S29° 49' 58"W    322.98'
   N 2,746,714.0789   E 918,097.0011                    3+22.98
LINE (1)

CURVE (2)
   BC    N 2,746,714.0789   E 918,097.0011              3+22.98
   CTR   N 2,746,742.5009   E 918,049.9140
   PI    N 2,746,692.6923   E 918,084.0920

      DIRECTION BACK   S31° 06' 55"W
         RADIUS        55.00'
         DELTA         48°51'16"(RT)
         LENGTH        46.90'
         TANGENT       24.98'
         CHORD DIRECTION     S55° 32' 33"W   DISTANCE   45.49'
      DIRECTION AHEAD S79° 58' 11"W

   EC    N 2,746,688.3415   E 918,059.4932              3+69.87
CURVE (2)

LINE (3)
   S79° 58' 11"W    230.22'
   N 2,746,648.2456   E 917,832.7959                    6+00.00
LINE (3)

   N 2,746,648.2456   E 917,832.7959                    6+00.00
END SAGAMORE M&R CL OF PRIMARY DRIVEWAY
**********************************************************

ALIGNMENT LENGTH: 600.00'
```

```
BEGIN SECONDARY DRIVEWAY
   N 2,746,687.8206   E 918,081.2041                    0+00.00

LINE (1)
   S31° 01' 52.19"W    219.273'
   N 2,746,499.9284   E 917,968.1679                    2+19.27
LINE (1)

CURVE (2)
   BC    N 2,746,499.9284   E 917,968.1679              2+19.27
   CTR   N 2,746,528.2811   E 917,921.0391
   PI    N 2,746,478.4810   E 917,955.2652

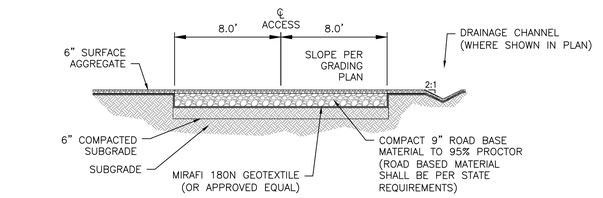
      DIRECTION BACK   S31° 01' 52.19"W
         RADIUS        55.000'
         DELTA         48°56'19"(RT)
         LENGTH        46.978'
         TANGENT       25.029'
         CHORD DIRECTION     S55° 30' 01.82"W   DISTANCE   45.563'
      DIRECTION AHEAD S79° 58' 11.44"W

   EC    N 2,746,474.1217   E 917,930.6183              2+66.25
CURVE (2)

LINE (3)
   S79° 58' 11.44"W    33.749'
   N 2,746,468.2437   E 917,897.3850                    3+00.00
LINE (3)

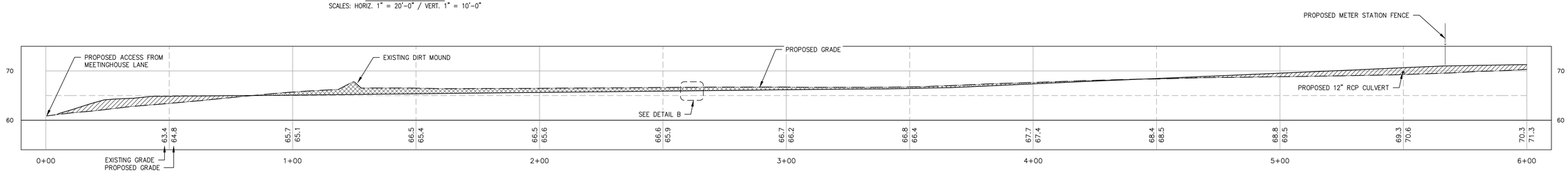
   N 2,746,468.2437   E 917,897.3850                    3+00.00
END SECONDARY DRIVEWAY
**********************************************************

ALIGNMENT LENGTH: 300.000'
```



DETAIL B – TYPICAL AGGREGATE ACCESS/FACILITY ROAD

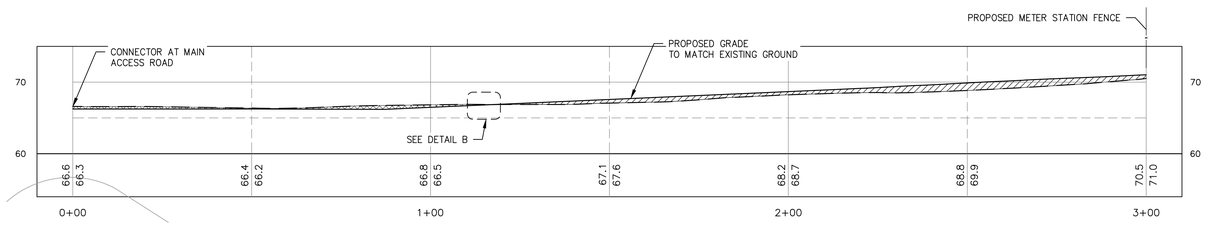
SCALE: NOT TO SCALE



REFER TO GRADING PLAN 00051-C.301-0001 AND 0002

MAIN ACCESS DRIVEWAY C/L PROFILE - A

SCALES: HORIZ. 1" = 20'-0" / VERT. 1" = 10'-0"



REFER TO GRADING PLAN 00051-C.301-0001 AND 0002

SECONDARY ACCESS DRIVEWAY C/L PROFILE - B

SCALES: HORIZ. 1" = 20'-0" / VERT. 1" = 10'-0"

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
No. 58957
PROFESSIONAL ENGINEER
06/24/26

ISSUED FOR PERMIT
06/18/2026

0 10' 20'
Scale: 1" = 10'
0 20' 40'
Scale: 1" = 20'

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		E	06/18/26	CR	DT	ISSUED FOR PERMIT
		D	05/15/26	CR	DT	ISSUED FOR BID
		C	05/15/26	CR	DT	ISSUED FOR PERMIT
00051-C.301-0002	CIVIL ACCESS ROAD PLAN	B	03/03/26	CR	PB	ISSUED FOR REVIEW – 90% REVIEW
00051-C.301-0001	CIVIL GRADING PLAN	A	05/29/25	CR	PB	ISSUED FOR REVIEW – 60% REVIEW

audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

TITLE	INITIALS	DATE
DRAWN BY:	CR	05/08/25
DESIGN CHECKER:	DT	06/18/26
DESIGN ENGINEER:	PB	06/18/26
PROJECT MANAGER:	AC	06/18/26

CAPE COD CANAL PIPELINE RELOCATION PROJECT
SAGAMORE M&R RELOCATION
M&R 00051

TITLE: CIVIL GRADING SECTIONS AND DETAILS

LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

YEAR: 2026 | W.O.: | SCALE: AS NOTED | DWG.: 00051-C.301-0003 | REV.: E

ENBRIDGE

Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

S:\AE\Projects\Enbridge\Mass\026356-001\200_Civil_Structural\170_Drawings\Grading\Mainland Sagamore\00051-C.301-0003.dwg – PLOT TIME: 6/18/2026 2:23 PM

Attachment B - Standard 1 Supporting Information

Grass Swales

Sediment Forebays

Infiltration Basin

Level Spreader

Check Dam

Grassed Channel



Description

Grassed Channels are treatment systems with a longer hydraulic residence time than drainage channels. The removal mechanisms are sedimentation and gravity separation, rather than filtration. To receive TSS credit, a sediment forebay or equivalent must be provided for pretreatment. Note that the sediment forebay does not receive a separate TSS removal credit.

Ability to Meet Massachusetts Stormwater Management Standards

Standard	Description
2 - Peak Flow	N/A
3 - Recharge	No infiltration credit
4 - TSS Removal	50% TSS with adequate pretreatment
5 - Higher Pollutant Loading	N/A
6 - Discharges near or to Critical Areas	Not suitable for vernal pools or bathing beaches. At other critical areas, may be used as a pretreatment device.
7 - Redevelopment	Typically not suited for retrofits.

Advantages/Benefits

- Provides pretreatment if used as the first part of a treatment train.
- Open drainage system aids maintenance
- Accepts sheet or pipe flow
- Compatible with LID design measures.
- Little or no entrapment hazard for amphibians or other small animals
- Disadvantages/Limitations
- Short retention time does not allow for full gravity separation
- Limited biofiltration provided by grass lining.
- Cannot alone achieve 80% TSS removal
- Must be designed carefully to achieve low flow rates for Water Quality Volume purposes (<1.0 fps)
- Mosquito control considerations
- Pollutant Removal Efficiencies
- Total Suspended Solids (TSS) 50%[1] for Regulatory Purposes (47%)[2]
- Total phosphorus (TP) -121%[2]
- Total Nitrogen Insufficient Data
- Metals (copper, lead, zinc, cadmium) insufficient Data
- Pathogens (coliform, e. coli) Insufficient Data

Maintenance

Activity	Frequency
Remove sediment from forebay	Annually
Remove sediment from grass channel	Annually
Mow	Once a month during growing season
Repair areas of erosion and revegetate	As needed, but no less than once a year

Special Features

Reduces volume and rate of runoff.

Maintenance

Access

Maintenance access must be designed as part of the grass channel. If located adjacent to a roadway, make the maintenance access at least 15 feet wide, which can also be combined with a breakdown lane along a highway or on- street parking along a residential street. When combined

with on-street parking, post signs prohibiting parking when the swale is to be inspected and cleaned. Do not use travel lanes along highways and streets as the required maintenance access.

Mowing

Set the mower blades no lower than 3 to 4 inches above the ground. Do not mow beneath the depth of the design flow during the storm associated with the water quality event (e.g., if the design flow is no more than 4 inches, do not cut the grass shorter than 4 inches). Mow on an as-needed basis during the growing season so that the grass height does not exceed 6 inches. Inspection: Inspect semi-annually the first year, and at least once a year thereafter. Inspect the grass for growth and the side slopes for signs of erosion and formation of rills and gullies. Plant an alternative grass species if the original grass cover is not successfully established. If grass growth is impaired by winter road salt or other deicer use, re-establish the grass in the spring. Trash/Debris Removal: Remove accumulated trash and debris prior to mowing.

Sediment Removal

Check on a yearly basis and clean as needed. Use hand methods (i.e., a person with a shovel) when cleaning to minimize disturbance to vegetation and underlying soils. Sediment build-up in the grass channel reduces its capacity to treat and convey the water quality event, 2-year and 10-year 24-hour storm.

Sediment Forebays



Description

A sediment forebay is a post-construction practice consisting of an excavated pit, bermed area, or cast structure combined with a weir, designed to slow incoming stormwater runoff and facilitating the gravity separation of suspended solids. This practice is different from a sediment trap used as a construction period BMP.

Ability to Meet Massachusetts Stormwater Management Standards

Standard	Description
2 - Peak Flow	Provides no peak flow attenuation
3 - Recharge	Provides no groundwater recharge
4 - TSS Removal	MassDEP requires a sediment forebay as pretreatment before stormwater is discharged to an extended dry detention basin, wet basin, constructed stormwater wetland or infiltration basin. No separate credit is given for the sediment forebay. For example, extended dry detention basins with sediment forebays receive a credit for 50% TSS removal. Wet basins and constructed stormwater wetlands with sediment forebays receive a credit for 80% TSS removal. When they provide pretreatment for other BMPs, sediment forebays receive a 25% TSS removal credit.
5 - Higher Pollutant Loading	Recommended as a pretreatment BMP
6 - Discharges near or to Critical Areas	Recommended as a pretreatment BMP
7 - Redevelopment	Usually not suitable due to land use constraints

Advantages/Benefits

- Provides pretreatment of runoff before delivery to other BMPs.
- Slows velocities of incoming stormwater.
- Easily accessed for sediment removal.
- Longevity is high with proper maintenance.
- Relatively inexpensive compared to other BMPs.
- Greater detention time than proprietary separators.
- Disadvantages/Limitations
- Removes only coarse sediment fractions.
- No removal of soluble pollutants.
- Provides no recharge to groundwater.
- No control of the volume of runoff.
- Frequent maintenance is essential.
- Pollutant Removal Efficiencies
- Total Suspended Solids (TSS) - 25%.
- Nutrients (Nitrogen, phosphorus) - Insufficient data.
- Metals (copper, lead, zinc, cadmium) - Insufficient data.
- Pathogens (coliform, e coli) - Insufficient data

Maintenance

Sediments and associated pollutants are removed only when sediment forebays are actually cleaned out, so regular maintenance is essential. Frequently removing accumulated sediments will make it less likely that sediments will be resuspended. At a minimum, inspect sediment forebays monthly and clean them out at least four times per year. Stabilize the floor and sidewalls of the sediment forebay before making it operational, otherwise the practice will discharge excess amounts of suspended sediments. When mowing grasses, keep the grass height no greater than 6 inches. Set mower blades no lower than 3 to 4 inches. Check for signs of rilling and gullying and repair as needed. After removing the sediment, replace any vegetation damaged during the clean-out by either reseeding or re-sodding. When reseeding, incorporate practices such as hydroseeding with a tackifier, blanket, or similar practice to ensure that no scour occurs in the forebay, while the seeds germinate and develop roots.

Activity	Frequency
Inspect sediment forebays	Monthly
Clean sediment forebays	Four times per year and when sediment depth is between 3 to 6 feet.

Infiltration-Recharge Basins

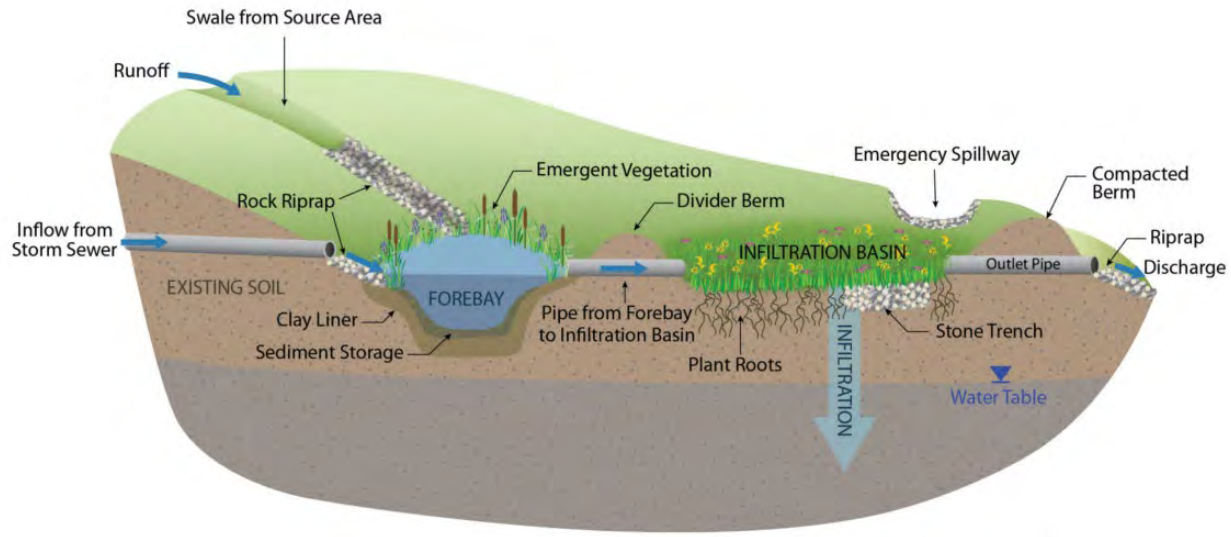


Illustration by Geosyntec Consultants, Inc.

Description

Recharge basins temporarily store runoff, but release at least a portion of that runoff by infiltrating the water into the ground. The recharge volume is stored and allowed to infiltrate into the underlying soils over a period of time following a storm event. The storage volume above this level may be released by an outlet structure designed to bypass all excess flows. Recharge Basins may be designed on-line or off-line. To maintain proper function of an infiltration-recharge basin, it is important to avoid soil compaction.

General Information		
Applicable DEP Stormwater Management Policy Performance Standards	Standards #3 and #4.	
TSS Removal	DEP Credit:	80% (for infiltration basin)
	Estimated Range from Literature:	>90%
Relative Cost	Construction: Moderate to high; varies depending on types soils of contributing drainage area, soils at site of system, storage depth, and type of outlet structure	

	Maintenance: Moderate to high
Potential Constraints to Use	Depth to groundwater Depth to bedrock or other impermeable stratum Suitability of site soils for infiltration
Other Considerations	Pre-treatment must be provided, to prevent clogging of soils surface by sediments in the influent storm water. Frequent maintenance may be required, to remove accumulated sediment and restore infiltrative capacity. Recharge systems can provide high levels of treatment of other pollutants, in addition to TSS removal.
Maintenance Requirements	Inspect a minimum of twice annually. Periodic mowing of embankments Removal of woody vegetation from embankments Removal of debris from outlet structures Clean forebay as required. Clean basin of accumulated sediment as required. Clean flow control structures at least once annually, or as indicated by inspection. Maintain vegetation in healthy condition.

Several of the design criteria regarding setbacks from slopes, foundations, and other site features have been adapted from the requirements for on-site sewage disposal systems described in Massachusetts Title 5 (310 CMR 15.000). However, storm water quantities and flow durations differ markedly from the hydraulic loadings to septic systems. The design engineer should be aware of these differences and may need to consider additional setbacks to provide for slope stability, protect structures, and provide for the satisfactory performance of the recharge system.

Attachment C - Standard 2 Supporting Information

NOAA Altas Rainfall Data

SSA Analysis: Existing and Proposed Conditions

NOAA ATLAS RAINFALL DATA

NOAA Atlas 14, Volume 10, Version 3
Location name: Sagamore Beach, Massachusetts, USA*
Latitude: 41.7807°, Longitude: -70.5404°
Elevation: 70 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sandra Pavlovic, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Orlan Wilhite

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.289 (0.236-0.352)	0.360 (0.293-0.440)	0.477 (0.387-0.584)	0.574 (0.463-0.706)	0.708 (0.552-0.905)	0.807 (0.617-1.05)	0.913 (0.678-1.23)	1.04 (0.722-1.41)	1.23 (0.819-1.71)	1.39 (0.904-1.97)
10-min	0.409 (0.334-0.499)	0.511 (0.416-0.623)	0.677 (0.548-0.828)	0.813 (0.656-1.00)	1.00 (0.782-1.28)	1.14 (0.873-1.49)	1.29 (0.961-1.74)	1.47 (1.02-2.00)	1.74 (1.16-2.43)	1.97 (1.28-2.79)
15-min	0.482 (0.393-0.587)	0.601 (0.489-0.733)	0.795 (0.645-0.974)	0.957 (0.771-1.18)	1.18 (0.920-1.51)	1.34 (1.03-1.75)	1.52 (1.13-2.05)	1.73 (1.20-2.35)	2.05 (1.37-2.86)	2.32 (1.51-3.28)
30-min	0.694 (0.565-0.846)	0.863 (0.703-1.05)	1.14 (0.926-1.40)	1.37 (1.10-1.68)	1.69 (1.32-2.16)	1.92 (1.47-2.51)	2.18 (1.62-2.94)	2.48 (1.72-3.37)	2.93 (1.96-4.09)	3.32 (2.16-4.70)
60-min	0.905 (0.738-1.10)	1.13 (0.917-1.38)	1.49 (1.21-1.82)	1.79 (1.44-2.20)	2.20 (1.72-2.81)	2.50 (1.91-3.27)	2.84 (2.11-3.82)	3.23 (2.24-4.38)	3.82 (2.54-5.32)	4.32 (2.81-6.12)
2-hr	1.22 (1.00-1.48)	1.52 (1.25-1.84)	2.01 (1.64-2.44)	2.42 (1.96-2.95)	2.98 (2.34-3.78)	3.39 (2.61-4.39)	3.84 (2.88-5.14)	4.38 (3.07-5.89)	5.20 (3.51-7.19)	5.91 (3.89-8.29)
3-hr	1.44 (1.19-1.74)	1.79 (1.47-2.16)	2.35 (1.93-2.85)	2.82 (2.30-3.43)	3.47 (2.74-4.38)	3.94 (3.06-5.08)	4.46 (3.37-5.95)	5.08 (3.59-6.80)	6.04 (4.09-8.29)	6.85 (4.54-9.55)
6-hr	1.89 (1.57-2.26)	2.30 (1.91-2.76)	2.98 (2.46-3.58)	3.54 (2.90-4.27)	4.31 (3.43-5.40)	4.88 (3.81-6.23)	5.50 (4.18-7.24)	6.23 (4.44-8.25)	7.33 (5.03-9.96)	8.27 (5.54-11.4)
12-hr	2.40 (2.00-2.85)	2.86 (2.39-3.40)	3.62 (3.01-4.32)	4.25 (3.52-5.09)	5.12 (4.10-6.34)	5.77 (4.53-7.26)	6.46 (4.93-8.37)	7.24 (5.22-9.49)	8.38 (5.81-11.3)	9.32 (6.31-12.7)
24-hr	2.89 (2.43-3.41)	3.41 (2.87-4.03)	4.27 (3.58-5.06)	4.98 (4.15-5.92)	5.96 (4.81-7.30)	6.70 (5.29-8.33)	7.47 (5.72-9.54)	8.31 (6.06-10.8)	9.50 (6.67-12.6)	10.5 (7.17-14.1)
2-day	3.33 (2.82-3.91)	3.93 (3.33-4.62)	4.92 (4.15-5.78)	5.73 (4.81-6.76)	6.85 (5.57-8.33)	7.70 (6.14-9.50)	8.58 (6.64-10.8)	9.54 (7.03-12.3)	10.9 (7.72-14.3)	12.0 (8.29-16.0)
3-day	3.66 (3.11-4.27)	4.28 (3.64-5.00)	5.31 (4.50-6.22)	6.16 (5.20-7.24)	7.34 (5.99-8.87)	8.23 (6.58-10.1)	9.15 (7.11-11.5)	10.1 (7.52-12.9)	11.5 (8.23-15.1)	12.6 (8.81-16.7)
4-day	3.94 (3.36-4.58)	4.58 (3.91-5.33)	5.63 (4.78-6.57)	6.50 (5.49-7.61)	7.69 (6.30-9.26)	8.60 (6.91-10.5)	9.54 (7.43-11.9)	10.5 (7.85-13.4)	11.9 (8.55-15.5)	13.0 (9.12-17.2)
7-day	4.67 (4.01-5.41)	5.34 (4.58-6.18)	6.42 (5.49-7.45)	7.32 (6.23-8.53)	8.57 (7.06-10.2)	9.52 (7.68-11.5)	10.5 (8.20-12.9)	11.5 (8.62-14.5)	12.8 (9.28-16.5)	13.8 (9.80-18.1)
10-day	5.35 (4.61-6.17)	6.04 (5.20-6.97)	7.17 (6.16-8.29)	8.11 (6.92-9.40)	9.40 (7.78-11.2)	10.4 (8.42-12.5)	11.4 (8.94-13.9)	12.4 (9.36-15.5)	13.7 (9.99-17.6)	14.7 (10.5-19.1)
20-day	7.37 (6.40-8.43)	8.15 (7.08-9.34)	9.44 (8.16-10.8)	10.5 (9.04-12.1)	12.0 (9.98-14.1)	13.1 (10.7-15.6)	14.2 (11.2-17.2)	15.3 (11.7-19.0)	16.6 (12.3-21.1)	17.6 (12.7-22.6)
30-day	9.07 (7.91-10.3)	9.94 (8.66-11.3)	11.4 (9.87-13.0)	12.5 (10.8-14.4)	14.2 (11.9-16.5)	15.4 (12.7-18.2)	16.7 (13.2-20.0)	17.8 (13.7-21.9)	19.2 (14.3-24.1)	20.1 (14.6-25.7)
45-day	11.2 (9.83-12.7)	12.2 (10.7-13.8)	13.8 (12.0-15.7)	15.1 (13.1-17.2)	16.9 (14.2-19.6)	18.4 (15.1-21.5)	19.7 (15.7-23.4)	20.9 (16.2-25.6)	22.3 (16.7-27.9)	23.3 (17.0-29.5)
60-day	13.1 (11.5-14.8)	14.1 (12.4-16.0)	15.8 (13.9-18.0)	17.3 (15.0-19.6)	19.2 (16.3-22.3)	20.8 (17.2-24.3)	22.3 (17.8-26.3)	23.5 (18.3-28.7)	25.0 (18.8-31.1)	25.9 (19.0-32.7)

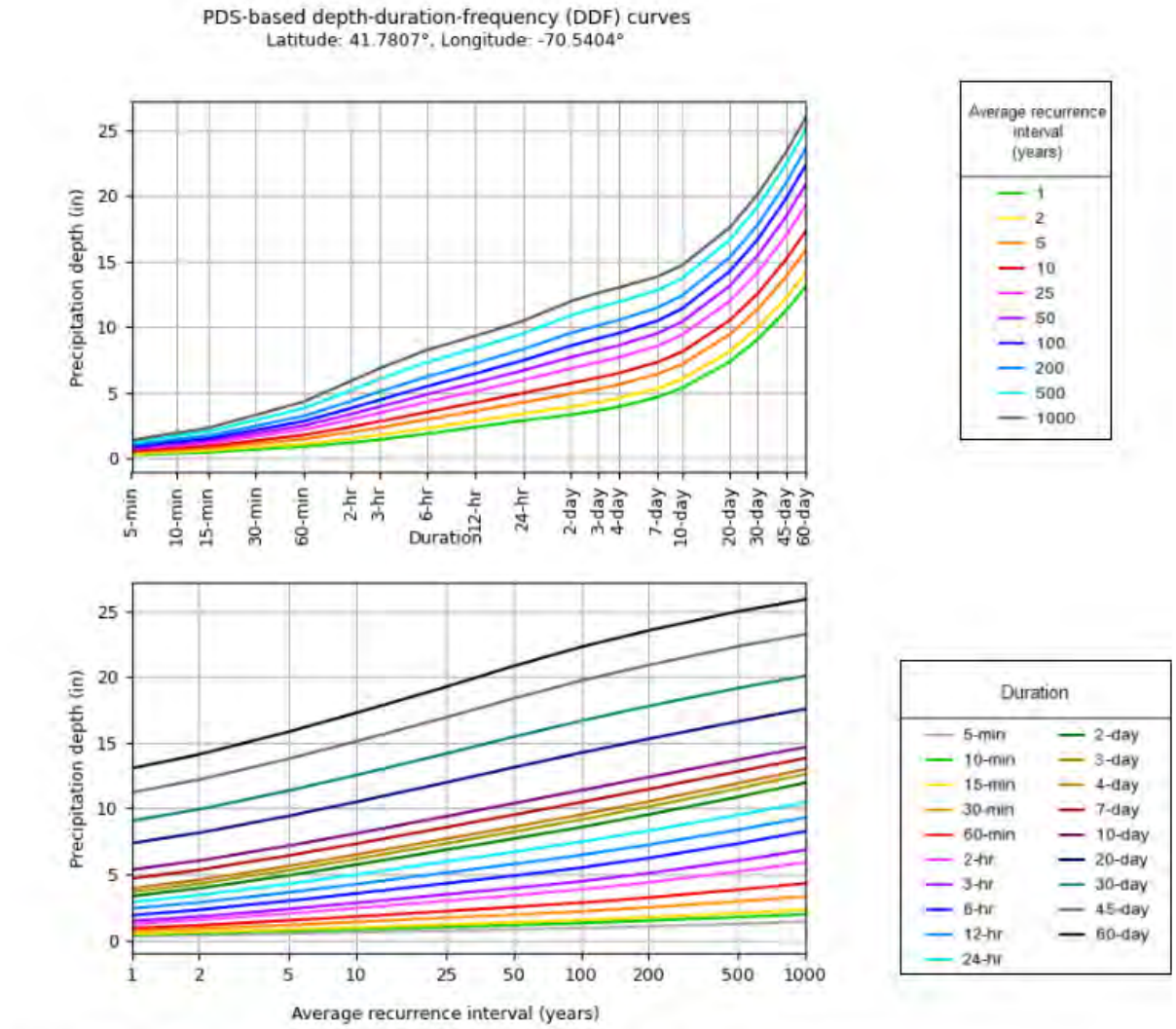
[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

Back to Top

PF graphical



NOAA Atlas 14, Volume 10, Version 3

Created (GMT): Wed Apr 15 17:15:38 2026

Back to Top

Maps & aerials

Small scale terrain



Large scale terrain



Large scale map



Large scale aerial



SSA Analysis Existing and Proposed

Project Description

File Name ..... Sagamore_Entire.Site.SPF

Project Options

Flow Units ..... CFS
Elevation Type ..... Elevation
Hydrology Method ..... SCS TR-20
Time of Concentration (TOC) Method ..... SCS TR-55
Link Routing Method ..... Hydrodynamic
Enable Overflow Ponding at Nodes ..... YES
Skip Steady State Analysis Time Periods ..... NO

Analysis Options

Start Analysis On ..... oct. 14, 2021 0:00:00
End Analysis On ..... oct. 17, 2021 0:00:00
Start Reporting On ..... oct. 14, 2021 0:00:00
Antecedent Dry Days ..... 0 days
Runoff (Dry Weather) Time Step ..... 0 01:00:00 days hh:mm:ss
Runoff (Wet Weather) Time Step ..... 0 00:05:00 days hh:mm:ss
Reporting Time Step ..... 0 00:05:00 days hh:mm:ss
Routing Time Step ..... 30 seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	13
Nodes	18
Junctions	0
Outfalls	10
Flow Diversions	0
Inlets	0
Storage Nodes	8
Links	8
Channels	0
Pipes	0
Pumps	0
Orifices	1
Weirs	7
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	2 years	Intensity	inches	Massachusetts	None	2.00	3.41	SCS Type III 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	A1	1.20	484.00	76.00	3.41	1.30	1.56	1.61	0 00:06:00
2	A1-1	0.39	484.00	98.00	3.41	3.18	1.24	1.03	0 00:10:55
3	A1-2	1.34	484.00	54.63	3.41	0.30	0.41	0.18	0 00:06:00
4	A1-3	1.03	484.00	49.00	3.41	0.15	0.15	0.02	0 00:40:16
5	A2	0.92	484.00	76.00	3.41	1.30	1.20	1.23	0 00:06:00
6	A-3	0.25	484.00	51.70	3.41	0.22	0.05	0.01	0 00:36:07
7	DA-Ditch-A1	1.35	484.00	76.00	3.41	1.30	1.76	1.81	0 00:06:00
8	DA-Ditch-A1-2	1.29	484.00	76.00	3.41	1.30	1.68	1.73	0 00:06:00
9	DA-Ditch-A2	0.67	484.00	76.00	3.41	1.30	0.87	0.90	0 00:06:00
10	Existing-E03-1_A1	0.89	484.00	49.00	3.41	0.15	0.13	0.02	0 00:34:49
11	Existing-E-07_A3	0.39	484.00	51.70	3.41	0.22	0.09	0.02	0 00:36:29
12	Existing-E3_A1-2	3.20	484.00	49.00	3.41	0.15	0.48	0.07	0 00:42:52
13	Existing-E5.1_A2	0.26	484.00	49.00	3.41	0.15	0.04	0.01	0 00:14:30

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Existing-Oufall-E3-1_Weir-B1	Outfall	0.00					0.02	0.00					
2	Existing-Outfall-E3_1	Outfall	0.00					0.00	0.00					
3	Existing-Outfall-E5.1_2	Outfall	0.00					0.01	0.00					
4	Existing-Outfall-E7_3	Outfall	0.00					0.02	0.00					
5	Out-D1	Outfall	0.00					1.72	0.00					
6	Out-D2	Outfall	0.00					0.86	0.00					
7	Out-D3	Outfall	0.00					1.65	0.00					
8	Proposed-Outfall.1	Outfall	0.00					0.00	0.00					
9	Proposed-Outfall.2	Outfall	60.00					0.00	60.00					
10	Proposed-Outfall.3	Outfall	0.00					0.01	0.00					
11	A1-1-BASIN	Storage Node	66.00	69.00	66.00		0.00	1.00	68.06				0.00	0.00
12	BASIN-1	Storage Node	63.00	69.00	63.00		0.00	1.53	65.08				0.00	0.00
13	BASIN-2	Storage Node	63.00	67.00	63.00		0.00	0.01	63.01				0.00	0.00
14	Exist-Catch-Basin	Storage Node	43.00	53.00	43.00		0.00	0.07	44.00				0.00	0.00
15	Existing-Catch-Basin	Storage Node	43.00	53.00	43.00		0.00	0.15	44.04				0.00	0.00
16	FOREBAY-1	Storage Node	66.00	70.00	66.00		0.00	1.53	67.23				0.00	0.00
17	FOREBAY-1-2	Storage Node	62.00	66.00	62.00		0.00	0.18	63.08				0.00	0.00
18	FOREBAY-2	Storage Node	65.00	69.00	65.00		0.00	1.18	68.00				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(ft)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
1	12RCP	Orifice	A1-1-BASIN	FOREBAY-1		66.00	66.00		1.000		0.04							
2	Exist-Catch-Basin-Weir	Weir	Exist-Catch-Basin	Existing-Outfall-E3_1		43.00	0.00				0.00							
3	Existing-Catch-Basin-Weir	Weir	Existing-Catch-Basin	Proposed-Outfall.1		43.00	0.00				0.00							
4	Weir-B1	Weir	BASIN-1	FOREBAY-1-2		63.00	62.00				0.00							
5	Weir-B2	Weir	BASIN-2	Proposed-Outfall.2		63.00	60.00				0.00							
6	Weir-F1	Weir	FOREBAY-1	BASIN-1		66.00	63.00				1.53							
7	Weir-F1-2	Weir	FOREBAY-1-2	Existing-Catch-Basin		62.00	43.00				0.15							
8	Weir-F2	Weir	FOREBAY-2	BASIN-2		65.00	63.00				0.01							

Subbasin Hydrology

Subbasin : A1

Input Data

Area (ac) 1.2
Peak Rate Factor 484
Weighted Curve Number 76
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	1.2	A	76
Composite Area & Weighted CN	1.2		76

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft^2)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	300	0	0
Slope (%) :	1.51	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	1.23	0	0
Computed Flow Time (min) :	4.05	0	0

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	20.6	0	0
Slope (%) :	1.86	0	0
Surface Type :	Unpaved	Unpaved	Unpaved
Velocity (ft/sec) :	2.2	0	0
Computed Flow Time (min) :	0.16	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	99.64	0	0
Channel Slope (%) :	0.5	0	0
Cross Section Area (ft^2) :	29.79	0	0
Wetted Perimeter (ft) :	20.98	0	0
Velocity (ft/sec) :	4.44	0	0
Computed Flow Time (min) :	0.37	0	0

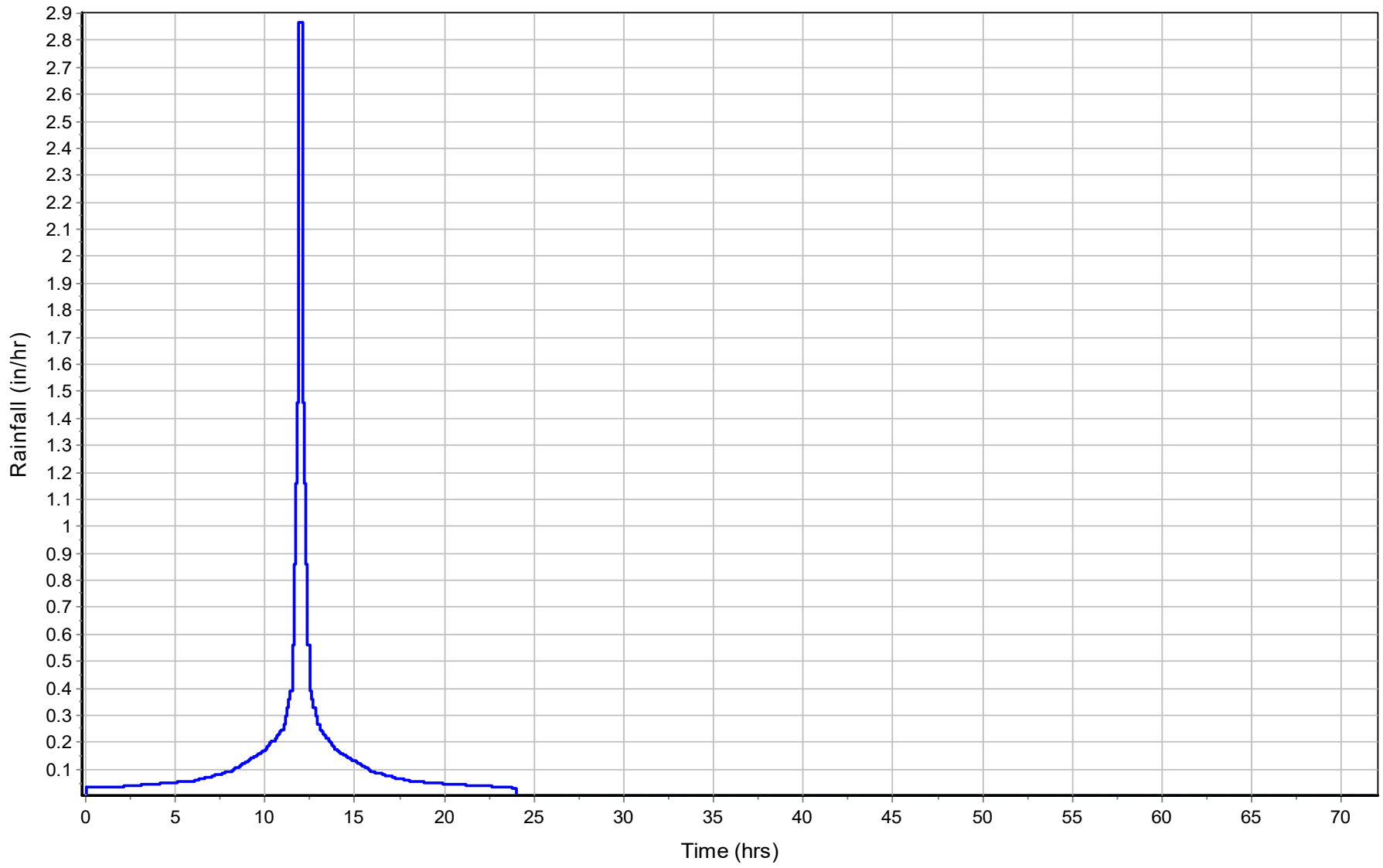
Total TOC (min) 4.58

Subbasin Runoff Results

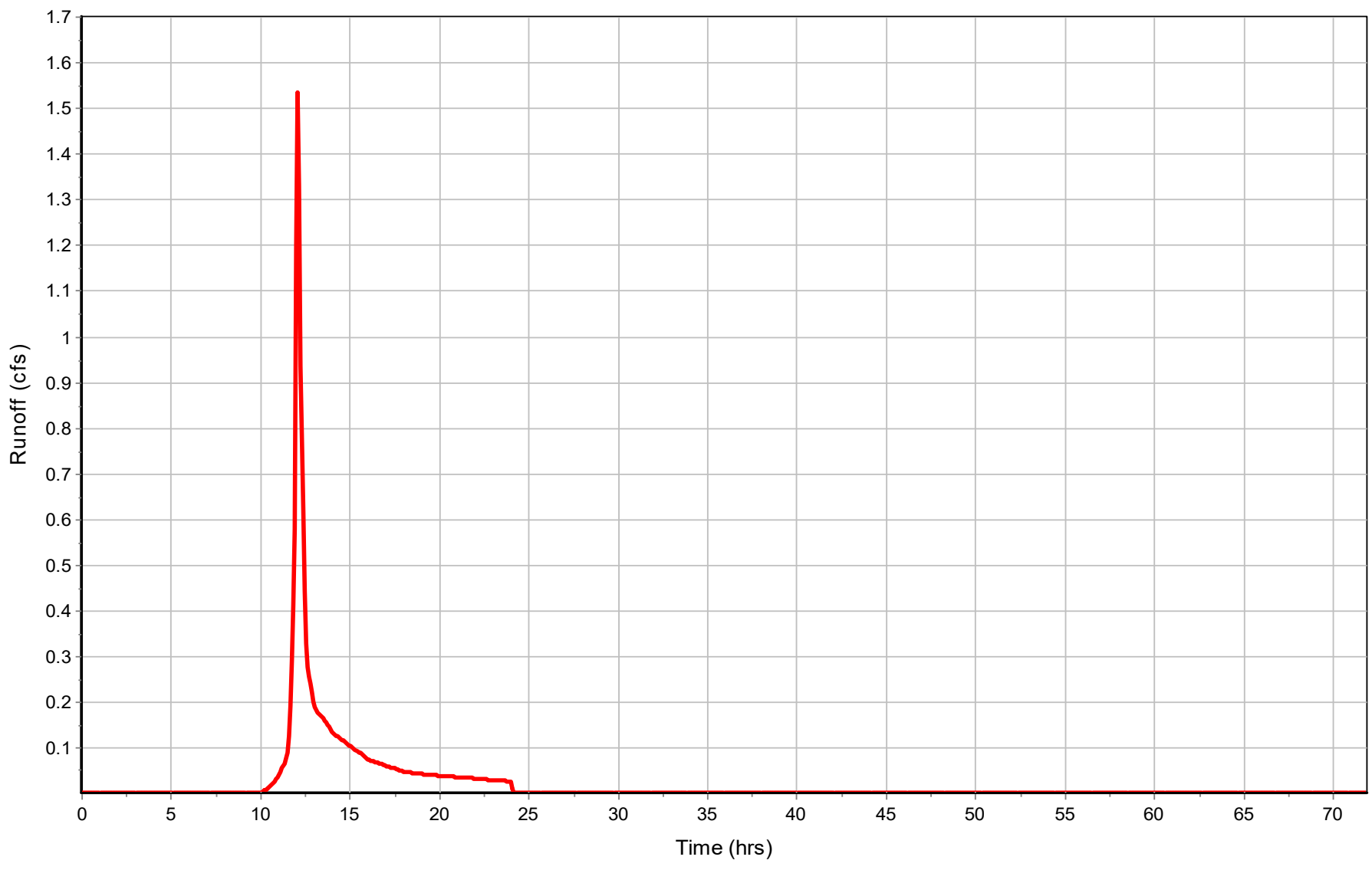
Total Rainfall (in) 3.41
Total Runoff (in) 1.3
Peak Runoff (cfs) 1.61
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:04:35

Subbasin : A1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : A1-1

Input Data

Area (ac) 0.39
Peak Rate Factor 484
Weighted Curve Number 98
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Paved parking & roofs	0.39	A	98
Composite Area & Weighted CN	0.39		98

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.05	0	0
Flow Length (ft) :	178.81	0	0
Slope (%) :	0.5	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.27	0	0
Computed Flow Time (min) :	10.92	0	0

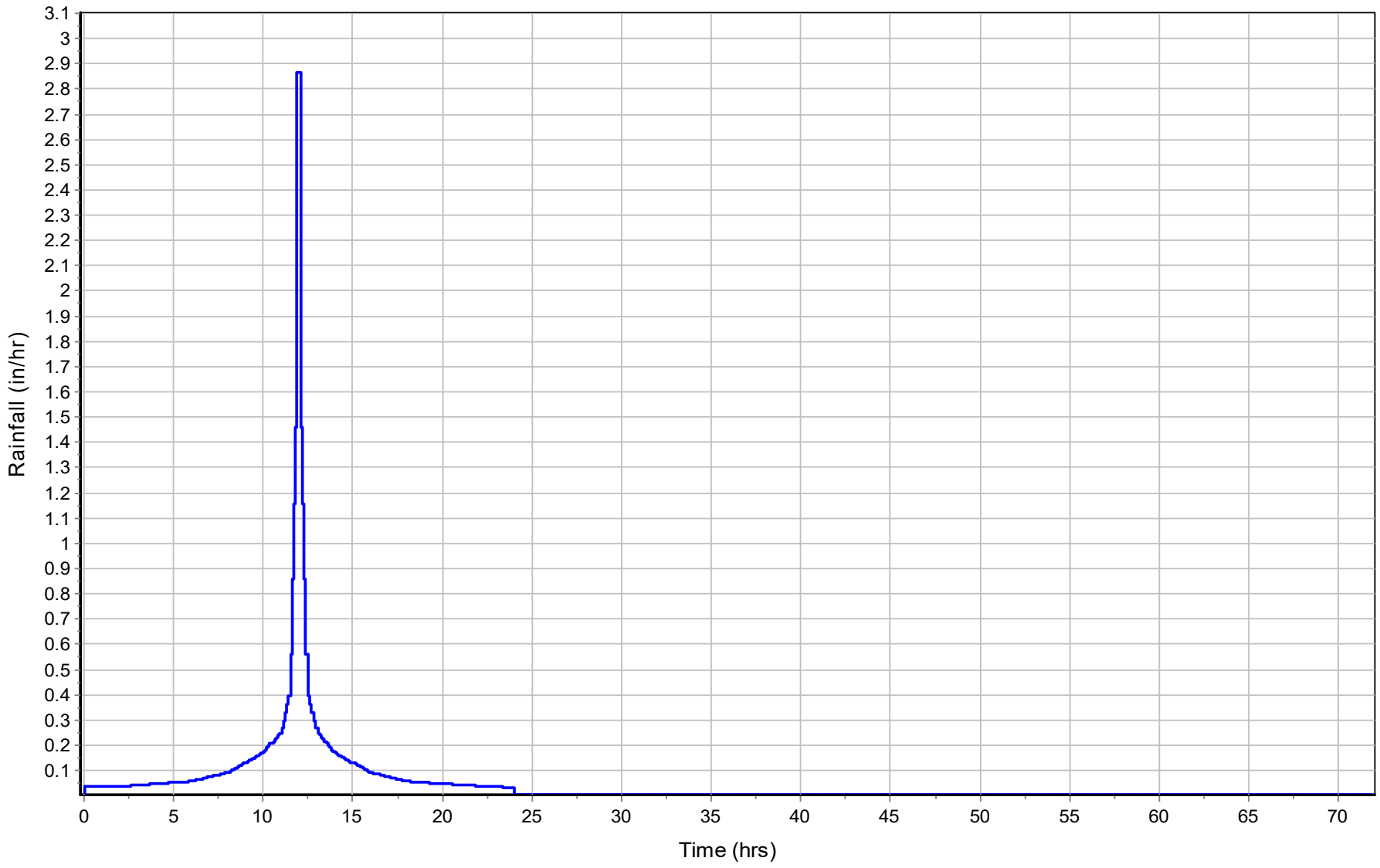
Total TOC (min) 10.92

Subbasin Runoff Results

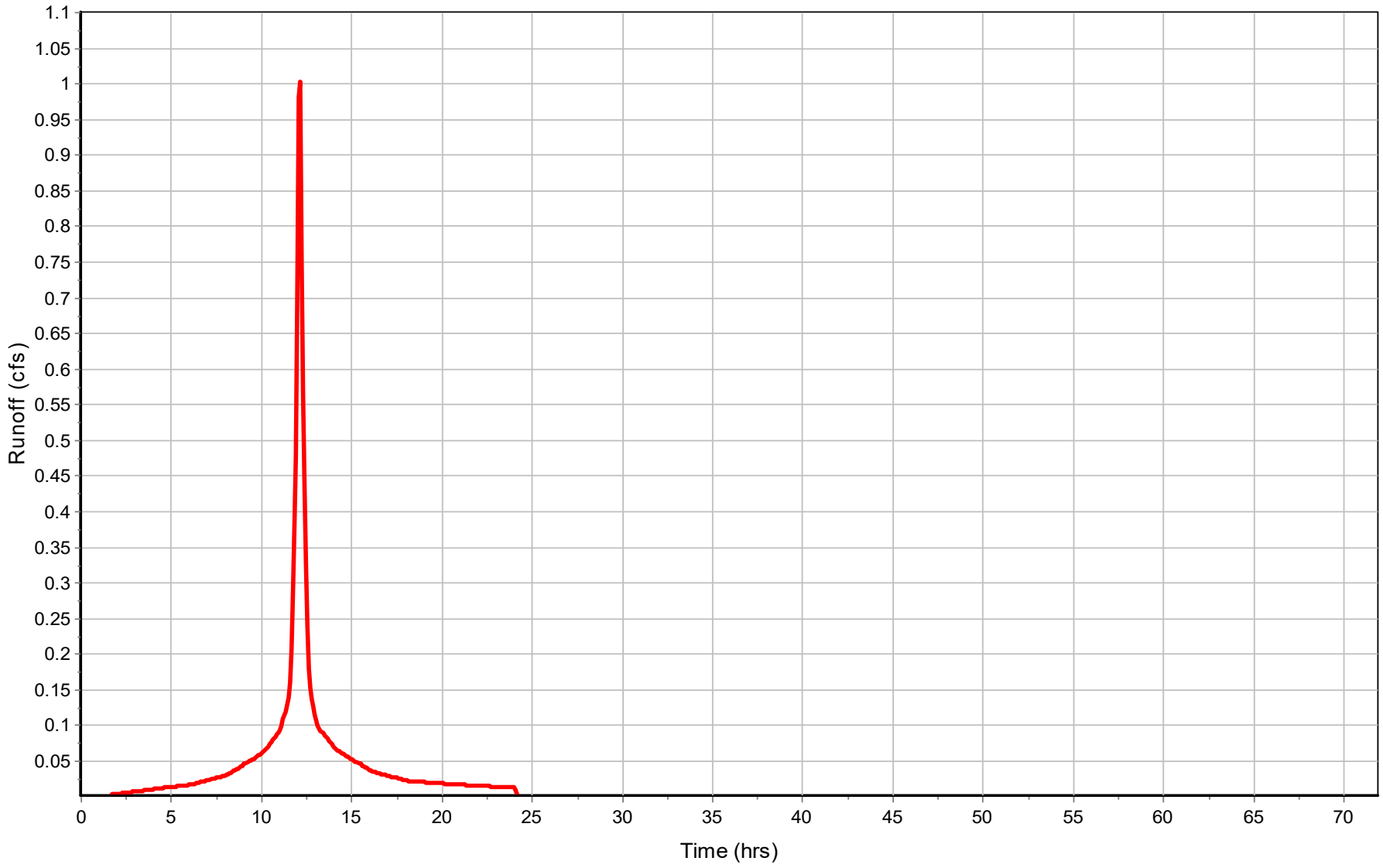
Total Rainfall (in) 3.41
Total Runoff (in) 3.18
Peak Runoff (cfs) 1.03
Weighted Curve Number 98
Time of Concentration (days hh:mm:ss) 0 00:10:55

Subbasin : A1-1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : A1-2

Input Data

Area (ac) 1.34
Peak Rate Factor 484
Weighted Curve Number 54.63
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	0.28	A	76
-	1.06	-	49
Composite Area & Weighted CN	1.34		54.63

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	131.55	0	0
Slope (%) :	4	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	1.54	0	0
Computed Flow Time (min) :	1.42	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	358.95	0	0
Channel Slope (%) :	0.3	0	0
Cross Section Area (ft^2) :	13.52	0	0
Wetted Perimeter (ft) :	11.63	0	0
Velocity (ft/sec) :	3.01	0	0
Computed Flow Time (min) :	1.99	0	0

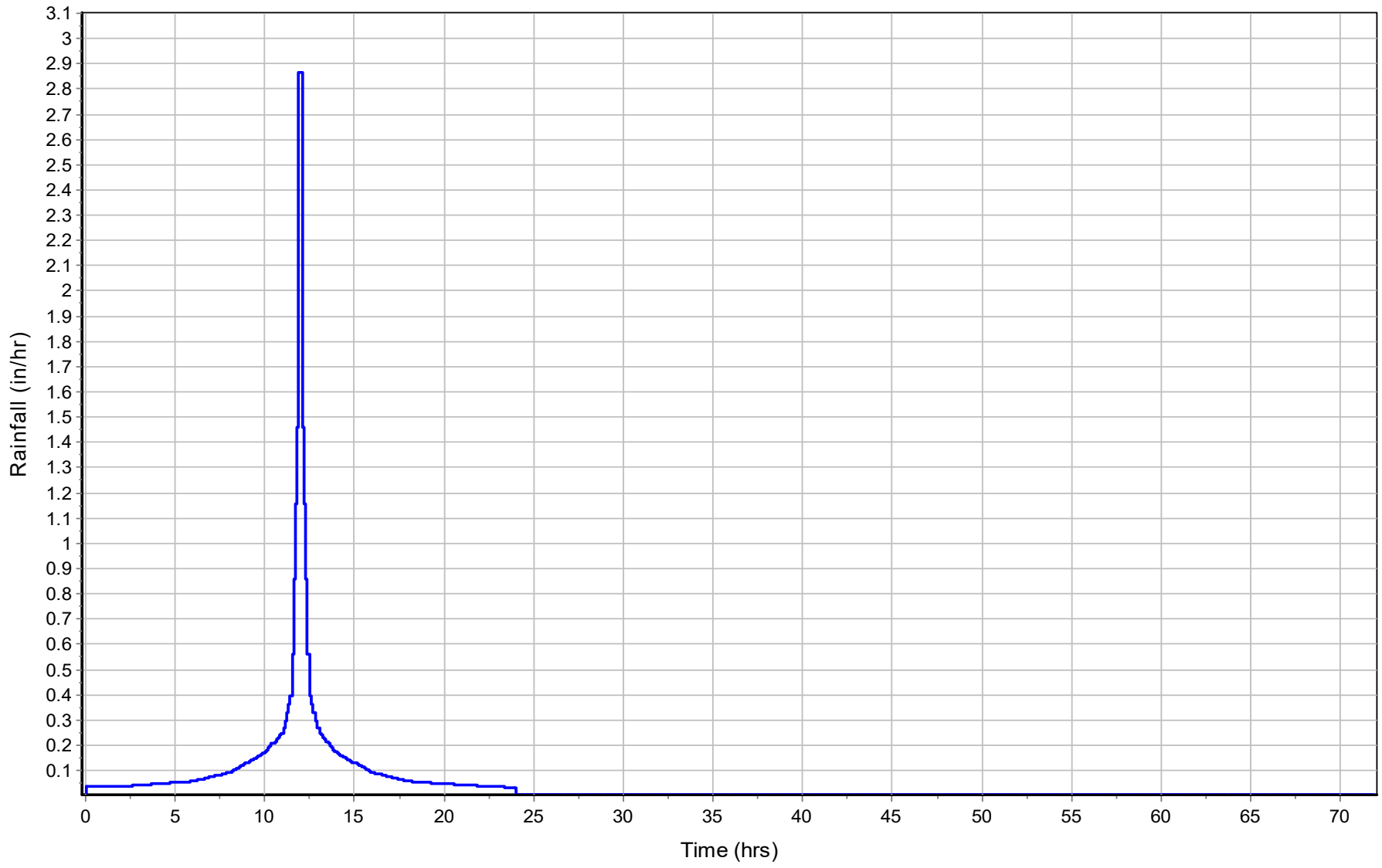
Total TOC (min) 3.41

Subbasin Runoff Results

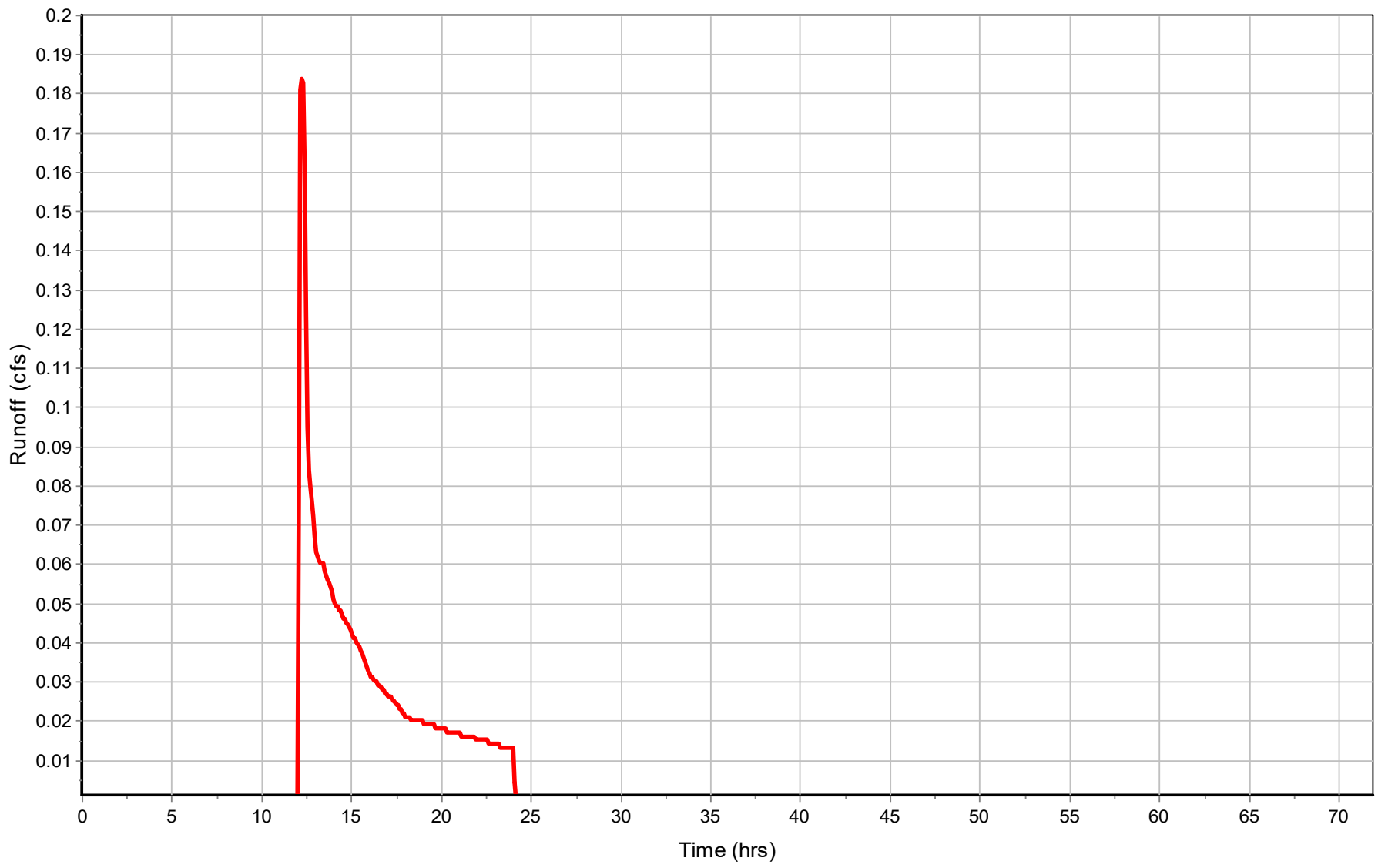
Total Rainfall (in) 3.41
Total Runoff (in) 0.3
Peak Runoff (cfs) 0.18
Weighted Curve Number 54.63
Time of Concentration (days hh:mm:ss) 0 00:03:25

Subbasin : A1-2

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : A1-3

Input Data

Area (ac) 1.03
Peak Rate Factor 484
Weighted Curve Number 49
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	1.03	A	49
Composite Area & Weighted CN	1.03		49

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.4	0	0
Flow Length (ft) :	300	0	0
Slope (%) :	4	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.13	0	0
Computed Flow Time (min) :	37.97	0	0

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	13.33	0	0
Slope (%) :	4	0	0
Surface Type :	Grassed waterway	Unpaved	Unpaved
Velocity (ft/sec) :	3	0	0
Computed Flow Time (min) :	0.07	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	403.18	0	0
Channel Slope (%) :	0.3	0	0
Cross Section Area (ft^2) :	13.52	0	0
Wetted Perimeter (ft) :	11.63	0	0
Velocity (ft/sec) :	3.01	0	0
Computed Flow Time (min) :	2.23	0	0

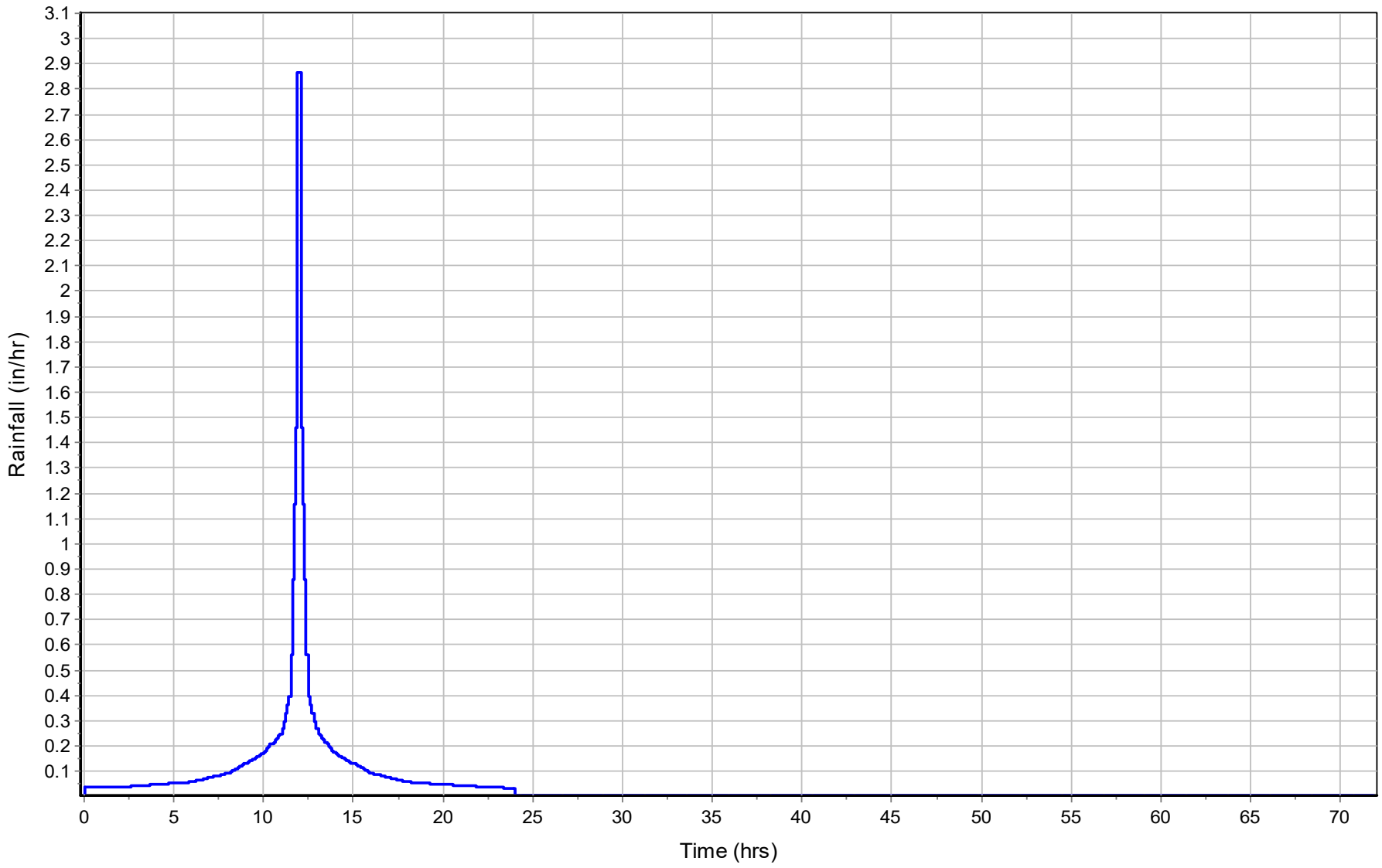
Total TOC (min) 40.27

Subbasin Runoff Results

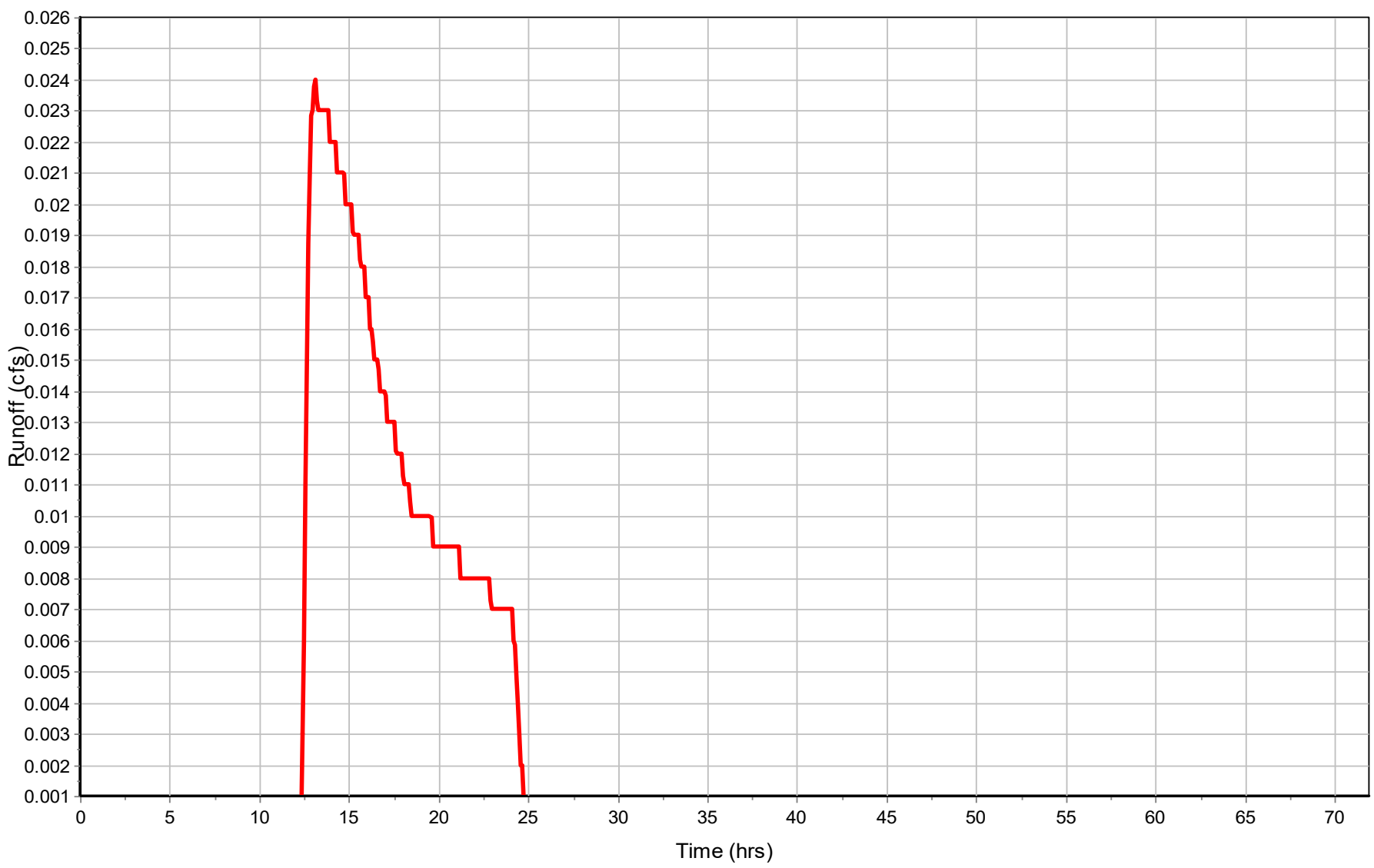
Total Rainfall (in) 3.41
Total Runoff (in) 0.15
Peak Runoff (cfs) 0.02
Weighted Curve Number 49
Time of Concentration (days hh:mm:ss) 0 00:40:16

Subbasin : A1-3

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : A2

Input Data

Area (ac) 0.92
Peak Rate Factor 484
Weighted Curve Number 76
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	0.92	A	76
Composite Area & Weighted CN	0.92		76

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	85.5	0	0
Slope (%) :	1.5	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.96	0	0
Computed Flow Time (min) :	1.49	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	255.68	0	0
Channel Slope (%) :	1.17	0	0
Cross Section Area (ft^2) :	1.475	0	0
Wetted Perimeter (ft) :	5.99	0	0
Velocity (ft/sec) :	2.11	0	0
Computed Flow Time (min) :	2.02	0	0

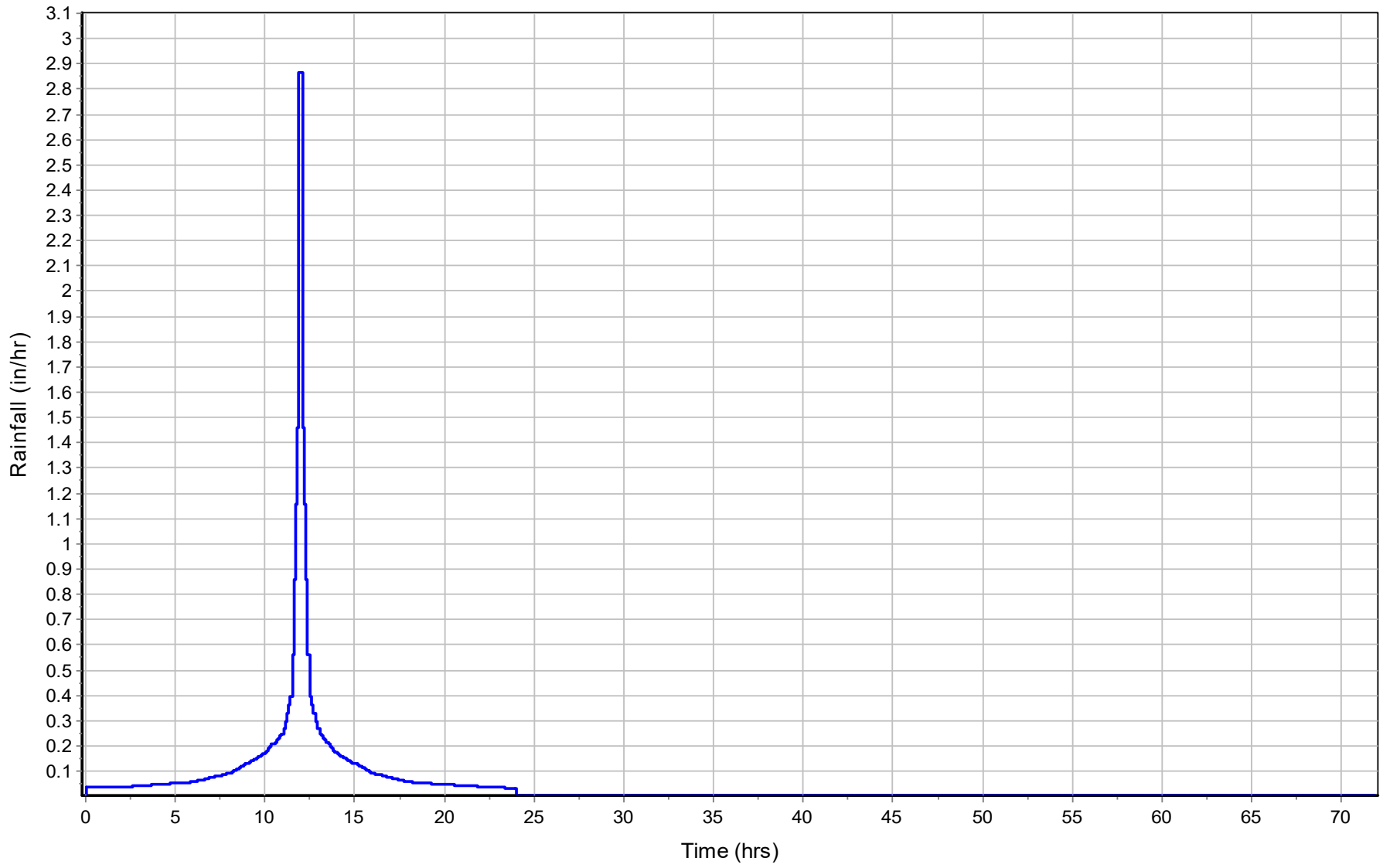
Total TOC (min) 3.51

Subbasin Runoff Results

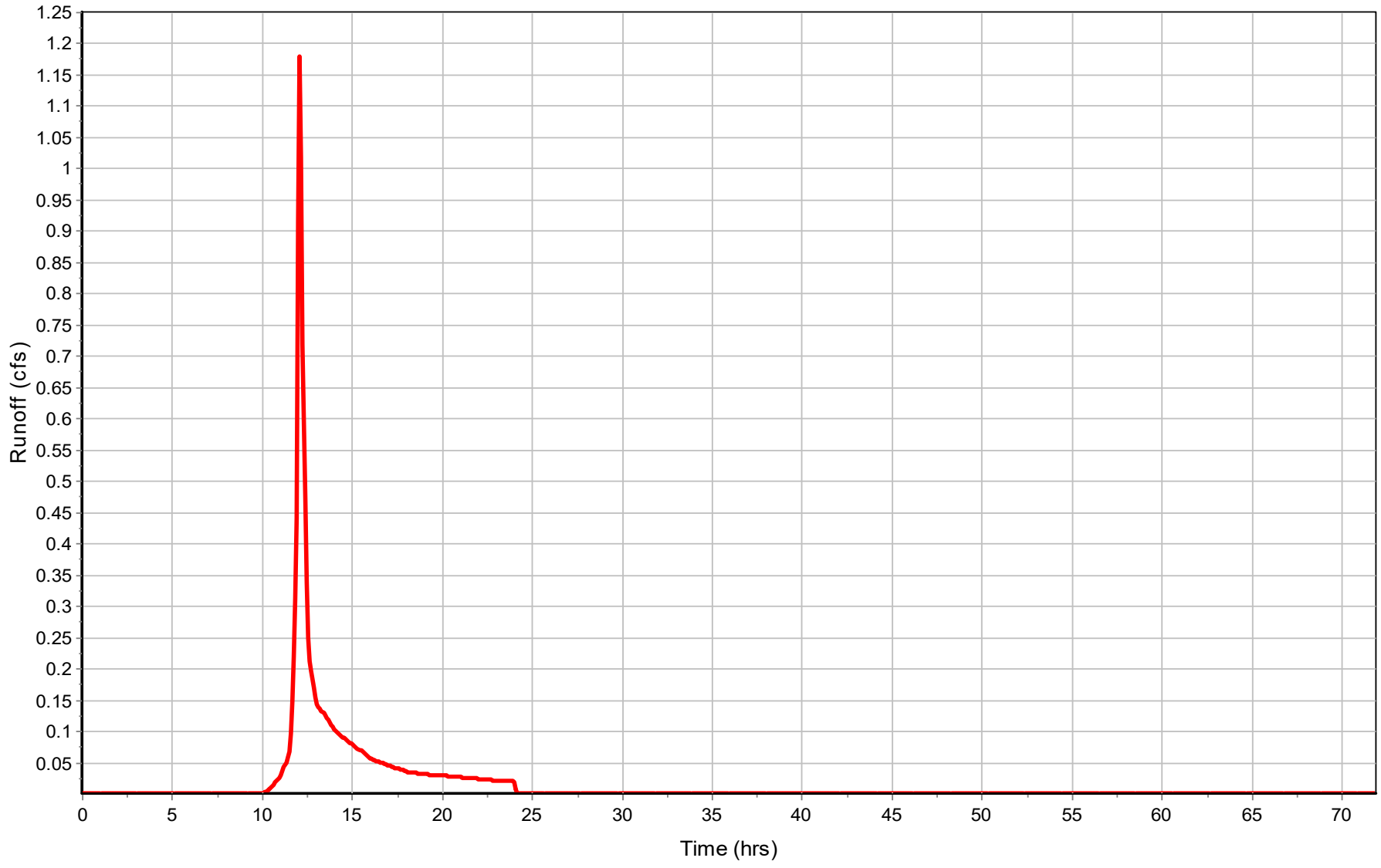
Total Rainfall (in) 3.41
Total Runoff (in) 1.3
Peak Runoff (cfs) 1.23
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:03:31

Subbasin : A2

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : A-3

Input Data

Area (ac) 0.25
Peak Rate Factor 484
Weighted Curve Number 51.7
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
-	0.23	-	49
-	0.03	-	76
Composite Area & Weighted CN	0.26		51.7

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.4	0	0
Flow Length (ft) :	300	0	0
Slope (%) :	5	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.14	0	0
Computed Flow Time (min) :	34.72	0	0

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	83.1895	0	0
Slope (%) :	2	0	0
Surface Type :	Grass pasture	Unpaved	Unpaved
Velocity (ft/sec) :	0.99	0	0
Computed Flow Time (min) :	1.4	0	0

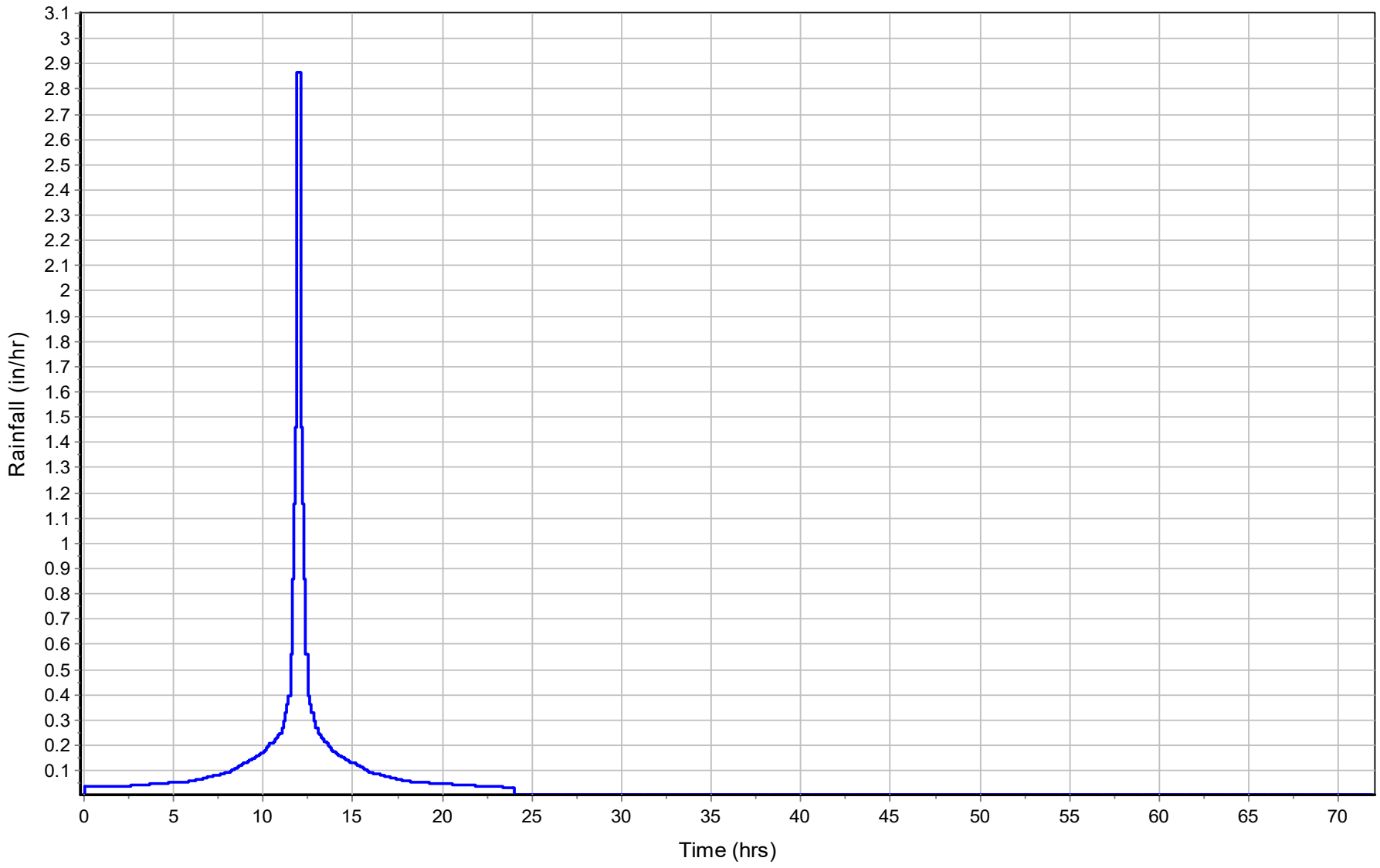
Total TOC (min) 36.12

Subbasin Runoff Results

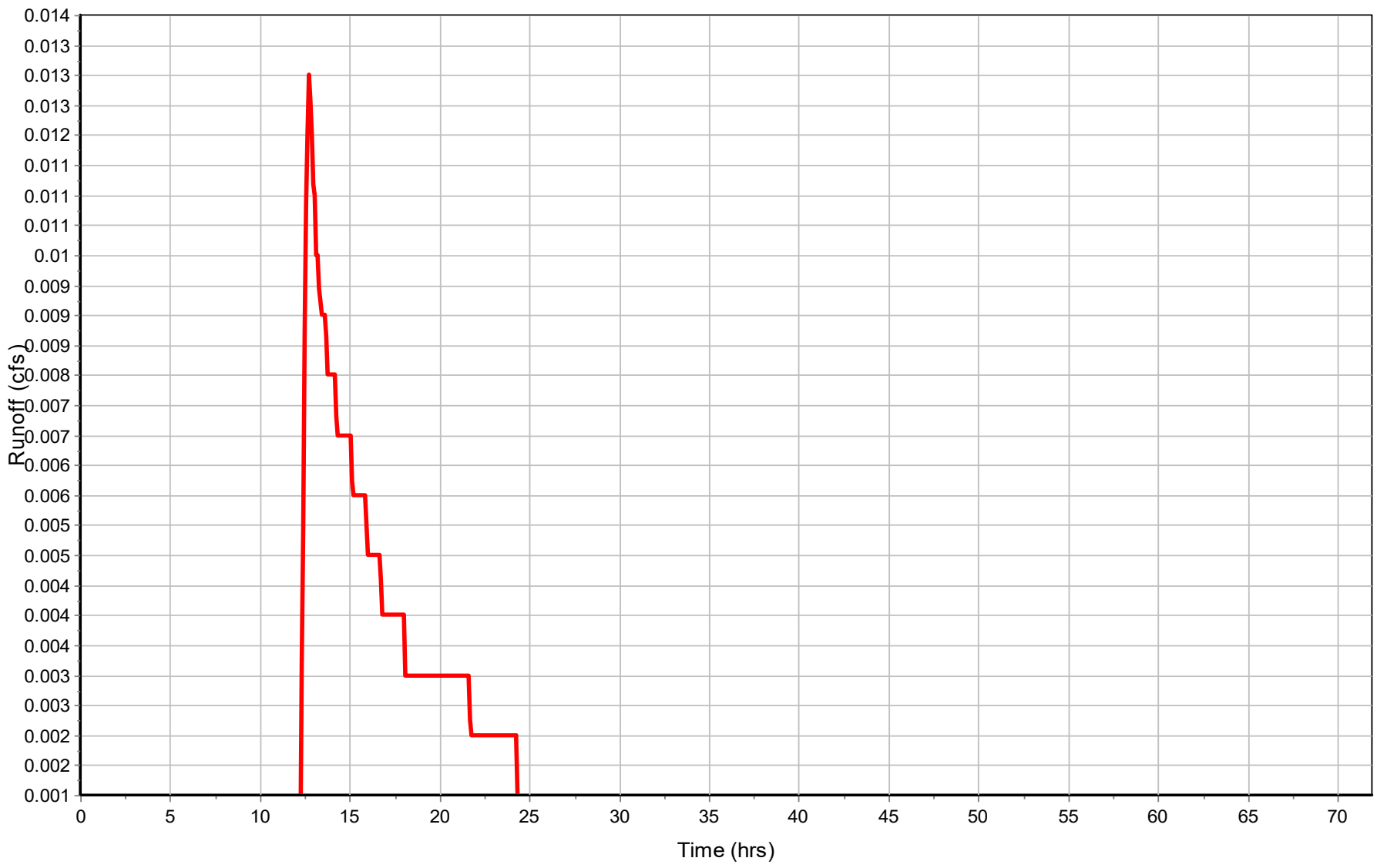
Total Rainfall (in) 3.41
Total Runoff (in) 0.22
Peak Runoff (cfs) 0.01
Weighted Curve Number 51.7
Time of Concentration (days hh:mm:ss) 0 00:36:07

Subbasin : A-3

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : DA-Ditch-A1

Input Data

Area (ac) 1.35
Peak Rate Factor 484
Weighted Curve Number 76
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
50 - 75% grass cover, Fair	1.35	A	76
Composite Area & Weighted CN	1.35		76

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	217.17	0	0
Slope (%) :	1.5	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	1.15	0	0
Computed Flow Time (min) :	3.14	0	0

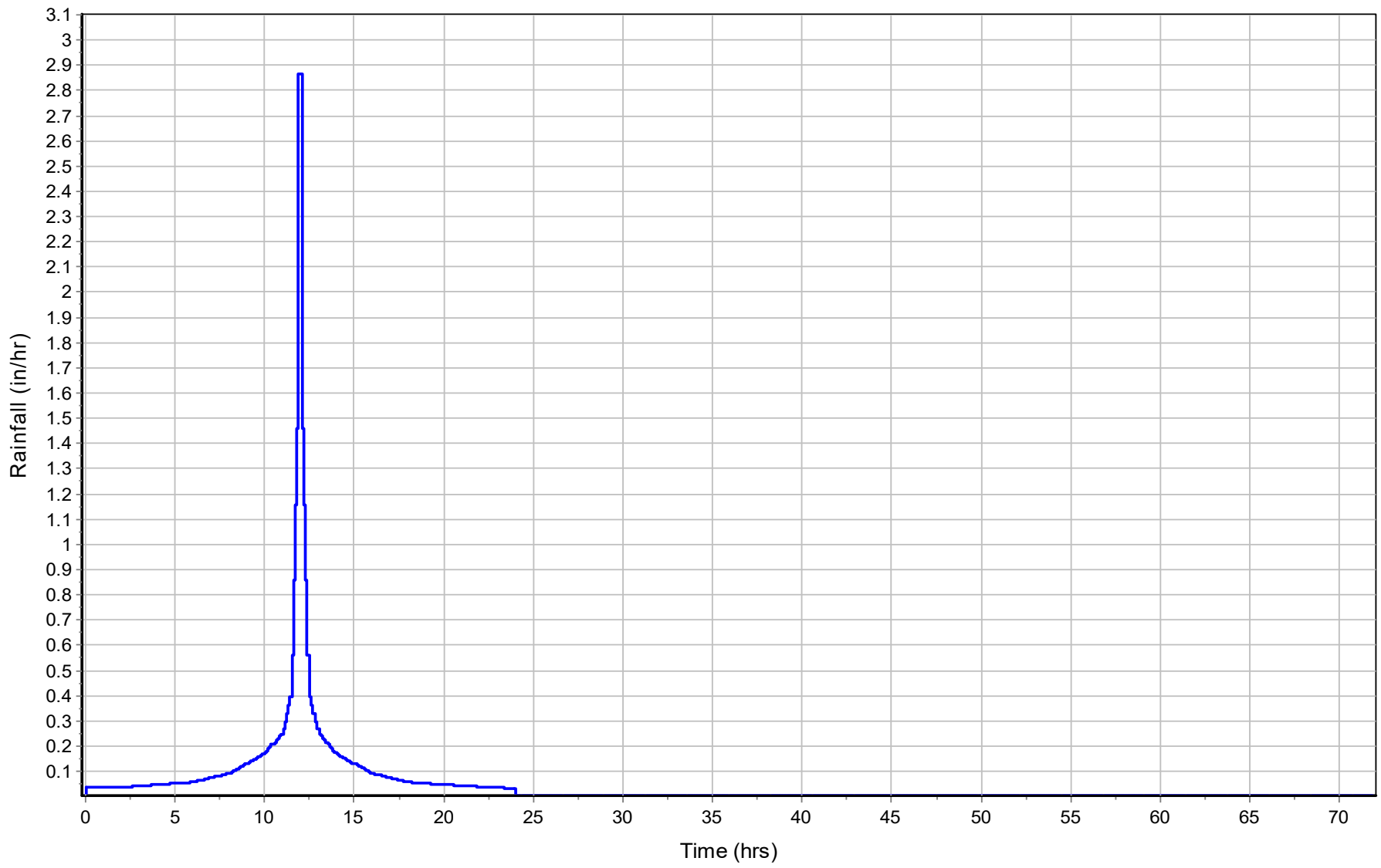
Total TOC (min) 3.14

Subbasin Runoff Results

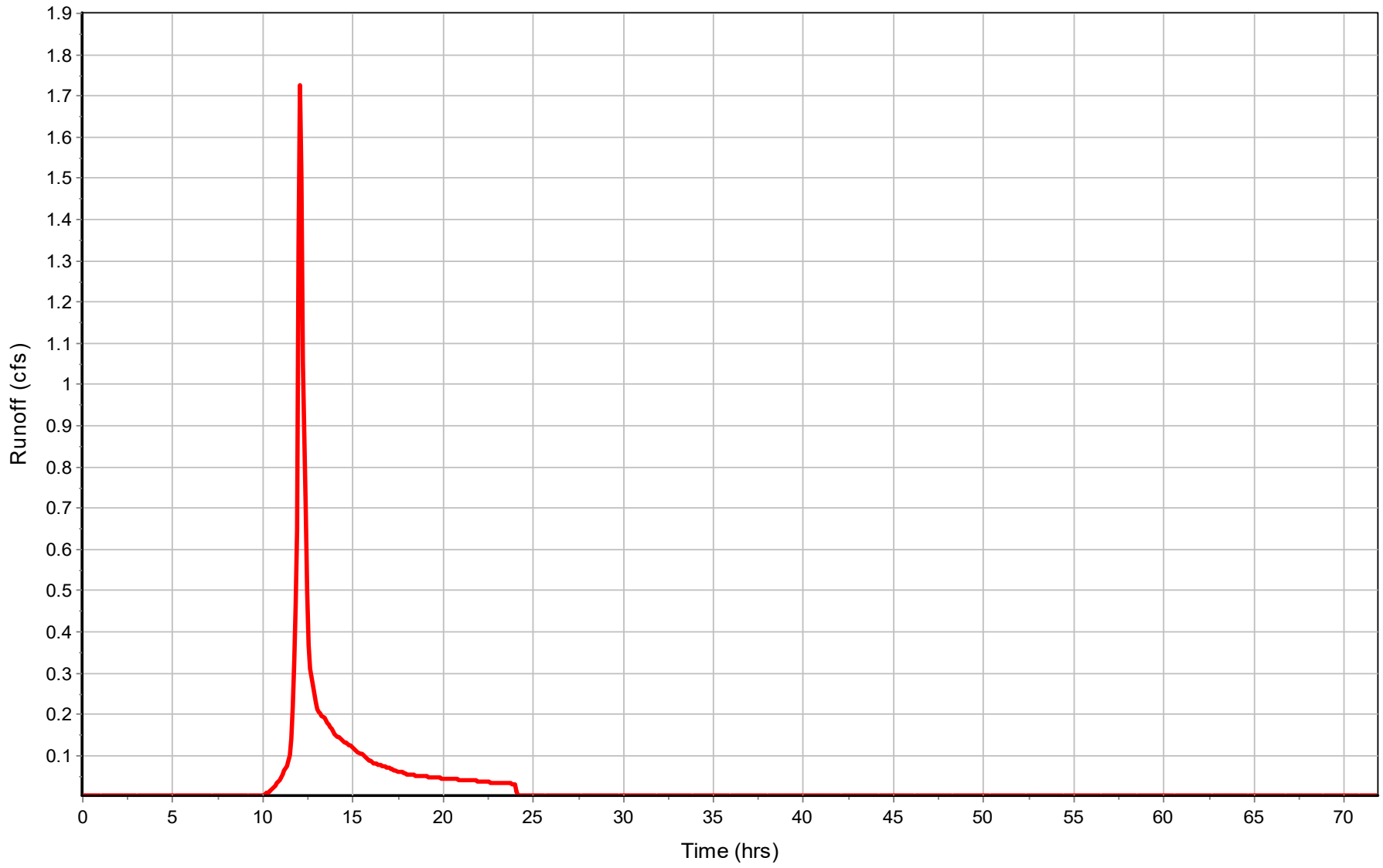
Total Rainfall (in) 3.41
Total Runoff (in) 1.3
Peak Runoff (cfs) 1.81
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:03:08

Subbasin : DA-Ditch-A1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : DA-Ditch-A1-2

Input Data

Area (ac) 1.29
Peak Rate Factor 484
Weighted Curve Number 76
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
50 - 75% grass cover, Fair	1.29	A	76
Composite Area & Weighted CN	1.29		76

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	131.55	0	0
Slope (%) :	1.5	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	1.04	0	0
Computed Flow Time (min) :	2.1	0	0

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	7.88	0	0
Slope (%) :	1.5	0	0
Surface Type :	Unpaved	Unpaved	Unpaved
Velocity (ft/sec) :	1.98	0	0
Computed Flow Time (min) :	0.07	0	0

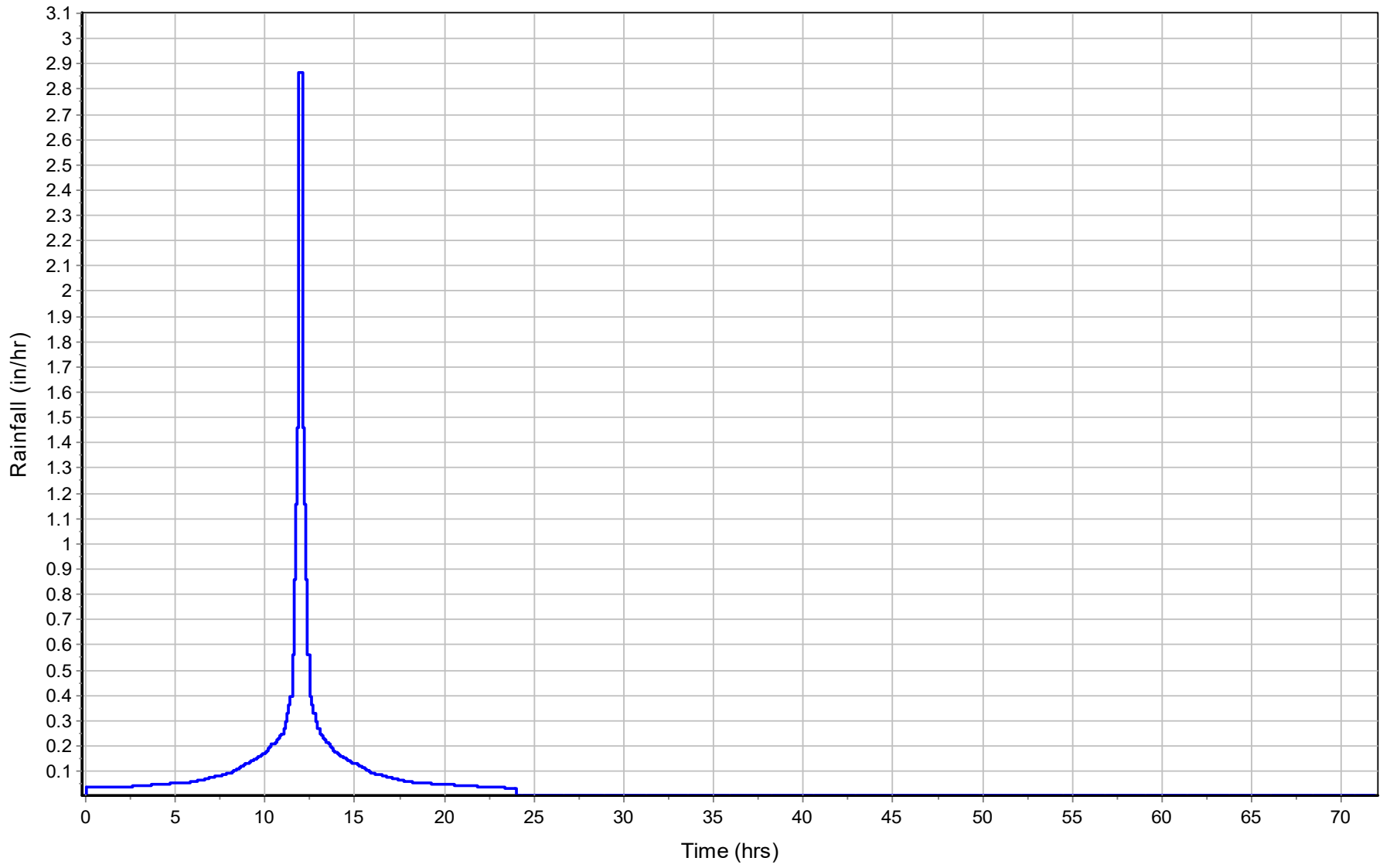
Total TOC (min) 2.17

Subbasin Runoff Results

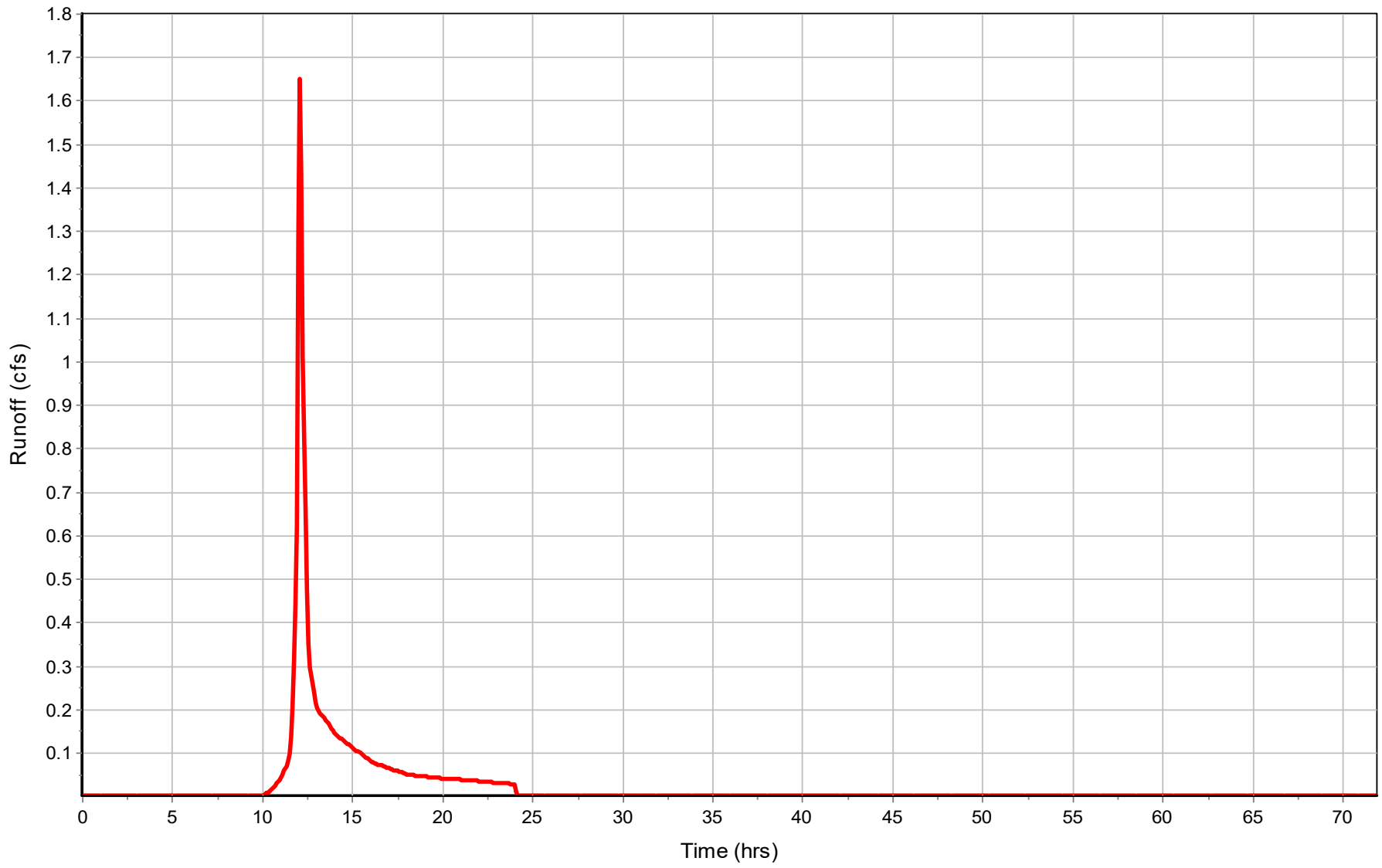
Total Rainfall (in) 3.41
Total Runoff (in) 1.3
Peak Runoff (cfs) 1.73
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:02:10

Subbasin : DA-Ditch-A1-2

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : DA-Ditch-A2

Input Data

Area (ac)	0.67
Peak Rate Factor	484
Weighted Curve Number	76
Rain Gage ID	Rain Gage-01

Composite Curve Number

32

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
50 - 75% grass cover, Fair	0.67	A	76
Composite Area & Weighted CN	0.67		76

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	300	0	0
Slope (%) :	1.5	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	1.23	0	0
Computed Flow Time (min) :	4.06	0	0

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	7.88	0	0
Slope (%) :	1.5	0	0
Surface Type :	Unpaved	Unpaved	Unpaved
Velocity (ft/sec) :	1.98	0	0
Computed Flow Time (min) :	0.07	0	0

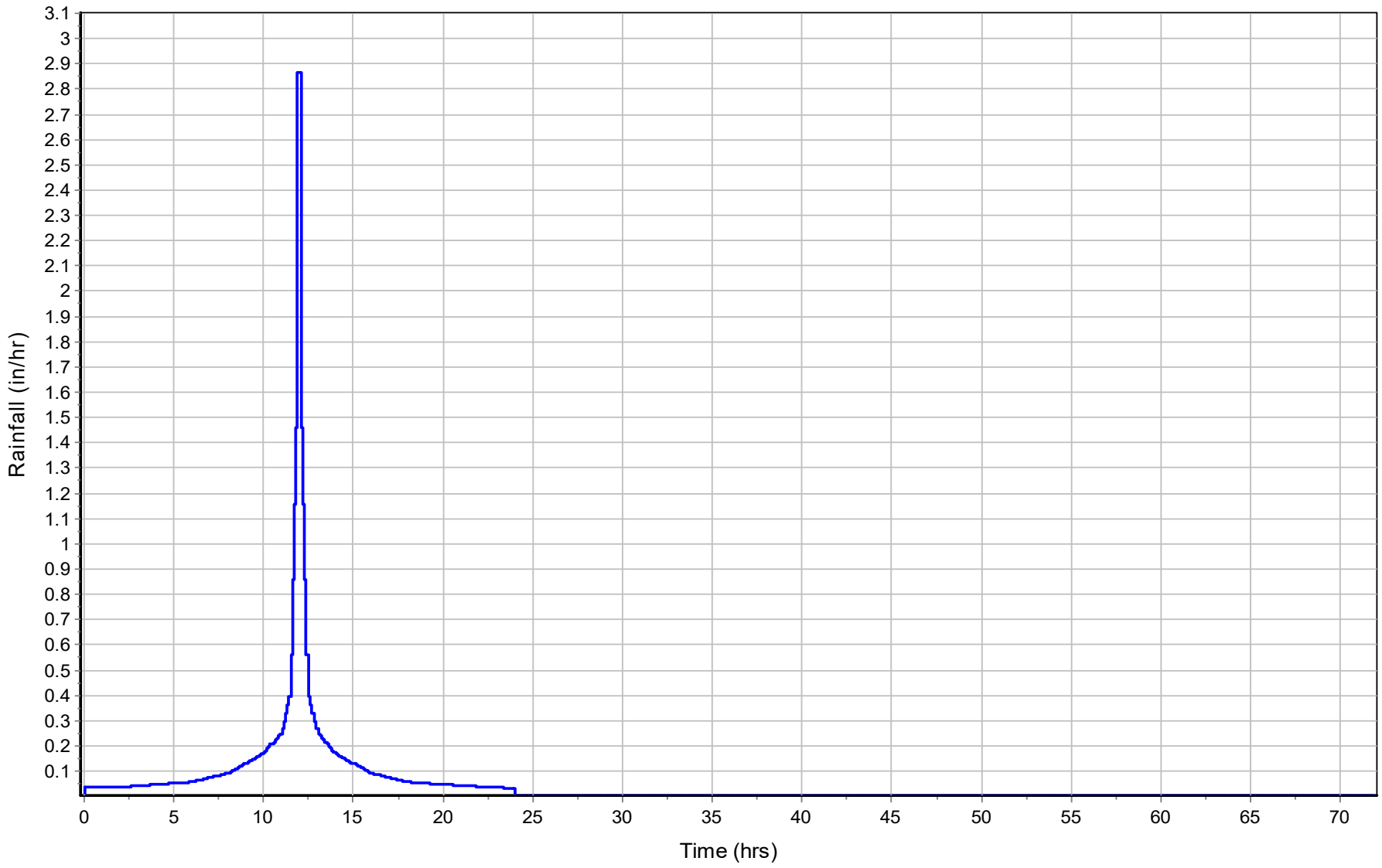
Total TOC (min) 4.13

Subbasin Runoff Results

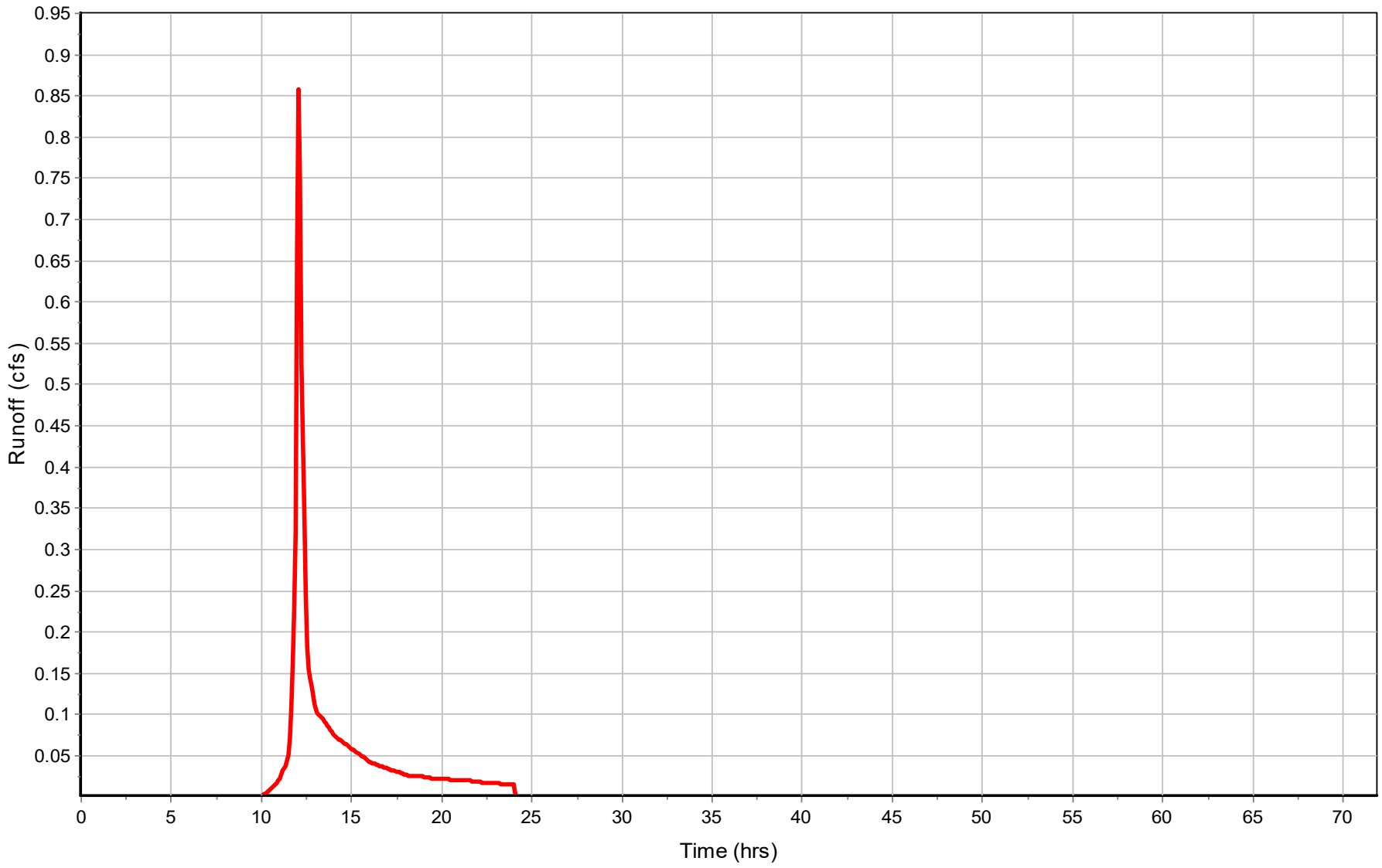
Total Rainfall (in)	3.41
Total Runoff (in)	1.3
Peak Runoff (cfs)	0.9
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:04:08

Subbasin : DA-Ditch-A2

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Existing-E03-1_A1

Input Data

Area (ac)	0.89
Peak Rate Factor	484
Weighted Curve Number	49
Rain Gage ID	Rain Gage-01

Composite Curve Number

32

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
50 - 75% grass cover, Fair	0.89	A	49
Composite Area & Weighted CN	0.89		49

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.4	0	0
Flow Length (ft) :	251.94	0	0
Slope (%) :	3.5	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.12	0	0
Computed Flow Time (min) :	34.83	0	0

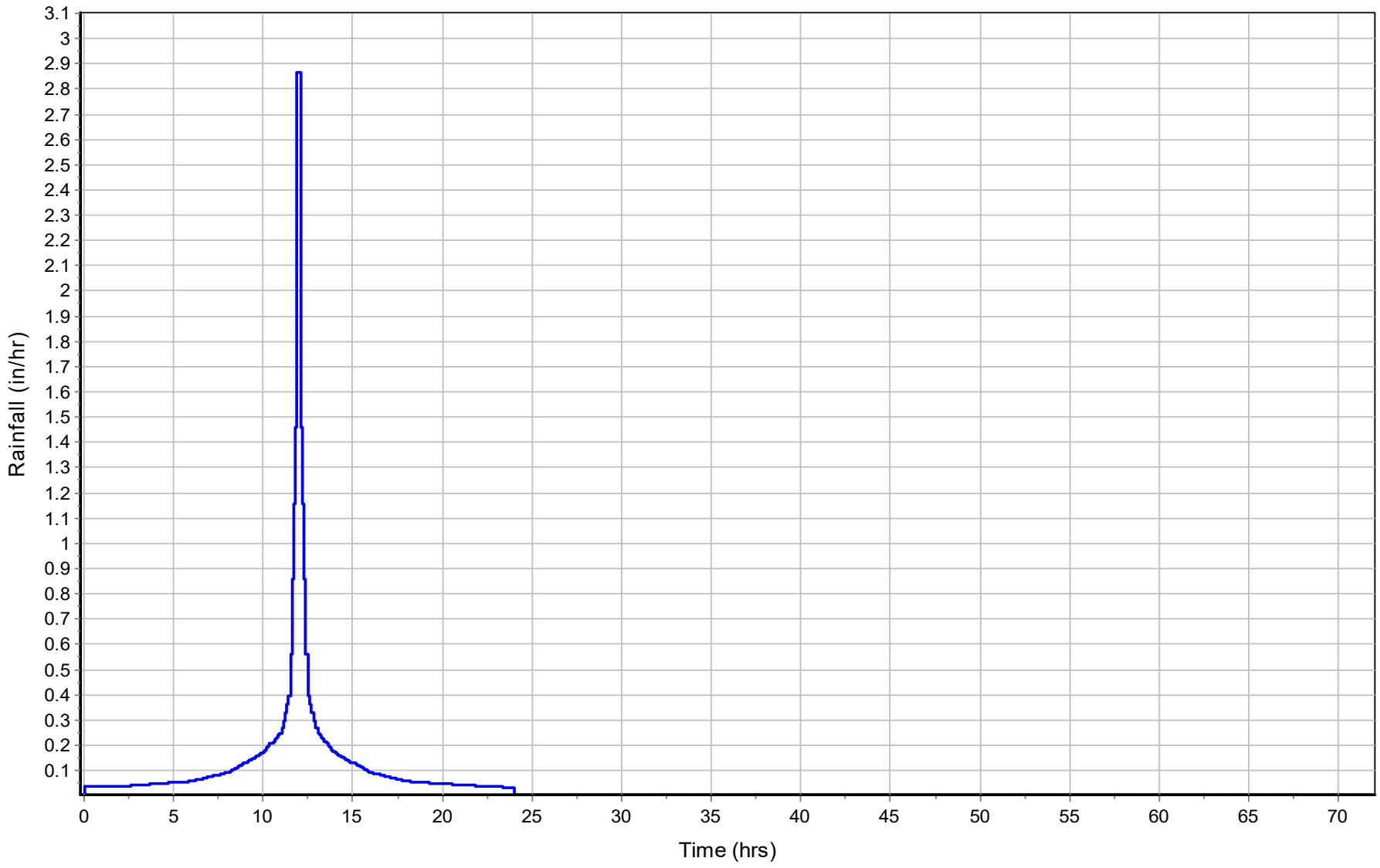
Total TOC (min) 34.83

Subbasin Runoff Results

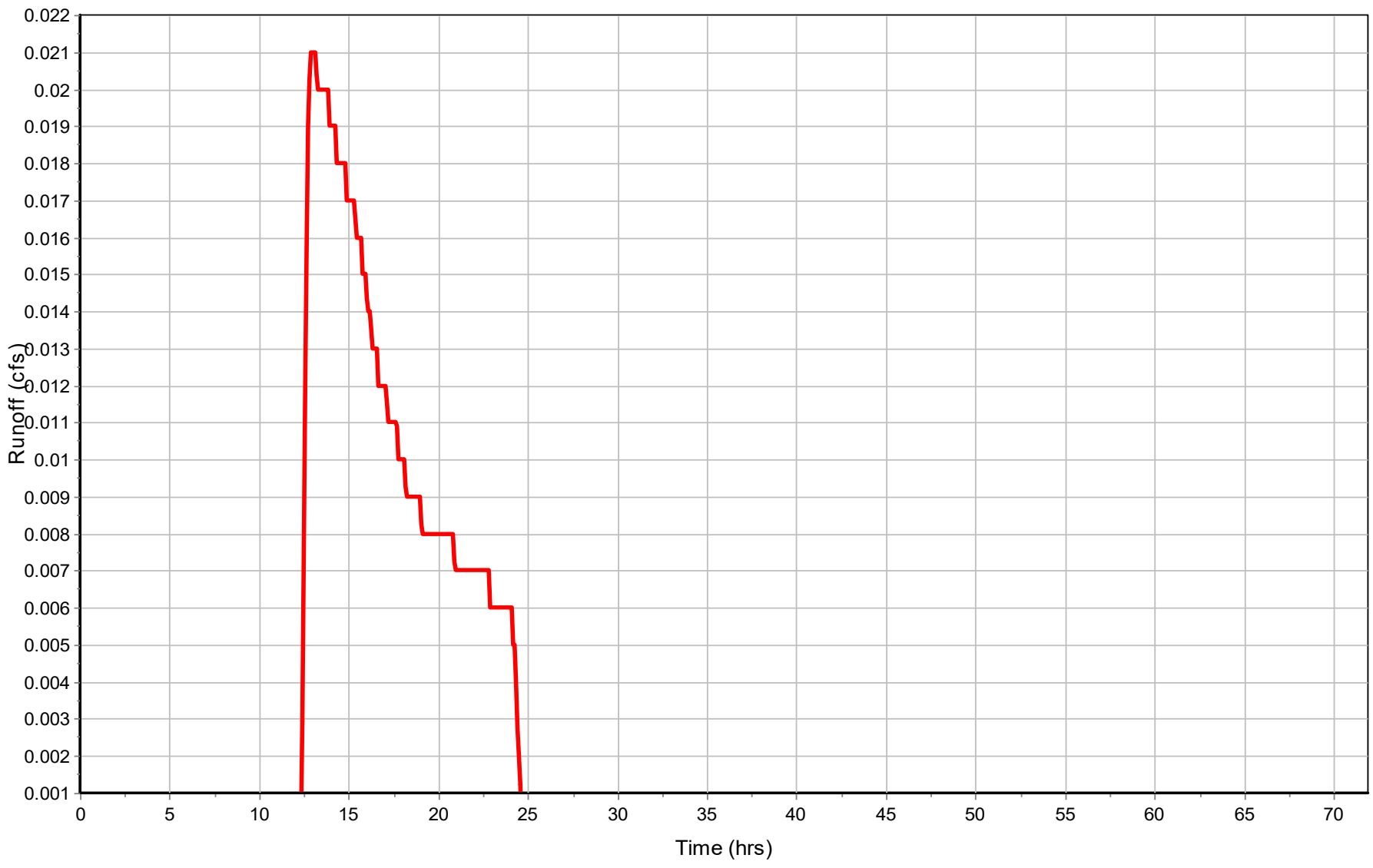
Total Rainfall (in)	3.41
Total Runoff (in)	0.15
Peak Runoff (cfs)	0.02
Weighted Curve Number	49
Time of Concentration (days hh:mm:ss)	0 00:34:50

Subbasin : Existing-E03-1_A1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Existing-E-07_A3

Input Data

Area (ac)	0.39
Peak Rate Factor	484
Weighted Curve Number	51.7
Rain Gage ID	Rain Gage-01

Composite Curve Number

32

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
50 - 75% grass cover, Fair	0.35	A	49
-	0.04	-	76
Composite Area & Weighted CN	0.39		51.7

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.4	0	0
Flow Length (ft) :	300	0	0
Slope (%) :	5	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.14	0	0
Computed Flow Time (min) :	34.72	0	0

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	105.18	0	0
Slope (%) :	2	0	0
Surface Type :	Grass pasture	Unpaved	Unpaved
Velocity (ft/sec) :	0.99	0	0
Computed Flow Time (min) :	1.77	0	0

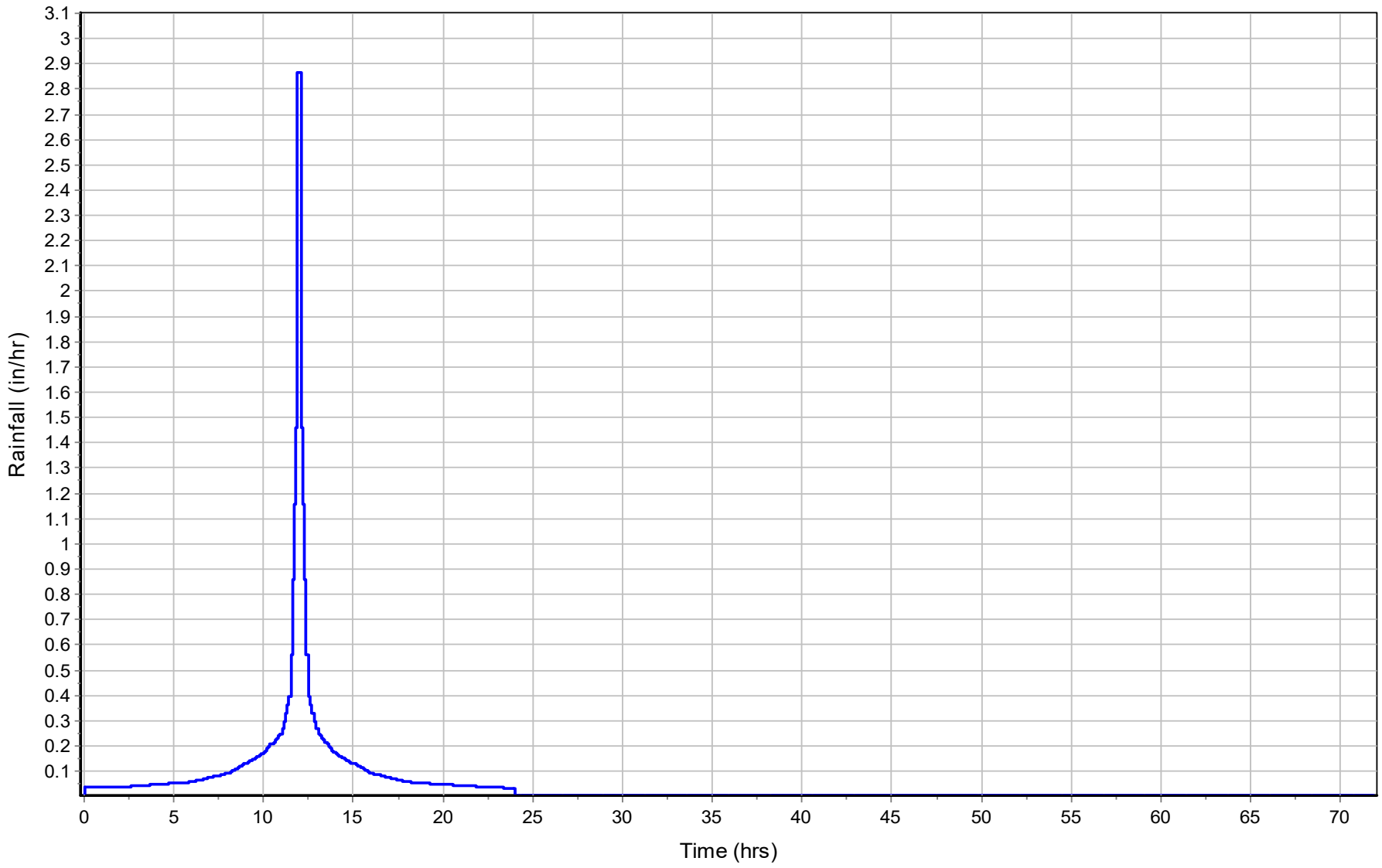
Total TOC (min) 36.49

Subbasin Runoff Results

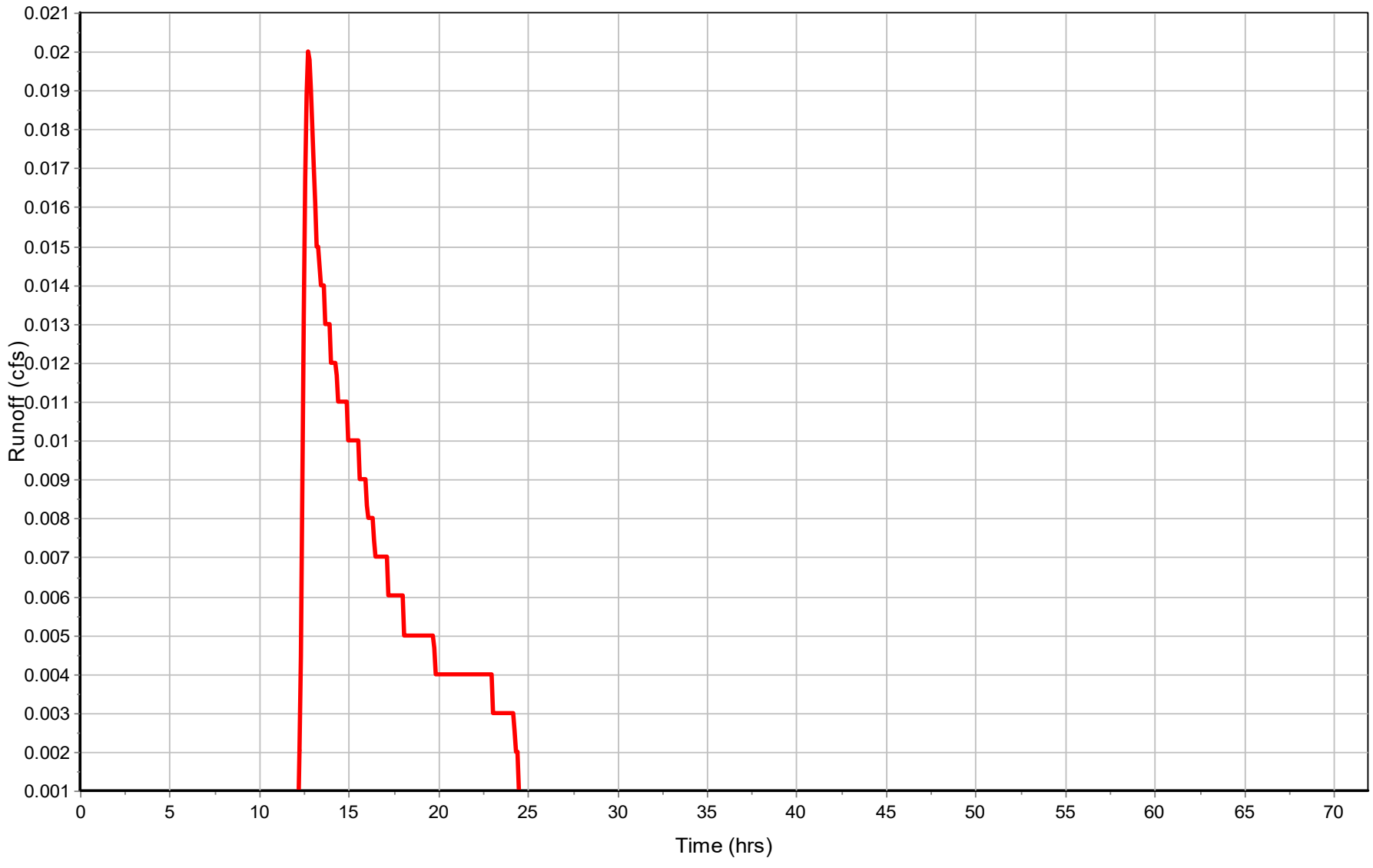
Total Rainfall (in)	3.41
Total Runoff (in)	0.22
Peak Runoff (cfs)	0.02
Weighted Curve Number	51.7
Time of Concentration (days hh:mm:ss)	0 00:36:29

Subbasin : Existing-E-07_A3

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Existing-E3_A1-2

Input Data

Area (ac)	3.2
Peak Rate Factor	484
Weighted Curve Number	49
Rain Gage ID	Rain Gage-01

Composite Curve Number

32

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
-	3.2	-	49
Composite Area & Weighted CN	3.2		49

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.4	0	0
Flow Length (ft) :	300	0	0
Slope (%) :	3.5	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.12	0	0
Computed Flow Time (min) :	40.05	0	0

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	205.17	0	0
Slope (%) :	3	0	0
Surface Type :	Grass pasture	Unpaved	Unpaved
Velocity (ft/sec) :	1.21	0	0
Computed Flow Time (min) :	2.83	0	0

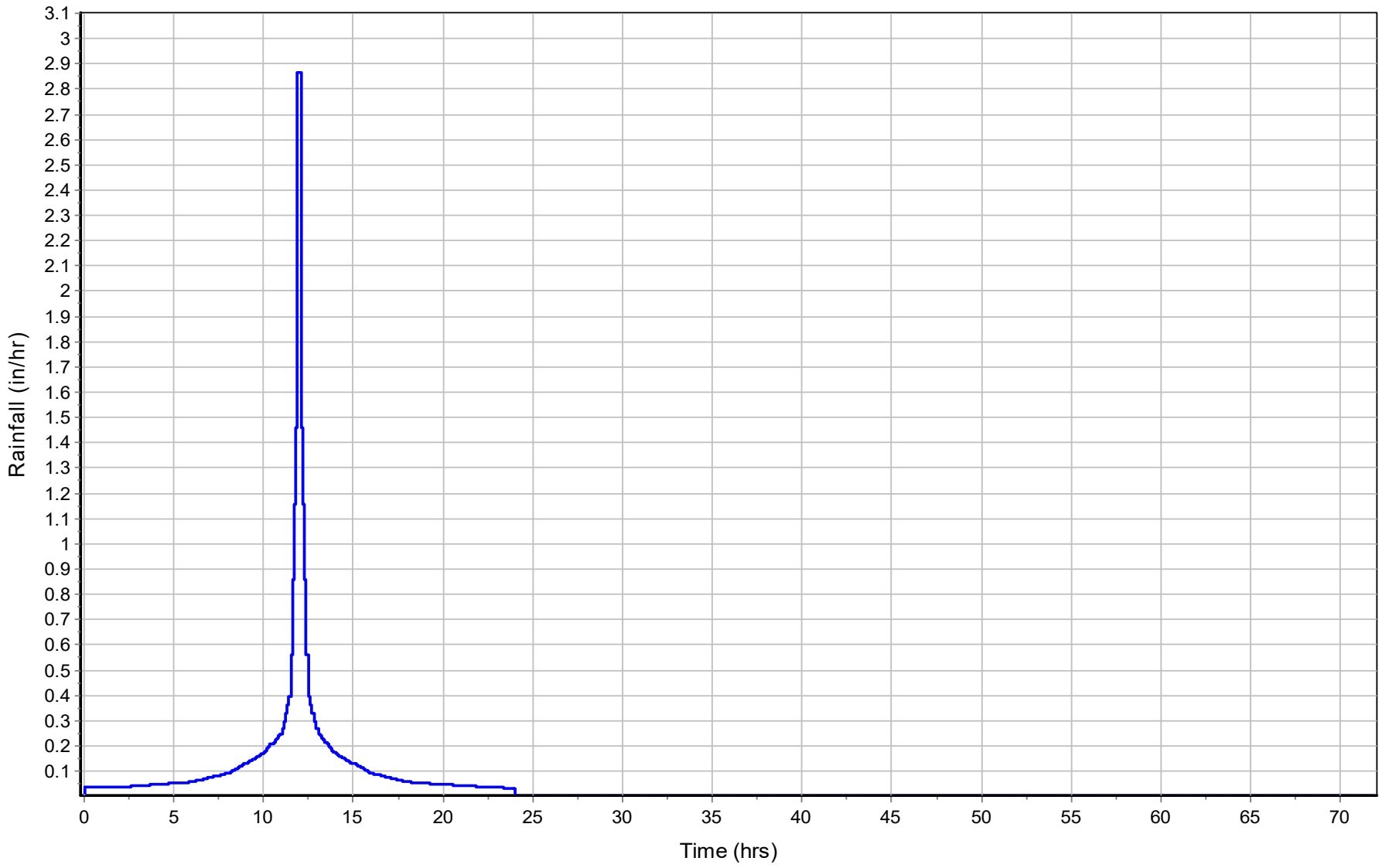
Total TOC (min) 42.87

Subbasin Runoff Results

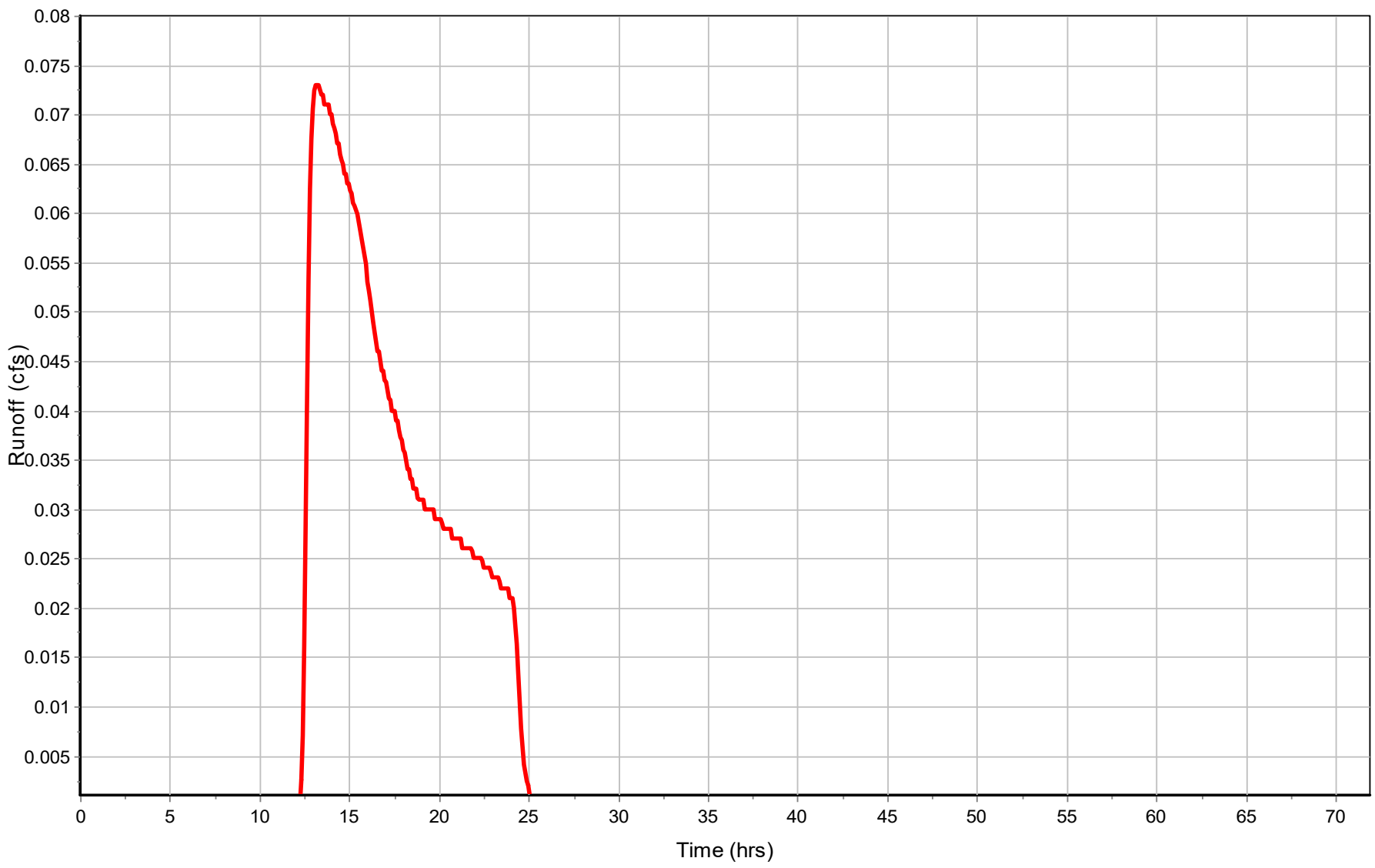
Total Rainfall (in)	3.41
Total Runoff (in)	0.15
Peak Runoff (cfs)	0.07
Weighted Curve Number	49
Time of Concentration (days hh:mm:ss)	0 00:42:52

Subbasin : Existing-E3_A1-2

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Existing-E5.1_A2

Input Data

Area (ac)	0.26
Peak Rate Factor	484
Weighted Curve Number	49
Rain Gage ID	Rain Gage-01

Composite Curve Number

32

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
50 - 75% grass cover, Fair	0.26	A	49
Composite Area & Weighted CN	0.26		49

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.4	0	0
Flow Length (ft) :	142.47	0	0
Slope (%) :	10	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.16	0	0
Computed Flow Time (min) :	14.5	0	0

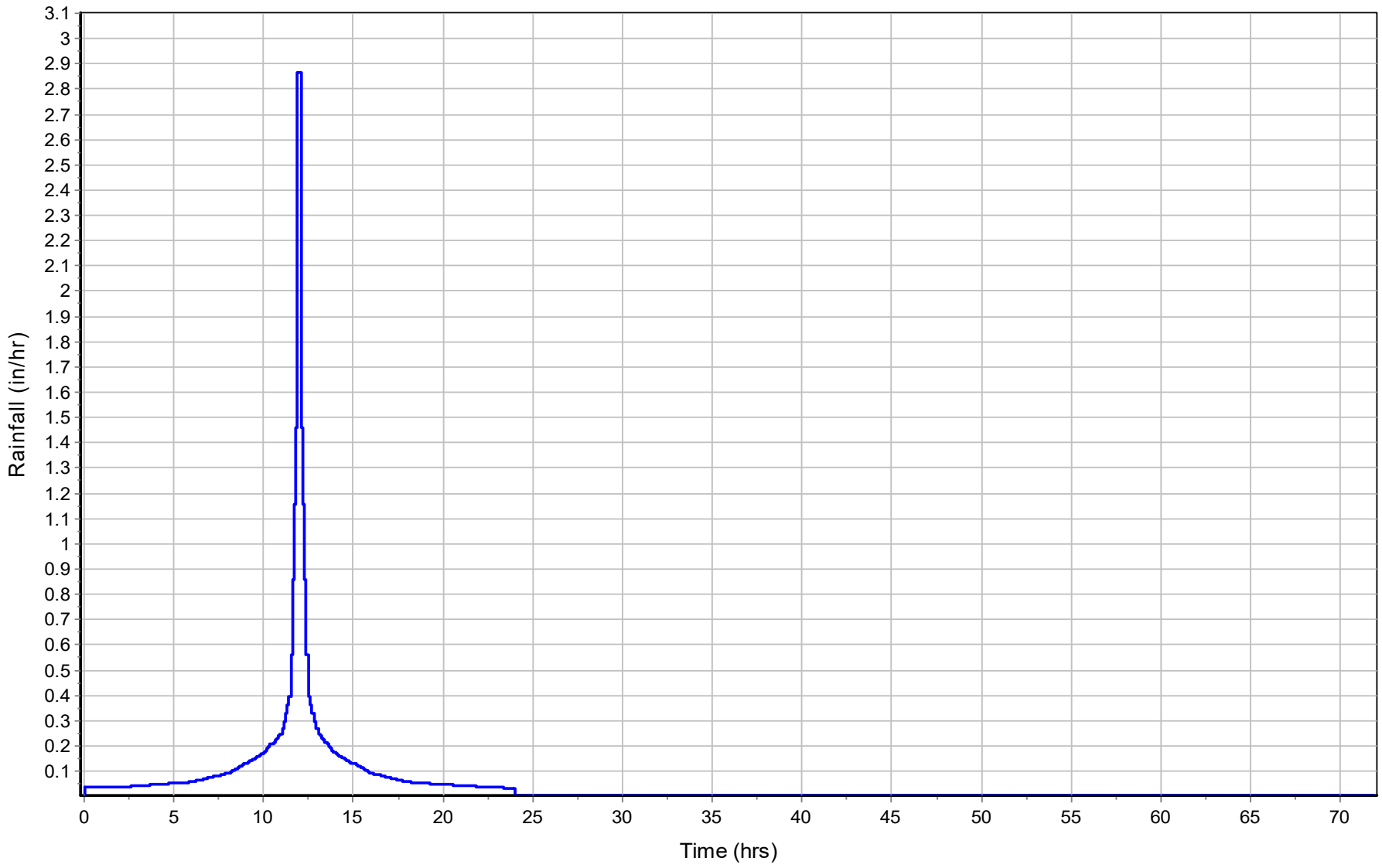
Total TOC (min) 14.50

Subbasin Runoff Results

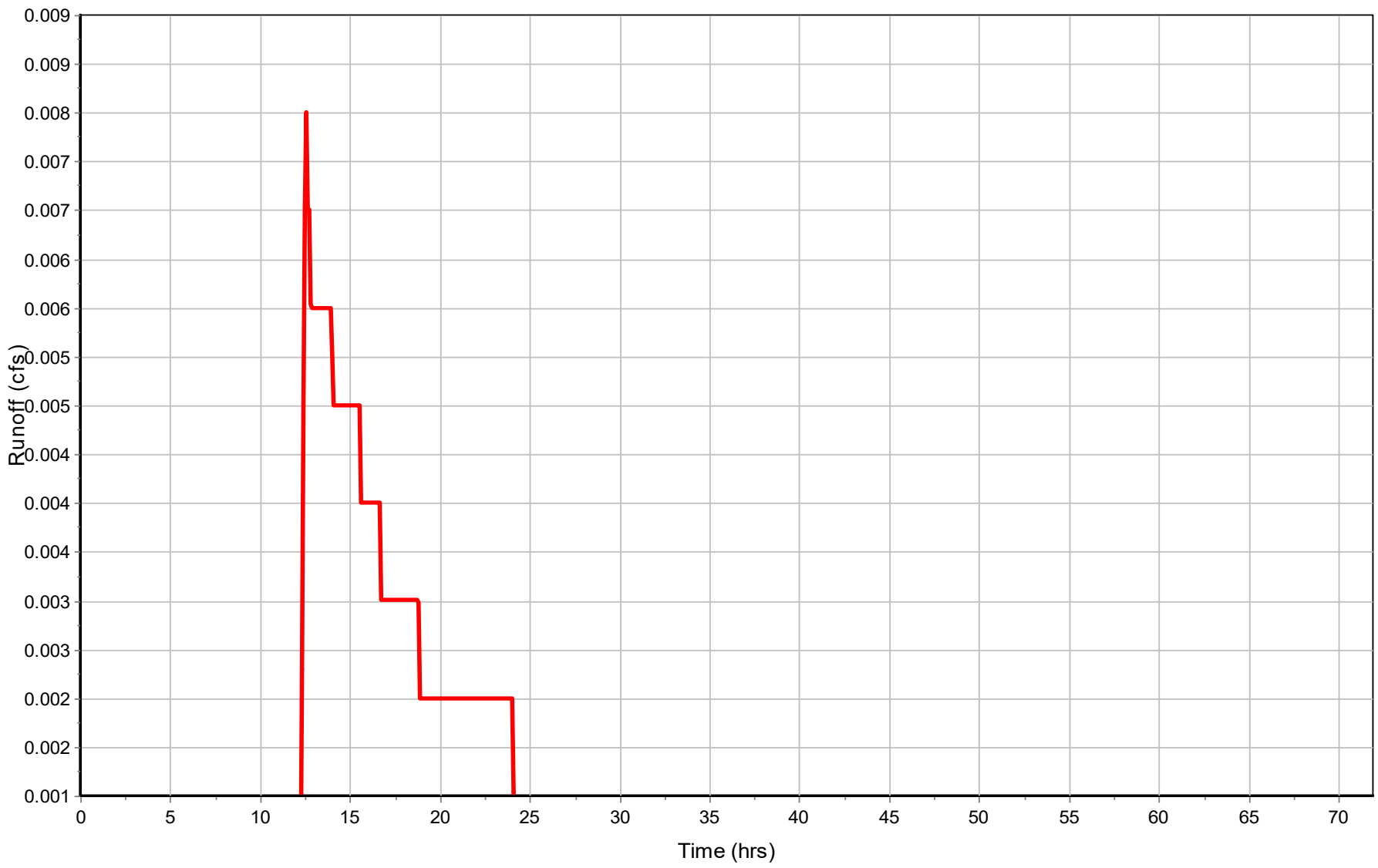
Total Rainfall (in)	3.41
Total Runoff (in)	0.15
Peak Runoff (cfs)	0.01
Weighted Curve Number	49
Time of Concentration (days hh:mm:ss)	0 00:14:30

Subbasin : Existing-E5.1_A2

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : A1-1-BASIN

Input Data

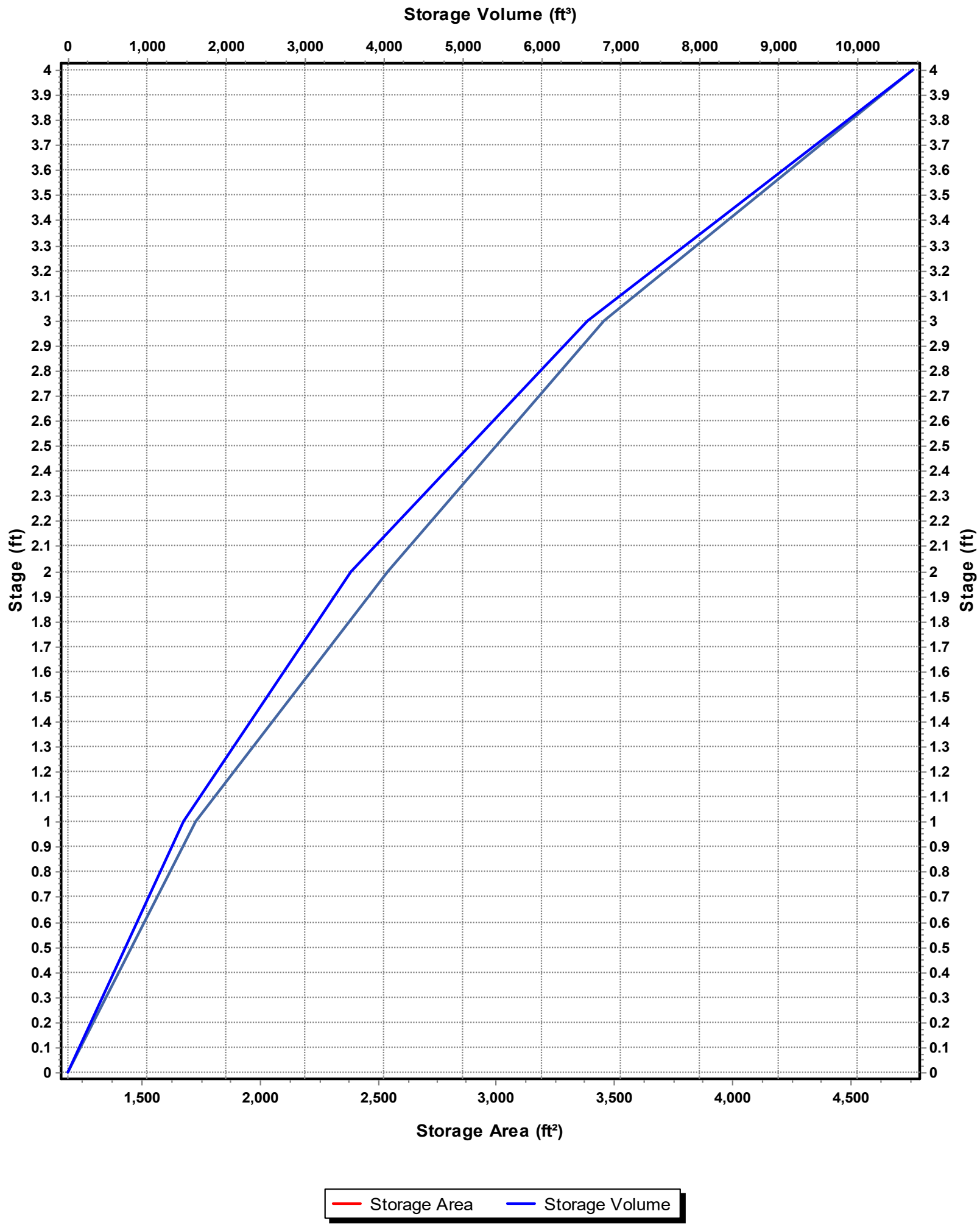
Invert Elevation (ft)	66.00
Max (Rim) Elevation (ft)	69.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	66.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : EXISTING POND.North

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	1188.1	0
1	1729.54	1458.82
2	2543.02	3595.1
3	3461.12	6597.17
4	4767.41	10711.44

Storage Area Volume Curves



Storage Node : A1-1-BASIN (continued)

Outflow Orifices

SN	Element ID	Orifice Type	Orifice Shape	Flap Gate	Circular Orifice Diameter (ft)	Rectangular Orifice Height (ft)	Rectangular Orifice Width (ft)	Orifice Invert Elevation (ft)	Orifice Coefficient
1	12RCP	Side	CIRCULAR	No	1.00			68.00	0.61

Output Summary Results

Peak Inflow (cfs)	1
Peak Lateral Inflow (cfs)	1
Peak Outflow (cfs)	0.04
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	68.06
Max HGL Depth Attained (ft)	2.06
Average HGL Elevation Attained (ft)	67.7
Average HGL Depth Attained (ft)	1.7
Time of Max HGL Occurrence (days hh:mm)	0 15:52
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : BASIN-1

Input Data

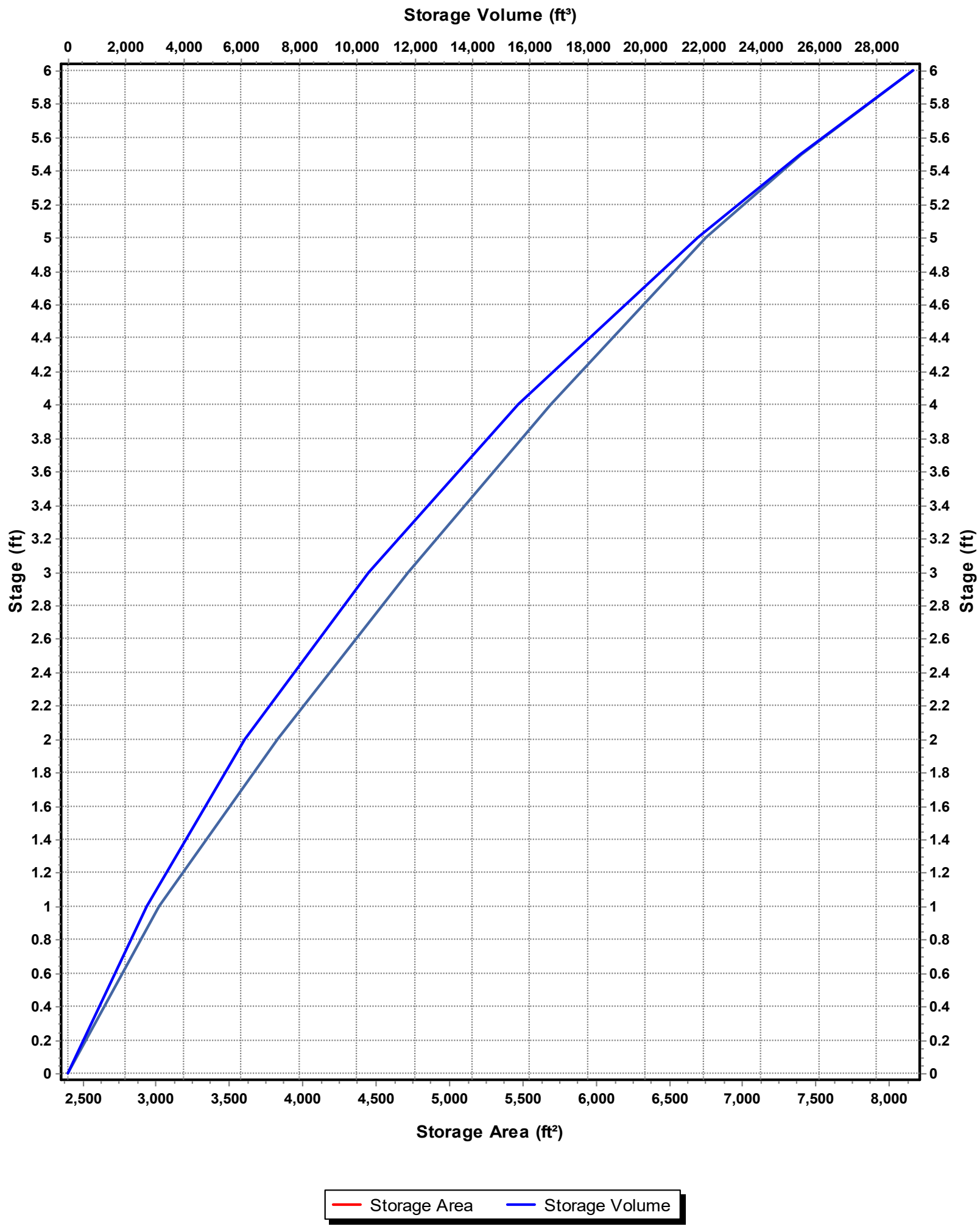
Invert Elevation (ft)	63.00
Max (Rim) Elevation (ft)	69.00
Max (Rim) Offset (ft)	6.00
Initial Water Elevation (ft)	63.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : POND-1

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	2401.32	0
1	3024.34	2712.83
2	3828.08	6139.04
3	4718.62	10412.39
4	5693.33	15618.37
5	6754.28	21842.18
5.5	7407.96	25382.74
6	8166.38	29276.33

Storage Area Volume Curves



Storage Node : BASIN-1 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-B1	Trapezoidal	No	68.50	5.50	10.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	1.53
Peak Lateral Inflow (cfs)	0
Peak Outflow (cfs)	0
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	65.08
Max HGL Depth Attained (ft)	2.08
Average HGL Elevation Attained (ft)	64.66
Average HGL Depth Attained (ft)	1.66
Time of Max HGL Occurrence (days hh:mm)	2 23:59
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : BASIN-2

Input Data

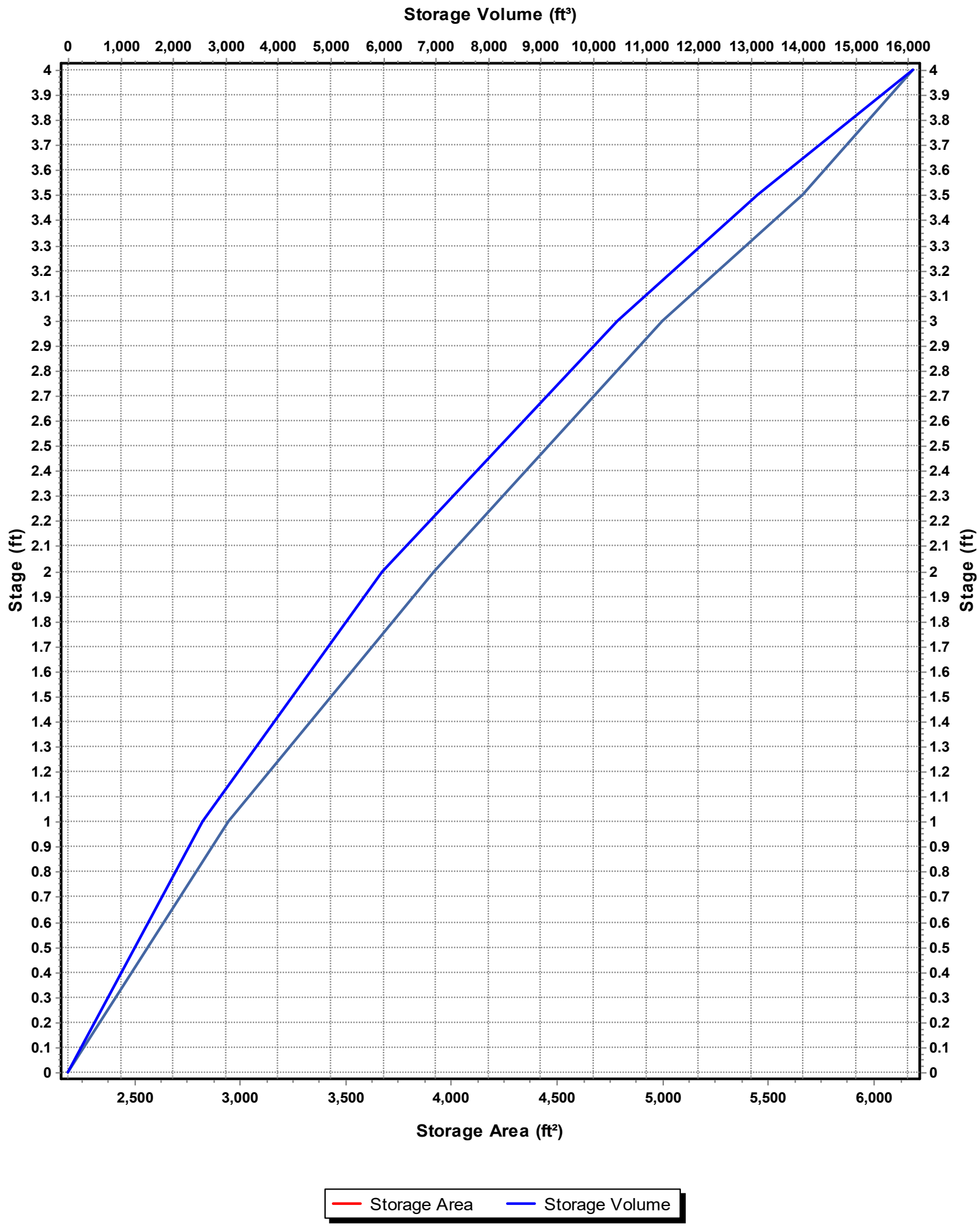
Invert Elevation (ft)	63.00
Max (Rim) Elevation (ft)	67.00
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	63.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : POND-2

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	2186.8	0
1	2944.52	2565.66
2	3920.59	5998.22
3	5001.46	10459.25
3.5	5669	13126.87
4	6188.64	16091.28

Storage Area Volume Curves



Storage Node : BASIN-2 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-B2	Trapezoidal	No	66.50	3.50	10.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	0.01
Peak Lateral Inflow (cfs)	0
Peak Outflow (cfs)	0
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	63.01
Max HGL Depth Attained (ft)	0.01
Average HGL Elevation Attained (ft)	63.01
Average HGL Depth Attained (ft)	0.01
Time of Max HGL Occurrence (days hh:mm)	1 03:12
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Exist-Catch-Basin

Input Data

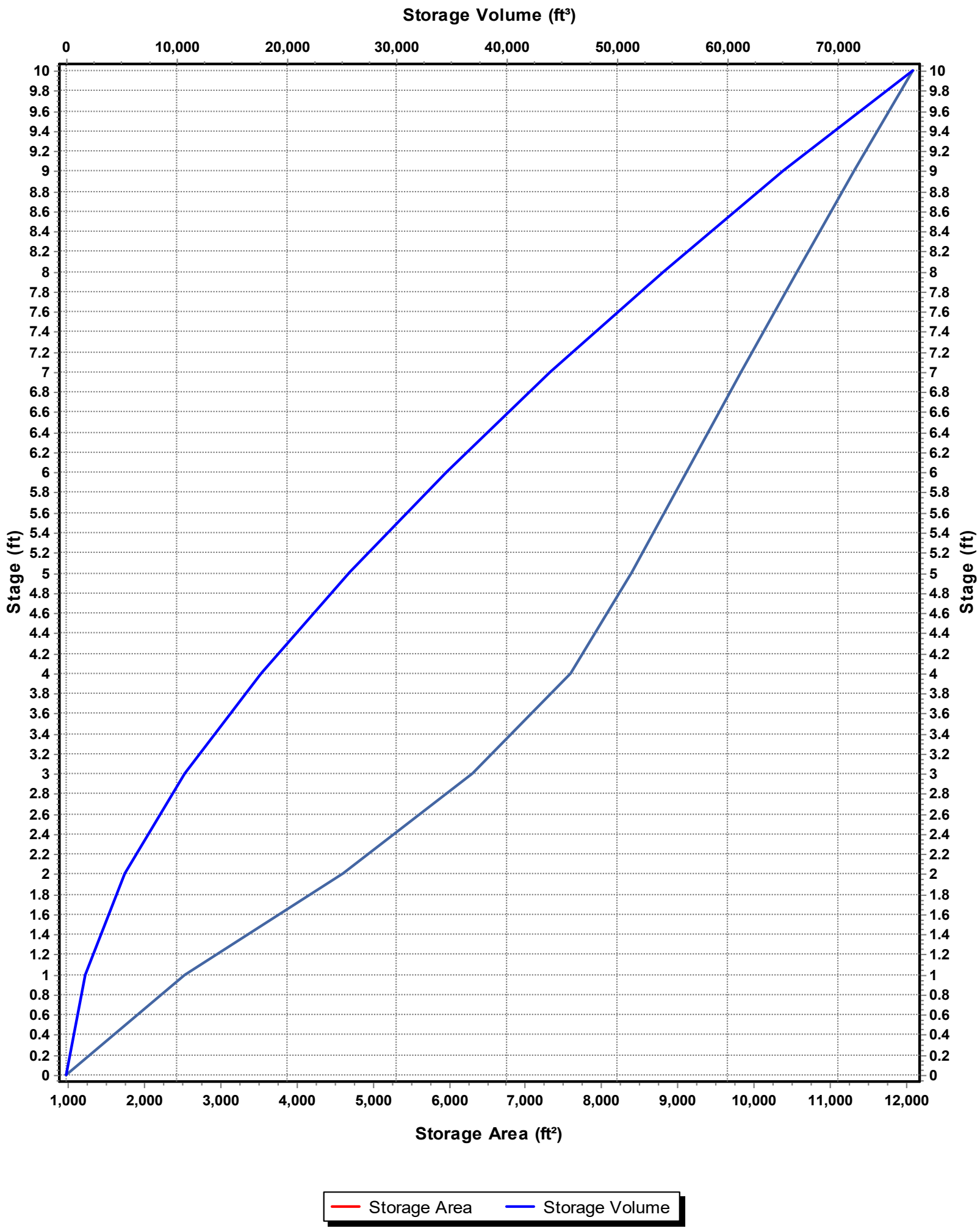
Invert Elevation (ft)	43.00
Max (Rim) Elevation (ft)	53.00
Max (Rim) Offset (ft)	10.00
Initial Water Elevation (ft)	43.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : EXISTING POND.South

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	974.38	0
1	2524.45	1749.42
2	4602.46	5312.88
3	6308.57	10768.4
4	7605.38	17725.38
5	8399.21	25727.68
6	9117.86	34486.22
7	9840.94	43965.62
8	10576.98	54174.58
9	11329.31	65127.73
10	12097.94	76841.36

Storage Area Volume Curves



Storage Node : Exist-Catch-Basin (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Exist-Catch-Basin-Weir	Trapezoidal	No	52.50	9.50	5.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	0.07
Peak Lateral Inflow (cfs)	0.07
Peak Outflow (cfs)	0
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	44
Max HGL Depth Attained (ft)	1
Average HGL Elevation Attained (ft)	43.77
Average HGL Depth Attained (ft)	0.77
Time of Max HGL Occurrence (days hh:mm)	1 01:15
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Existing-Catch-Basin

Input Data

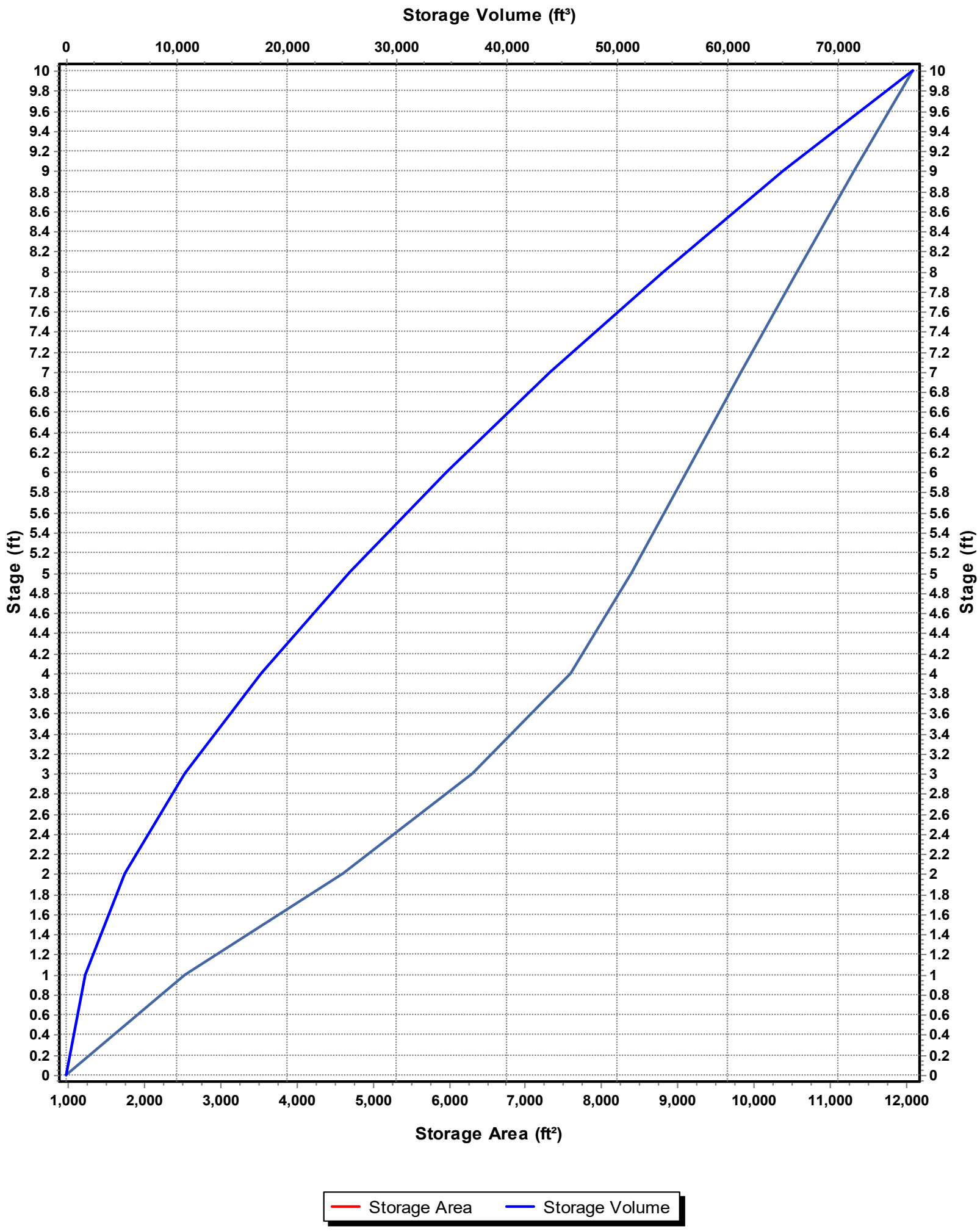
Invert Elevation (ft)	43.00
Max (Rim) Elevation (ft)	53.00
Max (Rim) Offset (ft)	10.00
Initial Water Elevation (ft)	43.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : EXISTING POND.South

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	974.38	0
1	2524.45	1749.42
2	4602.46	5312.88
3	6308.57	10768.4
4	7605.38	17725.38
5	8399.21	25727.68
6	9117.86	34486.22
7	9840.94	43965.62
8	10576.98	54174.58
9	11329.31	65127.73
10	12097.94	76841.36

Storage Area Volume Curves



Storage Node : Existing-Catch-Basin (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Existing-Catch-Basin-Weir	Trapezoidal	No	52.50	9.50	5.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	0.15
Peak Lateral Inflow (cfs)	0.02
Peak Outflow (cfs)	0
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	44.04
Max HGL Depth Attained (ft)	1.04
Average HGL Elevation Attained (ft)	43.81
Average HGL Depth Attained (ft)	0.81
Time of Max HGL Occurrence (days hh:mm)	1 02:10
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : FOREBAY-1

Input Data

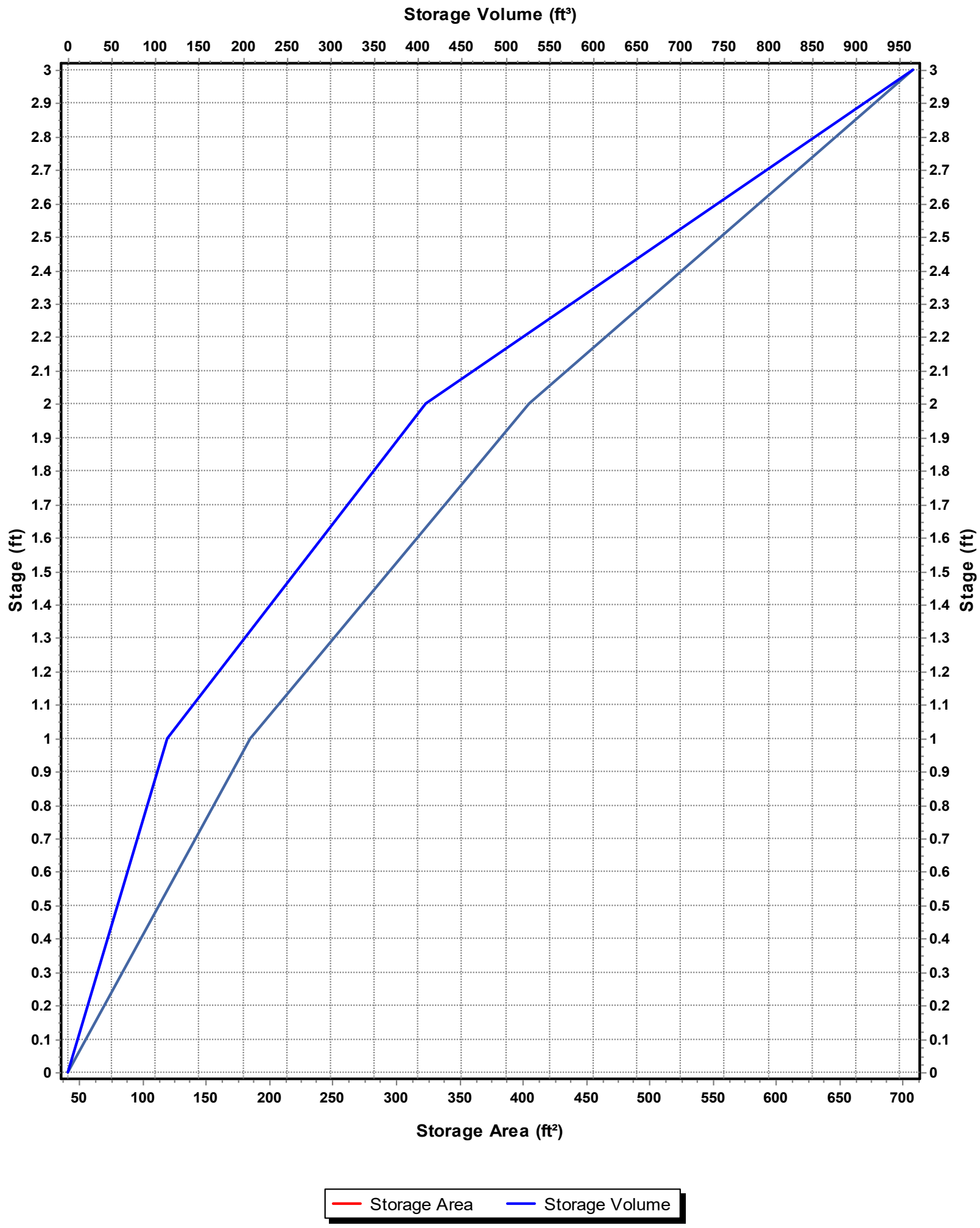
Invert Elevation (ft)	66.00
Max (Rim) Elevation (ft)	70.00
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	66.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : FOREBAY-1

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	41.13	0
1	185.44	113.29
2	405.49	408.76
3	708.15	965.58

Storage Area Volume Curves



Storage Node : FOREBAY-1 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-F1	Trapezoidal	No	67.00	1.00	4.00	3.00	3.33

Output Summary Results

Peak Inflow (cfs)	1.53
Peak Lateral Inflow (cfs)	1.53
Peak Outflow (cfs)	1.53
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	67.23
Max HGL Depth Attained (ft)	1.23
Average HGL Elevation Attained (ft)	66.86
Average HGL Depth Attained (ft)	0.86
Time of Max HGL Occurrence (days hh:mm)	0 12:10
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : FOREBAY-1-2

Input Data

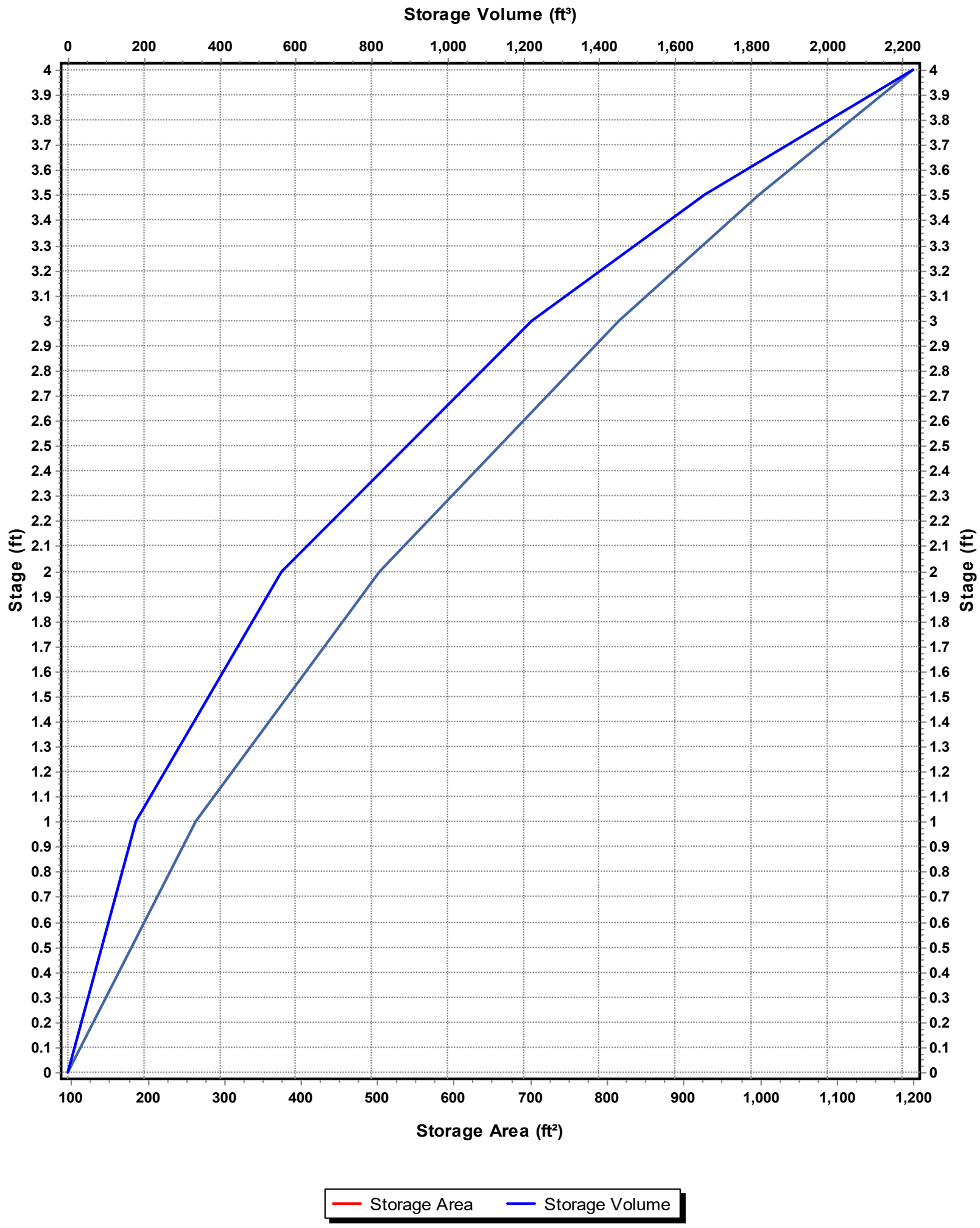
Invert Elevation (ft)	62.00
Max (Rim) Elevation (ft)	66.00
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	62.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : FOREBAY-3

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	96	0
1	264	180
2	504	564
3	816	1224
3.5	999	1677.75
4	1200	2227.5

Storage Area Volume Curves



Storage Node : FOREBAY-1-2 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-F1-2	Trapezoidal	No	63.00	1.00	2.00	3.00	3.33

Output Summary Results

Peak Inflow (cfs)	0.18
Peak Lateral Inflow (cfs)	0.18
Peak Outflow (cfs)	0.15
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	63.08
Max HGL Depth Attained (ft)	1.08
Average HGL Elevation Attained (ft)	62.83
Average HGL Depth Attained (ft)	0.83
Time of Max HGL Occurrence (days hh:mm)	0 12:31
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : FOREBAY-2

Input Data

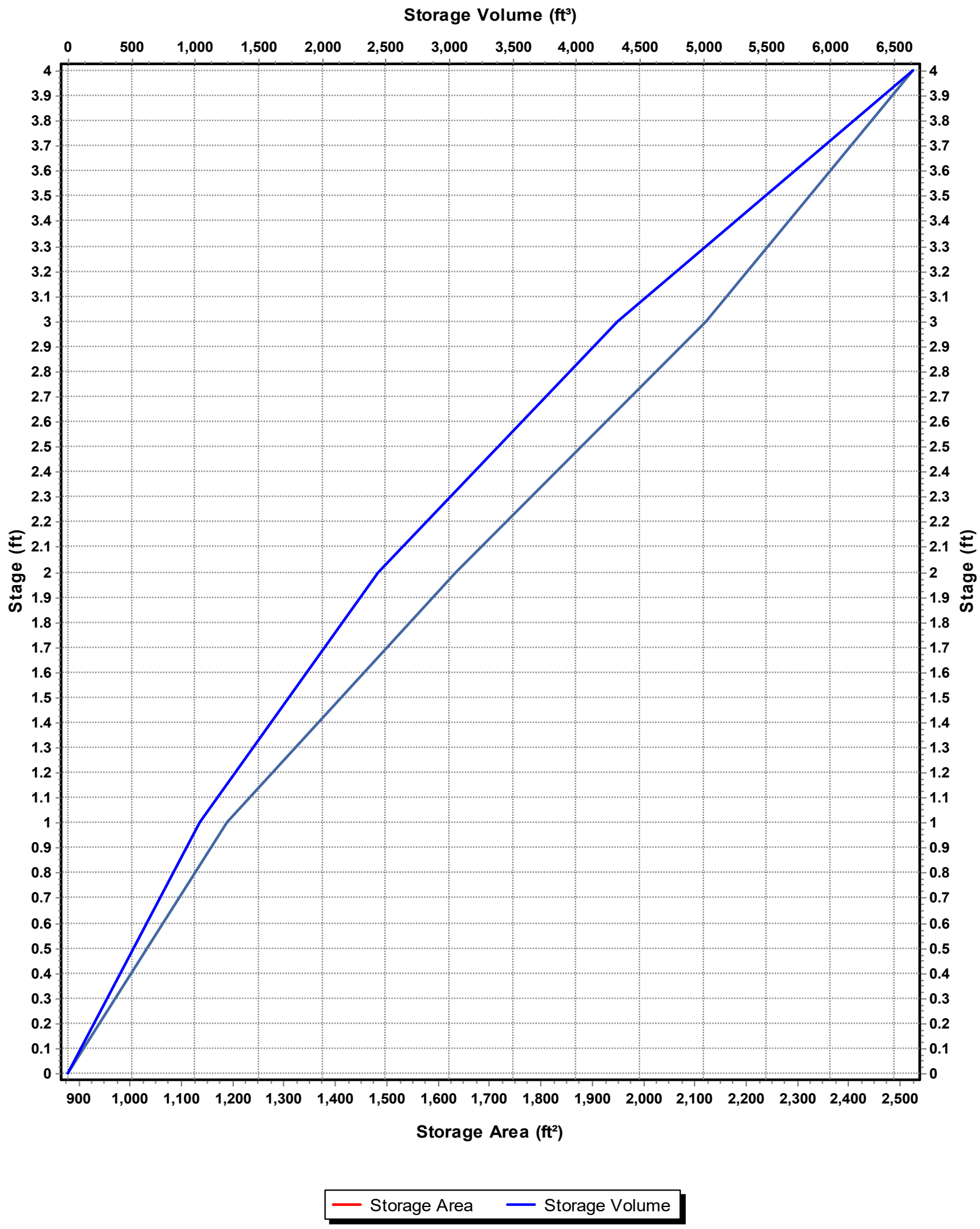
Invert Elevation (ft)	65.00
Max (Rim) Elevation (ft)	69.00
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	65.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : FOREBAY-2

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	880.04	0
1	1189.5	1034.77
2	1635.09	2447.07
3	2123.92	4326.58
4	2526	6651.54

Storage Area Volume Curves



Storage Node : FOREBAY-2 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-F2	Trapezoidal	No	68.00	3.00	10.00	1.00	3.33

Output Summary Results

Peak Inflow (cfs)	1.18
Peak Lateral Inflow (cfs)	1.18
Peak Outflow (cfs)	0.01
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	68
Max HGL Depth Attained (ft)	3
Average HGL Elevation Attained (ft)	67.43
Average HGL Depth Attained (ft)	2.43
Time of Max HGL Occurrence (days hh:mm)	1 00:08
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Project Description

File Name ..... Sagamore_Entire.Site.SPF

Project Options

Flow Units ..... CFS
Elevation Type ..... Elevation
Hydrology Method ..... SCS TR-20
Time of Concentration (TOC) Method ..... SCS TR-55
Link Routing Method ..... Hydrodynamic
Enable Overflow Ponding at Nodes ..... YES
Skip Steady State Analysis Time Periods ..... NO

Analysis Options

Start Analysis On ..... oct. 14, 2021 0:00:00
End Analysis On ..... oct. 17, 2021 0:00:00
Start Reporting On ..... oct. 14, 2021 0:00:00
Antecedent Dry Days ..... 0 days
Runoff (Dry Weather) Time Step ..... 0 01:00:00 days hh:mm:ss
Runoff (Wet Weather) Time Step ..... 0 00:05:00 days hh:mm:ss
Reporting Time Step ..... 0 00:05:00 days hh:mm:ss
Routing Time Step ..... 30 seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	13
Nodes	18
Junctions	0
Outfalls	10
Flow Diversions	0
Inlets	0
Storage Nodes	8
Links	8
Channels	0
Pipes	0
Pumps	0
Orifices	1
Weirs	7
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	10 years	Intensity	inches	Massachusetts	None	10.00	4.98	SCS Type III 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	A1	1.20	484.00	76.00	4.98	2.52	3.02	3.13	0 00:06:00
2	A1-1	0.39	484.00	98.00	4.98	4.74	1.85	1.52	0 00:10:55
3	A1-2	1.34	484.00	54.63	4.98	0.95	1.27	1.13	0 00:06:00
4	A1-3	1.03	484.00	49.00	4.98	0.63	0.65	0.25	0 00:40:16
5	A2	0.92	484.00	76.00	4.98	2.52	2.32	2.40	0 00:06:00
6	A-3	0.25	484.00	51.70	4.98	0.78	0.19	0.09	0 00:36:07
7	DA-Ditch-A1	1.35	484.00	76.00	4.98	2.52	3.40	3.52	0 00:06:00
8	DA-Ditch-A1-2	1.29	484.00	76.00	4.98	2.52	3.25	3.37	0 00:06:00
9	DA-Ditch-A2	0.67	484.00	76.00	4.98	2.52	1.69	1.75	0 00:06:00
10	Existing-E03-1_A1	0.89	484.00	49.00	4.98	0.63	0.56	0.23	0 00:34:49
11	Existing-E-07_A3	0.39	484.00	51.70	4.98	0.78	0.30	0.14	0 00:36:29
12	Existing-E3_A1-2	3.20	484.00	49.00	4.98	0.63	2.02	0.76	0 00:42:52
13	Existing-E5.1_A2	0.26	484.00	49.00	4.98	0.63	0.16	0.09	0 00:14:30

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft²)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Existing-Oufall-E3-1_Weir-B1	Outfall	0.00					0.23	0.00					
2	Existing-Outfall-E3_1	Outfall	0.00					0.00	0.00					
3	Existing-Outfall-E5.1_2	Outfall	0.00					0.09	0.00					
4	Existing-Outfall-E7_3	Outfall	0.00					0.14	0.00					
5	Out-D1	Outfall	0.00					3.42	0.00					
6	Out-D2	Outfall	0.00					1.70	0.00					
7	Out-D3	Outfall	0.00					3.27	0.00					
8	Proposed-Outfall.1	Outfall	0.00					0.00	0.00					
9	Proposed-Outfall.2	Outfall	60.00					0.00	60.00					
10	Proposed-Outfall.3	Outfall	0.00					0.09	0.00					
11	A1-1-BASIN	Storage Node	66.00	69.00	66.00		0.00	1.47	68.25				0.00	0.00
12	BASIN-1	Storage Node	63.00	69.00	63.00		0.00	3.03	66.71				0.00	0.00
13	BASIN-2	Storage Node	63.00	67.00	63.00		0.00	0.43	64.48				0.00	0.00
14	Exist-Catch-Basin	Storage Node	43.00	53.00	43.00		0.00	0.75	45.41				0.00	0.00
15	Existing-Catch-Basin	Storage Node	43.00	53.00	43.00		0.00	1.03	45.30				0.00	0.00
16	FOREBAY-1	Storage Node	66.00	70.00	66.00		0.00	3.04	67.36				0.00	0.00
17	FOREBAY-1-2	Storage Node	62.00	66.00	62.00		0.00	0.99	63.26				0.00	0.00
18	FOREBAY-2	Storage Node	65.00	69.00	65.00		0.00	2.33	68.06				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length (ft)	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Average Slope (%)	Diameter or Height (ft)	Manning's Roughness	Peak Flow (cfs)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Reported Condition
1	12RCP	Orifice	A1-1-BASIN	FOREBAY-1		66.00	66.00		1.000		0.34							
2	Exist-Catch-Basin-Weir	Weir	Exist-Catch-Basin	Existing-Outfall-E3_1		43.00	0.00				0.00							
3	Existing-Catch-Basin-Weir	Weir	Existing-Catch-Basin	Proposed-Outfall.1		43.00	0.00				0.00							
4	Weir-B1	Weir	BASIN-1	FOREBAY-1-2		63.00	62.00				0.00							
5	Weir-B2	Weir	BASIN-2	Proposed-Outfall.2		63.00	60.00				0.00							
6	Weir-F1	Weir	FOREBAY-1	BASIN-1		66.00	63.00				3.03							
7	Weir-F1-2	Weir	FOREBAY-1-2	Existing-Catch-Basin		62.00	43.00				0.99							
8	Weir-F2	Weir	FOREBAY-2	BASIN-2		65.00	63.00				0.43							

Subbasin Hydrology

Subbasin : A1

Input Data

Area (ac) 1.2
Peak Rate Factor 484
Weighted Curve Number 76
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	1.2	A	76
Composite Area & Weighted CN	1.2		76

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft^2)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	300	0	0
Slope (%) :	1.51	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	1.23	0	0
Computed Flow Time (min) :	4.05	0	0

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	20.6	0	0
Slope (%) :	1.86	0	0
Surface Type :	Unpaved	Unpaved	Unpaved
Velocity (ft/sec) :	2.2	0	0
Computed Flow Time (min) :	0.16	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	99.64	0	0
Channel Slope (%) :	0.5	0	0
Cross Section Area (ft^2) :	29.79	0	0
Wetted Perimeter (ft) :	20.98	0	0
Velocity (ft/sec) :	4.44	0	0
Computed Flow Time (min) :	0.37	0	0

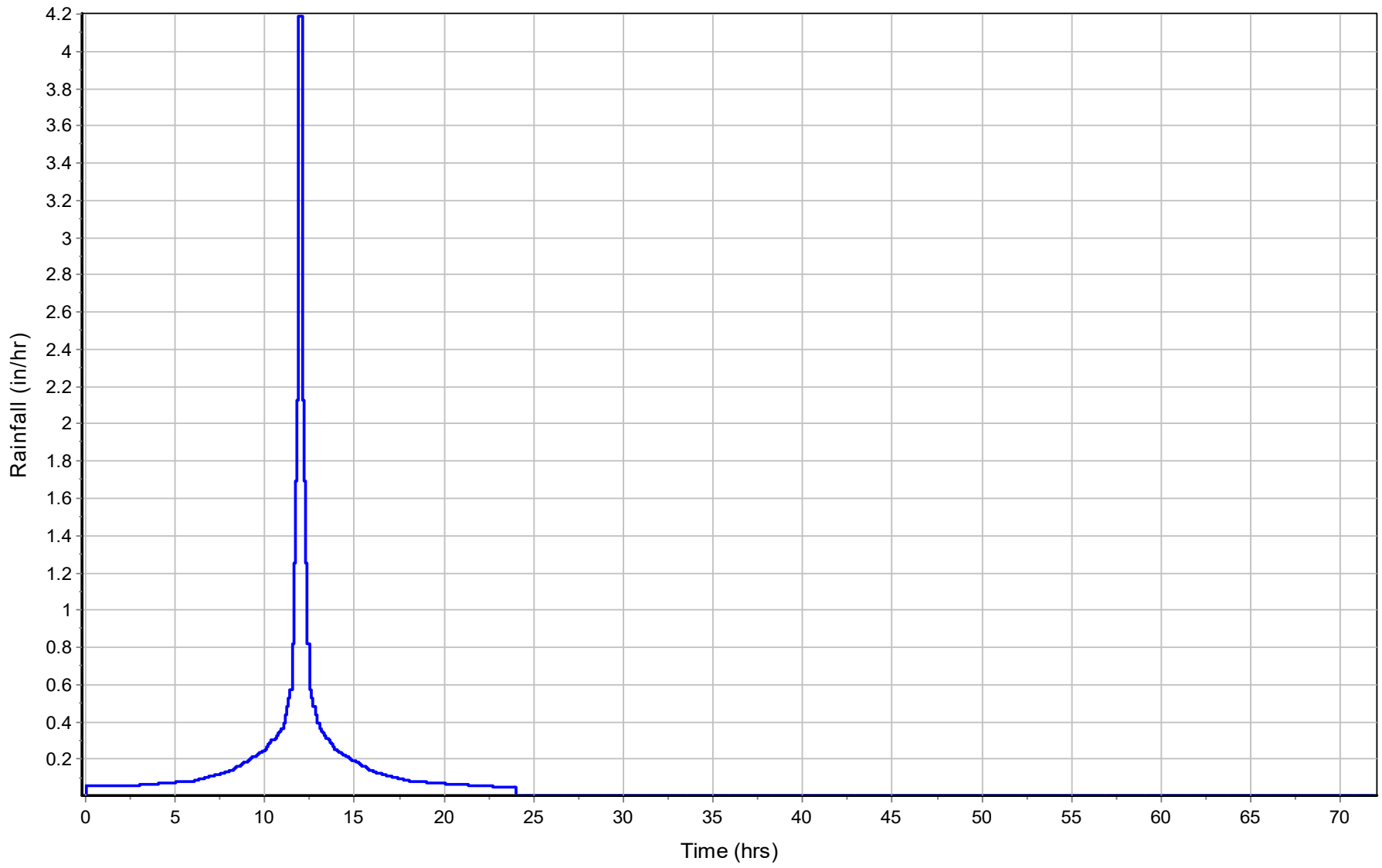
Total TOC (min) 4.58

Subbasin Runoff Results

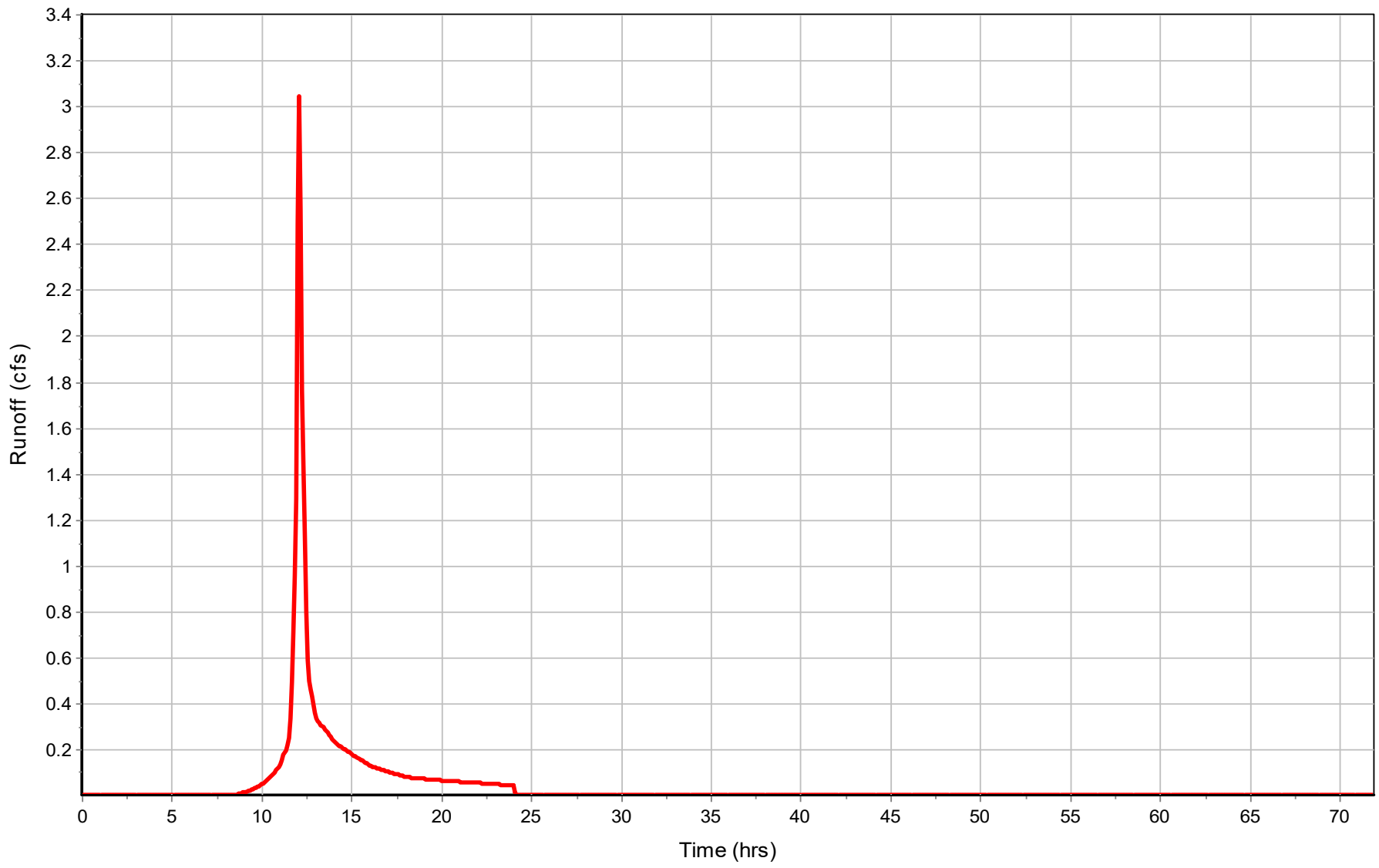
Total Rainfall (in) 4.98
Total Runoff (in) 2.52
Peak Runoff (cfs) 3.13
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:04:35

Subbasin : A1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : A1-1

Input Data

Area (ac) 0.39
Peak Rate Factor 484
Weighted Curve Number 98
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Paved parking & roofs	0.39	A	98
Composite Area & Weighted CN	0.39		98

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.05	0	0
Flow Length (ft) :	178.81	0	0
Slope (%) :	0.5	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.27	0	0
Computed Flow Time (min) :	10.92	0	0

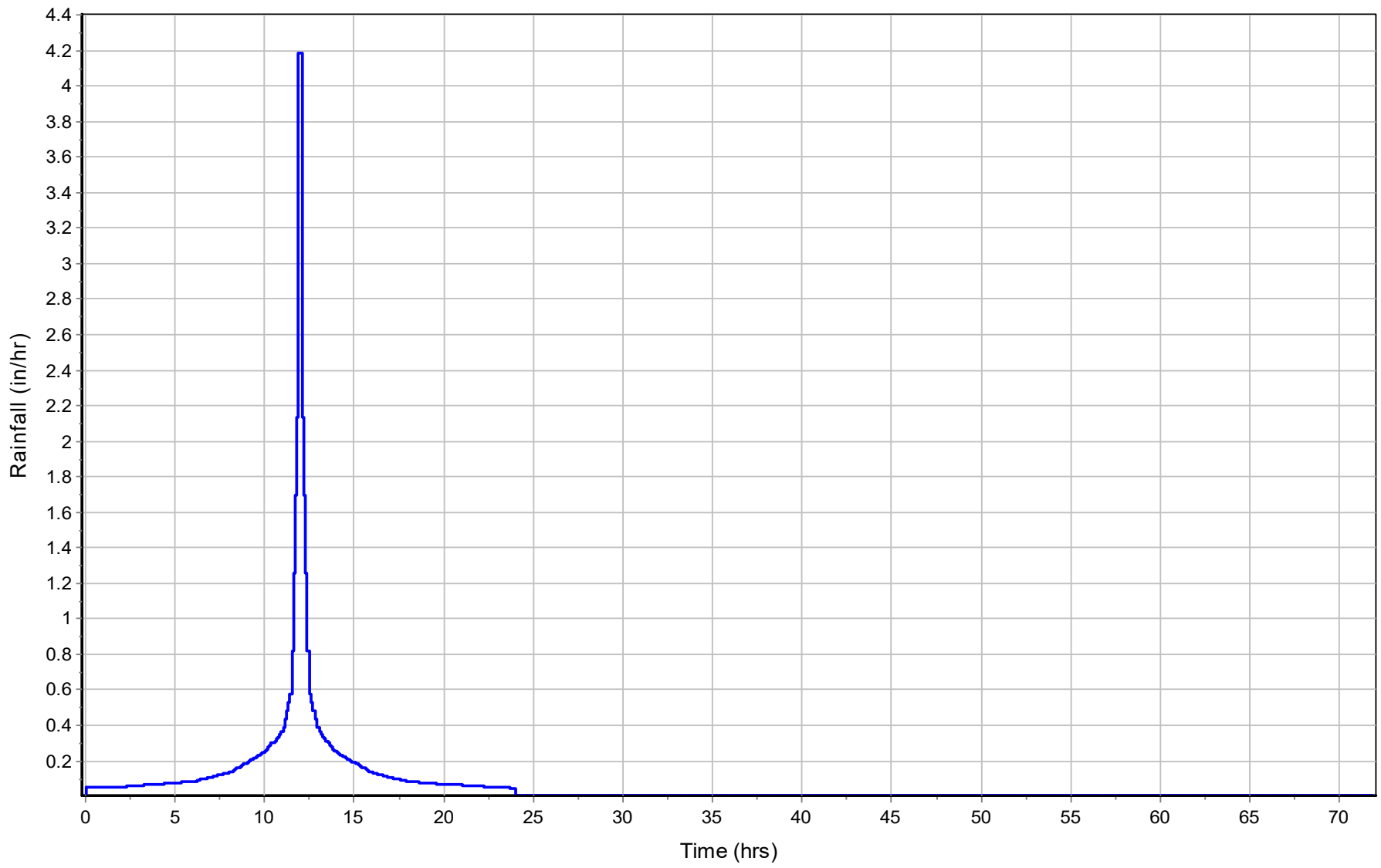
Total TOC (min) 10.92

Subbasin Runoff Results

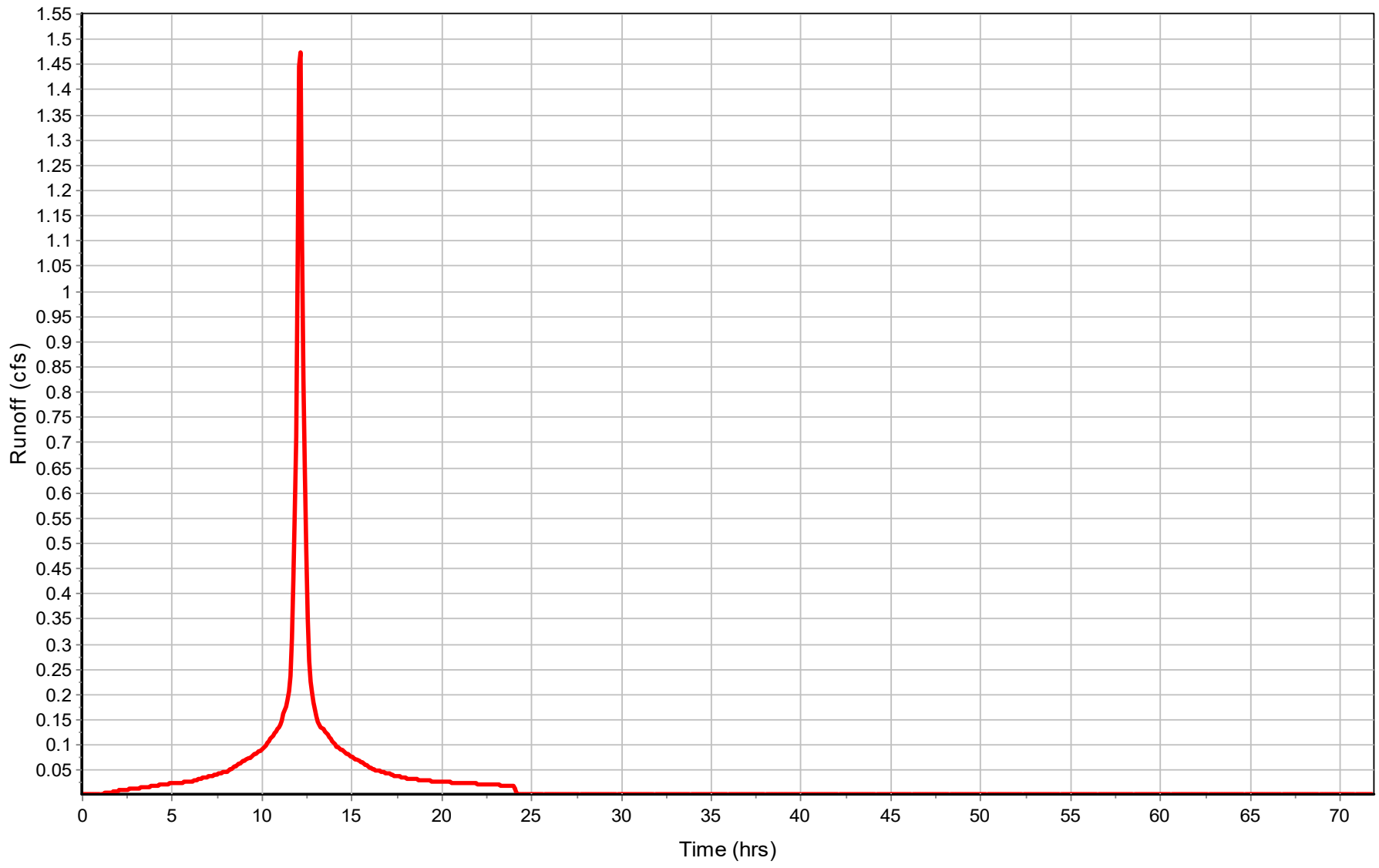
Total Rainfall (in) 4.98
Total Runoff (in) 4.74
Peak Runoff (cfs) 1.52
Weighted Curve Number 98
Time of Concentration (days hh:mm:ss) 0 00:10:55

Subbasin : A1-1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : A1-2

Input Data

Area (ac) 1.34
Peak Rate Factor 484
Weighted Curve Number 54.63
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	0.28	A	76
-	1.06	-	49
Composite Area & Weighted CN	1.34		54.63

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	131.55	0	0
Slope (%) :	4	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	1.54	0	0
Computed Flow Time (min) :	1.42	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	358.95	0	0
Channel Slope (%) :	0.3	0	0
Cross Section Area (ft^2) :	13.52	0	0
Wetted Perimeter (ft) :	11.63	0	0
Velocity (ft/sec) :	3.01	0	0
Computed Flow Time (min) :	1.99	0	0

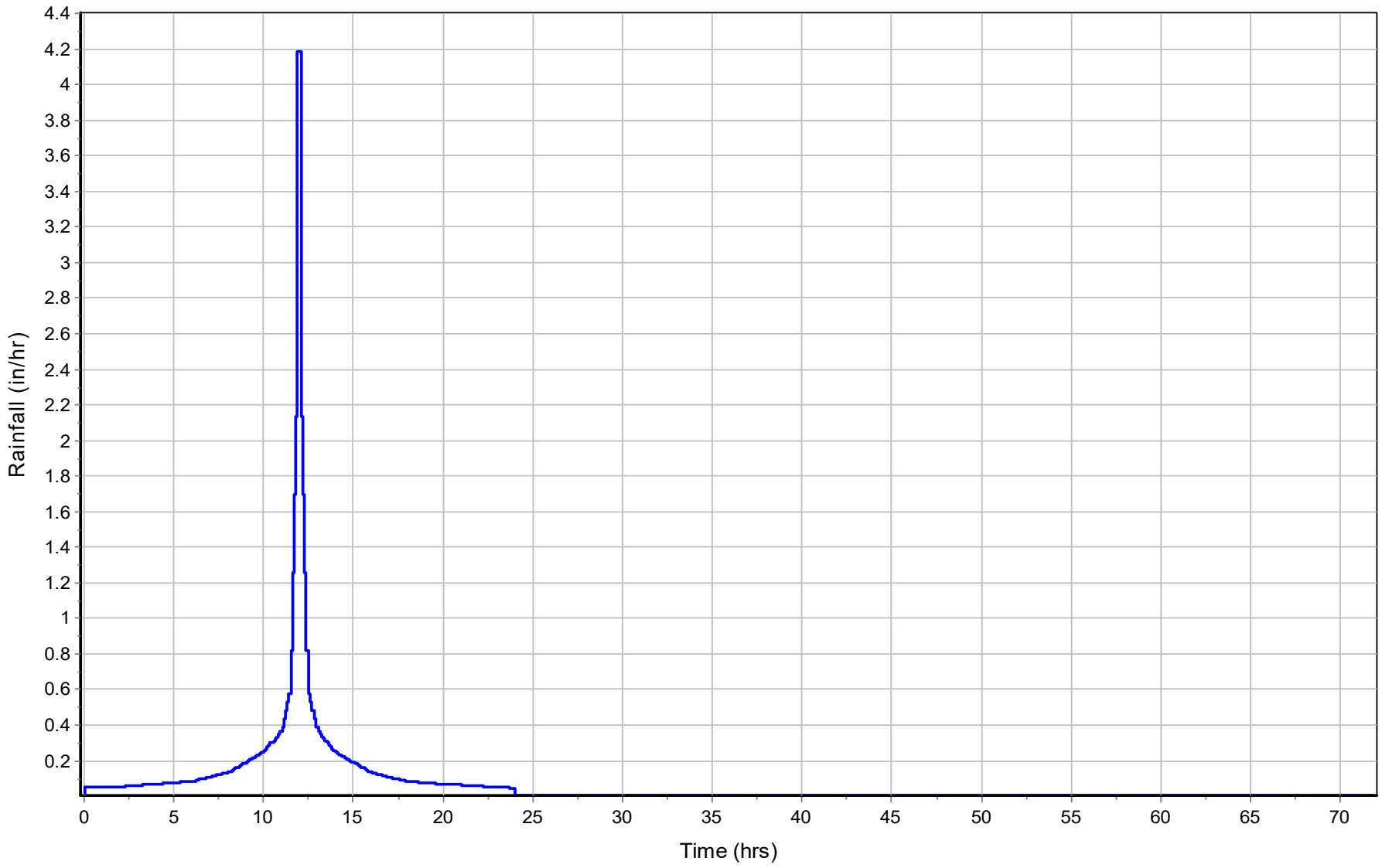
Total TOC (min) 3.41

Subbasin Runoff Results

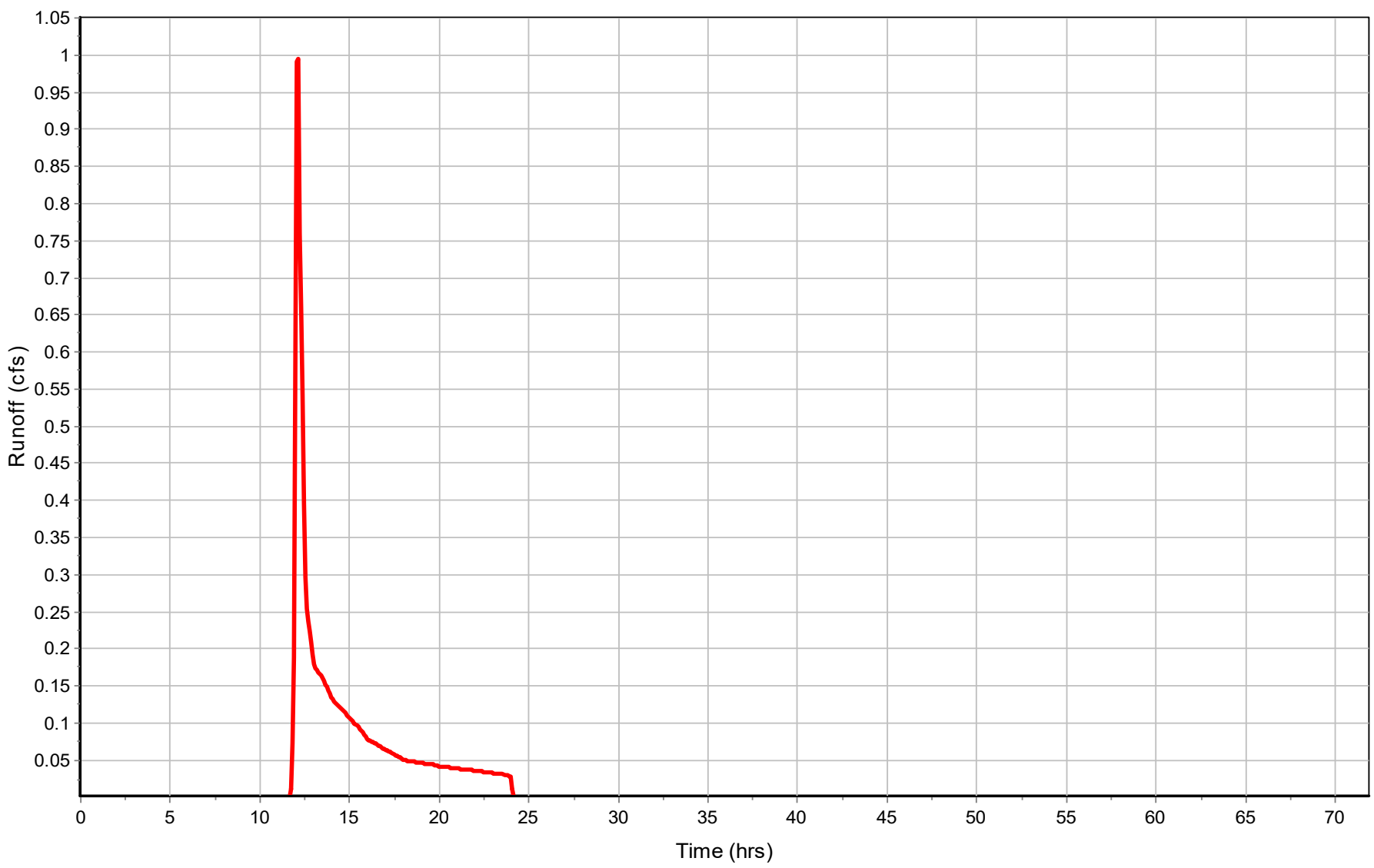
Total Rainfall (in) 4.98
Total Runoff (in) 0.95
Peak Runoff (cfs) 1.13
Weighted Curve Number 54.63
Time of Concentration (days hh:mm:ss) 0 00:03:25

Subbasin : A1-2

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : A1-3

Input Data

Area (ac) 1.03
Peak Rate Factor 484
Weighted Curve Number 49
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	1.03	A	49
Composite Area & Weighted CN	1.03		49

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.4	0	0
Flow Length (ft) :	300	0	0
Slope (%) :	4	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.13	0	0
Computed Flow Time (min) :	37.97	0	0

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	13.33	0	0
Slope (%) :	4	0	0
Surface Type :	Grassed waterway	Unpaved	Unpaved
Velocity (ft/sec) :	3	0	0
Computed Flow Time (min) :	0.07	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	403.18	0	0
Channel Slope (%) :	0.3	0	0
Cross Section Area (ft^2) :	13.52	0	0
Wetted Perimeter (ft) :	11.63	0	0
Velocity (ft/sec) :	3.01	0	0
Computed Flow Time (min) :	2.23	0	0

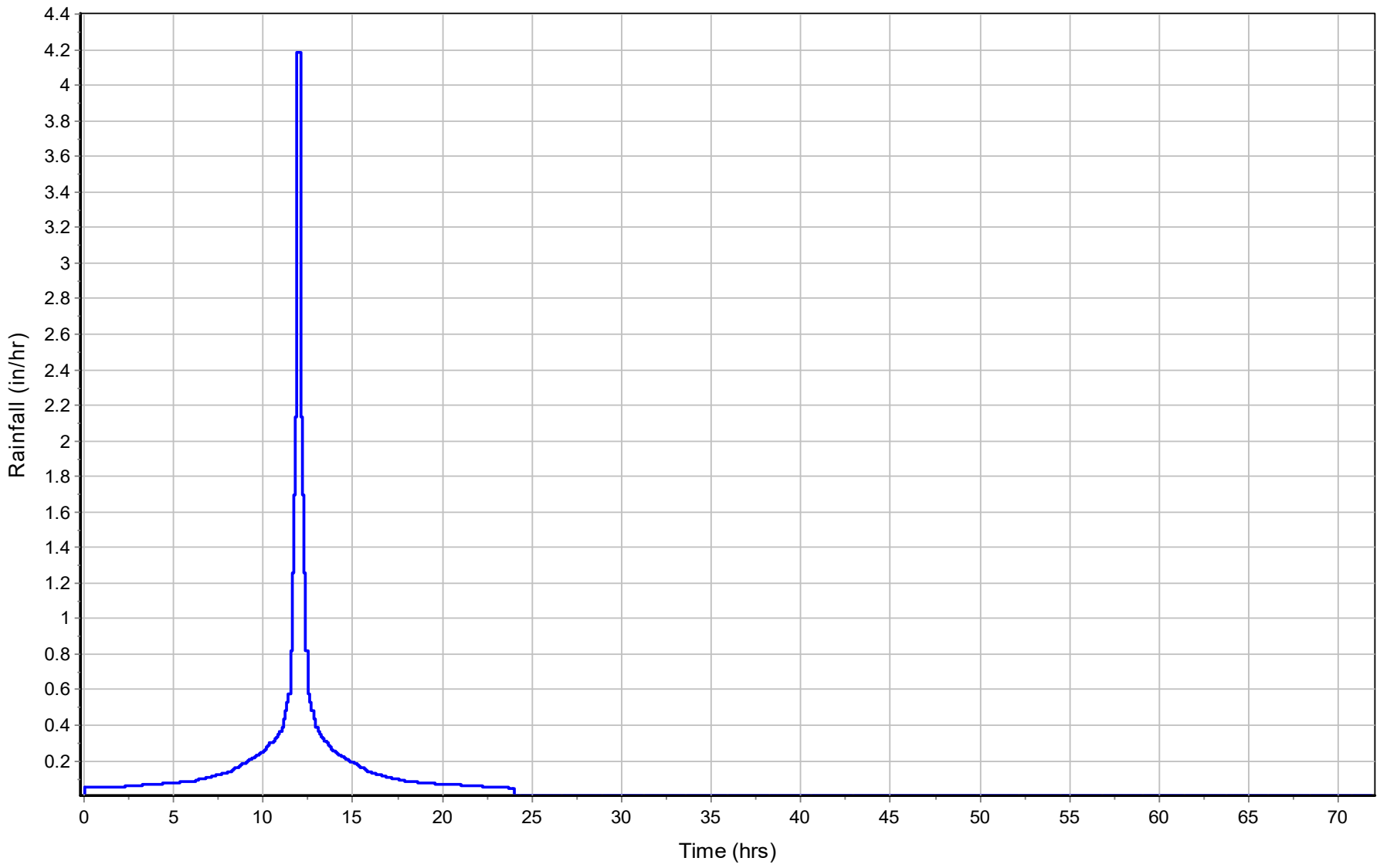
Total TOC (min) 40.27

Subbasin Runoff Results

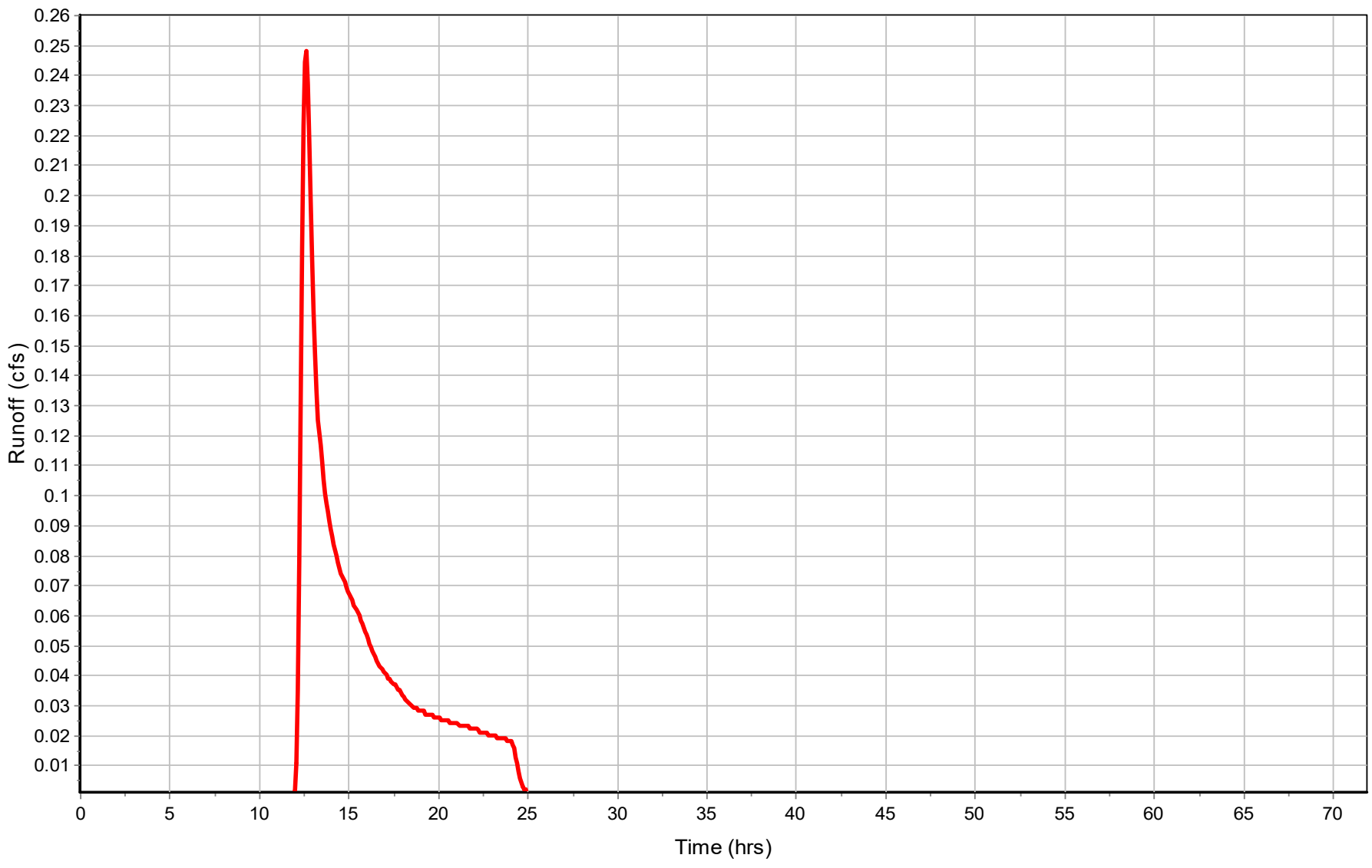
Total Rainfall (in) 4.98
Total Runoff (in) 0.63
Peak Runoff (cfs) 0.25
Weighted Curve Number 49
Time of Concentration (days hh:mm:ss) 0 00:40:16

Subbasin : A1-3

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : A2

Input Data

Area (ac) 0.92
Peak Rate Factor 484
Weighted Curve Number 76
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	0.92	A	76
Composite Area & Weighted CN	0.92		76

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	85.5	0	0
Slope (%) :	1.5	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.96	0	0
Computed Flow Time (min) :	1.49	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	255.68	0	0
Channel Slope (%) :	1.17	0	0
Cross Section Area (ft^2) :	1.475	0	0
Wetted Perimeter (ft) :	5.99	0	0
Velocity (ft/sec) :	2.11	0	0
Computed Flow Time (min) :	2.02	0	0

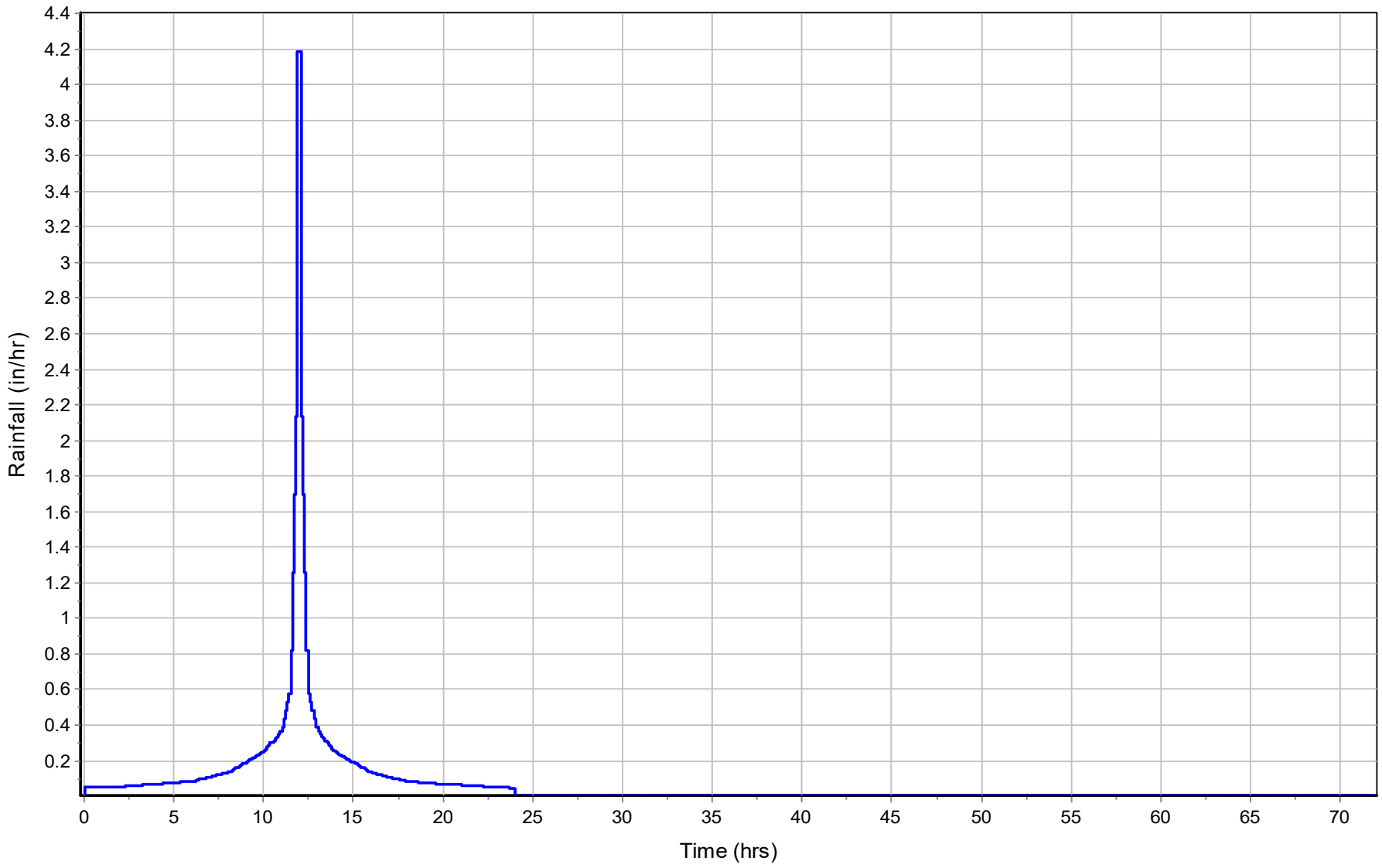
Total TOC (min) 3.51

Subbasin Runoff Results

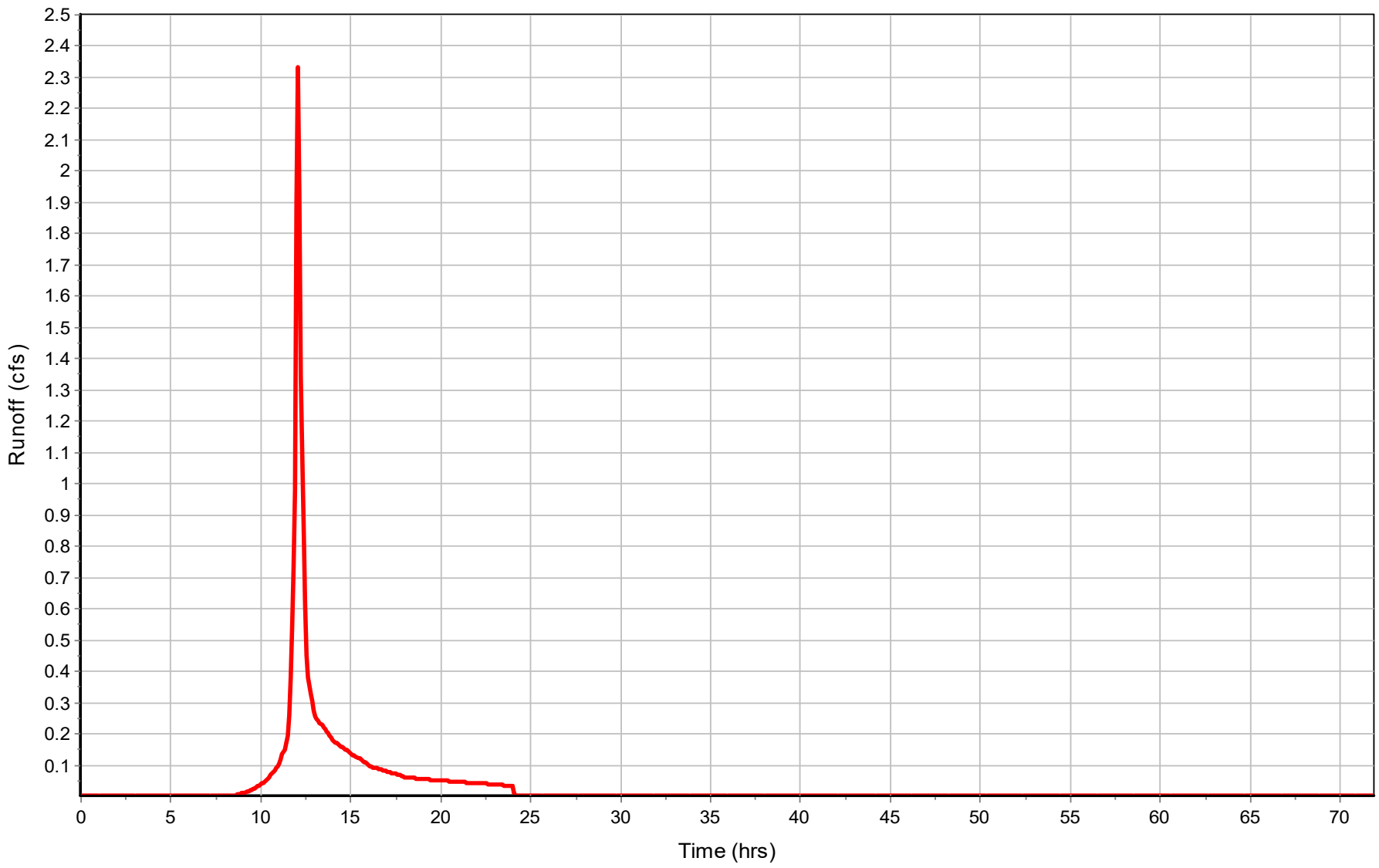
Total Rainfall (in) 4.98
Total Runoff (in) 2.52
Peak Runoff (cfs) 2.4
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:03:31

Subbasin : A2

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : A-3

Input Data

Area (ac)	0.25
Peak Rate Factor	484
Weighted Curve Number	51.7
Rain Gage ID	Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
-	0.23	-	49
-	0.03	-	76
Composite Area & Weighted CN	0.26		51.7

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.4	0	0
Flow Length (ft) :	300	0	0
Slope (%) :	5	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.14	0	0
Computed Flow Time (min) :	34.72	0	0

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	83.1895	0	0
Slope (%) :	2	0	0
Surface Type :	Grass pasture	Unpaved	Unpaved
Velocity (ft/sec) :	0.99	0	0
Computed Flow Time (min) :	1.4	0	0

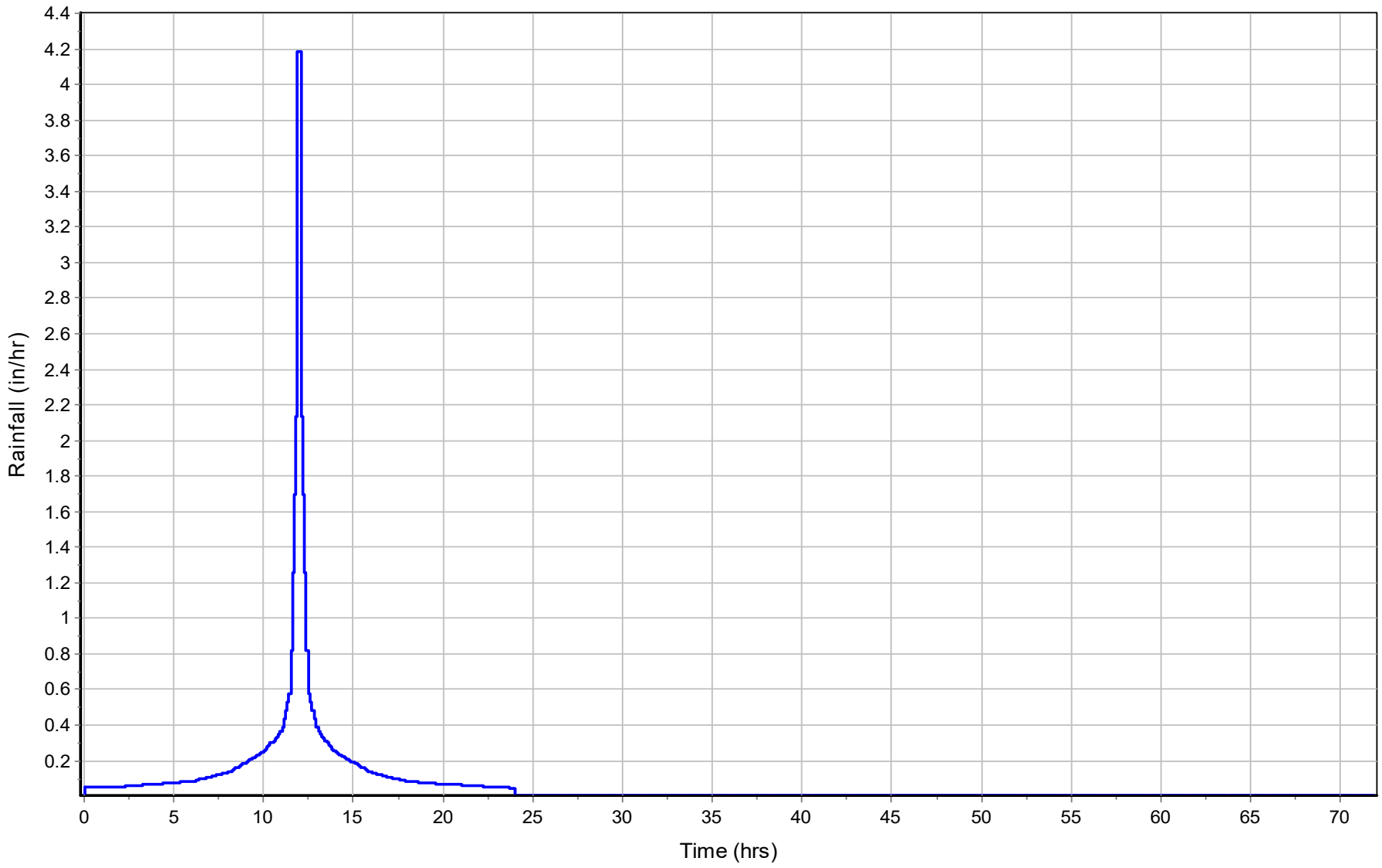
Total TOC (min) 36.12

Subbasin Runoff Results

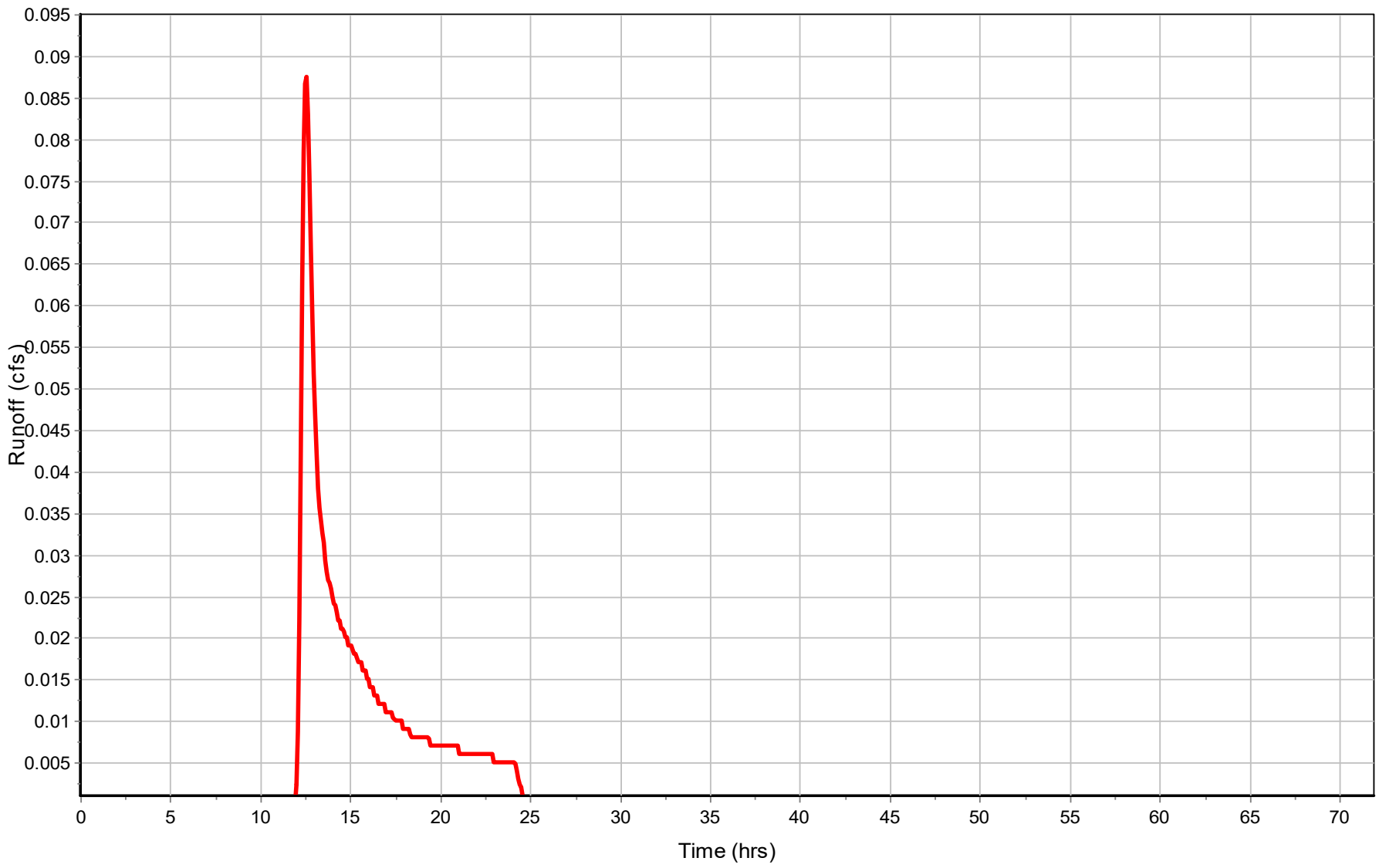
Total Rainfall (in)	4.98
Total Runoff (in)	0.78
Peak Runoff (cfs)	0.09
Weighted Curve Number	51.7
Time of Concentration (days hh:mm:ss)	0 00:36:07

Subbasin : A-3

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : DA-Ditch-A1

Input Data

Area (ac) 1.35
Peak Rate Factor 484
Weighted Curve Number 76
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
50 - 75% grass cover, Fair	1.35	A	76
Composite Area & Weighted CN	1.35		76

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	217.17	0	0
Slope (%) :	1.5	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	1.15	0	0
Computed Flow Time (min) :	3.14	0	0

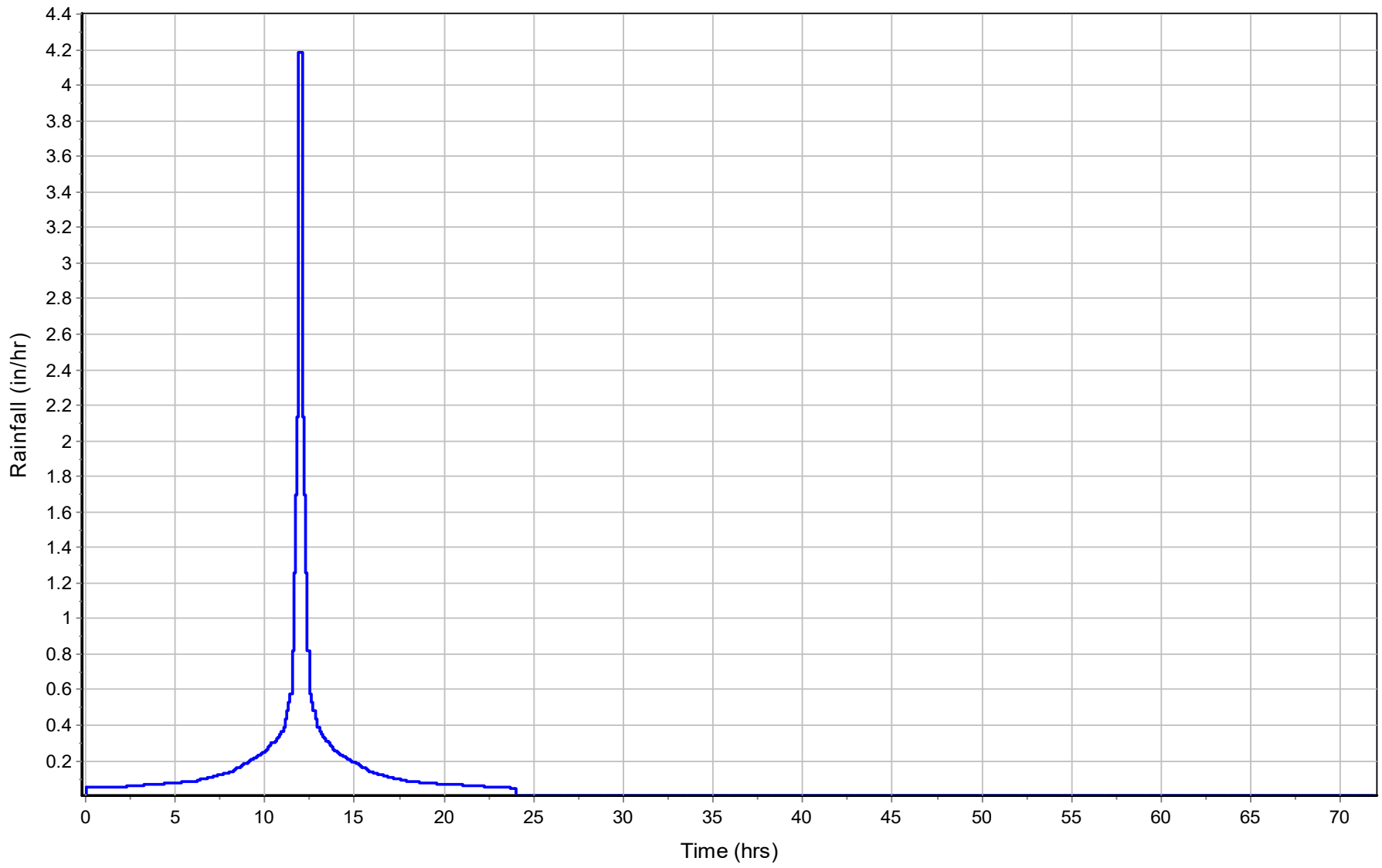
Total TOC (min) 3.14

Subbasin Runoff Results

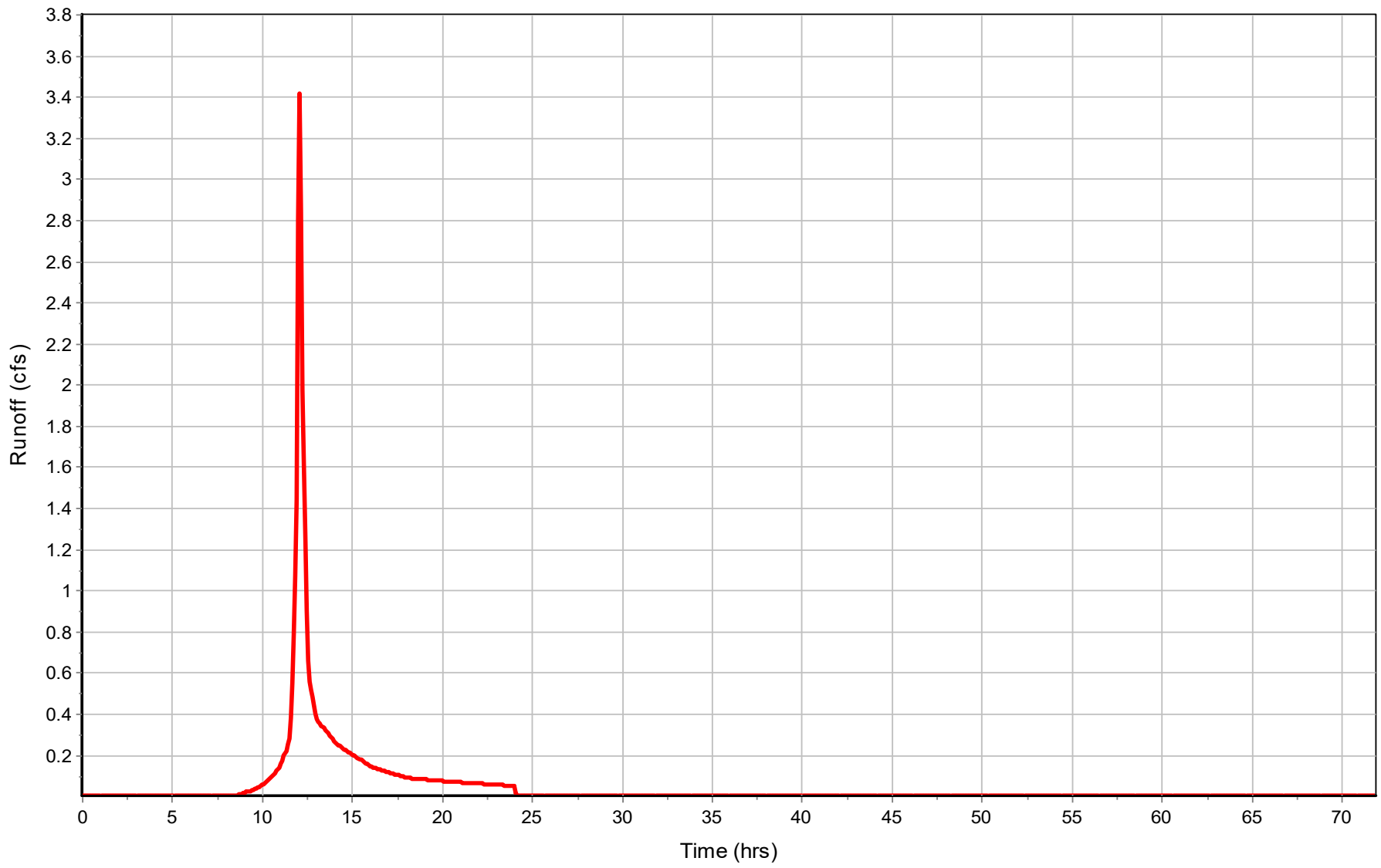
Total Rainfall (in) 4.98
Total Runoff (in) 2.52
Peak Runoff (cfs) 3.52
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:03:08

Subbasin : DA-Ditch-A1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : DA-Ditch-A1-2

Input Data

Area (ac) 1.29
Peak Rate Factor 484
Weighted Curve Number 76
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
50 - 75% grass cover, Fair	1.29	A	76
Composite Area & Weighted CN	1.29		76

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	131.55	0	0
Slope (%) :	1.5	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	1.04	0	0
Computed Flow Time (min) :	2.1	0	0

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	7.88	0	0
Slope (%) :	1.5	0	0
Surface Type :	Unpaved	Unpaved	Unpaved
Velocity (ft/sec) :	1.98	0	0
Computed Flow Time (min) :	0.07	0	0

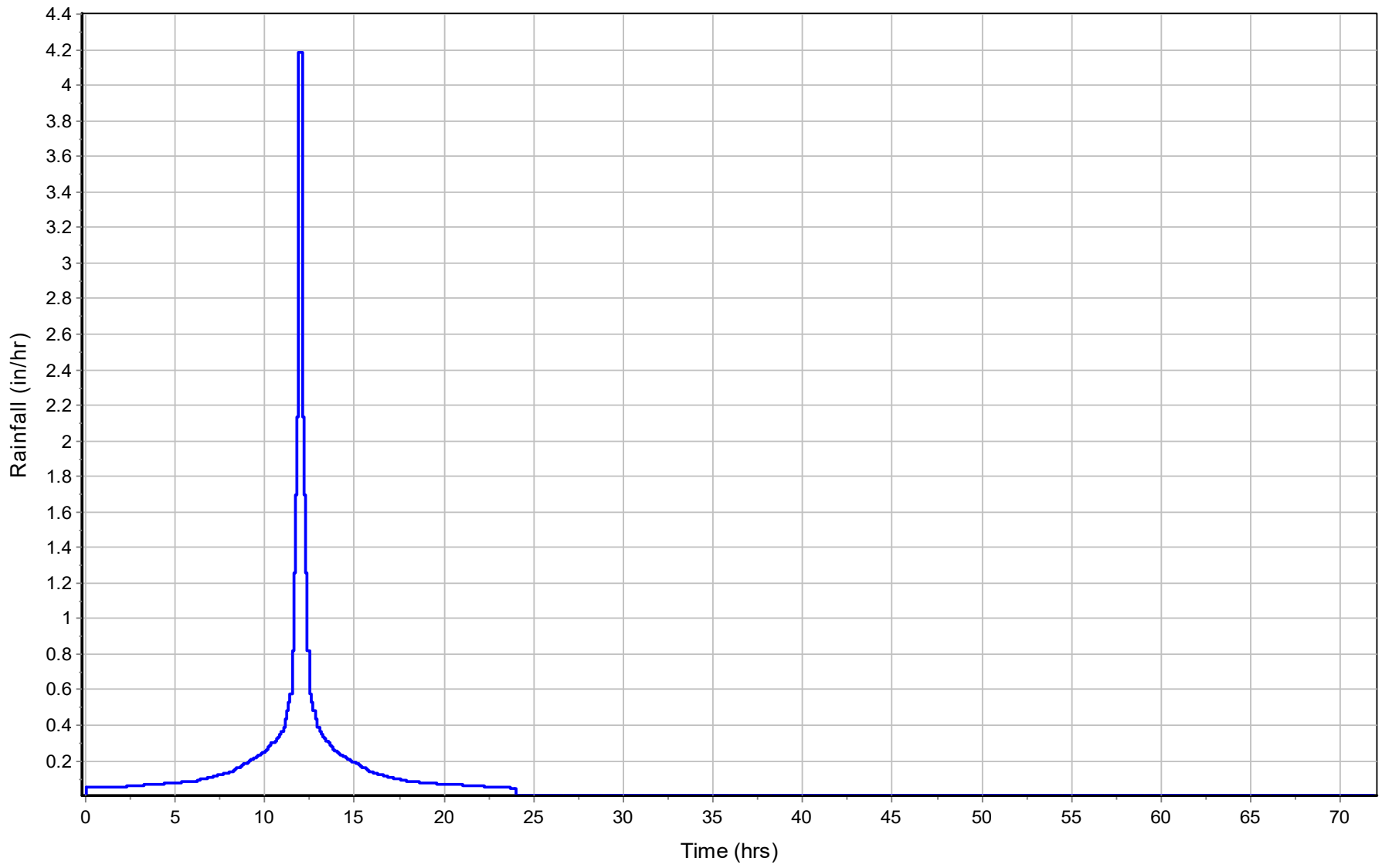
Total TOC (min) 2.17

Subbasin Runoff Results

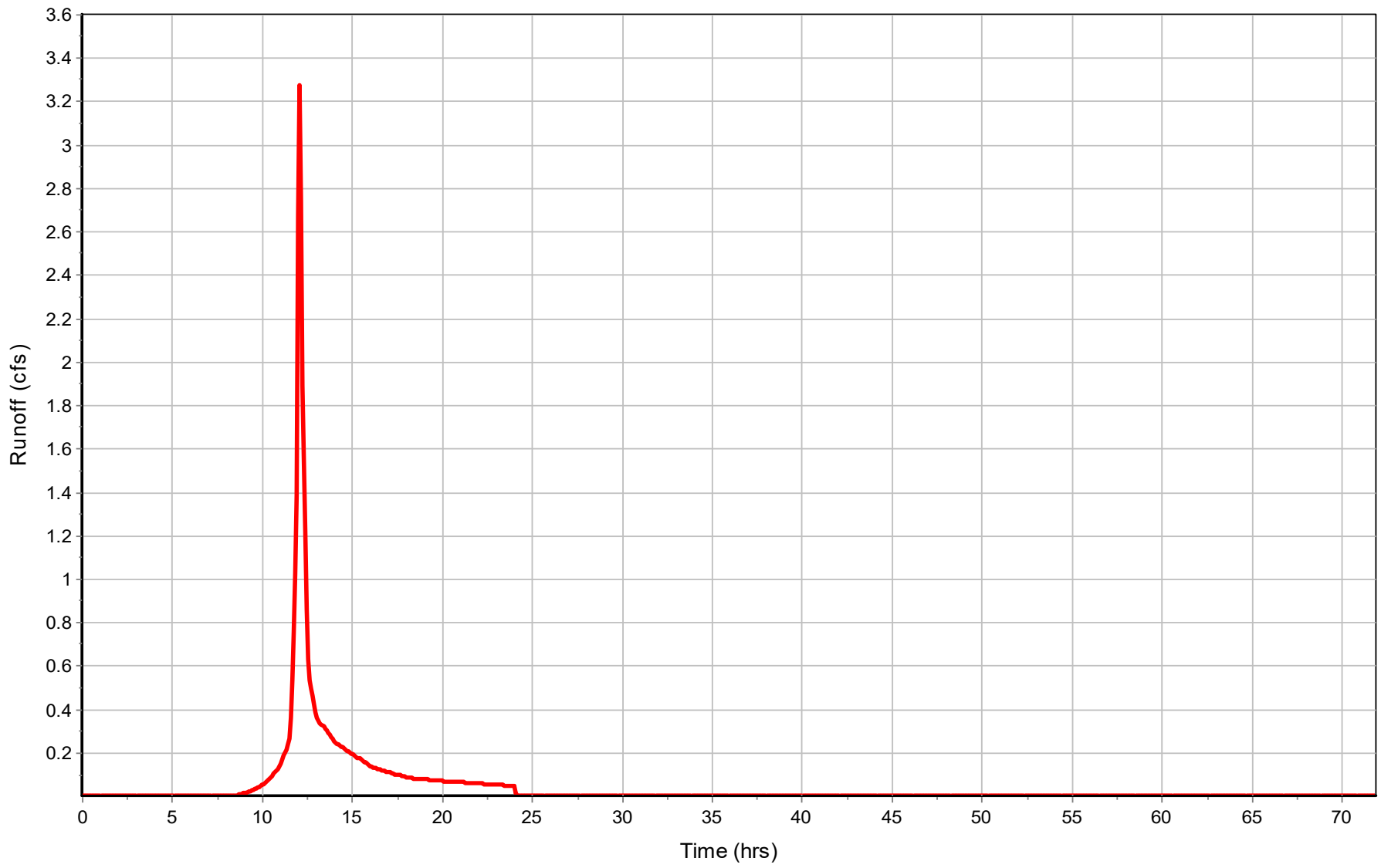
Total Rainfall (in) 4.98
Total Runoff (in) 2.52
Peak Runoff (cfs) 3.37
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:02:10

Subbasin : DA-Ditch-A1-2

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : DA-Ditch-A2

Input Data

Area (ac)	0.67
Peak Rate Factor	484
Weighted Curve Number	76
Rain Gage ID	Rain Gage-01

Composite Curve Number

32

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
50 - 75% grass cover, Fair	0.67	A	76
Composite Area & Weighted CN	0.67		76

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	300	0	0
Slope (%) :	1.5	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	1.23	0	0
Computed Flow Time (min) :	4.06	0	0

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	7.88	0	0
Slope (%) :	1.5	0	0
Surface Type :	Unpaved	Unpaved	Unpaved
Velocity (ft/sec) :	1.98	0	0
Computed Flow Time (min) :	0.07	0	0

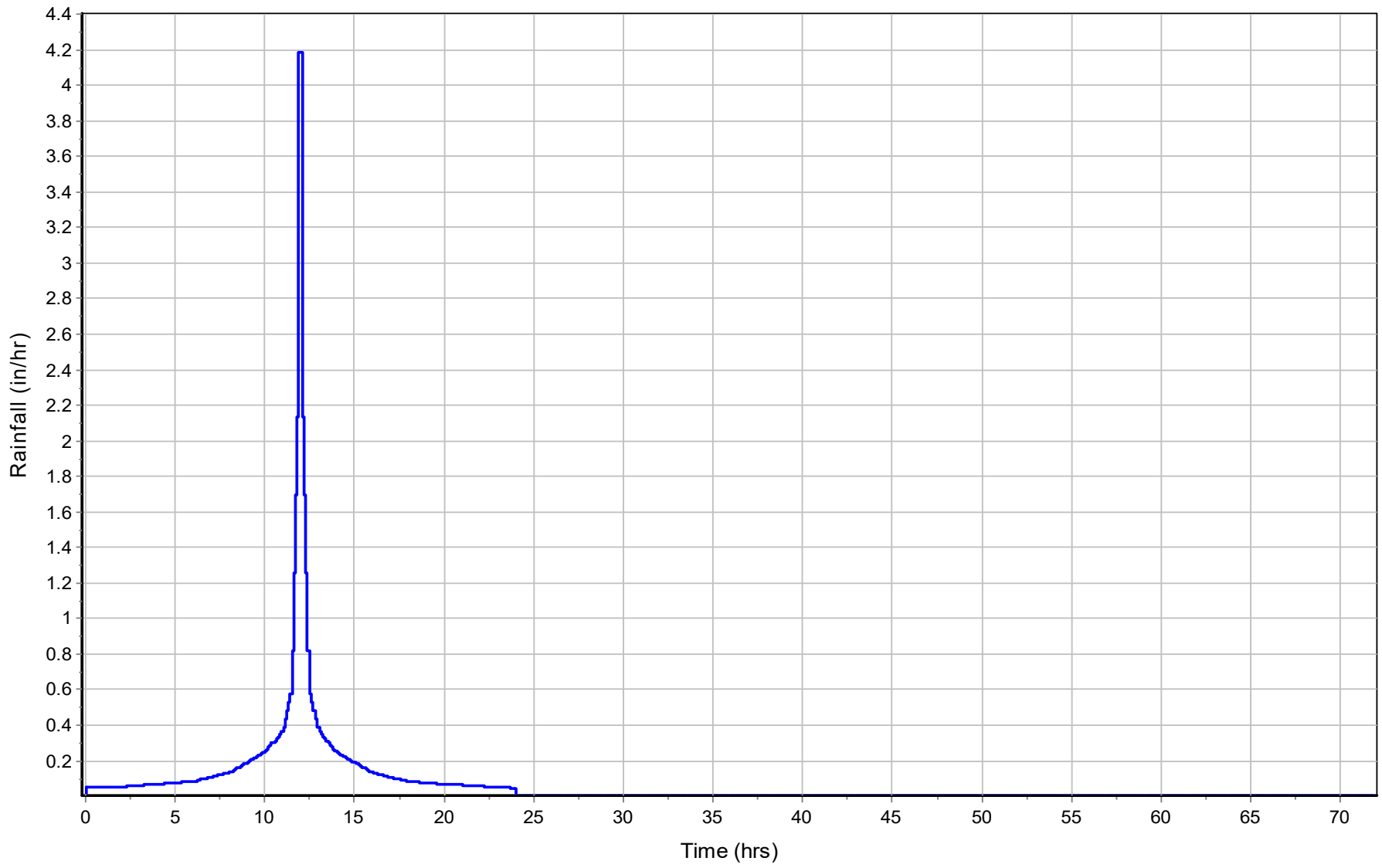
Total TOC (min) 4.13

Subbasin Runoff Results

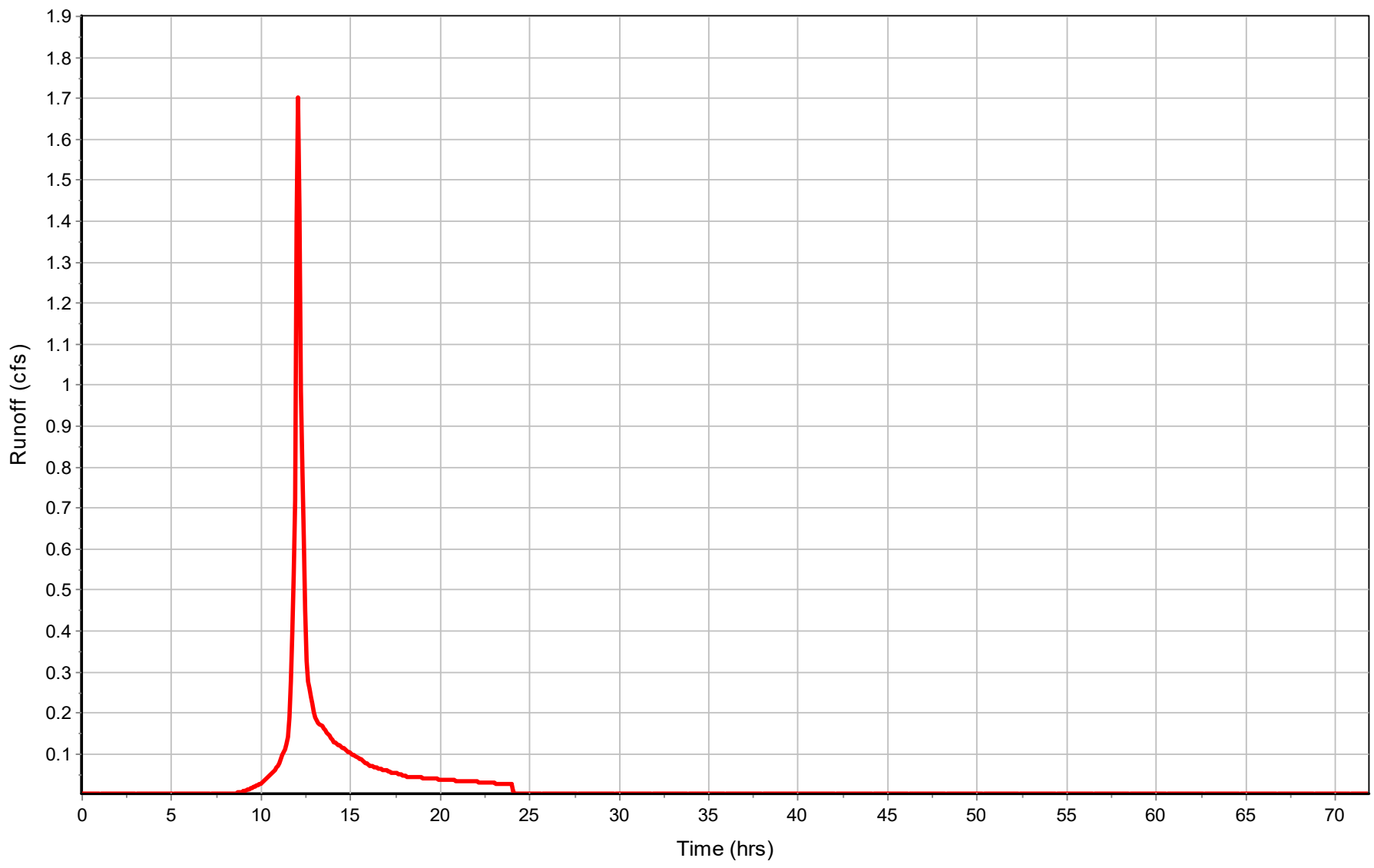
Total Rainfall (in)	4.98
Total Runoff (in)	2.52
Peak Runoff (cfs)	1.75
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:04:08

Subbasin : DA-Ditch-A2

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Existing-E03-1_A1

Input Data

Area (ac)	0.89
Peak Rate Factor	484
Weighted Curve Number	49
Rain Gage ID	Rain Gage-01

Composite Curve Number

32

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
50 - 75% grass cover, Fair	0.89	A	49
Composite Area & Weighted CN	0.89		49

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.4	0	0
Flow Length (ft) :	251.94	0	0
Slope (%) :	3.5	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.12	0	0
Computed Flow Time (min) :	34.83	0	0

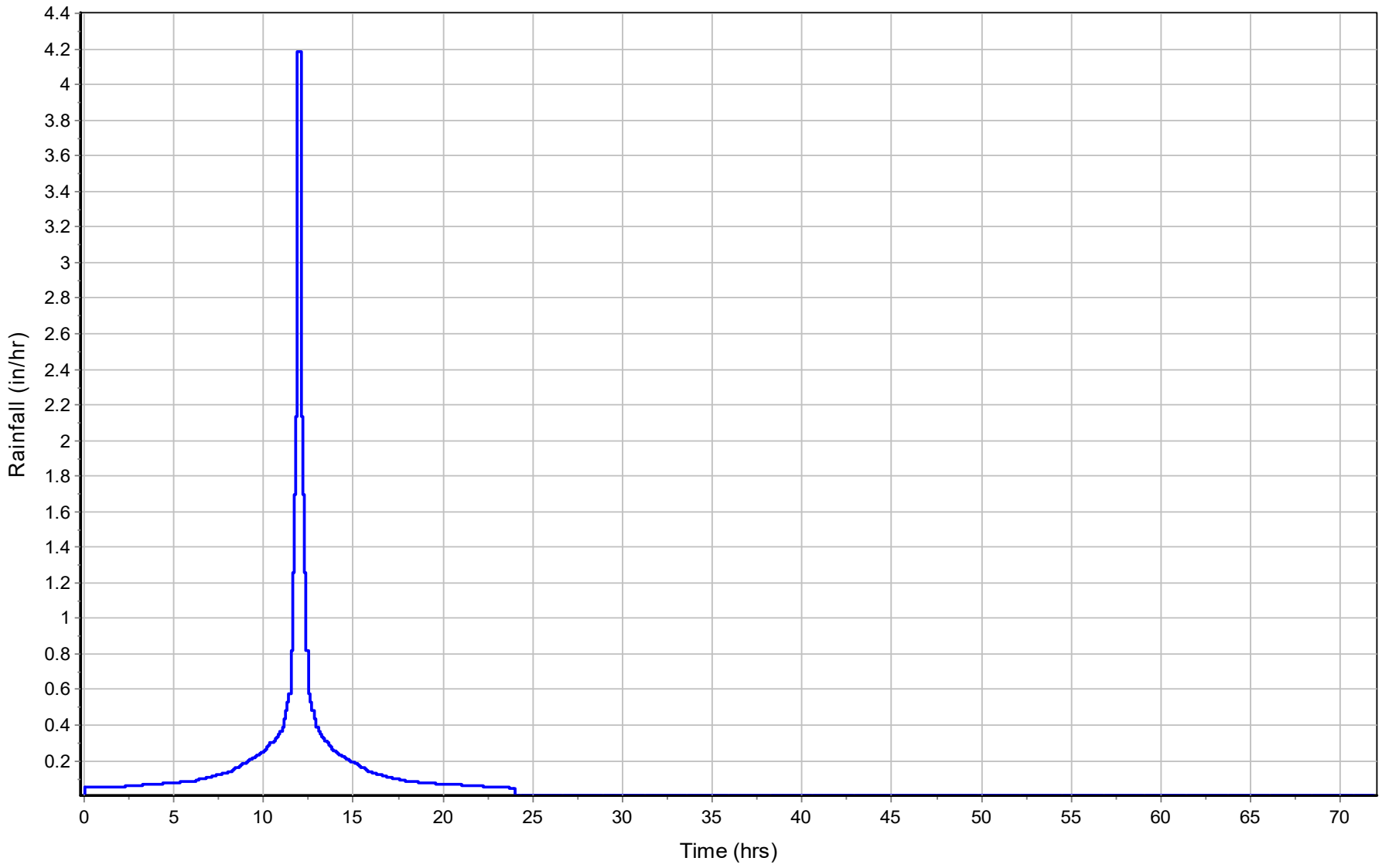
Total TOC (min) 34.83

Subbasin Runoff Results

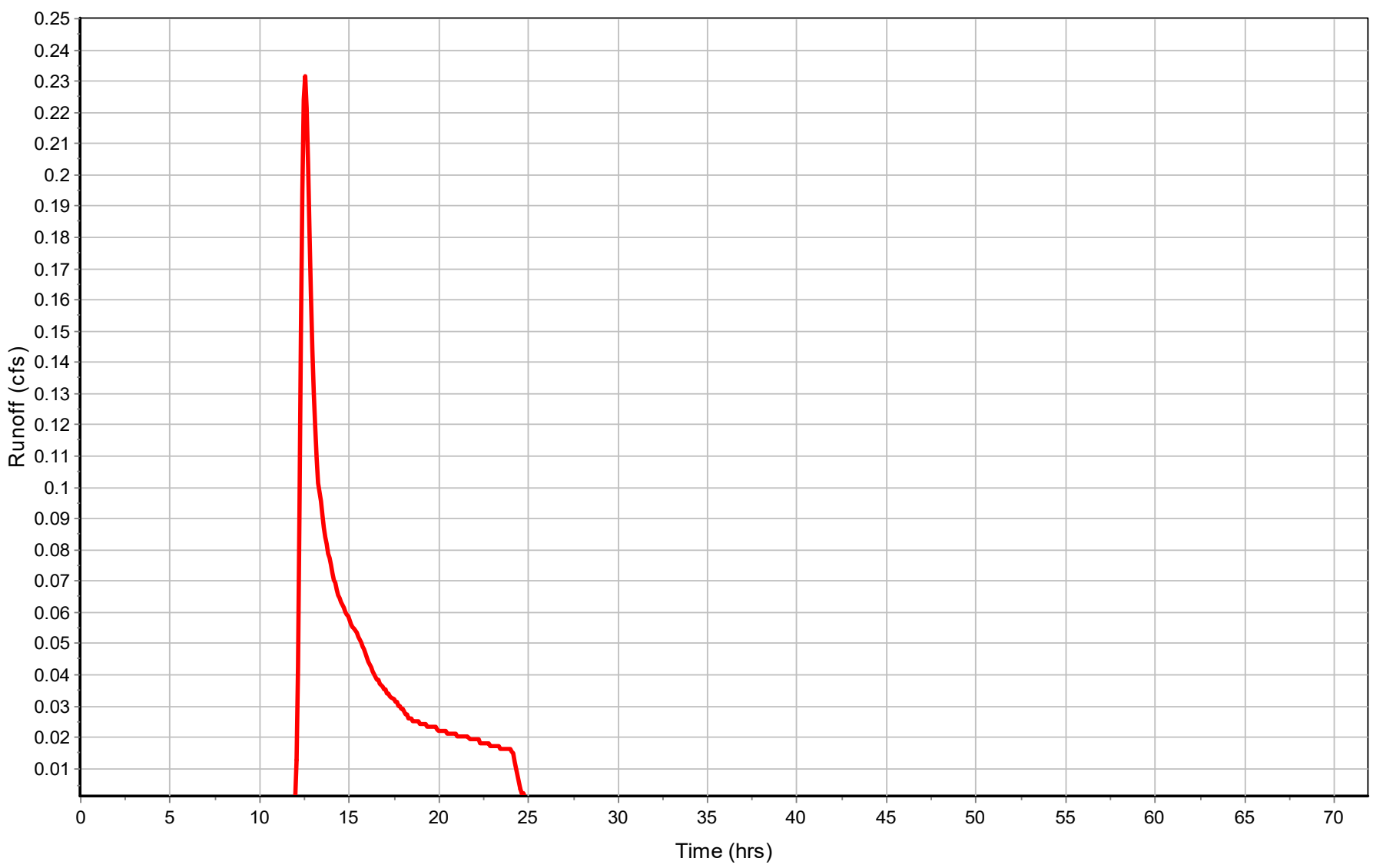
Total Rainfall (in)	4.98
Total Runoff (in)	0.63
Peak Runoff (cfs)	0.23
Weighted Curve Number	49
Time of Concentration (days hh:mm:ss)	0 00:34:50

Subbasin : Existing-E03-1_A1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Existing-E-07_A3

Input Data

Area (ac)	0.39
Peak Rate Factor	484
Weighted Curve Number	51.7
Rain Gage ID	Rain Gage-01

Composite Curve Number

32

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
50 - 75% grass cover, Fair	0.35	A	49
-	0.04	-	76
Composite Area & Weighted CN	0.39		51.7

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.4	0	0
Flow Length (ft) :	300	0	0
Slope (%) :	5	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.14	0	0
Computed Flow Time (min) :	34.72	0	0

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	105.18	0	0
Slope (%) :	2	0	0
Surface Type :	Grass pasture	Unpaved	Unpaved
Velocity (ft/sec) :	0.99	0	0
Computed Flow Time (min) :	1.77	0	0

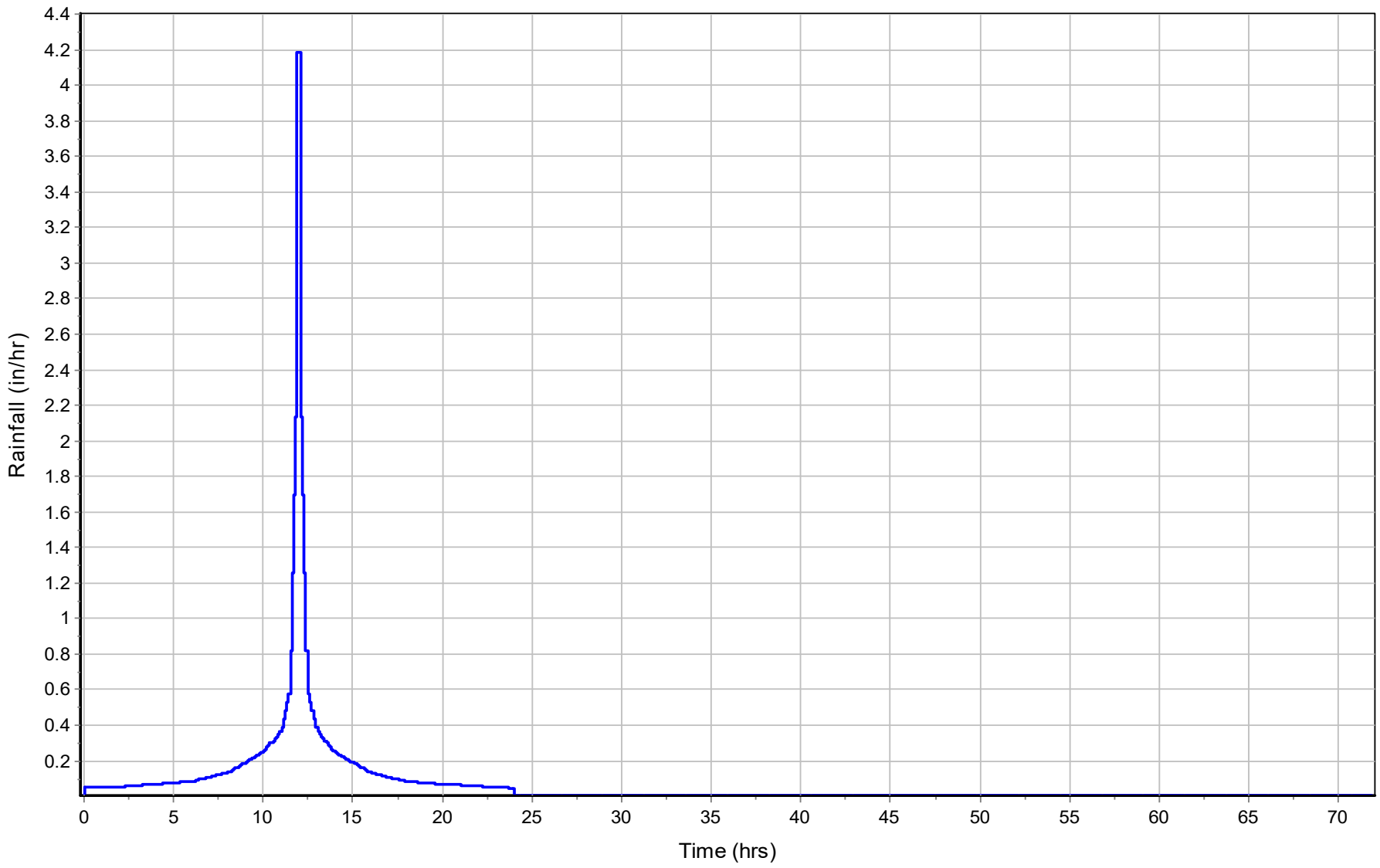
Total TOC (min) 36.49

Subbasin Runoff Results

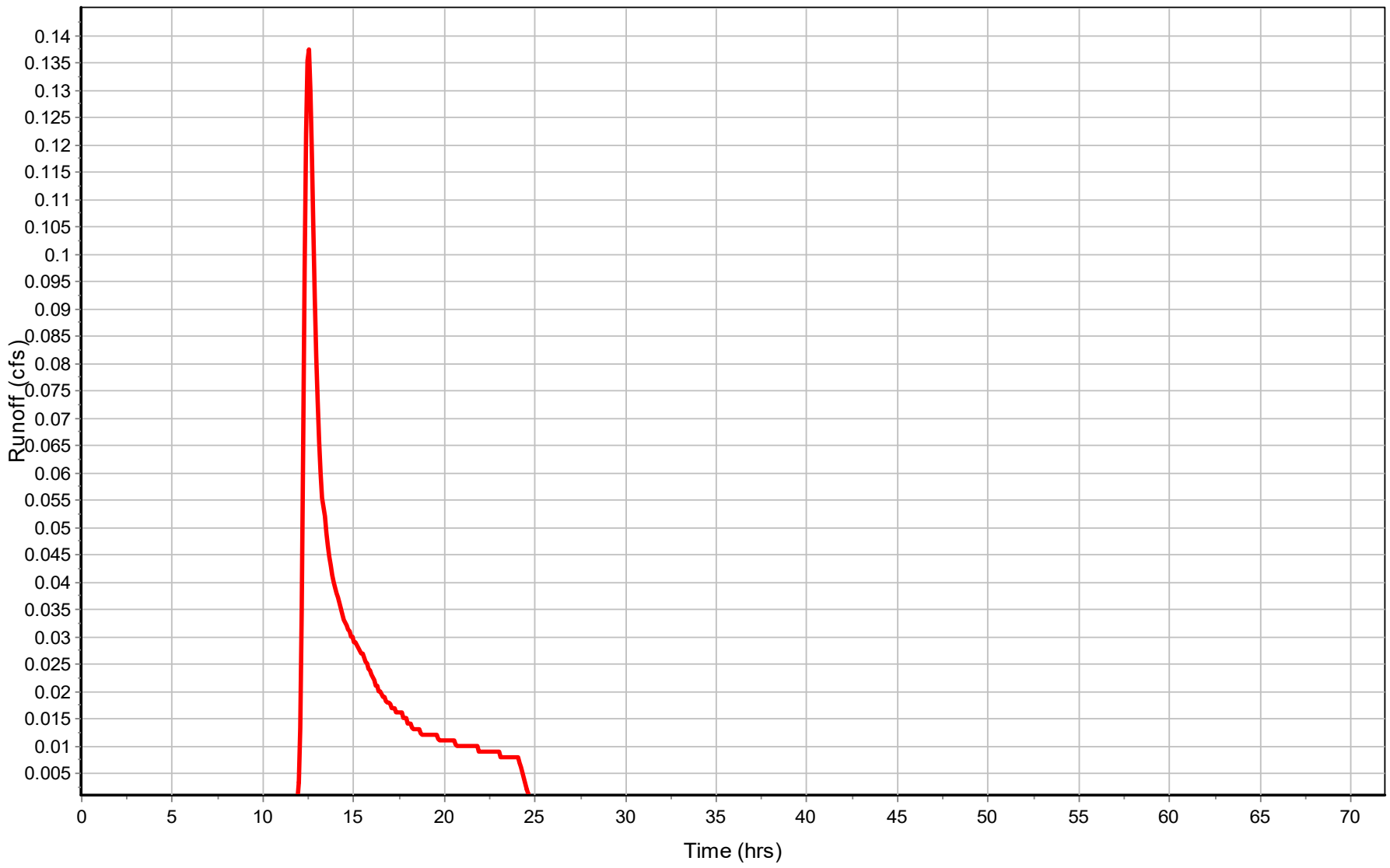
Total Rainfall (in)	4.98
Total Runoff (in)	0.78
Peak Runoff (cfs)	0.14
Weighted Curve Number	51.7
Time of Concentration (days hh:mm:ss)	0 00:36:29

Subbasin : Existing-E-07_A3

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Existing-E3_A1-2

Input Data

Area (ac)	3.2
Peak Rate Factor	484
Weighted Curve Number	49
Rain Gage ID	Rain Gage-01

Composite Curve Number

32

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
-	3.2	-	49
Composite Area & Weighted CN	3.2		49

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.4	0	0
Flow Length (ft) :	300	0	0
Slope (%) :	3.5	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.12	0	0
Computed Flow Time (min) :	40.05	0	0

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	205.17	0	0
Slope (%) :	3	0	0
Surface Type :	Grass pasture	Unpaved	Unpaved
Velocity (ft/sec) :	1.21	0	0
Computed Flow Time (min) :	2.83	0	0

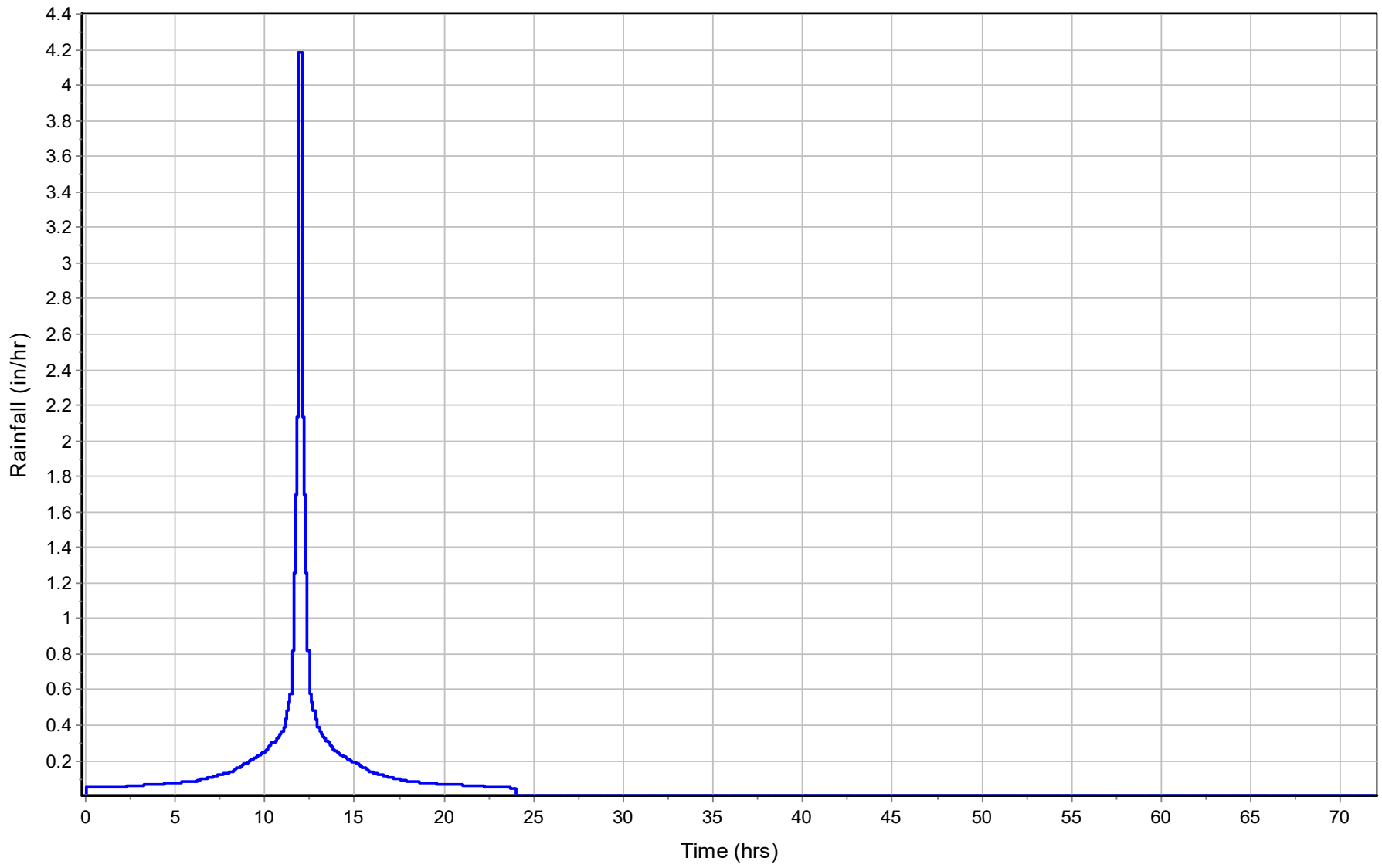
Total TOC (min) 42.87

Subbasin Runoff Results

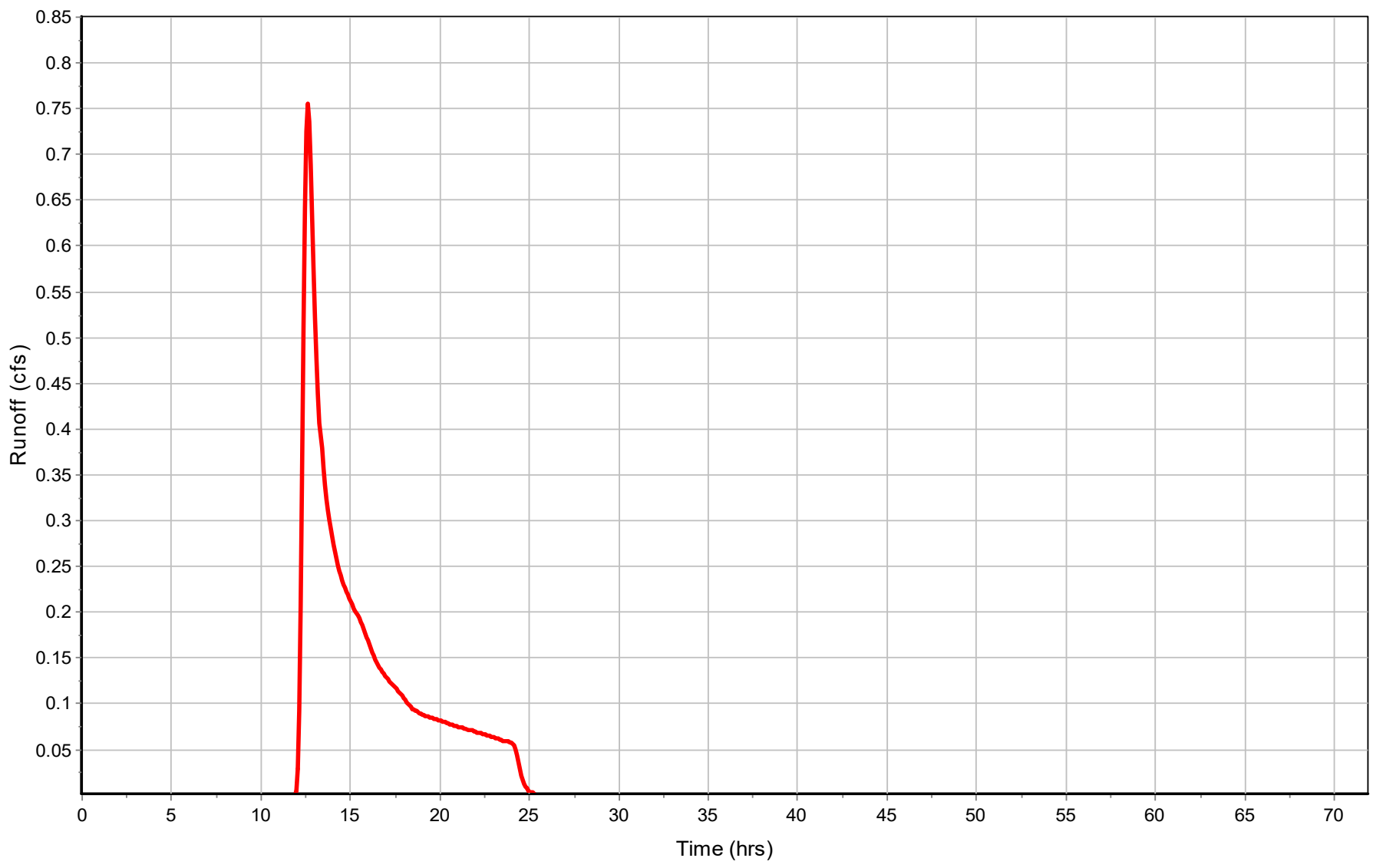
Total Rainfall (in)	4.98
Total Runoff (in)	0.63
Peak Runoff (cfs)	0.76
Weighted Curve Number	49
Time of Concentration (days hh:mm:ss)	0 00:42:52

Subbasin : Existing-E3_A1-2

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Existing-E5.1_A2

Input Data

Area (ac)	0.26
Peak Rate Factor	484
Weighted Curve Number	49
Rain Gage ID	Rain Gage-01

Composite Curve Number

32

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
50 - 75% grass cover, Fair	0.26	A	49
Composite Area & Weighted CN	0.26		49

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.4	0	0
Flow Length (ft) :	142.47	0	0
Slope (%) :	10	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.16	0	0
Computed Flow Time (min) :	14.5	0	0

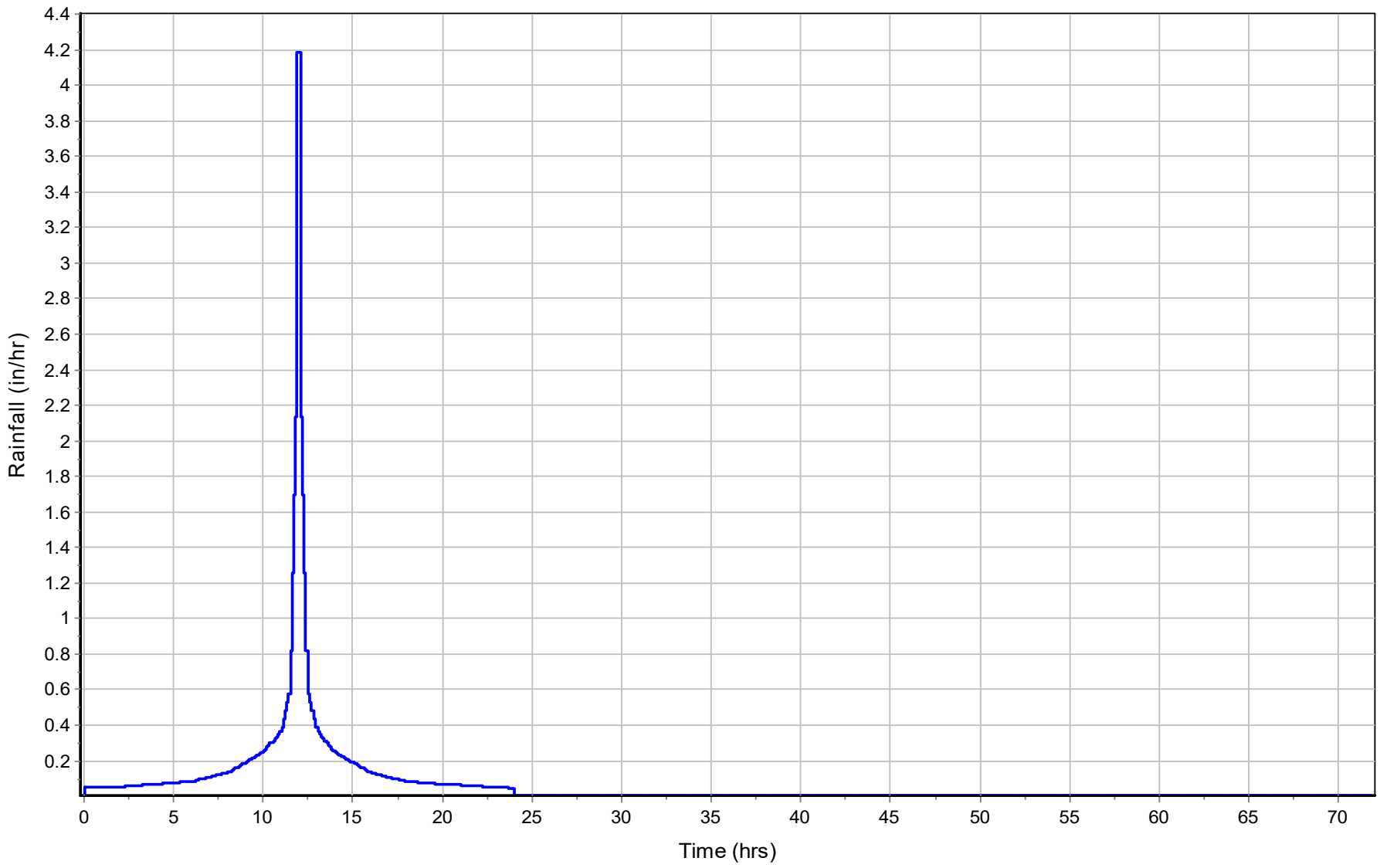
Total TOC (min) 14.50

Subbasin Runoff Results

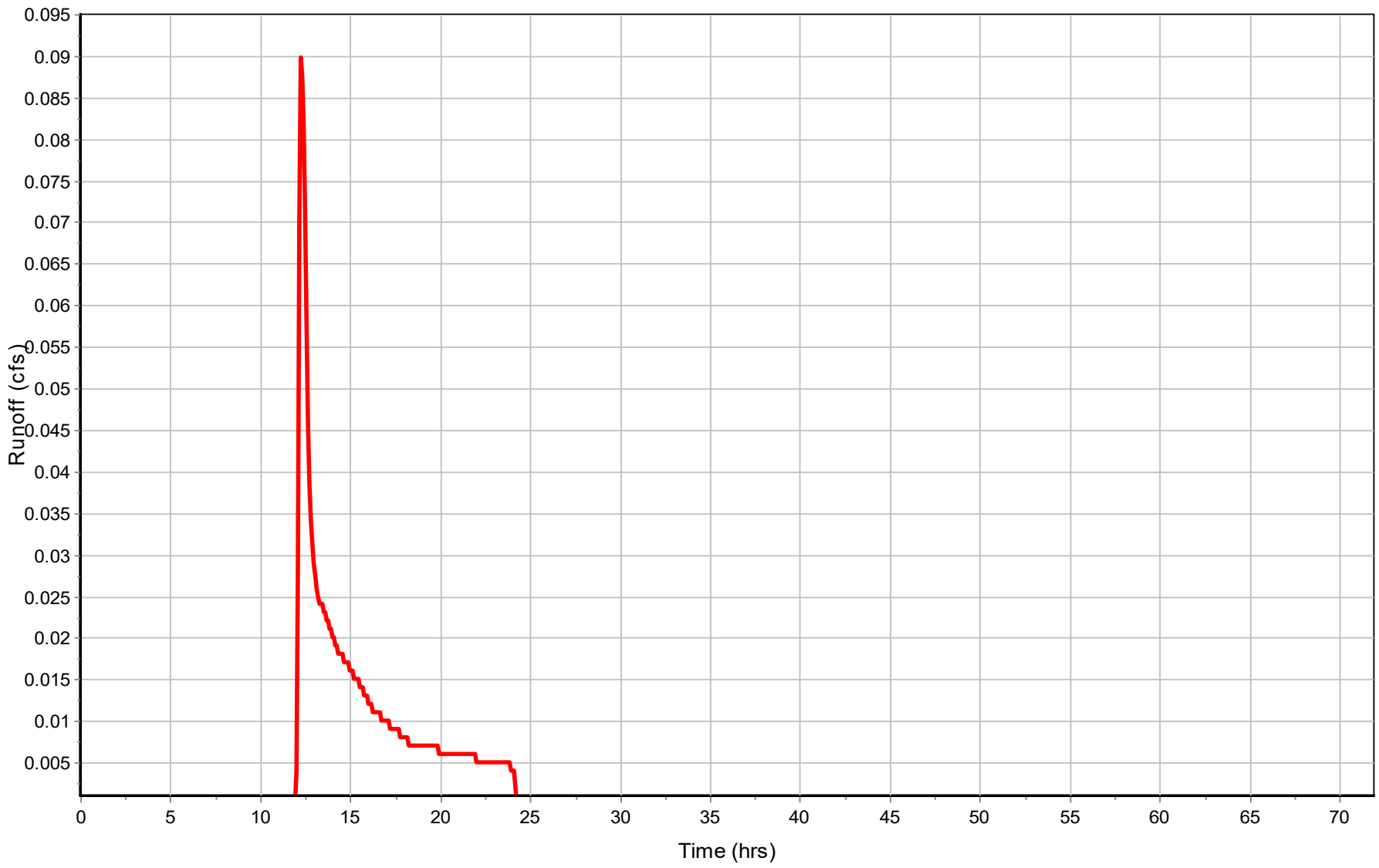
Total Rainfall (in)	4.98
Total Runoff (in)	0.63
Peak Runoff (cfs)	0.09
Weighted Curve Number	49
Time of Concentration (days hh:mm:ss)	0 00:14:30

Subbasin : Existing-E5.1_A2

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : A1-1-BASIN

Input Data

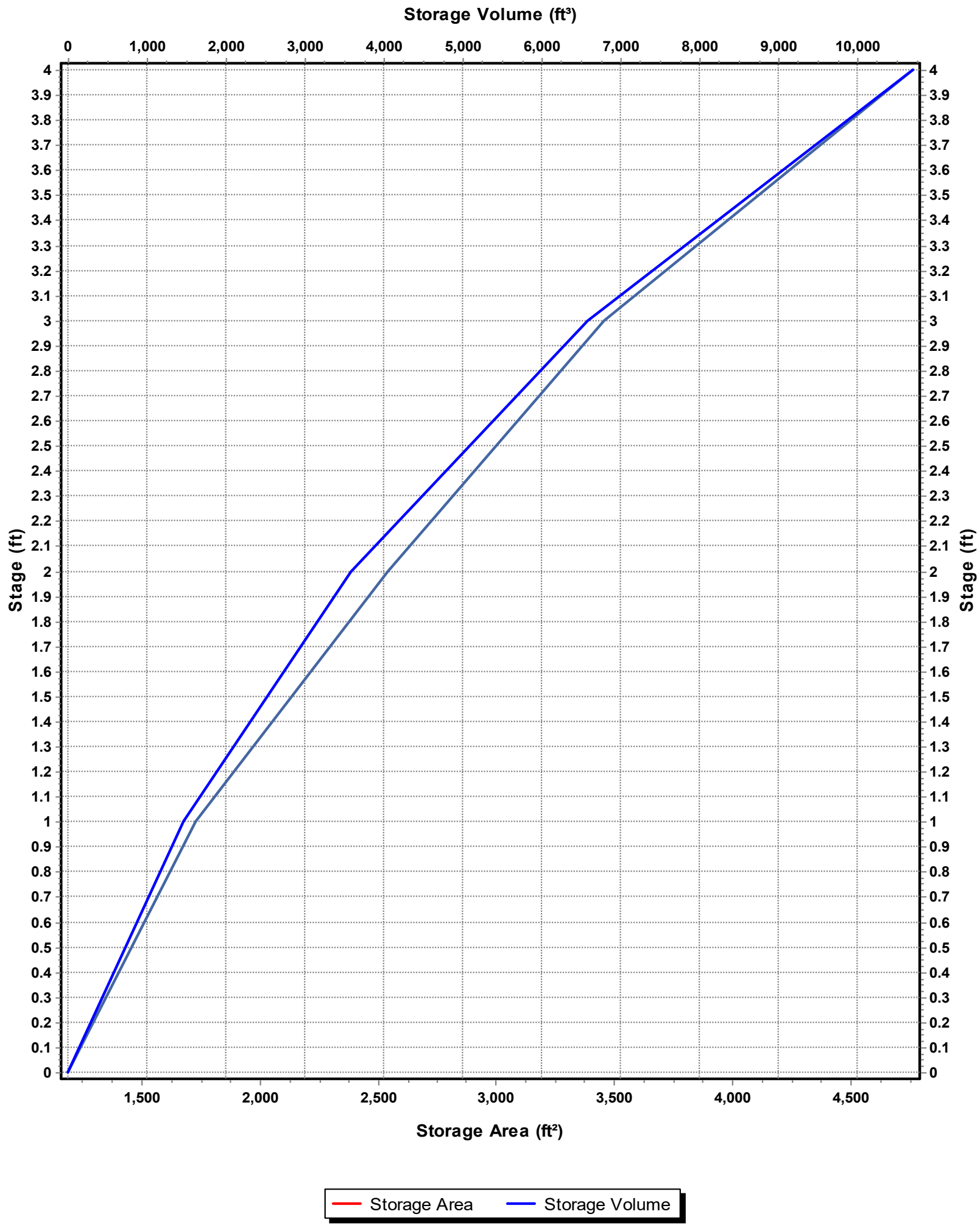
Invert Elevation (ft)	66.00
Max (Rim) Elevation (ft)	69.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	66.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : EXISTING POND.North

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	1188.1	0
1	1729.54	1458.82
2	2543.02	3595.1
3	3461.12	6597.17
4	4767.41	10711.44

Storage Area Volume Curves



Storage Node : A1-1-BASIN (continued)

Outflow Orifices

SN	Element ID	Orifice Type	Orifice Shape	Flap Gate	Circular Orifice Diameter (ft)	Rectangular Orifice Height (ft)	Rectangular Orifice Width (ft)	Orifice Invert Elevation (ft)	Orifice Coefficient
1	12RCP	Side	CIRCULAR	No	1.00			68.00	0.61

Output Summary Results

Peak Inflow (cfs)	1.47
Peak Lateral Inflow (cfs)	1.47
Peak Outflow (cfs)	0.34
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	68.25
Max HGL Depth Attained (ft)	2.25
Average HGL Elevation Attained (ft)	67.73
Average HGL Depth Attained (ft)	1.73
Time of Max HGL Occurrence (days hh:mm)	0 12:40
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : BASIN-1

Input Data

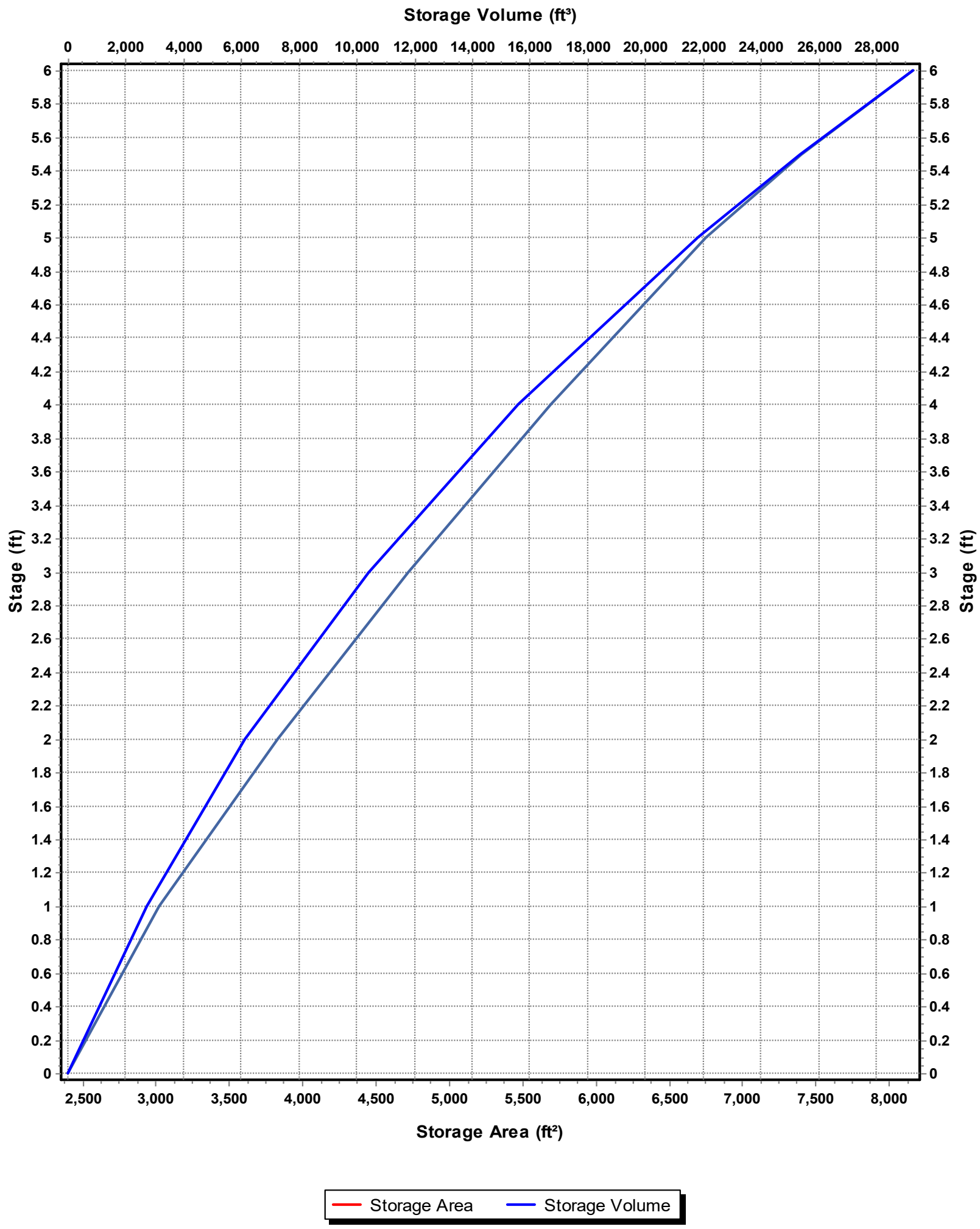
Invert Elevation (ft)	63.00
Max (Rim) Elevation (ft)	69.00
Max (Rim) Offset (ft)	6.00
Initial Water Elevation (ft)	63.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : POND-1

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	2401.32	0
1	3024.34	2712.83
2	3828.08	6139.04
3	4718.62	10412.39
4	5693.33	15618.37
5	6754.28	21842.18
5.5	7407.96	25382.74
6	8166.38	29276.33

Storage Area Volume Curves



Storage Node : BASIN-1 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-B1	Trapezoidal	No	68.50	5.50	10.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	3.03
Peak Lateral Inflow (cfs)	0
Peak Outflow (cfs)	0
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	66.71
Max HGL Depth Attained (ft)	3.71
Average HGL Elevation Attained (ft)	66
Average HGL Depth Attained (ft)	3
Time of Max HGL Occurrence (days hh:mm)	3 00:00
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : BASIN-2

Input Data

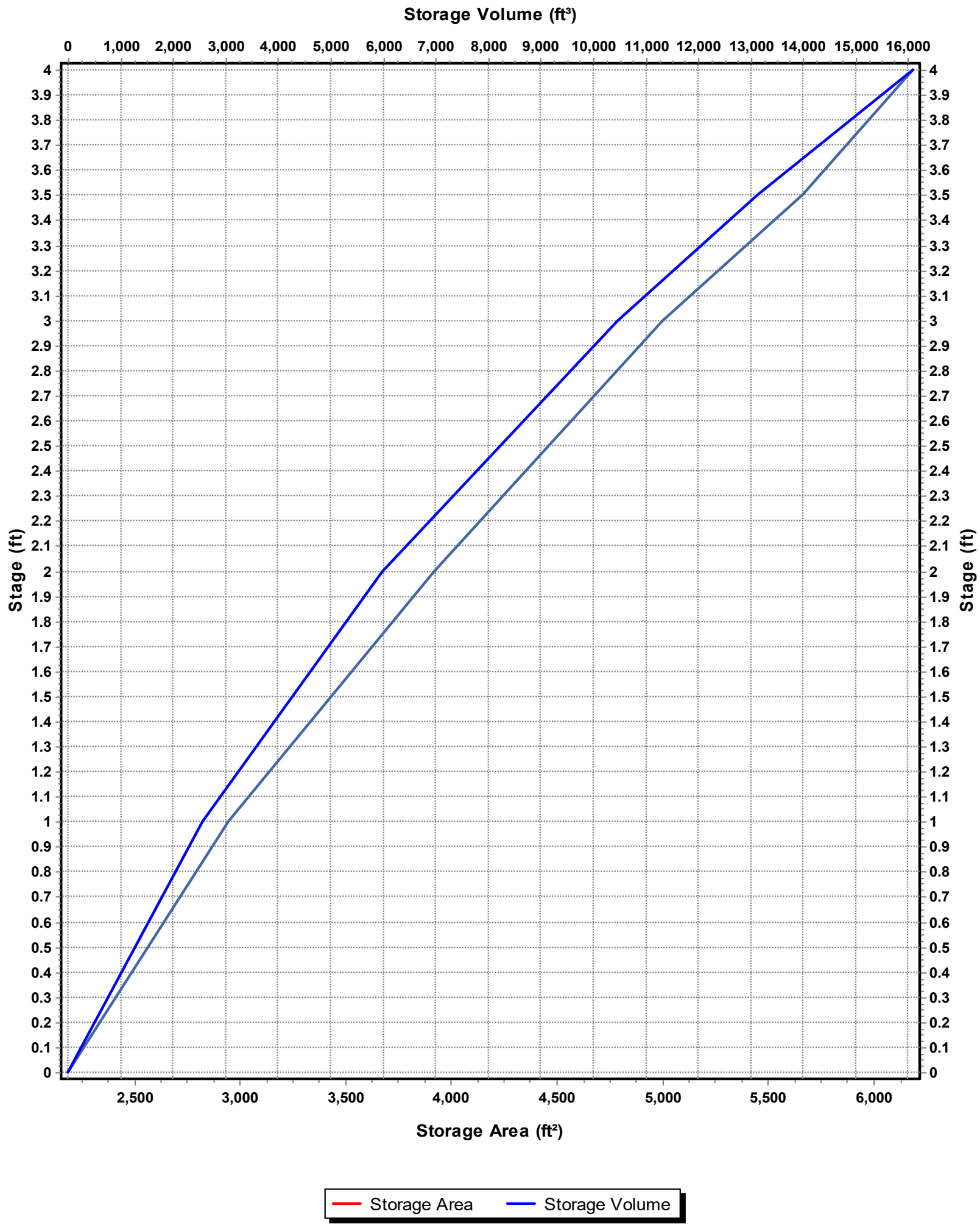
Invert Elevation (ft)	63.00
Max (Rim) Elevation (ft)	67.00
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	63.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : POND-2

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	2186.8	0
1	2944.52	2565.66
2	3920.59	5998.22
3	5001.46	10459.25
3.5	5669	13126.87
4	6188.64	16091.28

Storage Area Volume Curves



Storage Node : BASIN-2 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-B2	Trapezoidal	No	66.50	3.50	10.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	0.43
Peak Lateral Inflow (cfs)	0
Peak Outflow (cfs)	0
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	64.48
Max HGL Depth Attained (ft)	1.48
Average HGL Elevation Attained (ft)	64.15
Average HGL Depth Attained (ft)	1.15
Time of Max HGL Occurrence (days hh:mm)	1 03:20
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Exist-Catch-Basin

Input Data

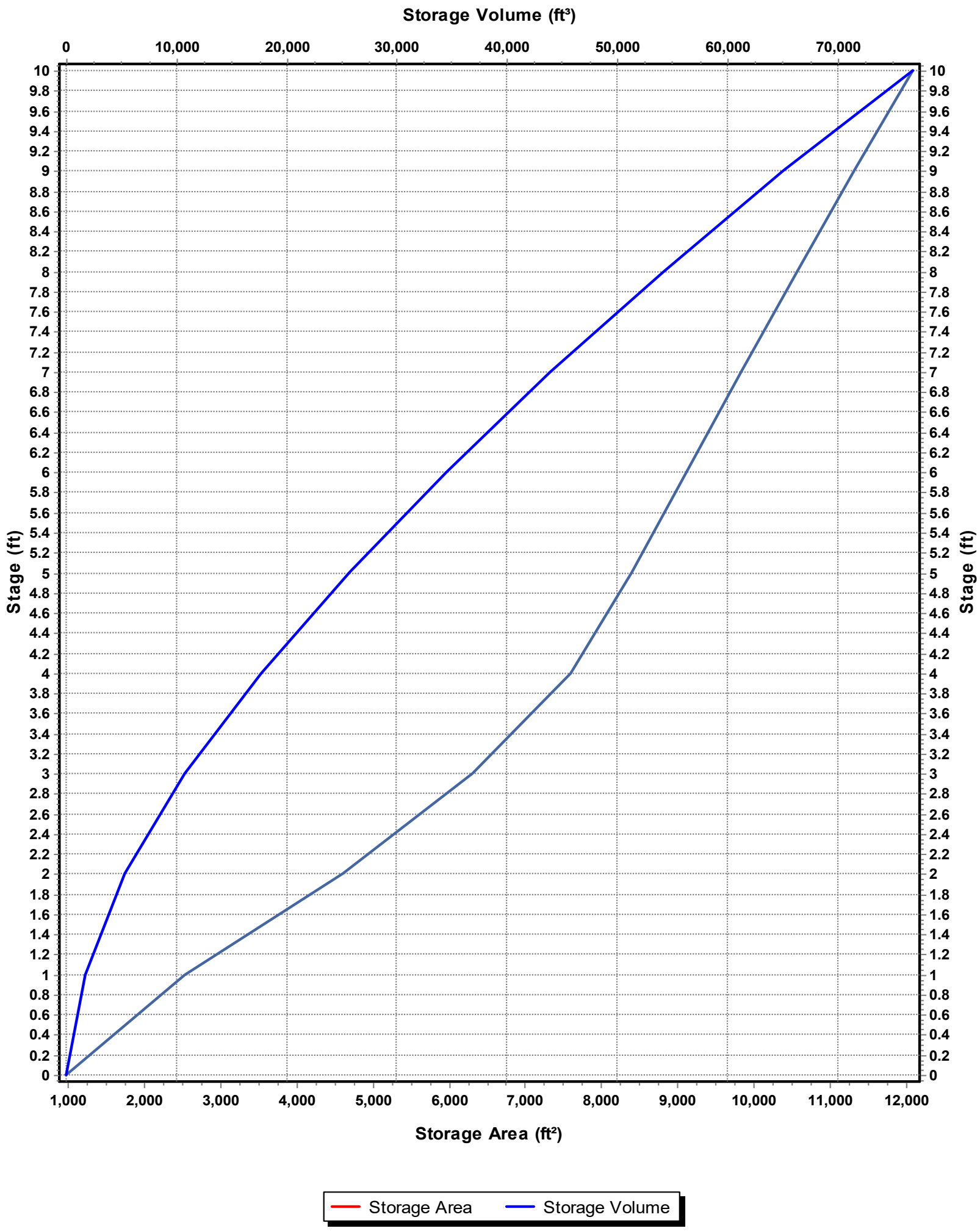
Invert Elevation (ft)	43.00
Max (Rim) Elevation (ft)	53.00
Max (Rim) Offset (ft)	10.00
Initial Water Elevation (ft)	43.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : EXISTING POND.South

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	974.38	0
1	2524.45	1749.42
2	4602.46	5312.88
3	6308.57	10768.4
4	7605.38	17725.38
5	8399.21	25727.68
6	9117.86	34486.22
7	9840.94	43965.62
8	10576.98	54174.58
9	11329.31	65127.73
10	12097.94	76841.36

Storage Area Volume Curves



Storage Node : Exist-Catch-Basin (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Exist-Catch-Basin-Weir	Trapezoidal	No	52.50	9.50	5.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	0.75
Peak Lateral Inflow (cfs)	0.75
Peak Outflow (cfs)	0
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	45.41
Max HGL Depth Attained (ft)	2.41
Average HGL Elevation Attained (ft)	44.91
Average HGL Depth Attained (ft)	1.91
Time of Max HGL Occurrence (days hh:mm)	1 01:30
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Existing-Catch-Basin

Input Data

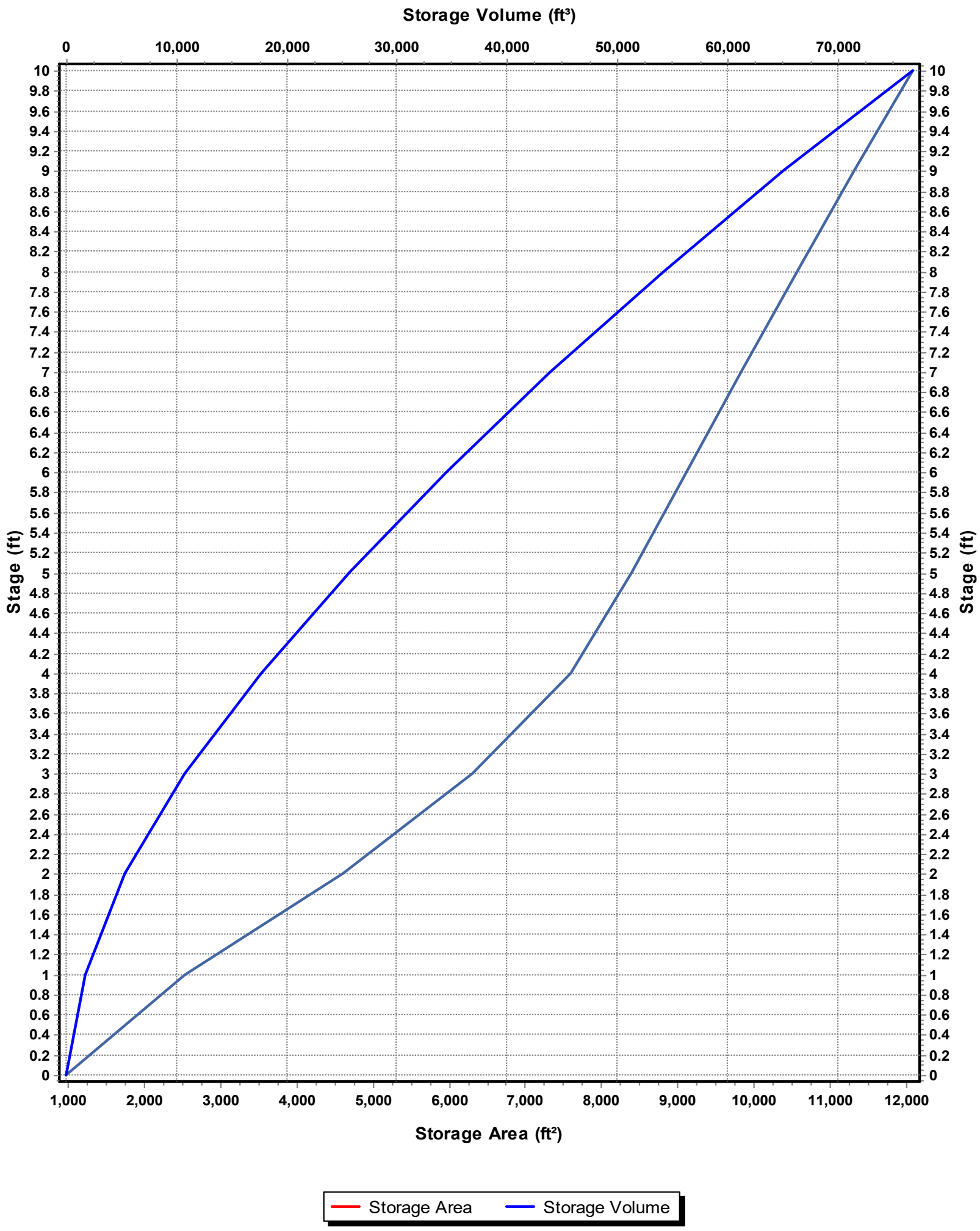
Invert Elevation (ft)	43.00
Max (Rim) Elevation (ft)	53.00
Max (Rim) Offset (ft)	10.00
Initial Water Elevation (ft)	43.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : EXISTING POND.South

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	974.38	0
1	2524.45	1749.42
2	4602.46	5312.88
3	6308.57	10768.4
4	7605.38	17725.38
5	8399.21	25727.68
6	9117.86	34486.22
7	9840.94	43965.62
8	10576.98	54174.58
9	11329.31	65127.73
10	12097.94	76841.36

Storage Area Volume Curves



Storage Node : Existing-Catch-Basin (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Existing-Catch-Basin-Weir	Trapezoidal	No	52.50	9.50	5.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	1.03
Peak Lateral Inflow (cfs)	0.25
Peak Outflow (cfs)	0
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	45.3
Max HGL Depth Attained (ft)	2.3
Average HGL Elevation Attained (ft)	44.84
Average HGL Depth Attained (ft)	1.84
Time of Max HGL Occurrence (days hh:mm)	1 02:13
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : FOREBAY-1

Input Data

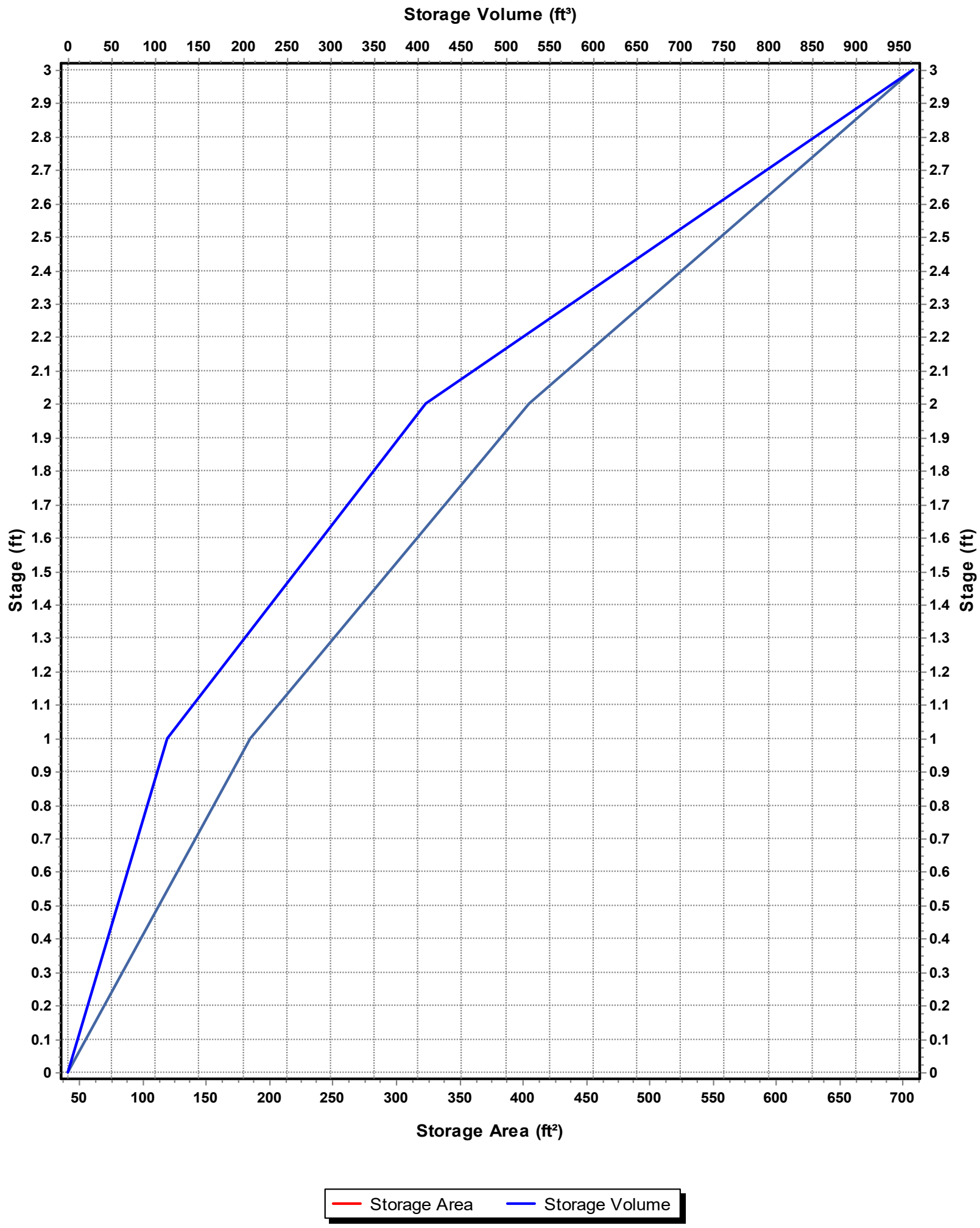
Invert Elevation (ft)	66.00
Max (Rim) Elevation (ft)	70.00
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	66.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : FOREBAY-1

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	41.13	0
1	185.44	113.29
2	405.49	408.76
3	708.15	965.58

Storage Area Volume Curves



Storage Node : FOREBAY-1 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-F1	Trapezoidal	No	67.00	1.00	4.00	3.00	3.33

Output Summary Results

Peak Inflow (cfs)	3.04
Peak Lateral Inflow (cfs)	3.04
Peak Outflow (cfs)	3.03
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	67.36
Max HGL Depth Attained (ft)	1.36
Average HGL Elevation Attained (ft)	66.88
Average HGL Depth Attained (ft)	0.88
Time of Max HGL Occurrence (days hh:mm)	0 12:10
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : FOREBAY-1-2

Input Data

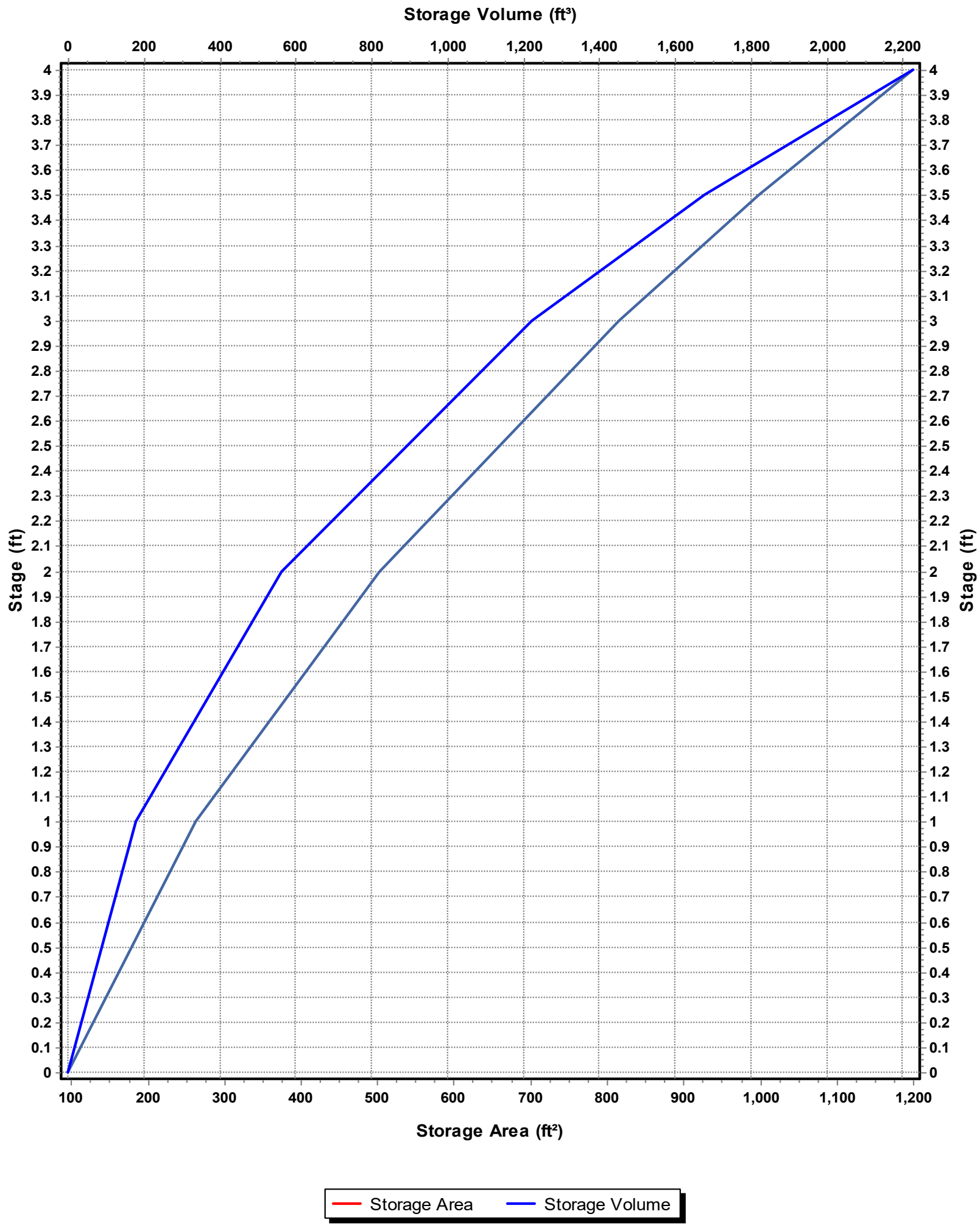
Invert Elevation (ft)	62.00
Max (Rim) Elevation (ft)	66.00
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	62.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : FOREBAY-3

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	96	0
1	264	180
2	504	564
3	816	1224
3.5	999	1677.75
4	1200	2227.5

Storage Area Volume Curves



Storage Node : FOREBAY-1-2 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-F1-2	Trapezoidal	No	63.00	1.00	2.00	3.00	3.33

Output Summary Results

Peak Inflow (cfs)	0.99
Peak Lateral Inflow (cfs)	0.99
Peak Outflow (cfs)	0.99
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	63.26
Max HGL Depth Attained (ft)	1.26
Average HGL Elevation Attained (ft)	62.84
Average HGL Depth Attained (ft)	0.84
Time of Max HGL Occurrence (days hh:mm)	0 12:15
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : FOREBAY-2

Input Data

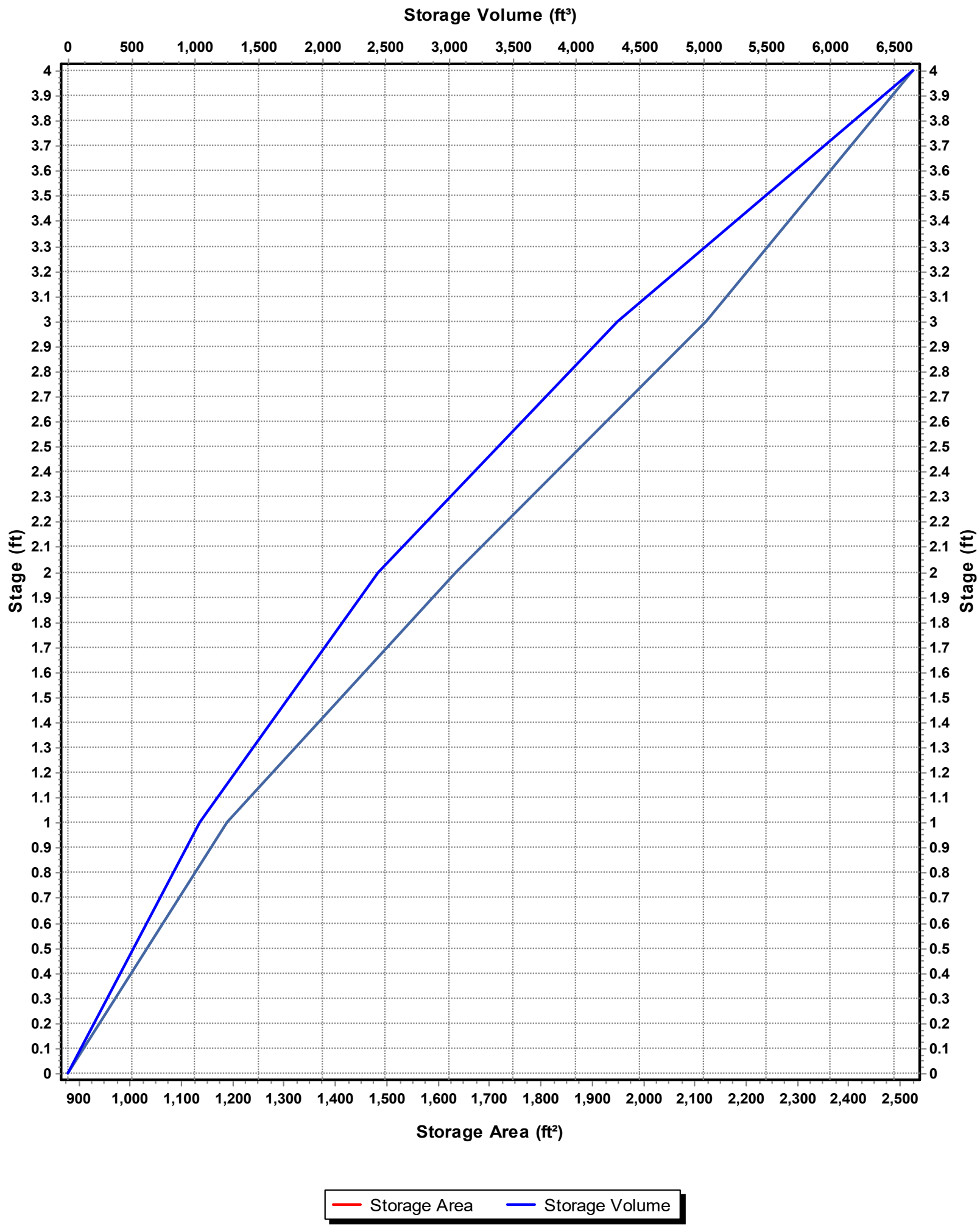
Invert Elevation (ft)	65.00
Max (Rim) Elevation (ft)	69.00
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	65.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : FOREBAY-2

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	880.04	0
1	1189.5	1034.77
2	1635.09	2447.07
3	2123.92	4326.58
4	2526	6651.54

Storage Area Volume Curves



Storage Node : FOREBAY-2 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-F2	Trapezoidal	No	68.00	3.00	10.00	1.00	3.33

Output Summary Results

Peak Inflow (cfs)	2.33
Peak Lateral Inflow (cfs)	2.33
Peak Outflow (cfs)	0.43
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	68.06
Max HGL Depth Attained (ft)	3.06
Average HGL Elevation Attained (ft)	67.51
Average HGL Depth Attained (ft)	2.51
Time of Max HGL Occurrence (days hh:mm)	0 12:41
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Project Description

File Name ..... Sagamore_Entire.Site.SPF

Project Options

Flow Units ..... CFS
Elevation Type ..... Elevation
Hydrology Method ..... SCS TR-20
Time of Concentration (TOC) Method ..... SCS TR-55
Link Routing Method ..... Hydrodynamic
Enable Overflow Ponding at Nodes ..... YES
Skip Steady State Analysis Time Periods ..... NO

Analysis Options

Start Analysis On ..... oct. 14, 2021 0:00:00
End Analysis On ..... oct. 17, 2021 0:00:00
Start Reporting On ..... oct. 14, 2021 0:00:00
Antecedent Dry Days ..... 0 days
Runoff (Dry Weather) Time Step ..... 0 01:00:00 days hh:mm:ss
Runoff (Wet Weather) Time Step ..... 0 00:05:00 days hh:mm:ss
Reporting Time Step ..... 0 00:05:00 days hh:mm:ss
Routing Time Step ..... 30 seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	13
Nodes	18
Junctions	0
Outfalls	10
Flow Diversions	0
Inlets	0
Storage Nodes	8
Links	8
Channels	0
Pipes	0
Pumps	0
Orifices	1
Weirs	7
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	25 years	Intensity	inches	Massachusetts	None	25.00	5.96	SCS Type III 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	A1	1.20	484.00	76.00	5.96	3.35	4.02	4.14	0 00:06:00
2	A1-1	0.39	484.00	98.00	5.96	5.72	2.23	1.82	0 00:10:55
3	A1-2	1.34	484.00	54.63	5.96	1.47	1.96	1.90	0 00:06:00
4	A1-3	1.03	484.00	49.00	5.96	1.05	1.08	0.50	0 00:40:16
5	A2	0.92	484.00	76.00	5.96	3.35	3.08	3.17	0 00:06:00
6	A-3	0.25	484.00	51.70	5.96	1.25	0.31	0.16	0 00:36:07
7	DA-Ditch-A1	1.35	484.00	76.00	5.96	3.35	4.52	4.65	0 00:06:00
8	DA-Ditch-A1-2	1.29	484.00	76.00	5.96	3.35	4.32	4.45	0 00:06:00
9	DA-Ditch-A2	0.67	484.00	76.00	5.96	3.35	2.24	2.31	0 00:06:00
10	Existing-E03-1_A1	0.89	484.00	49.00	5.96	1.05	0.94	0.46	0 00:34:49
11	Existing-E-07_A3	0.39	484.00	51.70	5.96	1.25	0.49	0.25	0 00:36:29
12	Existing-E3_A1-2	3.20	484.00	49.00	5.96	1.05	3.37	1.50	0 00:42:52
13	Existing-E5.1_A2	0.26	484.00	49.00	5.96	1.05	0.27	0.19	0 00:14:30

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Existing-Oufall-E3-1_Weir-B1	Outfall	0.00					0.46	0.00					
2	Existing-Outfall-E3_1	Outfall	0.00					0.00	0.00					
3	Existing-Outfall-E5.1_2	Outfall	0.00					0.19	0.00					
4	Existing-Outfall-E7_3	Outfall	0.00					0.25	0.00					
5	Out-D1	Outfall	0.00					4.54	0.00					
6	Out-D2	Outfall	0.00					2.26	0.00					
7	Out-D3	Outfall	0.00					4.35	0.00					
8	Proposed-Outfall.1	Outfall	0.00					0.00	0.00					
9	Proposed-Outfall.2	Outfall	60.00					0.00	60.00					
10	Proposed-Outfall.3	Outfall	0.00					0.16	0.00					
11	A1-1-BASIN	Storage Node	66.00	69.00	66.00		0.00	1.77	68.40				0.00	0.00
12	BASIN-1	Storage Node	63.00	69.00	63.00		0.00	4.03	67.78				0.00	0.00
13	BASIN-2	Storage Node	63.00	67.00	63.00		0.00	1.77	65.21				0.00	0.00
14	Exist-Catch-Basin	Storage Node	43.00	53.00	43.00		0.00	1.49	46.23				0.00	0.00
15	Existing-Catch-Basin	Storage Node	43.00	53.00	43.00		0.00	1.79	46.01				0.00	0.00
16	FOREBAY-1	Storage Node	66.00	70.00	66.00		0.00	4.05	67.83				0.00	0.00
17	FOREBAY-1-2	Storage Node	62.00	66.00	62.00		0.00	1.74	63.37				0.00	0.00
18	FOREBAY-2	Storage Node	65.00	69.00	65.00		0.00	3.09	68.14				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length (ft)	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Average Slope (%)	Diameter or Height (ft)	Manning's Roughness	Peak Flow (cfs)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Reported Condition
1	12RCP	Orifice	A1-1-BASIN	FOREBAY-1		66.00	66.00		1.000		0.69							
2	Exist-Catch-Basin-Weir	Weir	Exist-Catch-Basin	Existing-Outfall-E3_1		43.00	0.00				0.00							
3	Existing-Catch-Basin-Weir	Weir	Existing-Catch-Basin	Proposed-Outfall.1		43.00	0.00				0.00							
4	Weir-B1	Weir	BASIN-1	FOREBAY-1-2		63.00	62.00				0.00							
5	Weir-B2	Weir	BASIN-2	Proposed-Outfall.2		63.00	60.00				0.00							
6	Weir-F1	Weir	FOREBAY-1	BASIN-1		66.00	63.00				4.03							
7	Weir-F1-2	Weir	FOREBAY-1-2	Existing-Catch-Basin		62.00	43.00				1.72							
8	Weir-F2	Weir	FOREBAY-2	BASIN-2		65.00	63.00				1.77							

Subbasin Hydrology

Subbasin : A1

Input Data

Area (ac) 1.2
Peak Rate Factor 484
Weighted Curve Number 76
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	1.2	A	76
Composite Area & Weighted CN	1.2		76

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft^2)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	300	0	0
Slope (%) :	1.51	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	1.23	0	0
Computed Flow Time (min) :	4.05	0	0

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	20.6	0	0
Slope (%) :	1.86	0	0
Surface Type :	Unpaved	Unpaved	Unpaved
Velocity (ft/sec) :	2.2	0	0
Computed Flow Time (min) :	0.16	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	99.64	0	0
Channel Slope (%) :	0.5	0	0
Cross Section Area (ft^2) :	29.79	0	0
Wetted Perimeter (ft) :	20.98	0	0
Velocity (ft/sec) :	4.44	0	0
Computed Flow Time (min) :	0.37	0	0

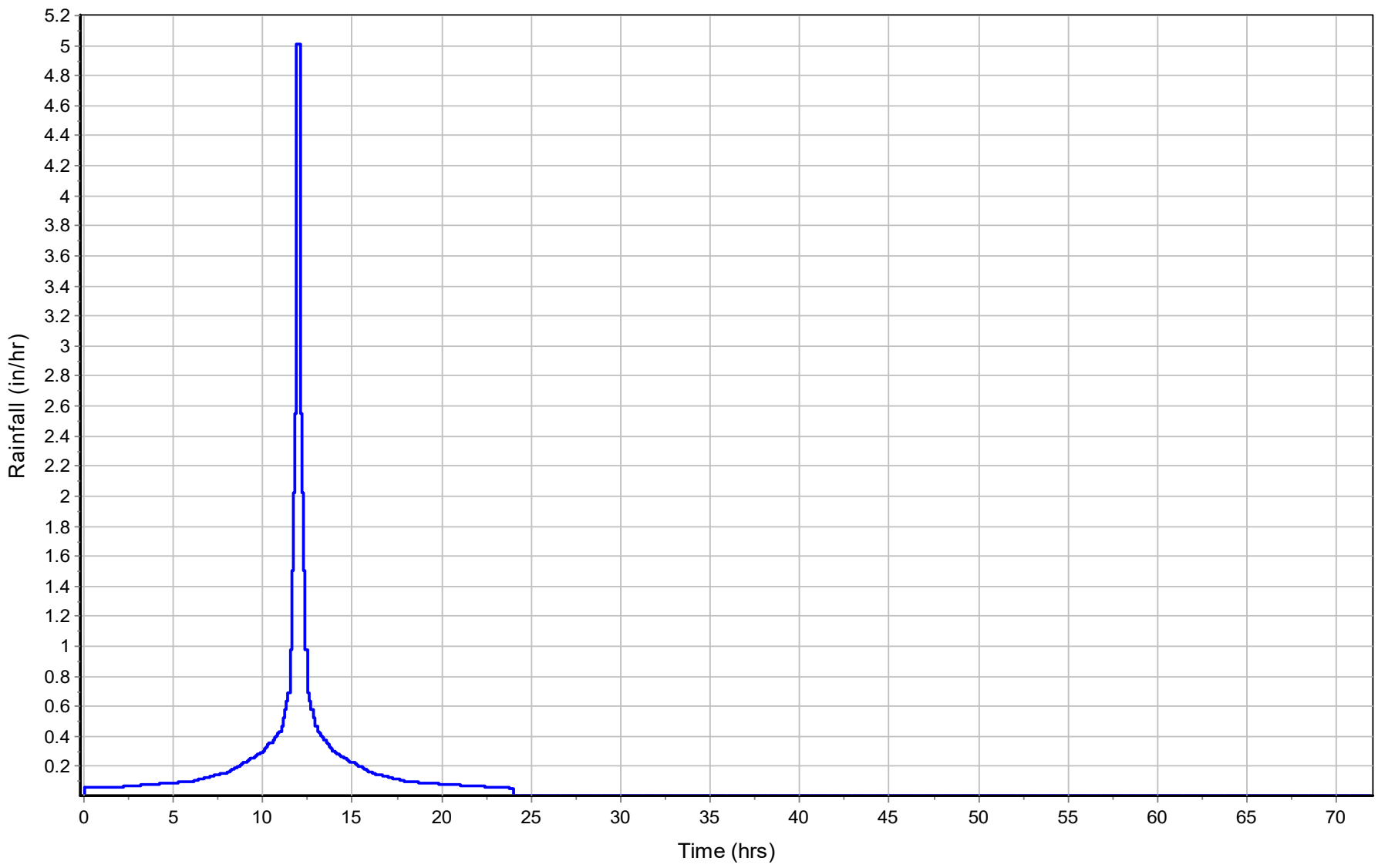
Total TOC (min) 4.58

Subbasin Runoff Results

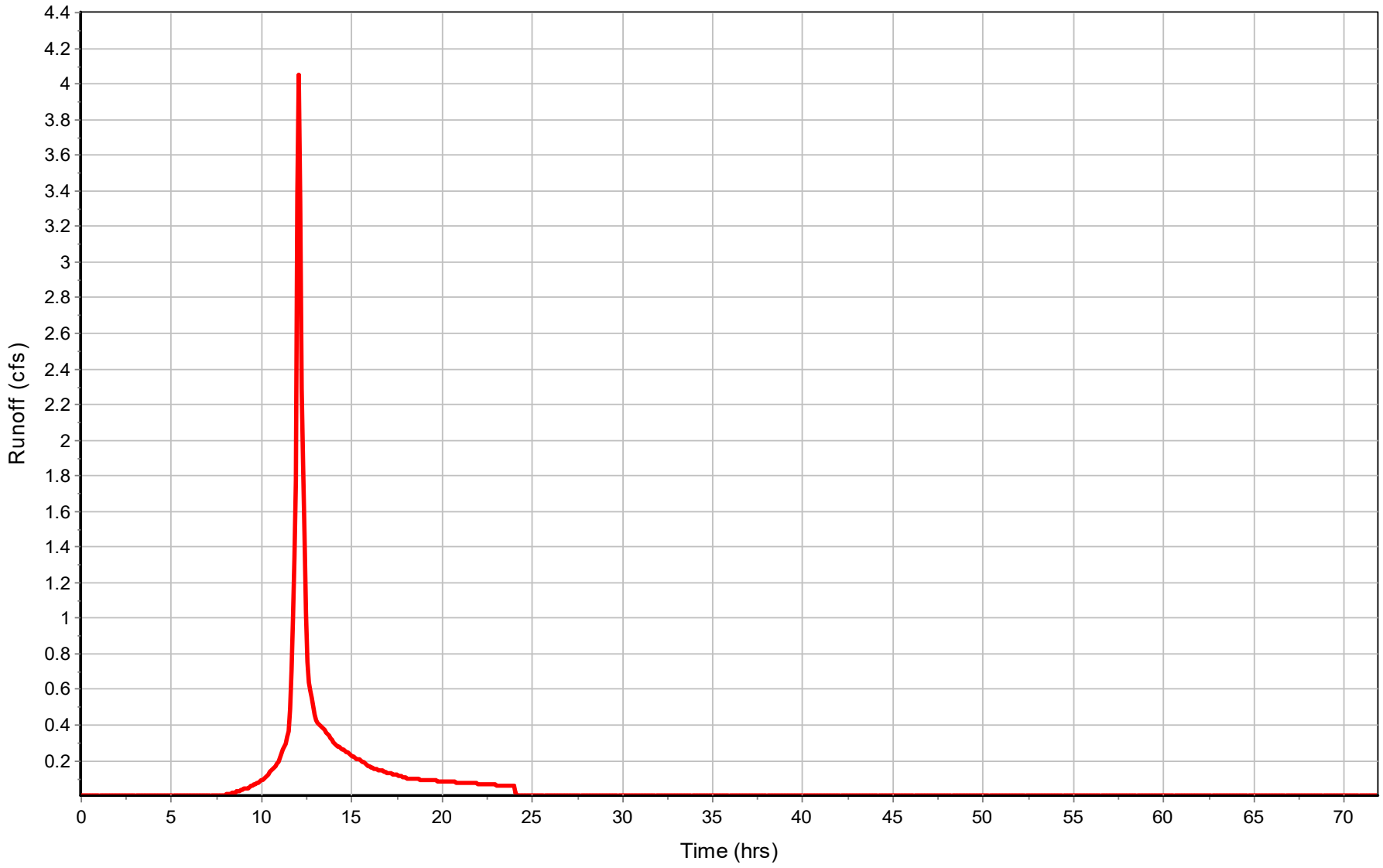
Total Rainfall (in) 5.96
Total Runoff (in) 3.35
Peak Runoff (cfs) 4.14
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:04:35

Subbasin : A1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : A1-1

Input Data

Area (ac) 0.39
Peak Rate Factor 484
Weighted Curve Number 98
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Paved parking & roofs	0.39	A	98
Composite Area & Weighted CN	0.39		98

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.05	0	0
Flow Length (ft) :	178.81	0	0
Slope (%) :	0.5	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.27	0	0
Computed Flow Time (min) :	10.92	0	0

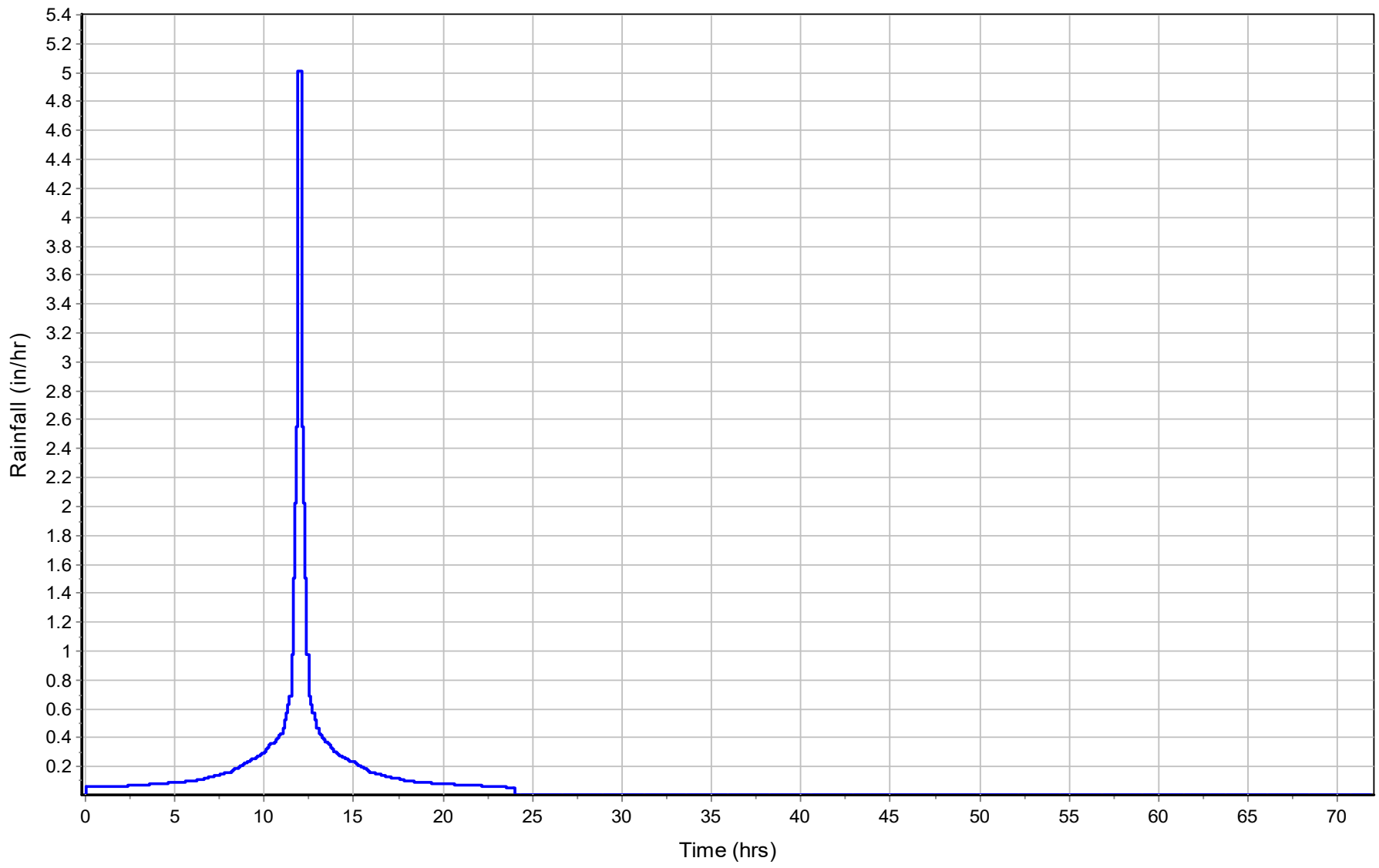
Total TOC (min) 10.92

Subbasin Runoff Results

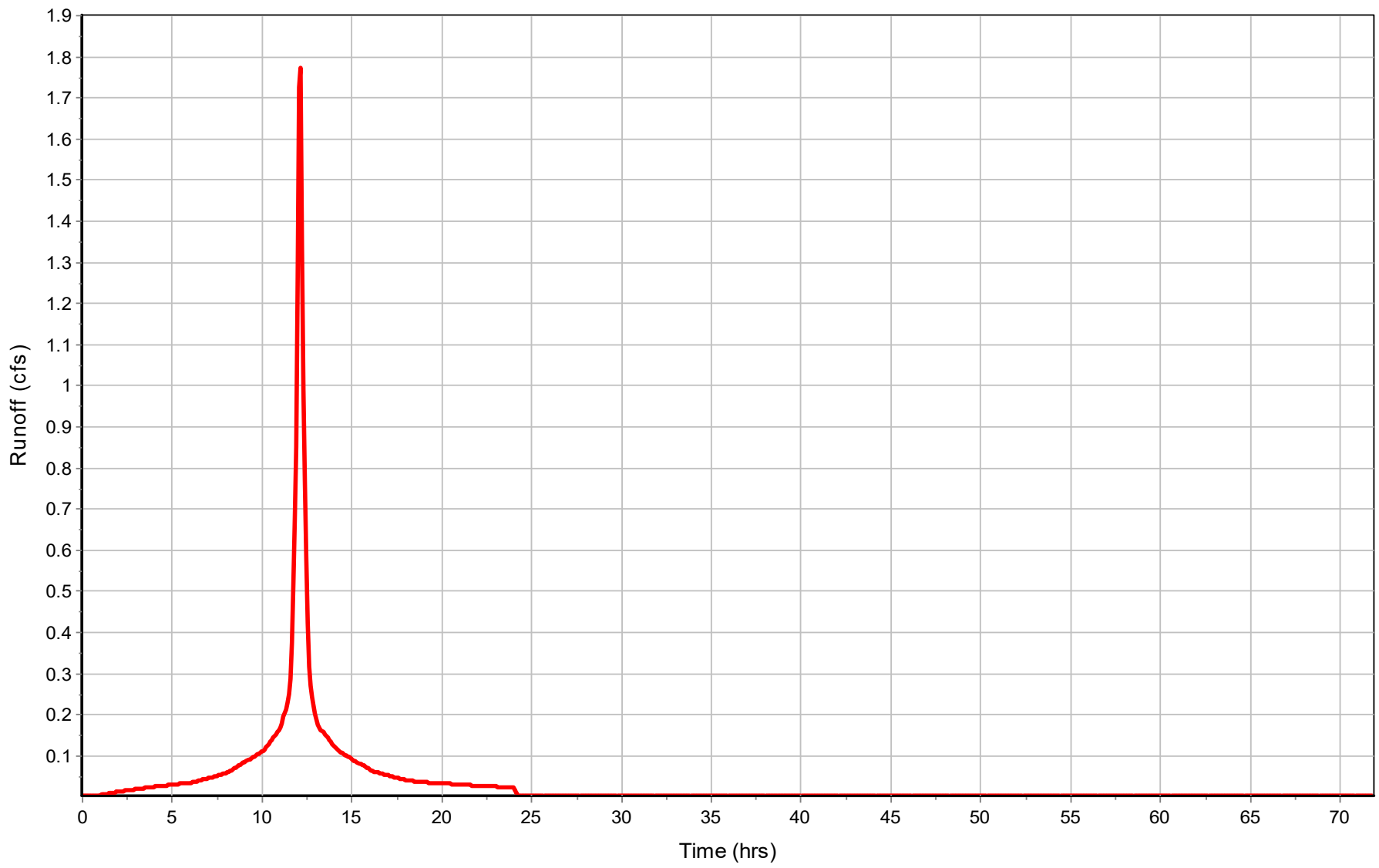
Total Rainfall (in) 5.96
Total Runoff (in) 5.72
Peak Runoff (cfs) 1.82
Weighted Curve Number 98
Time of Concentration (days hh:mm:ss) 0 00:10:55

Subbasin : A1-1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : A1-2

Input Data

Area (ac) 1.34
Peak Rate Factor 484
Weighted Curve Number 54.63
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	0.28	A	76
-	1.06	-	49
Composite Area & Weighted CN	1.34		54.63

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	131.55	0	0
Slope (%) :	4	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	1.54	0	0
Computed Flow Time (min) :	1.42	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	358.95	0	0
Channel Slope (%) :	0.3	0	0
Cross Section Area (ft^2) :	13.52	0	0
Wetted Perimeter (ft) :	11.63	0	0
Velocity (ft/sec) :	3.01	0	0
Computed Flow Time (min) :	1.99	0	0

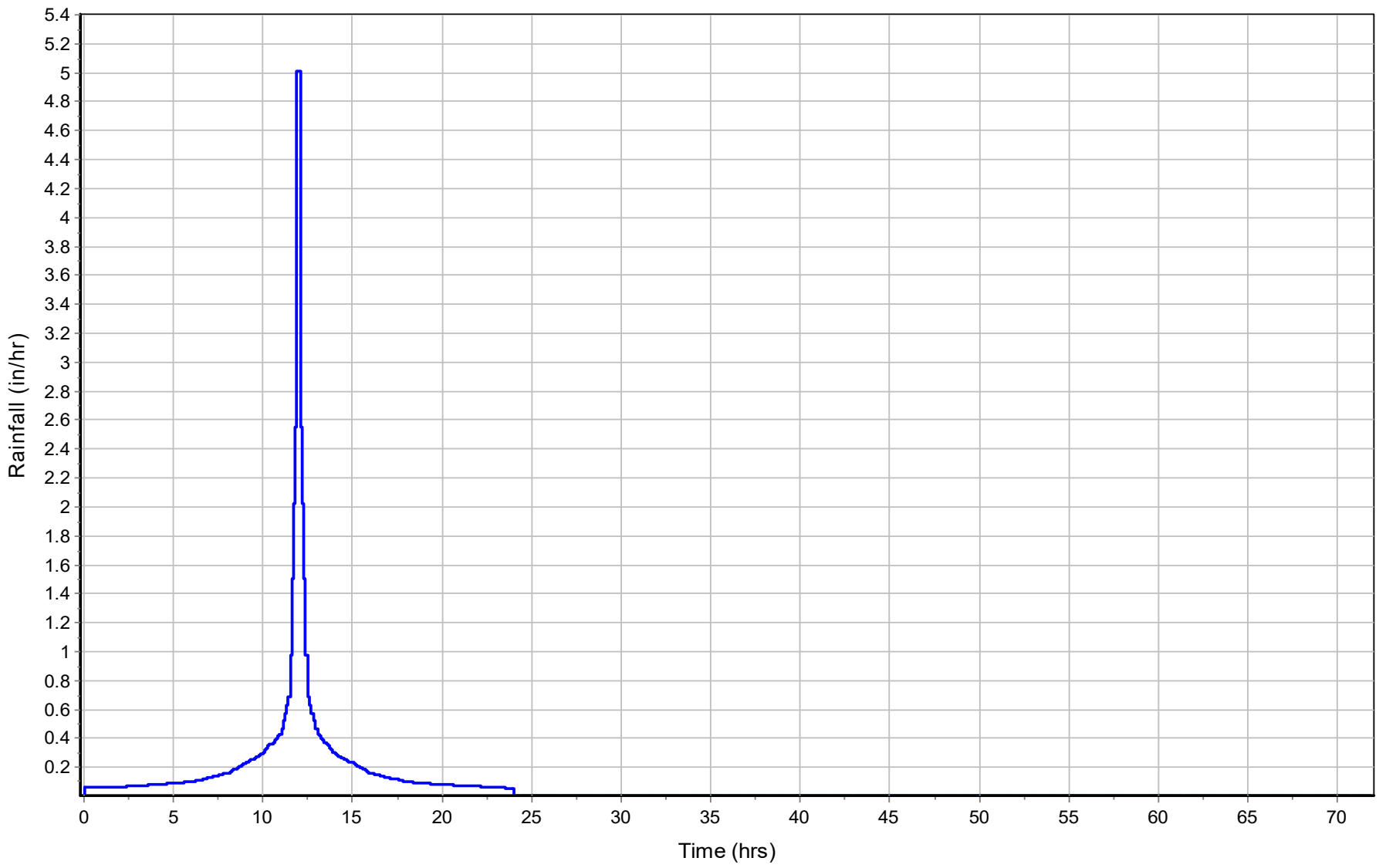
Total TOC (min) 3.41

Subbasin Runoff Results

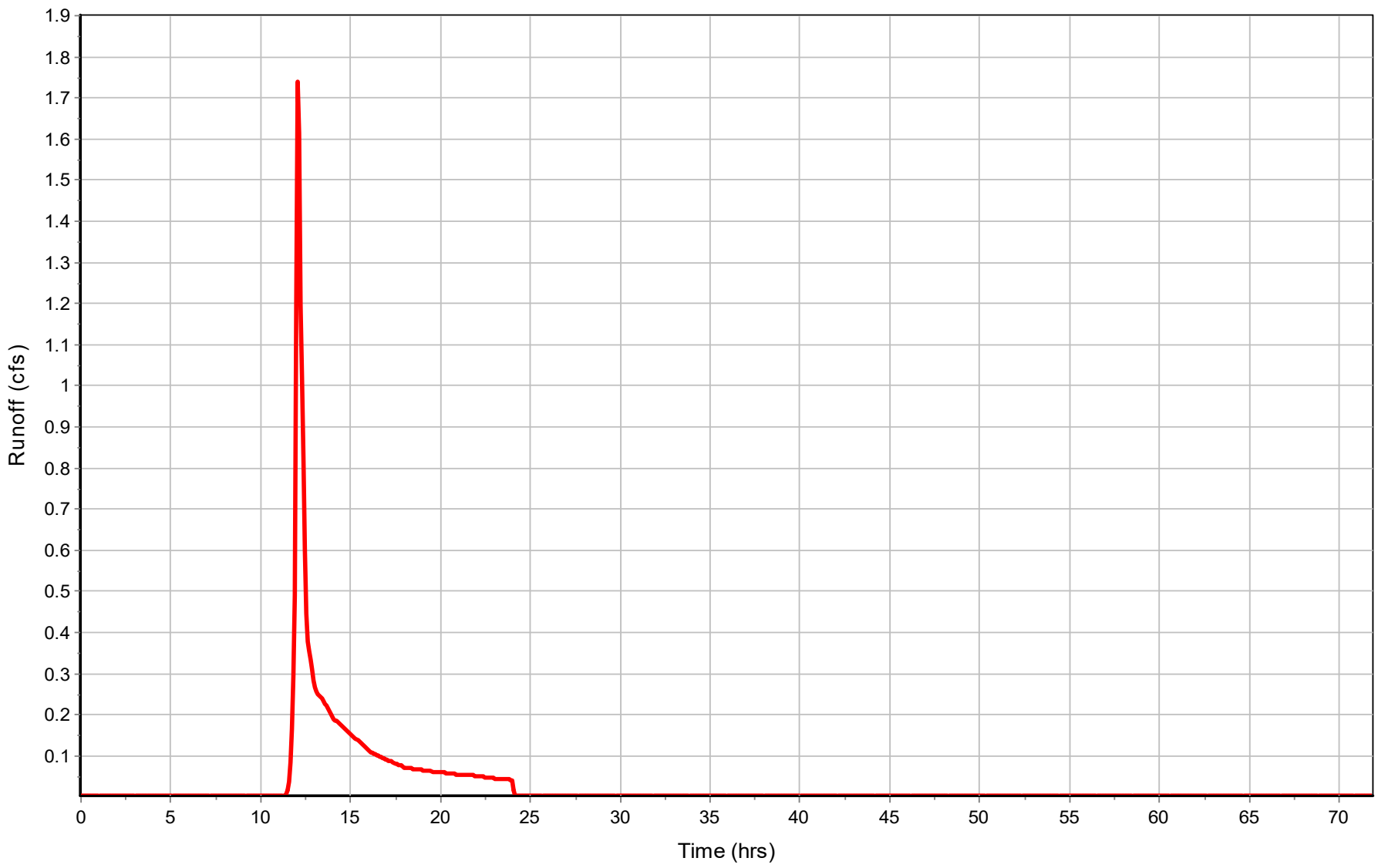
Total Rainfall (in) 5.96
Total Runoff (in) 1.47
Peak Runoff (cfs) 1.9
Weighted Curve Number 54.63
Time of Concentration (days hh:mm:ss) 0 00:03:25

Subbasin : A1-2

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : A1-3

Input Data

Area (ac) 1.03
Peak Rate Factor 484
Weighted Curve Number 49
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	1.03	A	49
Composite Area & Weighted CN	1.03		49

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.4	0	0
Flow Length (ft) :	300	0	0
Slope (%) :	4	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.13	0	0
Computed Flow Time (min) :	37.97	0	0

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	13.33	0	0
Slope (%) :	4	0	0
Surface Type :	Grassed waterway	Unpaved	Unpaved
Velocity (ft/sec) :	3	0	0
Computed Flow Time (min) :	0.07	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	403.18	0	0
Channel Slope (%) :	0.3	0	0
Cross Section Area (ft^2) :	13.52	0	0
Wetted Perimeter (ft) :	11.63	0	0
Velocity (ft/sec) :	3.01	0	0
Computed Flow Time (min) :	2.23	0	0

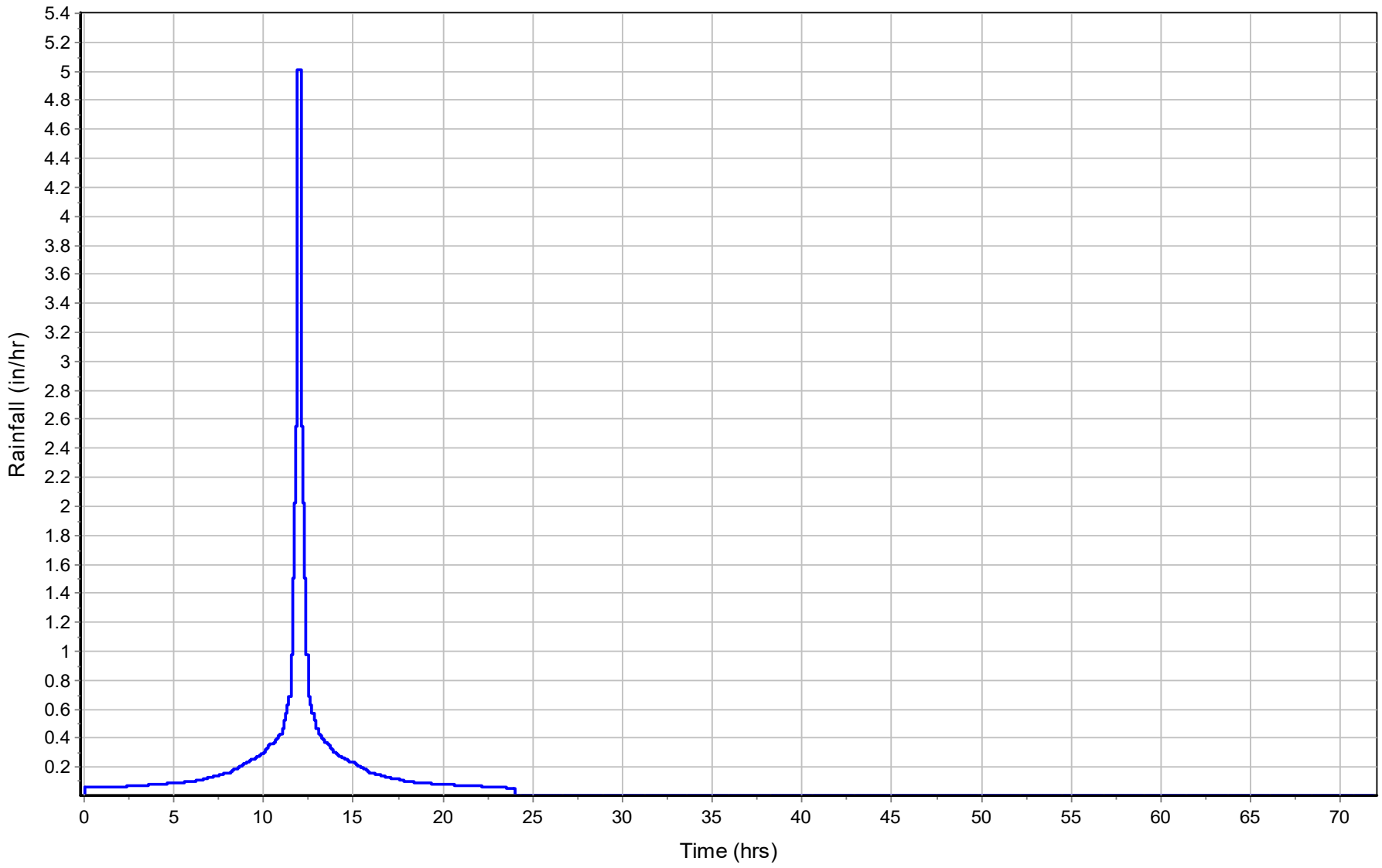
Total TOC (min) 40.27

Subbasin Runoff Results

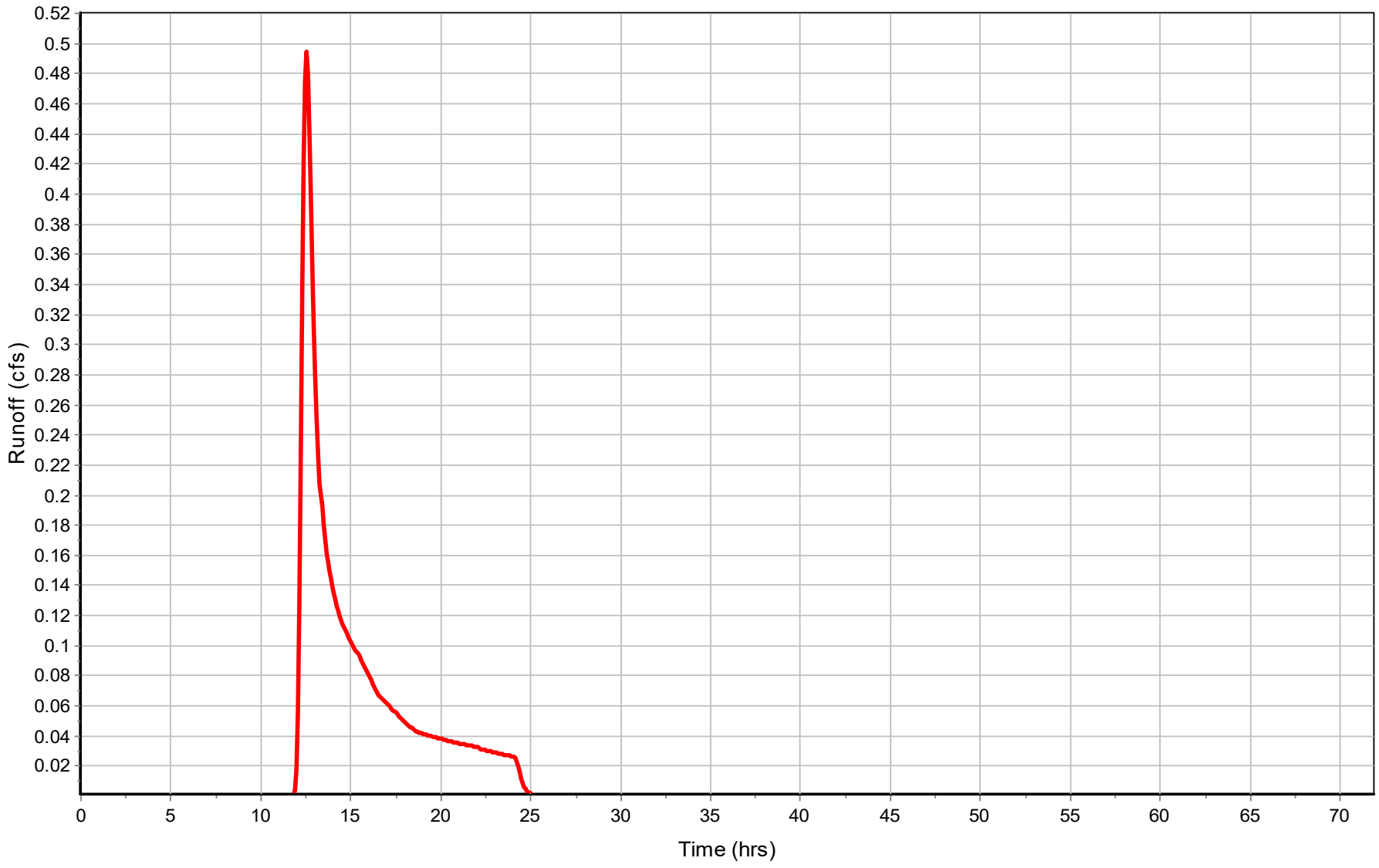
Total Rainfall (in) 5.96
Total Runoff (in) 1.05
Peak Runoff (cfs) 0.5
Weighted Curve Number 49
Time of Concentration (days hh:mm:ss) 0 00:40:16

Subbasin : A1-3

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : A2

Input Data

Area (ac) 0.92
Peak Rate Factor 484
Weighted Curve Number 76
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	0.92	A	76
Composite Area & Weighted CN	0.92		76

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	85.5	0	0
Slope (%) :	1.5	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.96	0	0
Computed Flow Time (min) :	1.49	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	255.68	0	0
Channel Slope (%) :	1.17	0	0
Cross Section Area (ft^2) :	1.475	0	0
Wetted Perimeter (ft) :	5.99	0	0
Velocity (ft/sec) :	2.11	0	0
Computed Flow Time (min) :	2.02	0	0

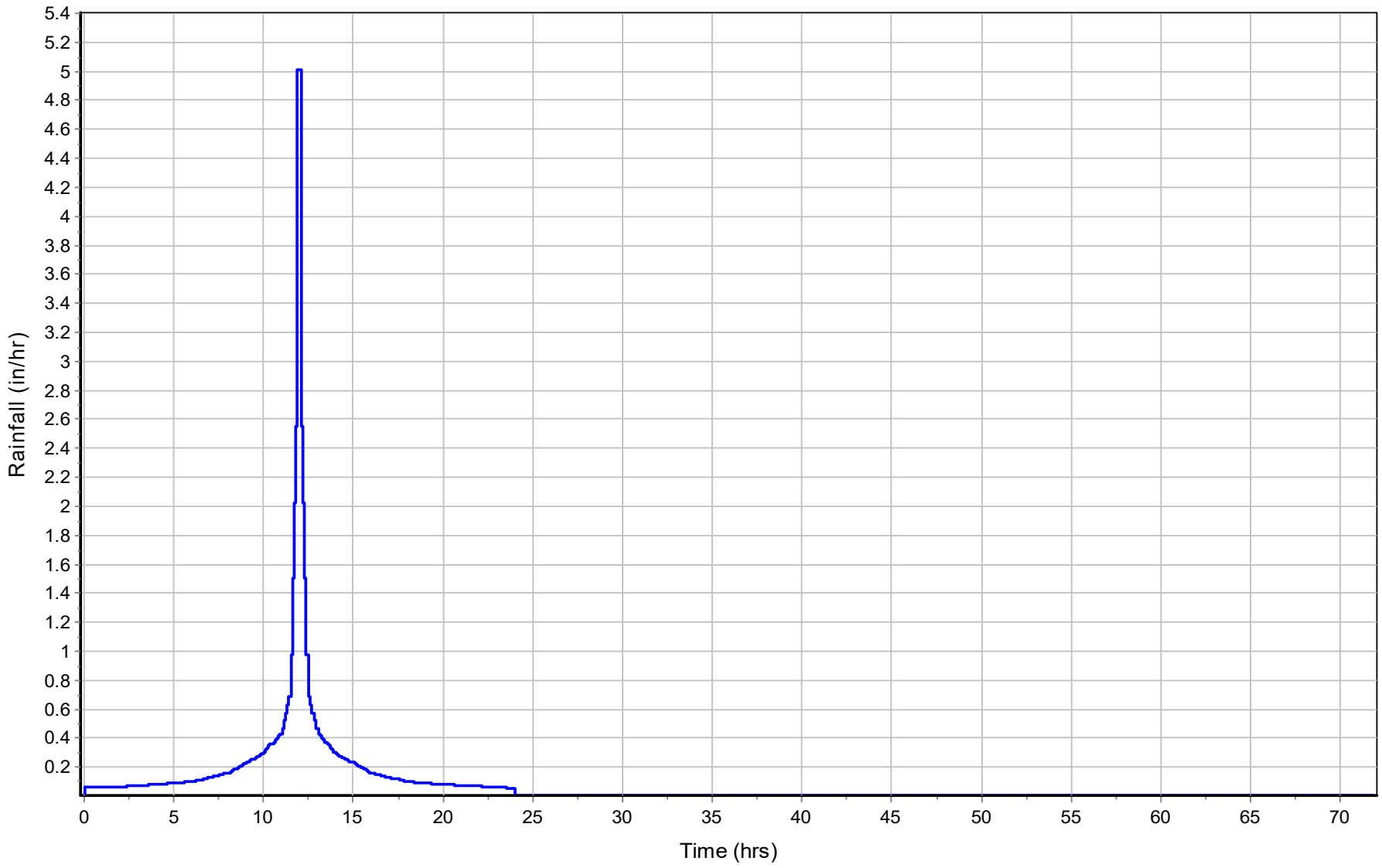
Total TOC (min) 3.51

Subbasin Runoff Results

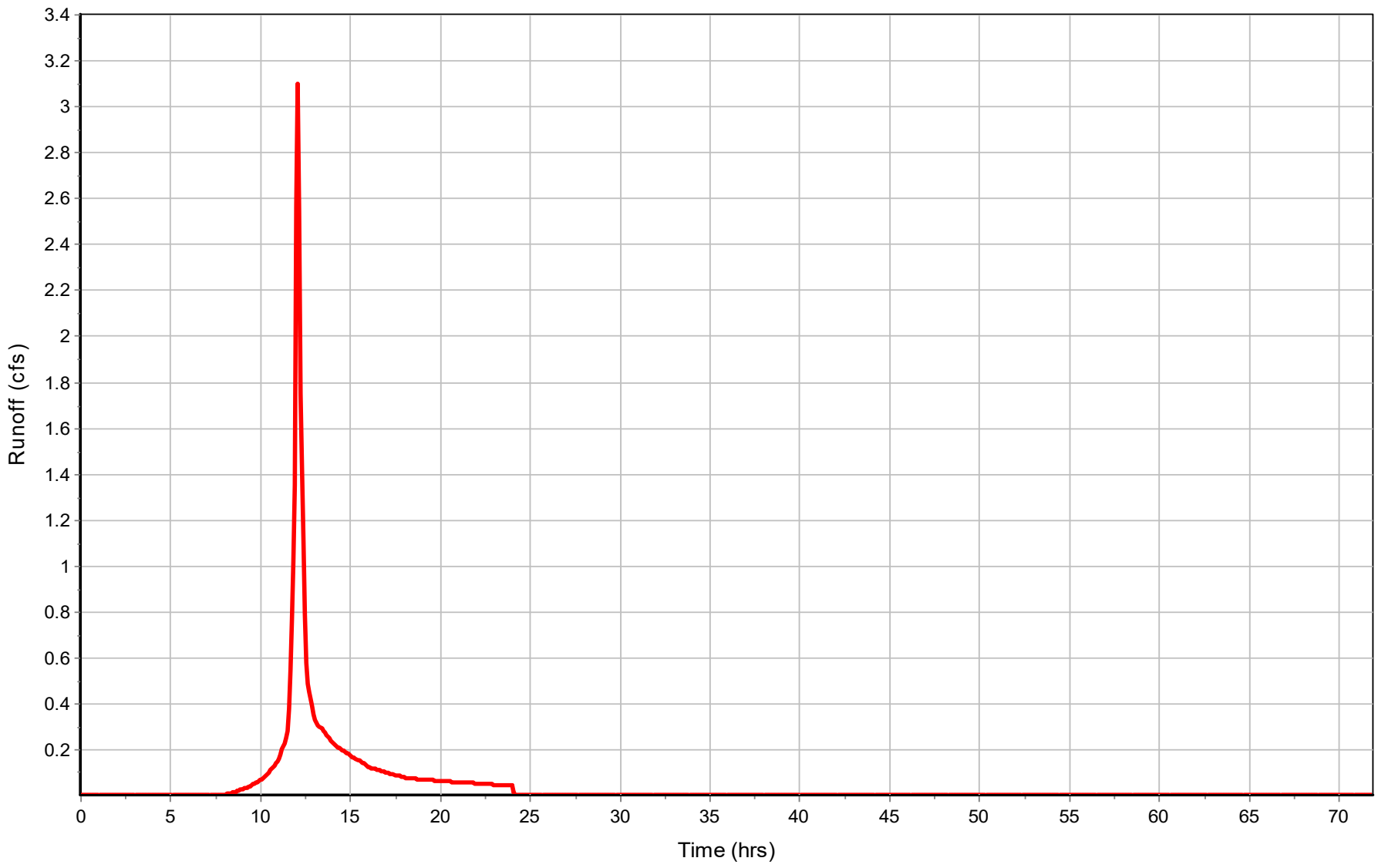
Total Rainfall (in) 5.96
Total Runoff (in) 3.35
Peak Runoff (cfs) 3.17
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:03:31

Subbasin : A2

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : A-3

Input Data

Area (ac)	0.25
Peak Rate Factor	484
Weighted Curve Number	51.7
Rain Gage ID	Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
-	0.23	-	49
-	0.03	-	76
Composite Area & Weighted CN	0.26		51.7

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.4	0	0
Flow Length (ft) :	300	0	0
Slope (%) :	5	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.14	0	0
Computed Flow Time (min) :	34.72	0	0

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	83.1895	0	0
Slope (%) :	2	0	0
Surface Type :	Grass pasture	Unpaved	Unpaved
Velocity (ft/sec) :	0.99	0	0
Computed Flow Time (min) :	1.4	0	0

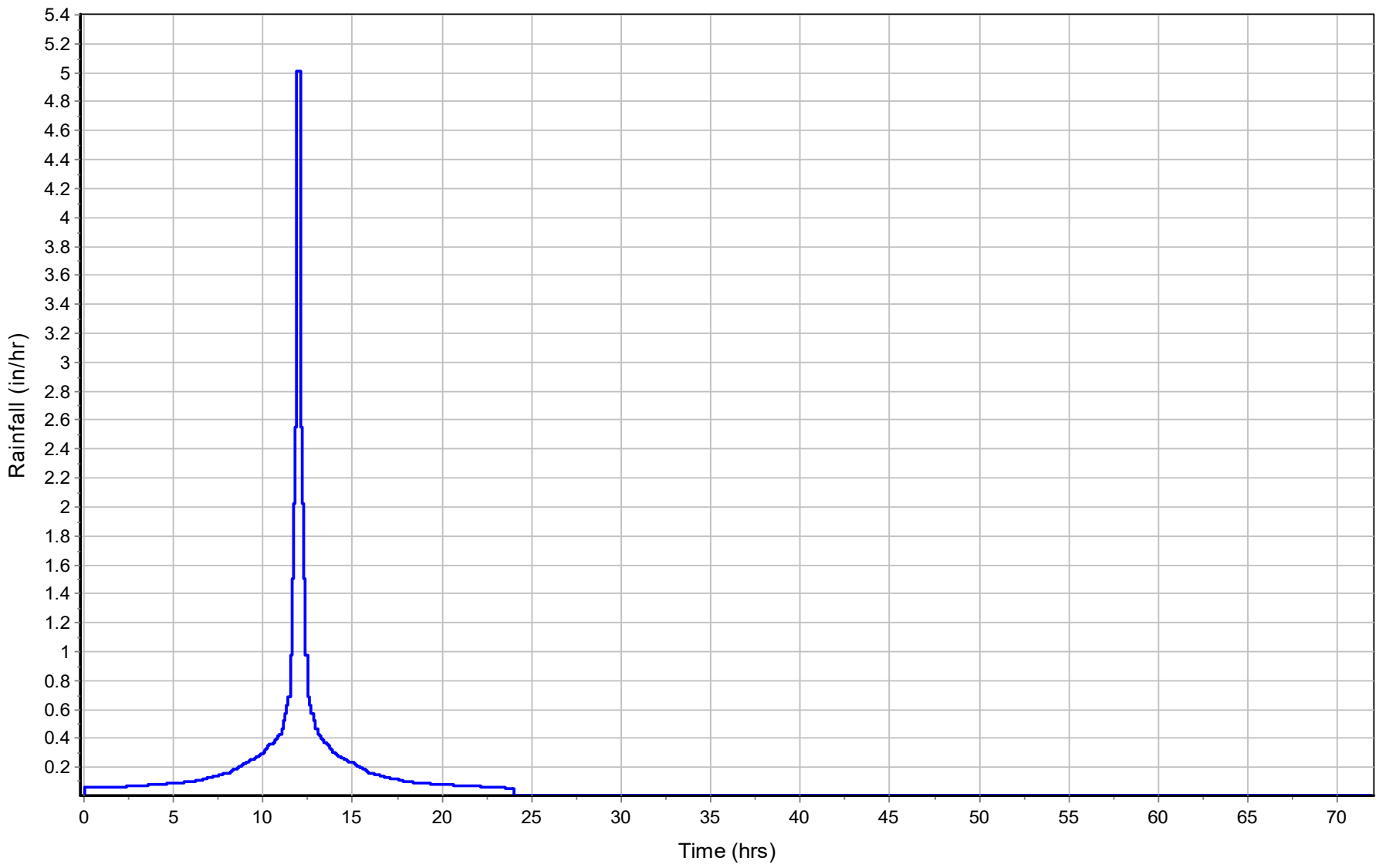
Total TOC (min) 36.12

Subbasin Runoff Results

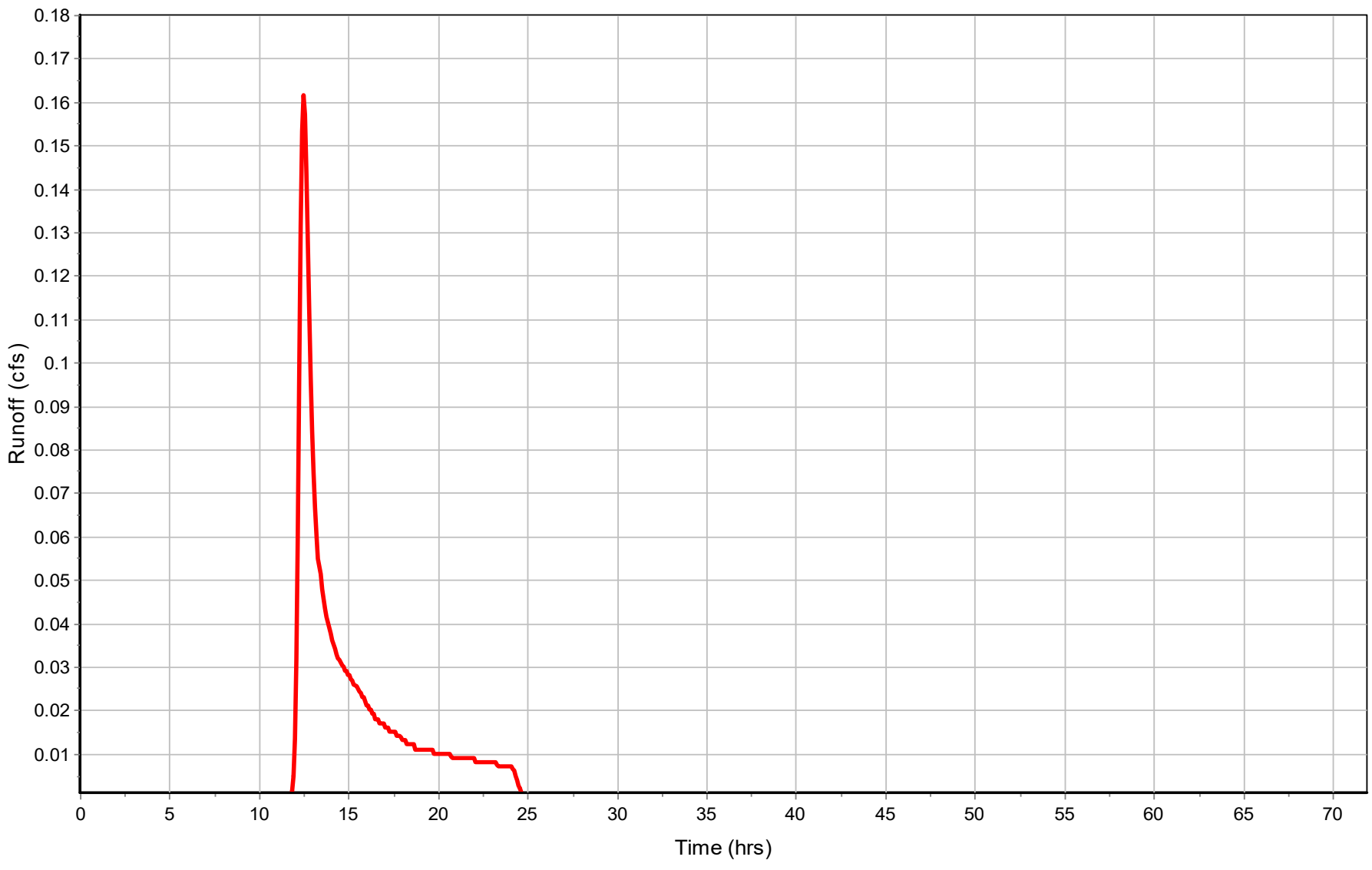
Total Rainfall (in)	5.96
Total Runoff (in)	1.25
Peak Runoff (cfs)	0.16
Weighted Curve Number	51.7
Time of Concentration (days hh:mm:ss)	0 00:36:07

Subbasin : A-3

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : DA-Ditch-A1

Input Data

Area (ac) 1.35
Peak Rate Factor 484
Weighted Curve Number 76
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
50 - 75% grass cover, Fair	1.35	A	76
Composite Area & Weighted CN	1.35		76

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	217.17	0	0
Slope (%) :	1.5	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	1.15	0	0
Computed Flow Time (min) :	3.14	0	0

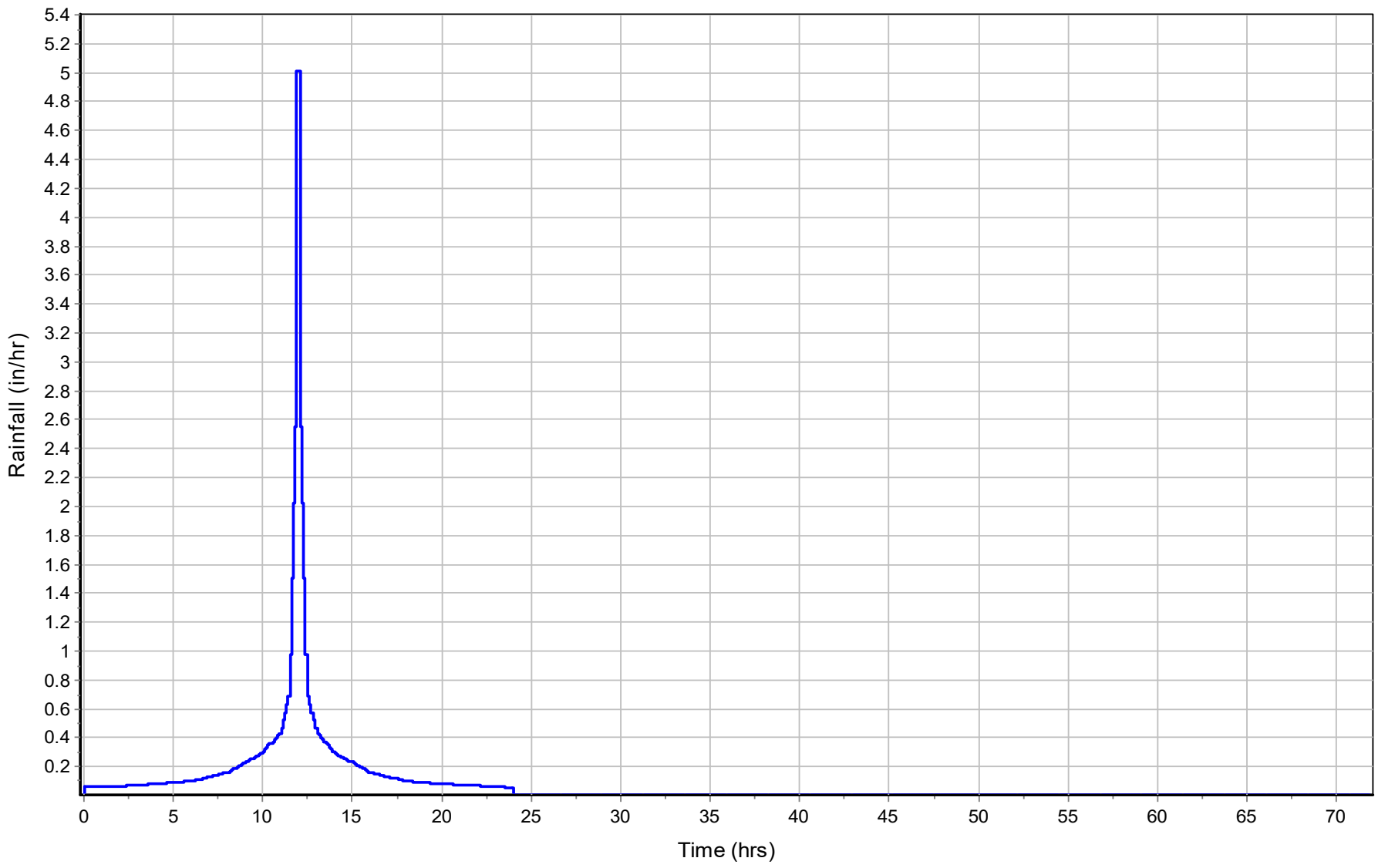
Total TOC (min) 3.14

Subbasin Runoff Results

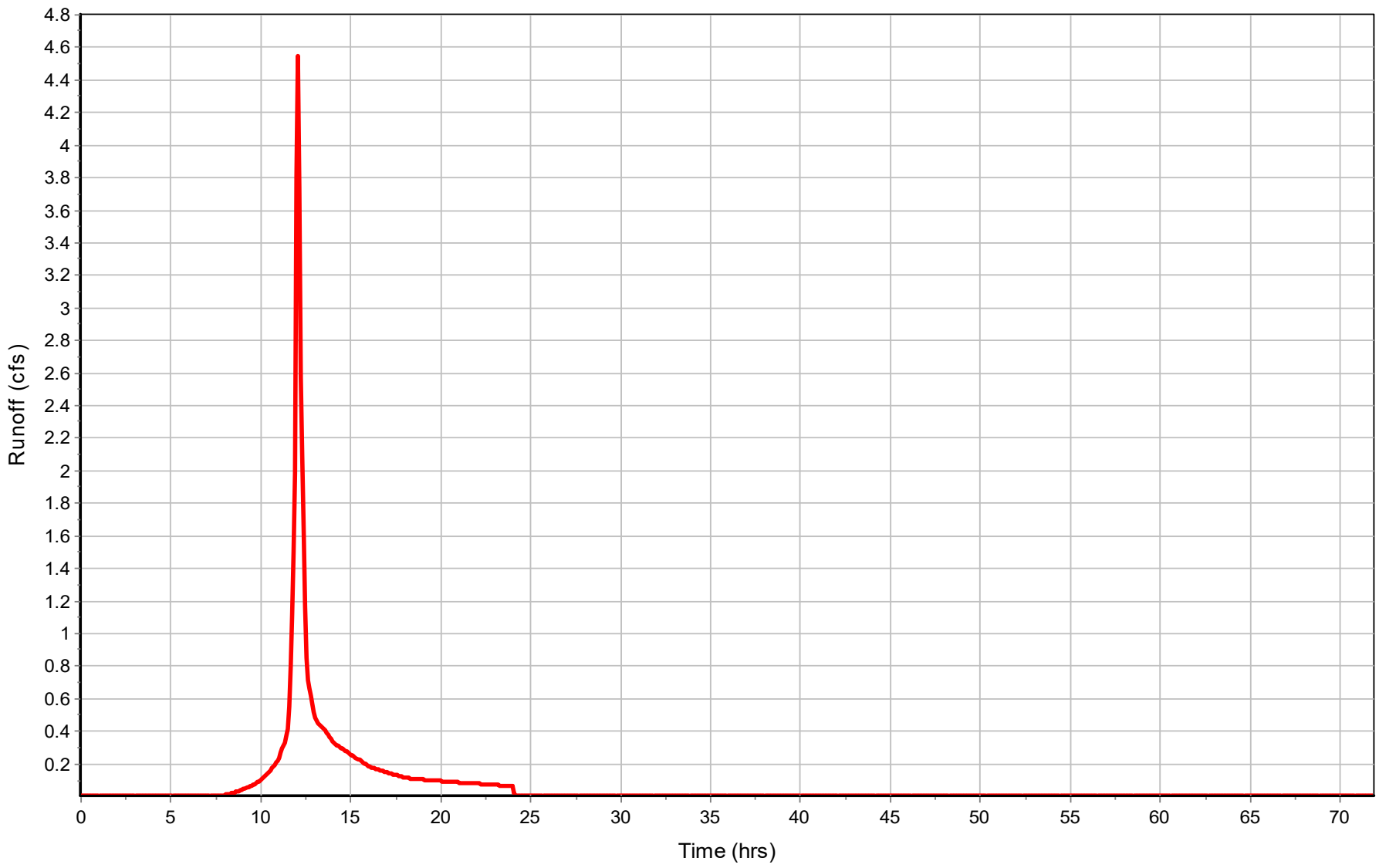
Total Rainfall (in) 5.96
Total Runoff (in) 3.35
Peak Runoff (cfs) 4.65
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:03:08

Subbasin : DA-Ditch-A1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : DA-Ditch-A1-2

Input Data

Area (ac) 1.29
Peak Rate Factor 484
Weighted Curve Number 76
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
50 - 75% grass cover, Fair	1.29	A	76
Composite Area & Weighted CN	1.29		76

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	131.55	0	0
Slope (%) :	1.5	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	1.04	0	0
Computed Flow Time (min) :	2.1	0	0

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	7.88	0	0
Slope (%) :	1.5	0	0
Surface Type :	Unpaved	Unpaved	Unpaved
Velocity (ft/sec) :	1.98	0	0
Computed Flow Time (min) :	0.07	0	0

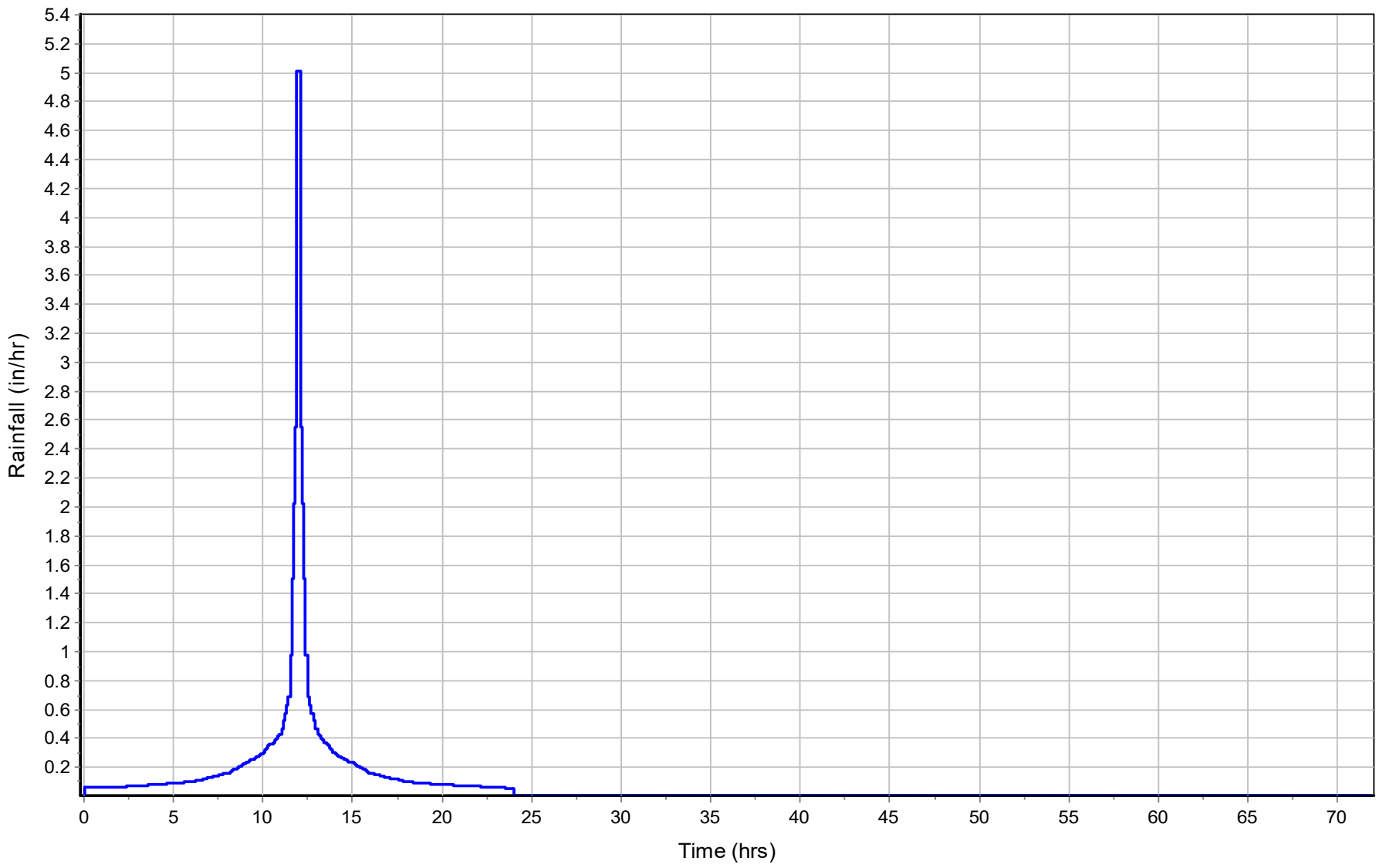
Total TOC (min) 2.17

Subbasin Runoff Results

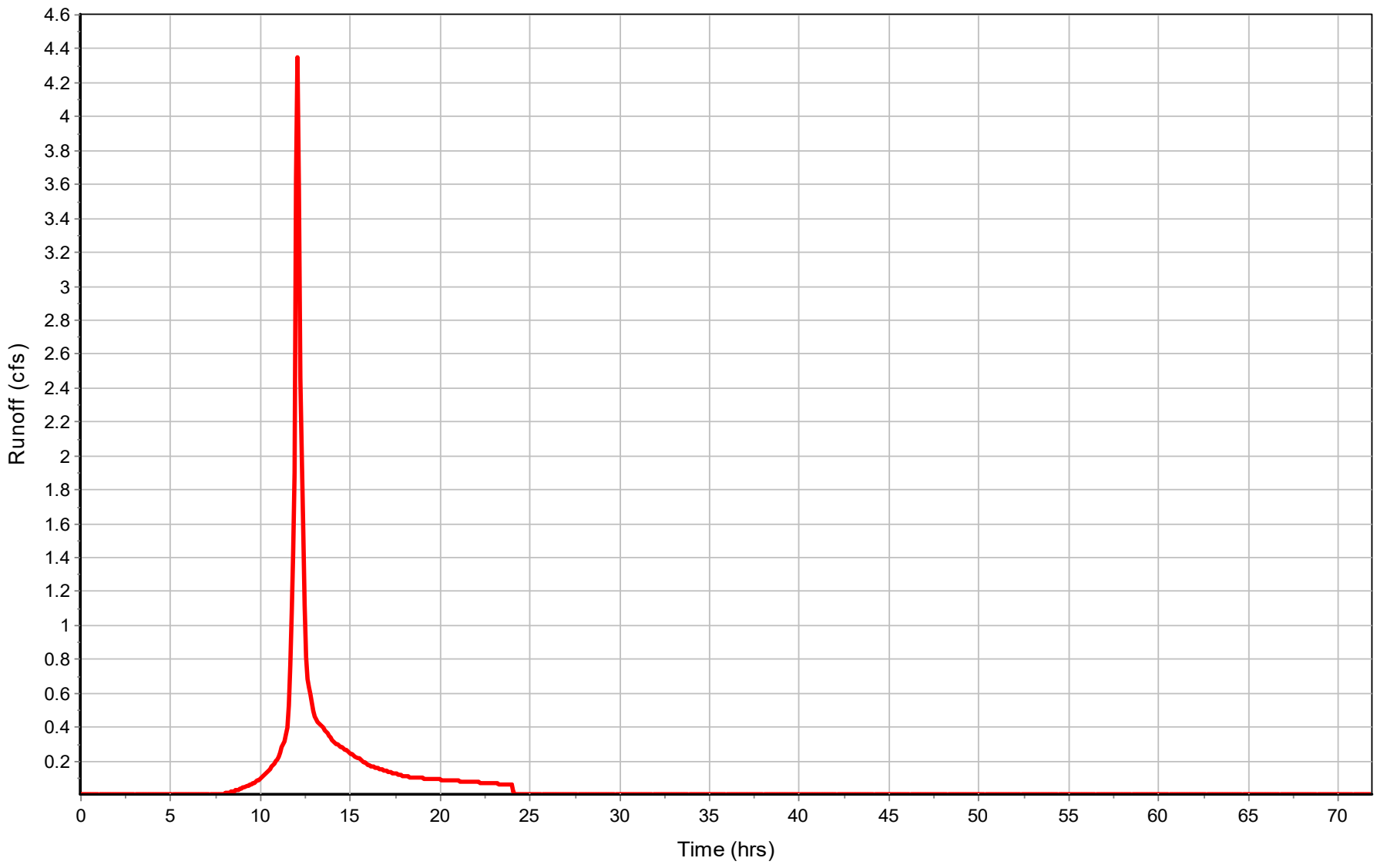
Total Rainfall (in) 5.96
Total Runoff (in) 3.35
Peak Runoff (cfs) 4.45
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:02:10

Subbasin : DA-Ditch-A1-2

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : DA-Ditch-A2

Input Data

Area (ac)	0.67
Peak Rate Factor	484
Weighted Curve Number	76
Rain Gage ID	Rain Gage-01

Composite Curve Number

32

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
50 - 75% grass cover, Fair	0.67	A	76
Composite Area & Weighted CN	0.67		76

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	300	0	0
Slope (%) :	1.5	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	1.23	0	0
Computed Flow Time (min) :	4.06	0	0

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	7.88	0	0
Slope (%) :	1.5	0	0
Surface Type :	Unpaved	Unpaved	Unpaved
Velocity (ft/sec) :	1.98	0	0
Computed Flow Time (min) :	0.07	0	0

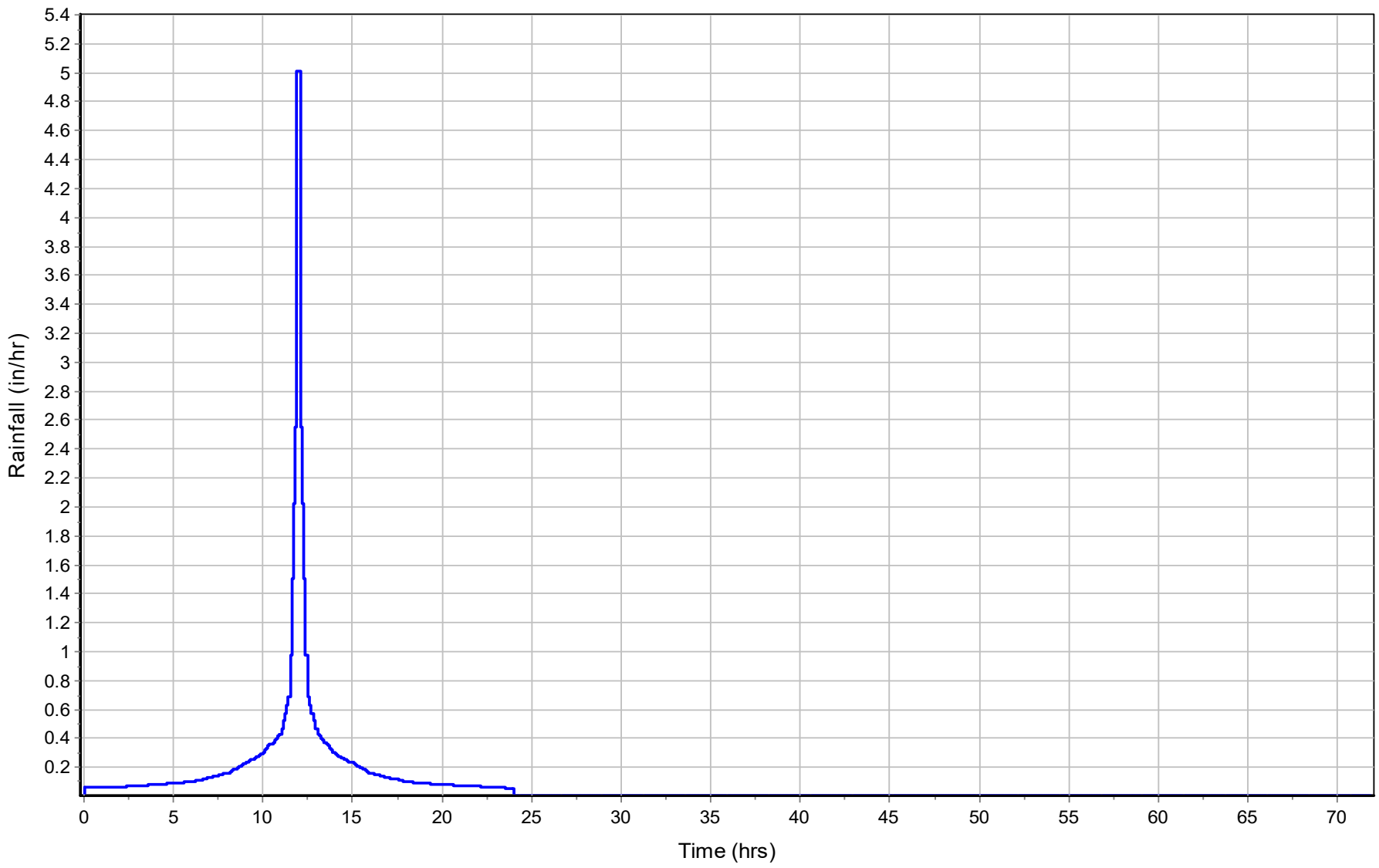
Total TOC (min) 4.13

Subbasin Runoff Results

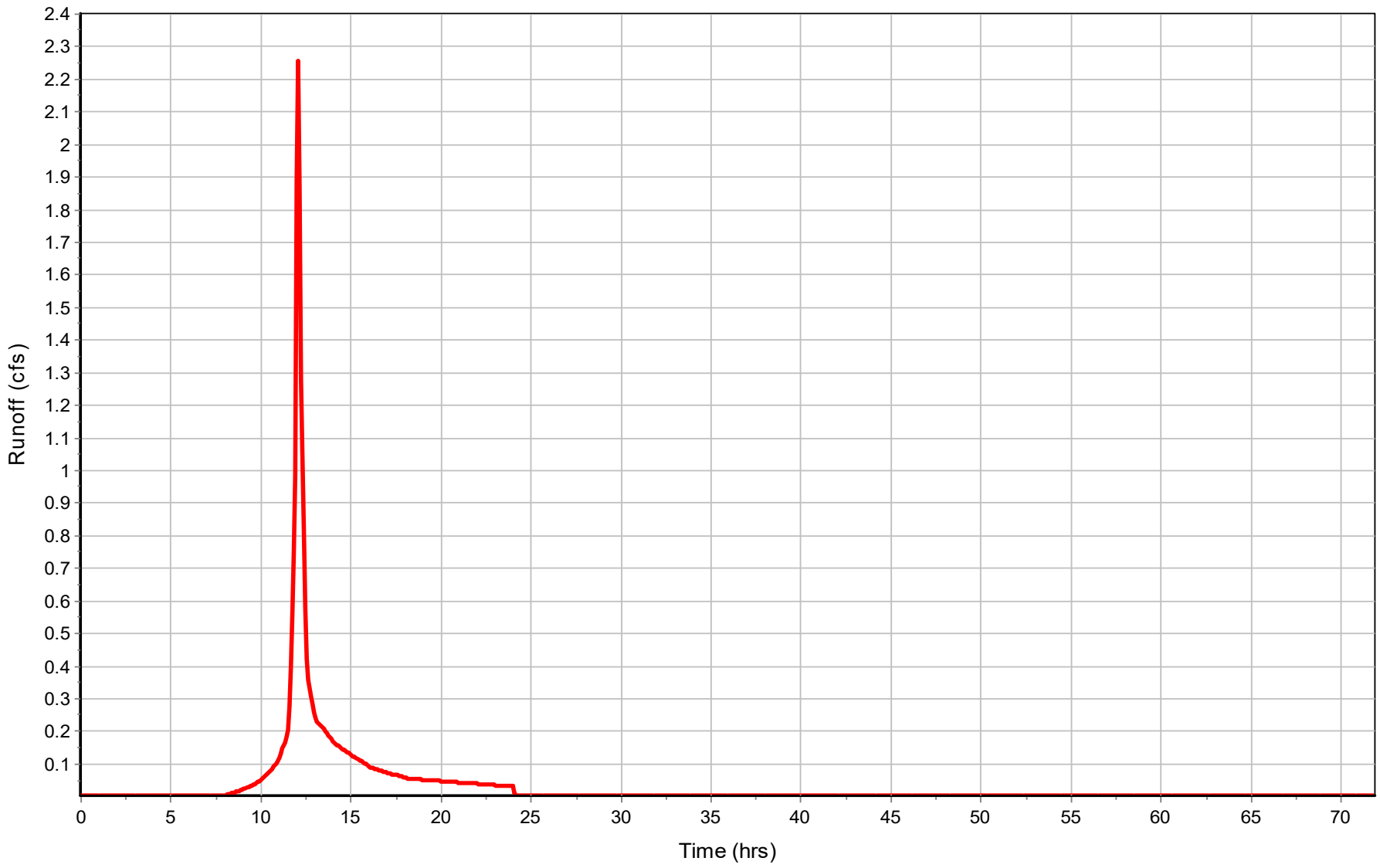
Total Rainfall (in)	5.96
Total Runoff (in)	3.35
Peak Runoff (cfs)	2.31
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:04:08

Subbasin : DA-Ditch-A2

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Existing-E03-1_A1

Input Data

Area (ac)	0.89
Peak Rate Factor	484
Weighted Curve Number	49
Rain Gage ID	Rain Gage-01

Composite Curve Number

32

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
50 - 75% grass cover, Fair	0.89	A	49
Composite Area & Weighted CN	0.89		49

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.4	0	0
Flow Length (ft) :	251.94	0	0
Slope (%) :	3.5	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.12	0	0
Computed Flow Time (min) :	34.83	0	0

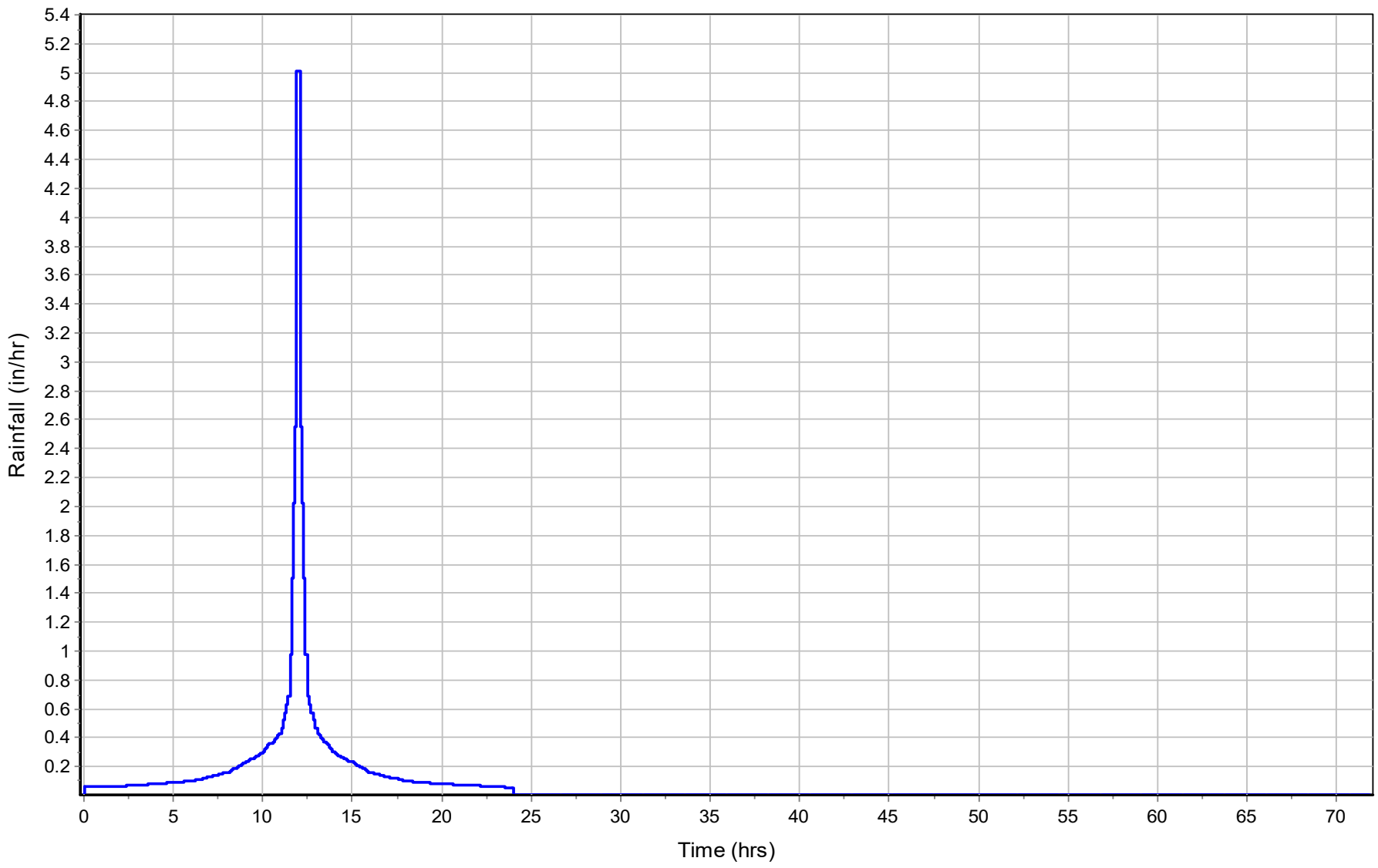
Total TOC (min) 34.83

Subbasin Runoff Results

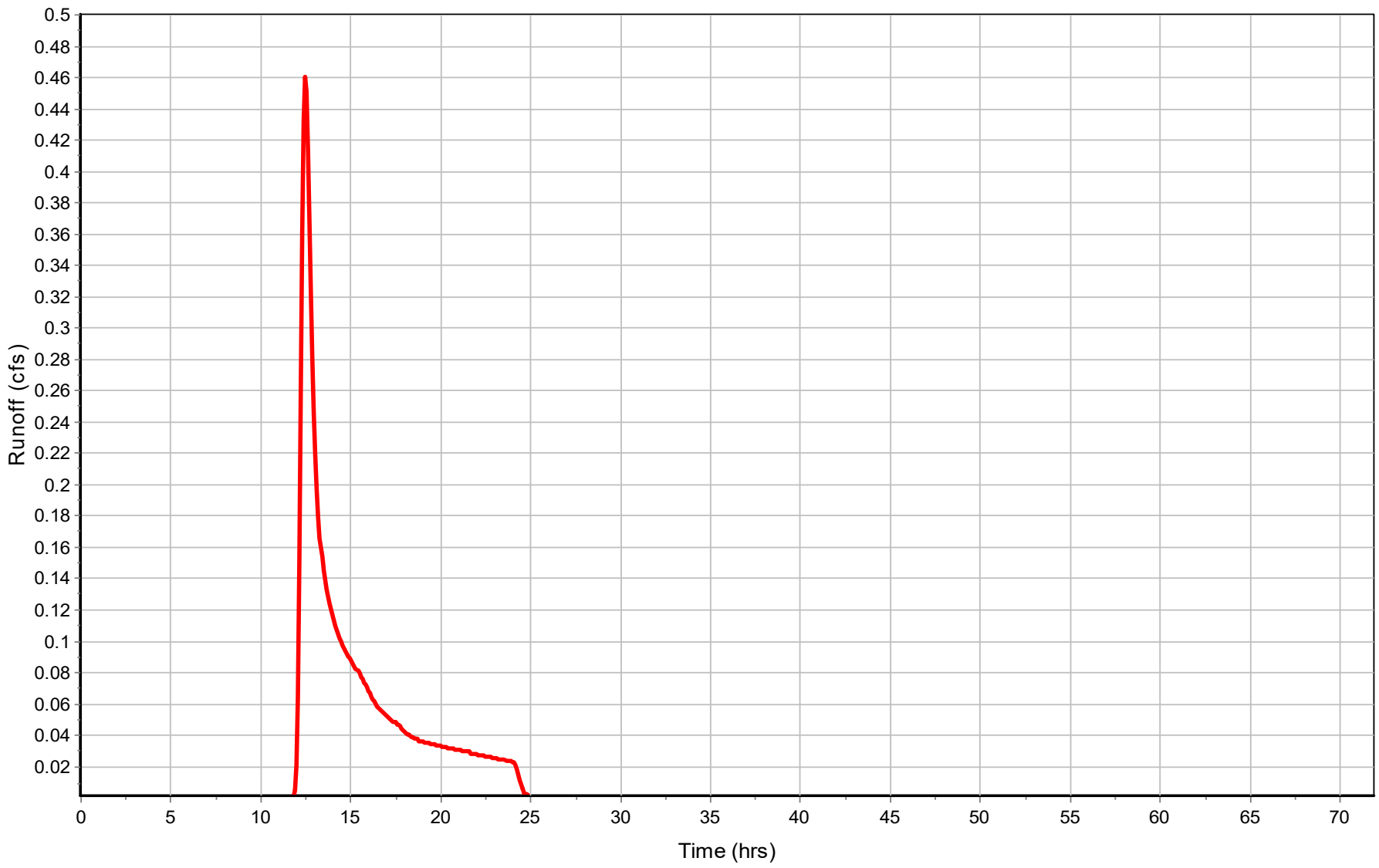
Total Rainfall (in)	5.96
Total Runoff (in)	1.05
Peak Runoff (cfs)	0.46
Weighted Curve Number	49
Time of Concentration (days hh:mm:ss)	0 00:34:50

Subbasin : Existing-E03-1_A1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Existing-E-07_A3

Input Data

Area (ac)	0.39
Peak Rate Factor	484
Weighted Curve Number	51.7
Rain Gage ID	Rain Gage-01

Composite Curve Number

32

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
50 - 75% grass cover, Fair	0.35	A	49
-	0.04	-	76
Composite Area & Weighted CN	0.39		51.7

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.4	0	0
Flow Length (ft) :	300	0	0
Slope (%) :	5	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.14	0	0
Computed Flow Time (min) :	34.72	0	0

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	105.18	0	0
Slope (%) :	2	0	0
Surface Type :	Grass pasture	Unpaved	Unpaved
Velocity (ft/sec) :	0.99	0	0
Computed Flow Time (min) :	1.77	0	0

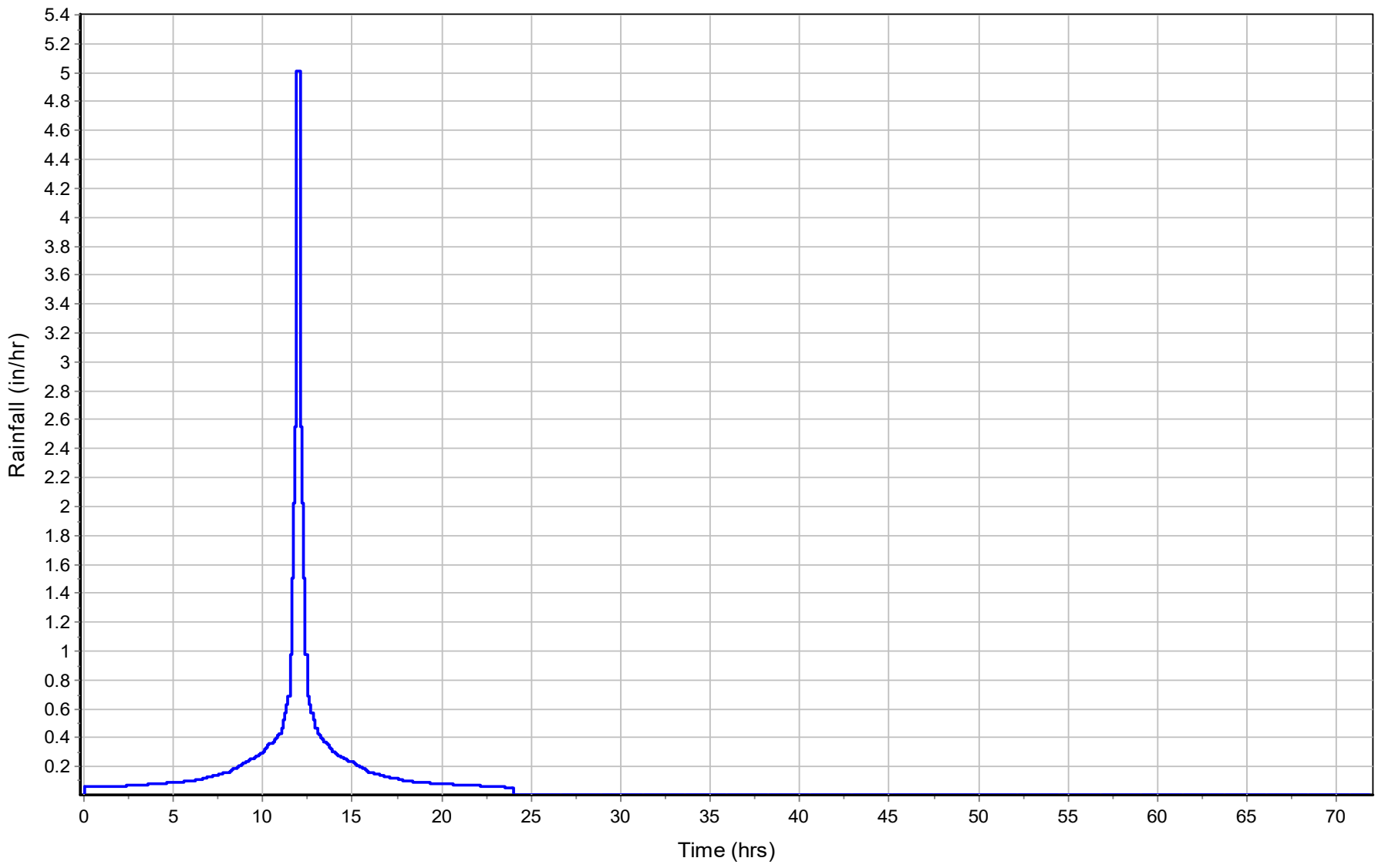
Total TOC (min) 36.49

Subbasin Runoff Results

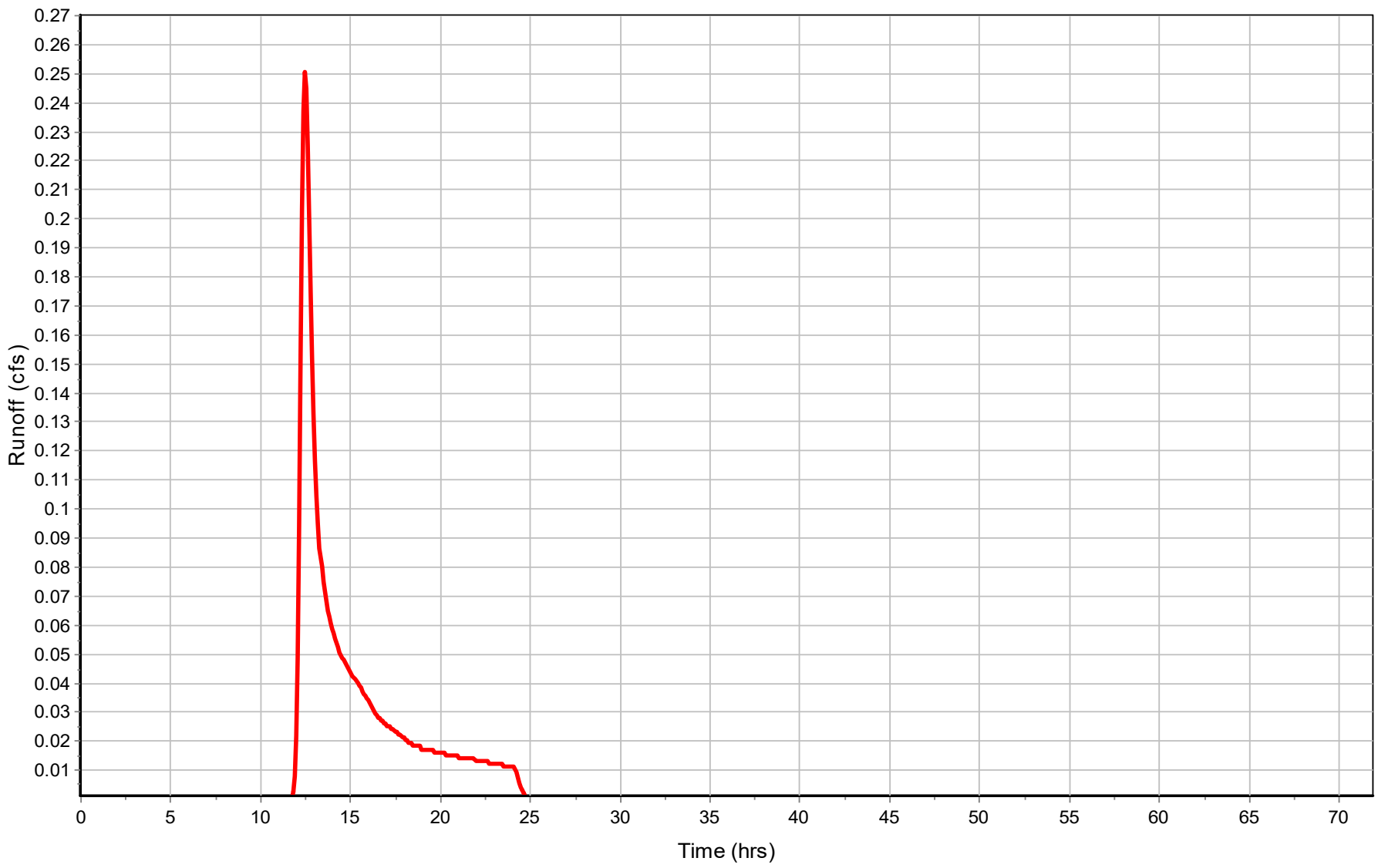
Total Rainfall (in)	5.96
Total Runoff (in)	1.25
Peak Runoff (cfs)	0.25
Weighted Curve Number	51.7
Time of Concentration (days hh:mm:ss)	0 00:36:29

Subbasin : Existing-E-07_A3

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Existing-E3_A1-2

Input Data

Area (ac)	3.2
Peak Rate Factor	484
Weighted Curve Number	49
Rain Gage ID	Rain Gage-01

Composite Curve Number

32

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
-	3.2	-	49
Composite Area & Weighted CN	3.2		49

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.4	0	0
Flow Length (ft) :	300	0	0
Slope (%) :	3.5	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.12	0	0
Computed Flow Time (min) :	40.05	0	0

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	205.17	0	0
Slope (%) :	3	0	0
Surface Type :	Grass pasture	Unpaved	Unpaved
Velocity (ft/sec) :	1.21	0	0
Computed Flow Time (min) :	2.83	0	0

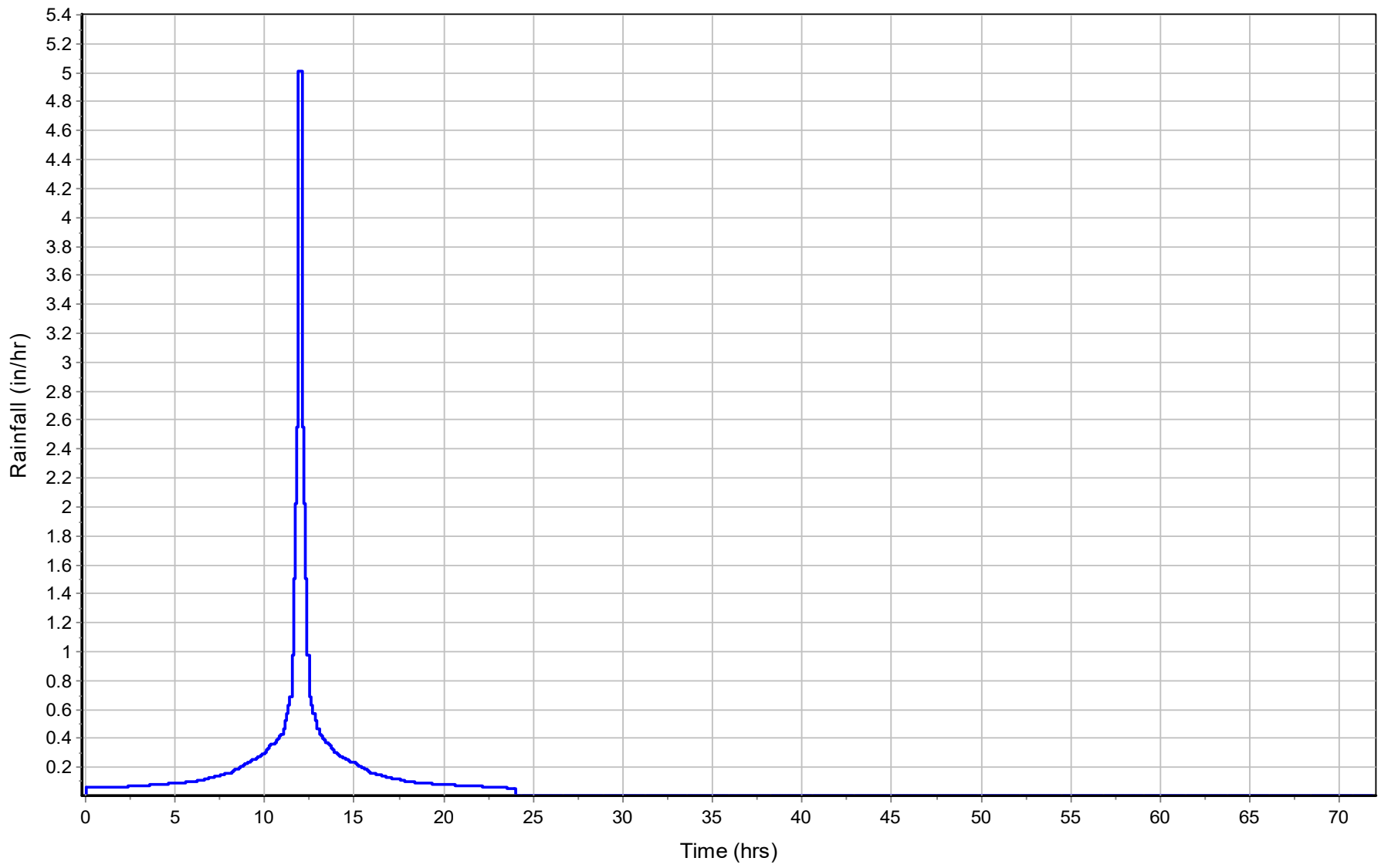
Total TOC (min) 42.87

Subbasin Runoff Results

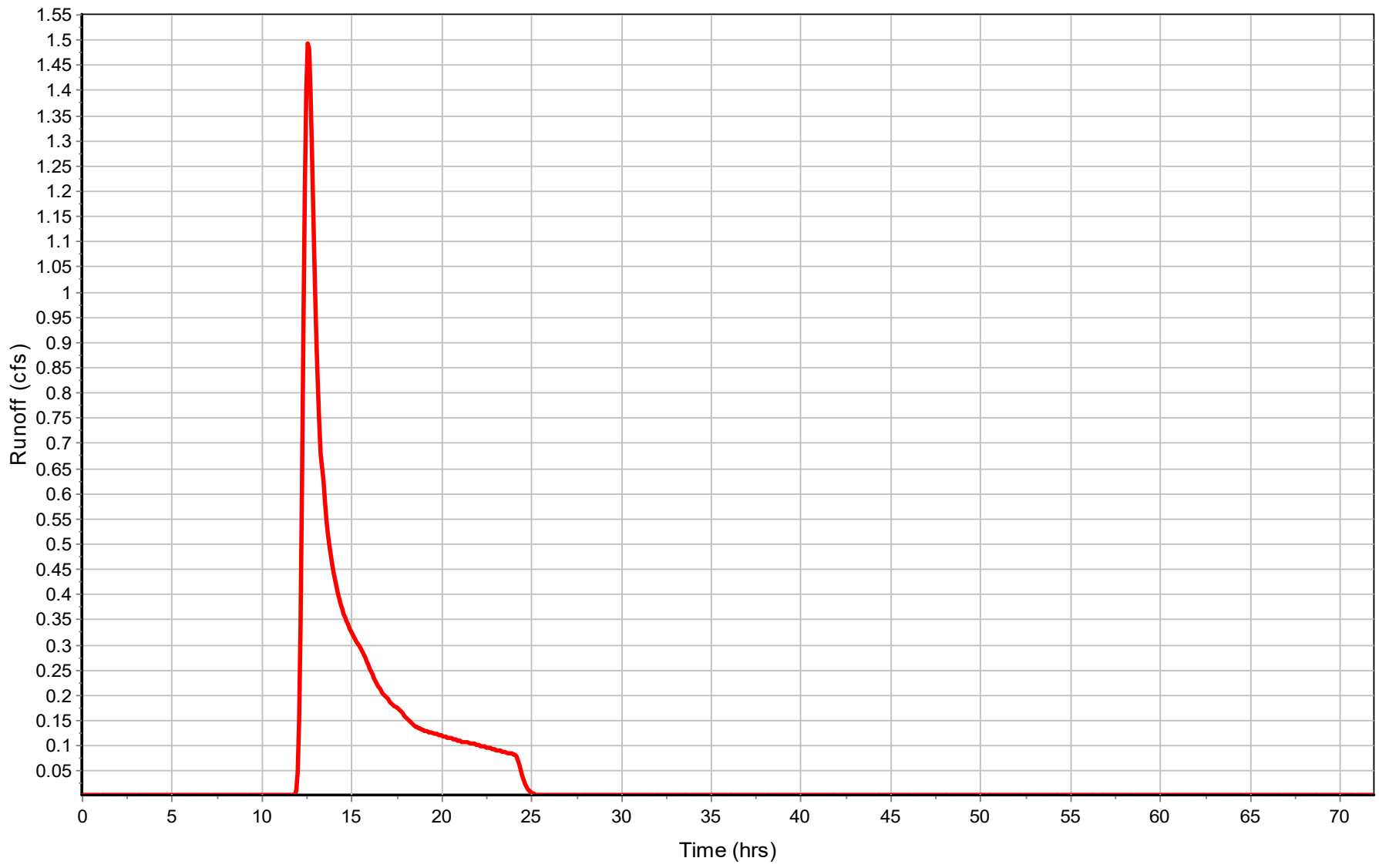
Total Rainfall (in)	5.96
Total Runoff (in)	1.05
Peak Runoff (cfs)	1.5
Weighted Curve Number	49
Time of Concentration (days hh:mm:ss)	0 00:42:52

Subbasin : Existing-E3_A1-2

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Existing-E5.1_A2

Input Data

Area (ac)	0.26
Peak Rate Factor	484
Weighted Curve Number	49
Rain Gage ID	Rain Gage-01

Composite Curve Number

32	Area	Soil	Curve
Soil/Surface Description	(acres)	Group	Number
50 - 75% grass cover, Fair	0.26	A	49
Composite Area & Weighted CN	0.26		49

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.4	0	0
Flow Length (ft) :	142.47	0	0
Slope (%) :	10	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.16	0	0
Computed Flow Time (min) :	14.5	0	0

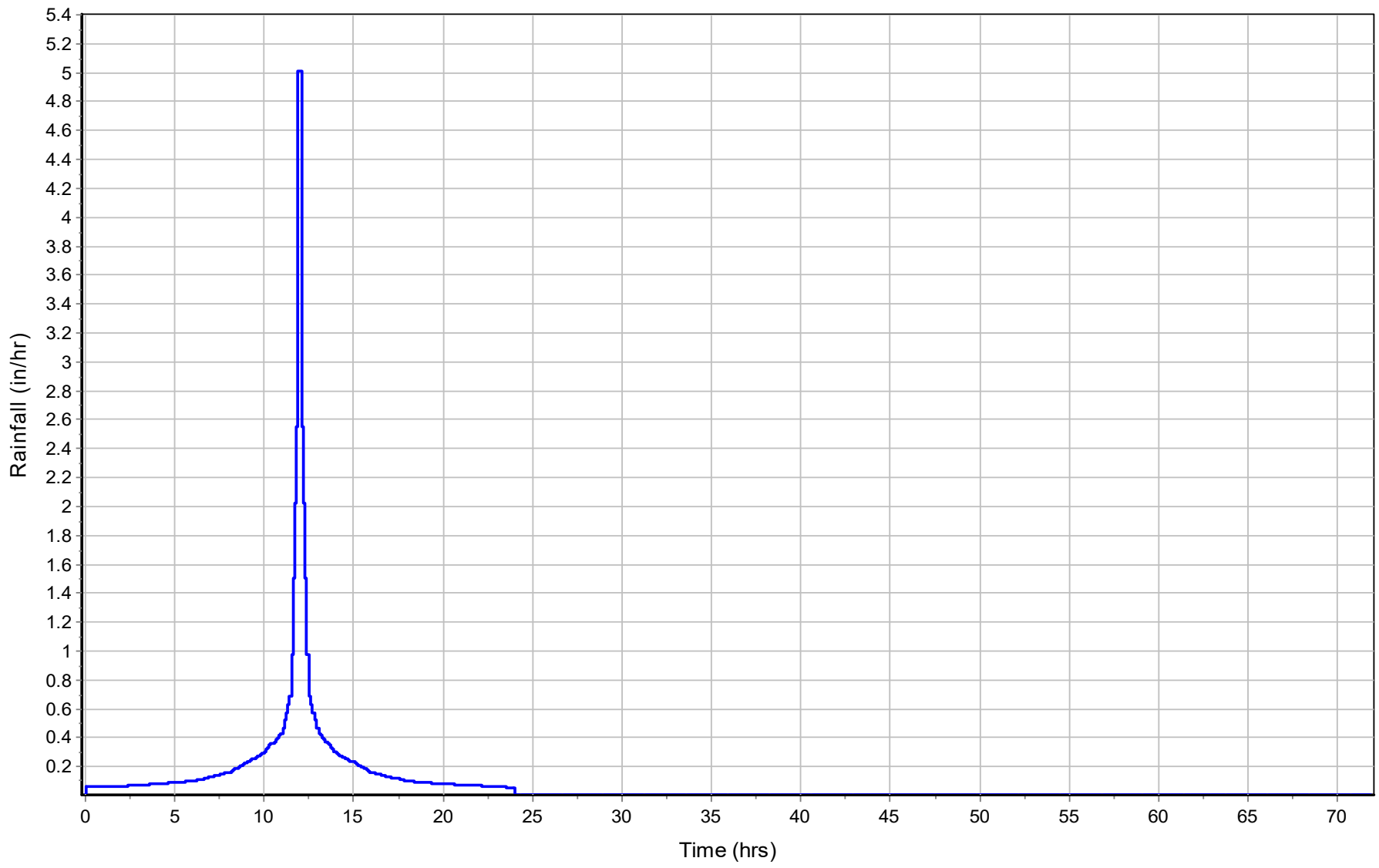
Total TOC (min) 14.50

Subbasin Runoff Results

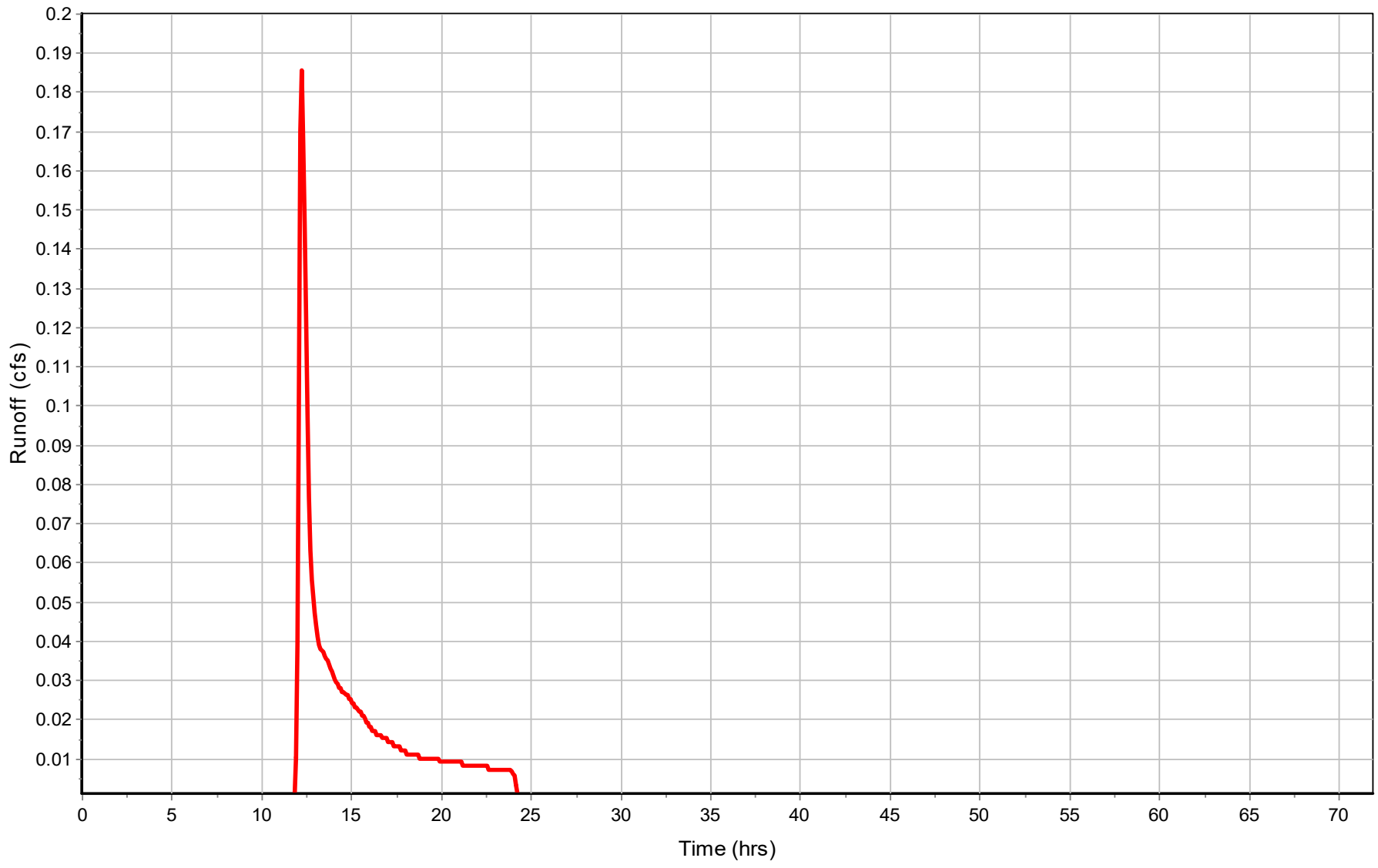
Total Rainfall (in)	5.96
Total Runoff (in)	1.05
Peak Runoff (cfs)	0.19
Weighted Curve Number	49
Time of Concentration (days hh:mm:ss)	0 00:14:30

Subbasin : Existing-E5.1_A2

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : A1-1-BASIN

Input Data

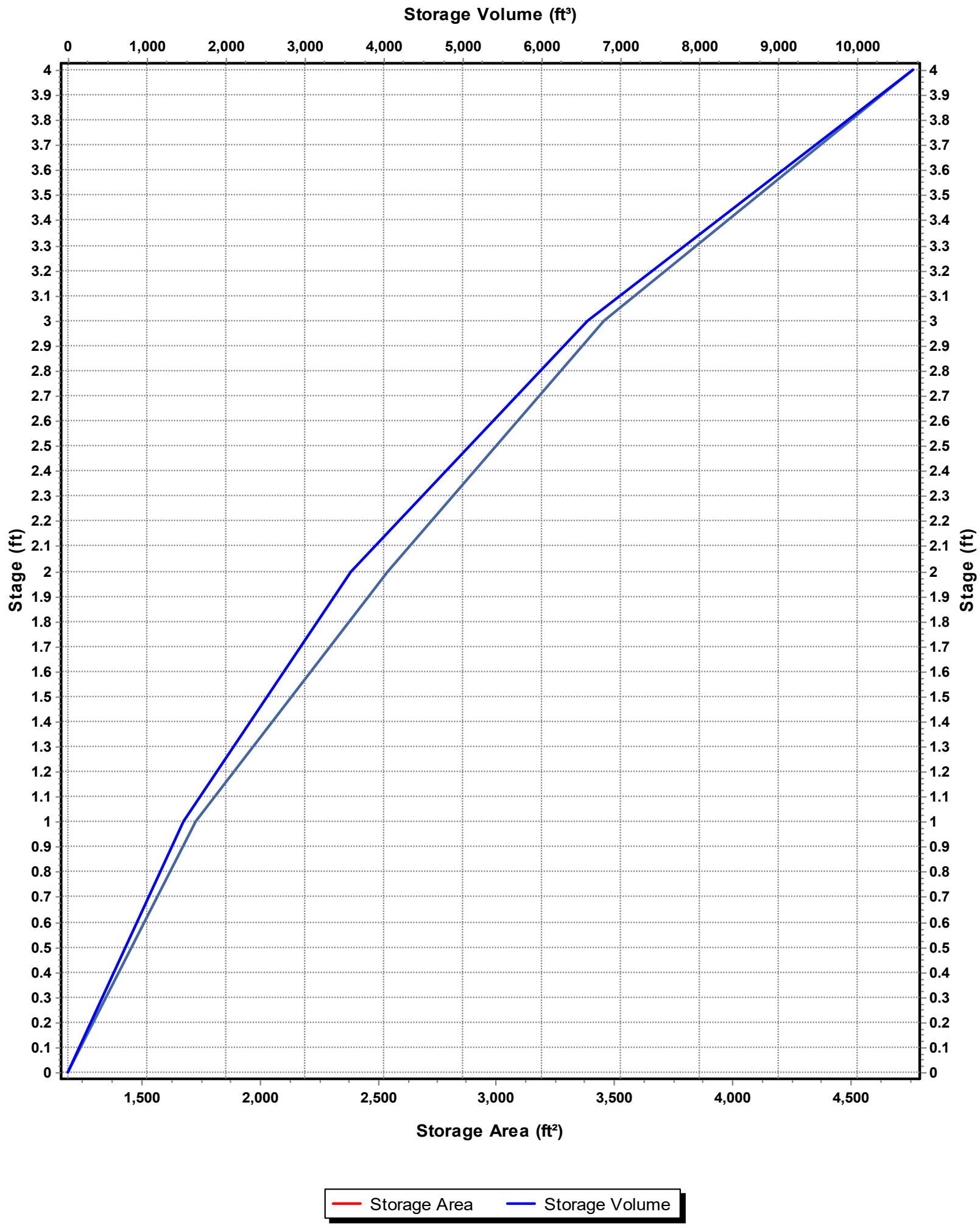
Invert Elevation (ft)	66.00
Max (Rim) Elevation (ft)	69.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	66.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : EXISTING POND.North

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	1188.1	0
1	1729.54	1458.82
2	2543.02	3595.1
3	3461.12	6597.17
4	4767.41	10711.44

Storage Area Volume Curves



Storage Node : A1-1-BASIN (continued)

Outflow Orifices

SN	Element ID	Orifice Type	Orifice Shape	Flap Gate	Circular Orifice Diameter (ft)	Rectangular Orifice Height (ft)	Rectangular Orifice Width (ft)	Orifice Invert Elevation (ft)	Orifice Coefficient
1	12RCP	Side	CIRCULAR	No	1.00			68.00	0.61

Output Summary Results

Peak Inflow (cfs)	1.77
Peak Lateral Inflow (cfs)	1.77
Peak Outflow (cfs)	0.69
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	68.4
Max HGL Depth Attained (ft)	2.4
Average HGL Elevation Attained (ft)	67.75
Average HGL Depth Attained (ft)	1.75
Time of Max HGL Occurrence (days hh:mm)	0 12:32
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : BASIN-1

Input Data

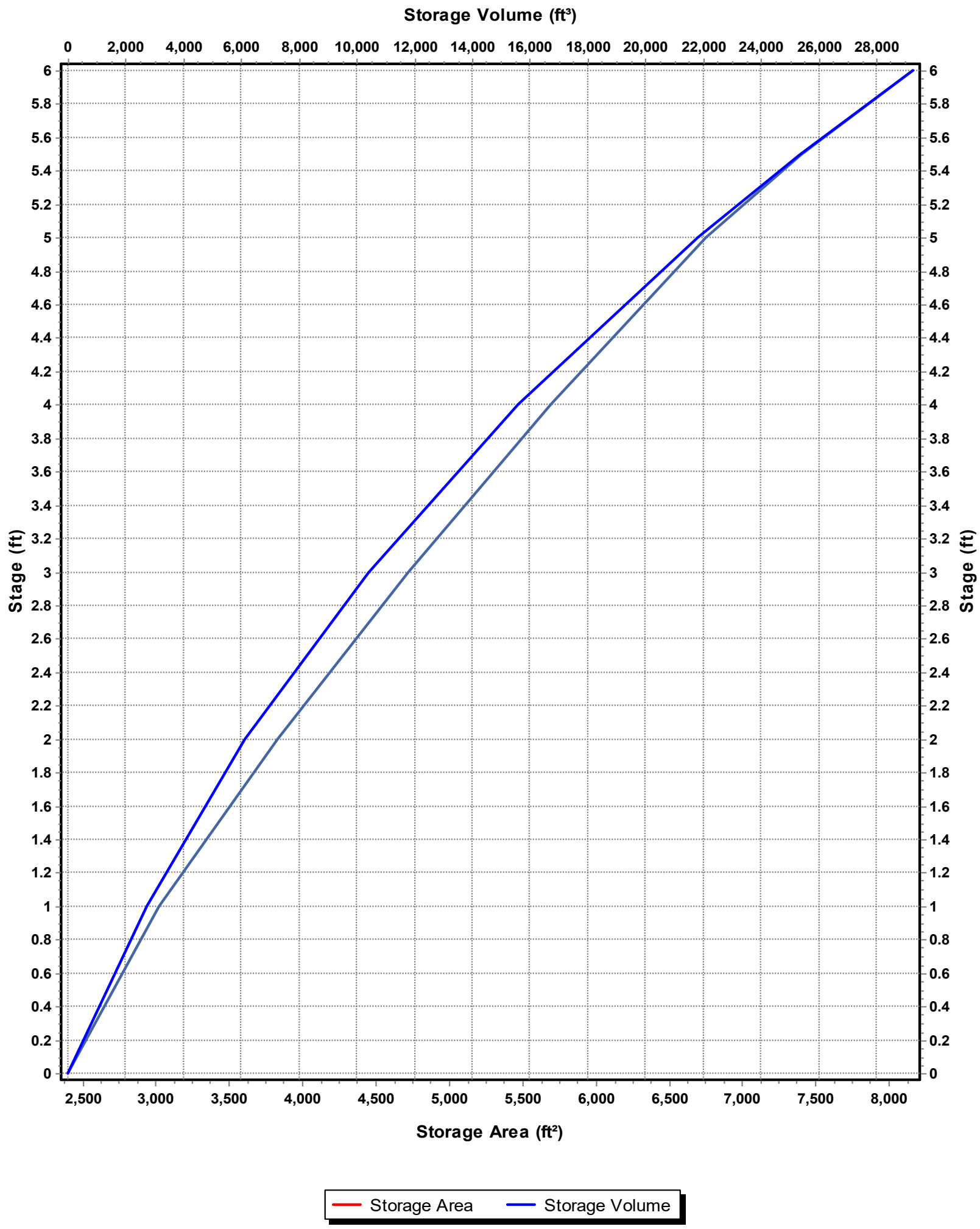
Invert Elevation (ft)	63.00
Max (Rim) Elevation (ft)	69.00
Max (Rim) Offset (ft)	6.00
Initial Water Elevation (ft)	63.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : POND-1

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	2401.32	0
1	3024.34	2712.83
2	3828.08	6139.04
3	4718.62	10412.39
4	5693.33	15618.37
5	6754.28	21842.18
5.5	7407.96	25382.74
6	8166.38	29276.33

Storage Area Volume Curves



Storage Node : BASIN-1 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-B1	Trapezoidal	No	68.50	5.50	10.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	4.03
Peak Lateral Inflow (cfs)	0
Peak Outflow (cfs)	1.13
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	67.78
Max HGL Depth Attained (ft)	4.78
Average HGL Elevation Attained (ft)	66.75
Average HGL Depth Attained (ft)	3.75
Time of Max HGL Occurrence (days hh:mm)	3 00:00
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : BASIN-2

Input Data

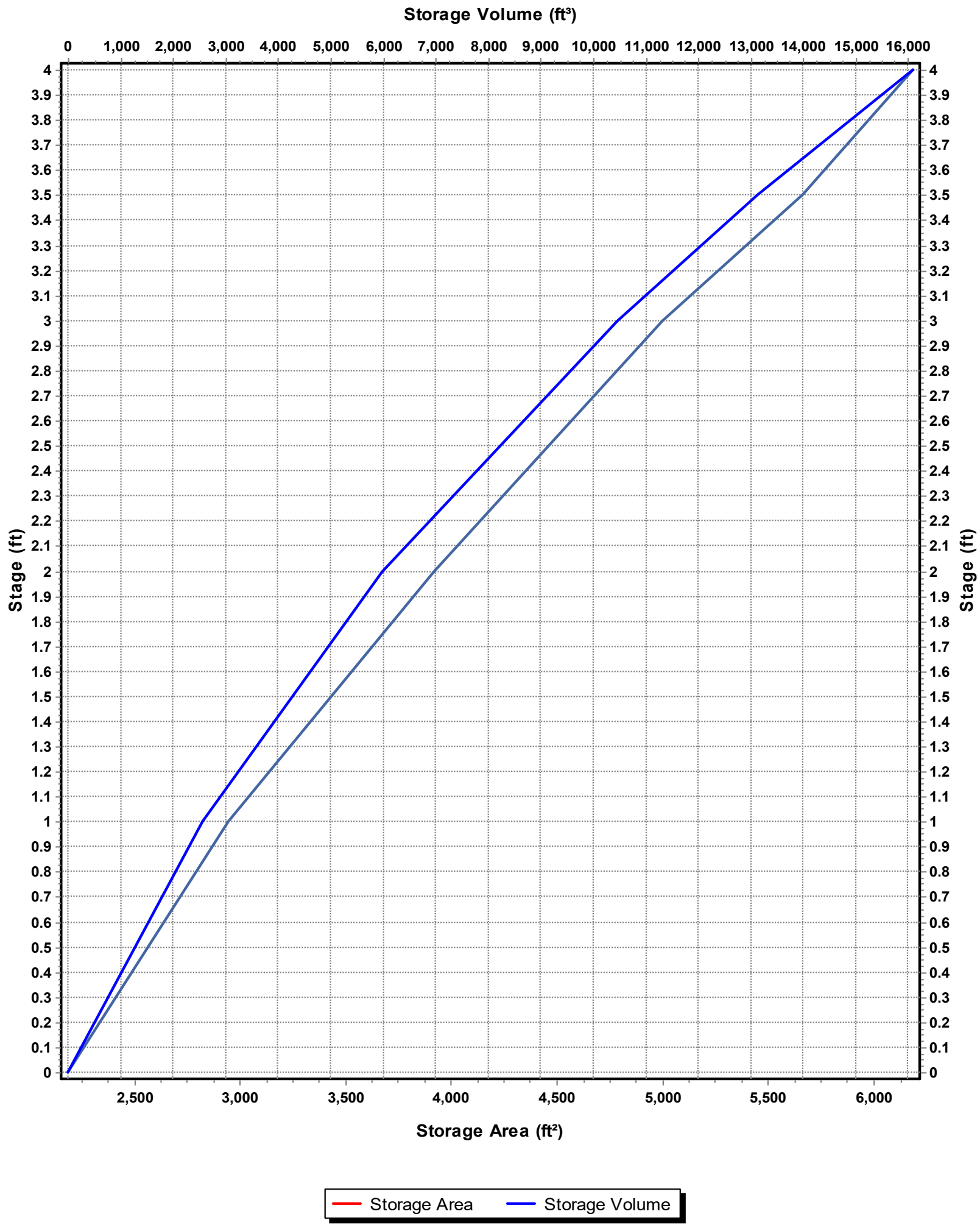
Invert Elevation (ft)	63.00
Max (Rim) Elevation (ft)	67.00
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	63.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : POND-2

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	2186.8	0
1	2944.52	2565.66
2	3920.59	5998.22
3	5001.46	10459.25
3.5	5669	13126.87
4	6188.64	16091.28

Storage Area Volume Curves



Storage Node : BASIN-2 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-B2	Trapezoidal	No	66.50	3.50	10.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	1.77
Peak Lateral Inflow (cfs)	0
Peak Outflow (cfs)	0
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	65.21
Max HGL Depth Attained (ft)	2.21
Average HGL Elevation Attained (ft)	64.76
Average HGL Depth Attained (ft)	1.76
Time of Max HGL Occurrence (days hh:mm)	1 03:22
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Exist-Catch-Basin

Input Data

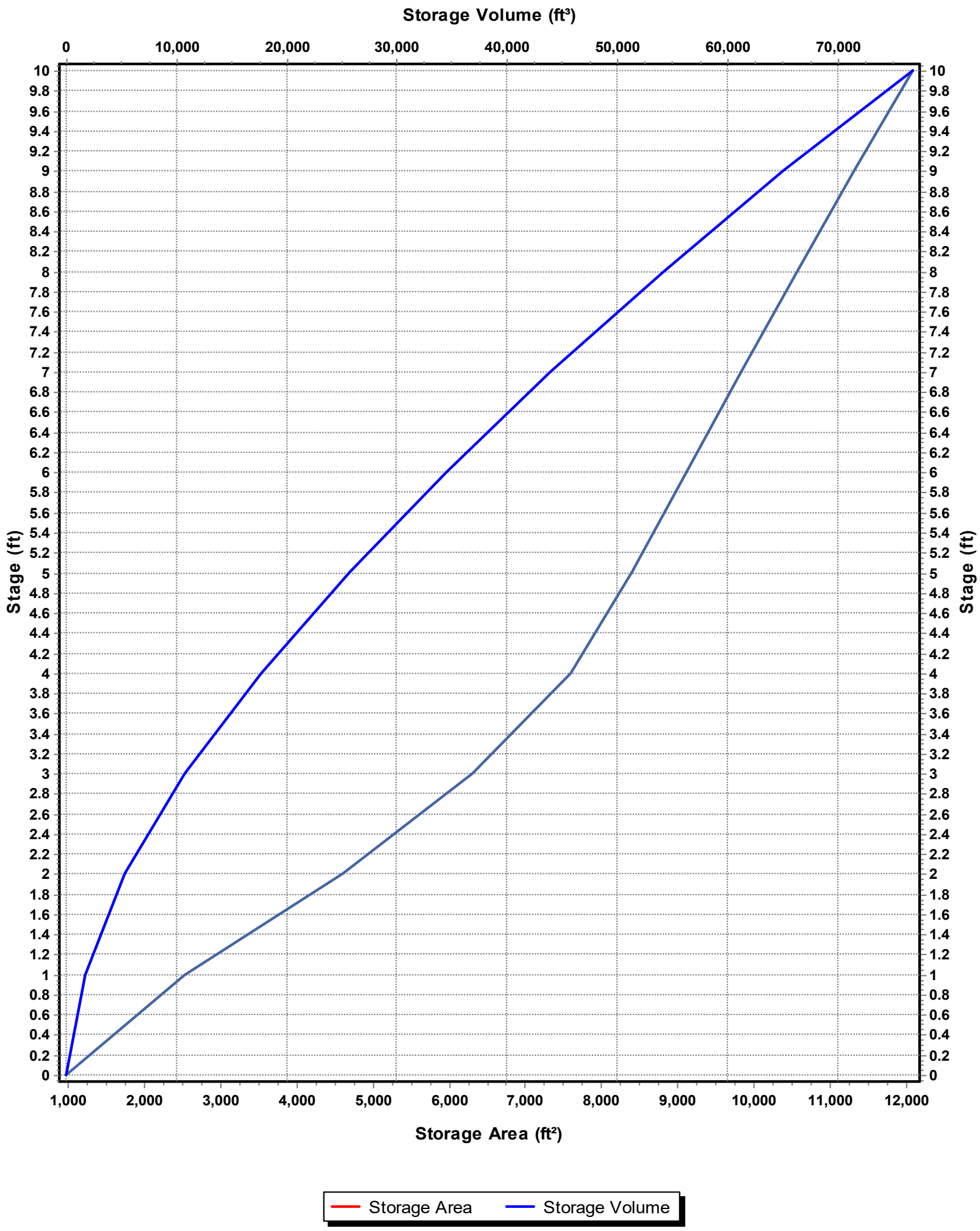
Invert Elevation (ft)	43.00
Max (Rim) Elevation (ft)	53.00
Max (Rim) Offset (ft)	10.00
Initial Water Elevation (ft)	43.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : EXISTING POND.South

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	974.38	0
1	2524.45	1749.42
2	4602.46	5312.88
3	6308.57	10768.4
4	7605.38	17725.38
5	8399.21	25727.68
6	9117.86	34486.22
7	9840.94	43965.62
8	10576.98	54174.58
9	11329.31	65127.73
10	12097.94	76841.36

Storage Area Volume Curves



Storage Node : Exist-Catch-Basin (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Exist-Catch-Basin-Weir	Trapezoidal	No	52.50	9.50	5.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	1.49
Peak Lateral Inflow (cfs)	1.49
Peak Outflow (cfs)	0
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	46.23
Max HGL Depth Attained (ft)	3.23
Average HGL Elevation Attained (ft)	45.58
Average HGL Depth Attained (ft)	2.58
Time of Max HGL Occurrence (days hh:mm)	1 01:35
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Existing-Catch-Basin

Input Data

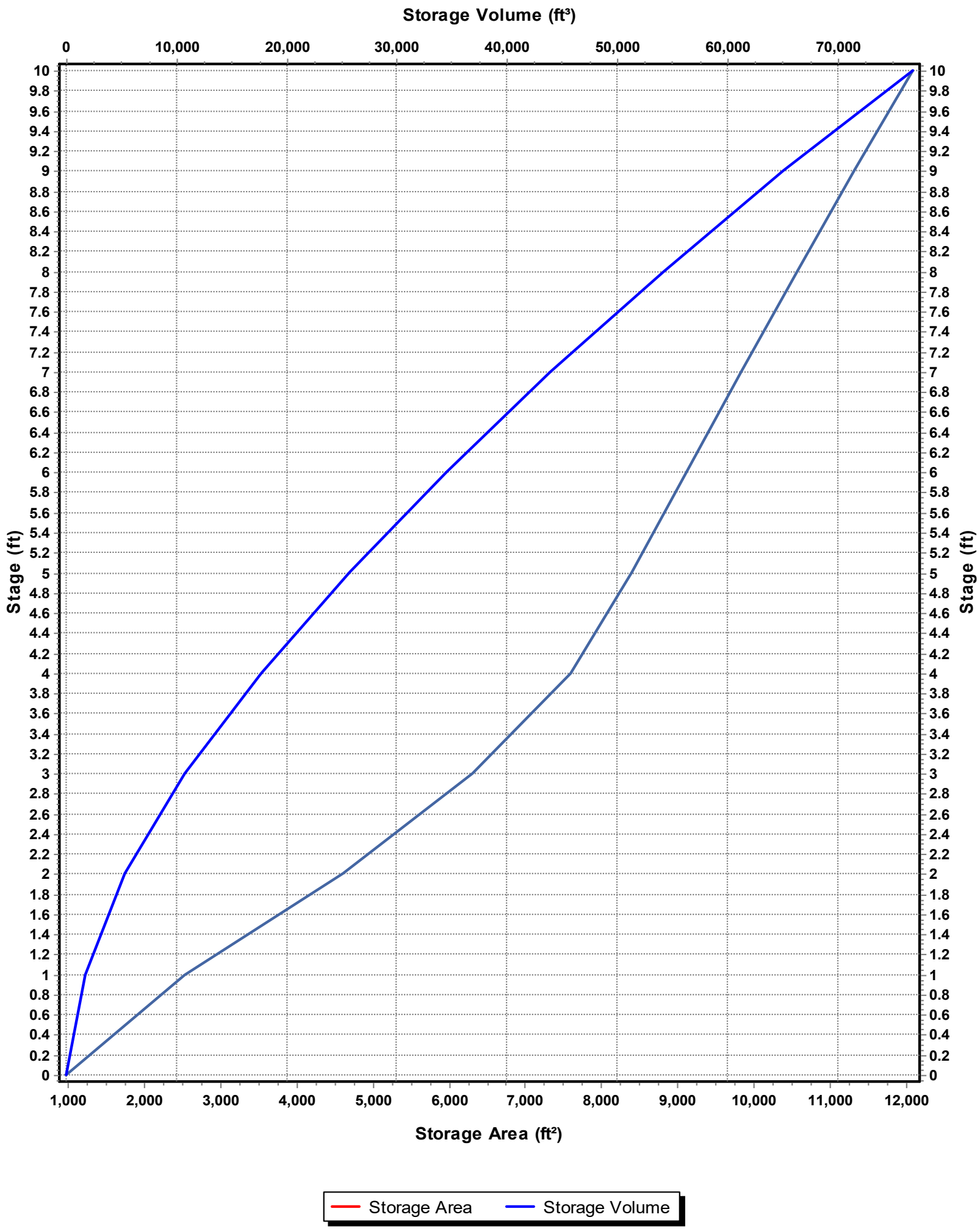
Invert Elevation (ft)	43.00
Max (Rim) Elevation (ft)	53.00
Max (Rim) Offset (ft)	10.00
Initial Water Elevation (ft)	43.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : EXISTING POND.South

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	974.38	0
1	2524.45	1749.42
2	4602.46	5312.88
3	6308.57	10768.4
4	7605.38	17725.38
5	8399.21	25727.68
6	9117.86	34486.22
7	9840.94	43965.62
8	10576.98	54174.58
9	11329.31	65127.73
10	12097.94	76841.36

Storage Area Volume Curves



Storage Node : Existing-Catch-Basin (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Existing-Catch-Basin-Weir	Trapezoidal	No	52.50	9.50	5.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	1.79
Peak Lateral Inflow (cfs)	0.49
Peak Outflow (cfs)	0
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	46.01
Max HGL Depth Attained (ft)	3.01
Average HGL Elevation Attained (ft)	45.42
Average HGL Depth Attained (ft)	2.42
Time of Max HGL Occurrence (days hh:mm)	1 02:15
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : FOREBAY-1

Input Data

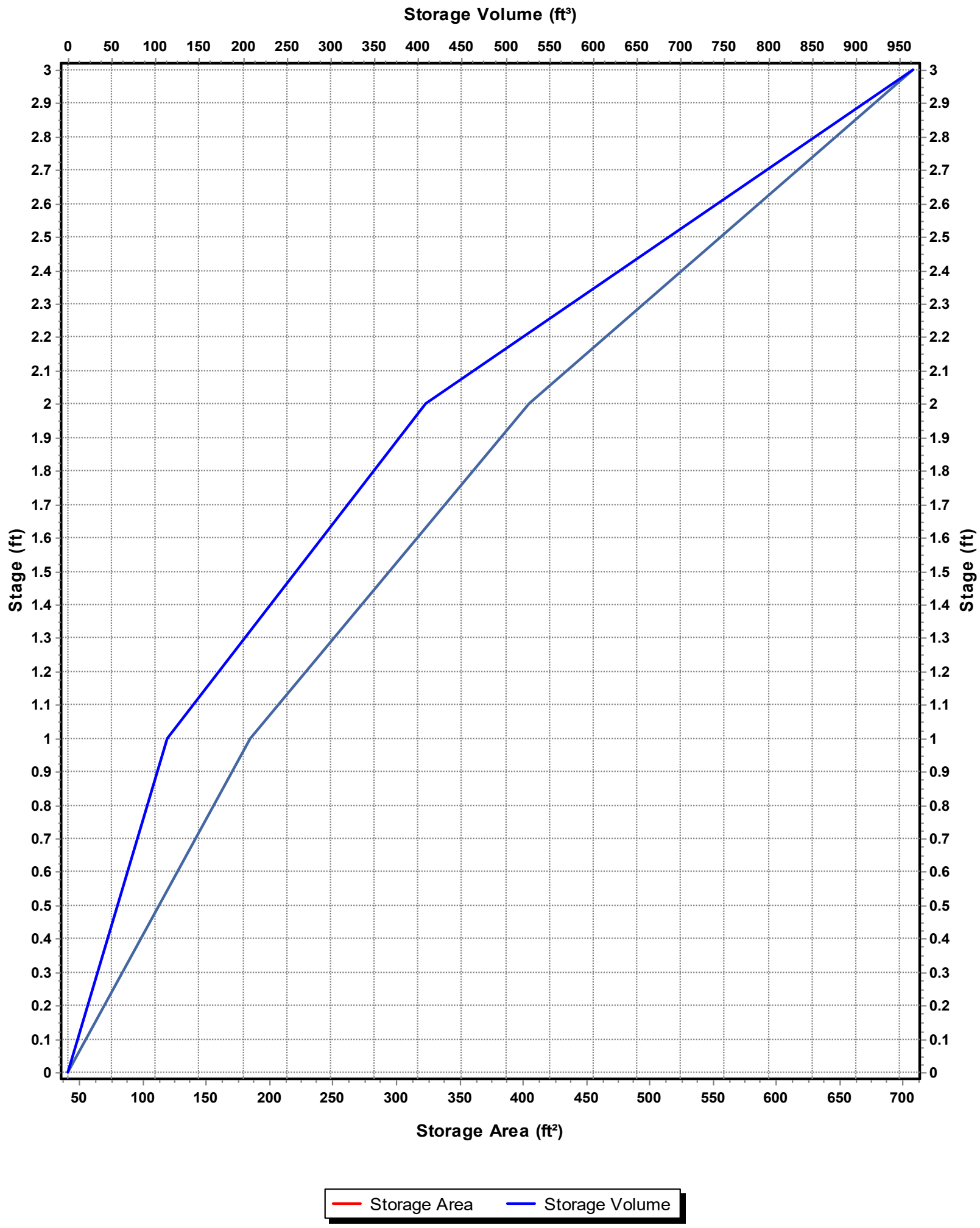
Invert Elevation (ft)	66.00
Max (Rim) Elevation (ft)	70.00
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	66.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : FOREBAY-1

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	41.13	0
1	185.44	113.29
2	405.49	408.76
3	708.15	965.58

Storage Area Volume Curves



Storage Node : FOREBAY-1 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-F1	Trapezoidal	No	67.00	1.00	4.00	3.00	3.33

Output Summary Results

Peak Inflow (cfs)	4.05
Peak Lateral Inflow (cfs)	4.05
Peak Outflow (cfs)	4.03
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	67.83
Max HGL Depth Attained (ft)	1.83
Average HGL Elevation Attained (ft)	67.36
Average HGL Depth Attained (ft)	1.36
Time of Max HGL Occurrence (days hh:mm)	3 00:00
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : FOREBAY-1-2

Input Data

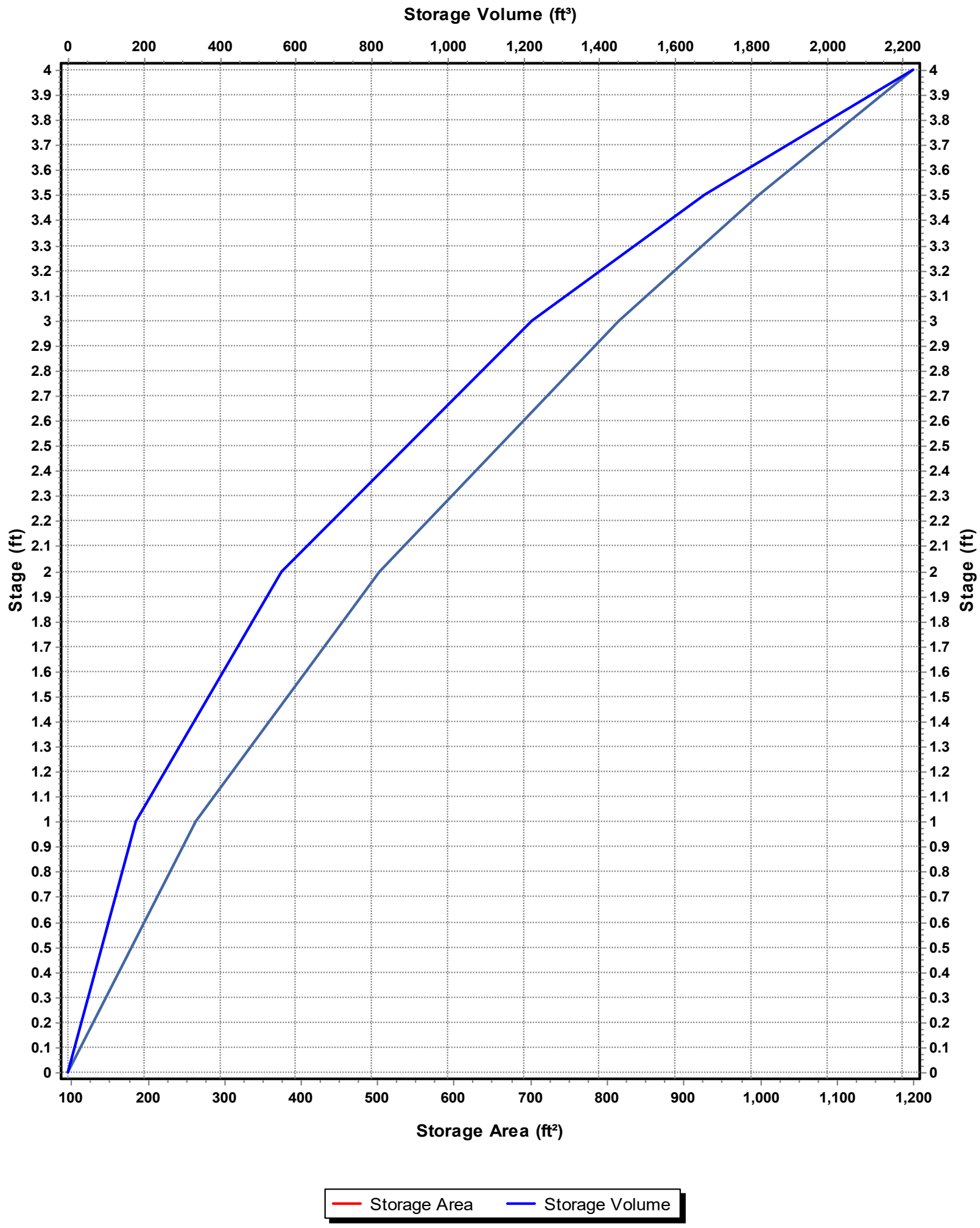
Invert Elevation (ft)	62.00
Max (Rim) Elevation (ft)	66.00
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	62.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : FOREBAY-3

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	96	0
1	264	180
2	504	564
3	816	1224
3.5	999	1677.75
4	1200	2227.5

Storage Area Volume Curves



Storage Node : FOREBAY-1-2 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-F1-2	Trapezoidal	No	63.00	1.00	2.00	3.00	3.33

Output Summary Results

Peak Inflow (cfs)	1.74
Peak Lateral Inflow (cfs)	1.74
Peak Outflow (cfs)	1.72
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	63.37
Max HGL Depth Attained (ft)	1.37
Average HGL Elevation Attained (ft)	62.85
Average HGL Depth Attained (ft)	0.85
Time of Max HGL Occurrence (days hh:mm)	0 12:11
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : FOREBAY-2

Input Data

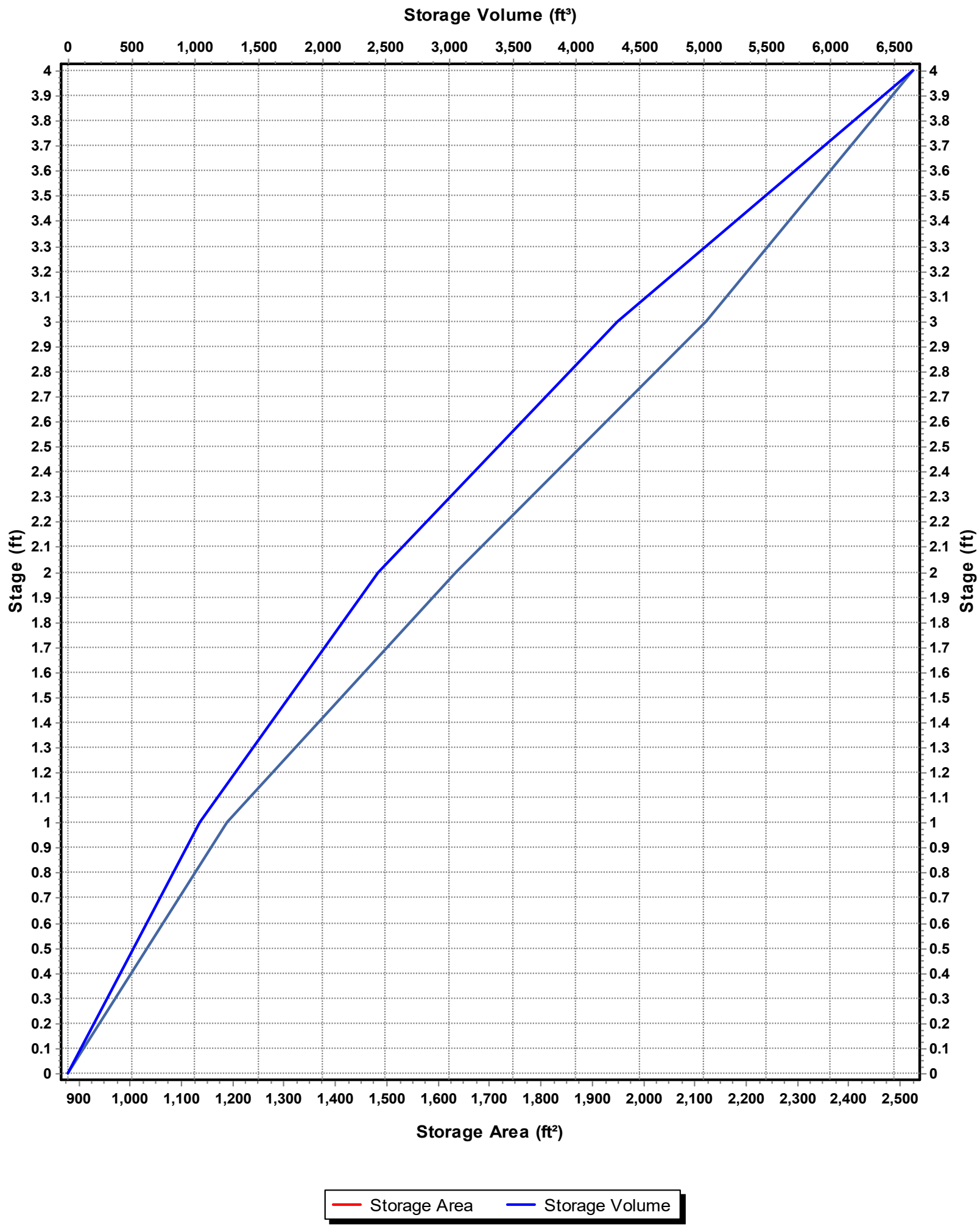
Invert Elevation (ft)	65.00
Max (Rim) Elevation (ft)	69.00
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	65.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : FOREBAY-2

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	880.04	0
1	1189.5	1034.77
2	1635.09	2447.07
3	2123.92	4326.58
4	2526	6651.54

Storage Area Volume Curves



Storage Node : FOREBAY-2 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-F2	Trapezoidal	No	68.00	3.00	10.00	1.00	3.33

Output Summary Results

Peak Inflow (cfs)	3.09
Peak Lateral Inflow (cfs)	3.09
Peak Outflow (cfs)	1.77
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	68.14
Max HGL Depth Attained (ft)	3.14
Average HGL Elevation Attained (ft)	67.52
Average HGL Depth Attained (ft)	2.52
Time of Max HGL Occurrence (days hh:mm)	0 12:20
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Project Description

File Name ..... Sagamore_Entire.Site.SPF

Project Options

Flow Units ..... CFS
Elevation Type ..... Elevation
Hydrology Method ..... SCS TR-20
Time of Concentration (TOC) Method ..... SCS TR-55
Link Routing Method ..... Hydrodynamic
Enable Overflow Ponding at Nodes ..... YES
Skip Steady State Analysis Time Periods ..... NO

Analysis Options

Start Analysis On ..... oct. 14, 2021 0:00:00
End Analysis On ..... oct. 17, 2021 0:00:00
Start Reporting On ..... oct. 14, 2021 0:00:00
Antecedent Dry Days ..... 0 days
Runoff (Dry Weather) Time Step ..... 0 01:00:00 days hh:mm:ss
Runoff (Wet Weather) Time Step ..... 0 00:05:00 days hh:mm:ss
Reporting Time Step ..... 0 00:05:00 days hh:mm:ss
Routing Time Step ..... 30 seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	13
Nodes	18
Junctions	0
Outfalls	10
Flow Diversions	0
Inlets	0
Storage Nodes	8
Links	8
Channels	0
Pipes	0
Pumps	0
Orifices	1
Weirs	7
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	50 years	Intensity	inches	Massachusetts	None	50.00	6.70	SCS Type III 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	A1	1.20	484.00	76.00	6.70	3.99	4.79	4.92	0 00:06:00
2	A1-1	0.39	484.00	98.00	6.70	6.46	2.51	2.05	0 00:10:55
3	A1-2	1.34	484.00	54.63	6.70	1.90	2.55	2.53	0 00:06:00
4	A1-3	1.03	484.00	49.00	6.70	1.42	1.45	0.72	0 00:40:16
5	A2	0.92	484.00	76.00	6.70	3.99	3.67	3.77	0 00:06:00
6	A-3	0.25	484.00	51.70	6.70	1.65	0.41	0.23	0 00:36:07
7	DA-Ditch-A1	1.35	484.00	76.00	6.70	3.99	5.39	5.52	0 00:06:00
8	DA-Ditch-A1-2	1.29	484.00	76.00	6.70	3.99	5.15	5.28	0 00:06:00
9	DA-Ditch-A2	0.67	484.00	76.00	6.70	3.99	2.67	2.75	0 00:06:00
10	Existing-E03-1_A1	0.89	484.00	49.00	6.70	1.42	1.26	0.67	0 00:34:49
11	Existing-E-07_A3	0.39	484.00	51.70	6.70	1.65	0.64	0.35	0 00:36:29
12	Existing-E3_A1-2	3.20	484.00	49.00	6.70	1.42	4.54	2.18	0 00:42:52
13	Existing-E5.1_A2	0.26	484.00	49.00	6.70	1.42	0.37	0.27	0 00:14:30

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft²)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Existing-Oufall-E3-1_Weir-B1	Outfall	0.00					0.67	0.00					
2	Existing-Outfall-E3_1	Outfall	0.00					0.00	0.00					
3	Existing-Outfall-E5.1_2	Outfall	0.00					0.27	0.00					
4	Existing-Outfall-E7_3	Outfall	0.00					0.35	0.00					
5	Out-D1	Outfall	0.00					5.40	0.00					
6	Out-D2	Outfall	0.00					2.69	0.00					
7	Out-D3	Outfall	0.00					5.17	0.00					
8	Proposed-Outfall.1	Outfall	0.00					0.00	0.00					
9	Proposed-Outfall.2	Outfall	60.00					0.00	60.00					
10	Proposed-Outfall.3	Outfall	0.00					0.22	0.00					
11	A1-1-BASIN	Storage Node	66.00	69.00	66.00		0.00	1.99	68.49				0.00	0.00
12	BASIN-1	Storage Node	63.00	69.00	63.00		0.00	4.96	68.26				0.00	0.00
13	BASIN-2	Storage Node	63.00	67.00	63.00		0.00	3.04	65.70				0.00	0.00
14	Exist-Catch-Basin	Storage Node	43.00	53.00	43.00		0.00	2.17	46.83				0.00	0.00
15	Existing-Catch-Basin	Storage Node	43.00	53.00	43.00		0.00	2.48	46.53				0.00	0.00
16	FOREBAY-1	Storage Node	66.00	70.00	66.00		0.00	5.12	68.31				0.00	0.00
17	FOREBAY-1-2	Storage Node	62.00	66.00	62.00		0.00	2.35	63.45				0.00	0.00
18	FOREBAY-2	Storage Node	65.00	69.00	65.00		0.00	3.69	68.20				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length (ft)	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Average Slope (%)	Diameter or Height (ft)	Manning's Roughness	Peak Flow (cfs)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Reported Condition
1	12RCP	Orifice	A1-1-BASIN	FOREBAY-1		66.00	66.00		1.000		0.95							
2	Exist-Catch-Basin-Weir	Weir	Exist-Catch-Basin	Existing-Outfall-E3_1		43.00	0.00				0.00							
3	Existing-Catch-Basin-Weir	Weir	Existing-Catch-Basin	Proposed-Outfall.1		43.00	0.00				0.00							
4	Weir-B1	Weir	BASIN-1	FOREBAY-1-2		63.00	62.00				0.00							
5	Weir-B2	Weir	BASIN-2	Proposed-Outfall.2		63.00	60.00				0.00							
6	Weir-F1	Weir	FOREBAY-1	BASIN-1		66.00	63.00				4.98							
7	Weir-F1-2	Weir	FOREBAY-1-2	Existing-Catch-Basin		62.00	43.00				2.33							
8	Weir-F2	Weir	FOREBAY-2	BASIN-2		65.00	63.00				3.04							

Subbasin Hydrology

Subbasin : A1

Input Data

Area (ac) 1.2
Peak Rate Factor 484
Weighted Curve Number 76
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	1.2	A	76
Composite Area & Weighted CN	1.2		76

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft^2)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	300	0	0
Slope (%) :	1.51	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	1.23	0	0
Computed Flow Time (min) :	4.05	0	0

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	20.6	0	0
Slope (%) :	1.86	0	0
Surface Type :	Unpaved	Unpaved	Unpaved
Velocity (ft/sec) :	2.2	0	0
Computed Flow Time (min) :	0.16	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	99.64	0	0
Channel Slope (%) :	0.5	0	0
Cross Section Area (ft^2) :	29.79	0	0
Wetted Perimeter (ft) :	20.98	0	0
Velocity (ft/sec) :	4.44	0	0
Computed Flow Time (min) :	0.37	0	0

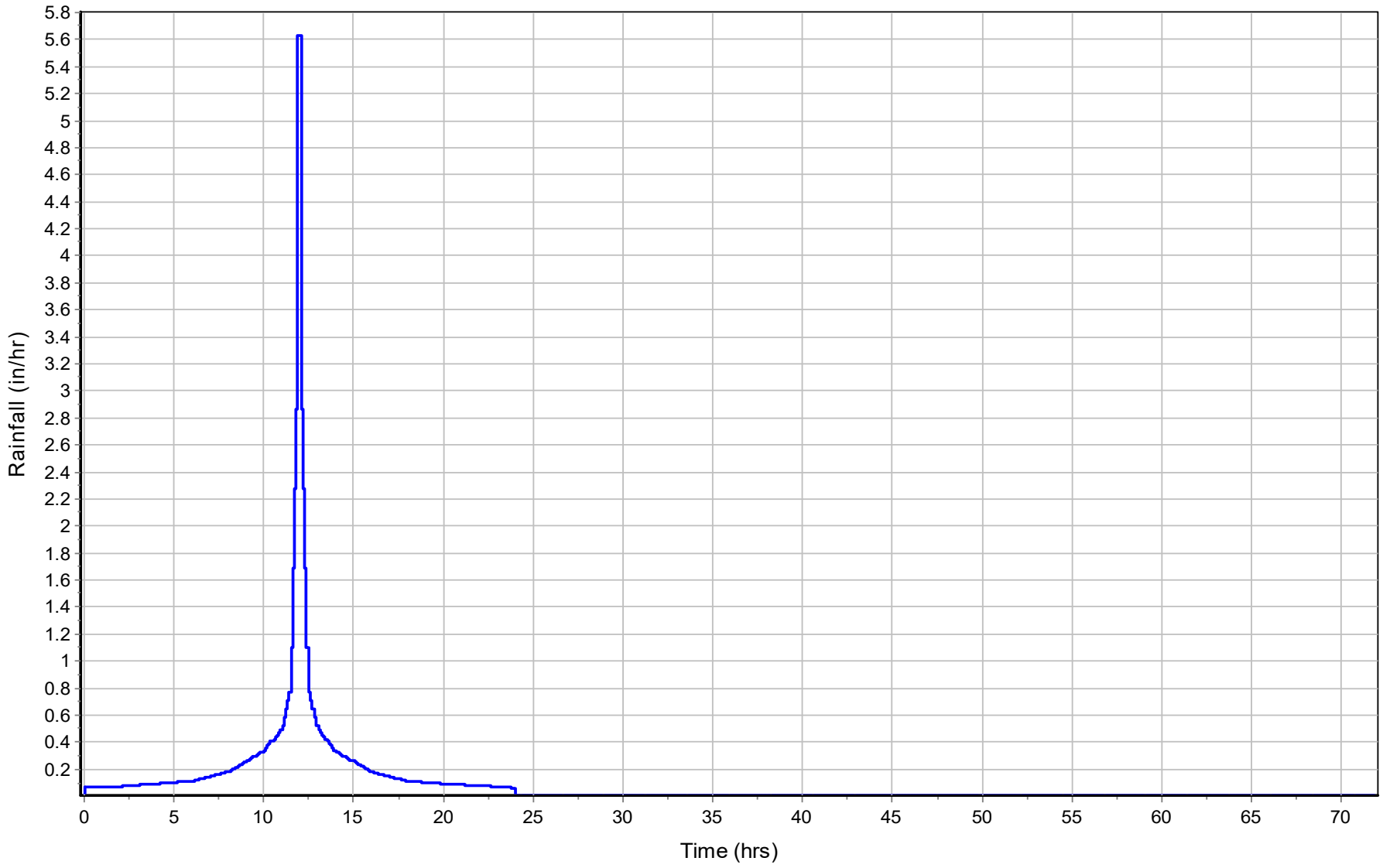
Total TOC (min) 4.58

Subbasin Runoff Results

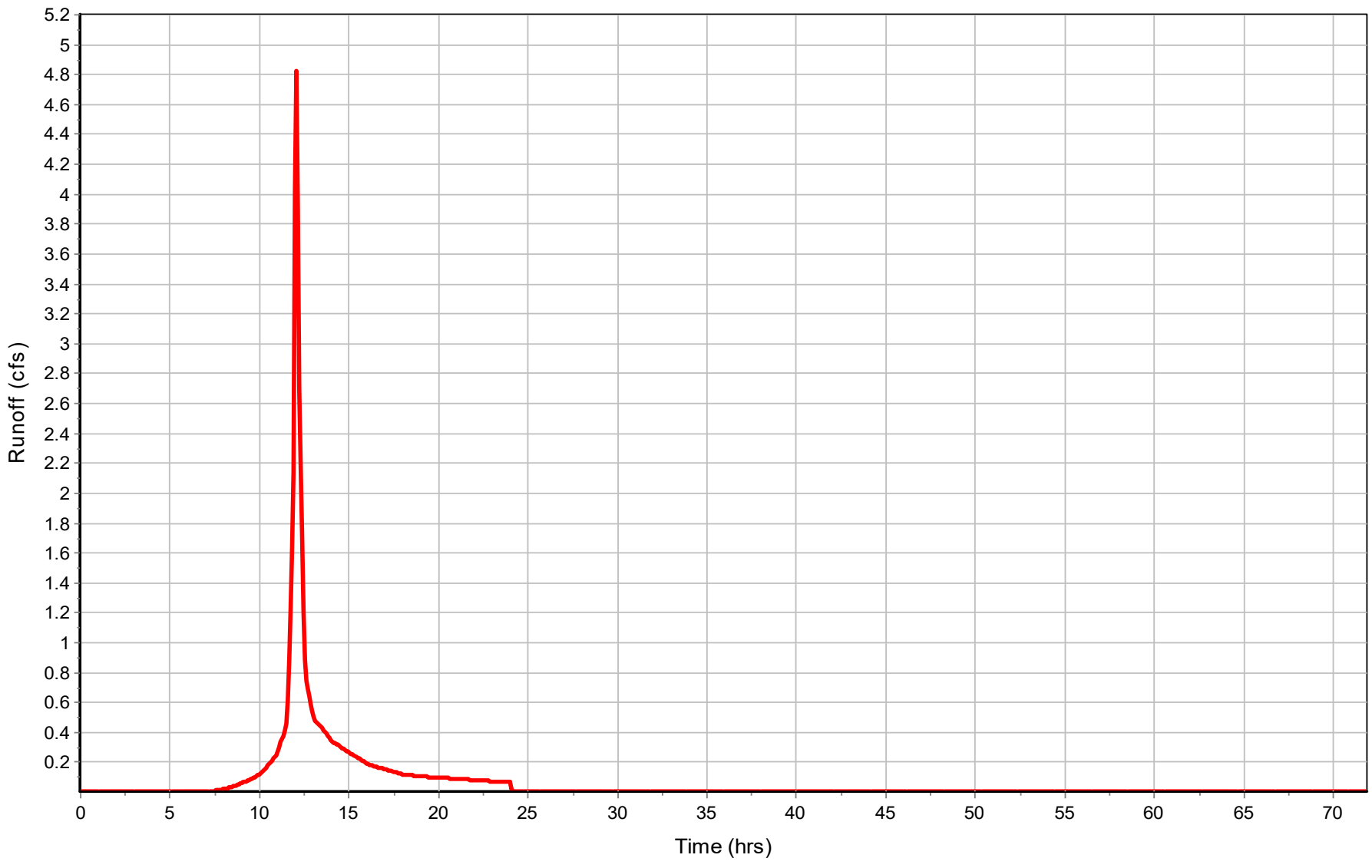
Total Rainfall (in) 6.7
Total Runoff (in) 3.99
Peak Runoff (cfs) 4.92
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:04:35

Subbasin : A1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : A1-1

Input Data

Area (ac) 0.39
Peak Rate Factor 484
Weighted Curve Number 98
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Paved parking & roofs	0.39	A	98
Composite Area & Weighted CN	0.39		98

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.05	0	0
Flow Length (ft) :	178.81	0	0
Slope (%) :	0.5	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.27	0	0
Computed Flow Time (min) :	10.92	0	0

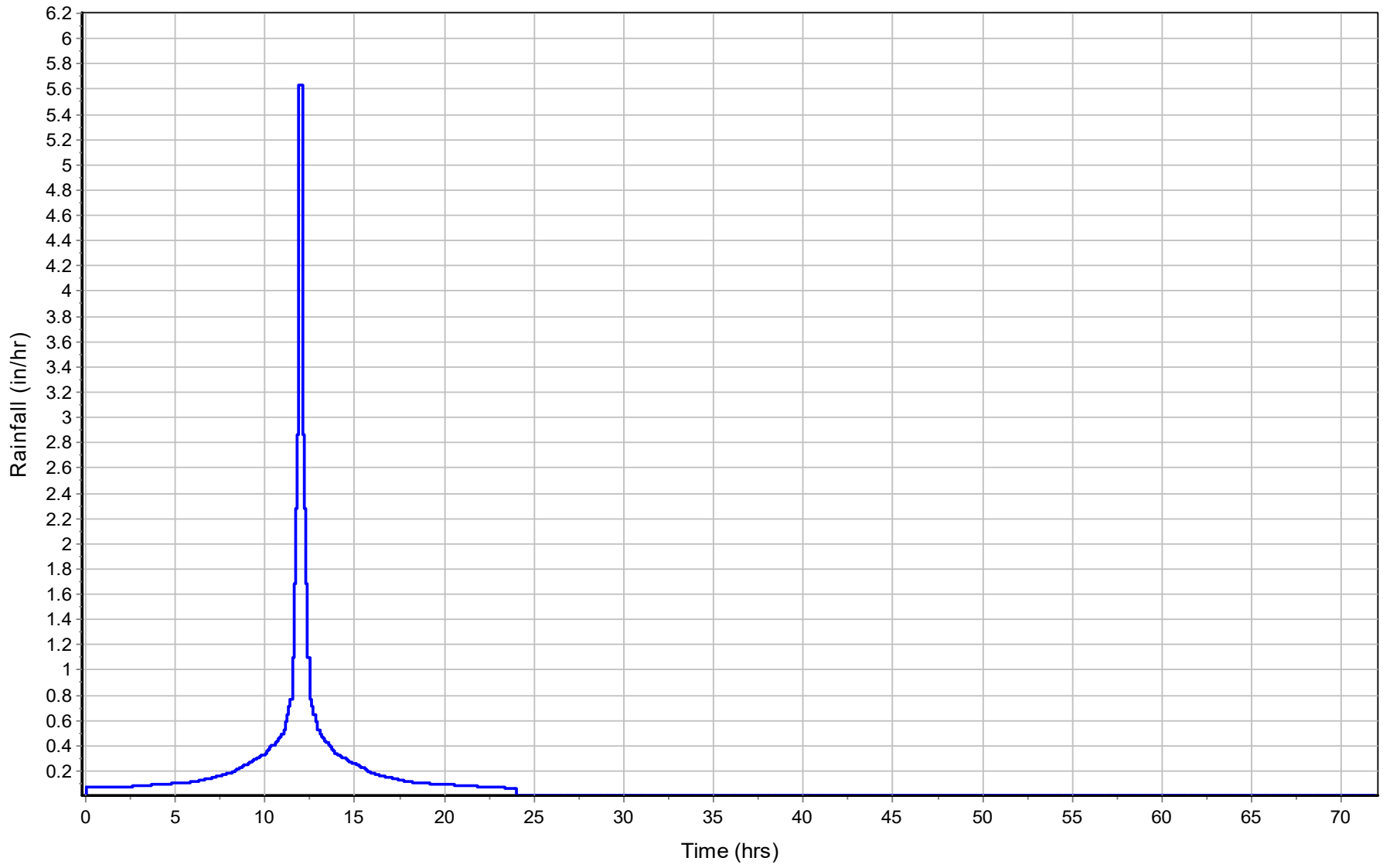
Total TOC (min) 10.92

Subbasin Runoff Results

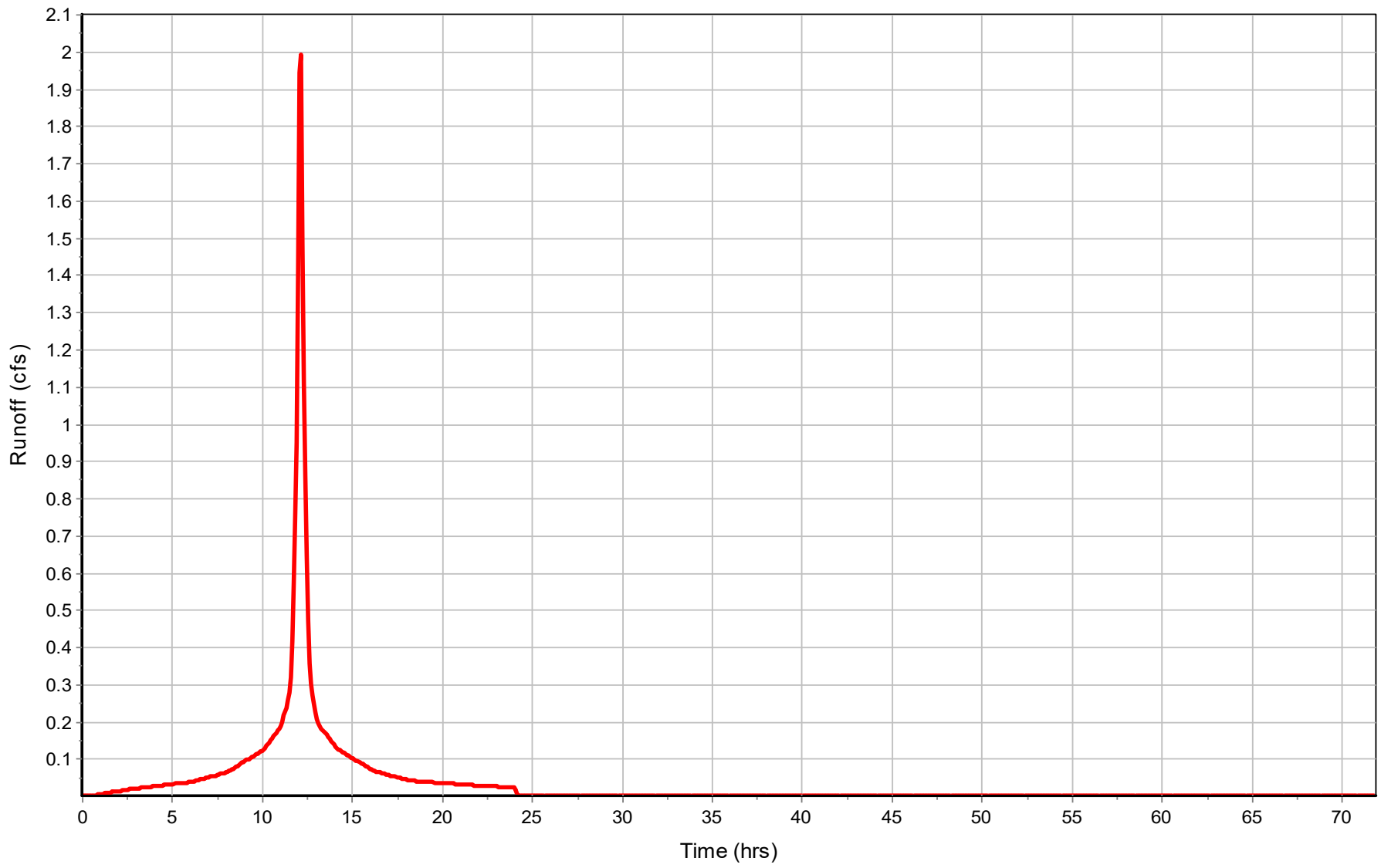
Total Rainfall (in) 6.7
Total Runoff (in) 6.46
Peak Runoff (cfs) 2.05
Weighted Curve Number 98
Time of Concentration (days hh:mm:ss) 0 00:10:55

Subbasin : A1-1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : A1-2

Input Data

Area (ac) 1.34
Peak Rate Factor 484
Weighted Curve Number 54.63
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	0.28	A	76
-	1.06	-	49
Composite Area & Weighted CN	1.34		54.63

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	131.55	0	0
Slope (%) :	4	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	1.54	0	0
Computed Flow Time (min) :	1.42	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	358.95	0	0
Channel Slope (%) :	0.3	0	0
Cross Section Area (ft^2) :	13.52	0	0
Wetted Perimeter (ft) :	11.63	0	0
Velocity (ft/sec) :	3.01	0	0
Computed Flow Time (min) :	1.99	0	0

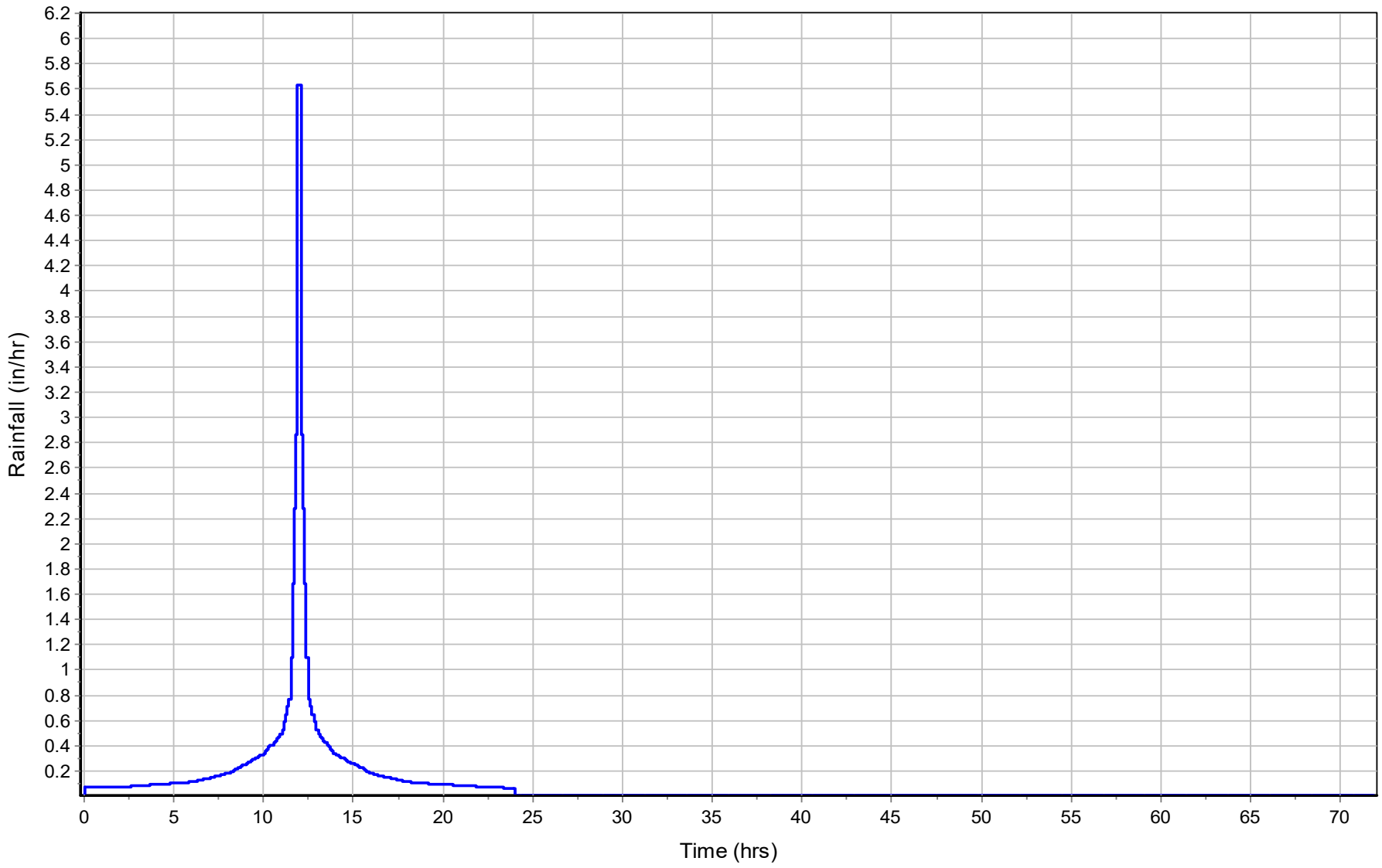
Total TOC (min) 3.41

Subbasin Runoff Results

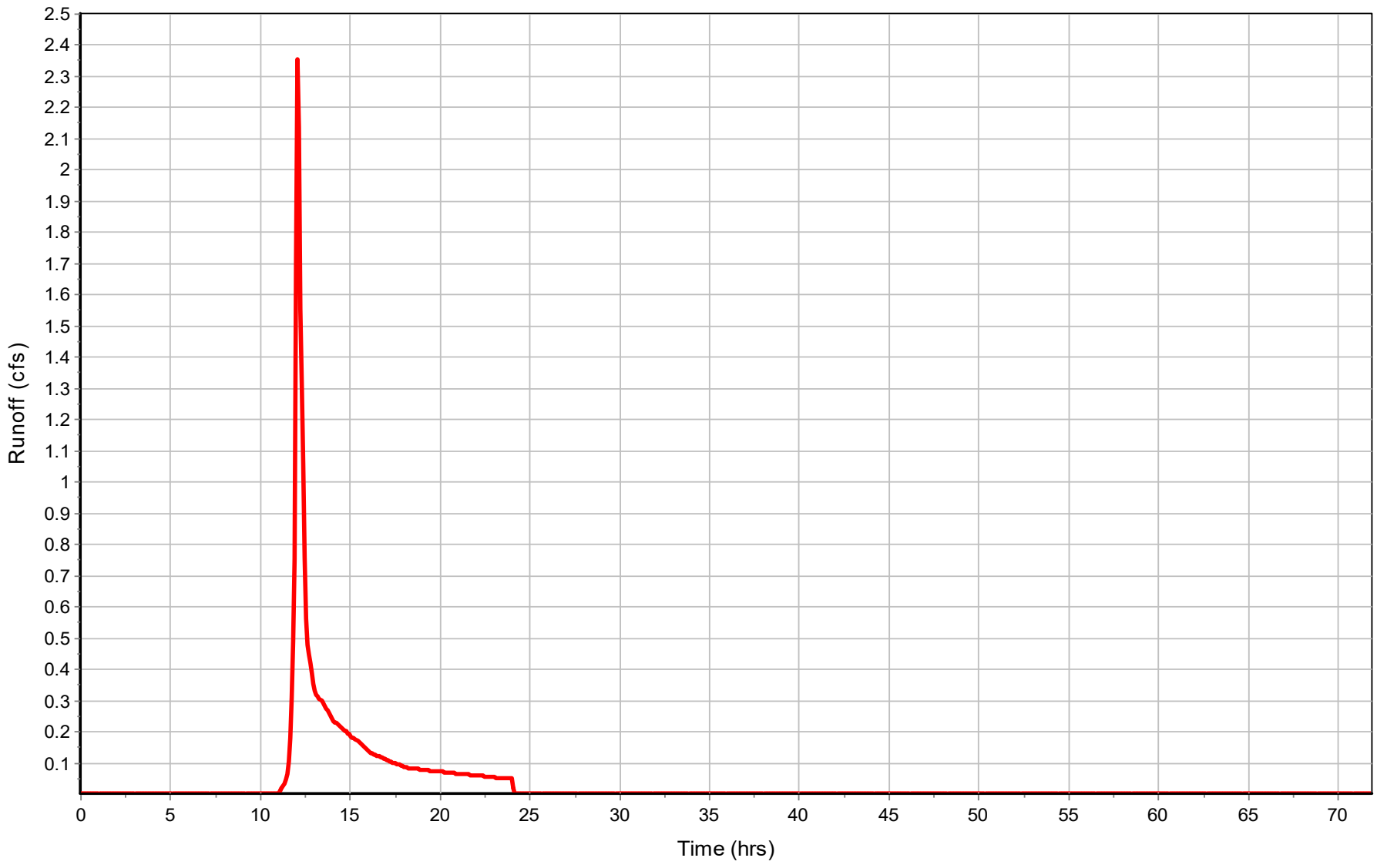
Total Rainfall (in) 6.7
Total Runoff (in) 1.9
Peak Runoff (cfs) 2.53
Weighted Curve Number 54.63
Time of Concentration (days hh:mm:ss) 0 00:03:25

Subbasin : A1-2

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : A1-3

Input Data

Area (ac) 1.03
Peak Rate Factor 484
Weighted Curve Number 49
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	1.03	A	49
Composite Area & Weighted CN	1.03		49

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.4	0	0
Flow Length (ft) :	300	0	0
Slope (%) :	4	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.13	0	0
Computed Flow Time (min) :	37.97	0	0

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	13.33	0	0
Slope (%) :	4	0	0
Surface Type :	Grassed waterway	Unpaved	Unpaved
Velocity (ft/sec) :	3	0	0
Computed Flow Time (min) :	0.07	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	403.18	0	0
Channel Slope (%) :	0.3	0	0
Cross Section Area (ft^2) :	13.52	0	0
Wetted Perimeter (ft) :	11.63	0	0
Velocity (ft/sec) :	3.01	0	0
Computed Flow Time (min) :	2.23	0	0

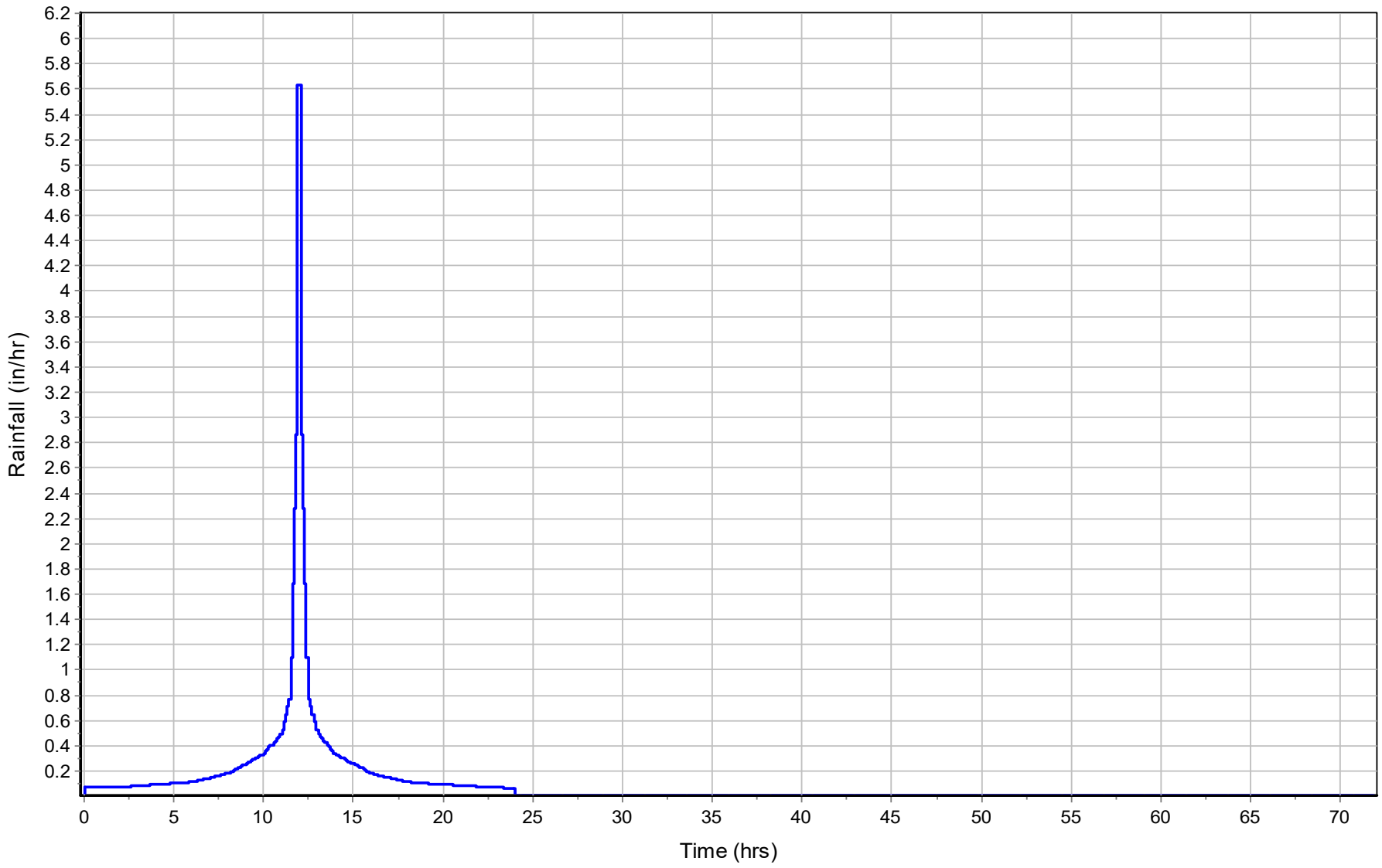
Total TOC (min) 40.27

Subbasin Runoff Results

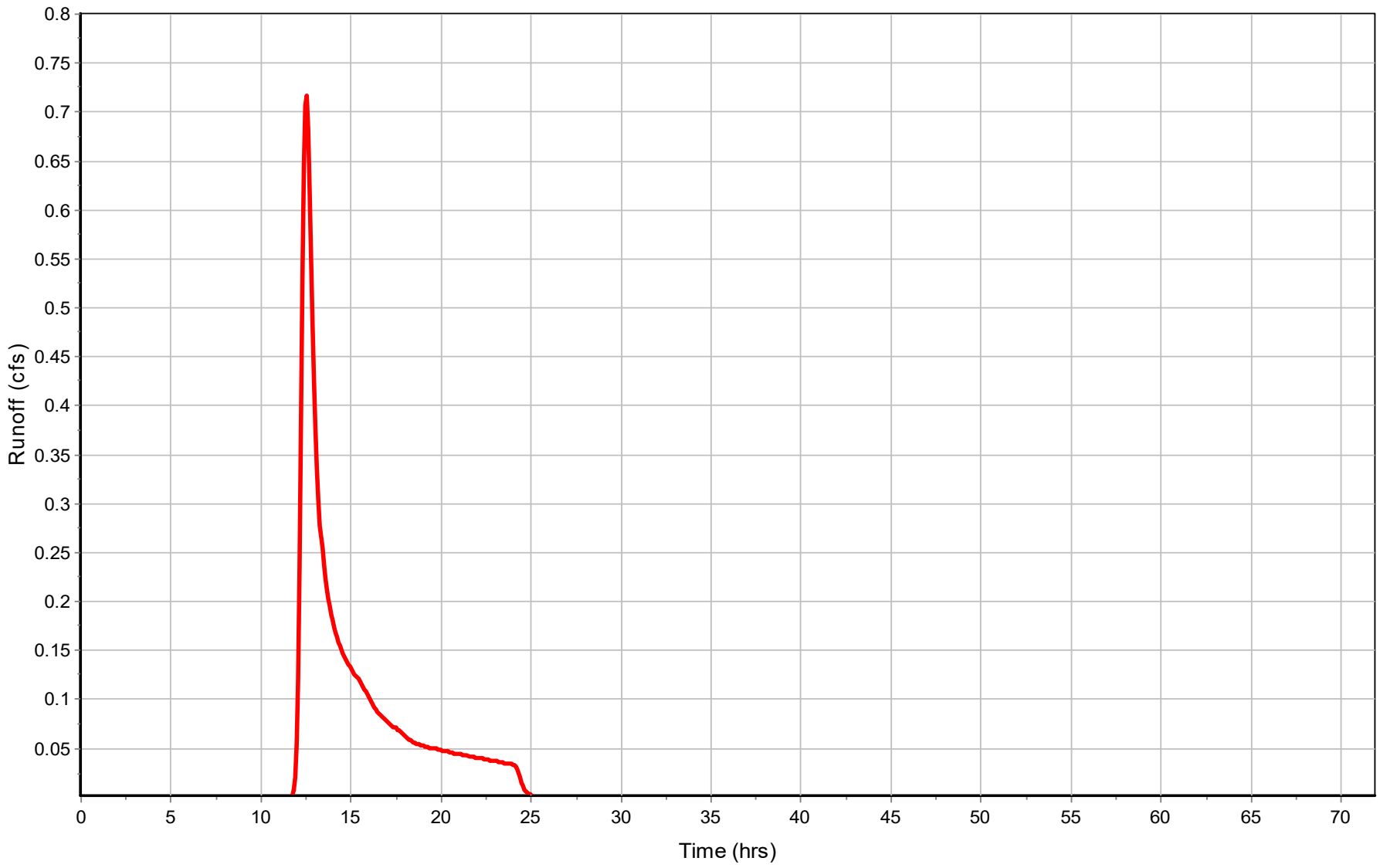
Total Rainfall (in) 6.7
Total Runoff (in) 1.42
Peak Runoff (cfs) 0.72
Weighted Curve Number 49
Time of Concentration (days hh:mm:ss) 0 00:40:16

Subbasin : A1-3

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : A2

Input Data

Area (ac) 0.92
Peak Rate Factor 484
Weighted Curve Number 76
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	0.92	A	76
Composite Area & Weighted CN	0.92		76

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	85.5	0	0
Slope (%) :	1.5	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.96	0	0
Computed Flow Time (min) :	1.49	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	255.68	0	0
Channel Slope (%) :	1.17	0	0
Cross Section Area (ft^2) :	1.475	0	0
Wetted Perimeter (ft) :	5.99	0	0
Velocity (ft/sec) :	2.11	0	0
Computed Flow Time (min) :	2.02	0	0

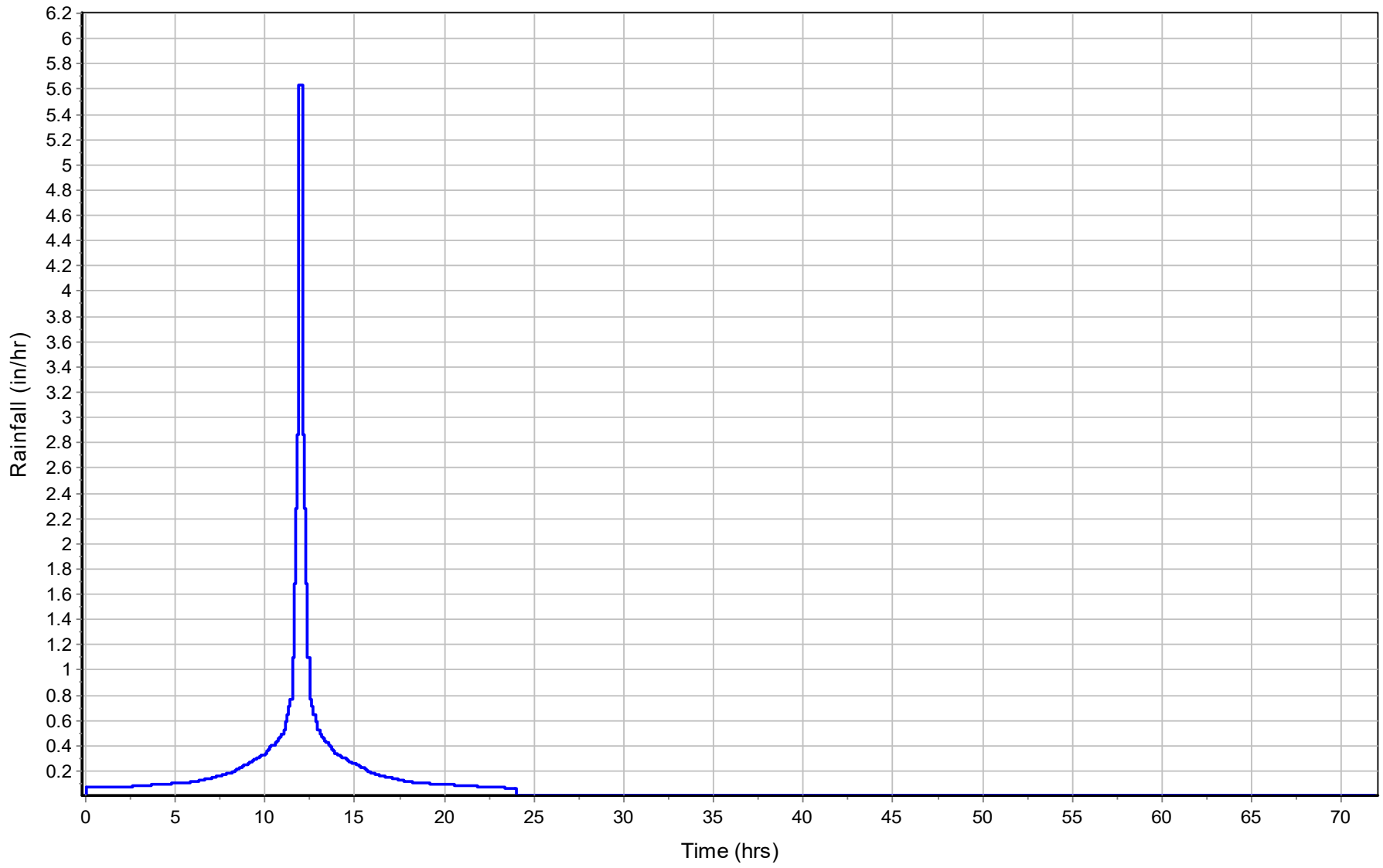
Total TOC (min) 3.51

Subbasin Runoff Results

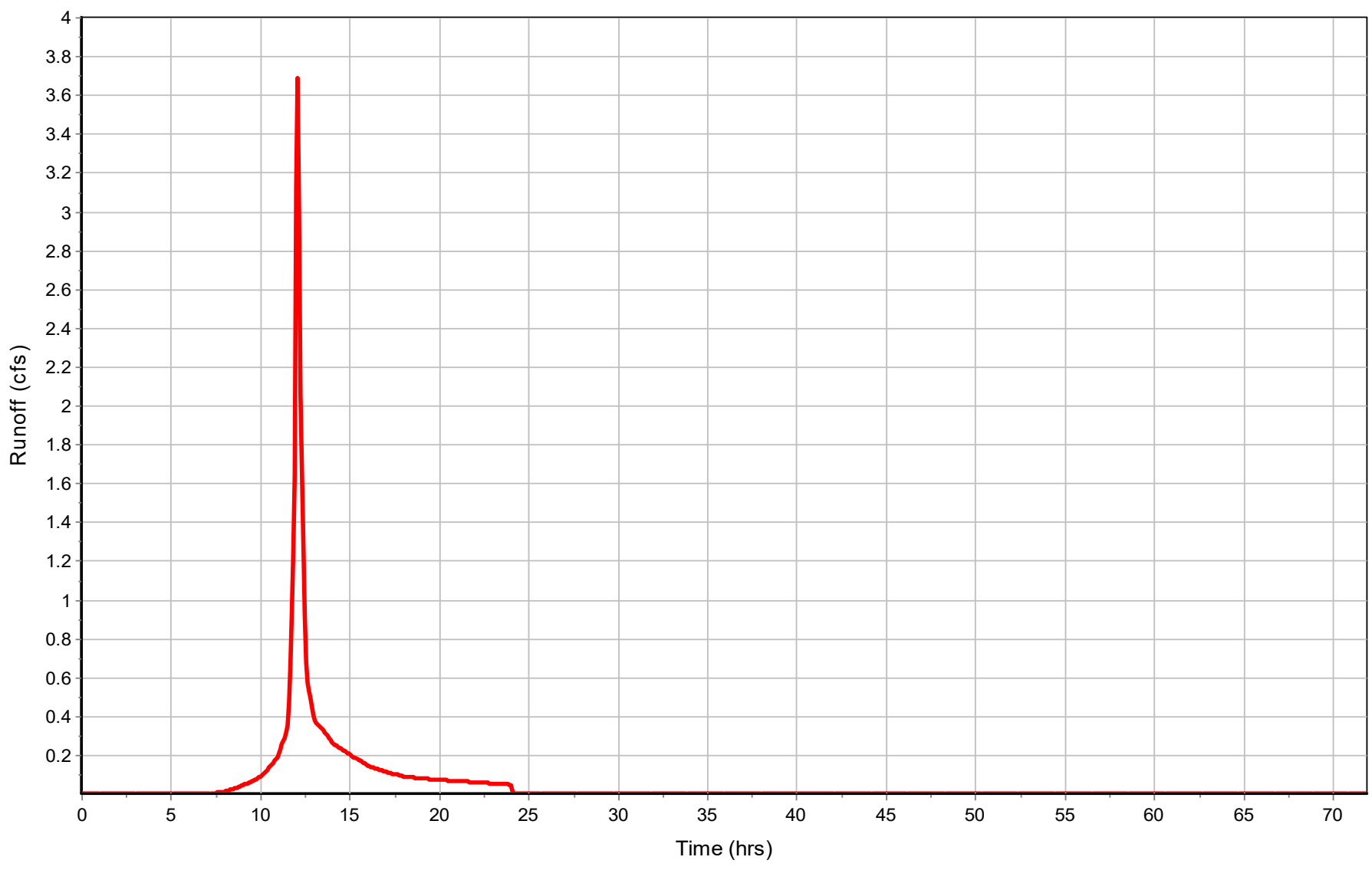
Total Rainfall (in) 6.7
Total Runoff (in) 3.99
Peak Runoff (cfs) 3.77
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:03:31

Subbasin : A2

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : A-3

Input Data

Area (ac) 0.25
Peak Rate Factor 484
Weighted Curve Number 51.7
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
-	0.23	-	49
-	0.03	-	76
Composite Area & Weighted CN	0.26		51.7

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.4	0	0
Flow Length (ft) :	300	0	0
Slope (%) :	5	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.14	0	0
Computed Flow Time (min) :	34.72	0	0

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	83.1895	0	0
Slope (%) :	2	0	0
Surface Type :	Grass pasture	Unpaved	Unpaved
Velocity (ft/sec) :	0.99	0	0
Computed Flow Time (min) :	1.4	0	0

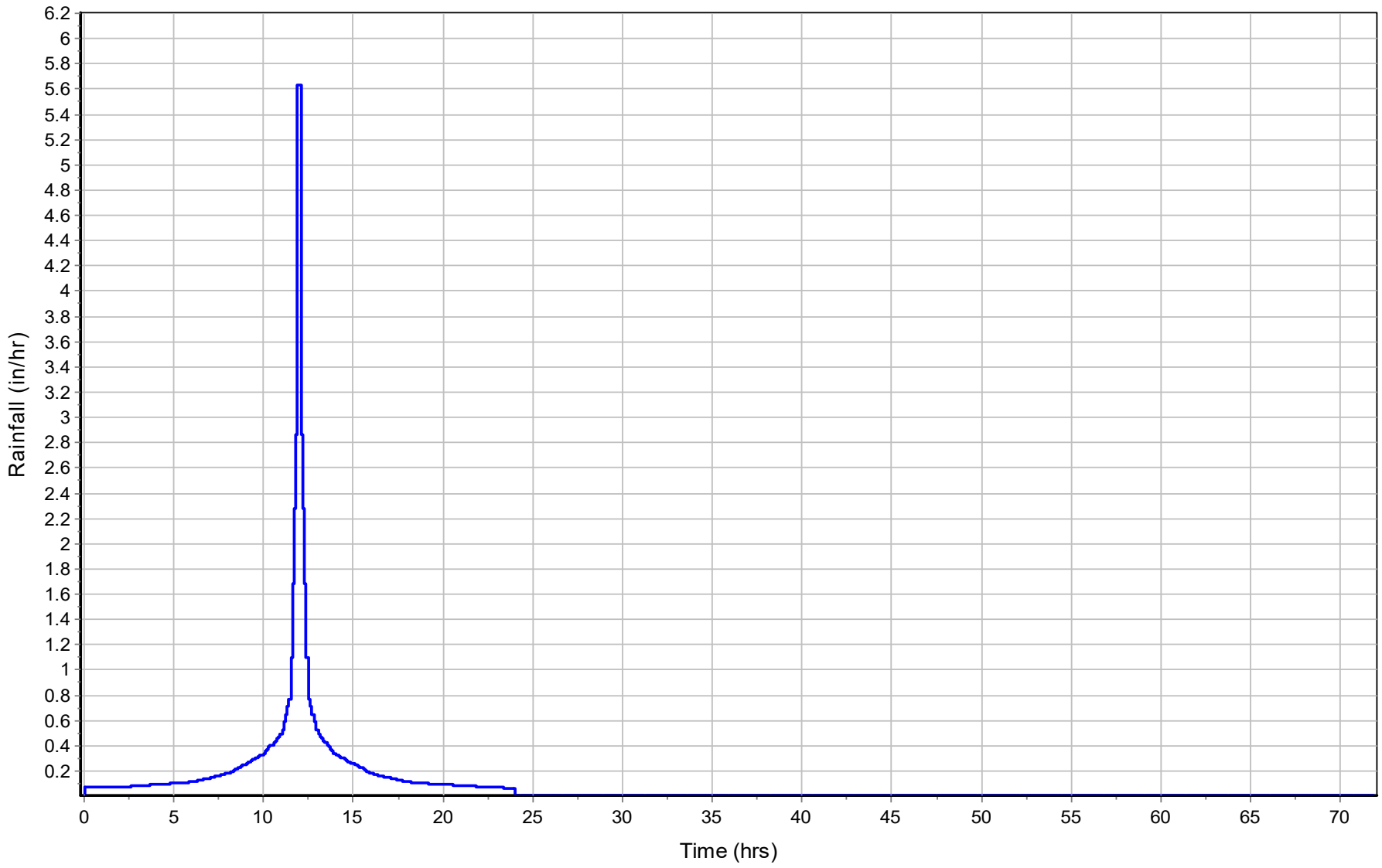
Total TOC (min) 36.12

Subbasin Runoff Results

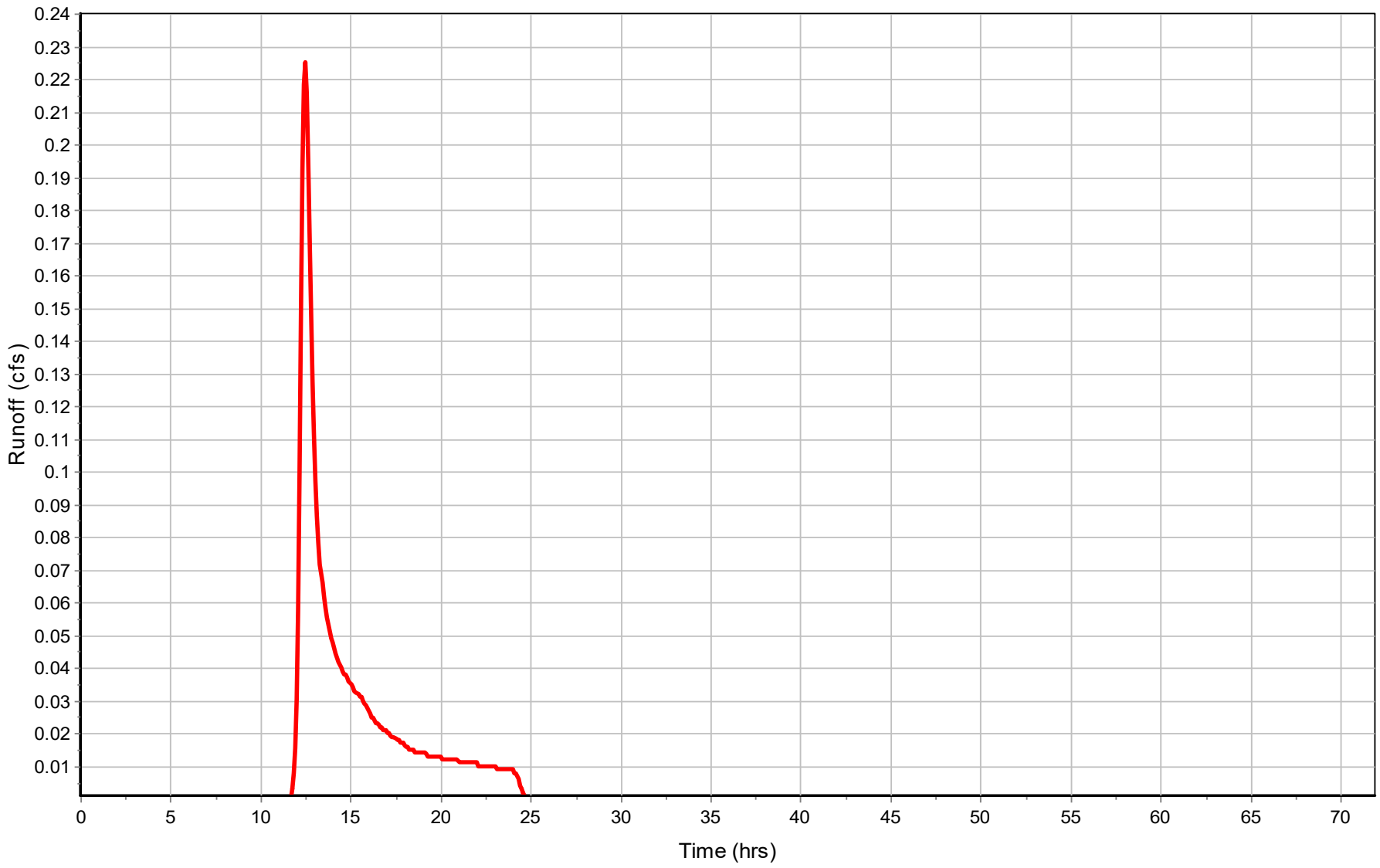
Total Rainfall (in) 6.7
Total Runoff (in) 1.65
Peak Runoff (cfs) 0.23
Weighted Curve Number 51.7
Time of Concentration (days hh:mm:ss) 0 00:36:07

Subbasin : A-3

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : DA-Ditch-A1

Input Data

Area (ac) 1.35
Peak Rate Factor 484
Weighted Curve Number 76
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
50 - 75% grass cover, Fair	1.35	A	76
Composite Area & Weighted CN	1.35		76

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	217.17	0	0
Slope (%) :	1.5	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	1.15	0	0
Computed Flow Time (min) :	3.14	0	0

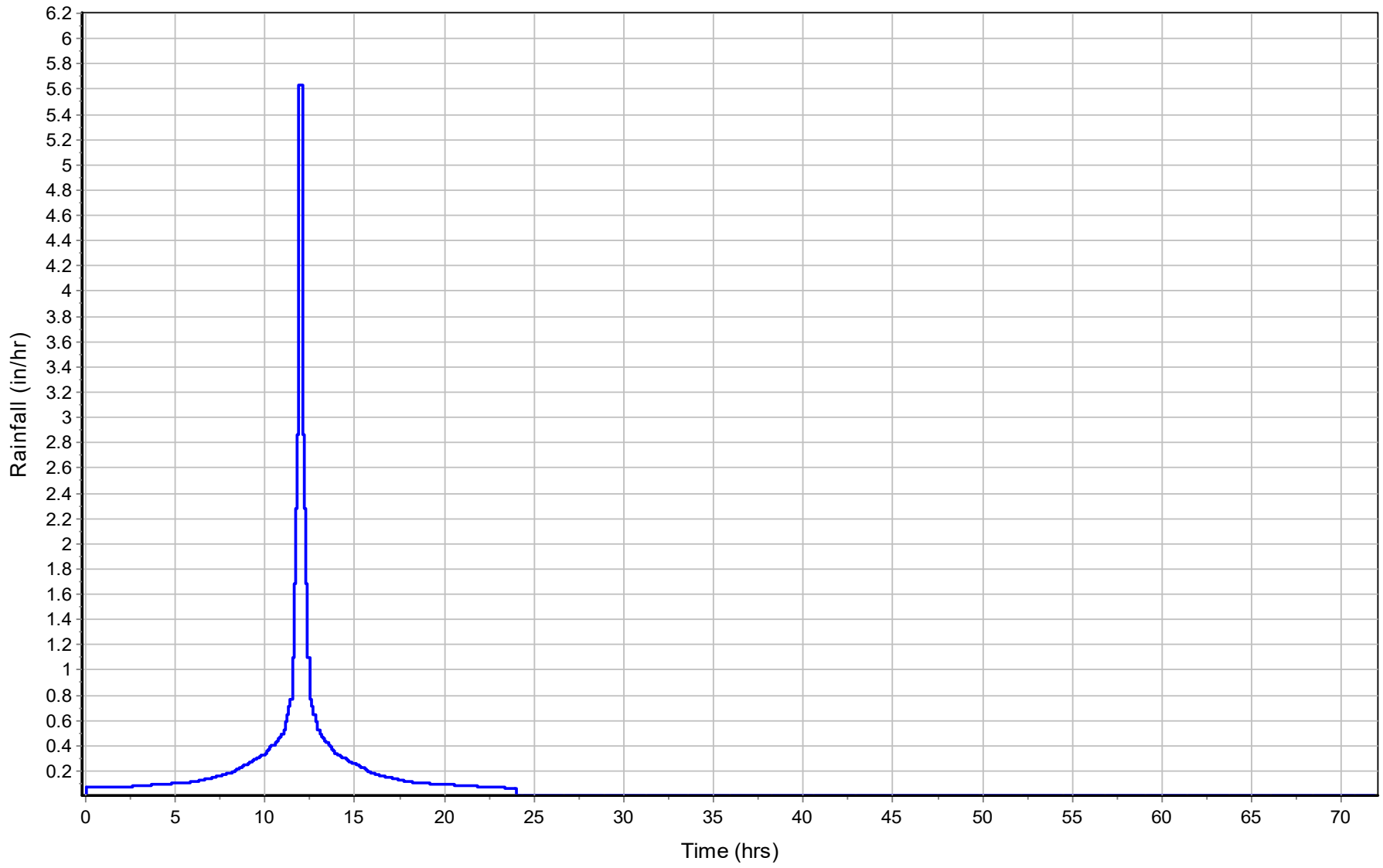
Total TOC (min) 3.14

Subbasin Runoff Results

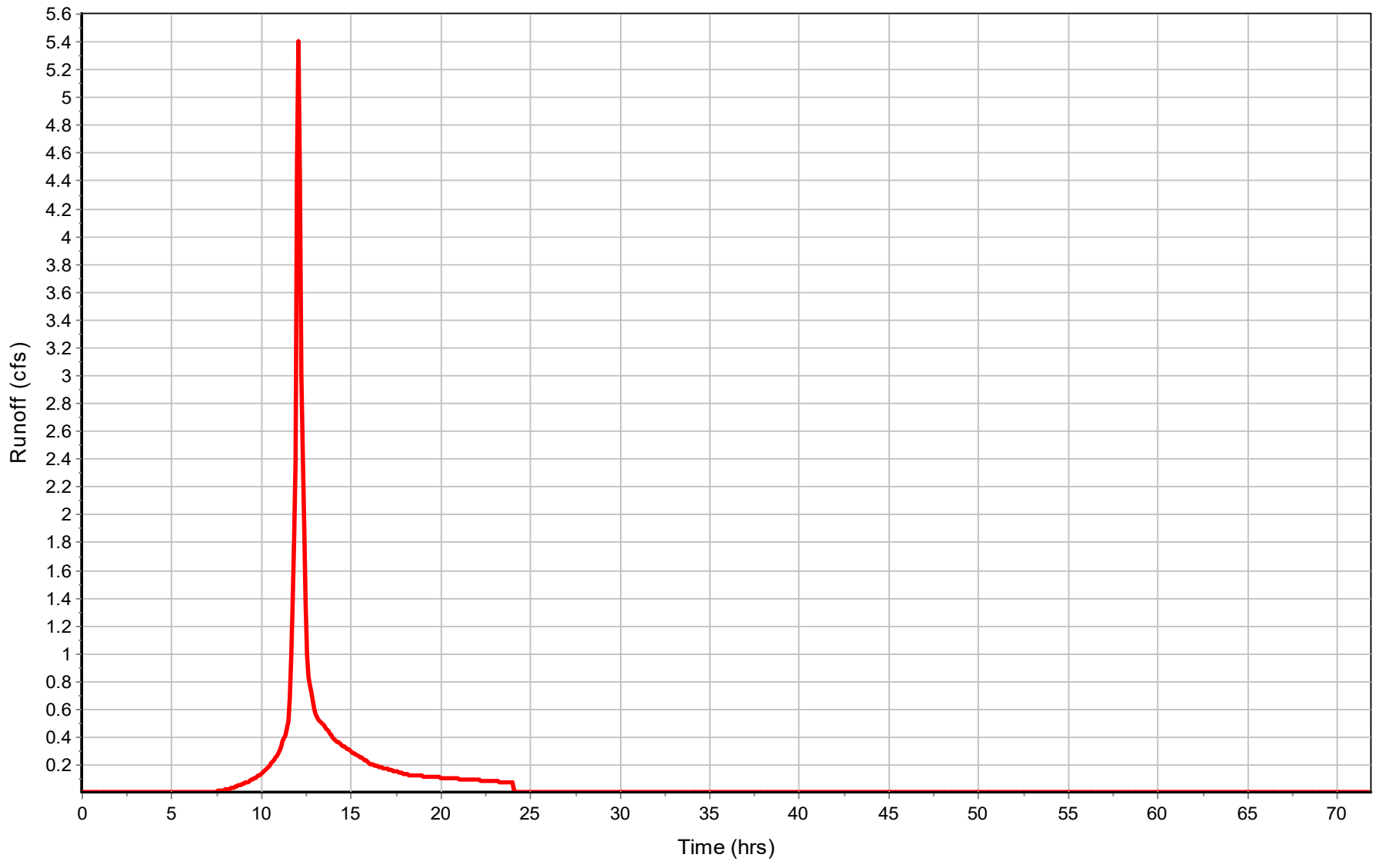
Total Rainfall (in) 6.7
Total Runoff (in) 3.99
Peak Runoff (cfs) 5.52
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:03:08

Subbasin : DA-Ditch-A1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : DA-Ditch-A1-2

Input Data

Area (ac) 1.29
Peak Rate Factor 484
Weighted Curve Number 76
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
50 - 75% grass cover, Fair	1.29	A	76
Composite Area & Weighted CN	1.29		76

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	131.55	0	0
Slope (%) :	1.5	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	1.04	0	0
Computed Flow Time (min) :	2.1	0	0

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	7.88	0	0
Slope (%) :	1.5	0	0
Surface Type :	Unpaved	Unpaved	Unpaved
Velocity (ft/sec) :	1.98	0	0
Computed Flow Time (min) :	0.07	0	0

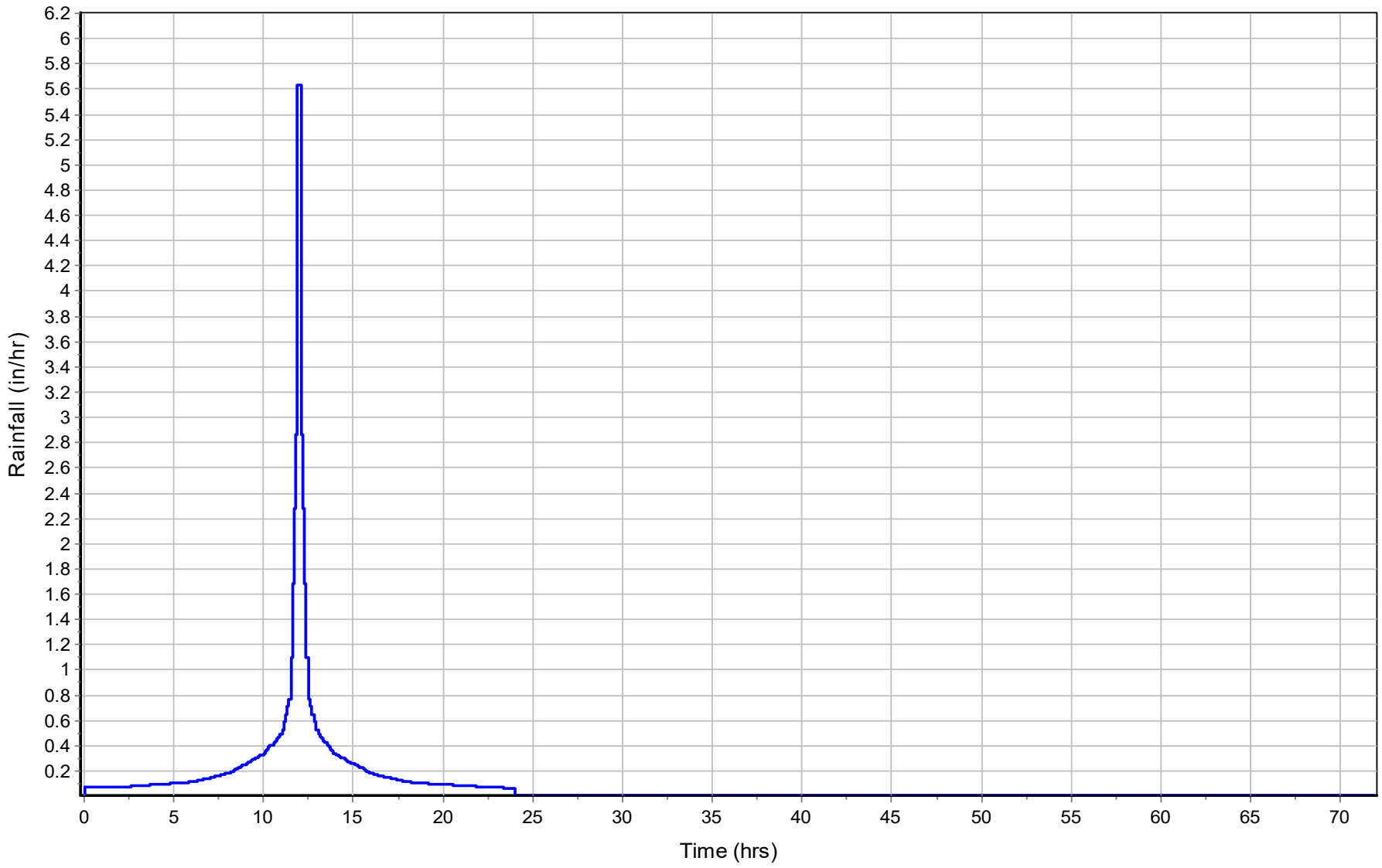
Total TOC (min) 2.17

Subbasin Runoff Results

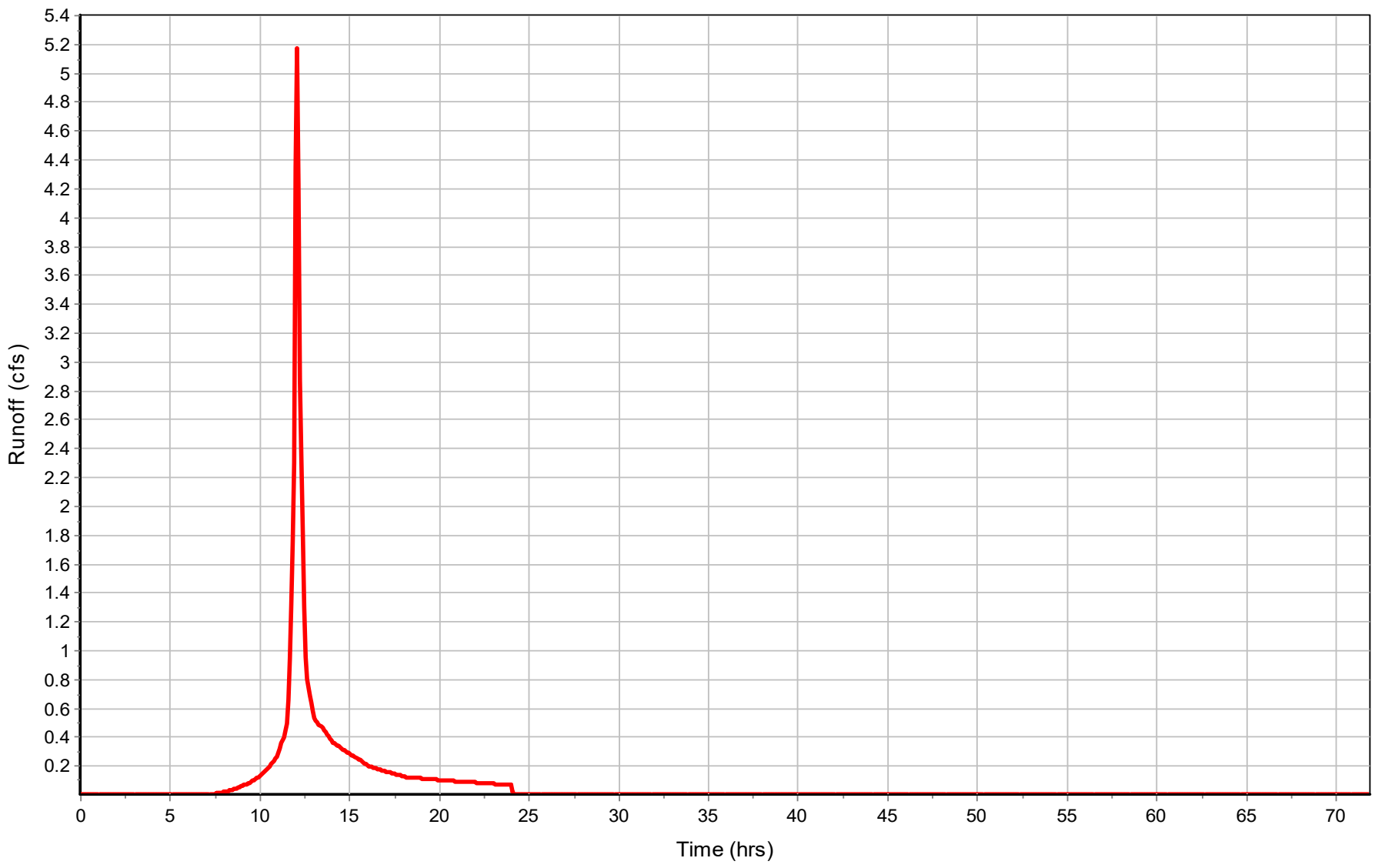
Total Rainfall (in) 6.7
Total Runoff (in) 3.99
Peak Runoff (cfs) 5.28
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:02:10

Subbasin : DA-Ditch-A1-2

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : DA-Ditch-A2

Input Data

Area (ac)	0.67
Peak Rate Factor	484
Weighted Curve Number	76
Rain Gage ID	Rain Gage-01

Composite Curve Number

32

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
50 - 75% grass cover, Fair	0.67	A	76
Composite Area & Weighted CN	0.67		76

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	300	0	0
Slope (%) :	1.5	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	1.23	0	0
Computed Flow Time (min) :	4.06	0	0

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	7.88	0	0
Slope (%) :	1.5	0	0
Surface Type :	Unpaved	Unpaved	Unpaved
Velocity (ft/sec) :	1.98	0	0
Computed Flow Time (min) :	0.07	0	0

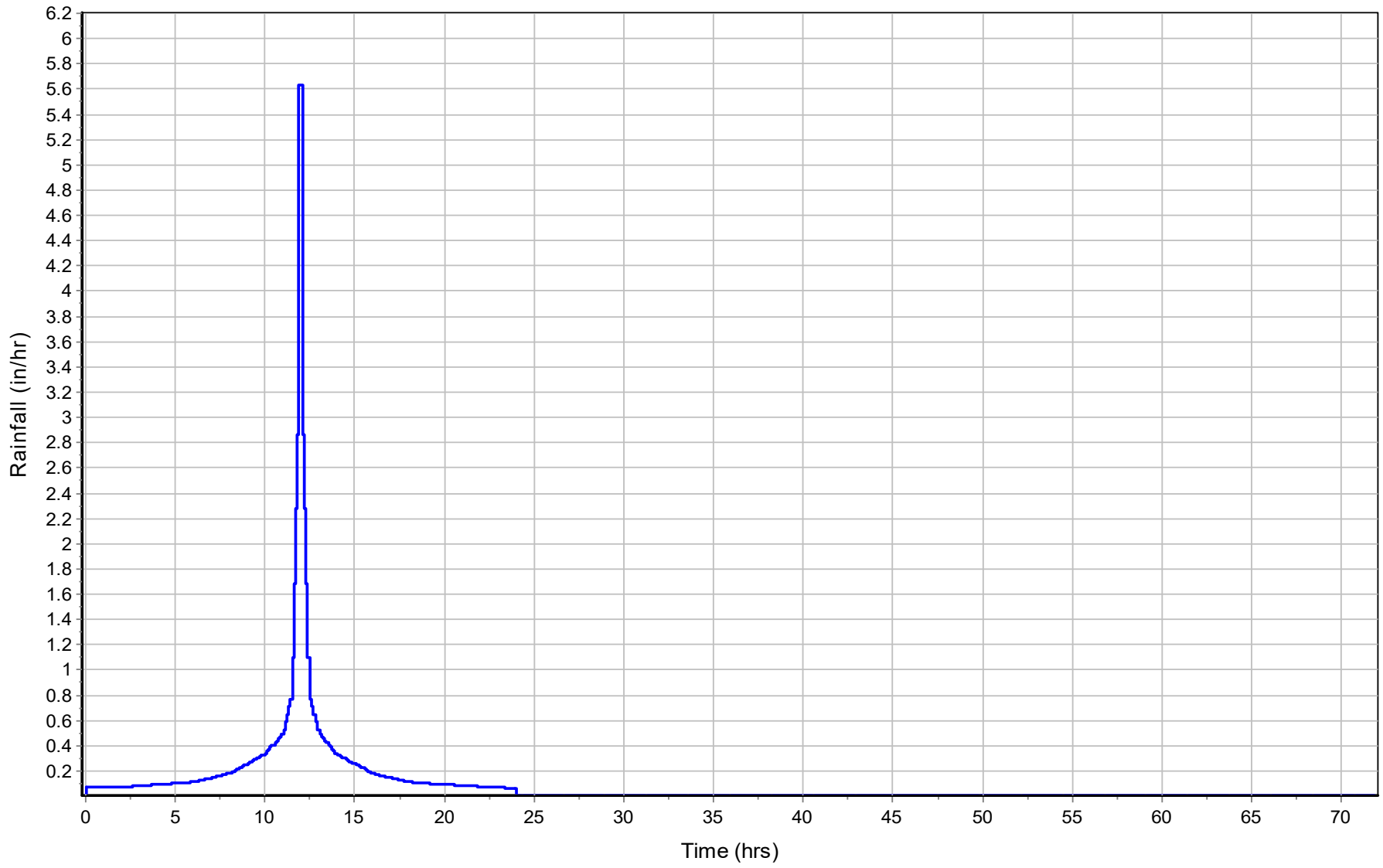
Total TOC (min) 4.13

Subbasin Runoff Results

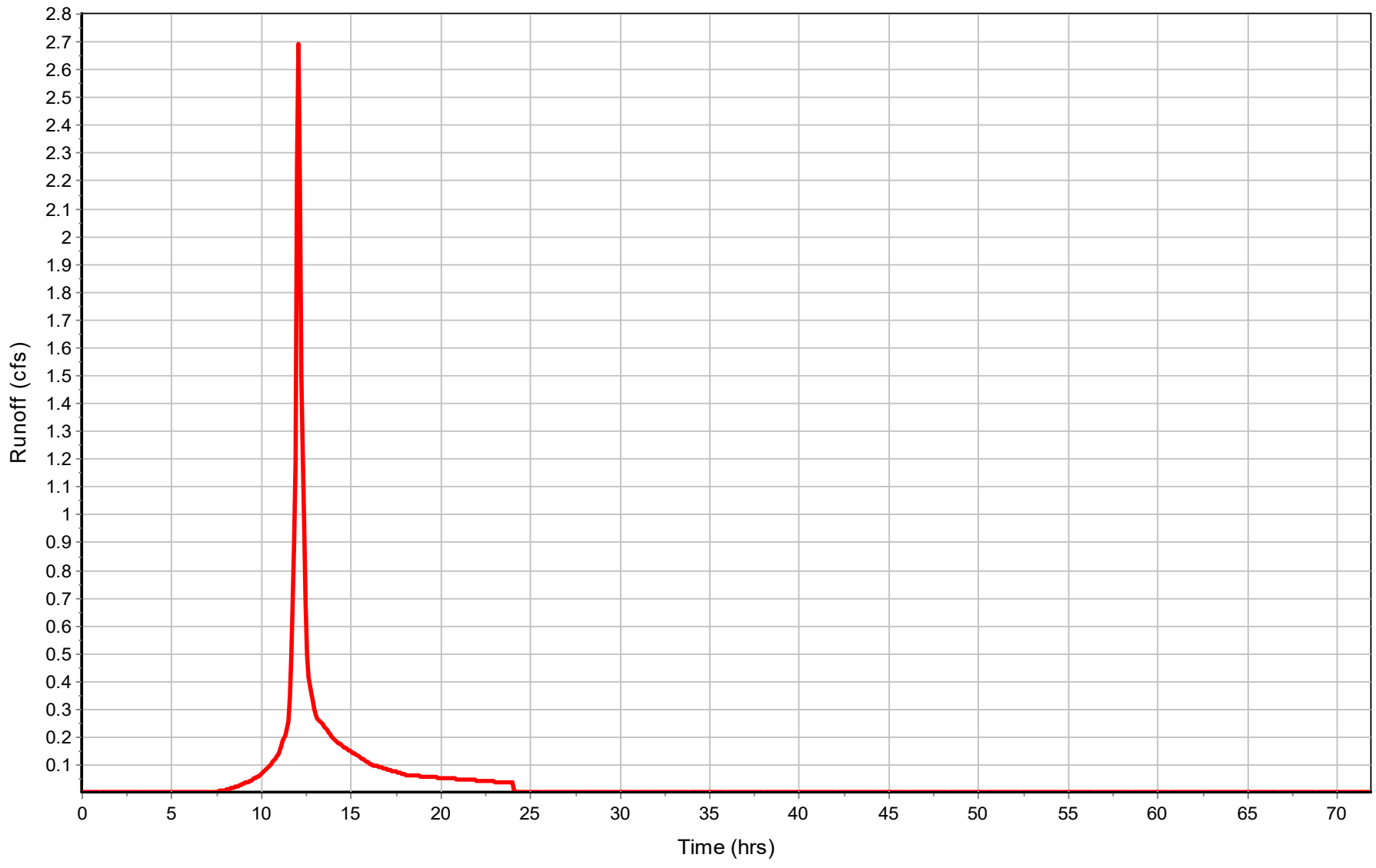
Total Rainfall (in)	6.7
Total Runoff (in)	3.99
Peak Runoff (cfs)	2.75
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:04:08

Subbasin : DA-Ditch-A2

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Existing-E03-1_A1

Input Data

Area (ac)	0.89
Peak Rate Factor	484
Weighted Curve Number	49
Rain Gage ID	Rain Gage-01

Composite Curve Number

32

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
50 - 75% grass cover, Fair	0.89	A	49
Composite Area & Weighted CN	0.89		49

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.4	0	0
Flow Length (ft) :	251.94	0	0
Slope (%) :	3.5	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.12	0	0
Computed Flow Time (min) :	34.83	0	0

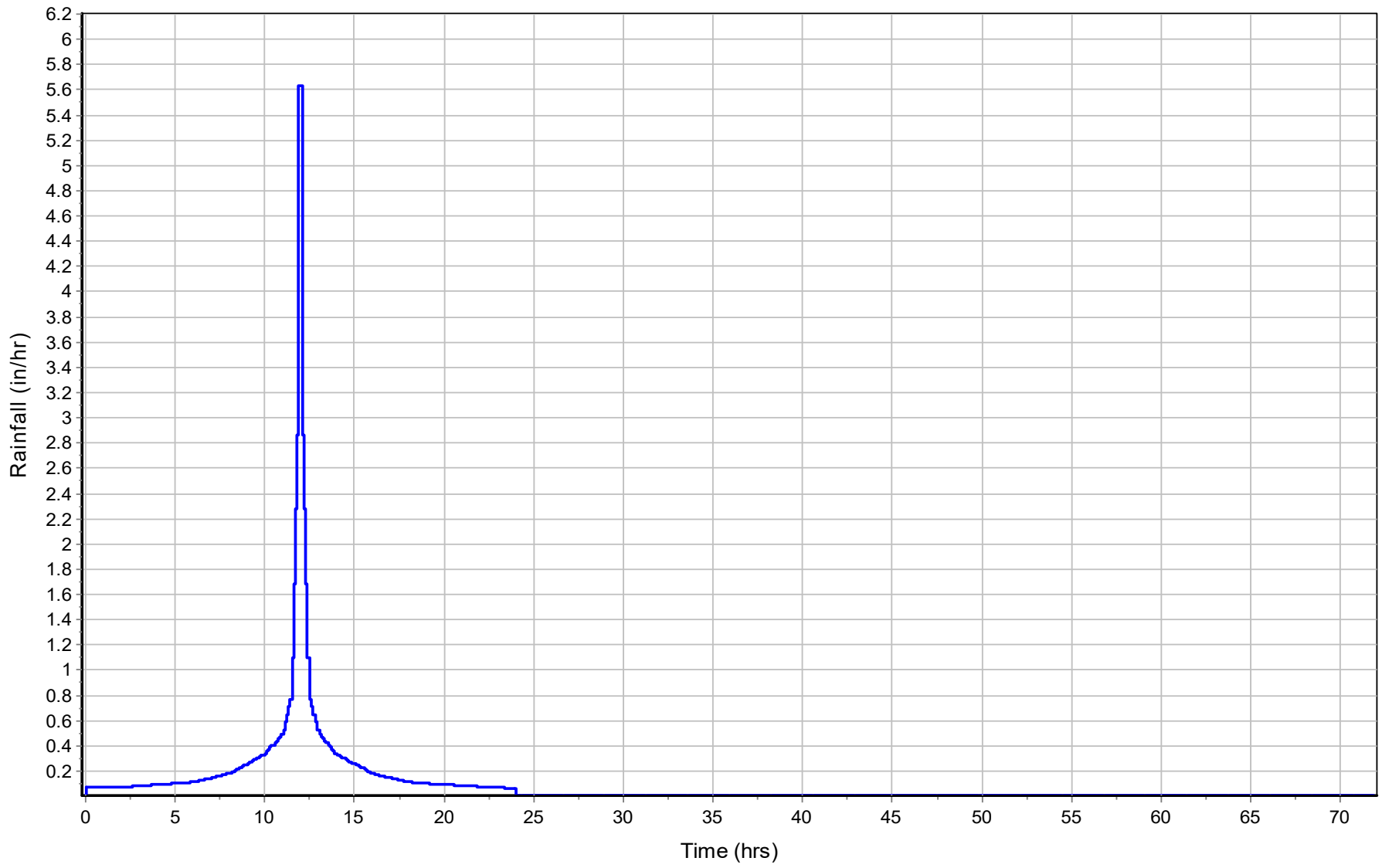
Total TOC (min) 34.83

Subbasin Runoff Results

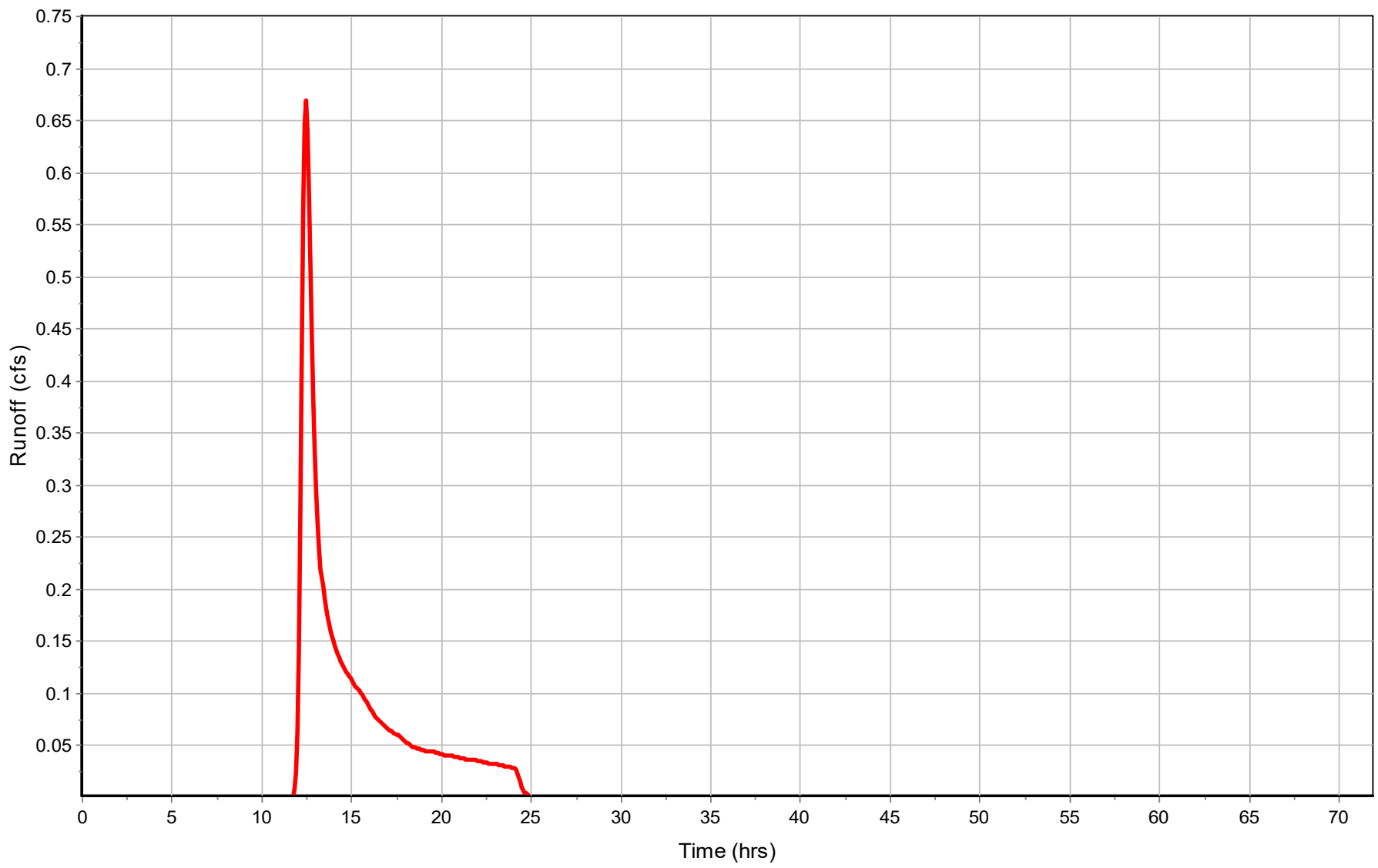
Total Rainfall (in)	6.7
Total Runoff (in)	1.42
Peak Runoff (cfs)	0.67
Weighted Curve Number	49
Time of Concentration (days hh:mm:ss)	0 00:34:50

Subbasin : Existing-E03-1_A1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Existing-E-07_A3

Input Data

Area (ac)	0.39
Peak Rate Factor	484
Weighted Curve Number	51.7
Rain Gage ID	Rain Gage-01

Composite Curve Number

32

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
50 - 75% grass cover, Fair	0.35	A	49
-	0.04	-	76
Composite Area & Weighted CN	0.39		51.7

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.4	0	0
Flow Length (ft) :	300	0	0
Slope (%) :	5	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.14	0	0
Computed Flow Time (min) :	34.72	0	0

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	105.18	0	0
Slope (%) :	2	0	0
Surface Type :	Grass pasture	Unpaved	Unpaved
Velocity (ft/sec) :	0.99	0	0
Computed Flow Time (min) :	1.77	0	0

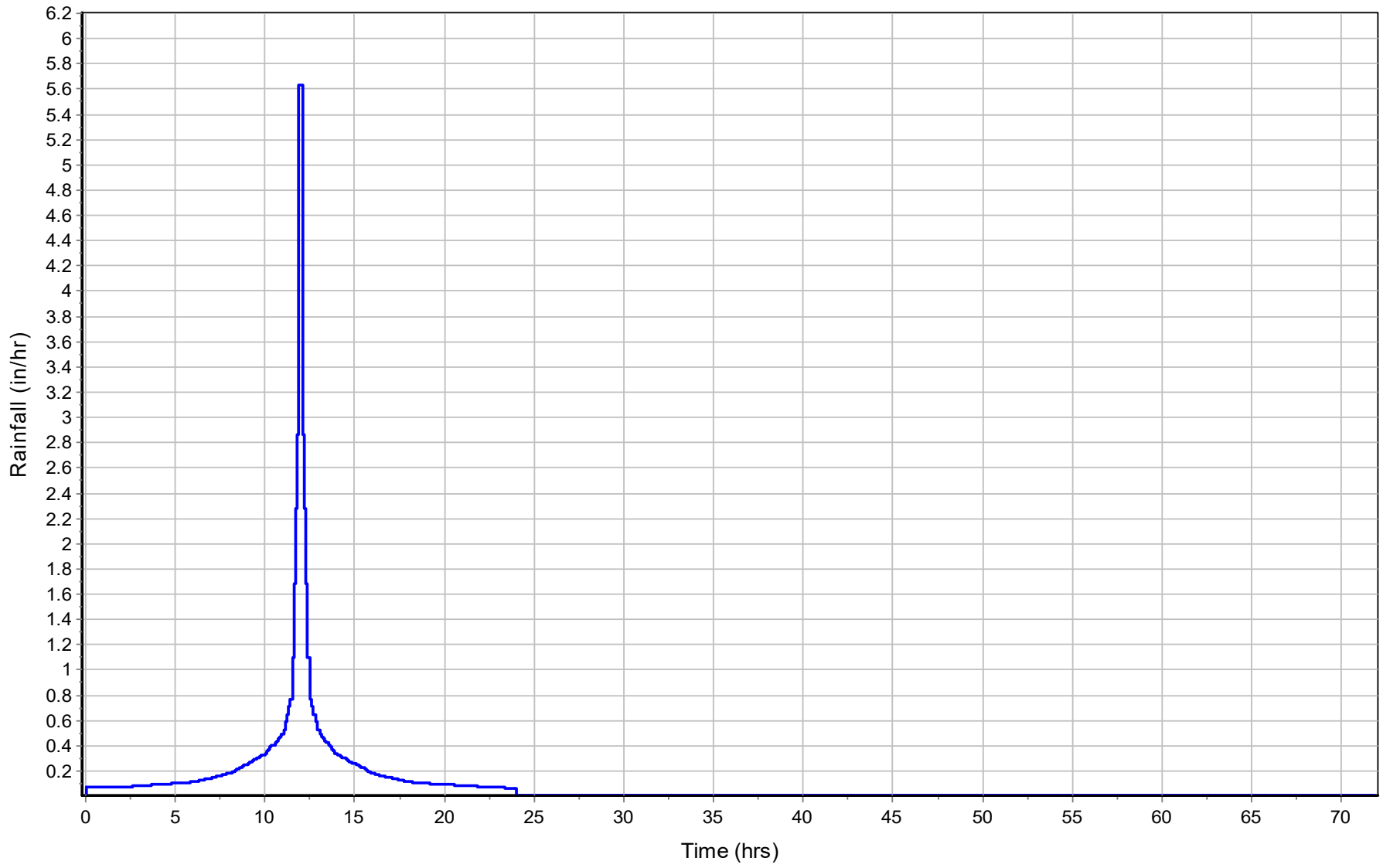
Total TOC (min) 36.49

Subbasin Runoff Results

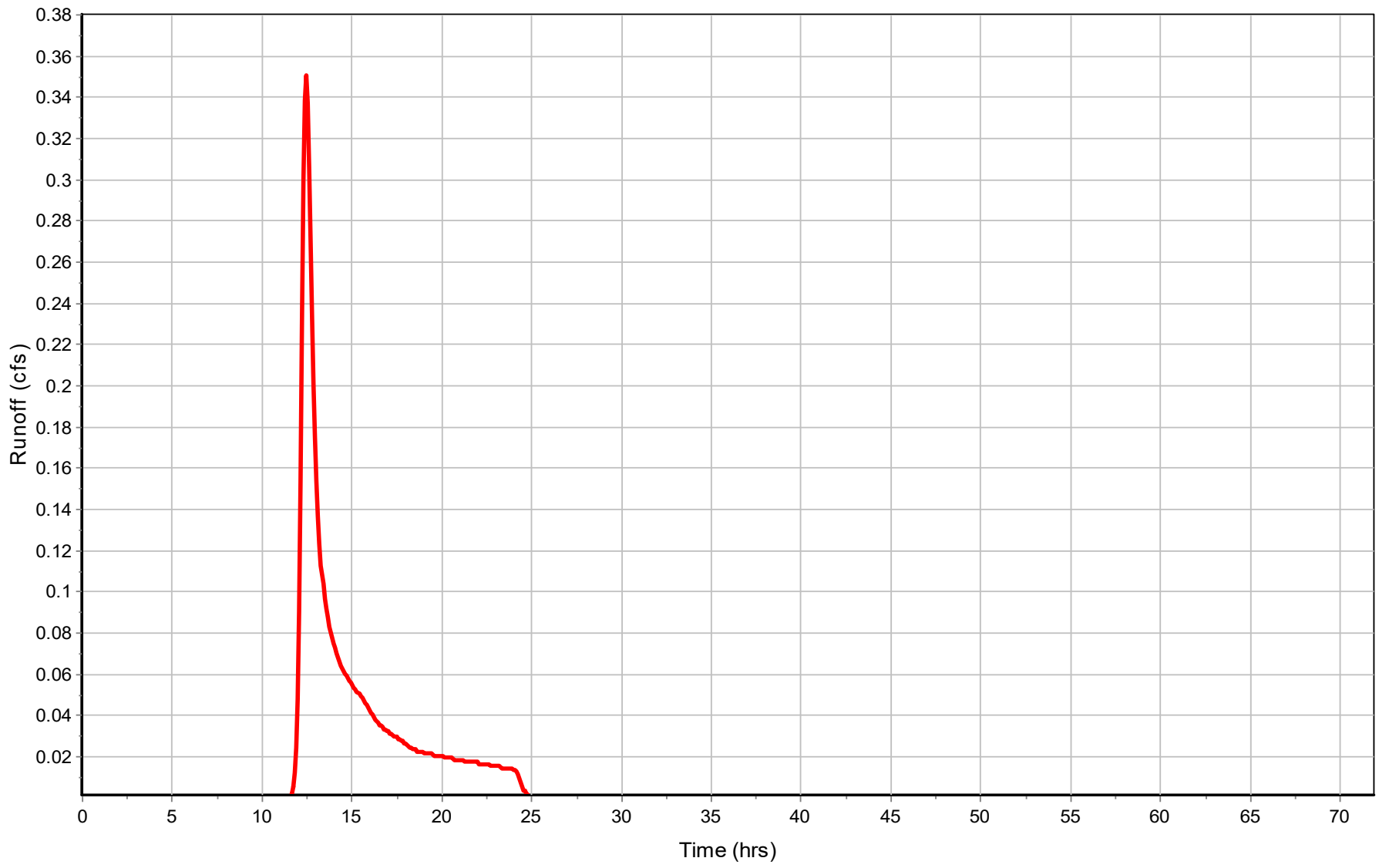
Total Rainfall (in)	6.7
Total Runoff (in)	1.65
Peak Runoff (cfs)	0.35
Weighted Curve Number	51.7
Time of Concentration (days hh:mm:ss)	0 00:36:29

Subbasin : Existing-E-07_A3

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Existing-E3_A1-2

Input Data

Area (ac)	3.2
Peak Rate Factor	484
Weighted Curve Number	49
Rain Gage ID	Rain Gage-01

Composite Curve Number

32

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
-	3.2	-	49
Composite Area & Weighted CN	3.2		49

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.4	0	0
Flow Length (ft) :	300	0	0
Slope (%) :	3.5	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.12	0	0
Computed Flow Time (min) :	40.05	0	0

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	205.17	0	0
Slope (%) :	3	0	0
Surface Type :	Grass pasture	Unpaved	Unpaved
Velocity (ft/sec) :	1.21	0	0
Computed Flow Time (min) :	2.83	0	0

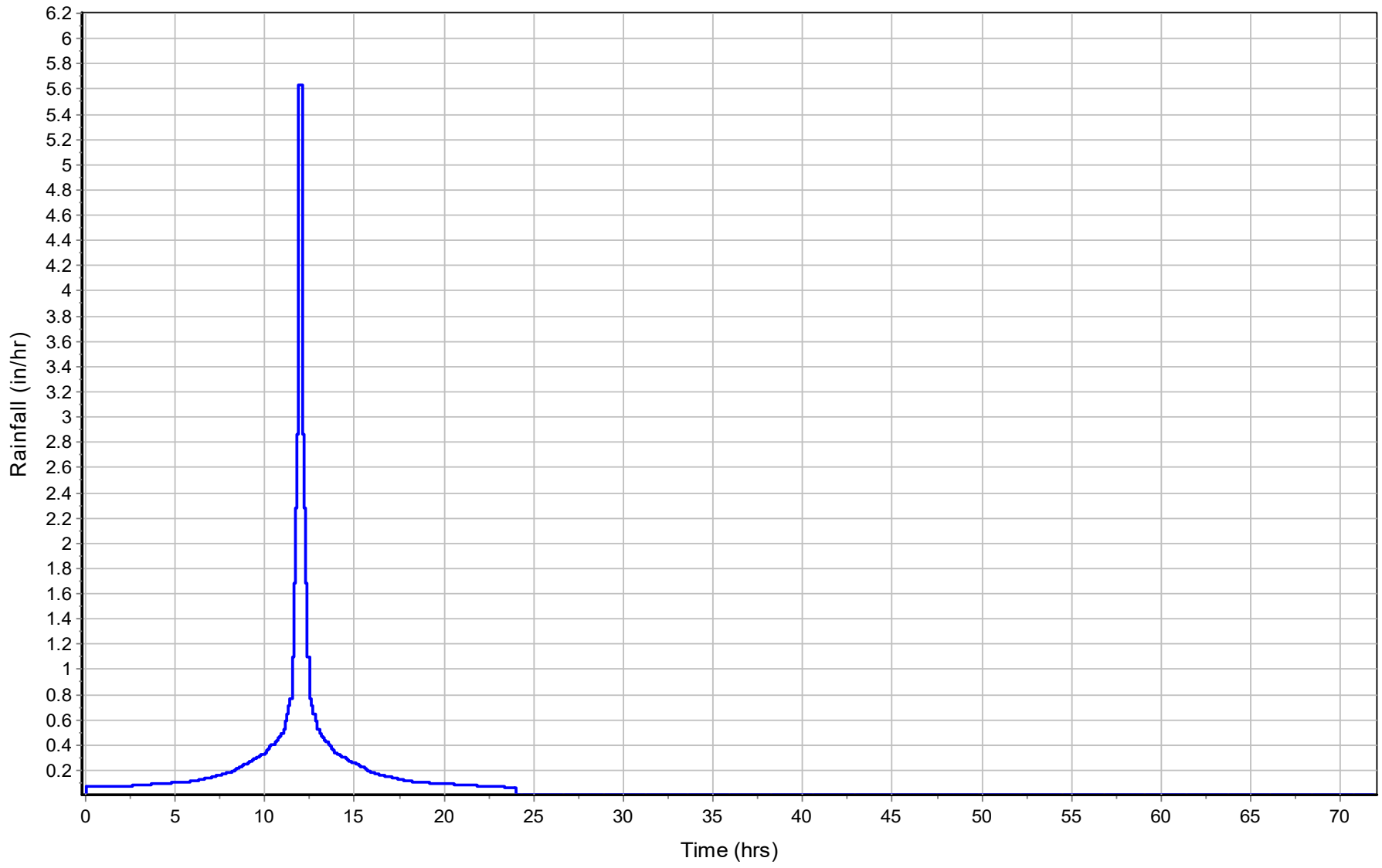
Total TOC (min) 42.87

Subbasin Runoff Results

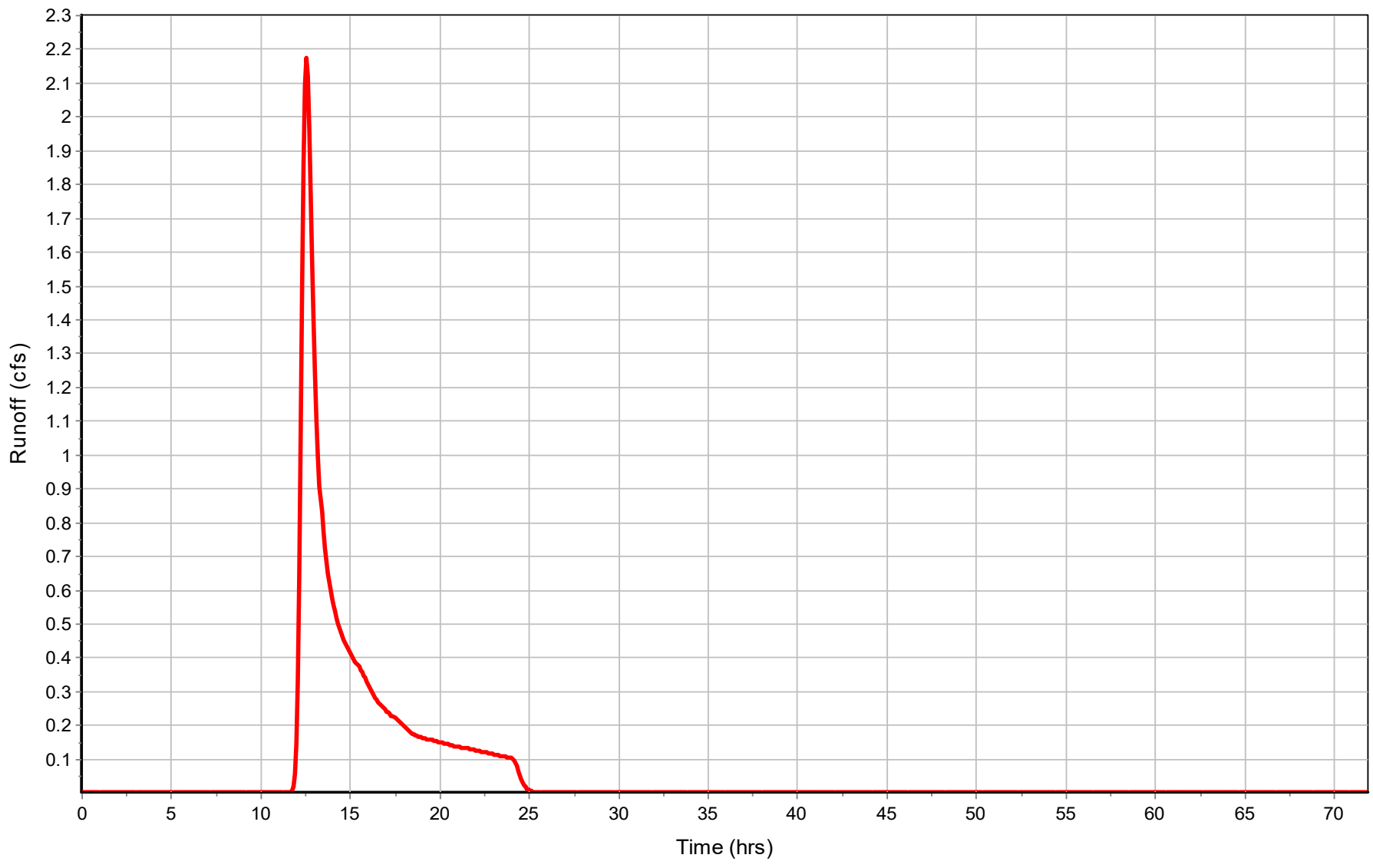
Total Rainfall (in)	6.7
Total Runoff (in)	1.42
Peak Runoff (cfs)	2.18
Weighted Curve Number	49
Time of Concentration (days hh:mm:ss)	0 00:42:52

Subbasin : Existing-E3_A1-2

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Existing-E5.1_A2

Input Data

Area (ac)	0.26
Peak Rate Factor	484
Weighted Curve Number	49
Rain Gage ID	Rain Gage-01

Composite Curve Number

32

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
50 - 75% grass cover, Fair	0.26	A	49
Composite Area & Weighted CN	0.26		49

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.4	0	0
Flow Length (ft) :	142.47	0	0
Slope (%) :	10	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.16	0	0
Computed Flow Time (min) :	14.5	0	0

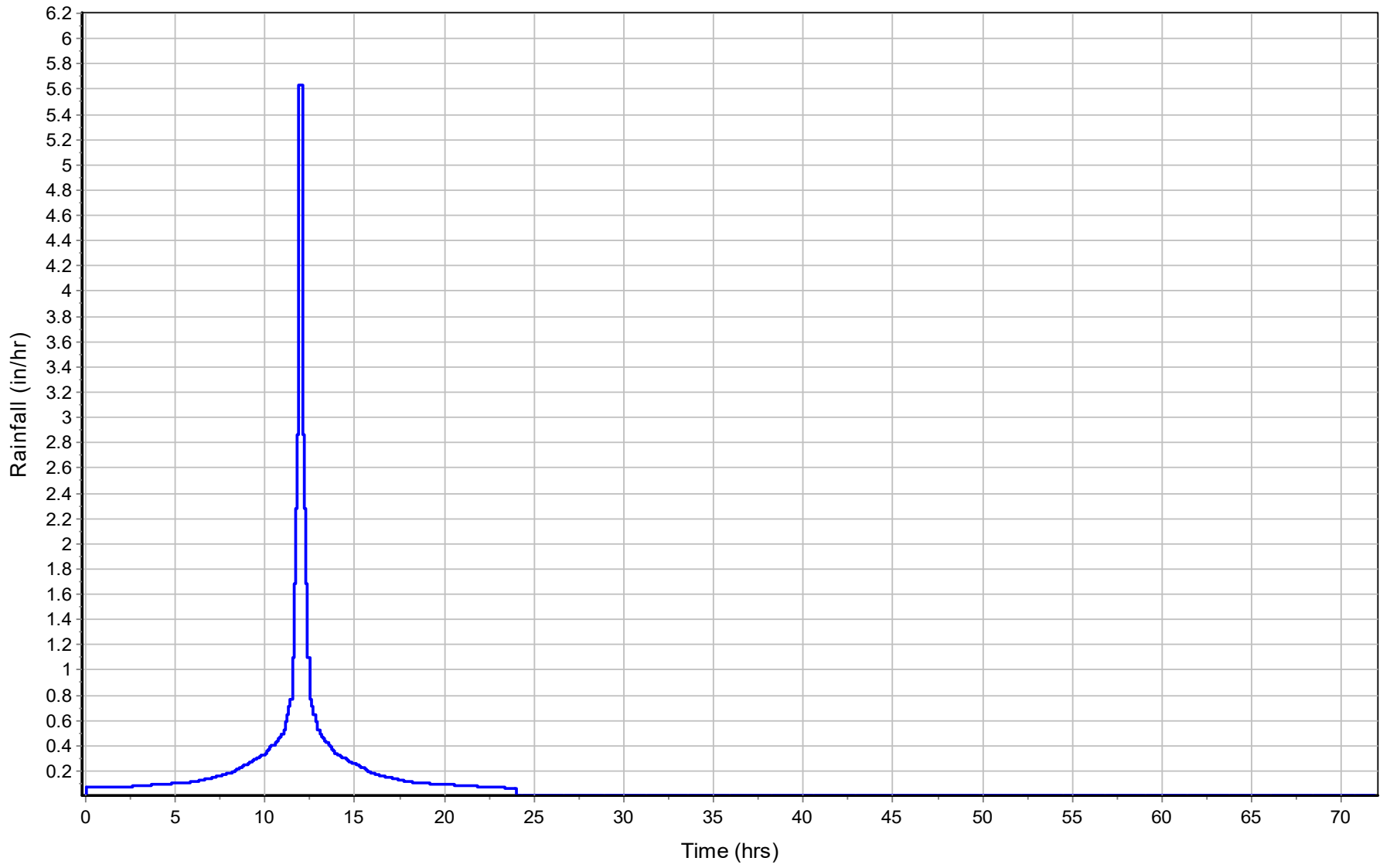
Total TOC (min) 14.50

Subbasin Runoff Results

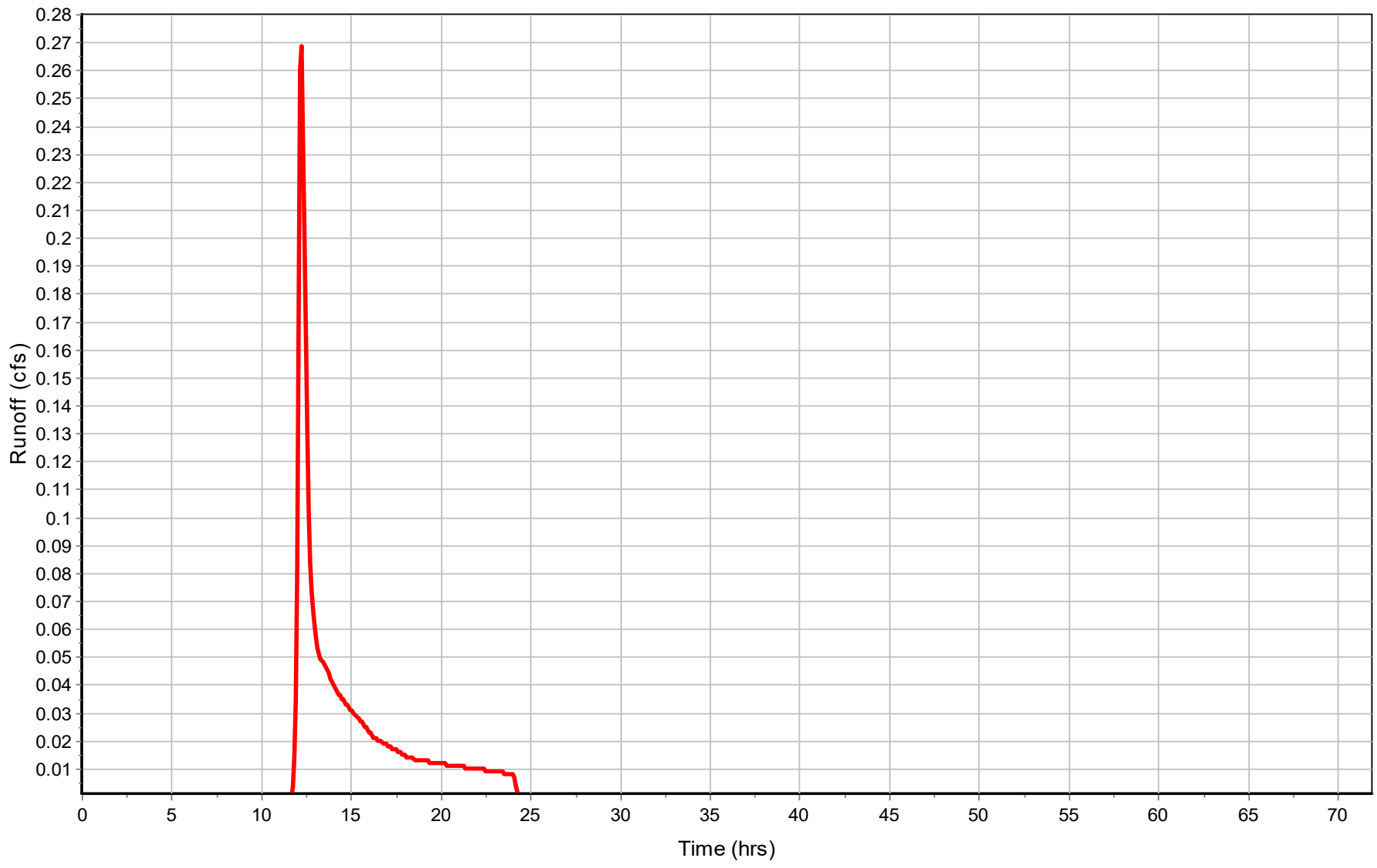
Total Rainfall (in)	6.7
Total Runoff (in)	1.42
Peak Runoff (cfs)	0.27
Weighted Curve Number	49
Time of Concentration (days hh:mm:ss)	0 00:14:30

Subbasin : Existing-E5.1_A2

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : A1-1-BASIN

Input Data

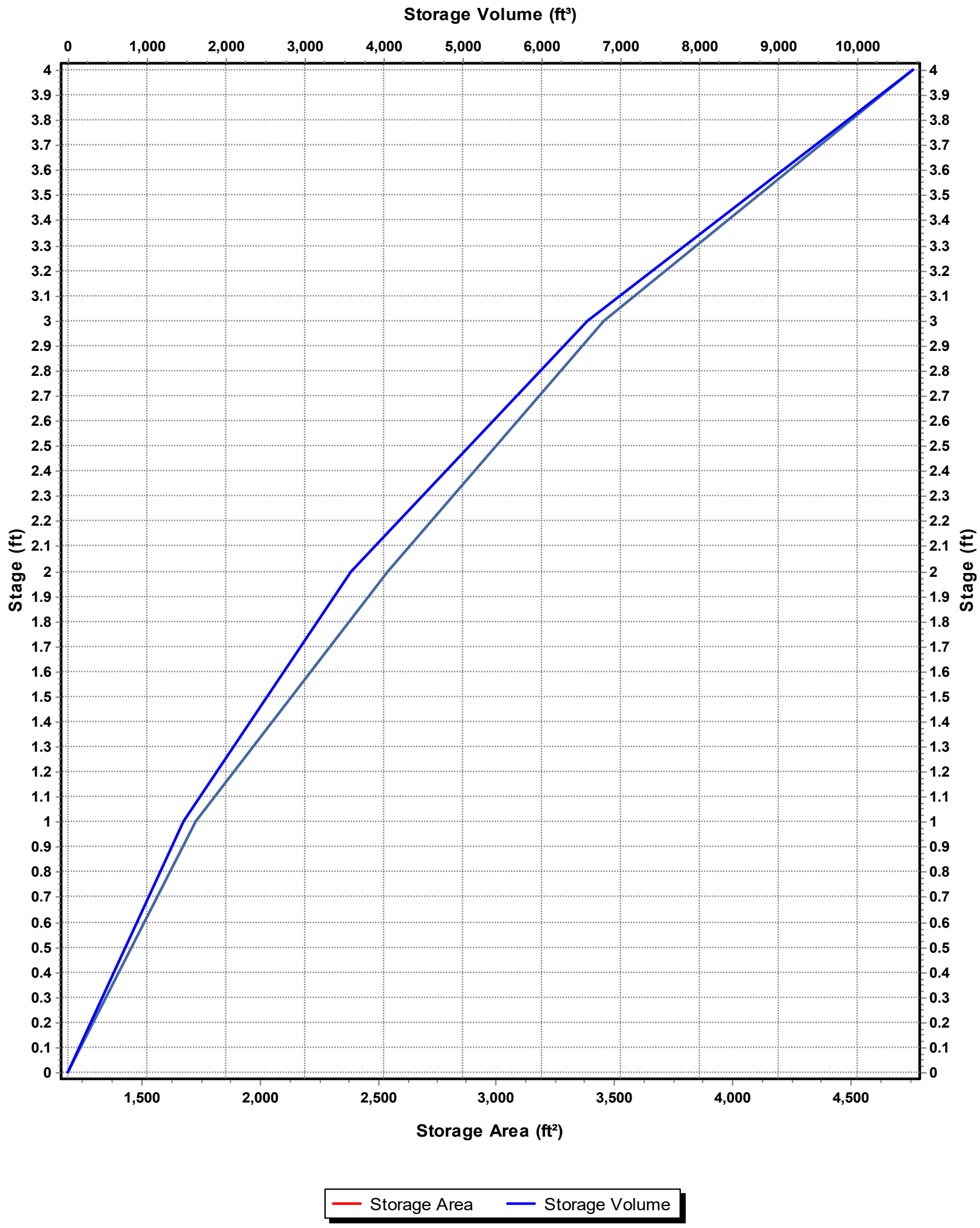
Invert Elevation (ft)	66.00
Max (Rim) Elevation (ft)	69.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	66.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : EXISTING POND.North

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	1188.1	0
1	1729.54	1458.82
2	2543.02	3595.1
3	3461.12	6597.17
4	4767.41	10711.44

Storage Area Volume Curves



Storage Node : A1-1-BASIN (continued)

Outflow Orifices

SN	Element ID	Orifice Type	Orifice Shape	Flap Gate	Circular Orifice Diameter (ft)	Rectangular Orifice Height (ft)	Rectangular Orifice Width (ft)	Orifice Invert Elevation (ft)	Orifice Coefficient
1	12RCP	Side	CIRCULAR	No	1.00			68.00	0.61

Output Summary Results

Peak Inflow (cfs)	1.99
Peak Lateral Inflow (cfs)	1.99
Peak Outflow (cfs)	0.95
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	68.49
Max HGL Depth Attained (ft)	2.49
Average HGL Elevation Attained (ft)	67.87
Average HGL Depth Attained (ft)	1.87
Time of Max HGL Occurrence (days hh:mm)	0 12:28
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : BASIN-1

Input Data

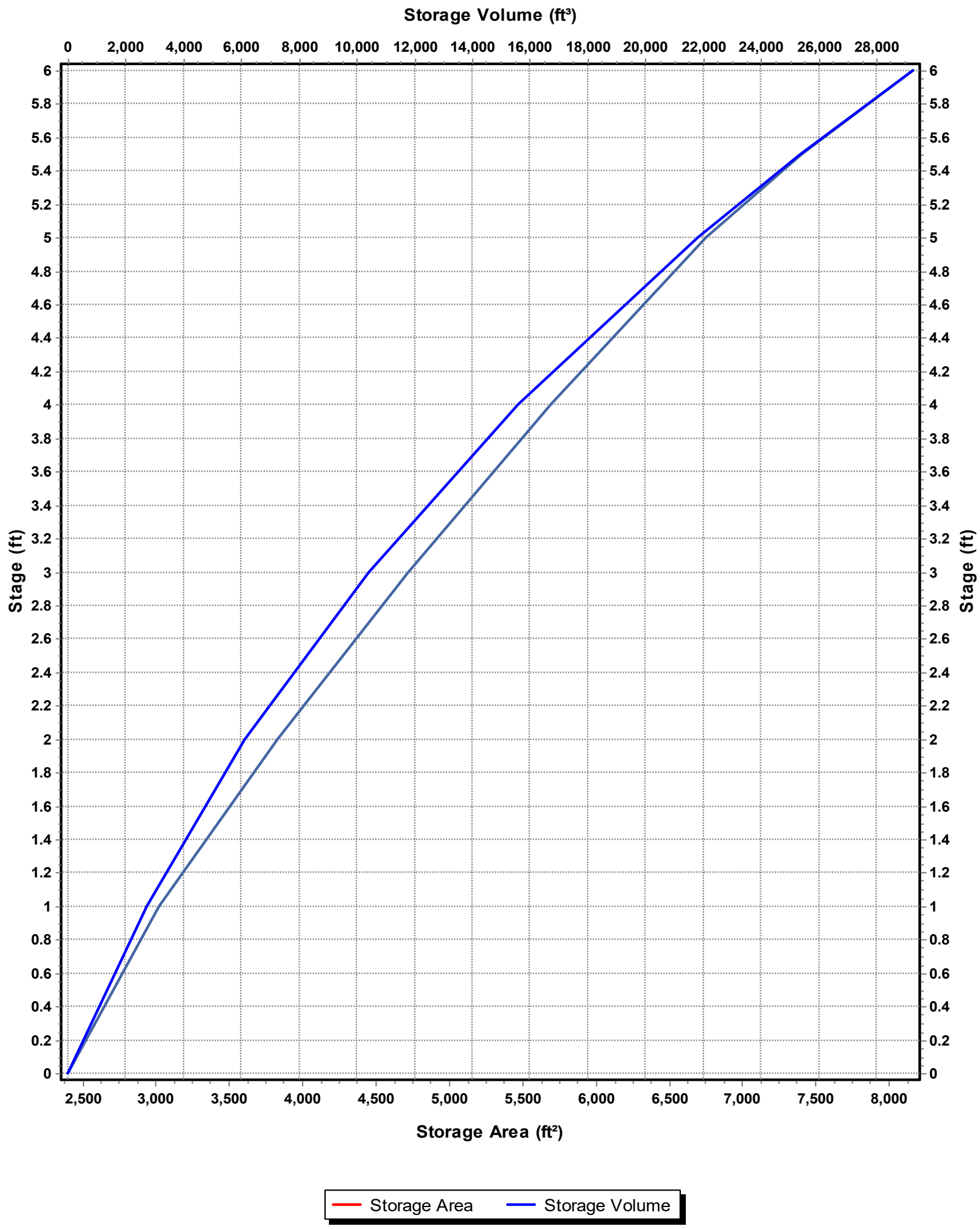
Invert Elevation (ft)	63.00
Max (Rim) Elevation (ft)	69.00
Max (Rim) Offset (ft)	6.00
Initial Water Elevation (ft)	63.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : POND-1

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	2401.32	0
1	3024.34	2712.83
2	3828.08	6139.04
3	4718.62	10412.39
4	5693.33	15618.37
5	6754.28	21842.18
5.5	7407.96	25382.74
6	8166.38	29276.33

Storage Area Volume Curves



Storage Node : BASIN-1 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-B1	Trapezoidal	No	68.50	5.50	10.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	4.96
Peak Lateral Inflow (cfs)	0
Peak Outflow (cfs)	4.98
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	68.26
Max HGL Depth Attained (ft)	5.26
Average HGL Elevation Attained (ft)	67.2
Average HGL Depth Attained (ft)	4.2
Time of Max HGL Occurrence (days hh:mm)	3 00:00
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : BASIN-2

Input Data

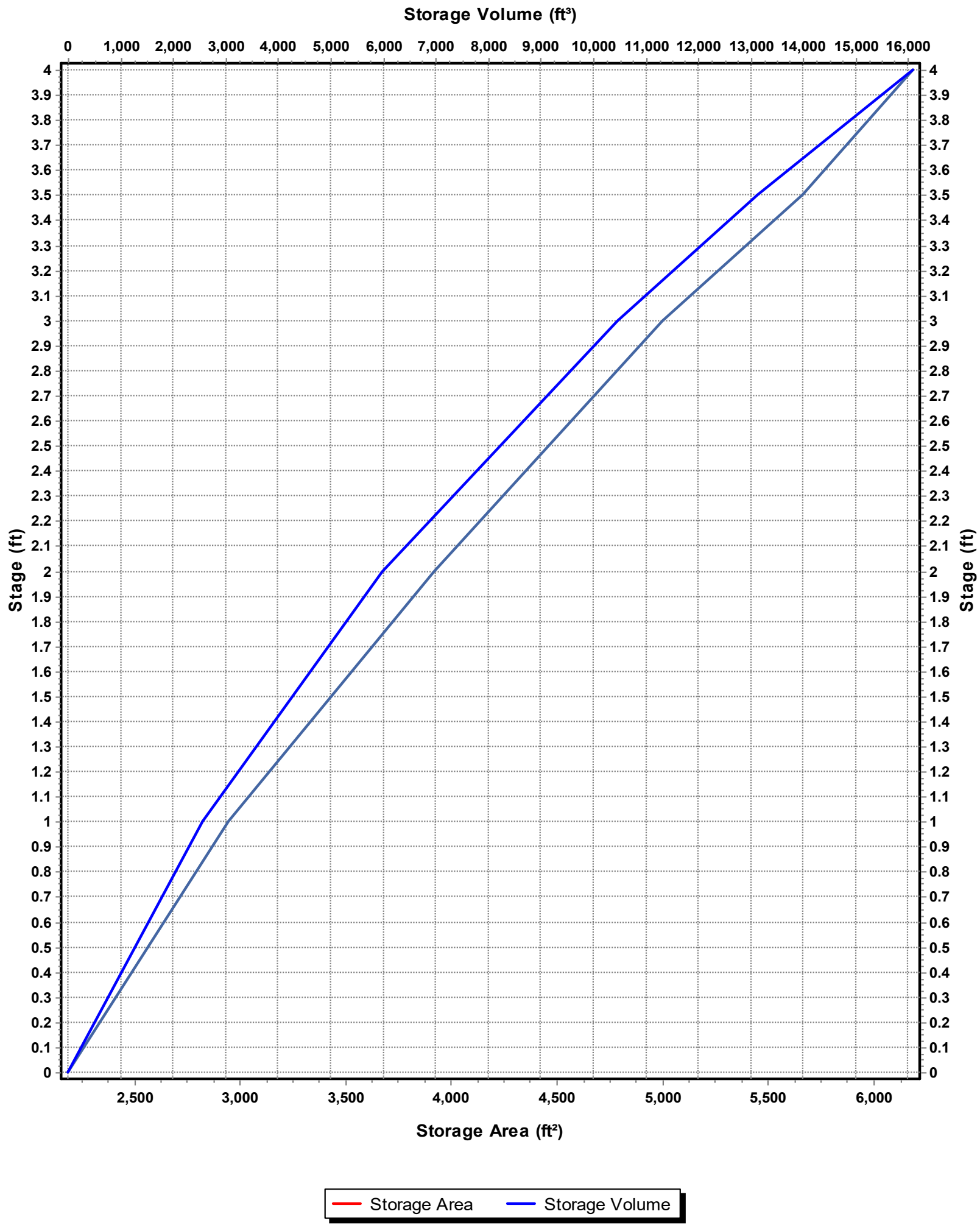
Invert Elevation (ft)	63.00
Max (Rim) Elevation (ft)	67.00
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	63.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : POND-2

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	2186.8	0
1	2944.52	2565.66
2	3920.59	5998.22
3	5001.46	10459.25
3.5	5669	13126.87
4	6188.64	16091.28

Storage Area Volume Curves



Storage Node : BASIN-2 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-B2	Trapezoidal	No	66.50	3.50	10.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	3.04
Peak Lateral Inflow (cfs)	0
Peak Outflow (cfs)	0
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	65.7
Max HGL Depth Attained (ft)	2.7
Average HGL Elevation Attained (ft)	65.17
Average HGL Depth Attained (ft)	2.17
Time of Max HGL Occurrence (days hh:mm)	1 03:23
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Exist-Catch-Basin

Input Data

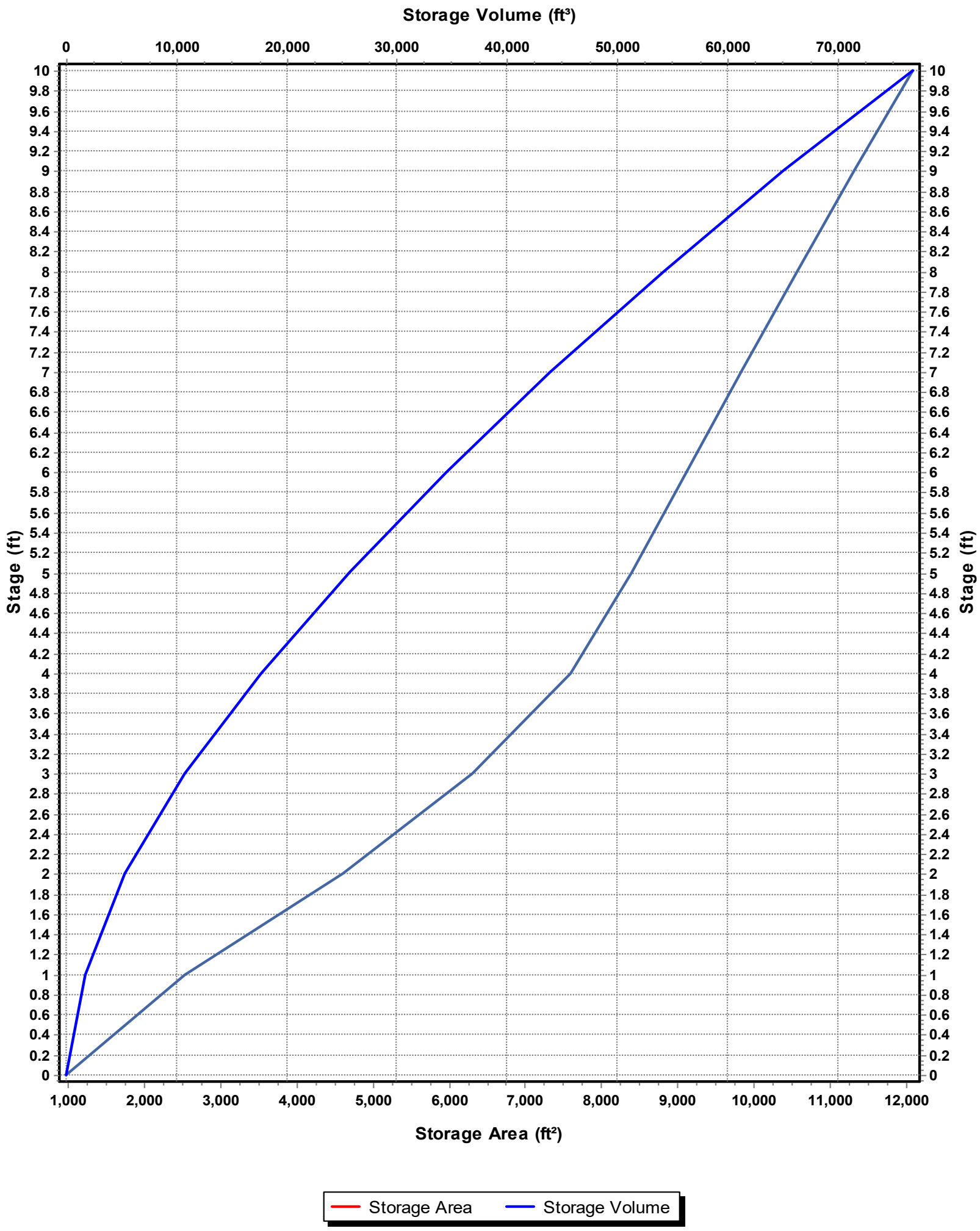
Invert Elevation (ft)	43.00
Max (Rim) Elevation (ft)	53.00
Max (Rim) Offset (ft)	10.00
Initial Water Elevation (ft)	43.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : EXISTING POND.South

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	974.38	0
1	2524.45	1749.42
2	4602.46	5312.88
3	6308.57	10768.4
4	7605.38	17725.38
5	8399.21	25727.68
6	9117.86	34486.22
7	9840.94	43965.62
8	10576.98	54174.58
9	11329.31	65127.73
10	12097.94	76841.36

Storage Area Volume Curves



Storage Node : Exist-Catch-Basin (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Exist-Catch-Basin-Weir	Trapezoidal	No	52.50	9.50	5.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	2.17
Peak Lateral Inflow (cfs)	2.17
Peak Outflow (cfs)	0
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	46.83
Max HGL Depth Attained (ft)	3.83
Average HGL Elevation Attained (ft)	46.07
Average HGL Depth Attained (ft)	3.07
Time of Max HGL Occurrence (days hh:mm)	1 01:40
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Existing-Catch-Basin

Input Data

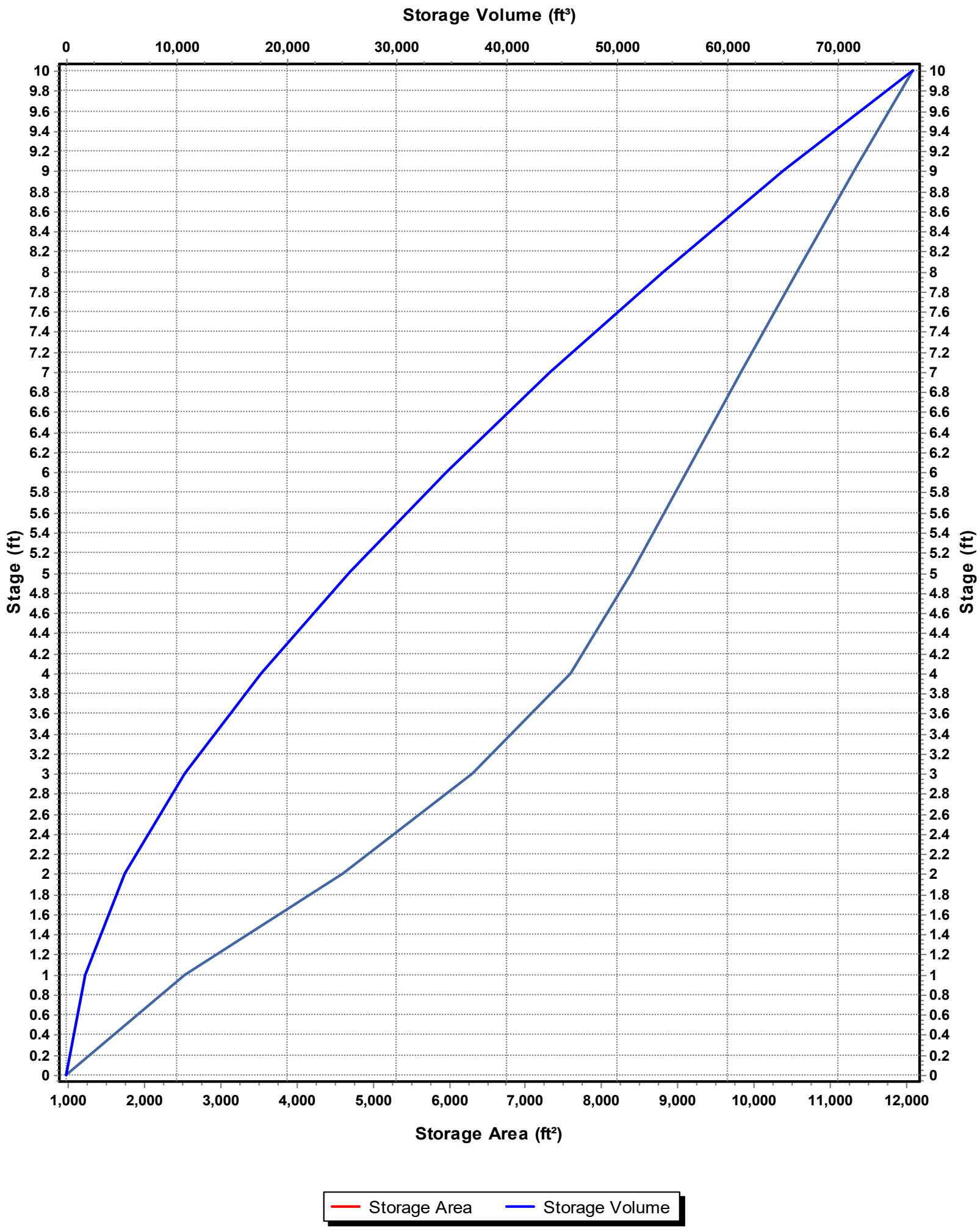
Invert Elevation (ft)	43.00
Max (Rim) Elevation (ft)	53.00
Max (Rim) Offset (ft)	10.00
Initial Water Elevation (ft)	43.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : EXISTING POND.South

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	974.38	0
1	2524.45	1749.42
2	4602.46	5312.88
3	6308.57	10768.4
4	7605.38	17725.38
5	8399.21	25727.68
6	9117.86	34486.22
7	9840.94	43965.62
8	10576.98	54174.58
9	11329.31	65127.73
10	12097.94	76841.36

Storage Area Volume Curves



Storage Node : Existing-Catch-Basin (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Existing-Catch-Basin-Weir	Trapezoidal	No	52.50	9.50	5.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	2.48
Peak Lateral Inflow (cfs)	0.72
Peak Outflow (cfs)	0
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	46.53
Max HGL Depth Attained (ft)	3.53
Average HGL Elevation Attained (ft)	45.85
Average HGL Depth Attained (ft)	2.85
Time of Max HGL Occurrence (days hh:mm)	1 02:16
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : FOREBAY-1

Input Data

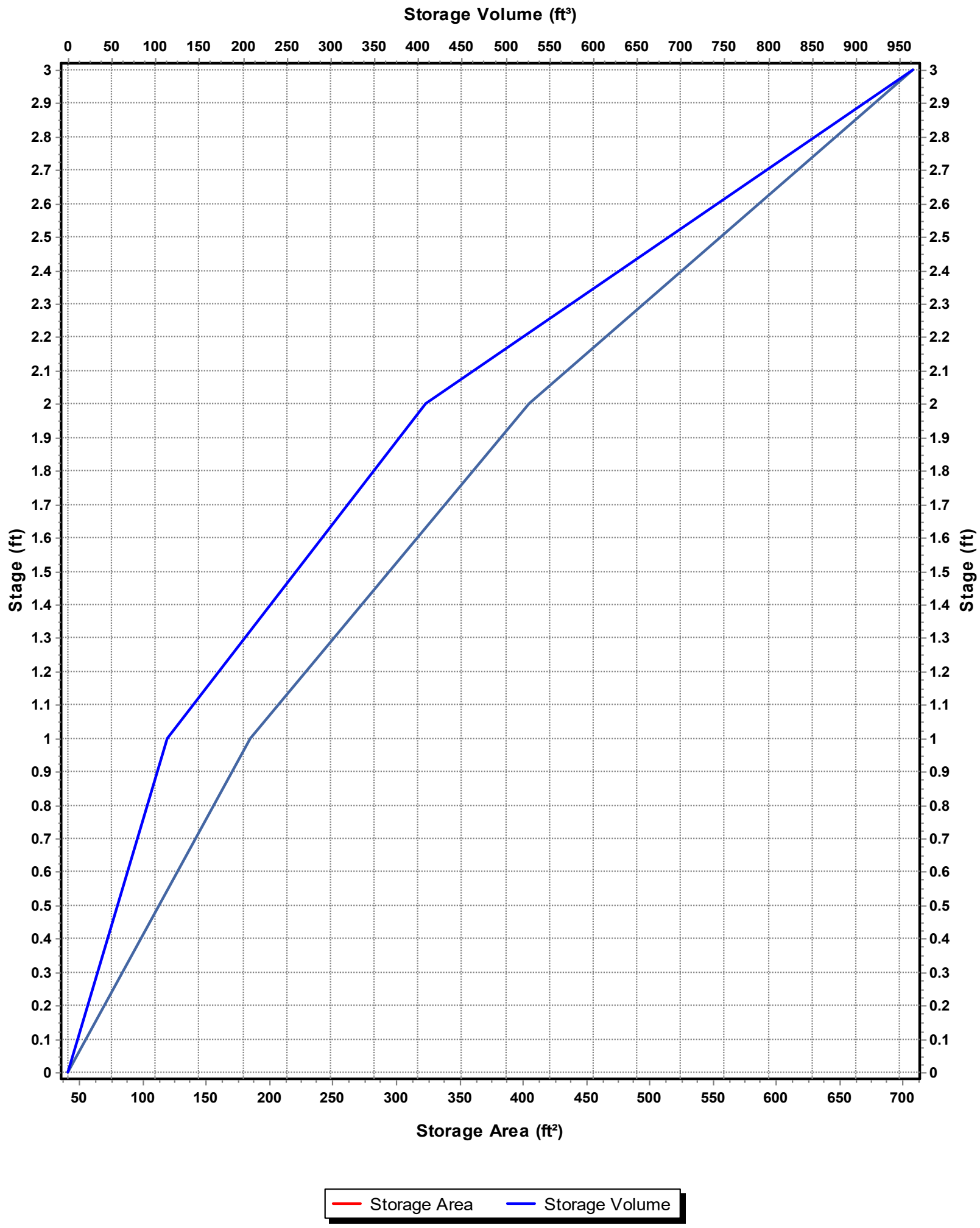
Invert Elevation (ft)	66.00
Max (Rim) Elevation (ft)	70.00
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	66.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : FOREBAY-1

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	41.13	0
1	185.44	113.29
2	405.49	408.76
3	708.15	965.58

Storage Area Volume Curves



Storage Node : FOREBAY-1 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-F1	Trapezoidal	No	67.00	1.00	4.00	3.00	3.33

Output Summary Results

Peak Inflow (cfs)	5.12
Peak Lateral Inflow (cfs)	4.82
Peak Outflow (cfs)	4.96
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	68.31
Max HGL Depth Attained (ft)	2.31
Average HGL Elevation Attained (ft)	67.78
Average HGL Depth Attained (ft)	1.78
Time of Max HGL Occurrence (days hh:mm)	2 23:58
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : FOREBAY-1-2

Input Data

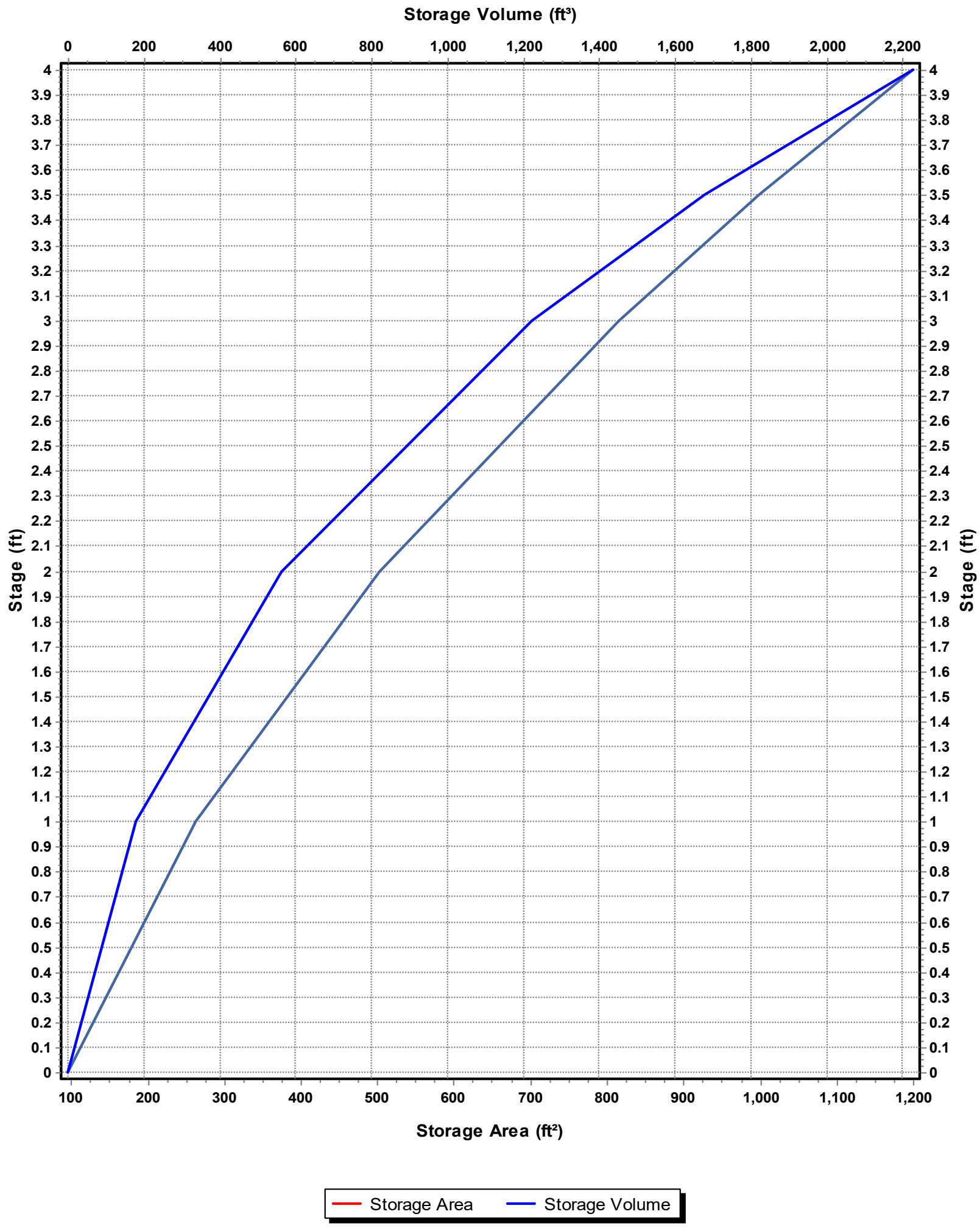
Invert Elevation (ft)	62.00
Max (Rim) Elevation (ft)	66.00
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	62.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : FOREBAY-3

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	96	0
1	264	180
2	504	564
3	816	1224
3.5	999	1677.75
4	1200	2227.5

Storage Area Volume Curves



Storage Node : FOREBAY-1-2 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-F1-2	Trapezoidal	No	63.00	1.00	2.00	3.00	3.33

Output Summary Results

Peak Inflow (cfs)	2.35
Peak Lateral Inflow (cfs)	2.35
Peak Outflow (cfs)	2.33
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	63.45
Max HGL Depth Attained (ft)	1.45
Average HGL Elevation Attained (ft)	62.85
Average HGL Depth Attained (ft)	0.85
Time of Max HGL Occurrence (days hh:mm)	0 12:10
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : FOREBAY-2

Input Data

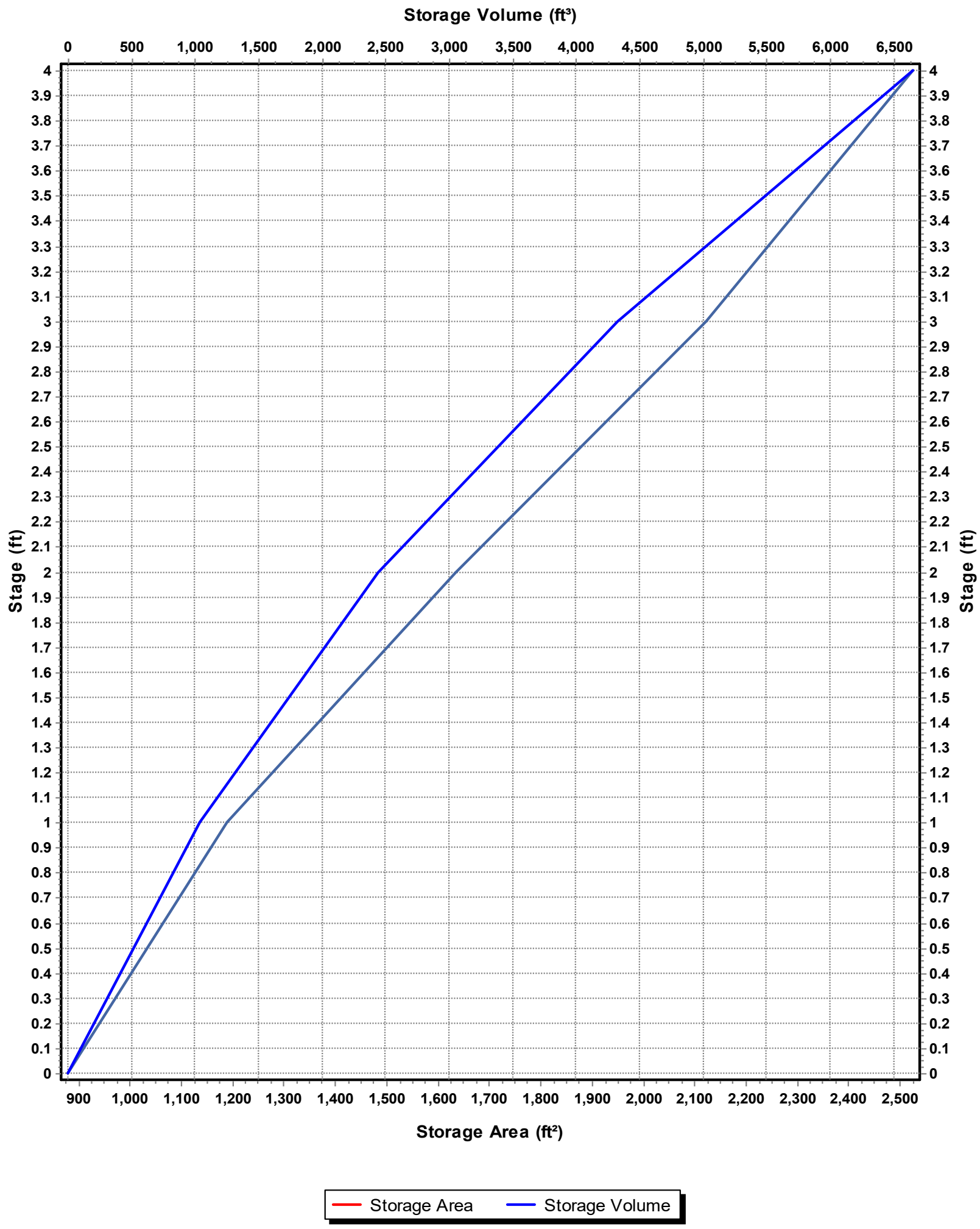
Invert Elevation (ft)	65.00
Max (Rim) Elevation (ft)	69.00
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	65.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : FOREBAY-2

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	880.04	0
1	1189.5	1034.77
2	1635.09	2447.07
3	2123.92	4326.58
4	2526	6651.54

Storage Area Volume Curves



Storage Node : FOREBAY-2 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-F2	Trapezoidal	No	68.00	3.00	10.00	1.00	3.33

Output Summary Results

Peak Inflow (cfs)	3.69
Peak Lateral Inflow (cfs)	3.69
Peak Outflow (cfs)	3.04
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	68.2
Max HGL Depth Attained (ft)	3.2
Average HGL Elevation Attained (ft)	67.53
Average HGL Depth Attained (ft)	2.53
Time of Max HGL Occurrence (days hh:mm)	0 12:15
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Project Description

File Name ..... Sagamore_Entire.Site.SPF

Project Options

Flow Units ..... CFS
Elevation Type ..... Elevation
Hydrology Method ..... SCS TR-20
Time of Concentration (TOC) Method ..... SCS TR-55
Link Routing Method ..... Hydrodynamic
Enable Overflow Ponding at Nodes ..... YES
Skip Steady State Analysis Time Periods ..... NO

Analysis Options

Start Analysis On ..... oct. 14, 2021 0:00:00
End Analysis On ..... oct. 17, 2021 0:00:00
Start Reporting On ..... oct. 14, 2021 0:00:00
Antecedent Dry Days ..... 0 days
Runoff (Dry Weather) Time Step ..... 0 01:00:00 days hh:mm:ss
Runoff (Wet Weather) Time Step ..... 0 00:05:00 days hh:mm:ss
Reporting Time Step ..... 0 00:05:00 days hh:mm:ss
Routing Time Step ..... 30 seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	13
Nodes	18
Junctions	0
Outfalls	10
Flow Diversions	0
Inlets	0
Storage Nodes	8
Links	8
Channels	0
Pipes	0
Pumps	0
Orifices	1
Weirs	7
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	100 years	Intensity	inches	Massachusetts	None	100.00	7.47	SCS Type III 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	A1	1.20	484.00	76.00	7.47	4.68	5.61	5.73	0 00:06:00
2	A1-1	0.39	484.00	98.00	7.47	7.23	2.81	2.29	0 00:10:55
3	A1-2	1.34	484.00	54.63	7.47	2.39	3.20	3.24	0 00:06:00
4	A1-3	1.03	484.00	49.00	7.47	1.84	1.88	0.98	0 00:40:16
5	A2	0.92	484.00	76.00	7.47	4.68	4.30	4.39	0 00:06:00
6	A-3	0.25	484.00	51.70	7.47	2.10	0.52	0.30	0 00:36:07
7	DA-Ditch-A1	1.35	484.00	76.00	7.47	4.68	6.32	6.44	0 00:06:00
8	DA-Ditch-A1-2	1.29	484.00	76.00	7.47	4.68	6.03	6.16	0 00:06:00
9	DA-Ditch-A2	0.67	484.00	76.00	7.47	4.68	3.13	3.20	0 00:06:00
10	Existing-E03-1_A1	0.89	484.00	49.00	7.47	1.84	1.64	0.91	0 00:34:49
11	Existing-E-07_A3	0.39	484.00	51.70	7.47	2.10	0.82	0.46	0 00:36:29
12	Existing-E3_A1-2	3.20	484.00	49.00	7.47	1.84	5.88	2.96	0 00:42:52
13	Existing-E5.1_A2	0.26	484.00	49.00	7.47	1.84	0.48	0.38	0 00:14:30

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft²)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Existing-Oufall-E3-1_Weir-B1	Outfall	0.00					0.91	0.00					
2	Existing-Outfall-E3_1	Outfall	0.00					0.00	0.00					
3	Existing-Outfall-E5.1_2	Outfall	0.00					0.36	0.00					
4	Existing-Outfall-E7_3	Outfall	0.00					0.46	0.00					
5	Out-D1	Outfall	0.00					6.31	0.00					
6	Out-D2	Outfall	0.00					3.14	0.00					
7	Out-D3	Outfall	0.00					6.04	0.00					
8	Proposed-Outfall.1	Outfall	0.00					0.00	0.00					
9	Proposed-Outfall.2	Outfall	60.00					0.00	60.00					
10	Proposed-Outfall.3	Outfall	0.00					0.30	0.00					
11	A1-1-BASIN	Storage Node	66.00	69.00	66.00		0.00	2.22	68.59				0.00	0.00
12	BASIN-1	Storage Node	63.00	69.00	63.00		0.00	7.06	68.51				0.00	0.00
13	BASIN-2	Storage Node	63.00	67.00	63.00		0.00	4.07	66.17				0.00	0.00
14	Exist-Catch-Basin	Storage Node	43.00	53.00	43.00		0.00	2.96	47.47				0.00	0.00
15	Existing-Catch-Basin	Storage Node	43.00	53.00	43.00		0.00	3.26	47.47				0.00	0.00
16	FOREBAY-1	Storage Node	66.00	70.00	66.00		0.00	7.20	68.57				0.00	0.00
17	FOREBAY-1-2	Storage Node	62.00	66.00	62.00		0.00	3.04	63.52				0.00	0.00
18	FOREBAY-2	Storage Node	65.00	69.00	65.00		0.00	4.30	68.24				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(ft)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
1	12RCP	Orifice	A1-1-BASIN	FOREBAY-1		66.00	66.00		1.000		1.23							
2	Exist-Catch-Basin-Weir	Weir	Exist-Catch-Basin	Existing-Outfall-E3_1		43.00	0.00				0.00							
3	Existing-Catch-Basin-Weir	Weir	Existing-Catch-Basin	Proposed-Outfall.1		43.00	0.00				0.00							
4	Weir-B1	Weir	BASIN-1	FOREBAY-1-2		63.00	62.00				0.03							
5	Weir-B2	Weir	BASIN-2	Proposed-Outfall.2		63.00	60.00				0.00							
6	Weir-F1	Weir	FOREBAY-1	BASIN-1		66.00	63.00				7.06							
7	Weir-F1-2	Weir	FOREBAY-1-2	Existing-Catch-Basin		62.00	43.00				3.01							
8	Weir-F2	Weir	FOREBAY-2	BASIN-2		65.00	63.00				4.07							

Subbasin Hydrology

Subbasin : A1

Input Data

Area (ac) 1.2
Peak Rate Factor 484
Weighted Curve Number 76
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	1.2	A	76
Composite Area & Weighted CN	1.2		76

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft^2)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	300	0	0
Slope (%) :	1.51	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	1.23	0	0
Computed Flow Time (min) :	4.05	0	0

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	20.6	0	0
Slope (%) :	1.86	0	0
Surface Type :	Unpaved	Unpaved	Unpaved
Velocity (ft/sec) :	2.2	0	0
Computed Flow Time (min) :	0.16	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	99.64	0	0
Channel Slope (%) :	0.5	0	0
Cross Section Area (ft^2) :	29.79	0	0
Wetted Perimeter (ft) :	20.98	0	0
Velocity (ft/sec) :	4.44	0	0
Computed Flow Time (min) :	0.37	0	0

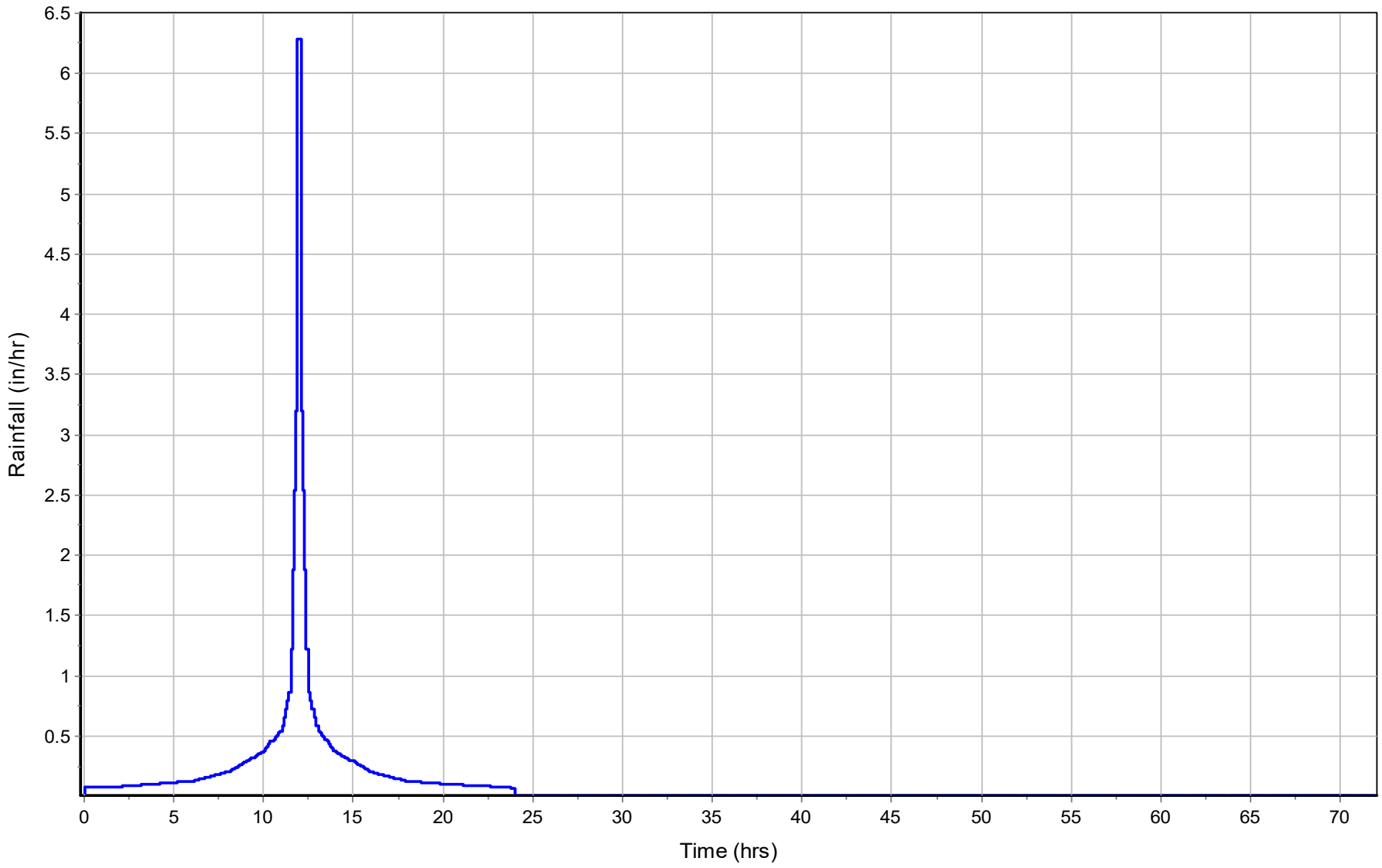
Total TOC (min) 4.58

Subbasin Runoff Results

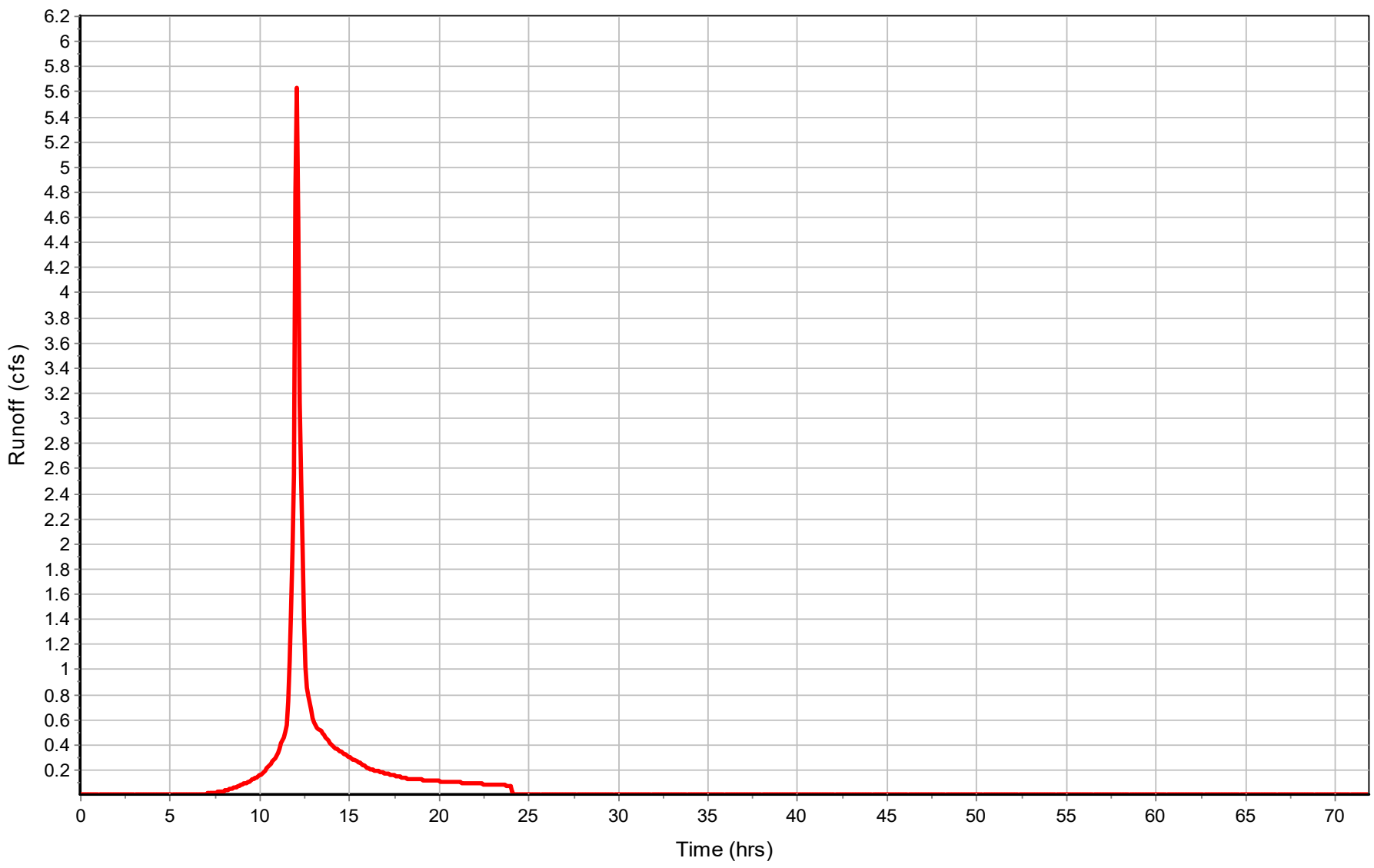
Total Rainfall (in) 7.47
Total Runoff (in) 4.68
Peak Runoff (cfs) 5.73
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:04:35

Subbasin : A1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : A1-1

Input Data

Area (ac) 0.39
Peak Rate Factor 484
Weighted Curve Number 98
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Paved parking & roofs	0.39	A	98
Composite Area & Weighted CN	0.39		98

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.05	0	0
Flow Length (ft) :	178.81	0	0
Slope (%) :	0.5	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.27	0	0
Computed Flow Time (min) :	10.92	0	0

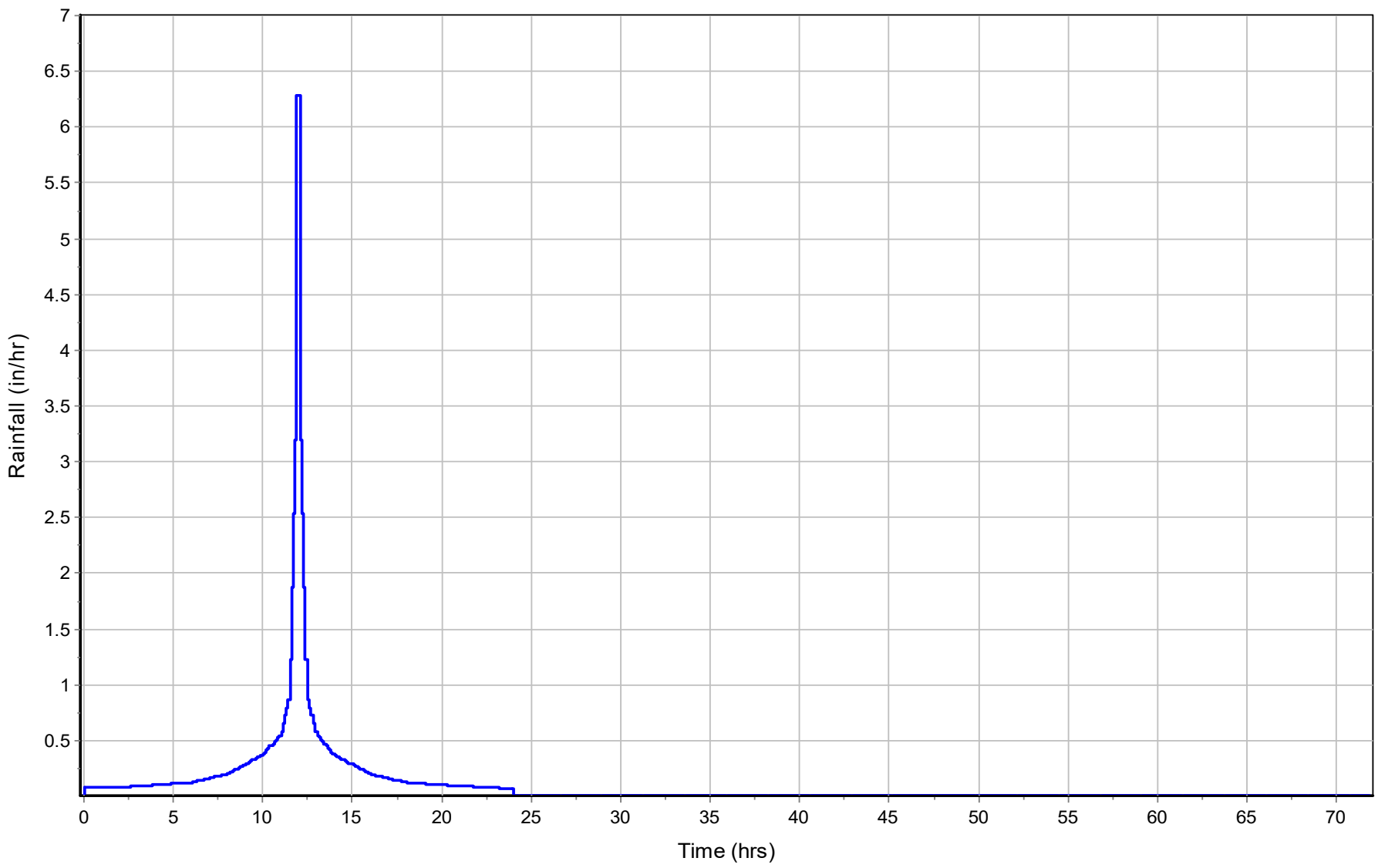
Total TOC (min) 10.92

Subbasin Runoff Results

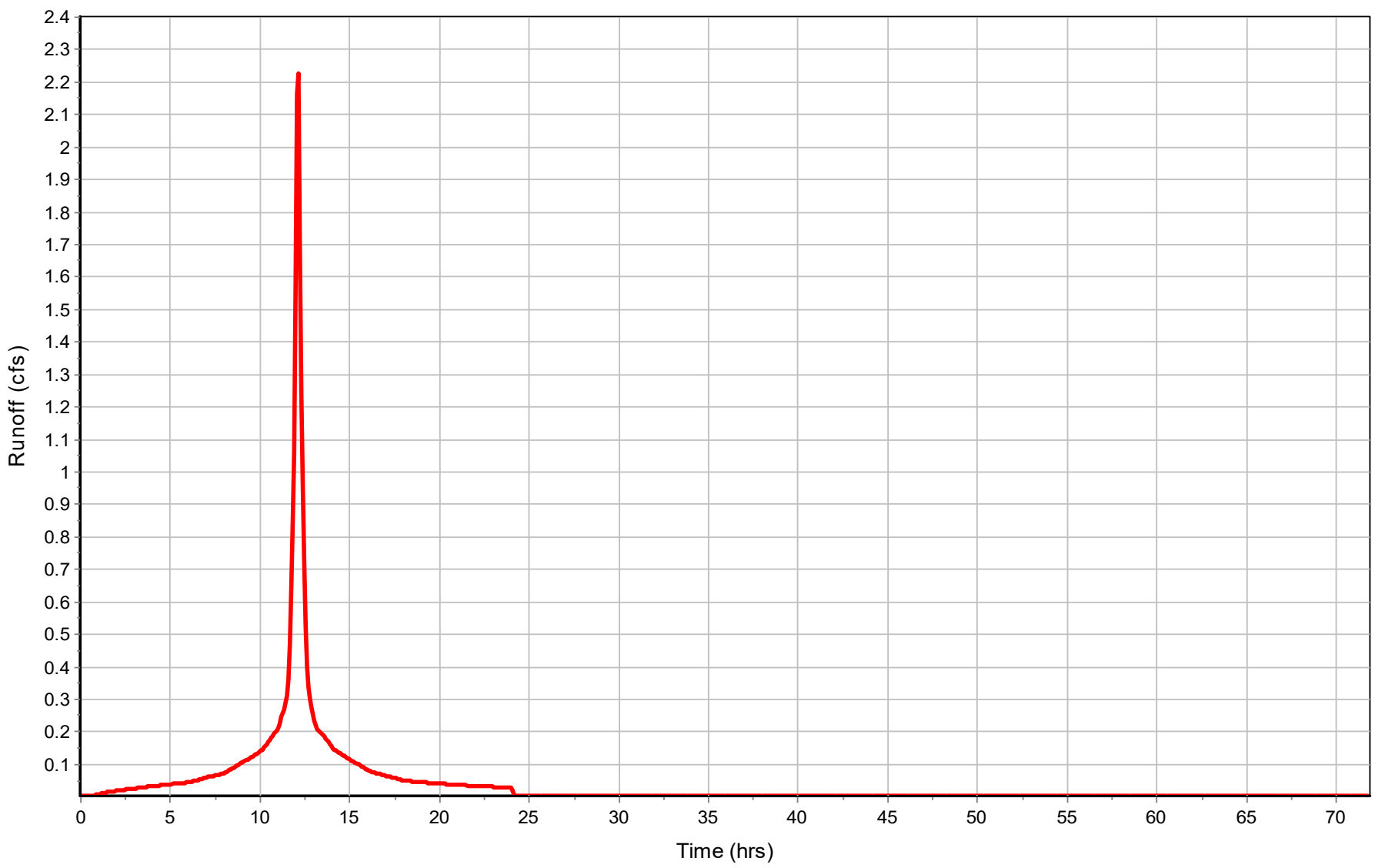
Total Rainfall (in) 7.47
Total Runoff (in) 7.23
Peak Runoff (cfs) 2.29
Weighted Curve Number 98
Time of Concentration (days hh:mm:ss) 0 00:10:55

Subbasin : A1-1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : A1-2

Input Data

Area (ac) 1.34
Peak Rate Factor 484
Weighted Curve Number 54.63
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	0.28	A	76
-	1.06	-	49
Composite Area & Weighted CN	1.34		54.63

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	131.55	0	0
Slope (%) :	4	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	1.54	0	0
Computed Flow Time (min) :	1.42	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	358.95	0	0
Channel Slope (%) :	0.3	0	0
Cross Section Area (ft^2) :	13.52	0	0
Wetted Perimeter (ft) :	11.63	0	0
Velocity (ft/sec) :	3.01	0	0
Computed Flow Time (min) :	1.99	0	0

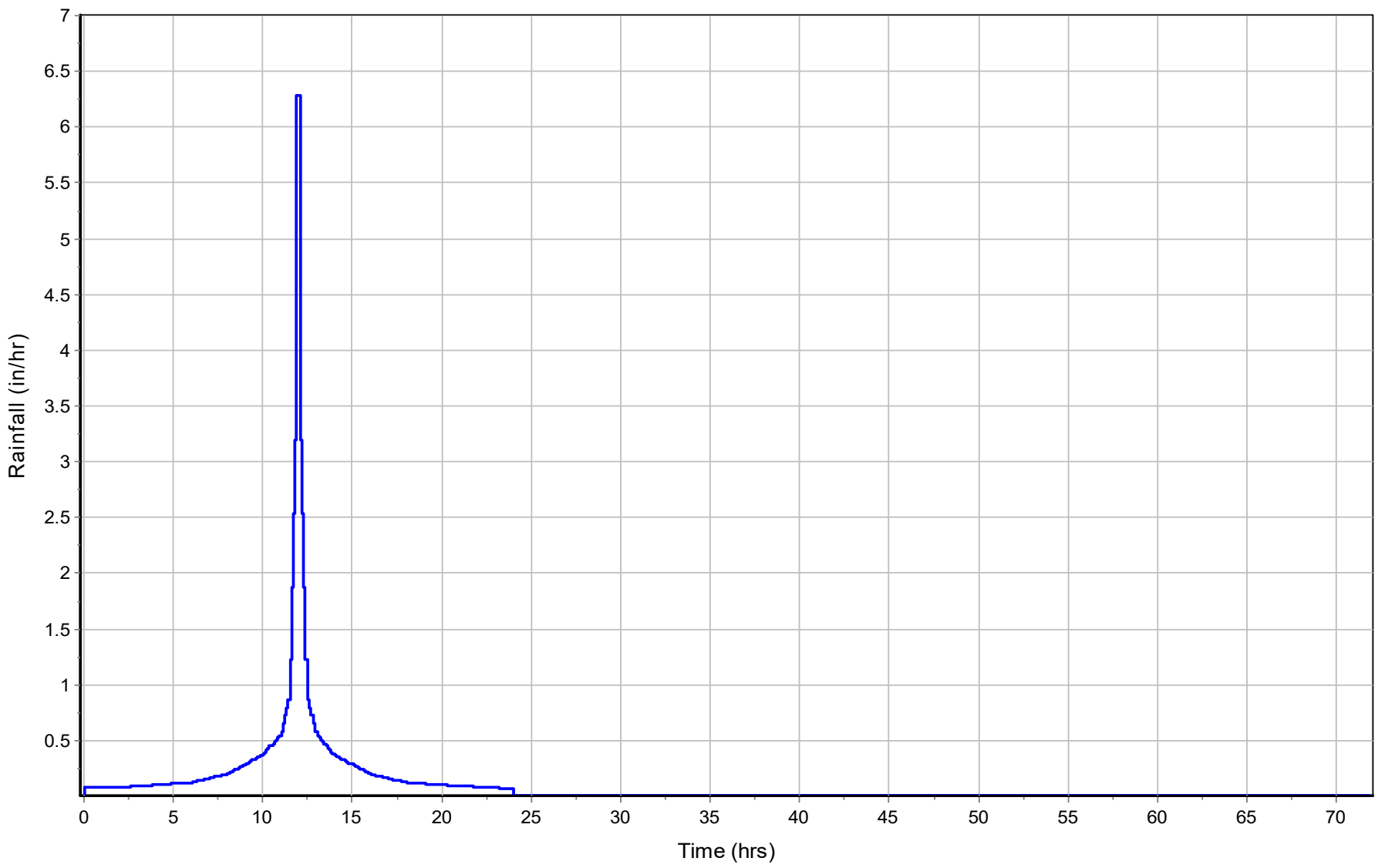
Total TOC (min) 3.41

Subbasin Runoff Results

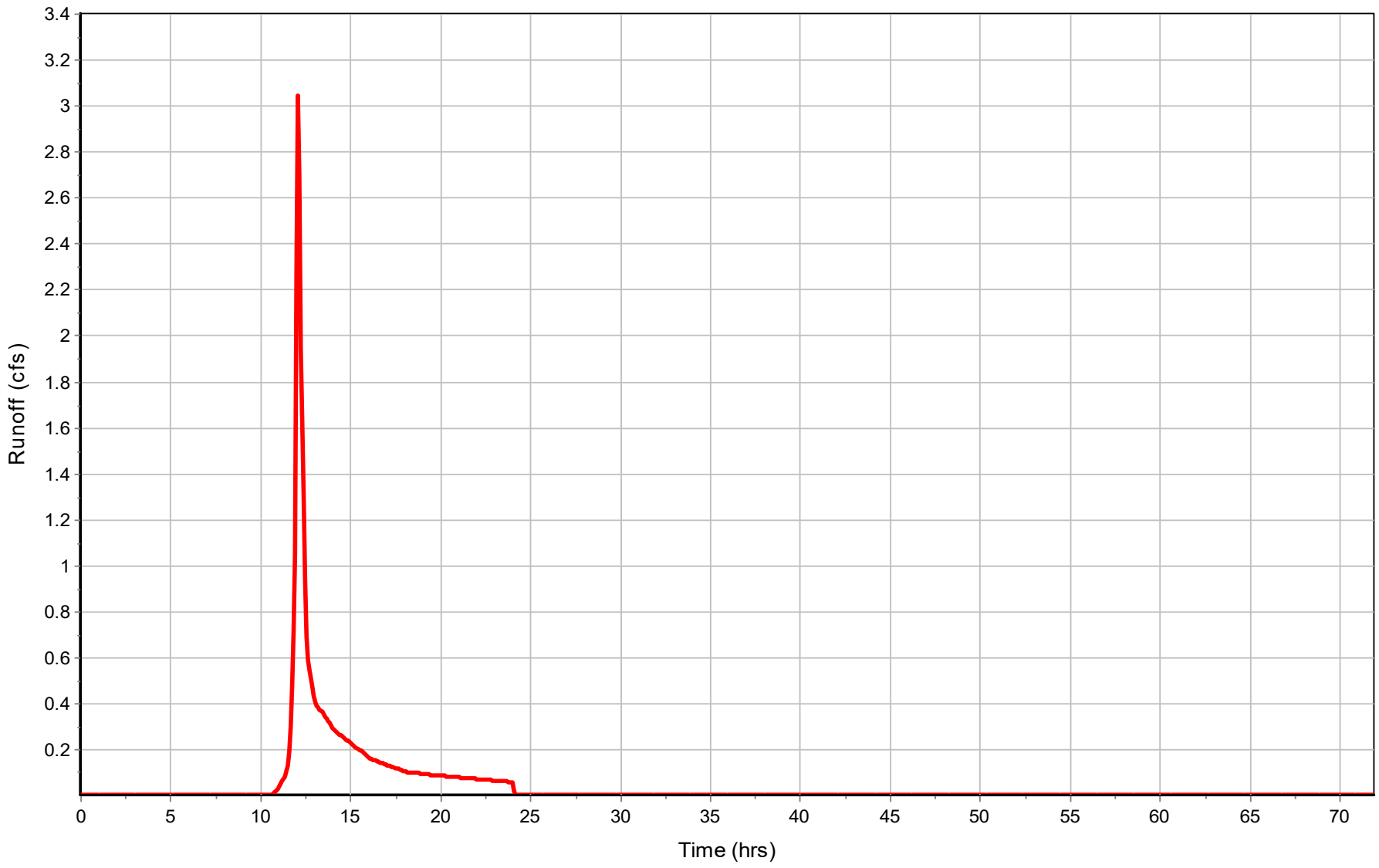
Total Rainfall (in) 7.47
Total Runoff (in) 2.39
Peak Runoff (cfs) 3.24
Weighted Curve Number 54.63
Time of Concentration (days hh:mm:ss) 0 00:03:25

Subbasin : A1-2

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : A1-3

Input Data

Area (ac) 1.03
Peak Rate Factor 484
Weighted Curve Number 49
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	1.03	A	49
Composite Area & Weighted CN	1.03		49

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.4	0	0
Flow Length (ft) :	300	0	0
Slope (%) :	4	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.13	0	0
Computed Flow Time (min) :	37.97	0	0

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	13.33	0	0
Slope (%) :	4	0	0
Surface Type :	Grassed waterway	Unpaved	Unpaved
Velocity (ft/sec) :	3	0	0
Computed Flow Time (min) :	0.07	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	403.18	0	0
Channel Slope (%) :	0.3	0	0
Cross Section Area (ft^2) :	13.52	0	0
Wetted Perimeter (ft) :	11.63	0	0
Velocity (ft/sec) :	3.01	0	0
Computed Flow Time (min) :	2.23	0	0

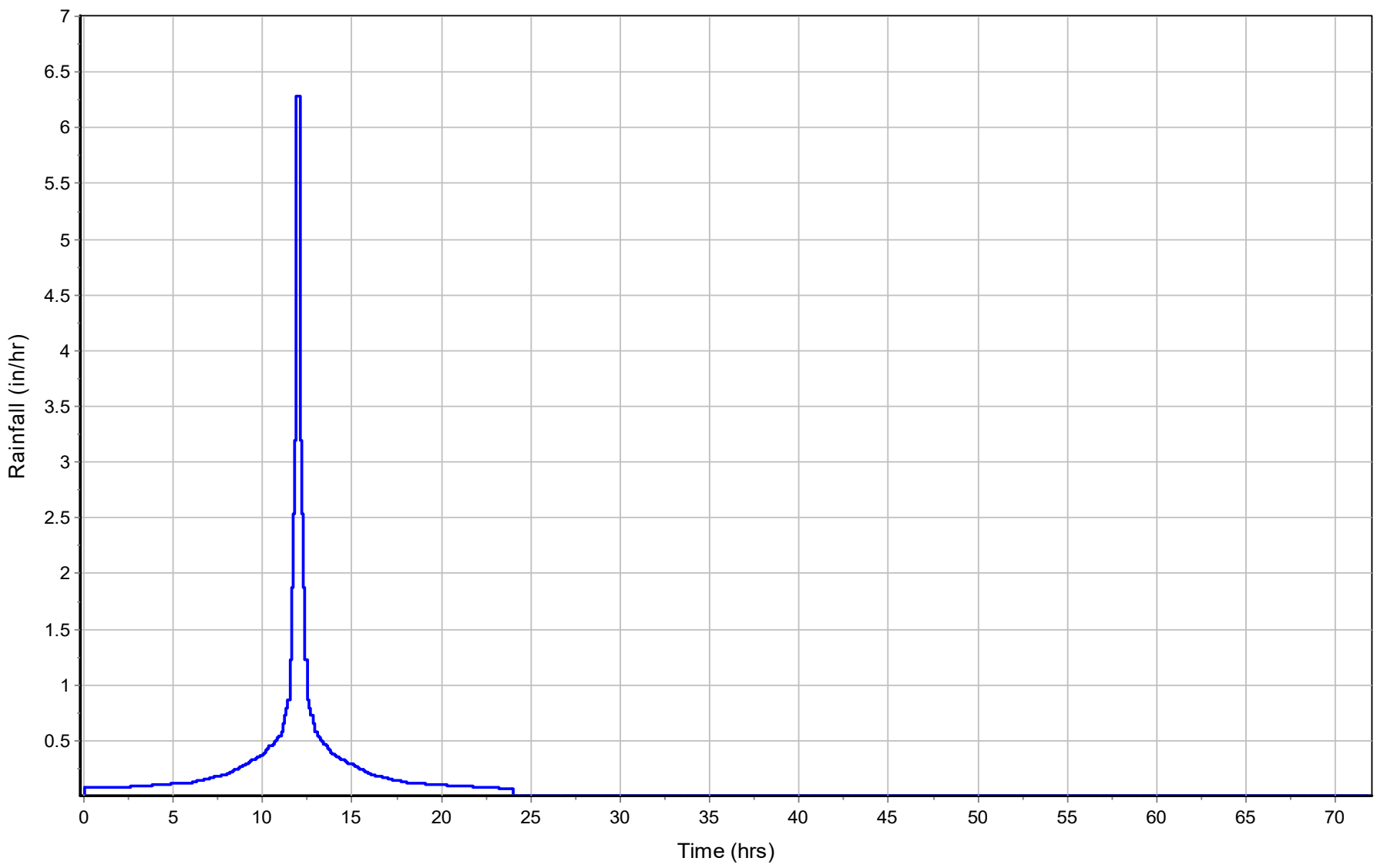
Total TOC (min) 40.27

Subbasin Runoff Results

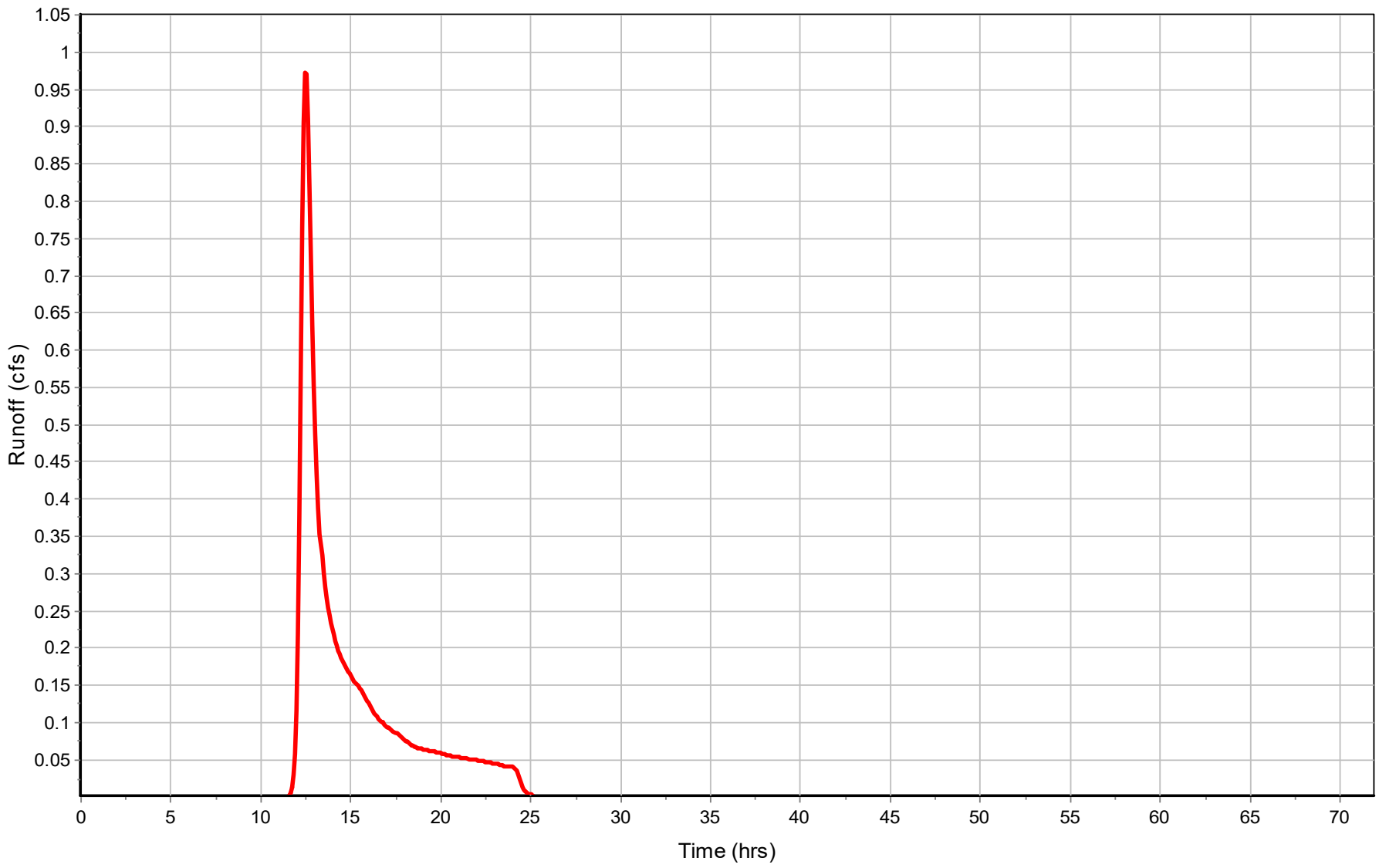
Total Rainfall (in) 7.47
Total Runoff (in) 1.84
Peak Runoff (cfs) 0.98
Weighted Curve Number 49
Time of Concentration (days hh:mm:ss) 0 00:40:16

Subbasin : A1-3

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : A2

Input Data

Area (ac) 0.92
Peak Rate Factor 484
Weighted Curve Number 76
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	0.92	A	76
Composite Area & Weighted CN	0.92		76

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	85.5	0	0
Slope (%) :	1.5	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.96	0	0
Computed Flow Time (min) :	1.49	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	255.68	0	0
Channel Slope (%) :	1.17	0	0
Cross Section Area (ft^2) :	1.475	0	0
Wetted Perimeter (ft) :	5.99	0	0
Velocity (ft/sec) :	2.11	0	0
Computed Flow Time (min) :	2.02	0	0

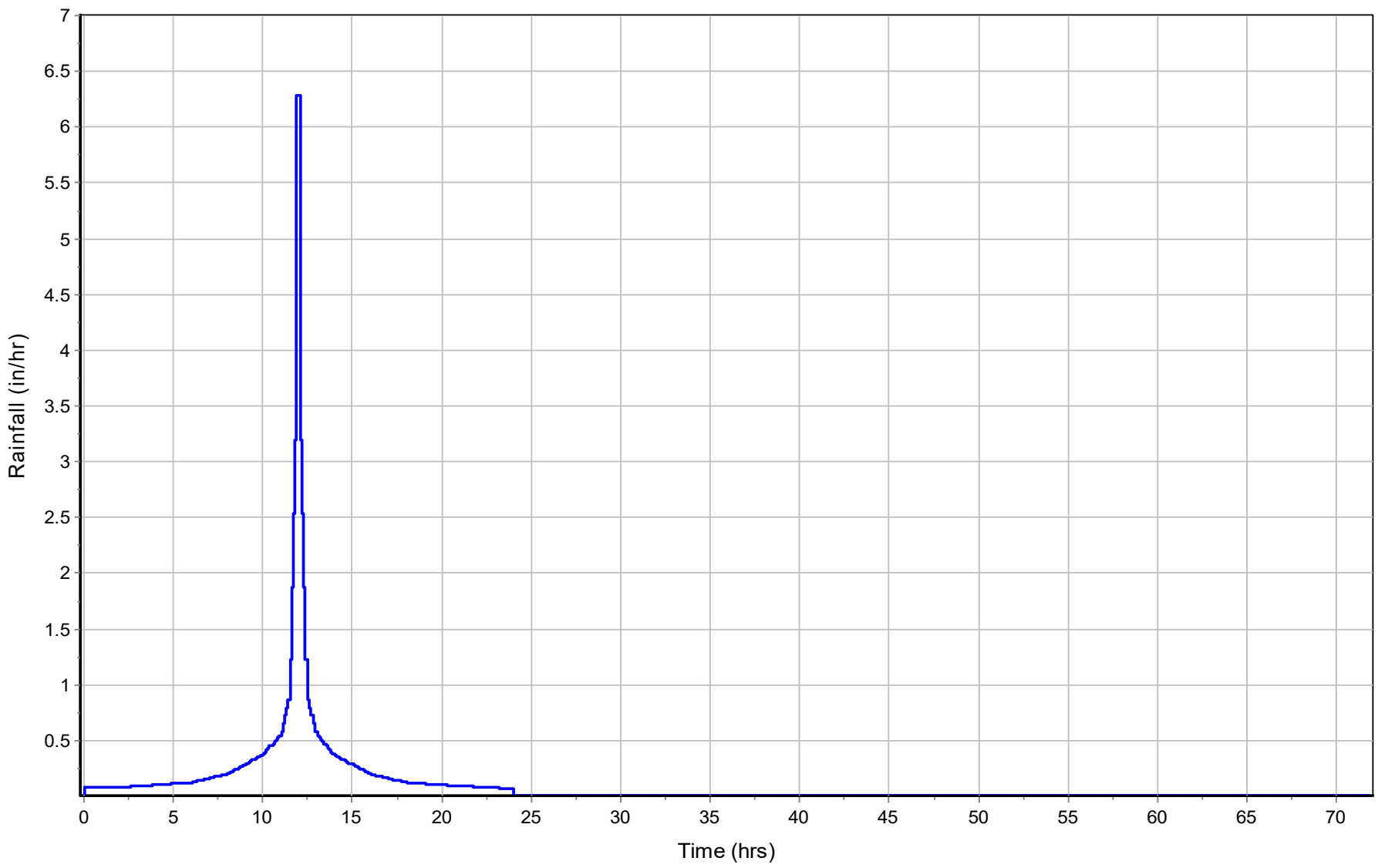
Total TOC (min) 3.51

Subbasin Runoff Results

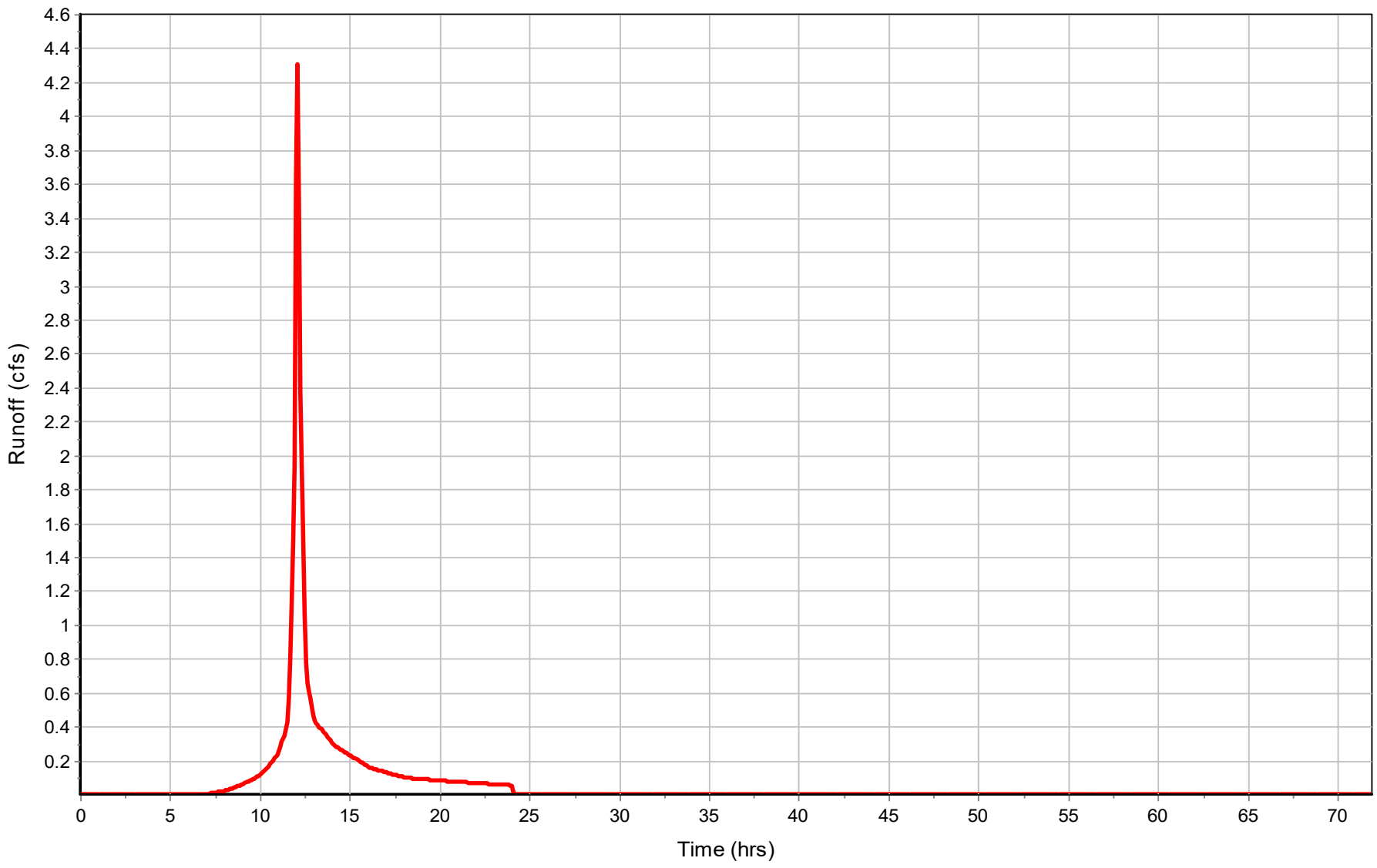
Total Rainfall (in) 7.47
Total Runoff (in) 4.68
Peak Runoff (cfs) 4.39
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:03:31

Subbasin : A2

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : A-3

Input Data

Area (ac) 0.25
Peak Rate Factor 484
Weighted Curve Number 51.7
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
-	0.23	-	49
-	0.03	-	76
Composite Area & Weighted CN	0.26		51.7

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.4	0	0
Flow Length (ft) :	300	0	0
Slope (%) :	5	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.14	0	0
Computed Flow Time (min) :	34.72	0	0

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	83.1895	0	0
Slope (%) :	2	0	0
Surface Type :	Grass pasture	Unpaved	Unpaved
Velocity (ft/sec) :	0.99	0	0
Computed Flow Time (min) :	1.4	0	0

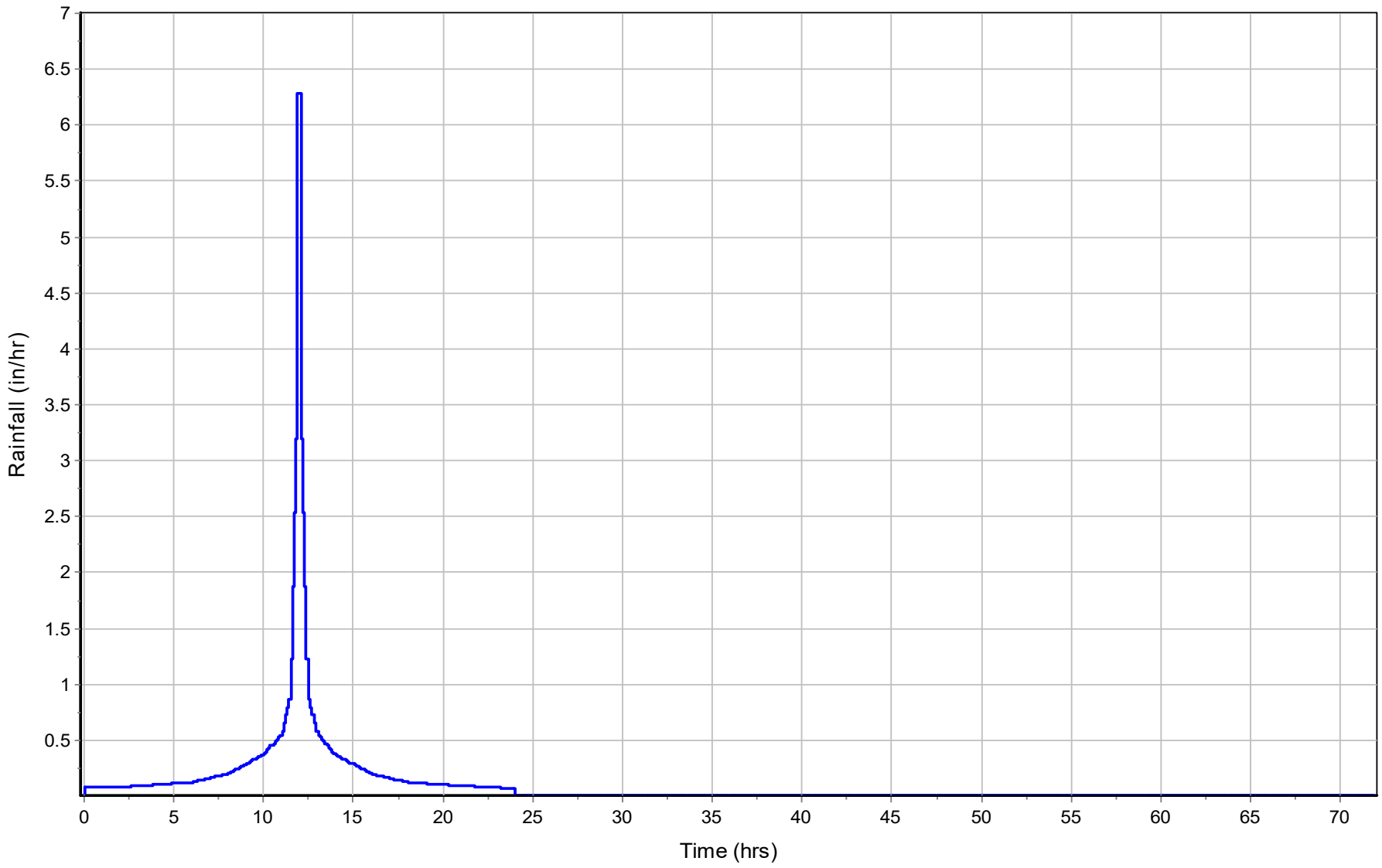
Total TOC (min) 36.12

Subbasin Runoff Results

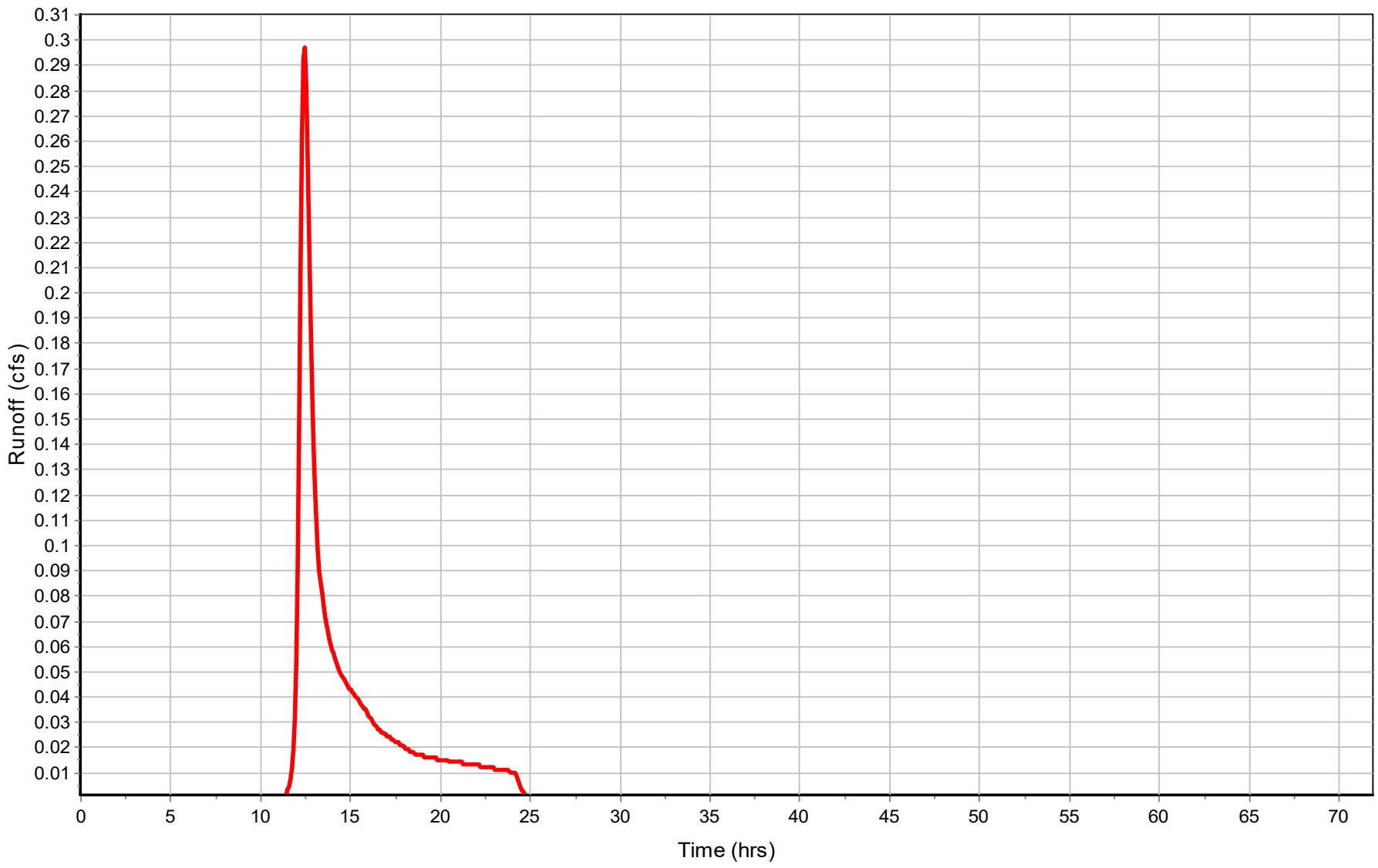
Total Rainfall (in) 7.47
Total Runoff (in) 2.1
Peak Runoff (cfs) 0.3
Weighted Curve Number 51.7
Time of Concentration (days hh:mm:ss) 0 00:36:07

Subbasin : A-3

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : DA-Ditch-A1

Input Data

Area (ac) 1.35
Peak Rate Factor 484
Weighted Curve Number 76
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
50 - 75% grass cover, Fair	1.35	A	76
Composite Area & Weighted CN	1.35		76

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	217.17	0	0
Slope (%) :	1.5	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	1.15	0	0
Computed Flow Time (min) :	3.14	0	0

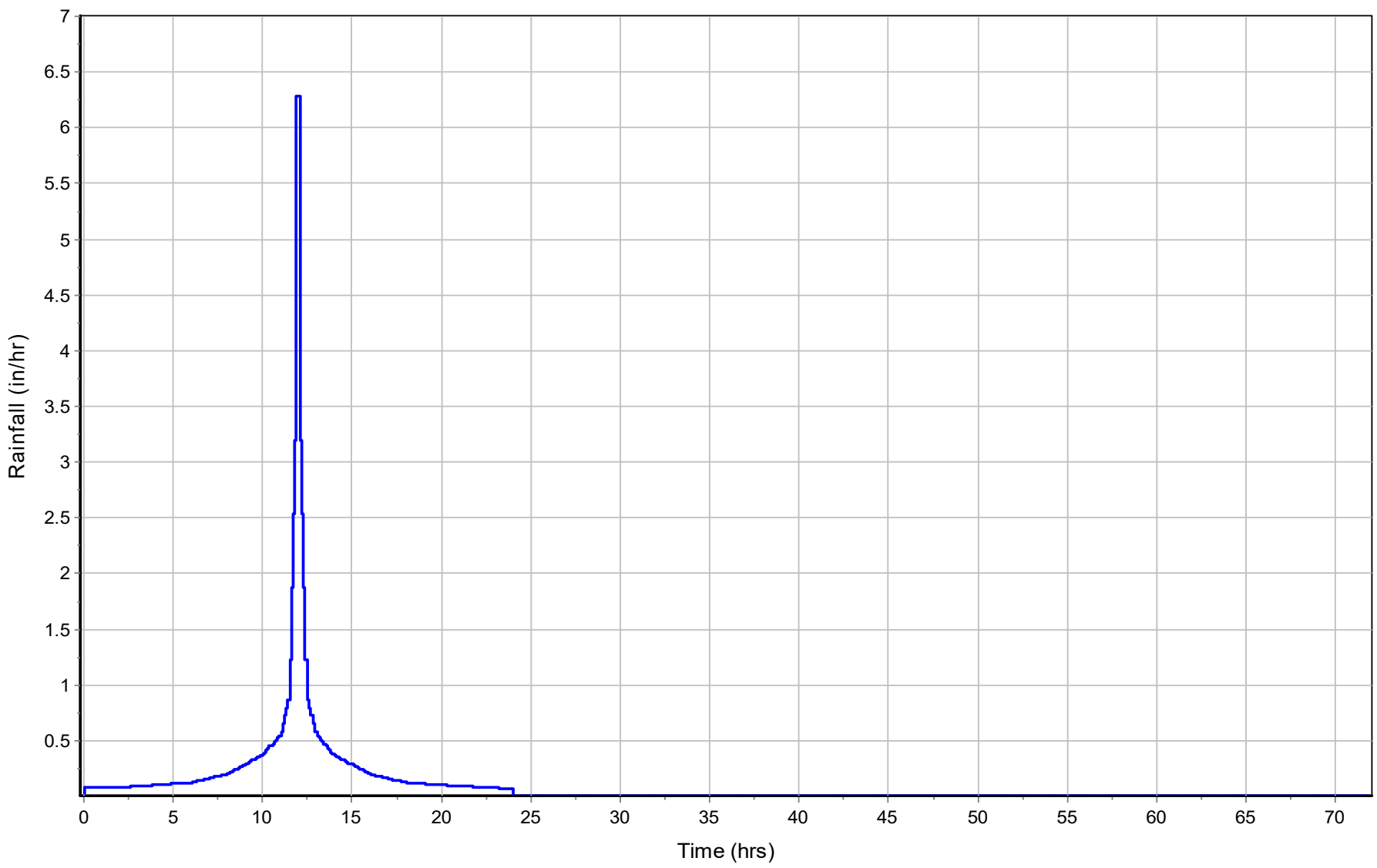
Total TOC (min) 3.14

Subbasin Runoff Results

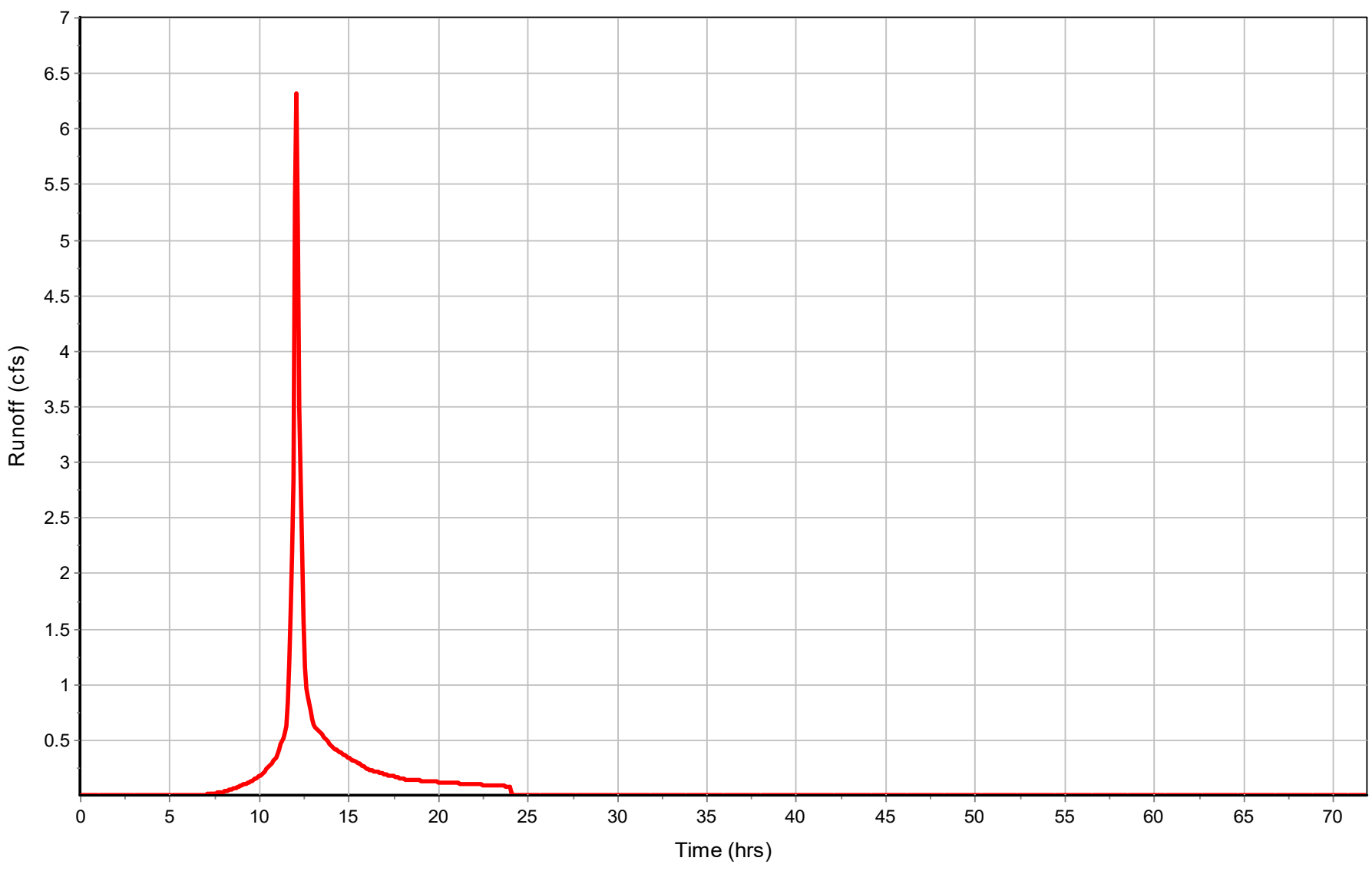
Total Rainfall (in) 7.47
Total Runoff (in) 4.68
Peak Runoff (cfs) 6.44
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:03:08

Subbasin : DA-Ditch-A1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : DA-Ditch-A1-2

Input Data

Area (ac) 1.29
Peak Rate Factor 484
Weighted Curve Number 76
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
50 - 75% grass cover, Fair	1.29	A	76
Composite Area & Weighted CN	1.29		76

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	131.55	0	0
Slope (%) :	1.5	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	1.04	0	0
Computed Flow Time (min) :	2.1	0	0

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	7.88	0	0
Slope (%) :	1.5	0	0
Surface Type :	Unpaved	Unpaved	Unpaved
Velocity (ft/sec) :	1.98	0	0
Computed Flow Time (min) :	0.07	0	0

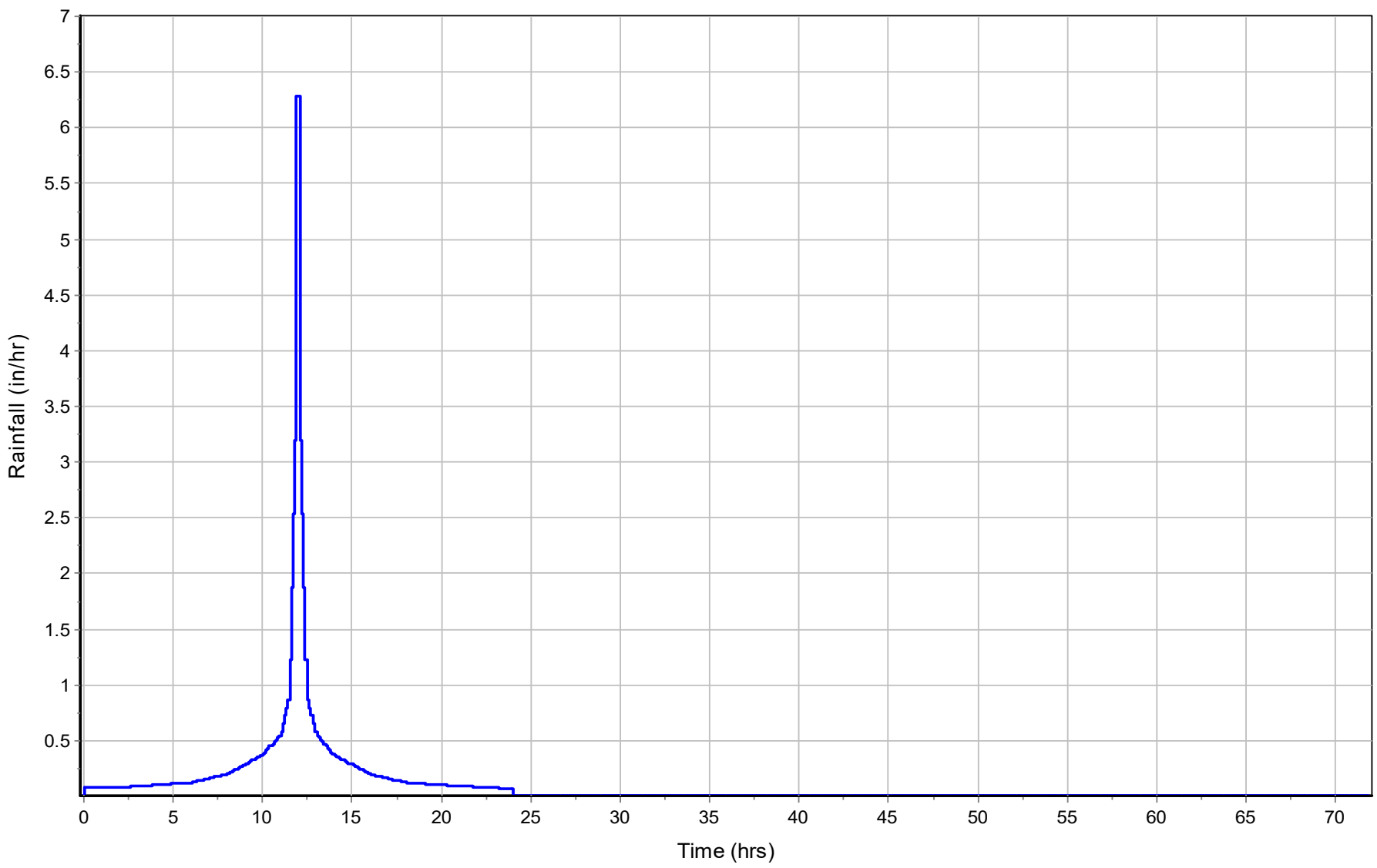
Total TOC (min) 2.17

Subbasin Runoff Results

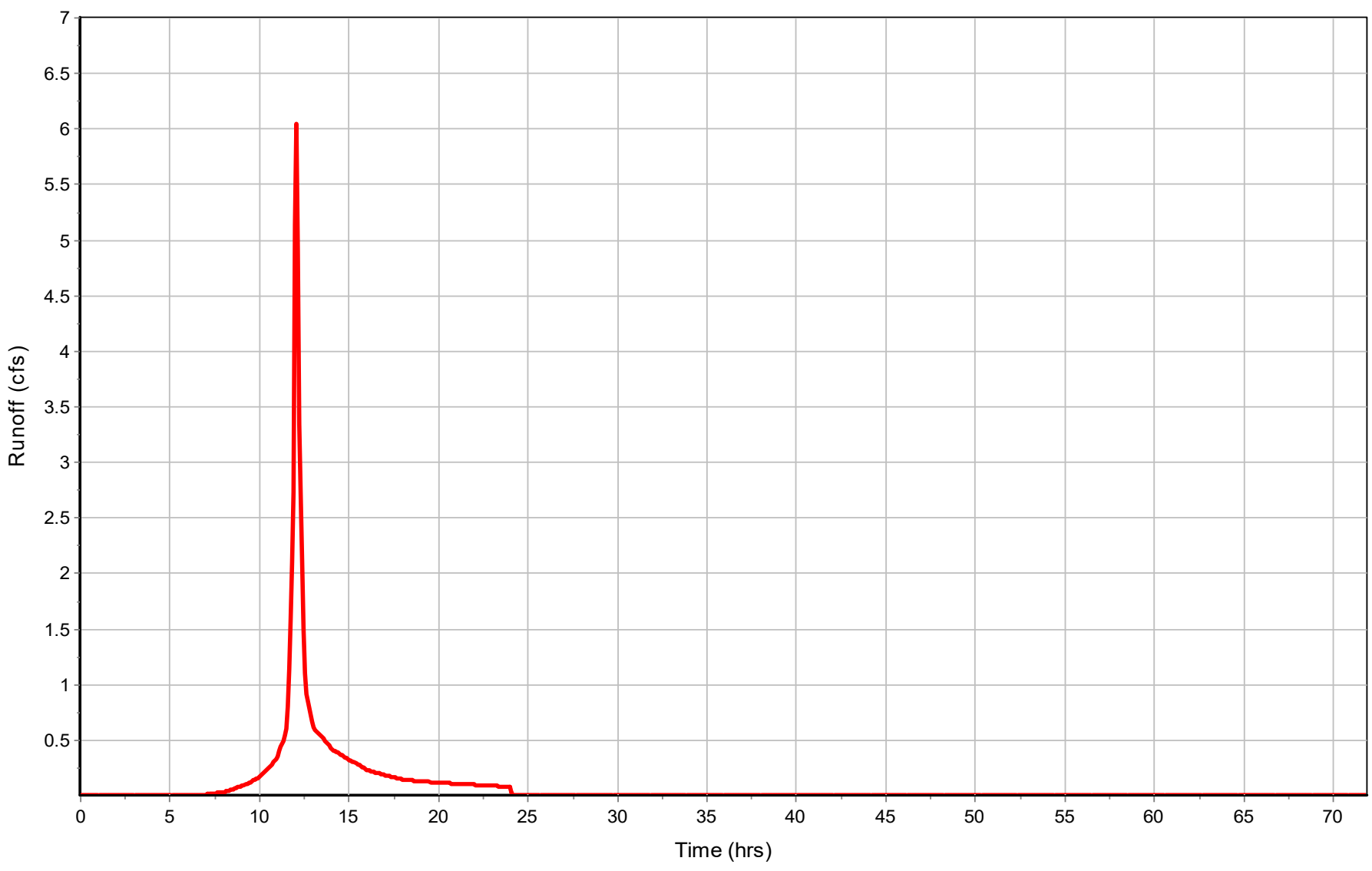
Total Rainfall (in) 7.47
Total Runoff (in) 4.68
Peak Runoff (cfs) 6.16
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:02:10

Subbasin : DA-Ditch-A1-2

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : DA-Ditch-A2

Input Data

Area (ac)	0.67
Peak Rate Factor	484
Weighted Curve Number	76
Rain Gage ID	Rain Gage-01

Composite Curve Number

32

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
50 - 75% grass cover, Fair	0.67	A	76
Composite Area & Weighted CN	0.67		76

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	300	0	0
Slope (%) :	1.5	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	1.23	0	0
Computed Flow Time (min) :	4.06	0	0

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	7.88	0	0
Slope (%) :	1.5	0	0
Surface Type :	Unpaved	Unpaved	Unpaved
Velocity (ft/sec) :	1.98	0	0
Computed Flow Time (min) :	0.07	0	0

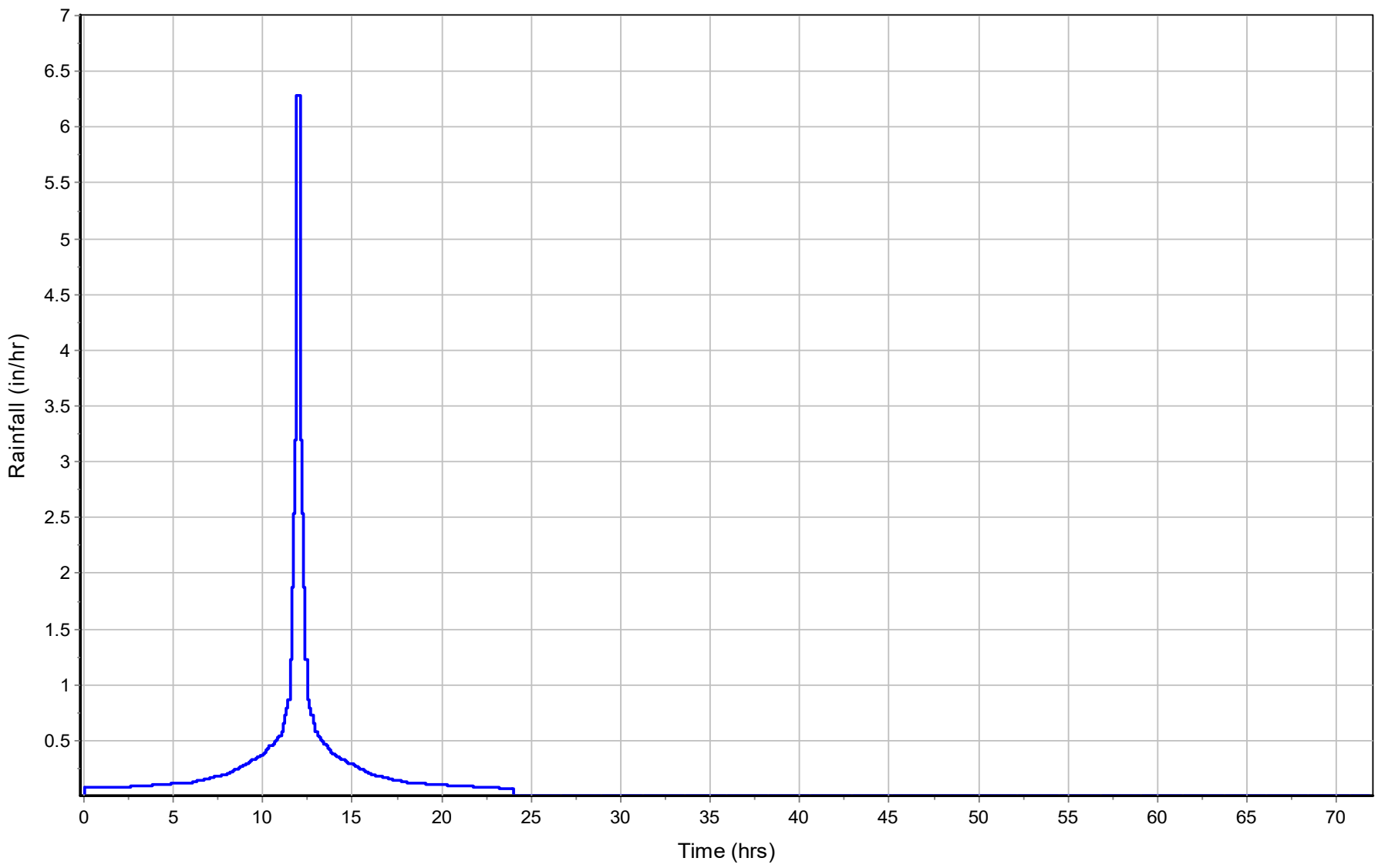
Total TOC (min) 4.13

Subbasin Runoff Results

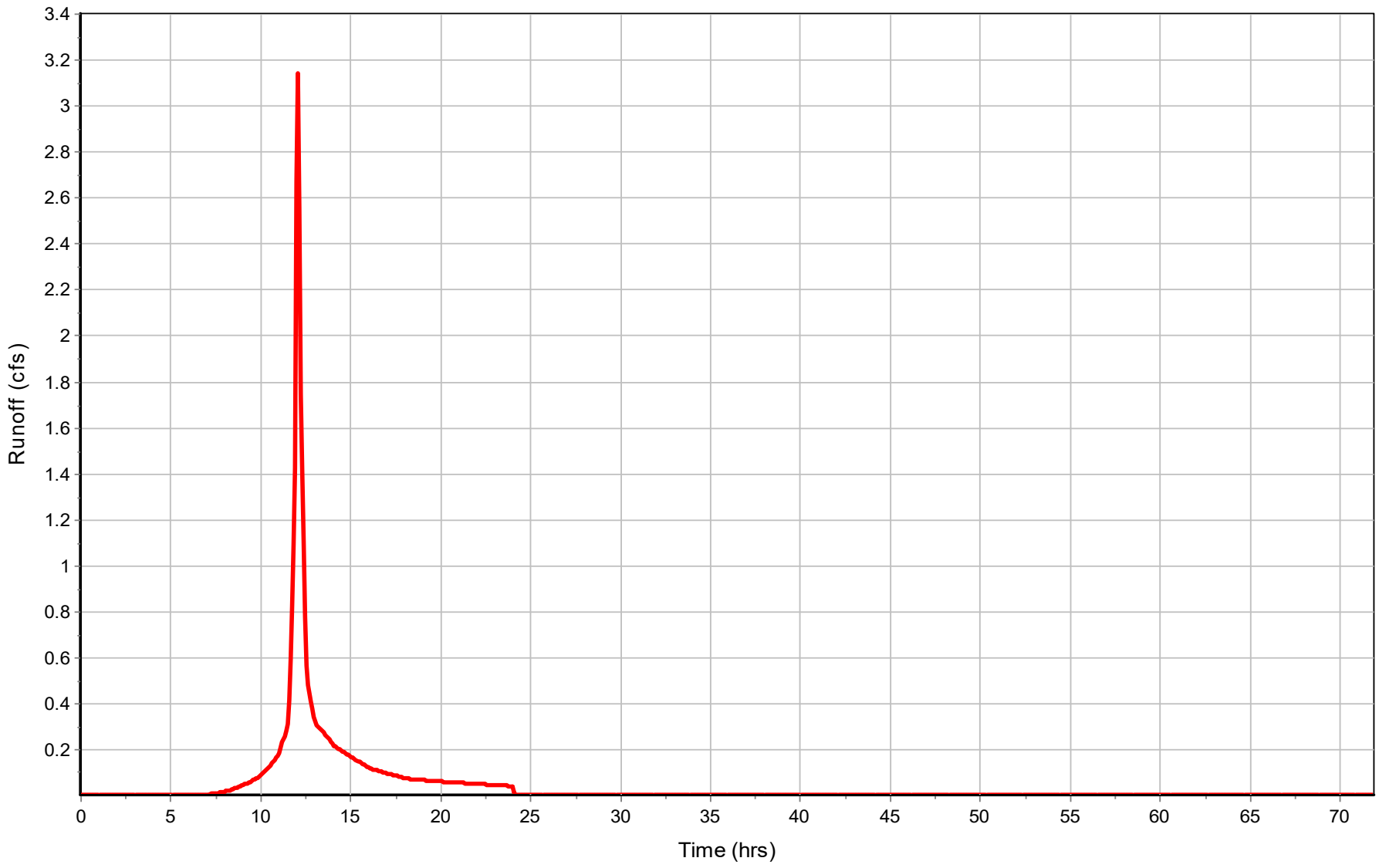
Total Rainfall (in)	7.47
Total Runoff (in)	4.68
Peak Runoff (cfs)	3.2
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:04:08

Subbasin : DA-Ditch-A2

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Existing-E03-1_A1

Input Data

Area (ac)	0.89
Peak Rate Factor	484
Weighted Curve Number	49
Rain Gage ID	Rain Gage-01

Composite Curve Number

32

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
50 - 75% grass cover, Fair	0.89	A	49
Composite Area & Weighted CN	0.89		49

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.4	0	0
Flow Length (ft) :	251.94	0	0
Slope (%) :	3.5	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.12	0	0
Computed Flow Time (min) :	34.83	0	0

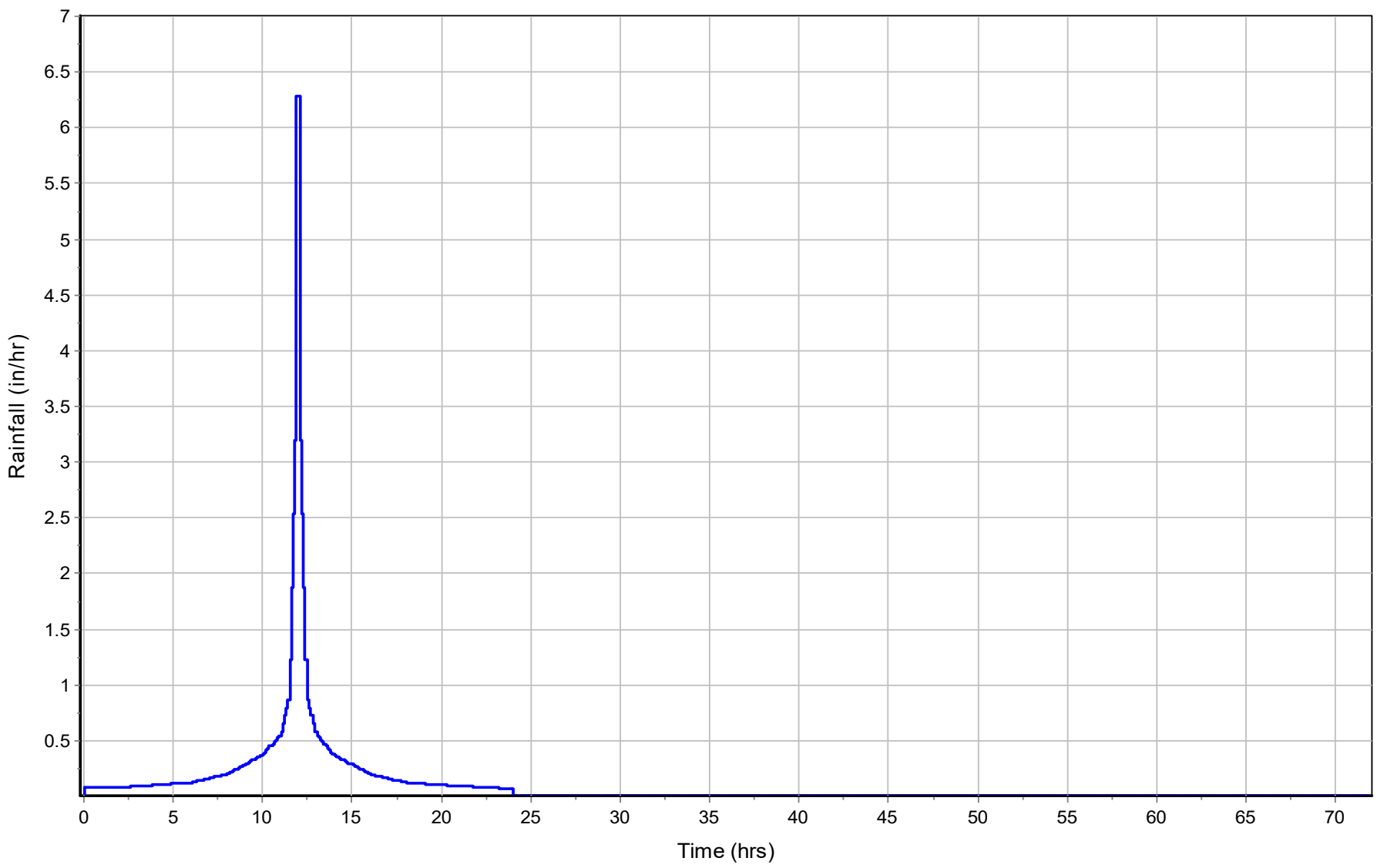
Total TOC (min) 34.83

Subbasin Runoff Results

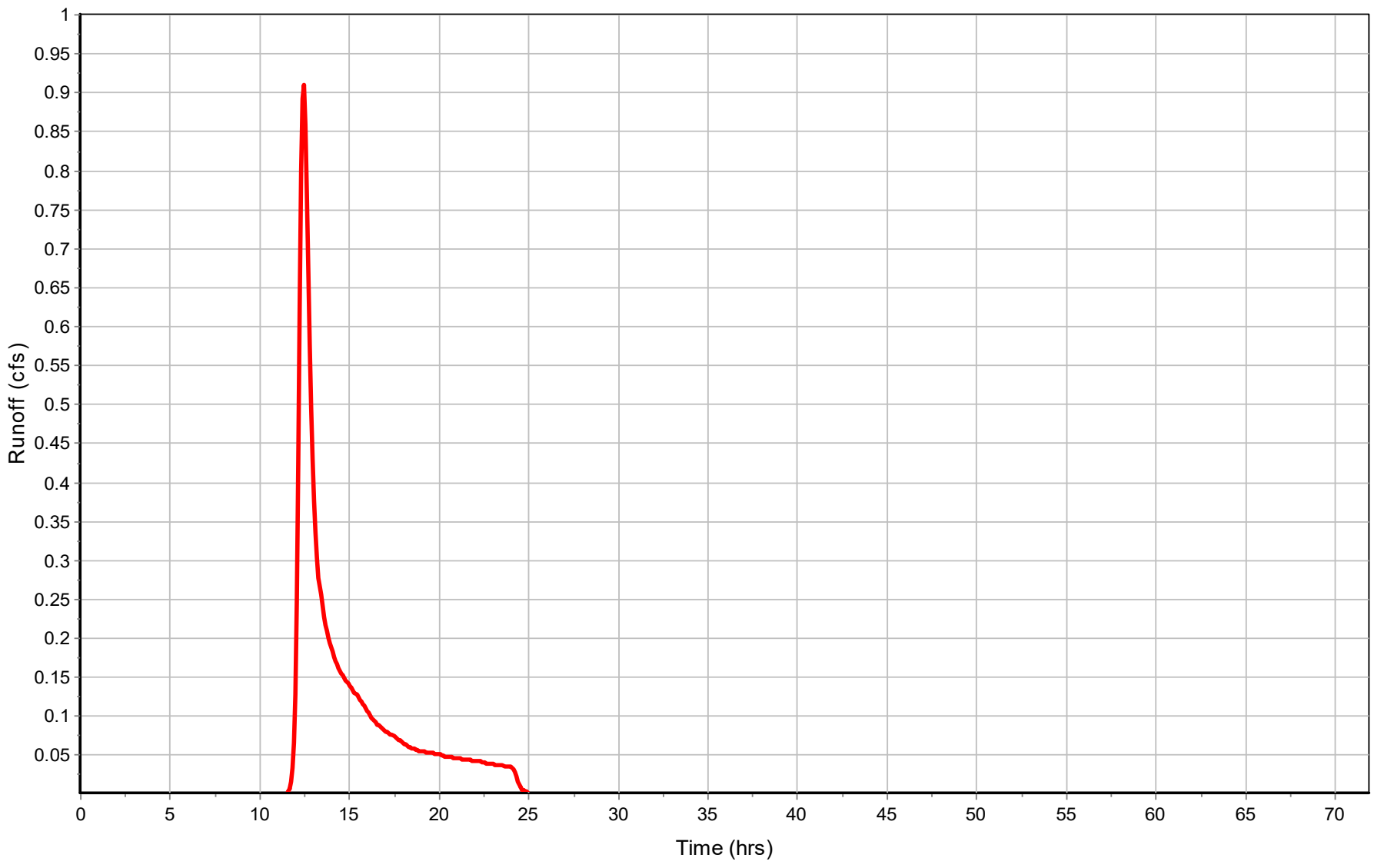
Total Rainfall (in)	7.47
Total Runoff (in)	1.84
Peak Runoff (cfs)	0.91
Weighted Curve Number	49
Time of Concentration (days hh:mm:ss)	0 00:34:50

Subbasin : Existing-E03-1_A1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Existing-E-07_A3

Input Data

Area (ac)	0.39
Peak Rate Factor	484
Weighted Curve Number	51.7
Rain Gage ID	Rain Gage-01

Composite Curve Number

32

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
50 - 75% grass cover, Fair	0.35	A	49
-	0.04	-	76
Composite Area & Weighted CN	0.39		51.7

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.4	0	0
Flow Length (ft) :	300	0	0
Slope (%) :	5	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.14	0	0
Computed Flow Time (min) :	34.72	0	0

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	105.18	0	0
Slope (%) :	2	0	0
Surface Type :	Grass pasture	Unpaved	Unpaved
Velocity (ft/sec) :	0.99	0	0
Computed Flow Time (min) :	1.77	0	0

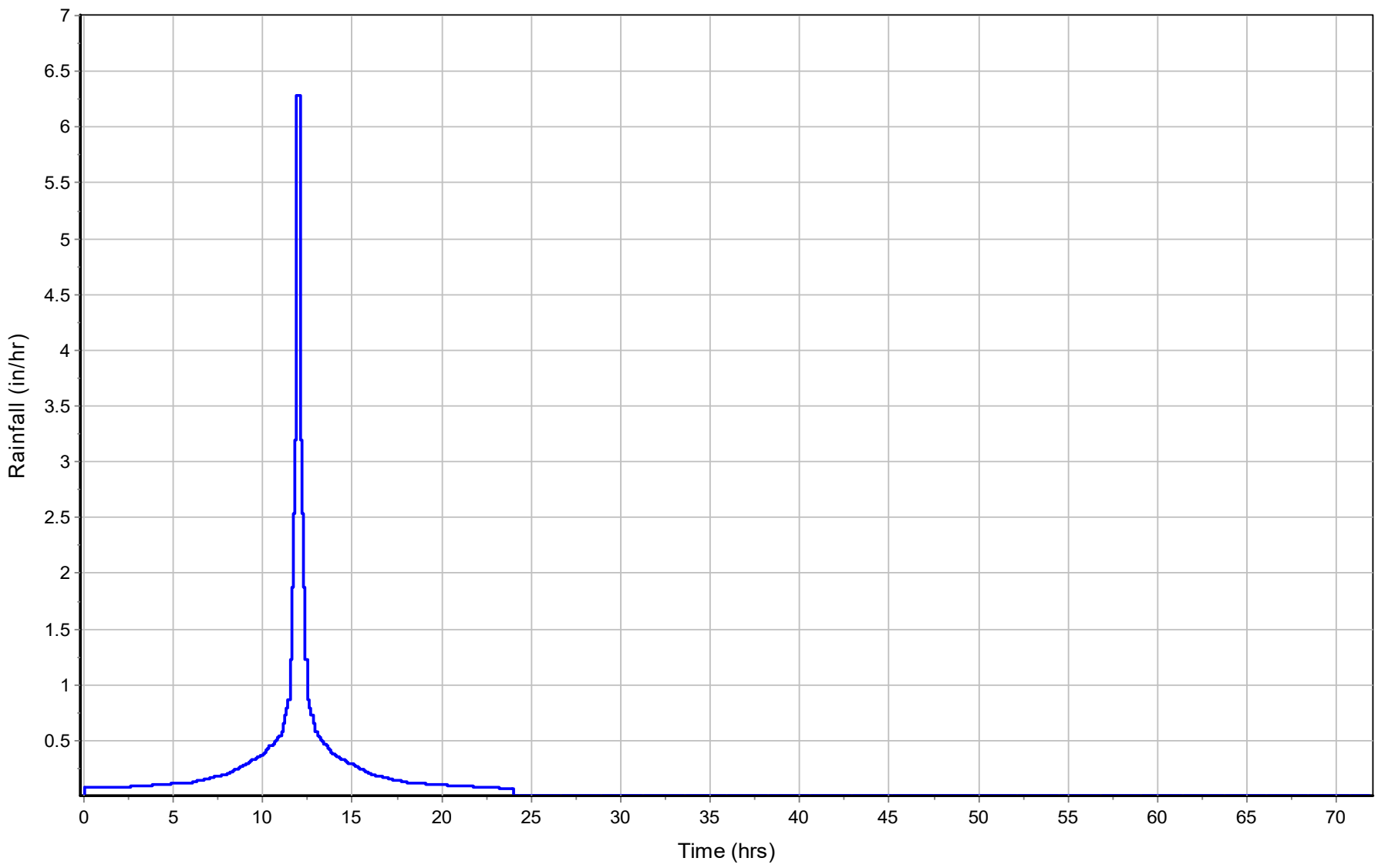
Total TOC (min) 36.49

Subbasin Runoff Results

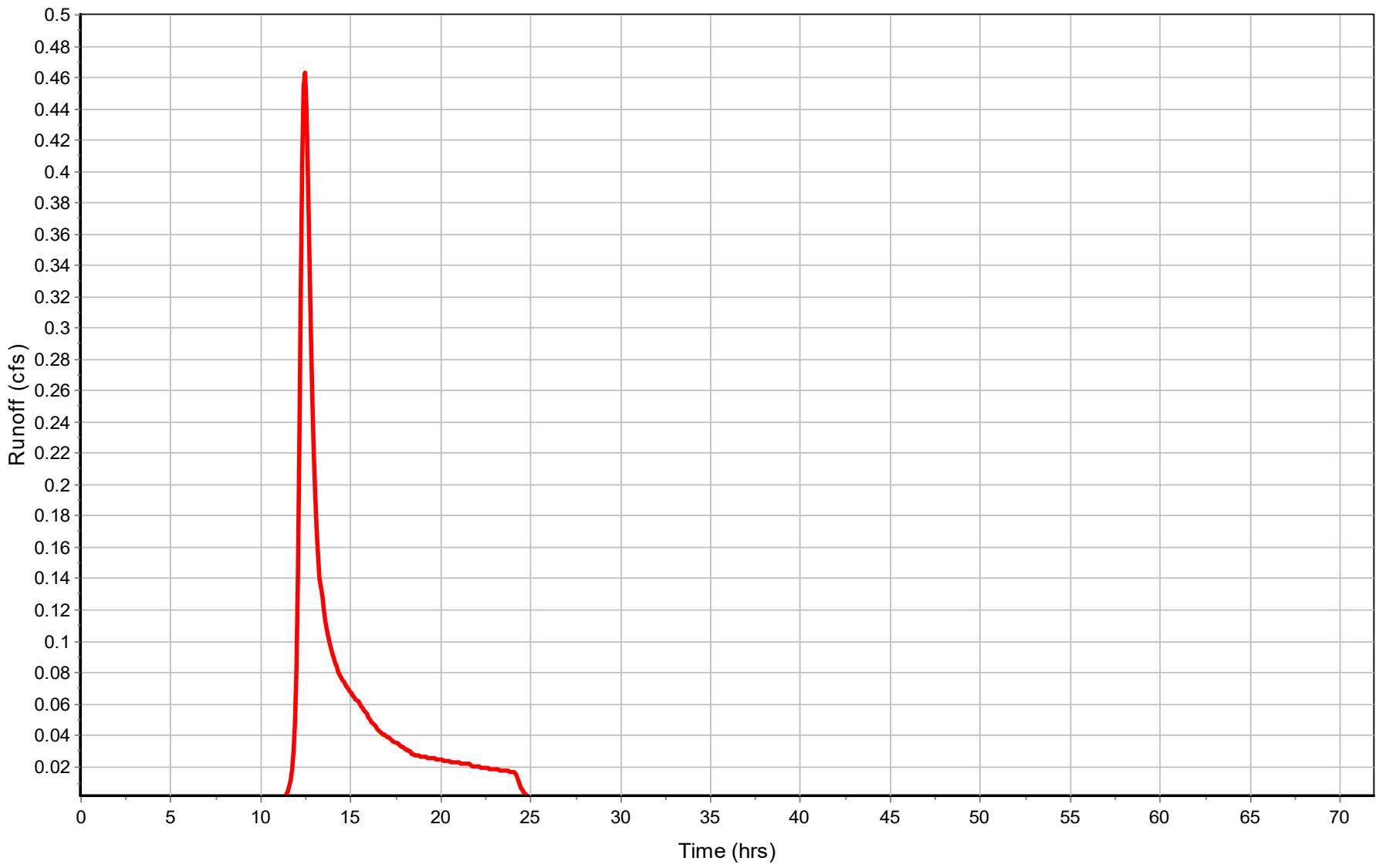
Total Rainfall (in)	7.47
Total Runoff (in)	2.1
Peak Runoff (cfs)	0.46
Weighted Curve Number	51.7
Time of Concentration (days hh:mm:ss)	0 00:36:29

Subbasin : Existing-E-07_A3

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Existing-E3_A1-2

Input Data

Area (ac)	3.2
Peak Rate Factor	484
Weighted Curve Number	49
Rain Gage ID	Rain Gage-01

Composite Curve Number

32

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
-	3.2	-	49
Composite Area & Weighted CN	3.2		49

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.4	0	0
Flow Length (ft) :	300	0	0
Slope (%) :	3.5	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.12	0	0
Computed Flow Time (min) :	40.05	0	0

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	205.17	0	0
Slope (%) :	3	0	0
Surface Type :	Grass pasture	Unpaved	Unpaved
Velocity (ft/sec) :	1.21	0	0
Computed Flow Time (min) :	2.83	0	0

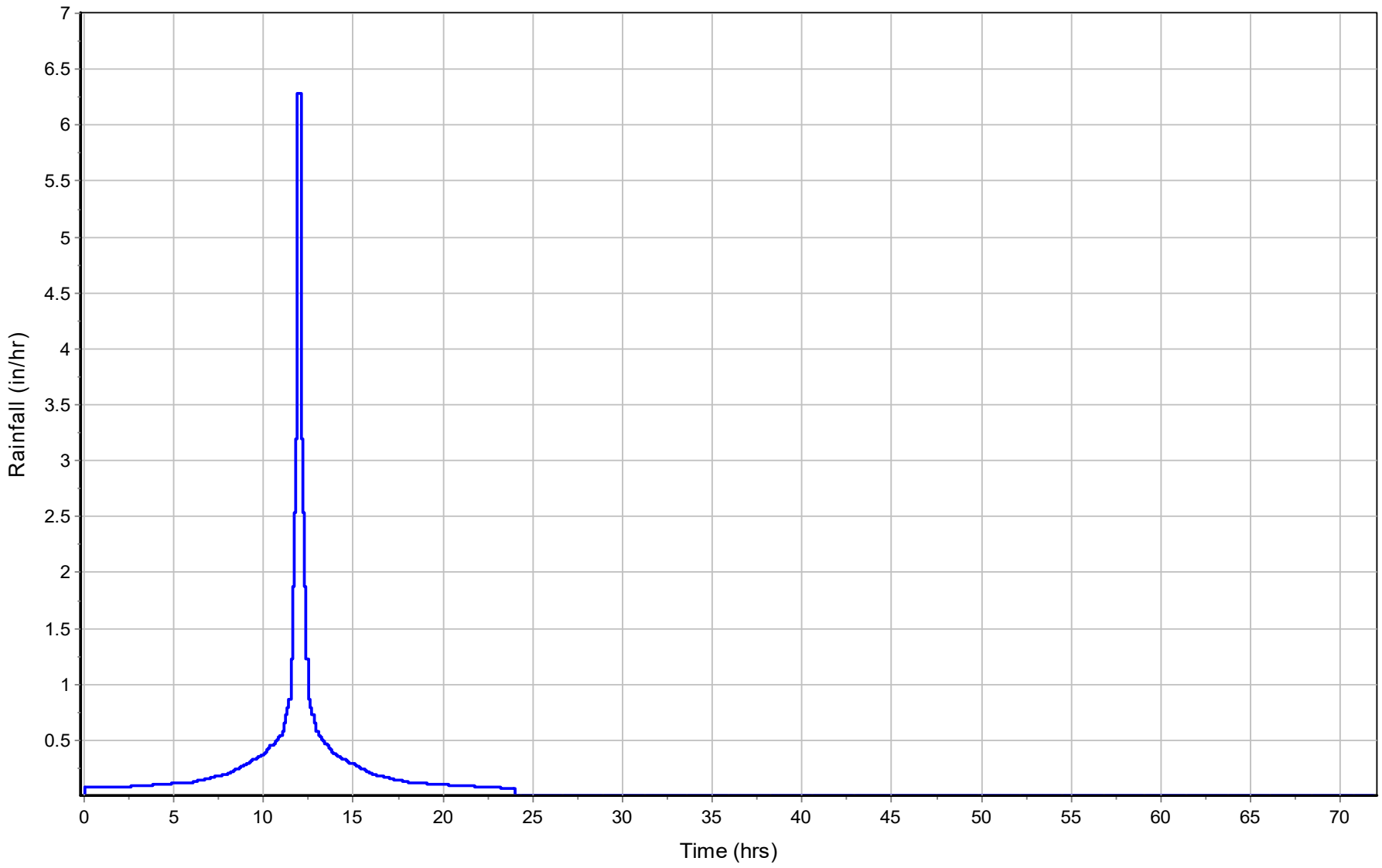
Total TOC (min) 42.87

Subbasin Runoff Results

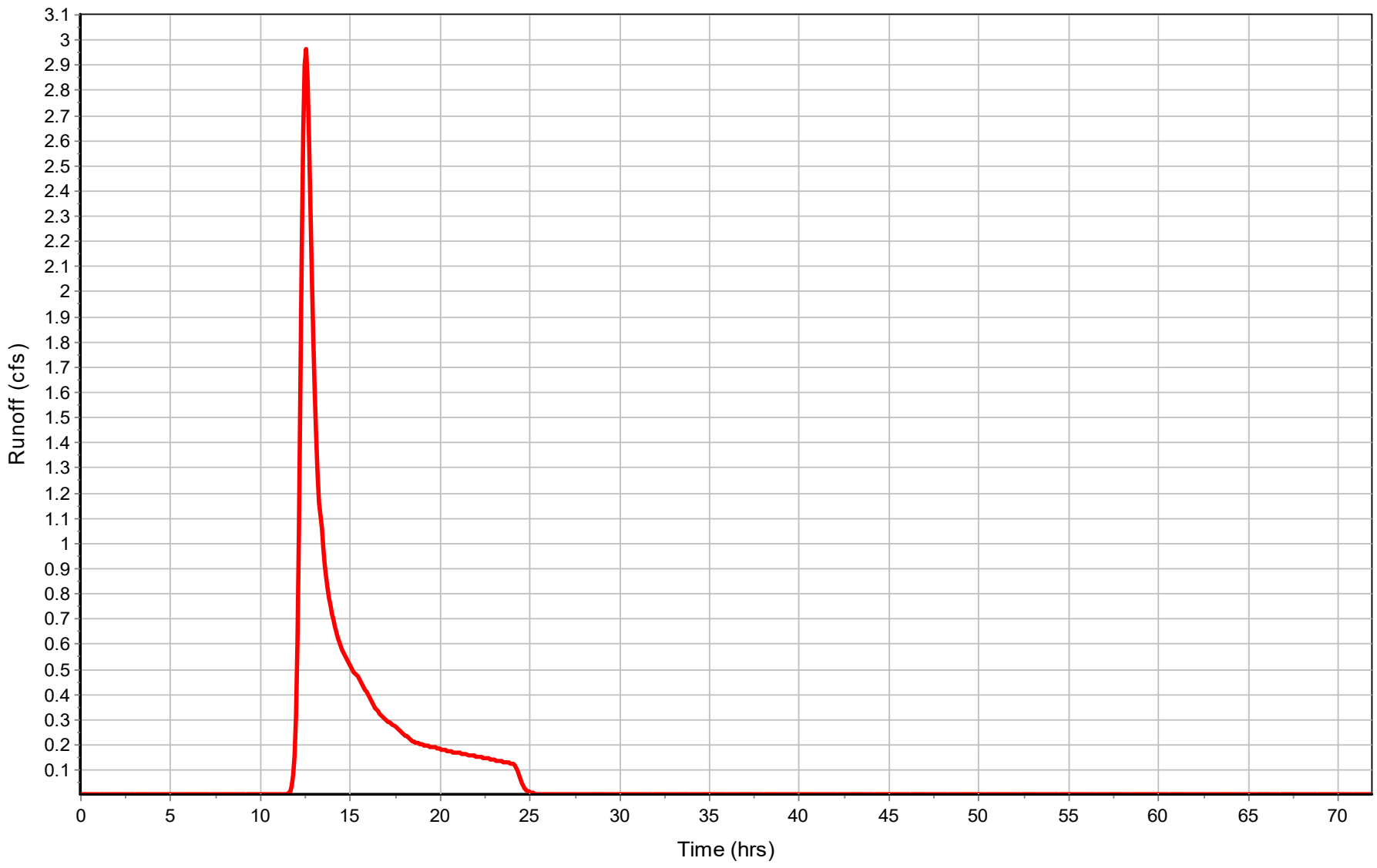
Total Rainfall (in)	7.47
Total Runoff (in)	1.84
Peak Runoff (cfs)	2.96
Weighted Curve Number	49
Time of Concentration (days hh:mm:ss)	0 00:42:52

Subbasin : Existing-E3_A1-2

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Existing-E5.1_A2

Input Data

Area (ac)	0.26
Peak Rate Factor	484
Weighted Curve Number	49
Rain Gage ID	Rain Gage-01

Composite Curve Number

32

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
50 - 75% grass cover, Fair	0.26	A	49
Composite Area & Weighted CN	0.26		49

Time of Concentration

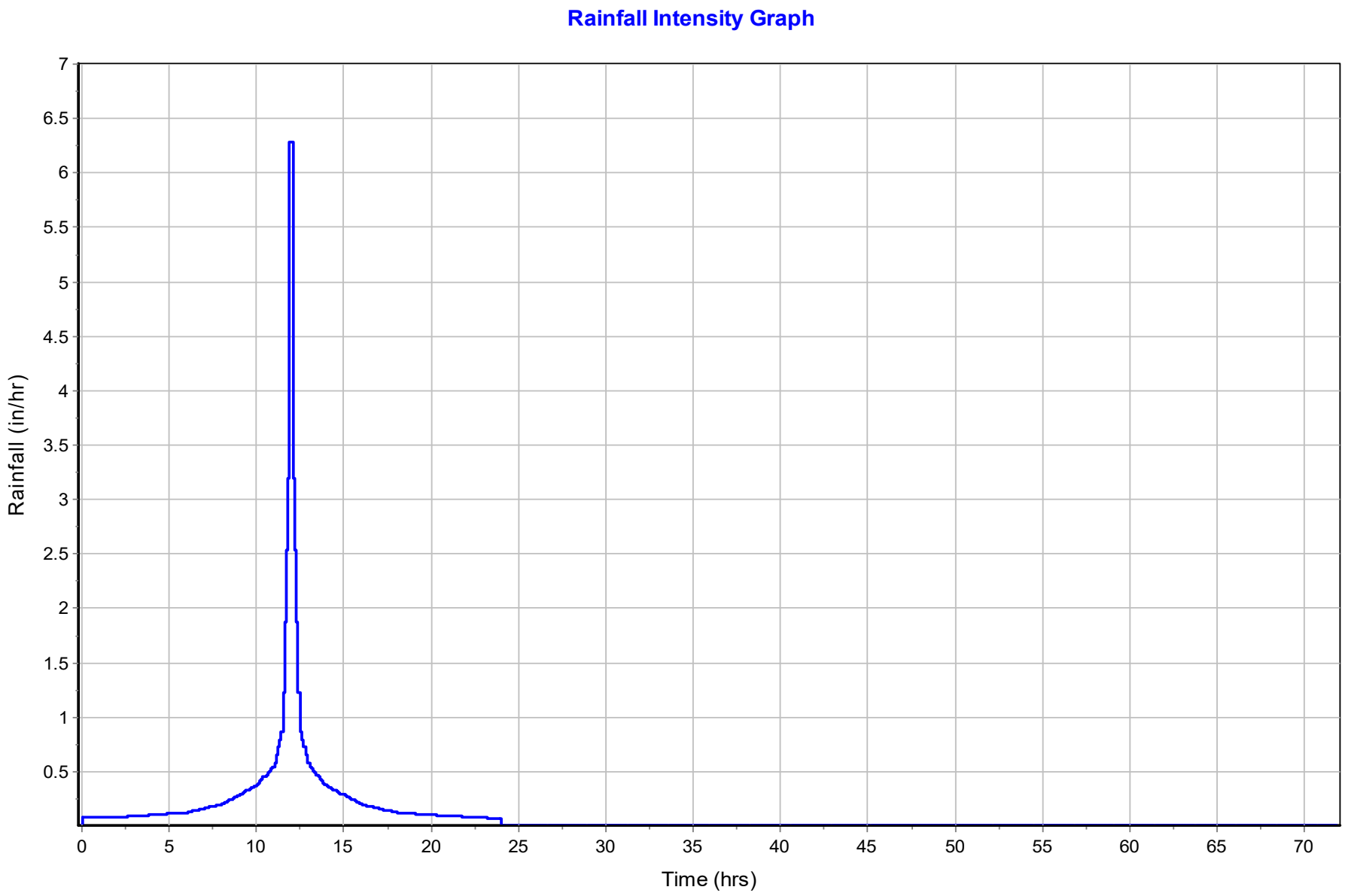
Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.4	0	0
Flow Length (ft) :	142.47	0	0
Slope (%) :	10	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.16	0	0
Computed Flow Time (min) :	14.5	0	0

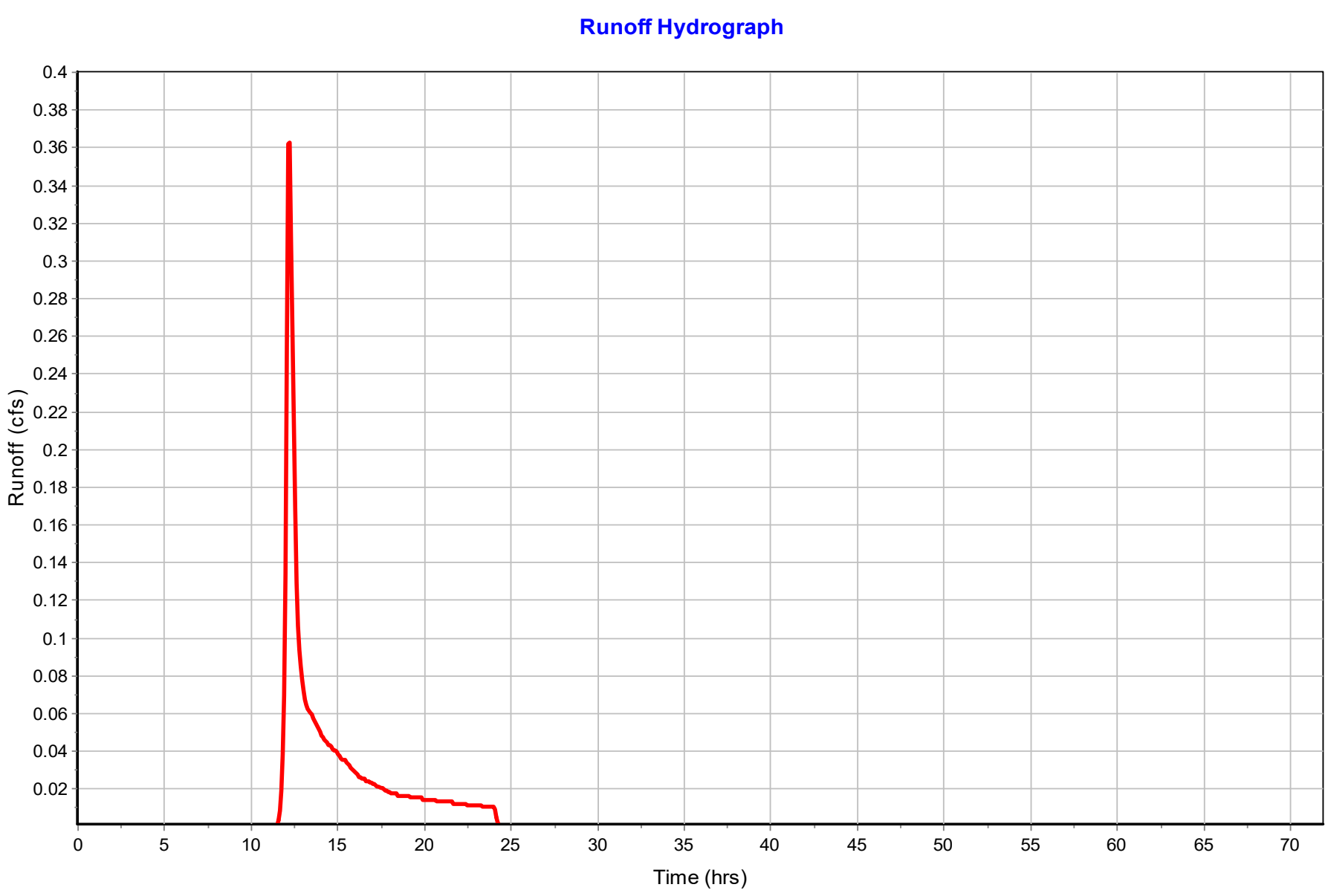
Total TOC (min) 14.50

Subbasin Runoff Results

Total Rainfall (in)	7.47
Total Runoff (in)	1.84
Peak Runoff (cfs)	0.38
Weighted Curve Number	49
Time of Concentration (days hh:mm:ss)	0 00:14:30

Subbasin : Existing-E5.1_A2





Storage Nodes

Storage Node : A1-1-BASIN

Input Data

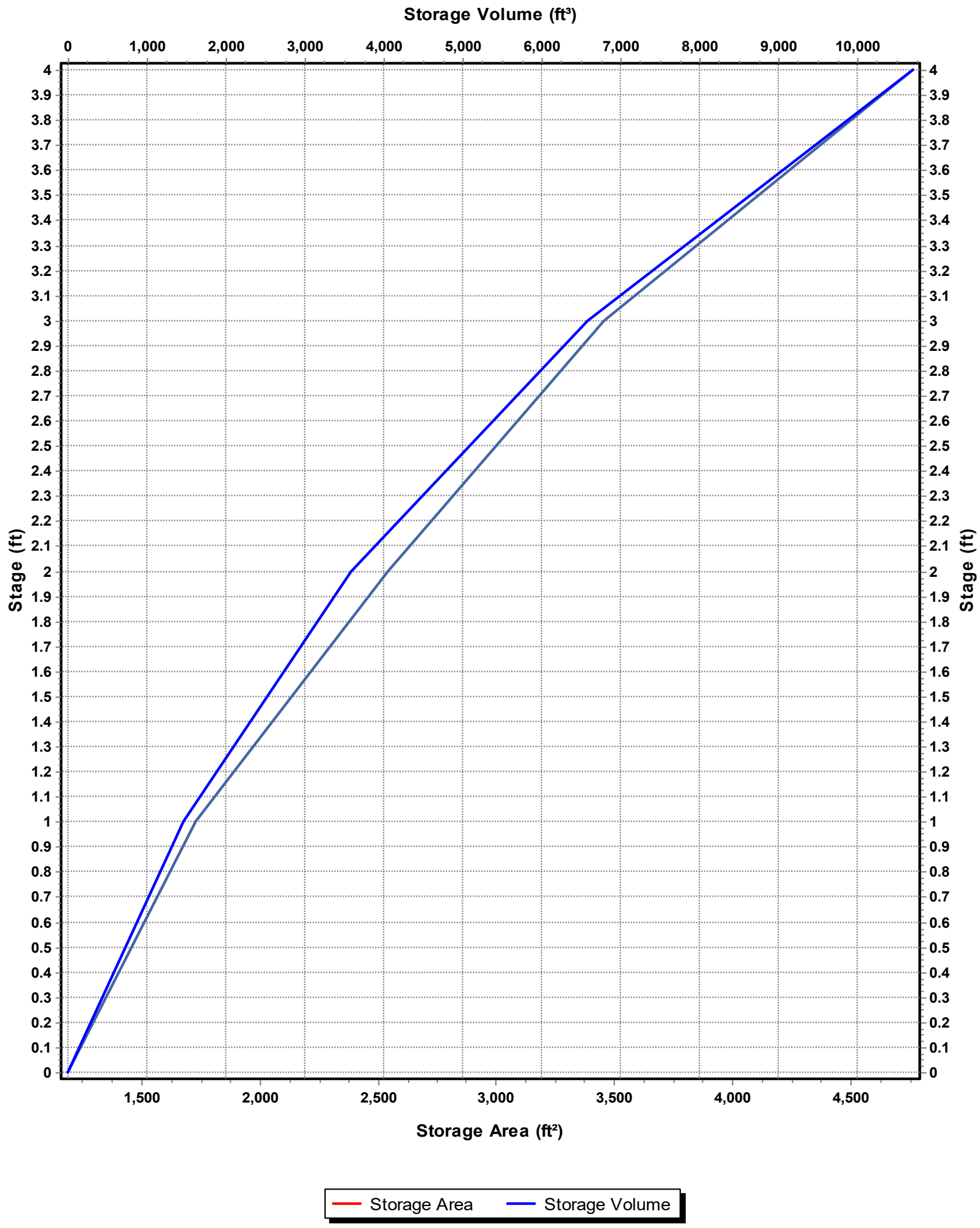
Invert Elevation (ft)	66.00
Max (Rim) Elevation (ft)	69.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	66.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : EXISTING POND.North

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	1188.1	0
1	1729.54	1458.82
2	2543.02	3595.1
3	3461.12	6597.17
4	4767.41	10711.44

Storage Area Volume Curves



Storage Node : A1-1-BASIN (continued)

Outflow Orifices

SN	Element ID	Orifice Type	Orifice Shape	Flap Gate	Circular Orifice Diameter (ft)	Rectangular Orifice Height (ft)	Rectangular Orifice Width (ft)	Orifice Invert Elevation (ft)	Orifice Coefficient
1	12RCP	Side	CIRCULAR	No	1.00			68.00	0.61

Output Summary Results

Peak Inflow (cfs)	2.22
Peak Lateral Inflow (cfs)	2.22
Peak Outflow (cfs)	1.23
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	68.59
Max HGL Depth Attained (ft)	2.59
Average HGL Elevation Attained (ft)	68.13
Average HGL Depth Attained (ft)	2.13
Time of Max HGL Occurrence (days hh:mm)	0 12:25
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : BASIN-1

Input Data

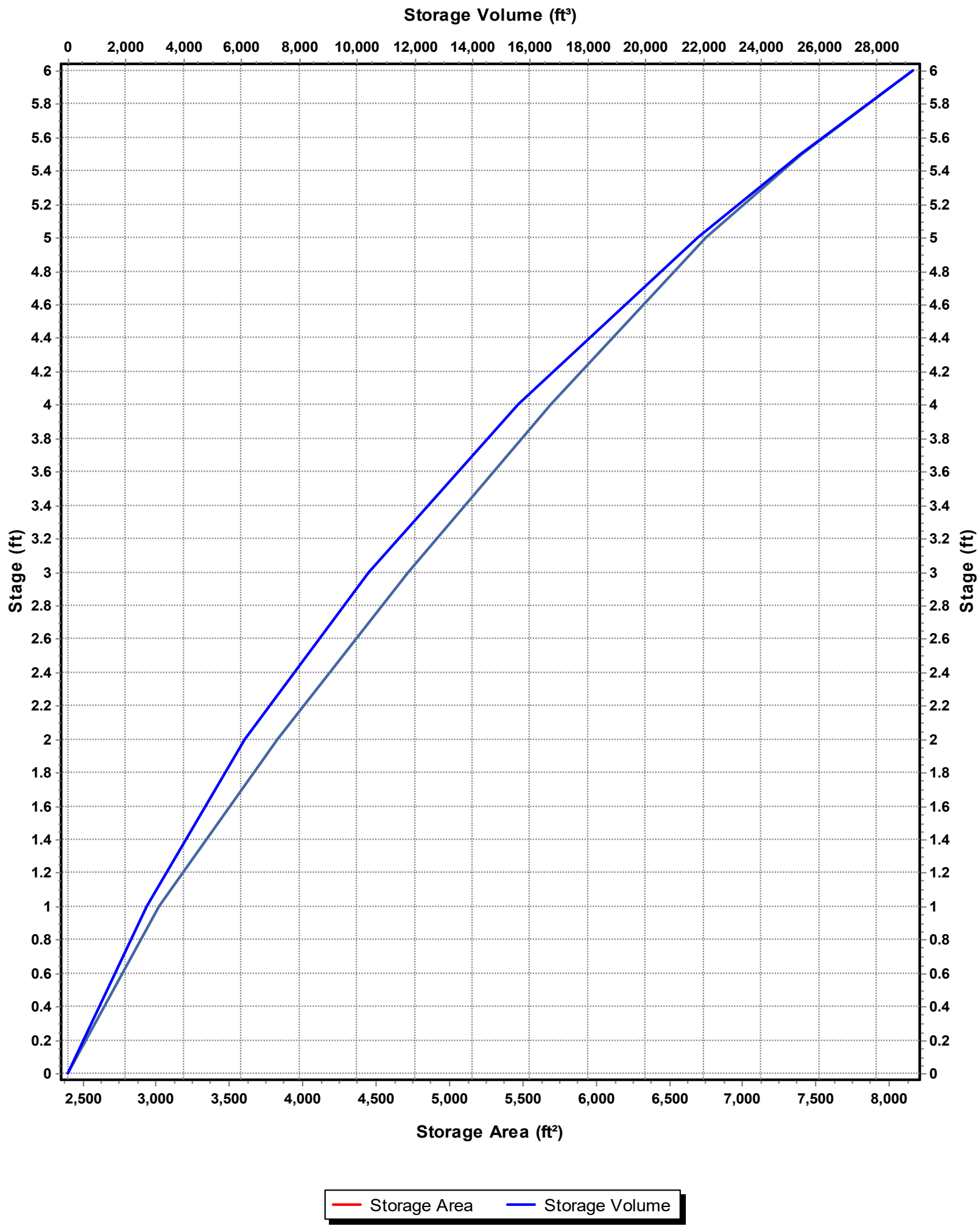
Invert Elevation (ft)	63.00
Max (Rim) Elevation (ft)	69.00
Max (Rim) Offset (ft)	6.00
Initial Water Elevation (ft)	63.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : POND-1

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	2401.32	0
1	3024.34	2712.83
2	3828.08	6139.04
3	4718.62	10412.39
4	5693.33	15618.37
5	6754.28	21842.18
5.5	7407.96	25382.74
6	8166.38	29276.33

Storage Area Volume Curves



Storage Node : BASIN-1 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-B1	Trapezoidal	No	68.50	5.50	10.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	7.06
Peak Lateral Inflow (cfs)	0
Peak Outflow (cfs)	6.89
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	68.51
Max HGL Depth Attained (ft)	5.51
Average HGL Elevation Attained (ft)	67.51
Average HGL Depth Attained (ft)	4.51
Time of Max HGL Occurrence (days hh:mm)	2 06:48
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : BASIN-2

Input Data

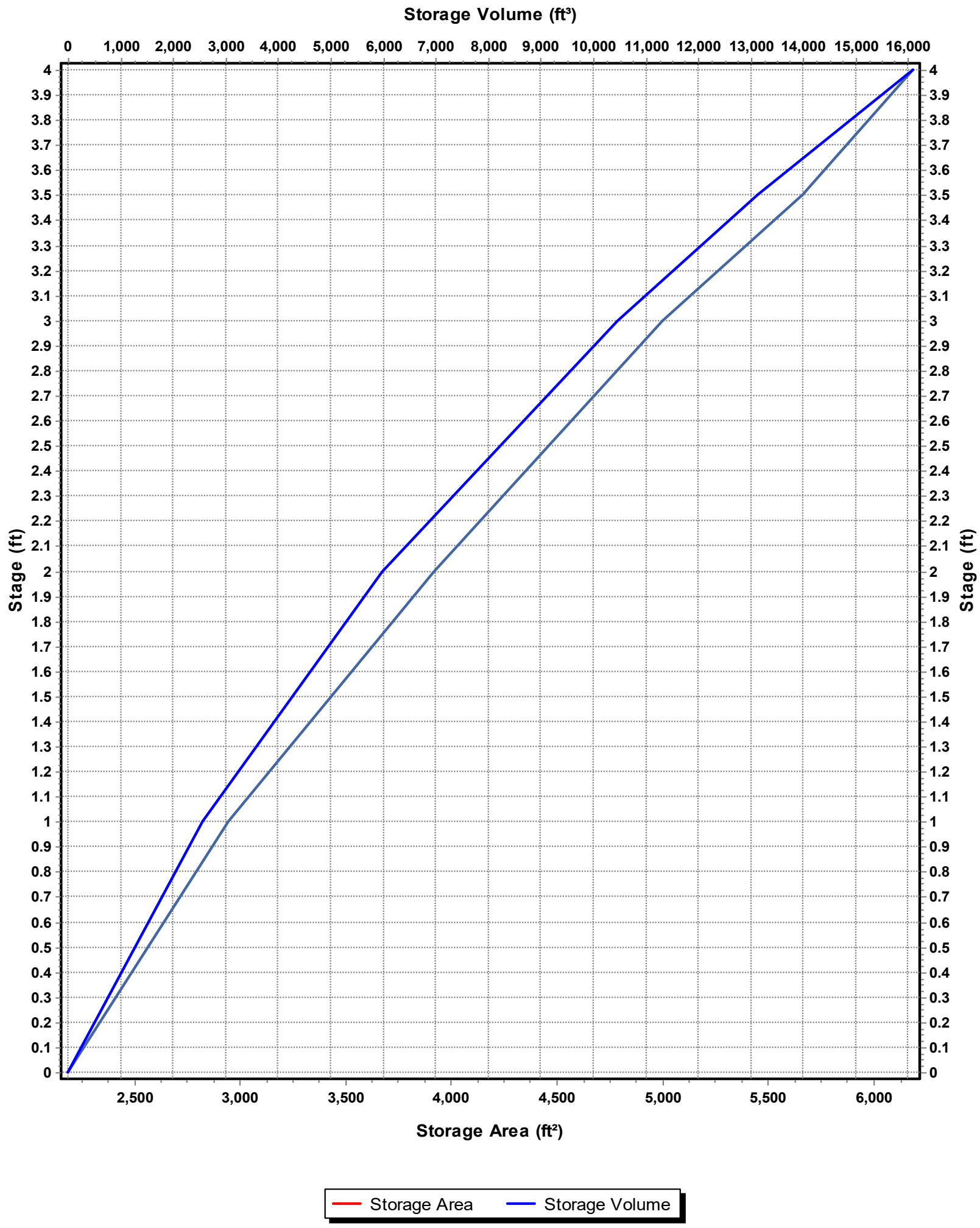
Invert Elevation (ft)	63.00
Max (Rim) Elevation (ft)	67.00
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	63.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : POND-2

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	2186.8	0
1	2944.52	2565.66
2	3920.59	5998.22
3	5001.46	10459.25
3.5	5669	13126.87
4	6188.64	16091.28

Storage Area Volume Curves



Storage Node : BASIN-2 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-B2	Trapezoidal	No	66.50	3.50	10.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	4.07
Peak Lateral Inflow (cfs)	0
Peak Outflow (cfs)	0
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	66.17
Max HGL Depth Attained (ft)	3.17
Average HGL Elevation Attained (ft)	65.55
Average HGL Depth Attained (ft)	2.55
Time of Max HGL Occurrence (days hh:mm)	1 03:24
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Exist-Catch-Basin

Input Data

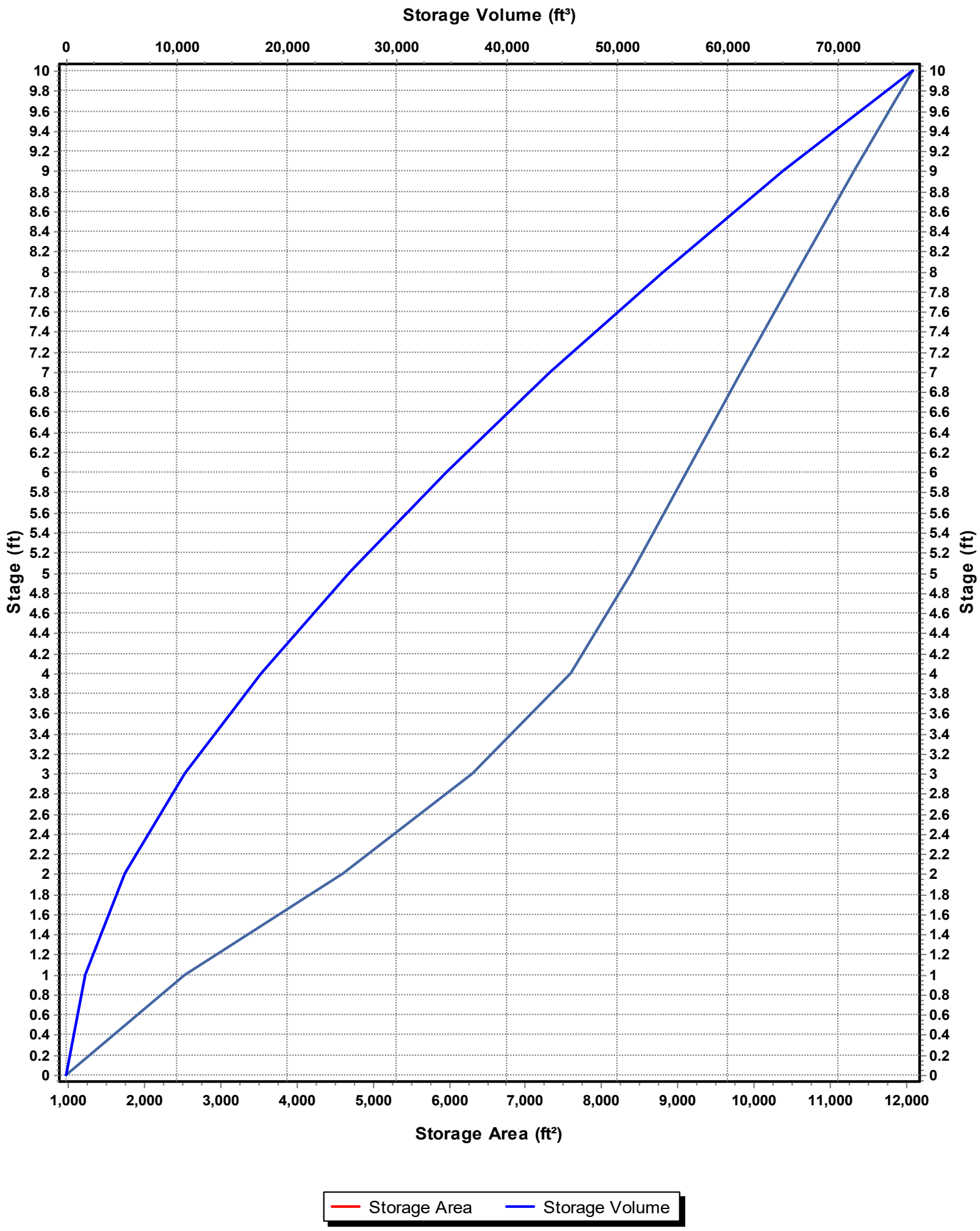
Invert Elevation (ft)	43.00
Max (Rim) Elevation (ft)	53.00
Max (Rim) Offset (ft)	10.00
Initial Water Elevation (ft)	43.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : EXISTING POND.South

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	974.38	0
1	2524.45	1749.42
2	4602.46	5312.88
3	6308.57	10768.4
4	7605.38	17725.38
5	8399.21	25727.68
6	9117.86	34486.22
7	9840.94	43965.62
8	10576.98	54174.58
9	11329.31	65127.73
10	12097.94	76841.36

Storage Area Volume Curves



Storage Node : Exist-Catch-Basin (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Exist-Catch-Basin-Weir	Trapezoidal	No	52.50	9.50	5.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	2.96
Peak Lateral Inflow (cfs)	2.96
Peak Outflow (cfs)	0
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	47.47
Max HGL Depth Attained (ft)	4.47
Average HGL Elevation Attained (ft)	46.58
Average HGL Depth Attained (ft)	3.58
Time of Max HGL Occurrence (days hh:mm)	1 01:45
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Existing-Catch-Basin

Input Data

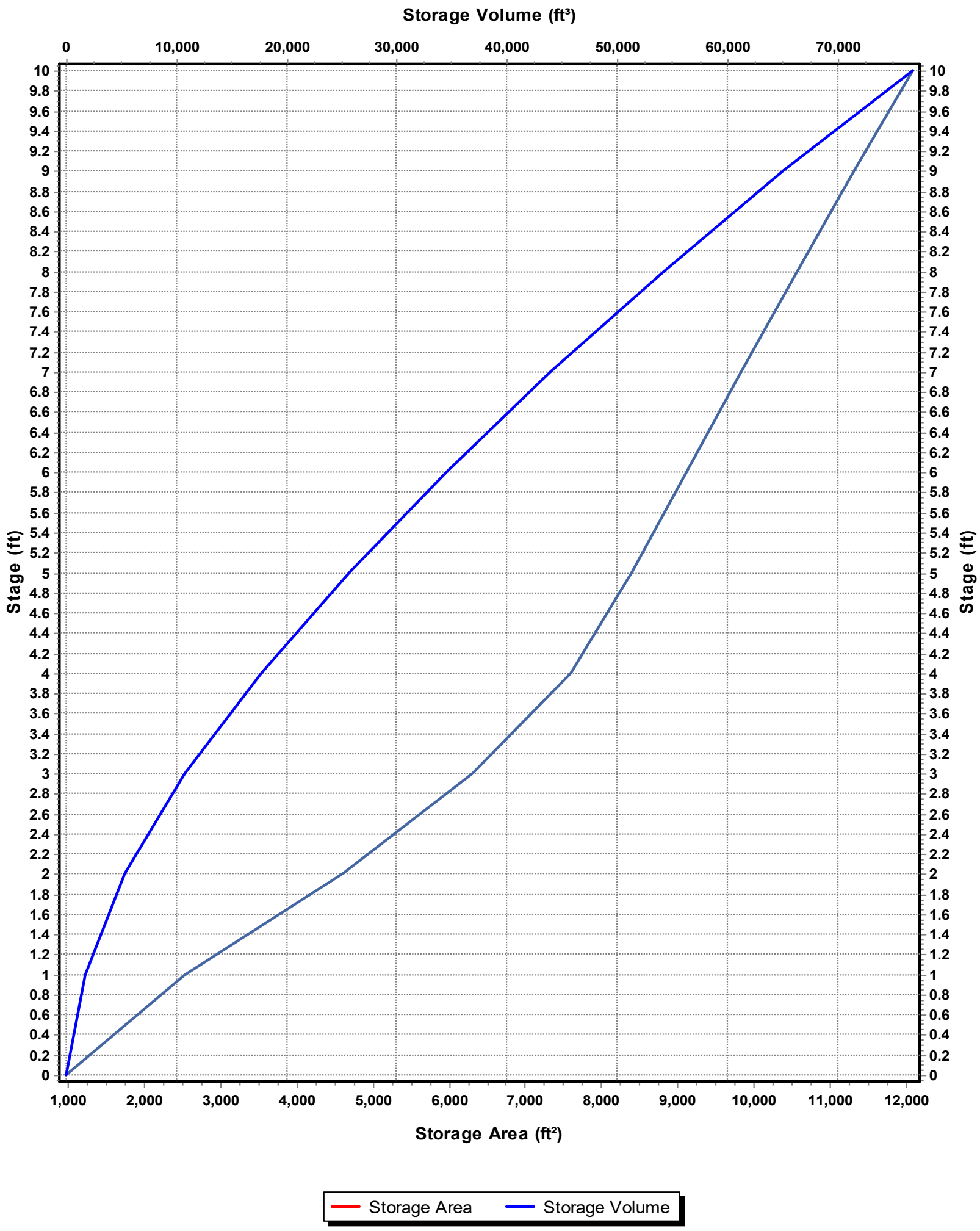
Invert Elevation (ft)	43.00
Max (Rim) Elevation (ft)	53.00
Max (Rim) Offset (ft)	10.00
Initial Water Elevation (ft)	43.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : EXISTING POND.South

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	974.38	0
1	2524.45	1749.42
2	4602.46	5312.88
3	6308.57	10768.4
4	7605.38	17725.38
5	8399.21	25727.68
6	9117.86	34486.22
7	9840.94	43965.62
8	10576.98	54174.58
9	11329.31	65127.73
10	12097.94	76841.36

Storage Area Volume Curves



Storage Node : Existing-Catch-Basin (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Existing-Catch-Basin-Weir	Trapezoidal	No	52.50	9.50	5.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	3.26
Peak Lateral Inflow (cfs)	0.97
Peak Outflow (cfs)	0
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	47.47
Max HGL Depth Attained (ft)	4.47
Average HGL Elevation Attained (ft)	46.42
Average HGL Depth Attained (ft)	3.42
Time of Max HGL Occurrence (days hh:mm)	3 00:00
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : FOREBAY-1

Input Data

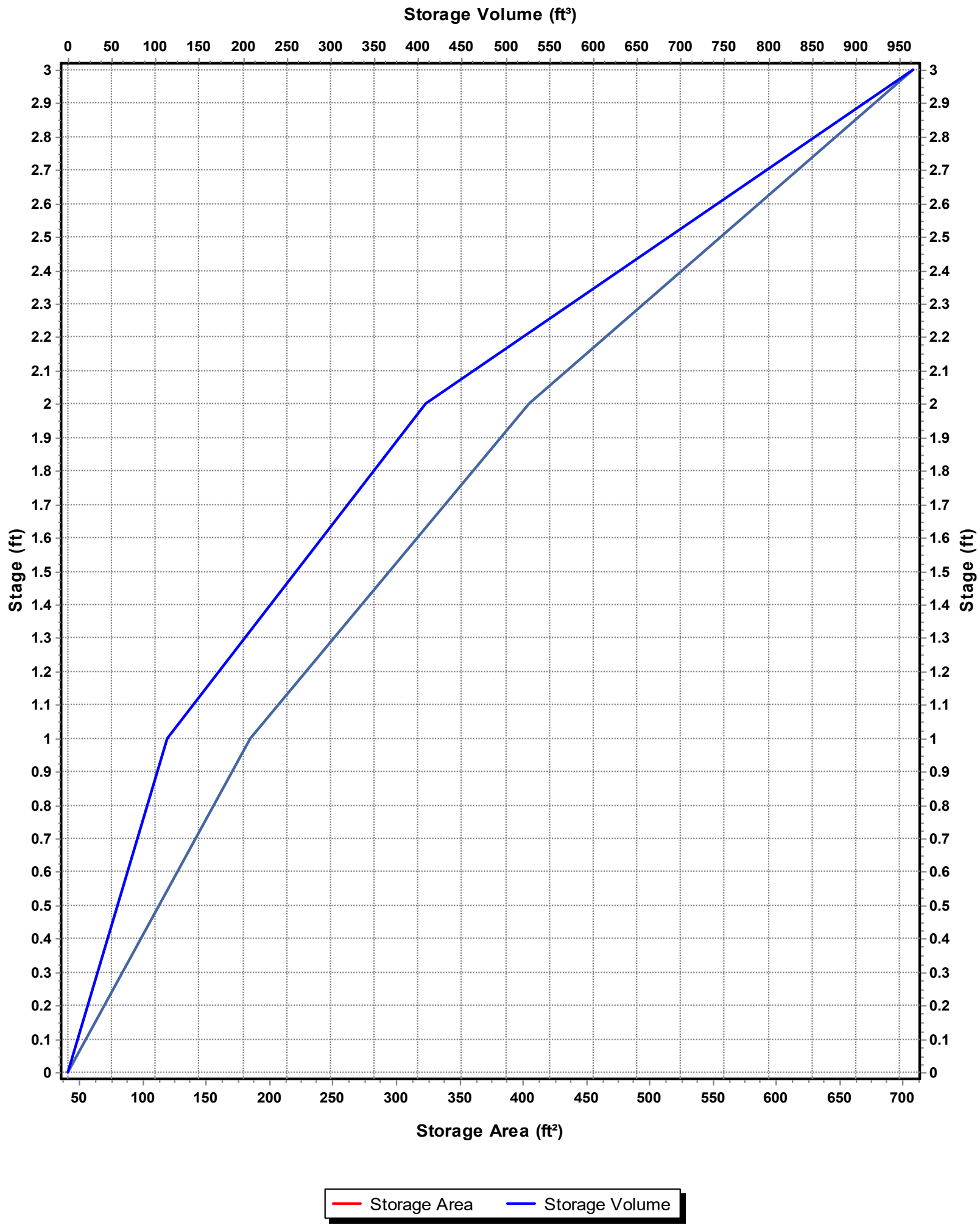
Invert Elevation (ft)	66.00
Max (Rim) Elevation (ft)	70.00
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	66.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : FOREBAY-1

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	41.13	0
1	185.44	113.29
2	405.49	408.76
3	708.15	965.58

Storage Area Volume Curves



Storage Node : FOREBAY-1 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-F1	Trapezoidal	No	67.00	1.00	4.00	3.00	3.33

Output Summary Results

Peak Inflow (cfs)	7.2
Peak Lateral Inflow (cfs)	5.62
Peak Outflow (cfs)	7.39
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	68.57
Max HGL Depth Attained (ft)	2.57
Average HGL Elevation Attained (ft)	68.08
Average HGL Depth Attained (ft)	2.08
Time of Max HGL Occurrence (days hh:mm)	2 06:12
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : FOREBAY-1-2

Input Data

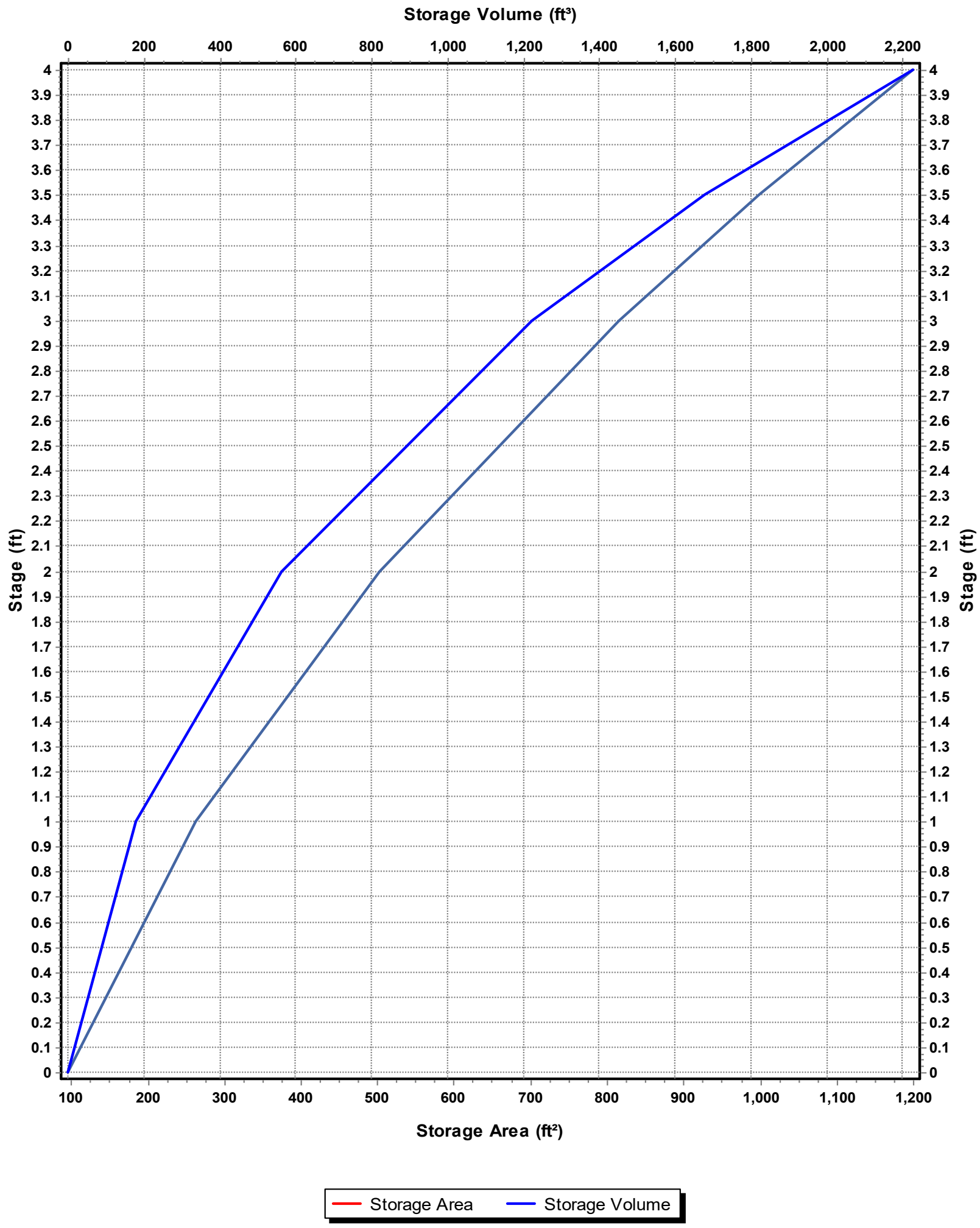
Invert Elevation (ft)	62.00
Max (Rim) Elevation (ft)	66.00
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	62.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : FOREBAY-3

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	96	0
1	264	180
2	504	564
3	816	1224
3.5	999	1677.75
4	1200	2227.5

Storage Area Volume Curves



Storage Node : FOREBAY-1-2 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-F1-2	Trapezoidal	No	63.00	1.00	2.00	3.00	3.33

Output Summary Results

Peak Inflow (cfs)	3.04
Peak Lateral Inflow (cfs)	3.04
Peak Outflow (cfs)	3.01
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	63.52
Max HGL Depth Attained (ft)	1.52
Average HGL Elevation Attained (ft)	62.87
Average HGL Depth Attained (ft)	0.87
Time of Max HGL Occurrence (days hh:mm)	0 12:10
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : FOREBAY-2

Input Data

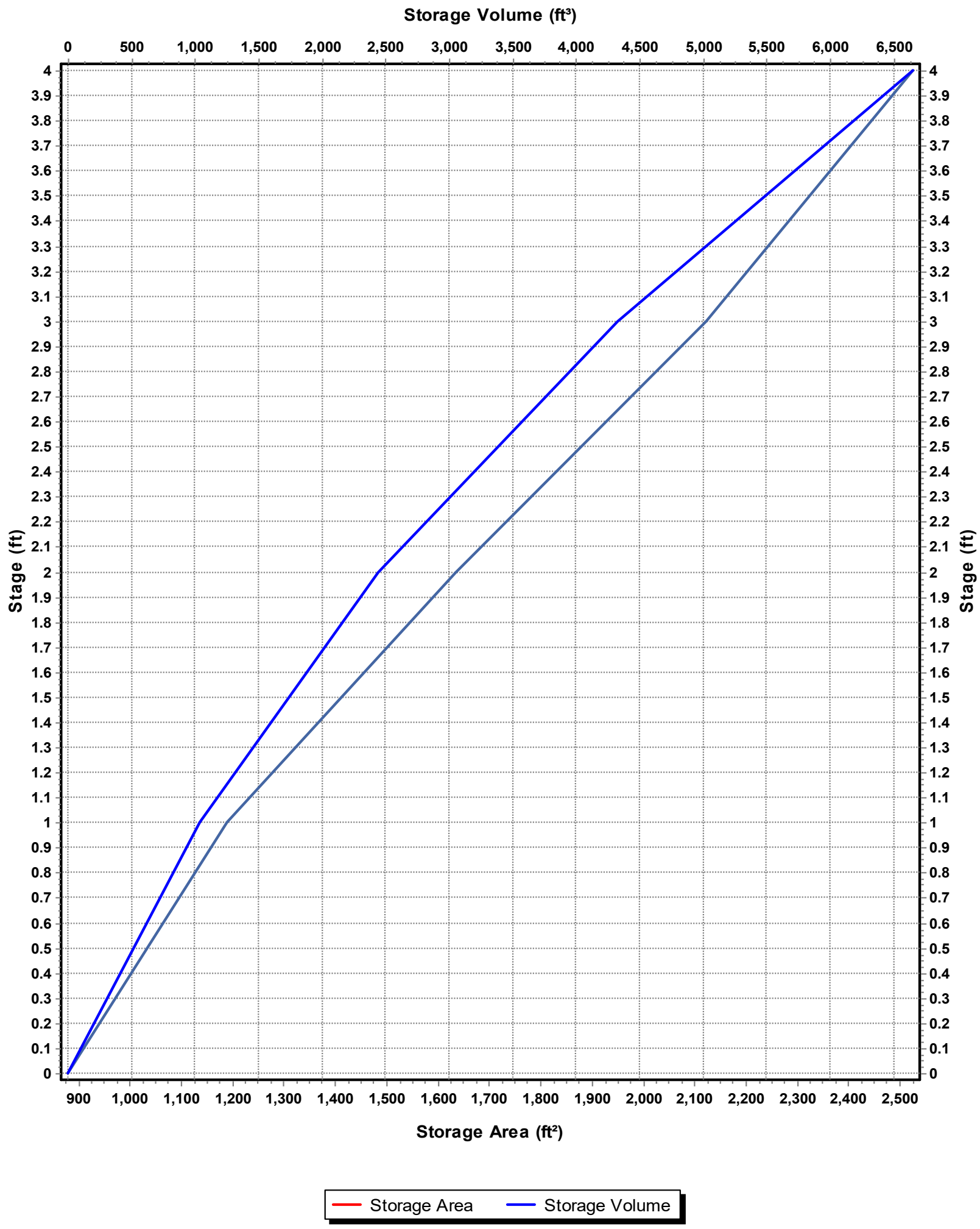
Invert Elevation (ft)	65.00
Max (Rim) Elevation (ft)	69.00
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	65.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : FOREBAY-2

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	880.04	0
1	1189.5	1034.77
2	1635.09	2447.07
3	2123.92	4326.58
4	2526	6651.54

Storage Area Volume Curves



Storage Node : FOREBAY-2 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-F2	Trapezoidal	No	68.00	3.00	10.00	1.00	3.33

Output Summary Results

Peak Inflow (cfs)	4.3
Peak Lateral Inflow (cfs)	4.3
Peak Outflow (cfs)	4.07
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	68.24
Max HGL Depth Attained (ft)	3.24
Average HGL Elevation Attained (ft)	67.54
Average HGL Depth Attained (ft)	2.54
Time of Max HGL Occurrence (days hh:mm)	0 12:11
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Project Description

File Name ..... Sagamore_Entire.Site.SPF

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	SCS TR-20
Time of Concentration (TOC) Method	SCS TR-55
Link Routing Method	Hydrodynamic
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	NO

Analysis Options

Start Analysis On	oct. 14, 2021	0:00:00
End Analysis On	oct. 17, 2021	0:00:00
Start Reporting On	oct. 14, 2021	0:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	13
Nodes	18
Junctions	0
Outfalls	10
Flow Diversions	0
Inlets	0
Storage Nodes	8
Links	8
Channels	0
Pipes	0
Pumps	0
Orifices	1
Weirs	7
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	50 Years-2070	Intensity	inches	Massachusetts	None	50.00	8.80	SCS Type III 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	A1	1.20	484.00	76.00	8.80	5.89	7.07	7.15	0 00:06:00
2	A1-1	0.39	484.00	98.00	8.80	8.56	3.33	2.70	0 00:10:55
3	A1-2	1.34	484.00	54.63	8.80	3.30	4.42	4.54	0 00:06:00
4	A1-3	1.03	484.00	49.00	8.80	2.64	2.70	1.48	0 00:40:16
5	A2	0.92	484.00	76.00	8.80	5.89	5.42	5.48	0 00:06:00
6	A-3	0.25	484.00	51.70	8.80	2.95	0.74	0.43	0 00:36:07
7	DA-Ditch-A1	1.35	484.00	76.00	8.80	5.89	7.95	8.02	0 00:06:00
8	DA-Ditch-A1-2	1.29	484.00	76.00	8.80	5.89	7.60	7.68	0 00:06:00
9	DA-Ditch-A2	0.67	484.00	76.00	8.80	5.89	3.95	3.99	0 00:06:00
10	Existing-E03-1_A1	0.89	484.00	49.00	8.80	2.64	2.35	1.38	0 00:34:49
11	Existing-E-07_A3	0.39	484.00	51.70	8.80	2.95	1.15	0.68	0 00:36:29
12	Existing-E3_A1-2	3.20	484.00	49.00	8.80	2.64	8.43	4.47	0 00:42:52
13	Existing-E5.1_A2	0.26	484.00	49.00	8.80	2.64	0.69	0.57	0 00:14:30

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Existing-Oufall-E3-1_Weir-B1	Outfall	0.00					1.36	0.00					
2	Existing-Outfall-E3_1	Outfall	0.00					0.00	0.00					
3	Existing-Outfall-E5.1_2	Outfall	0.00					0.56	0.00					
4	Existing-Outfall-E7_3	Outfall	0.00					0.67	0.00					
5	Out-D1	Outfall	0.00					7.89	0.00					
6	Out-D2	Outfall	0.00					3.93	0.00					
7	Out-D3	Outfall	0.00					7.56	0.00					
8	Proposed-Outfall.1	Outfall	0.00					0.00	0.00					
9	Proposed-Outfall.2	Outfall	60.00					0.12	60.00					
10	Proposed-Outfall.3	Outfall	0.00					0.43	0.00					
11	A1-1-BASIN	Storage Node	66.00	69.00	66.00		0.00	2.61	68.72				0.00	0.00
12	BASIN-1	Storage Node	63.00	69.00	63.00		0.00	7.95	68.55				0.00	0.00
13	BASIN-2	Storage Node	63.00	67.00	63.00		0.00	5.26	66.52				0.00	0.00
14	Exist-Catch-Basin	Storage Node	43.00	53.00	43.00		0.00	4.45	48.57				0.00	0.00
15	Existing-Catch-Basin	Storage Node	43.00	53.00	43.00		0.00	4.75	49.19				0.00	0.00
16	FOREBAY-1	Storage Node	66.00	70.00	66.00		0.00	7.98	68.57				0.00	0.00
17	FOREBAY-1-2	Storage Node	62.00	66.00	62.00		0.00	4.33	63.64				0.00	0.00
18	FOREBAY-2	Storage Node	65.00	69.00	65.00		0.00	5.38	68.29				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(ft)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
1	12RCP	Orifice	A1-1-BASIN	FOREBAY-1		66.00	66.00		1.000		1.67							
2	Exist-Catch-Basin-Weir	Weir	Exist-Catch-Basin	Existing-Outfall-E3_1		43.00	0.00				0.00							
3	Existing-Catch-Basin-Weir	Weir	Existing-Catch-Basin	Proposed-Outfall.1		43.00	0.00				0.00							
4	Weir-B1	Weir	BASIN-1	FOREBAY-1-2		63.00	62.00				0.40							
5	Weir-B2	Weir	BASIN-2	Proposed-Outfall.2		63.00	60.00				0.12							
6	Weir-F1	Weir	FOREBAY-1	BASIN-1		66.00	63.00				7.95							
7	Weir-F1-2	Weir	FOREBAY-1-2	Existing-Catch-Basin		62.00	43.00				4.29							
8	Weir-F2	Weir	FOREBAY-2	BASIN-2		65.00	63.00				5.26							

Subbasin Hydrology

Subbasin : A1

Input Data

Area (ac) 1.2
Peak Rate Factor 484
Weighted Curve Number 76
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	1.2	A	76
Composite Area & Weighted CN	1.2		76

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft^2)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	300	0	0
Slope (%) :	1.51	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	1.23	0	0
Computed Flow Time (min) :	4.05	0	0

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	20.6	0	0
Slope (%) :	1.86	0	0
Surface Type :	Unpaved	Unpaved	Unpaved
Velocity (ft/sec) :	2.2	0	0
Computed Flow Time (min) :	0.16	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	99.64	0	0
Channel Slope (%) :	0.5	0	0
Cross Section Area (ft^2) :	29.79	0	0
Wetted Perimeter (ft) :	20.98	0	0
Velocity (ft/sec) :	4.44	0	0
Computed Flow Time (min) :	0.37	0	0

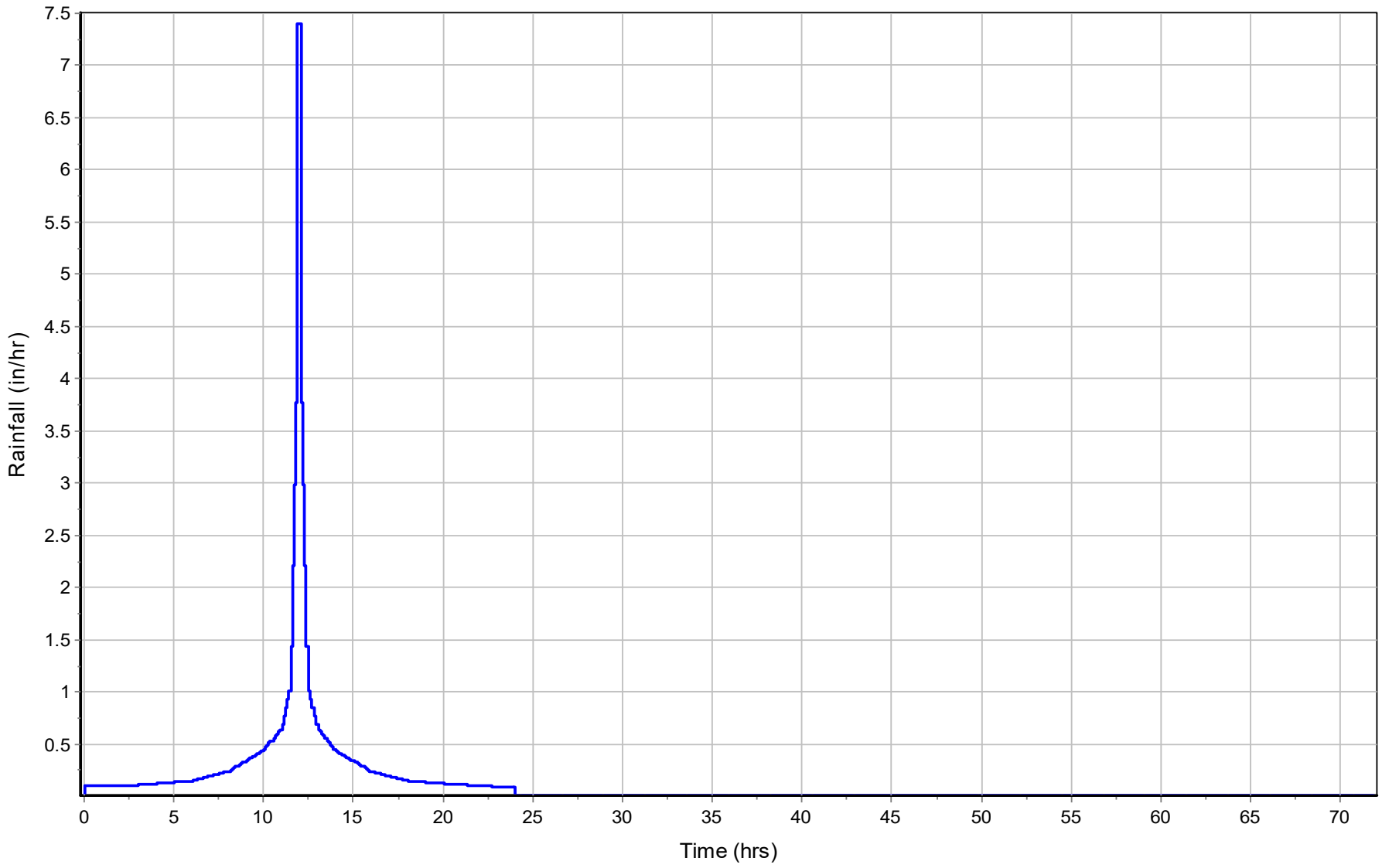
Total TOC (min) 4.58

Subbasin Runoff Results

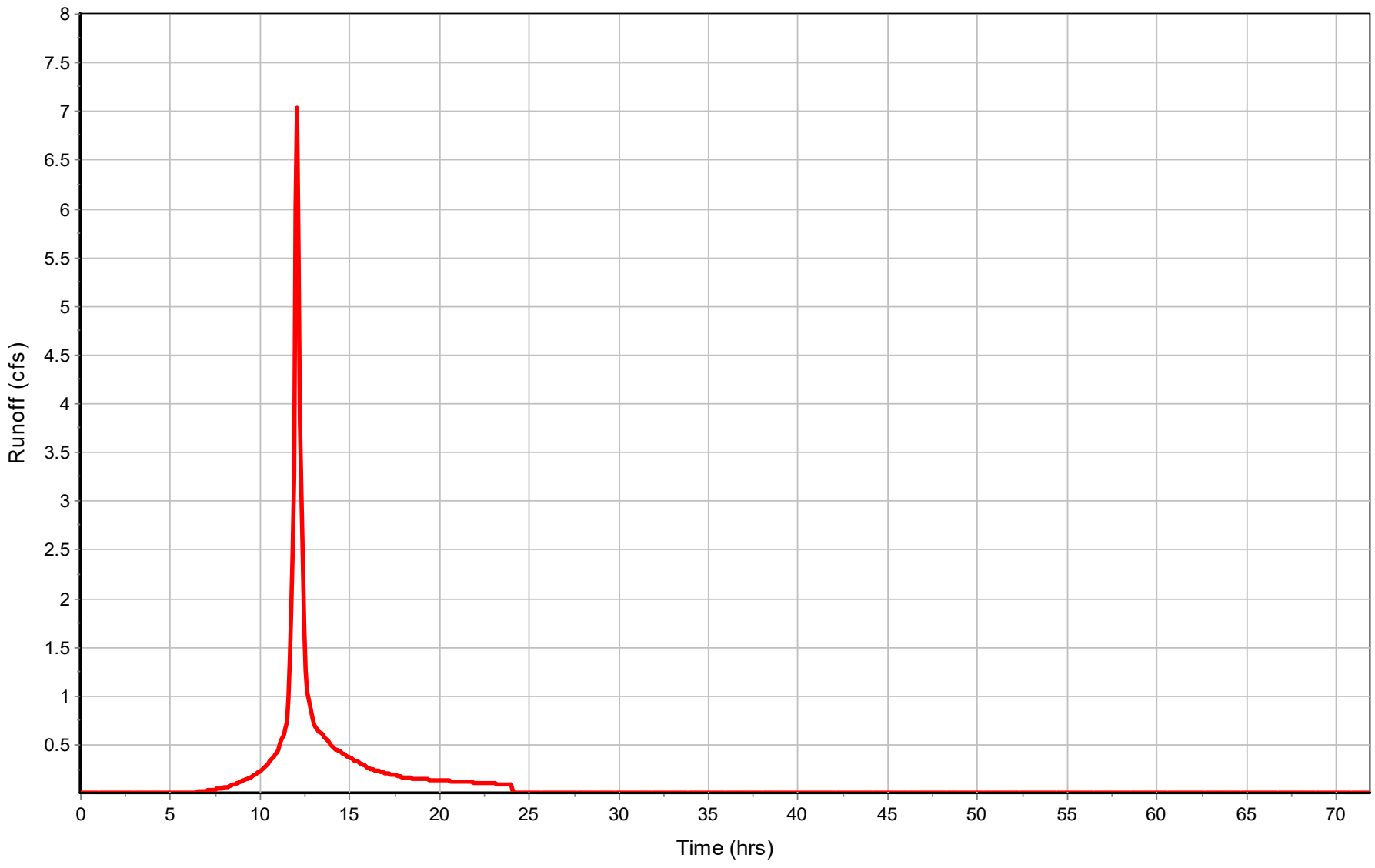
Total Rainfall (in) 8.8
Total Runoff (in) 5.89
Peak Runoff (cfs) 7.15
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:04:35

Subbasin : A1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : A1-1

Input Data

Area (ac) 0.39
Peak Rate Factor 484
Weighted Curve Number 98
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Paved parking & roofs	0.39	A	98
Composite Area & Weighted CN	0.39		98

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.05	0	0
Flow Length (ft) :	178.81	0	0
Slope (%) :	0.5	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.27	0	0
Computed Flow Time (min) :	10.92	0	0

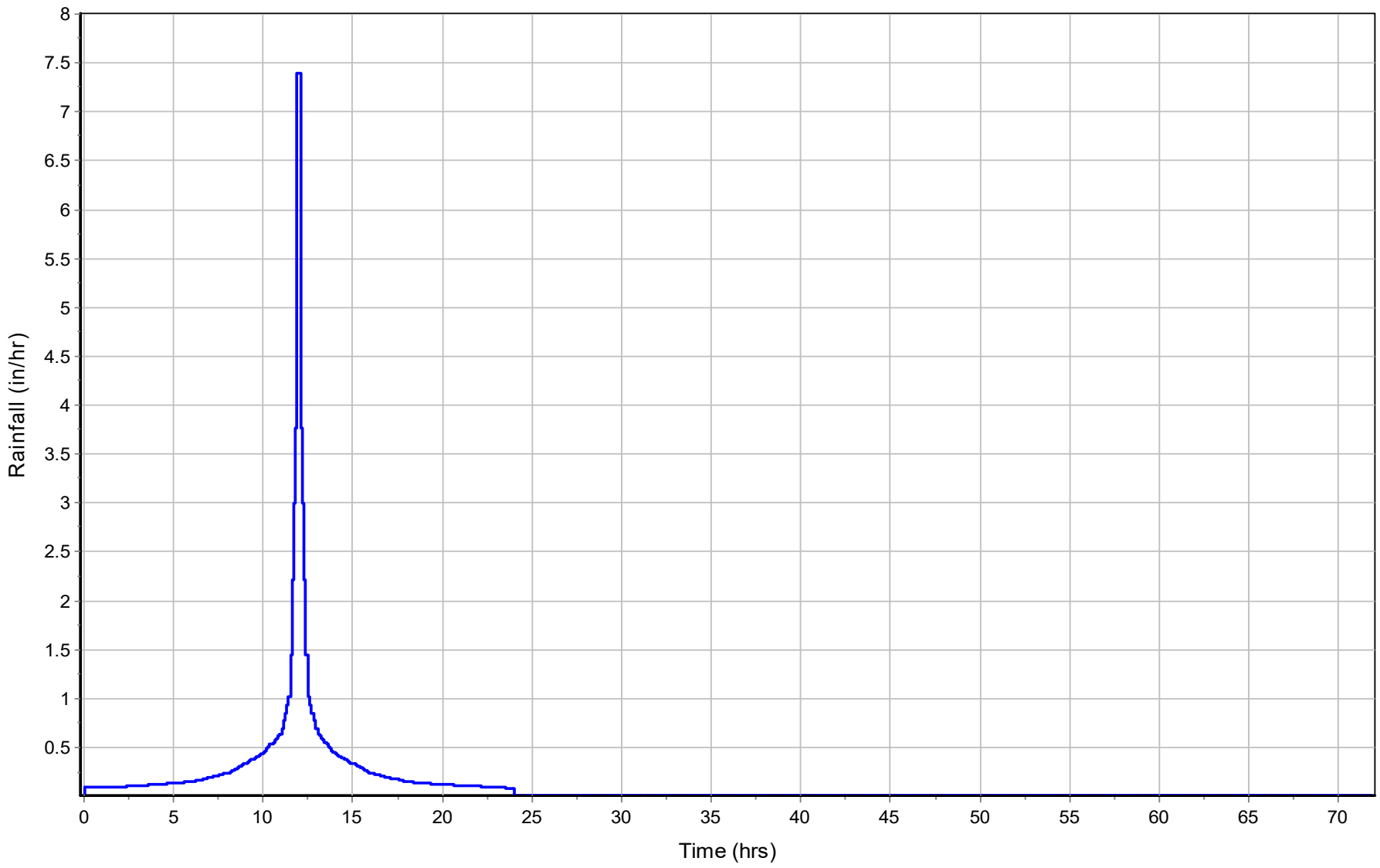
Total TOC (min) 10.92

Subbasin Runoff Results

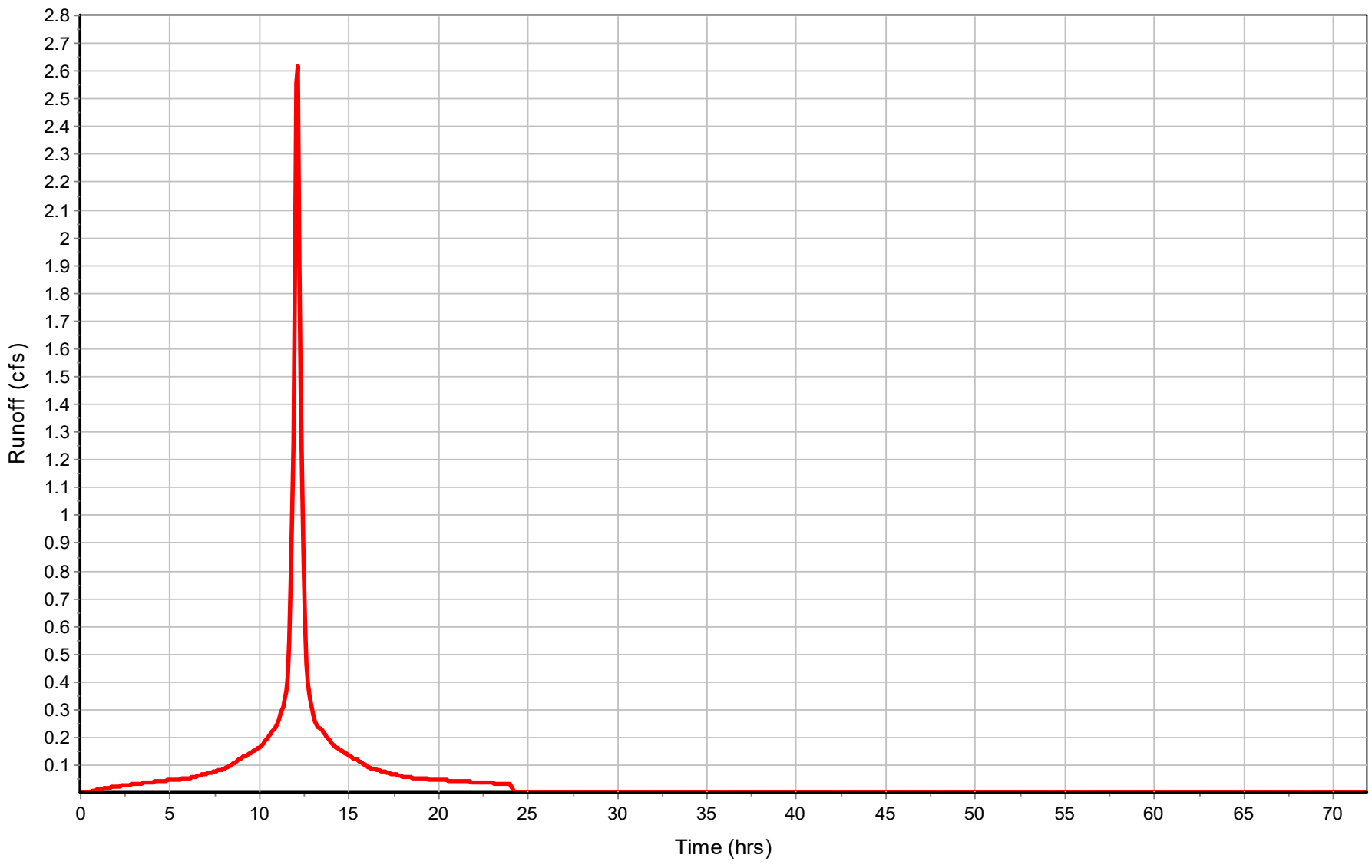
Total Rainfall (in) 8.8
Total Runoff (in) 8.56
Peak Runoff (cfs) 2.7
Weighted Curve Number 98
Time of Concentration (days hh:mm:ss) 0 00:10:55

Subbasin : A1-1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : A1-2

Input Data

Area (ac) 1.34
Peak Rate Factor 484
Weighted Curve Number 54.63
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	0.28	A	76
-	1.06	-	49
Composite Area & Weighted CN	1.34		54.63

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	131.55	0	0
Slope (%) :	4	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	1.54	0	0
Computed Flow Time (min) :	1.42	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	358.95	0	0
Channel Slope (%) :	0.3	0	0
Cross Section Area (ft^2) :	13.52	0	0
Wetted Perimeter (ft) :	11.63	0	0
Velocity (ft/sec) :	3.01	0	0
Computed Flow Time (min) :	1.99	0	0

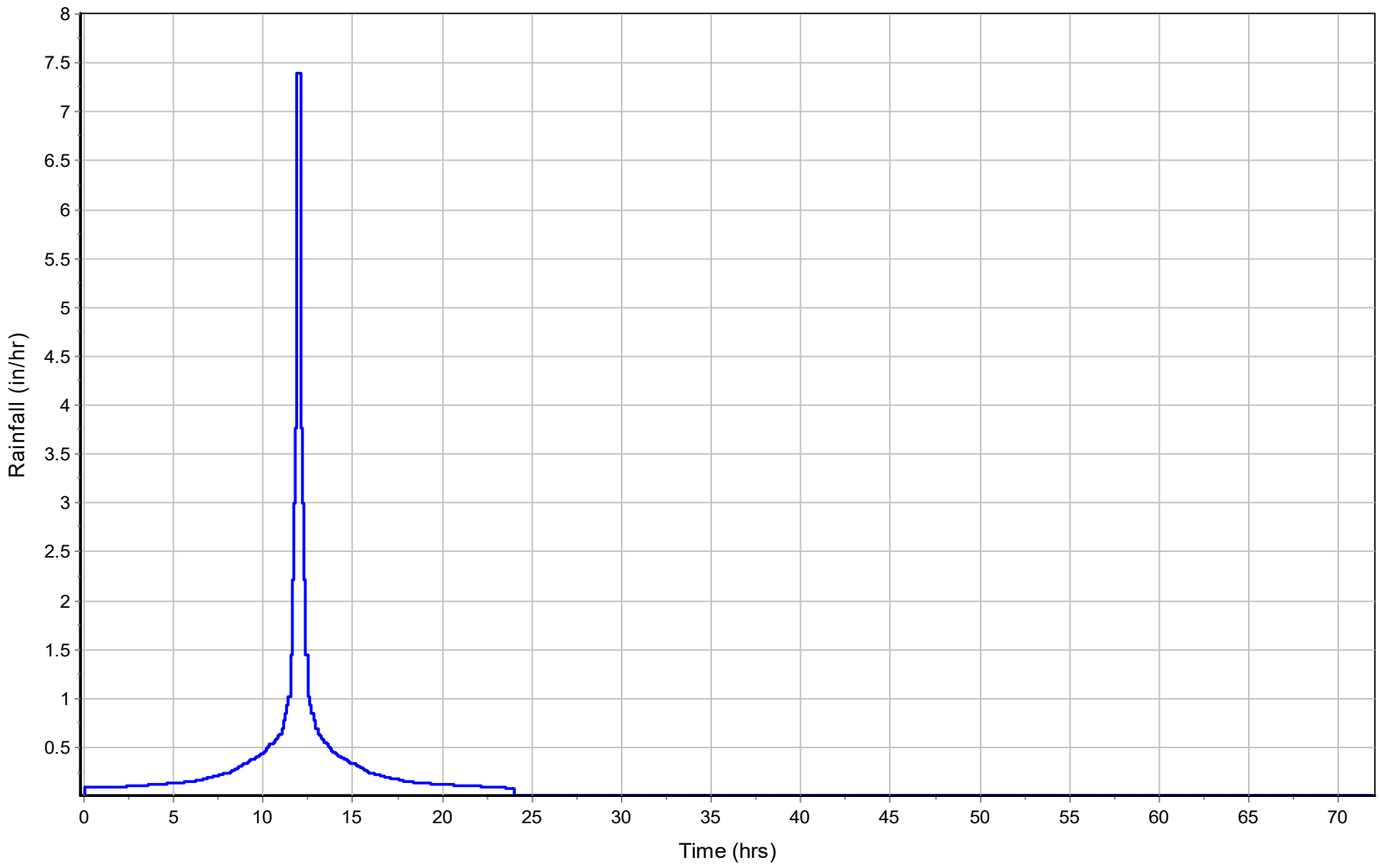
Total TOC (min) 3.41

Subbasin Runoff Results

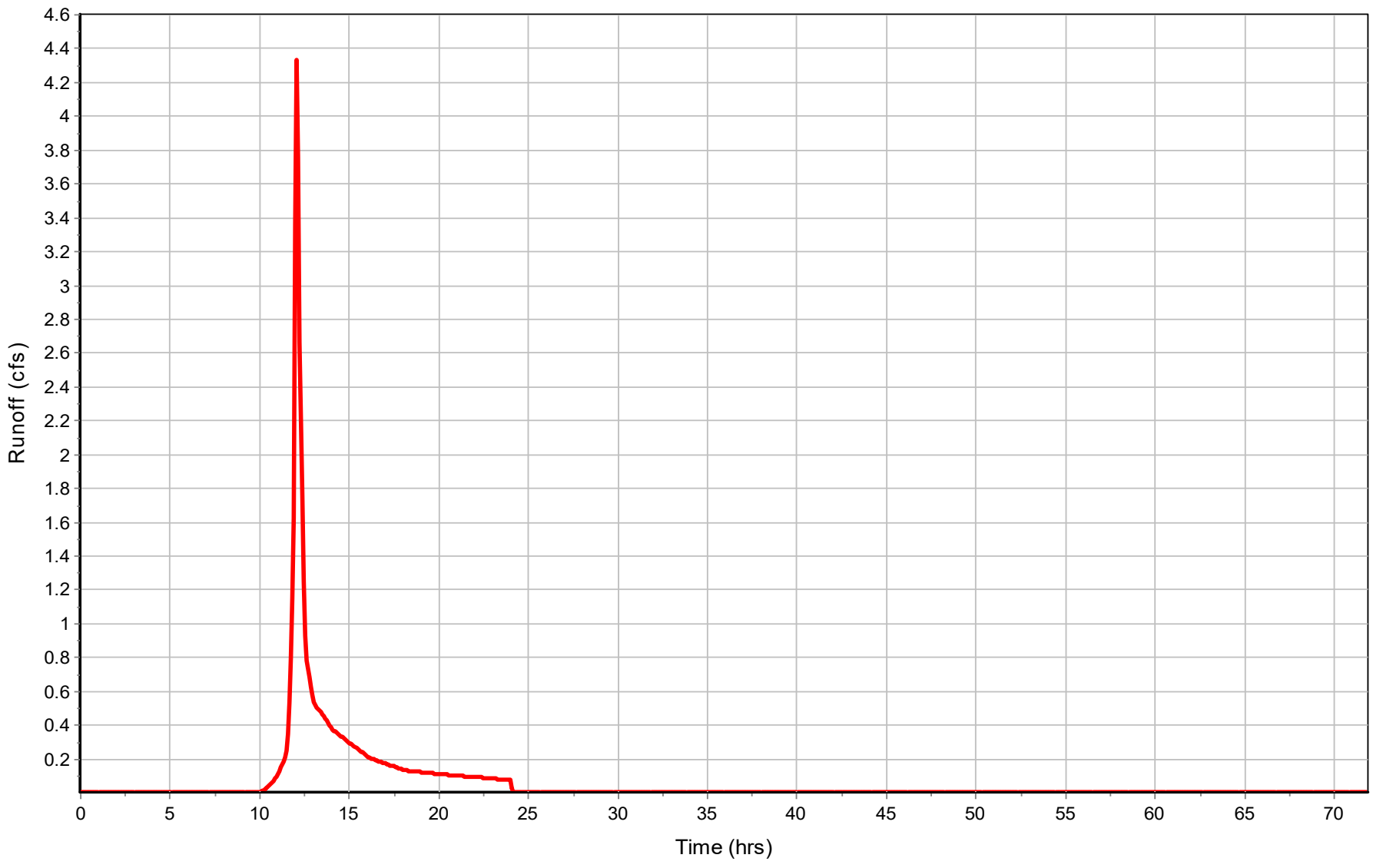
Total Rainfall (in) 8.8
Total Runoff (in) 3.3
Peak Runoff (cfs) 4.54
Weighted Curve Number 54.63
Time of Concentration (days hh:mm:ss) 0 00:03:25

Subbasin : A1-2

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : A1-3

Input Data

Area (ac) 1.03
Peak Rate Factor 484
Weighted Curve Number 49
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	1.03	A	49
Composite Area & Weighted CN	1.03		49

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.4	0	0
Flow Length (ft) :	300	0	0
Slope (%) :	4	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.13	0	0
Computed Flow Time (min) :	37.97	0	0

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	13.33	0	0
Slope (%) :	4	0	0
Surface Type :	Grassed waterway	Unpaved	Unpaved
Velocity (ft/sec) :	3	0	0
Computed Flow Time (min) :	0.07	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	403.18	0	0
Channel Slope (%) :	0.3	0	0
Cross Section Area (ft^2) :	13.52	0	0
Wetted Perimeter (ft) :	11.63	0	0
Velocity (ft/sec) :	3.01	0	0
Computed Flow Time (min) :	2.23	0	0

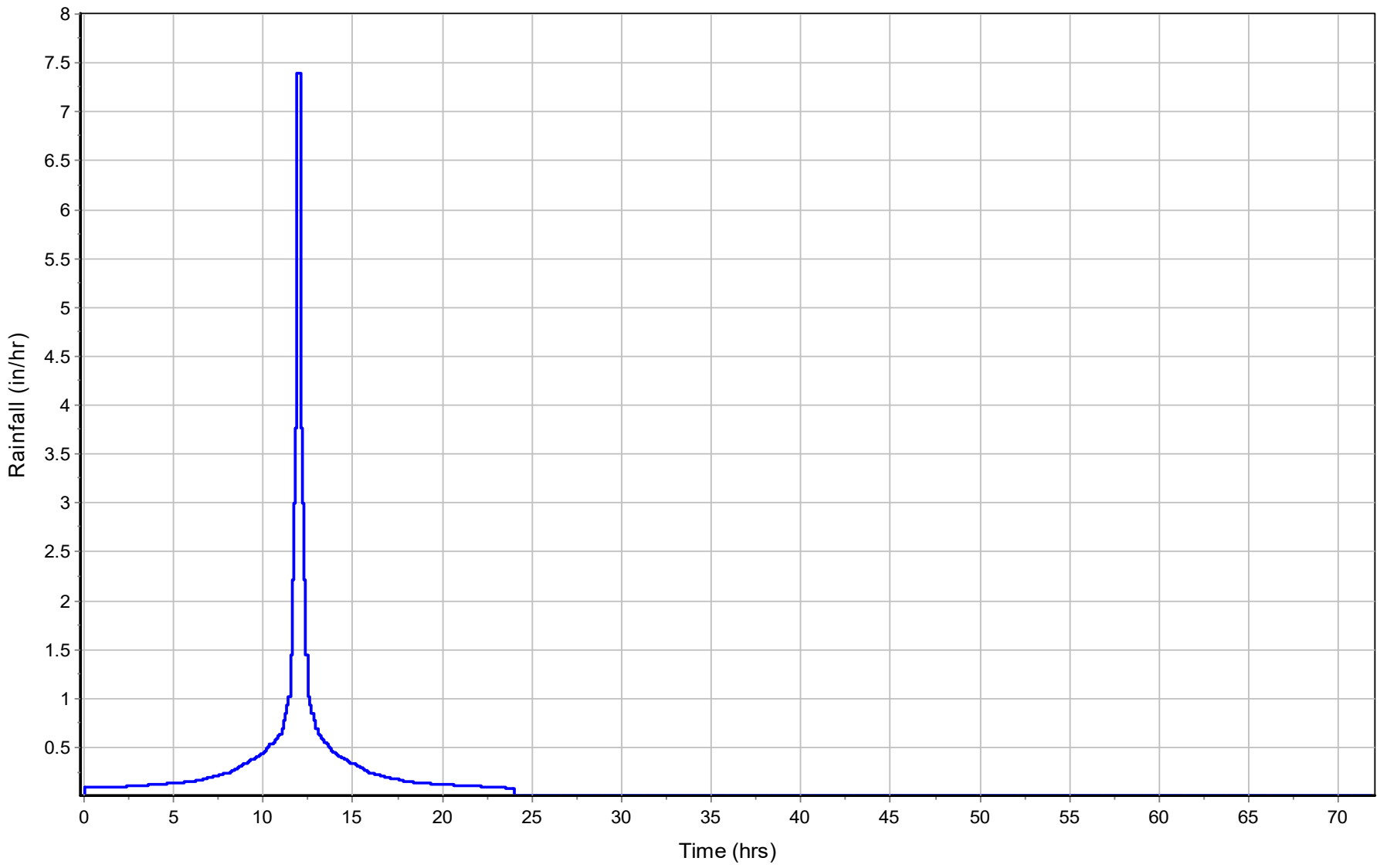
Total TOC (min) 40.27

Subbasin Runoff Results

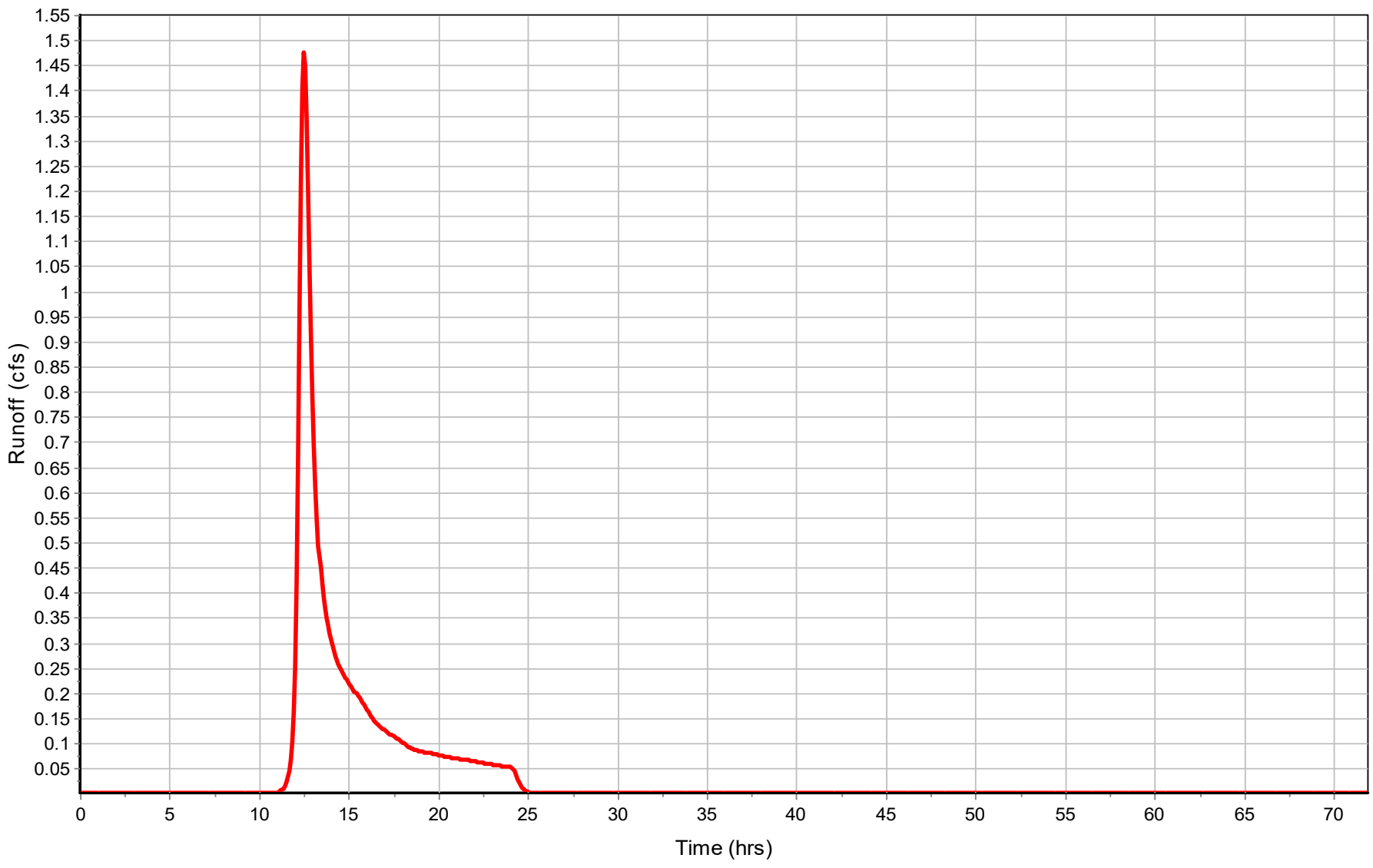
Total Rainfall (in) 8.8
Total Runoff (in) 2.64
Peak Runoff (cfs) 1.48
Weighted Curve Number 49
Time of Concentration (days hh:mm:ss) 0 00:40:16

Subbasin : A1-3

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : A2

Input Data

Area (ac) 0.92
Peak Rate Factor 484
Weighted Curve Number 76
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Gravel roads	0.92	A	76
Composite Area & Weighted CN	0.92		76

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	85.5	0	0
Slope (%) :	1.5	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.96	0	0
Computed Flow Time (min) :	1.49	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	255.68	0	0
Channel Slope (%) :	1.17	0	0
Cross Section Area (ft^2) :	1.475	0	0
Wetted Perimeter (ft) :	5.99	0	0
Velocity (ft/sec) :	2.11	0	0
Computed Flow Time (min) :	2.02	0	0

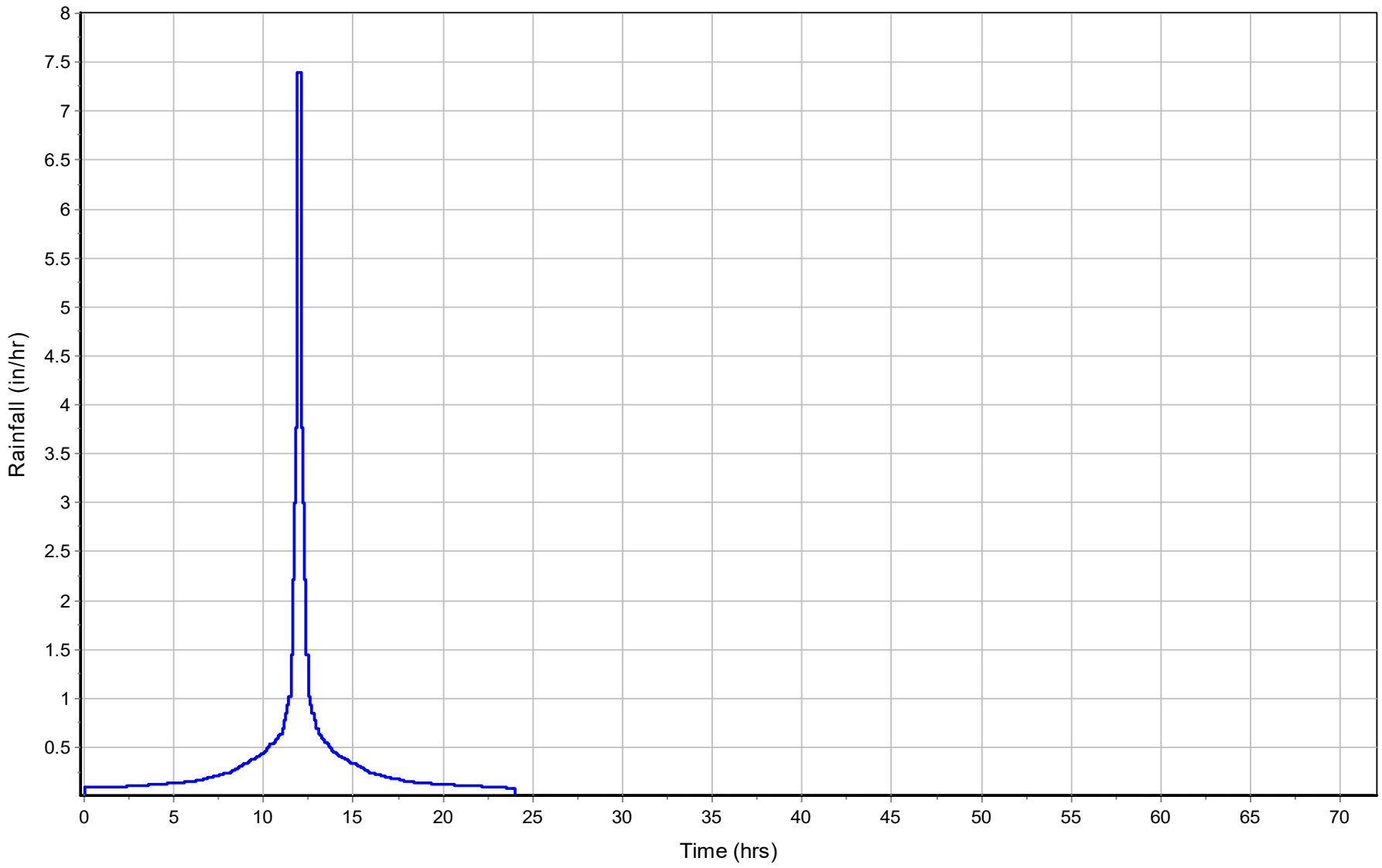
Total TOC (min) 3.51

Subbasin Runoff Results

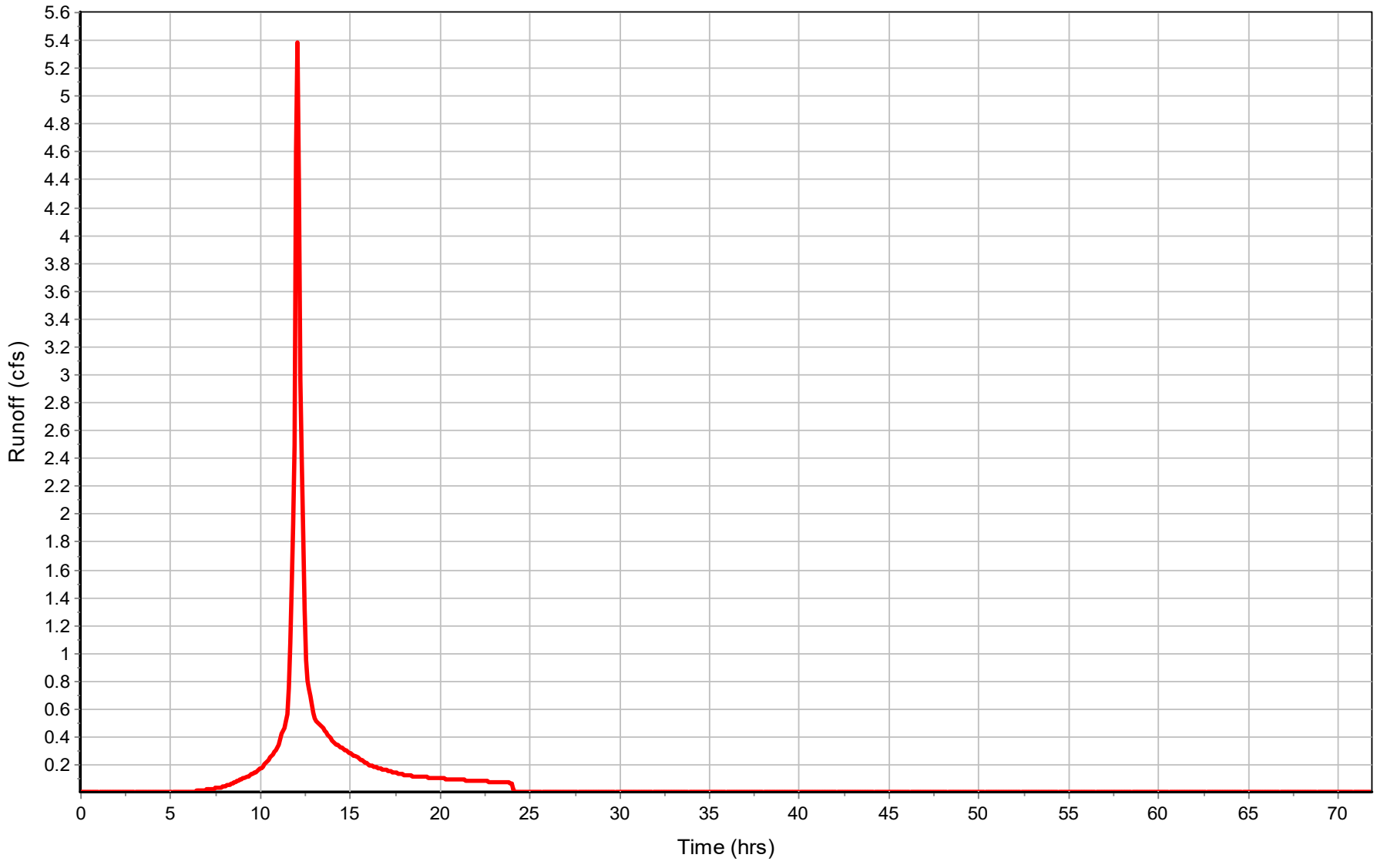
Total Rainfall (in) 8.8
Total Runoff (in) 5.89
Peak Runoff (cfs) 5.48
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:03:31

Subbasin : A2

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : A-3

Input Data

Area (ac)	0.25
Peak Rate Factor	484
Weighted Curve Number	51.7
Rain Gage ID	Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
-	0.23	-	49
-	0.03	-	76
Composite Area & Weighted CN	0.26		51.7

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.4	0	0
Flow Length (ft) :	300	0	0
Slope (%) :	5	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.14	0	0
Computed Flow Time (min) :	34.72	0	0

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	83.1895	0	0
Slope (%) :	2	0	0
Surface Type :	Grass pasture	Unpaved	Unpaved
Velocity (ft/sec) :	0.99	0	0
Computed Flow Time (min) :	1.4	0	0

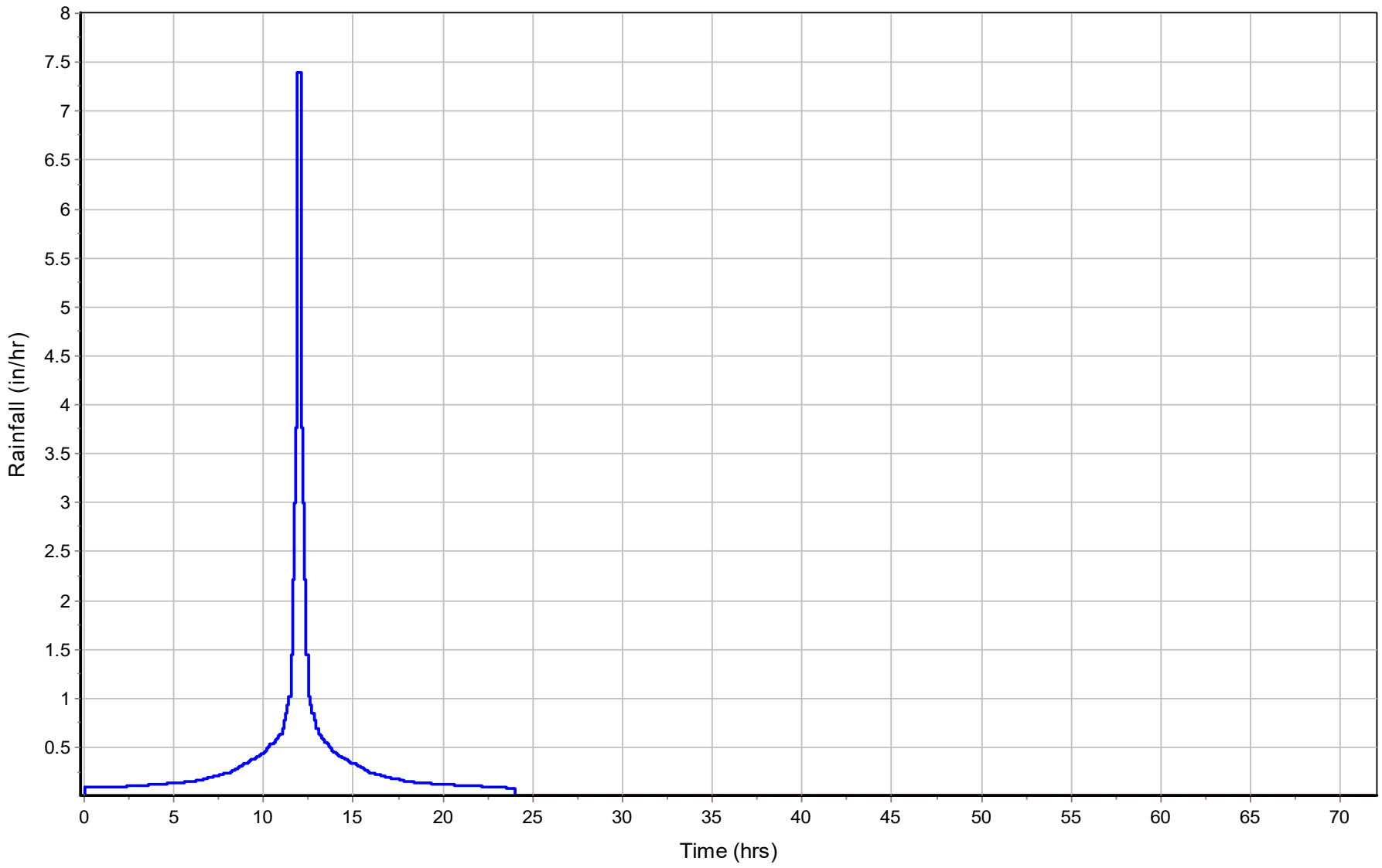
Total TOC (min) 36.12

Subbasin Runoff Results

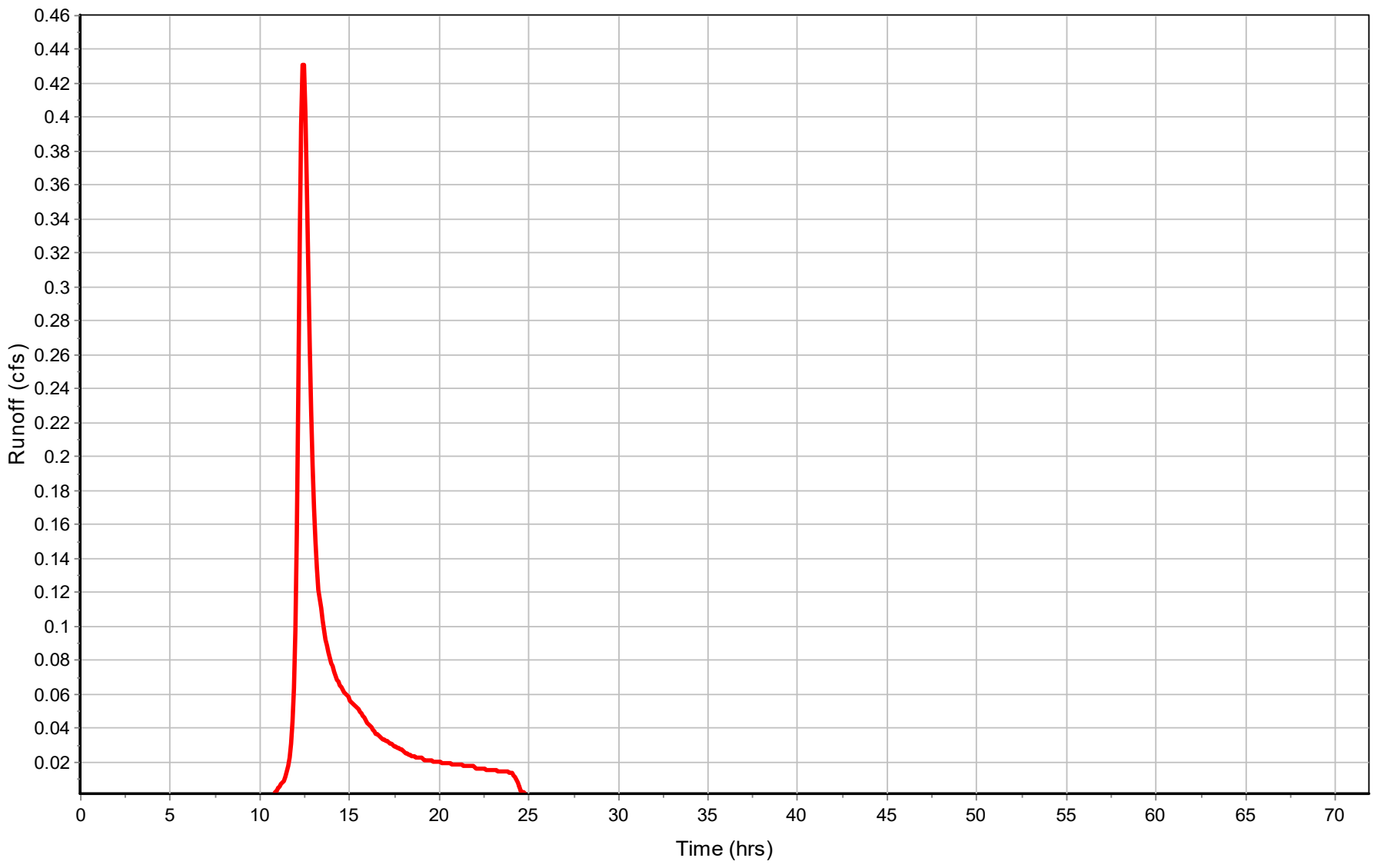
Total Rainfall (in)	8.8
Total Runoff (in)	2.95
Peak Runoff (cfs)	0.43
Weighted Curve Number	51.7
Time of Concentration (days hh:mm:ss)	0 00:36:07

Subbasin : A-3

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : DA-Ditch-A1

Input Data

Area (ac) 1.35
Peak Rate Factor 484
Weighted Curve Number 76
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
50 - 75% grass cover, Fair	1.35	A	76
Composite Area & Weighted CN	1.35		76

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	217.17	0	0
Slope (%) :	1.5	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	1.15	0	0
Computed Flow Time (min) :	3.14	0	0

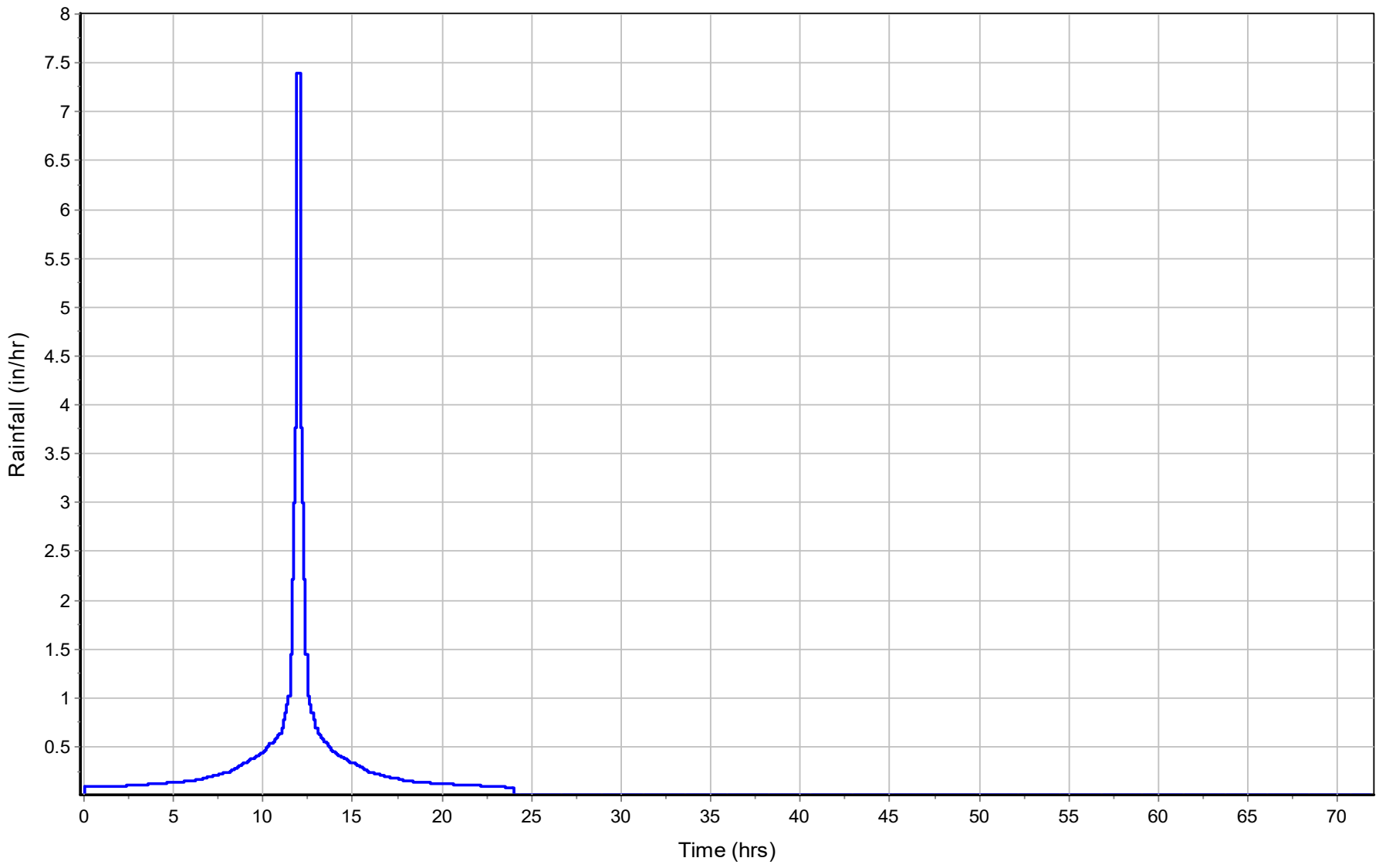
Total TOC (min) 3.14

Subbasin Runoff Results

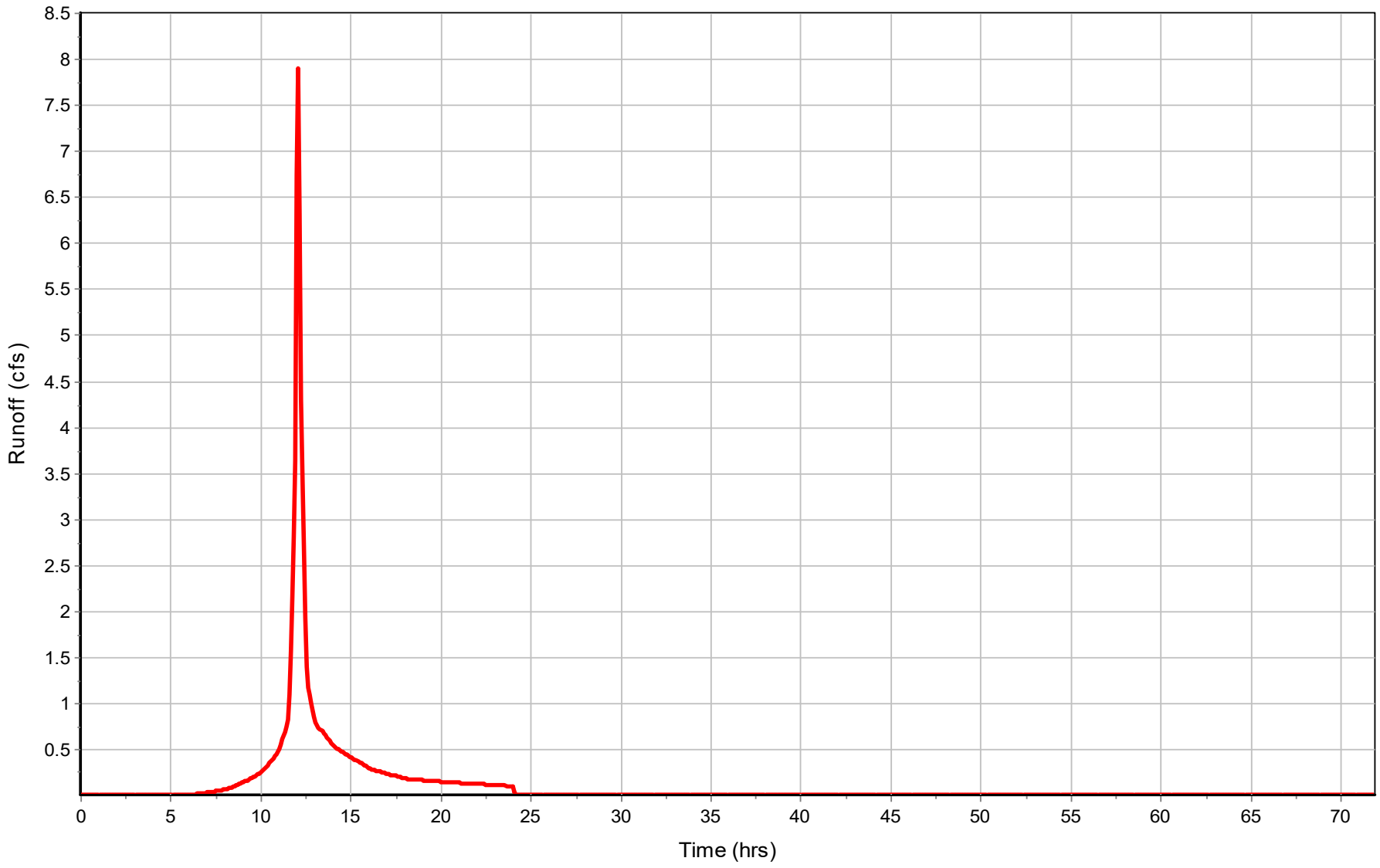
Total Rainfall (in) 8.8
Total Runoff (in) 5.89
Peak Runoff (cfs) 8.02
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:03:08

Subbasin : DA-Ditch-A1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : DA-Ditch-A1-2

Input Data

Area (ac) 1.29
Peak Rate Factor 484
Weighted Curve Number 76
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
50 - 75% grass cover, Fair	1.29	A	76
Composite Area & Weighted CN	1.29		76

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	131.55	0	0
Slope (%) :	1.5	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	1.04	0	0
Computed Flow Time (min) :	2.1	0	0

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	7.88	0	0
Slope (%) :	1.5	0	0
Surface Type :	Unpaved	Unpaved	Unpaved
Velocity (ft/sec) :	1.98	0	0
Computed Flow Time (min) :	0.07	0	0

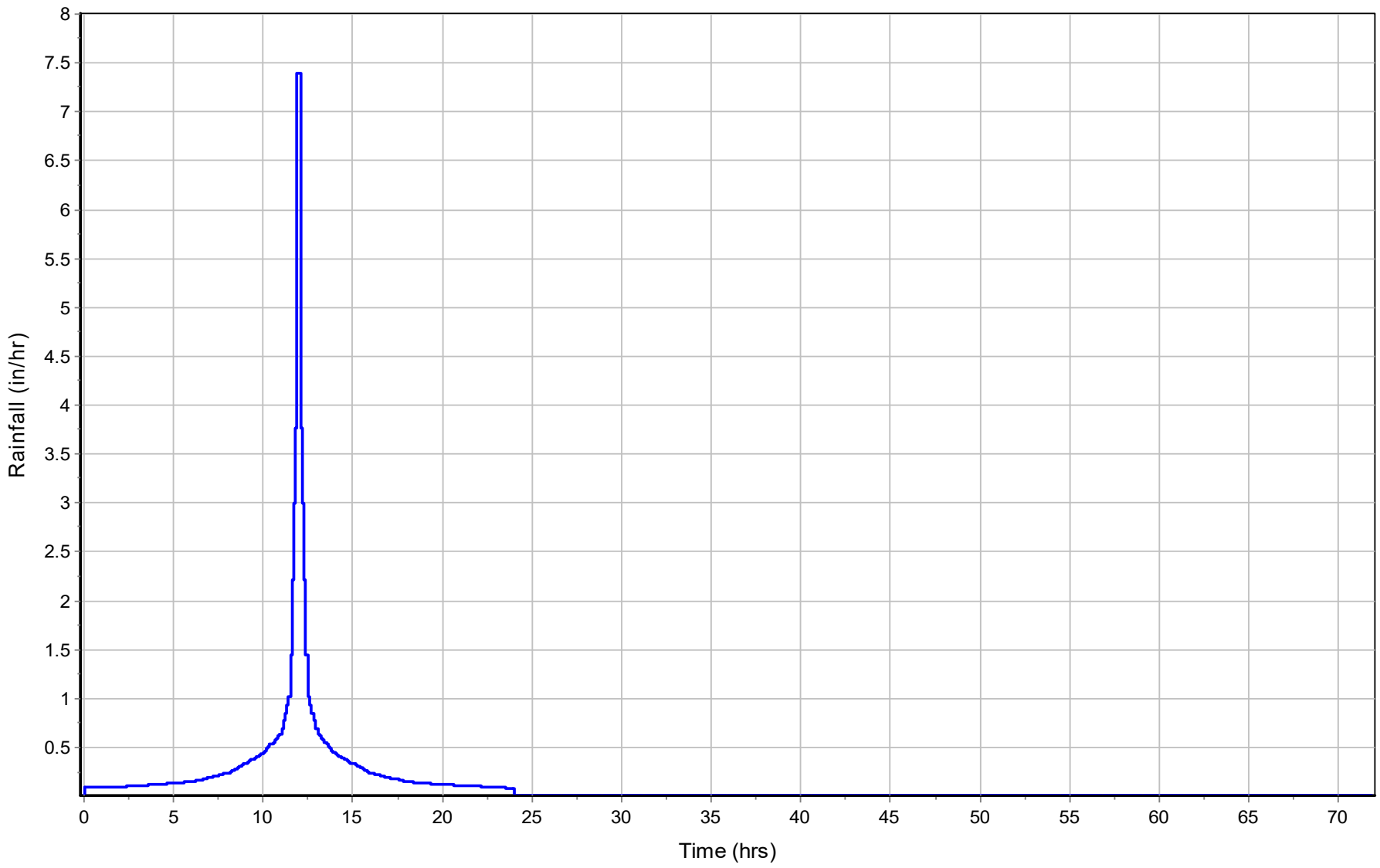
Total TOC (min) 2.17

Subbasin Runoff Results

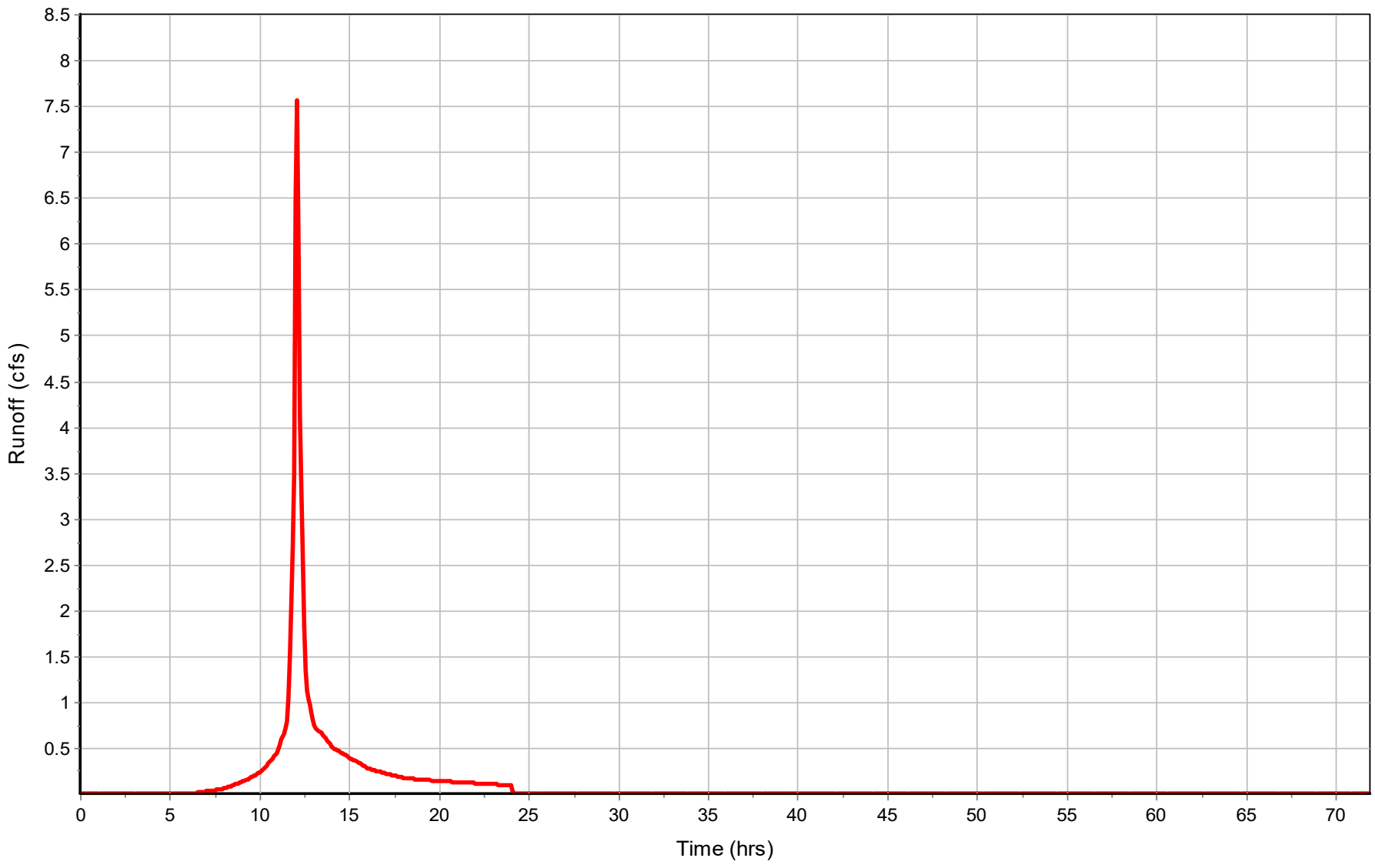
Total Rainfall (in) 8.8
Total Runoff (in) 5.89
Peak Runoff (cfs) 7.68
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:02:10

Subbasin : DA-Ditch-A1-2

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : DA-Ditch-A2

Input Data

Area (ac)	0.67
Peak Rate Factor	484
Weighted Curve Number	76
Rain Gage ID	Rain Gage-01

Composite Curve Number

32

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
50 - 75% grass cover, Fair	0.67	A	76
Composite Area & Weighted CN	0.67		76

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	300	0	0
Slope (%) :	1.5	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	1.23	0	0
Computed Flow Time (min) :	4.06	0	0

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	7.88	0	0
Slope (%) :	1.5	0	0
Surface Type :	Unpaved	Unpaved	Unpaved
Velocity (ft/sec) :	1.98	0	0
Computed Flow Time (min) :	0.07	0	0

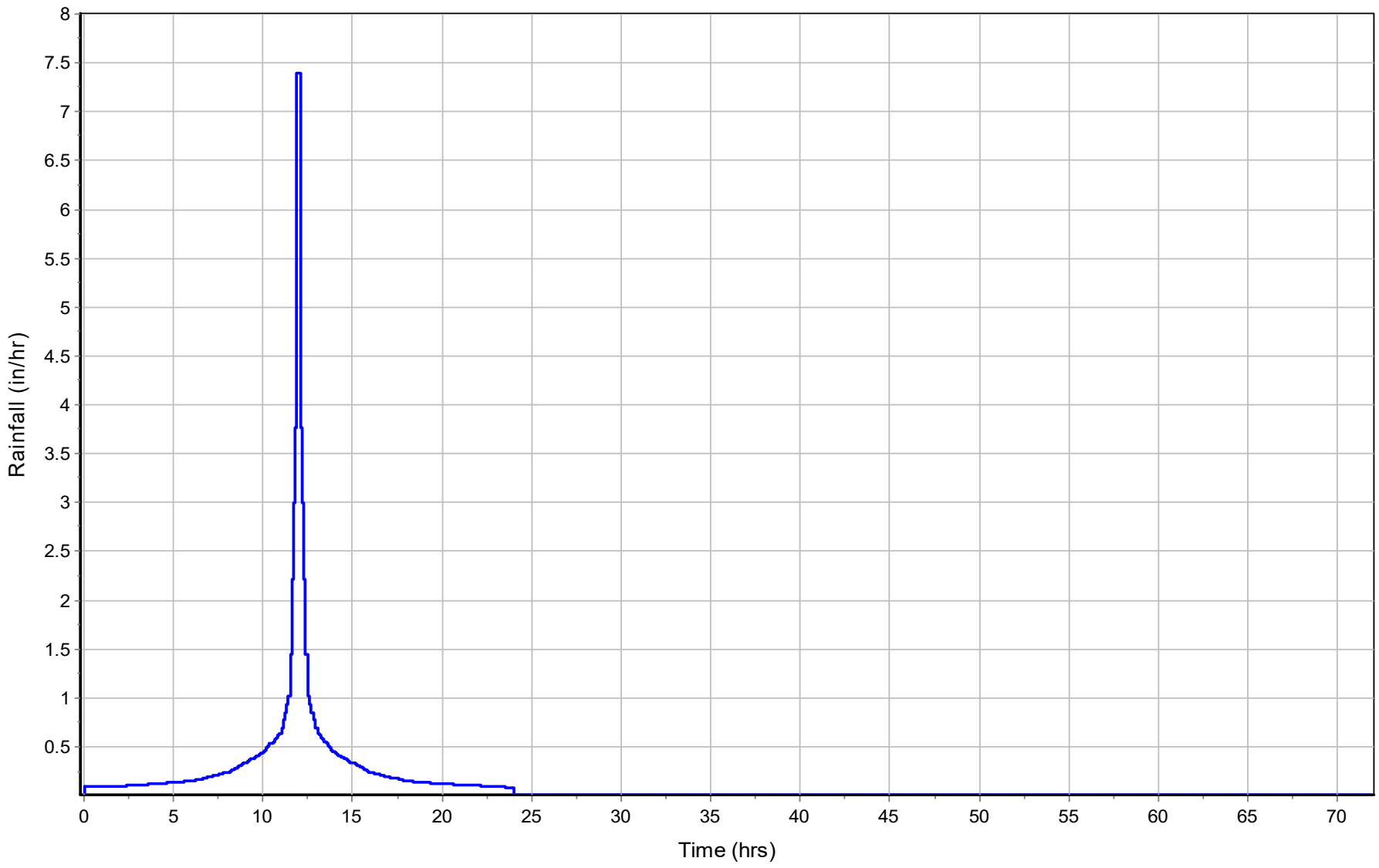
Total TOC (min) 4.13

Subbasin Runoff Results

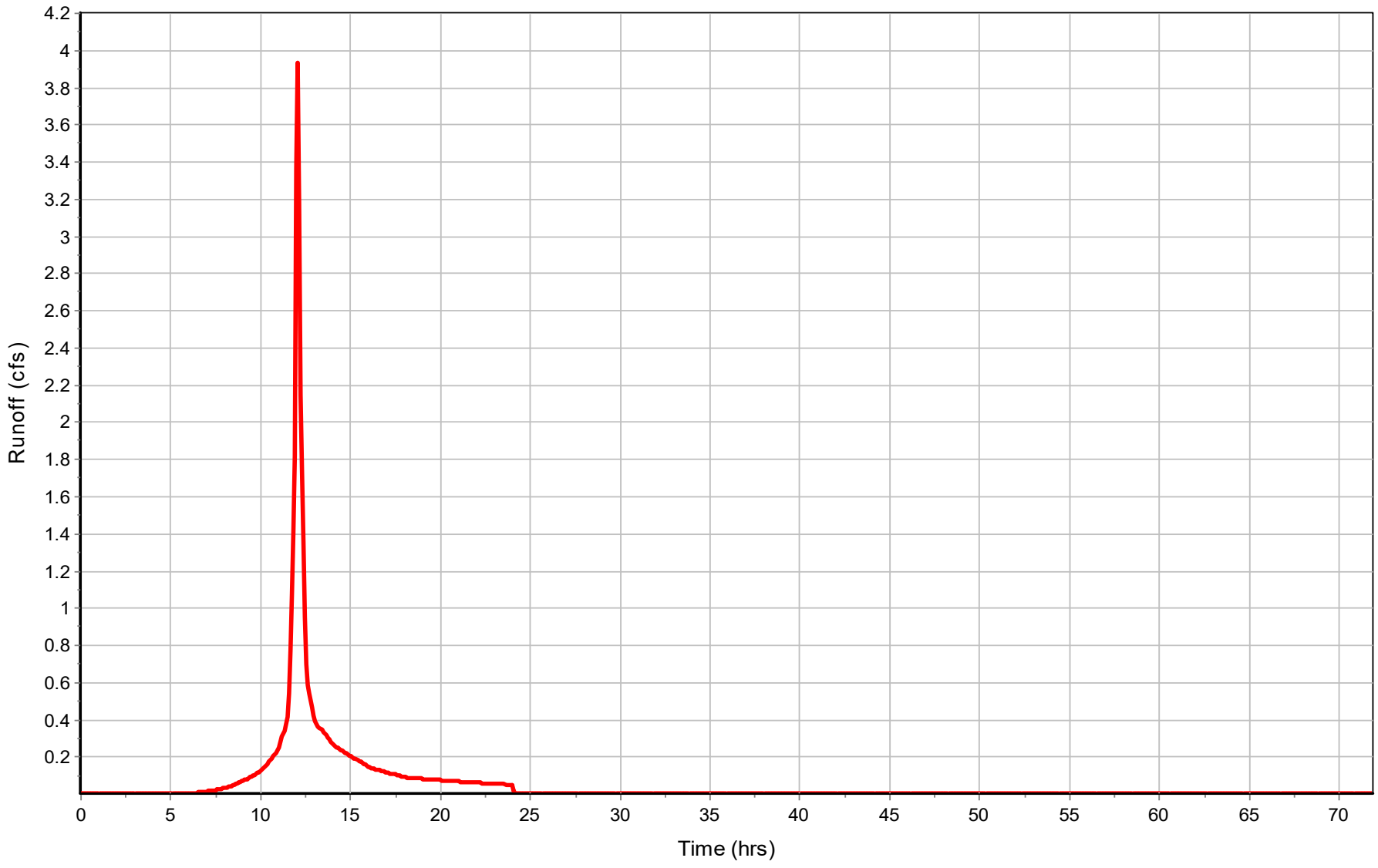
Total Rainfall (in)	8.8
Total Runoff (in)	5.89
Peak Runoff (cfs)	3.99
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:04:08

Subbasin : DA-Ditch-A2

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Existing-E03-1_A1

Input Data

Area (ac)	0.89
Peak Rate Factor	484
Weighted Curve Number	49
Rain Gage ID	Rain Gage-01

Composite Curve Number

32

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
50 - 75% grass cover, Fair	0.89	A	49
Composite Area & Weighted CN	0.89		49

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.4	0	0
Flow Length (ft) :	251.94	0	0
Slope (%) :	3.5	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.12	0	0
Computed Flow Time (min) :	34.83	0	0

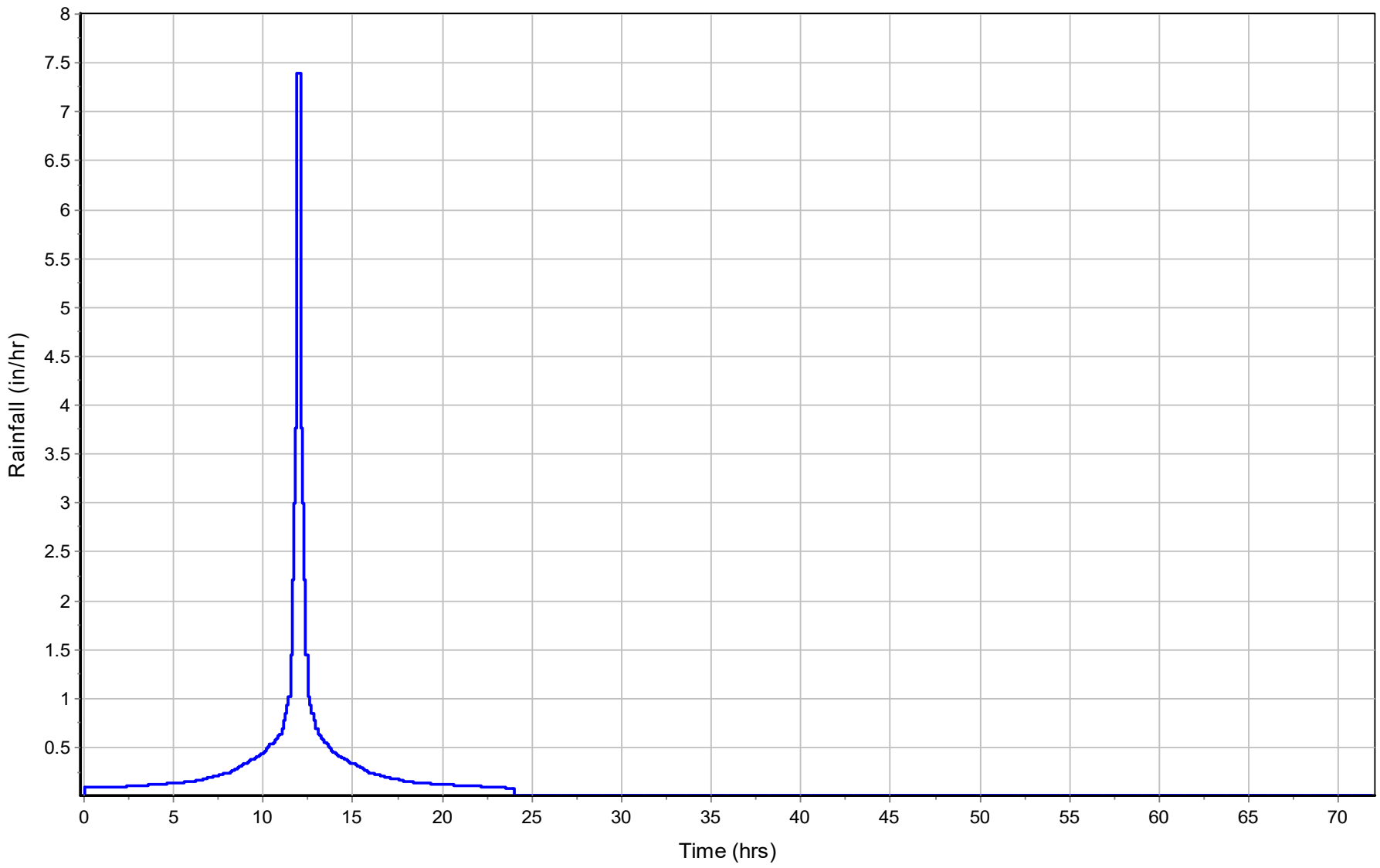
Total TOC (min) 34.83

Subbasin Runoff Results

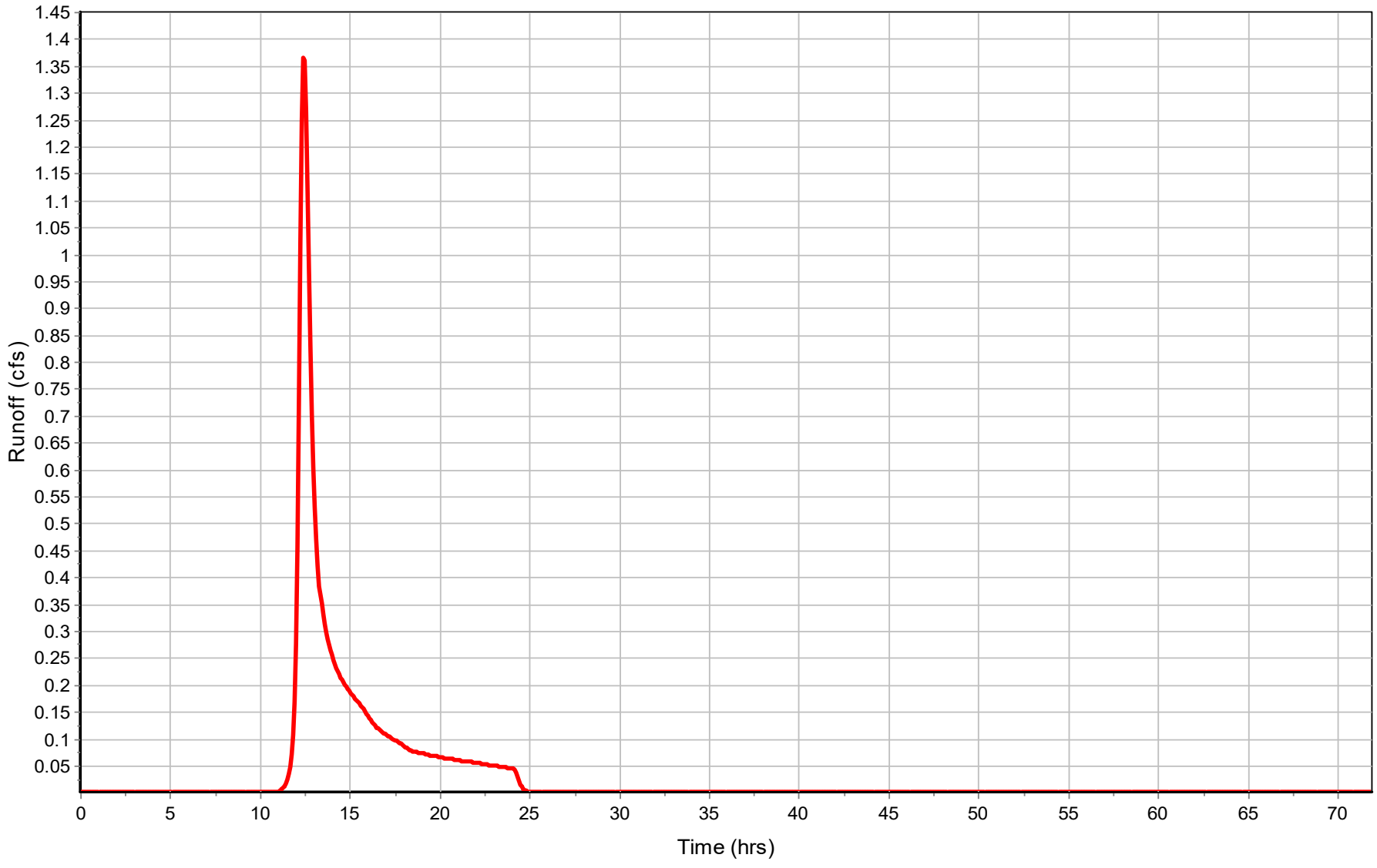
Total Rainfall (in)	8.8
Total Runoff (in)	2.64
Peak Runoff (cfs)	1.38
Weighted Curve Number	49
Time of Concentration (days hh:mm:ss)	0 00:34:50

Subbasin : Existing-E03-1_A1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Existing-E-07_A3

Input Data

Area (ac)	0.39
Peak Rate Factor	484
Weighted Curve Number	51.7
Rain Gage ID	Rain Gage-01

Composite Curve Number

32

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
50 - 75% grass cover, Fair	0.35	A	49
-	0.04	-	76
Composite Area & Weighted CN	0.39		51.7

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.4	0	0
Flow Length (ft) :	300	0	0
Slope (%) :	5	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.14	0	0
Computed Flow Time (min) :	34.72	0	0

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	105.18	0	0
Slope (%) :	2	0	0
Surface Type :	Grass pasture	Unpaved	Unpaved
Velocity (ft/sec) :	0.99	0	0
Computed Flow Time (min) :	1.77	0	0

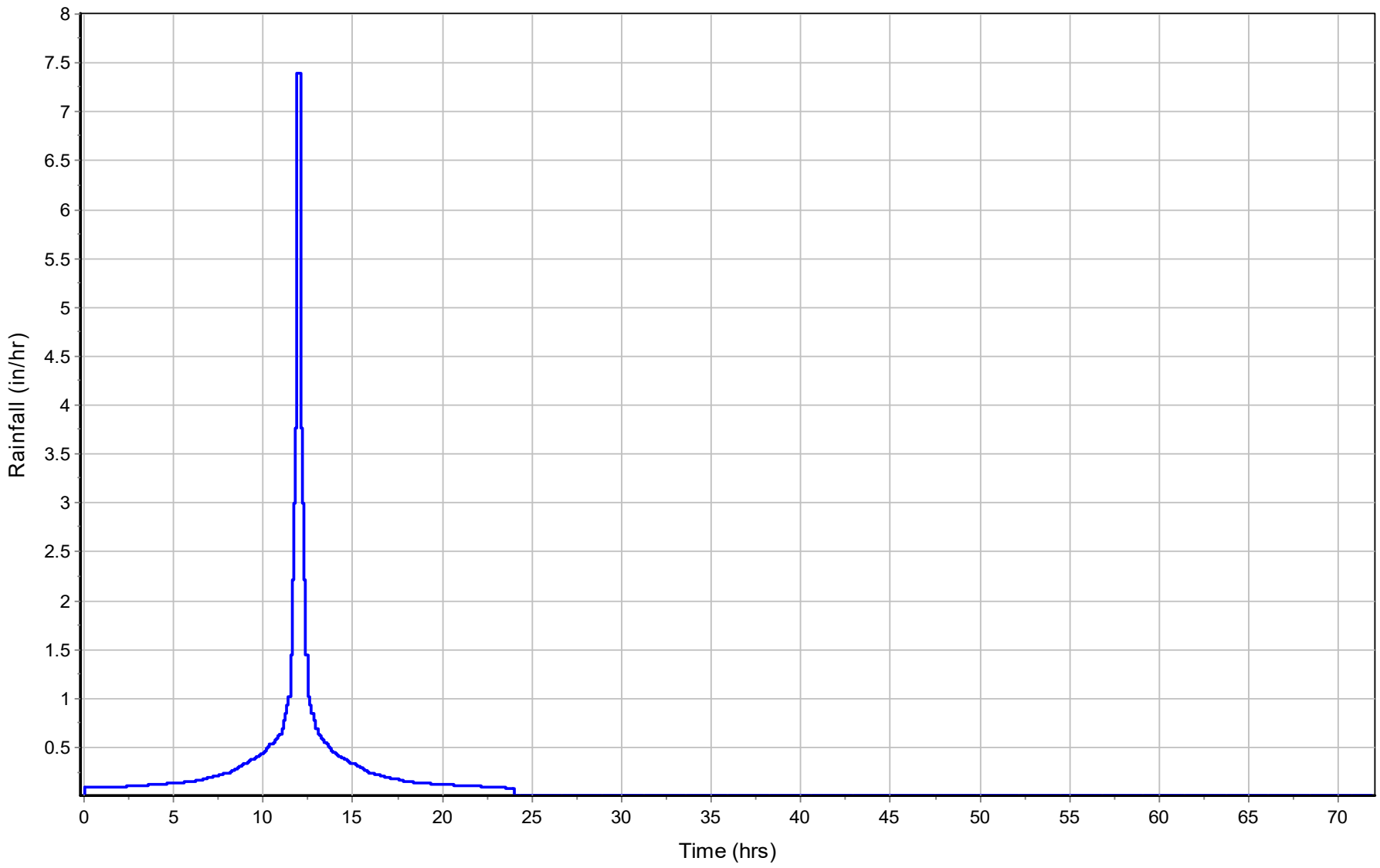
Total TOC (min) 36.49

Subbasin Runoff Results

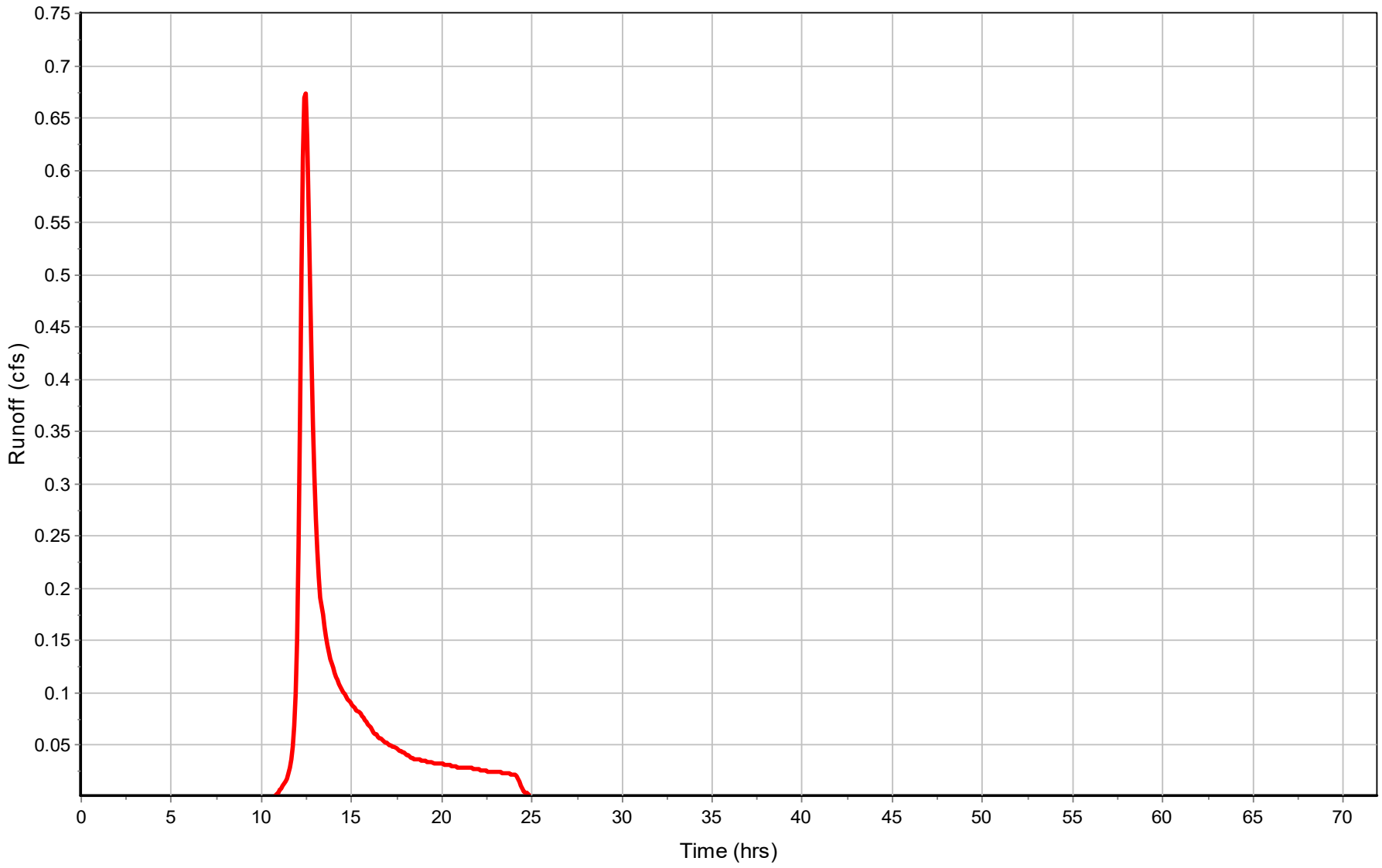
Total Rainfall (in)	8.8
Total Runoff (in)	2.95
Peak Runoff (cfs)	0.68
Weighted Curve Number	51.7
Time of Concentration (days hh:mm:ss)	0 00:36:29

Subbasin : Existing-E-07_A3

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Existing-E3_A1-2

Input Data

Area (ac)	3.2
Peak Rate Factor	484
Weighted Curve Number	49
Rain Gage ID	Rain Gage-01

Composite Curve Number

32

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
-	3.2	-	49
Composite Area & Weighted CN	3.2		49

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.4	0	0
Flow Length (ft) :	300	0	0
Slope (%) :	3.5	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.12	0	0
Computed Flow Time (min) :	40.05	0	0

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	205.17	0	0
Slope (%) :	3	0	0
Surface Type :	Grass pasture	Unpaved	Unpaved
Velocity (ft/sec) :	1.21	0	0
Computed Flow Time (min) :	2.83	0	0

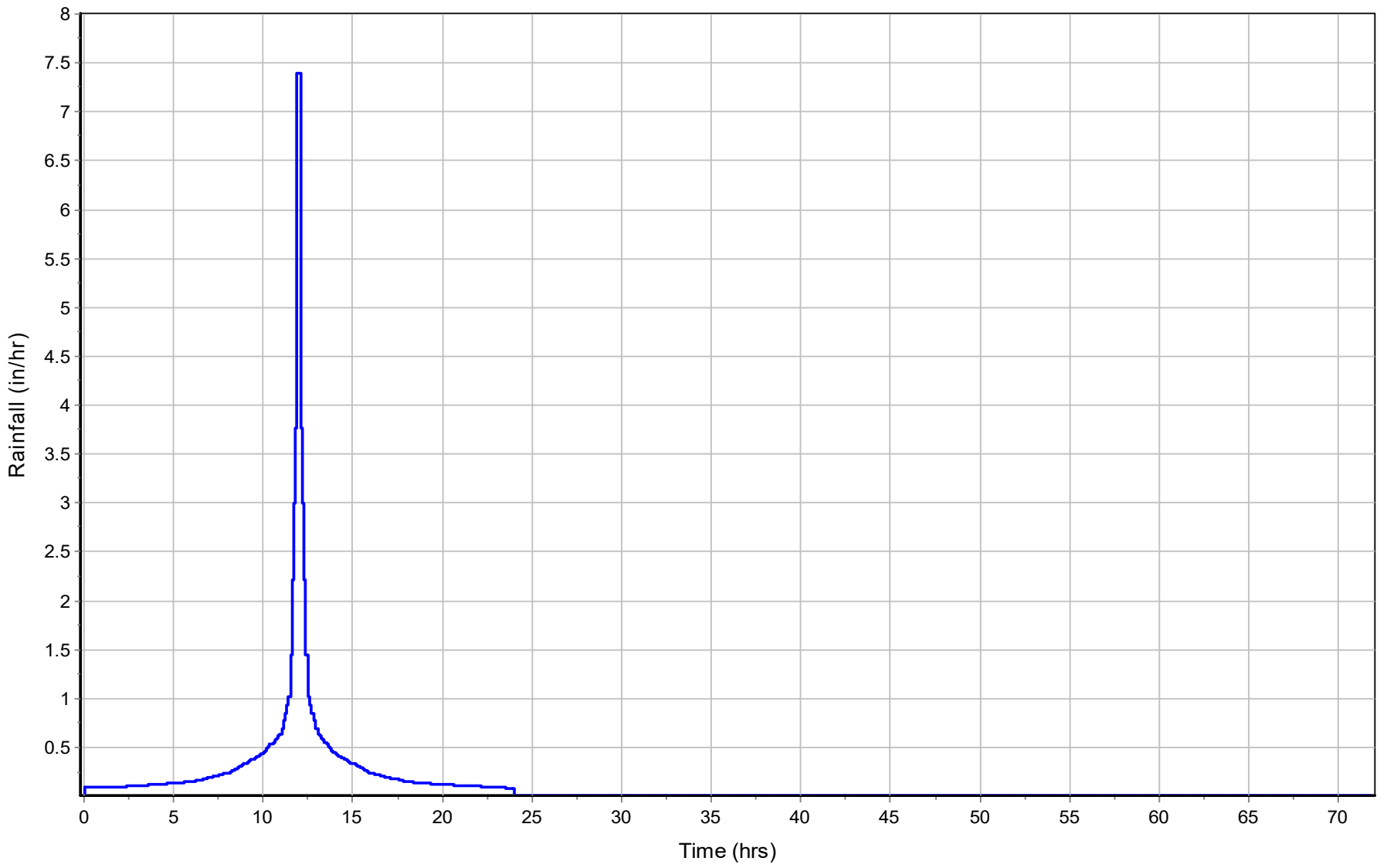
Total TOC (min) 42.87

Subbasin Runoff Results

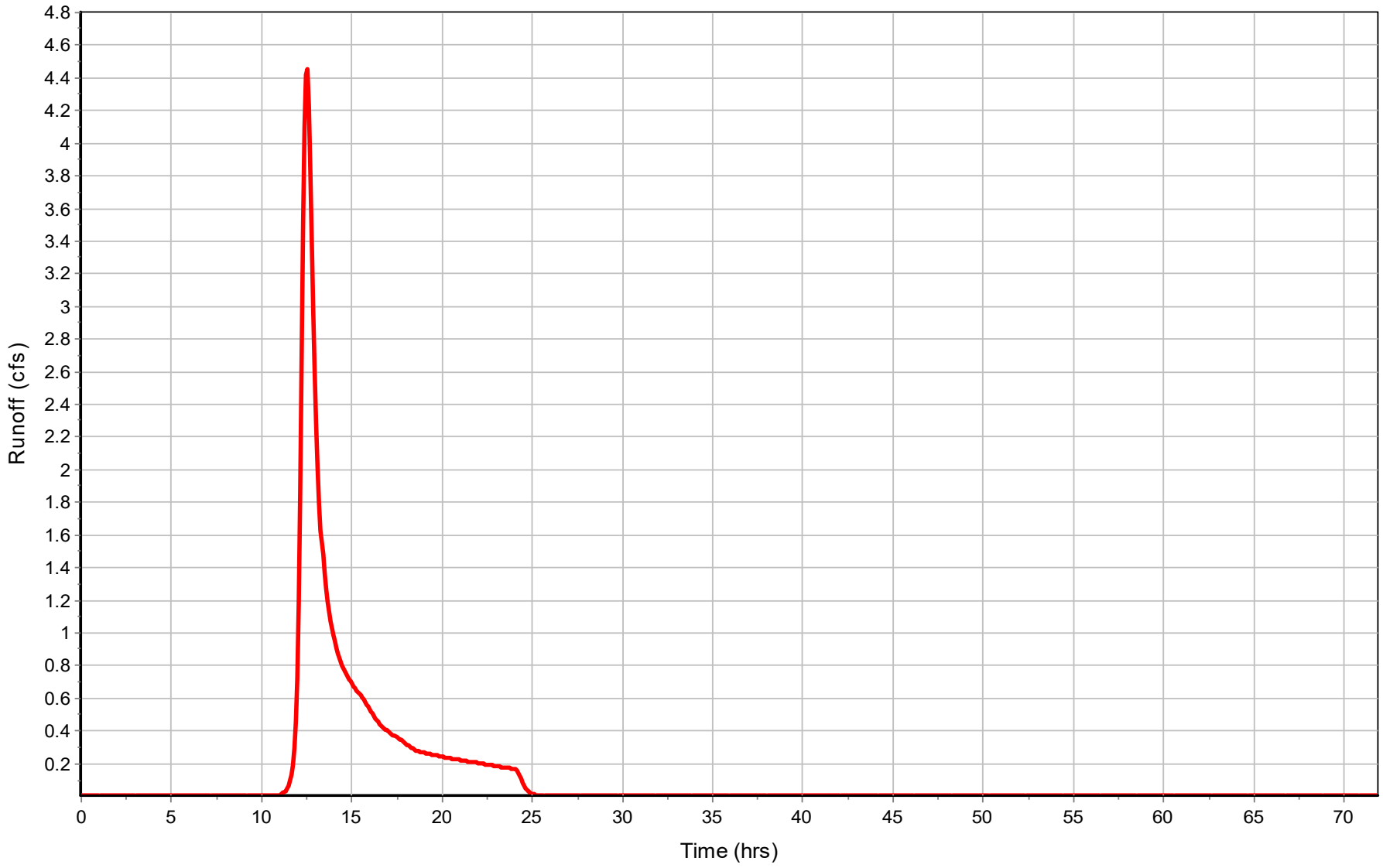
Total Rainfall (in)	8.8
Total Runoff (in)	2.64
Peak Runoff (cfs)	4.47
Weighted Curve Number	49
Time of Concentration (days hh:mm:ss)	0 00:42:52

Subbasin : Existing-E3_A1-2

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Existing-E5.1_A2

Input Data

Area (ac)	0.26
Peak Rate Factor	484
Weighted Curve Number	49
Rain Gage ID	Rain Gage-01

Composite Curve Number

32

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
50 - 75% grass cover, Fair	0.26	A	49
Composite Area & Weighted CN	0.26		49

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.4	0	0
Flow Length (ft) :	142.47	0	0
Slope (%) :	10	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.16	0	0
Computed Flow Time (min) :	14.5	0	0

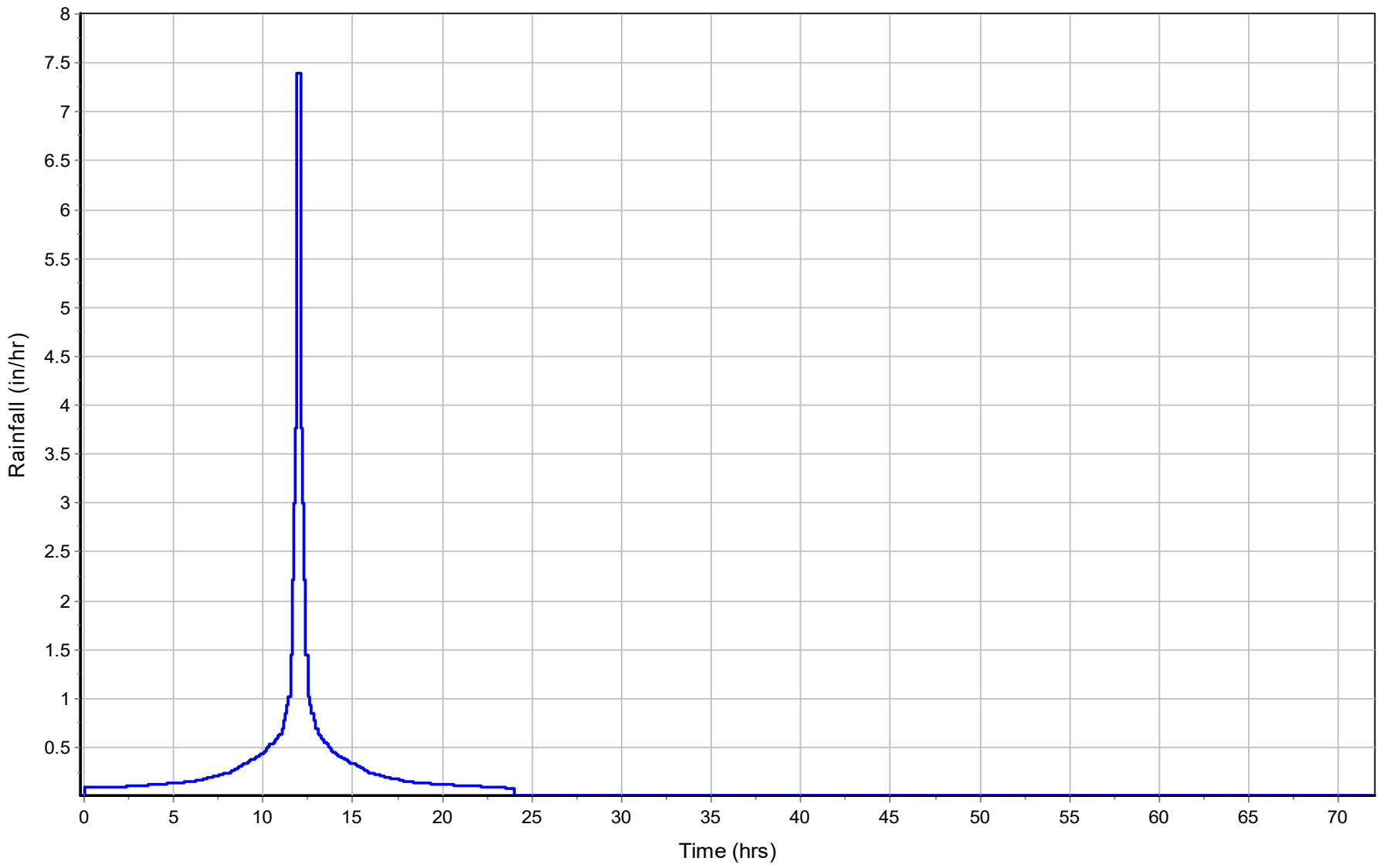
Total TOC (min) 14.50

Subbasin Runoff Results

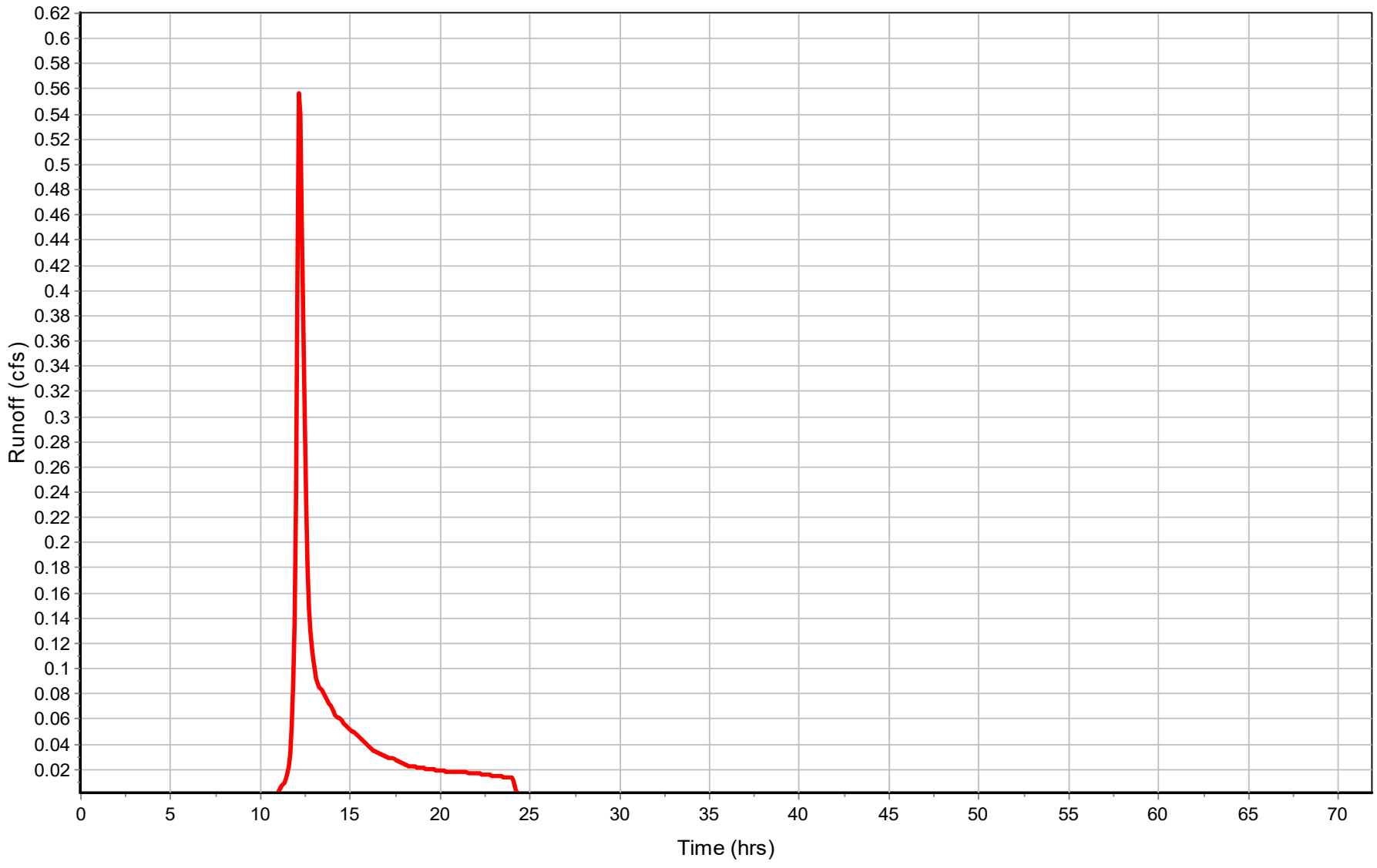
Total Rainfall (in)	8.8
Total Runoff (in)	2.64
Peak Runoff (cfs)	0.57
Weighted Curve Number	49
Time of Concentration (days hh:mm:ss)	0 00:14:30

Subbasin : Existing-E5.1_A2

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : A1-1-BASIN

Input Data

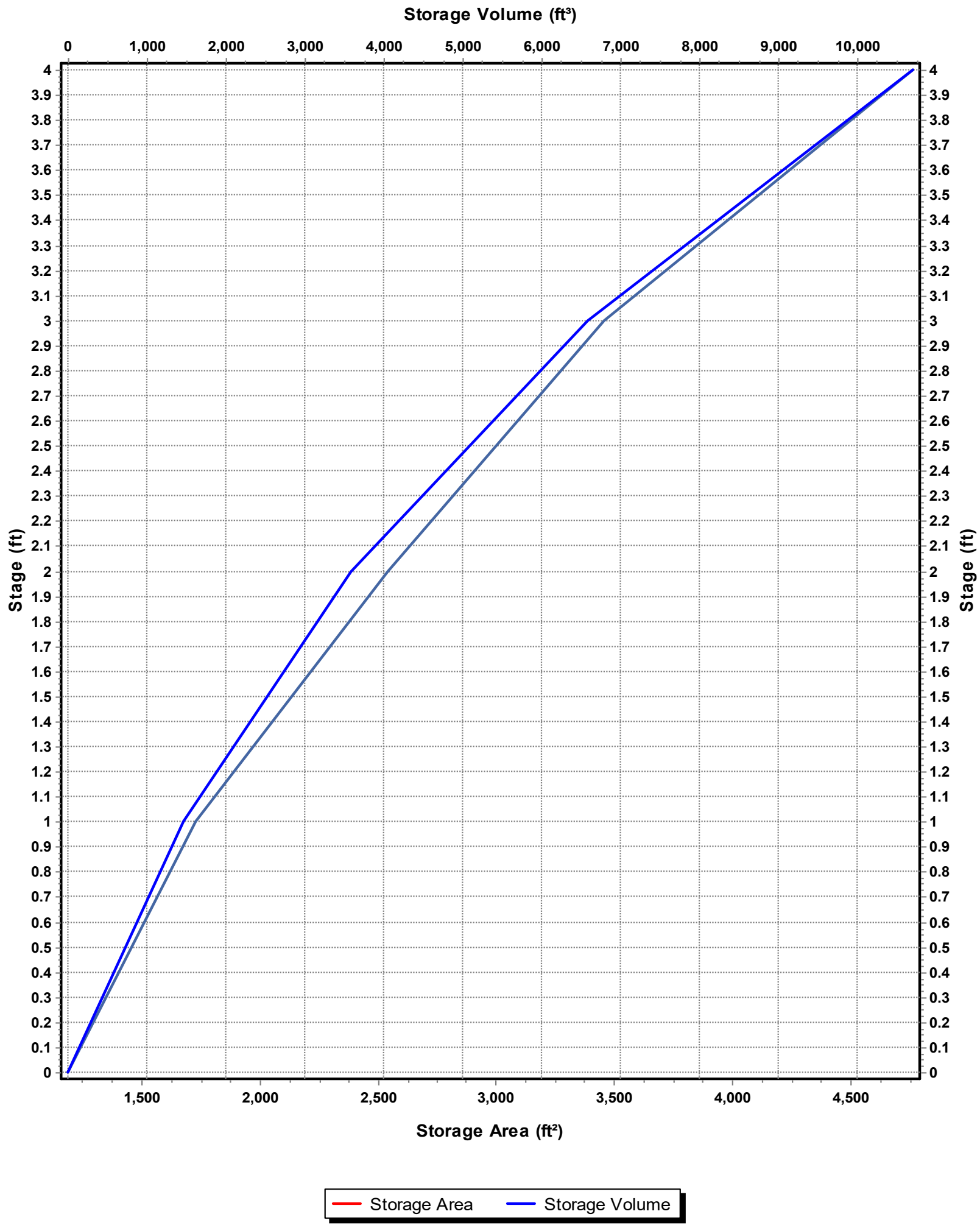
Invert Elevation (ft)	66.00
Max (Rim) Elevation (ft)	69.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	66.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : EXISTING POND.North

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	1188.1	0
1	1729.54	1458.82
2	2543.02	3595.1
3	3461.12	6597.17
4	4767.41	10711.44

Storage Area Volume Curves



Storage Node : A1-1-BASIN (continued)

Outflow Orifices

SN	Element ID	Orifice Type	Orifice Shape	Flap Gate	Circular Orifice Diameter (ft)	Rectangular Orifice Height (ft)	Rectangular Orifice Width (ft)	Orifice Invert Elevation (ft)	Orifice Coefficient
1	12RCP	Side	CIRCULAR	No	1.00			68.00	0.61

Output Summary Results

Peak Inflow (cfs)	2.61
Peak Lateral Inflow (cfs)	2.61
Peak Outflow (cfs)	1.67
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	68.72
Max HGL Depth Attained (ft)	2.72
Average HGL Elevation Attained (ft)	68.19
Average HGL Depth Attained (ft)	2.19
Time of Max HGL Occurrence (days hh:mm)	0 12:23
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : BASIN-1

Input Data

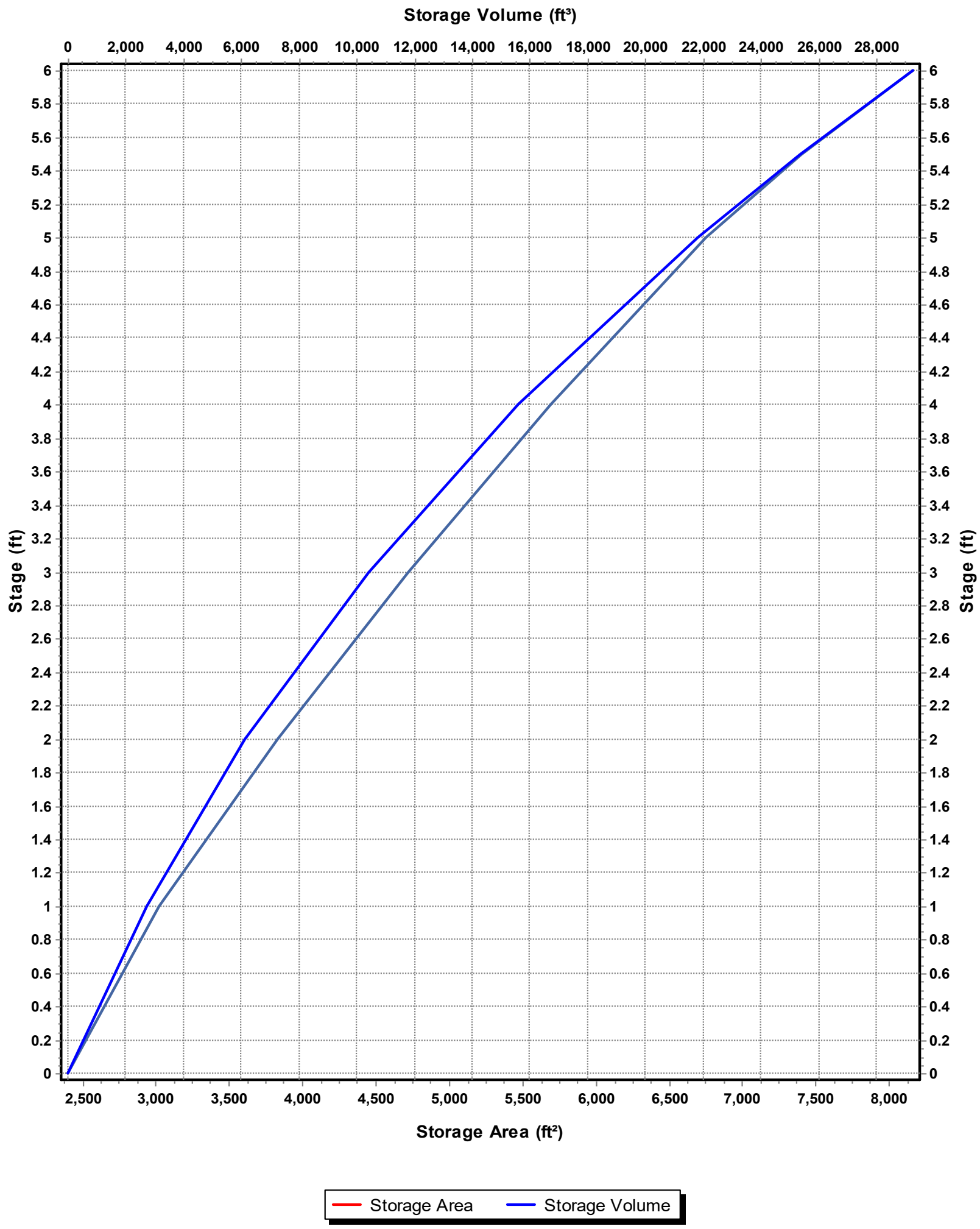
Invert Elevation (ft)	63.00
Max (Rim) Elevation (ft)	69.00
Max (Rim) Offset (ft)	6.00
Initial Water Elevation (ft)	63.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : POND-1

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	2401.32	0
1	3024.34	2712.83
2	3828.08	6139.04
3	4718.62	10412.39
4	5693.33	15618.37
5	6754.28	21842.18
5.5	7407.96	25382.74
6	8166.38	29276.33

Storage Area Volume Curves



Storage Node : BASIN-1 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-B1	Trapezoidal	No	68.50	5.50	10.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	7.95
Peak Lateral Inflow (cfs)	0
Peak Outflow (cfs)	7.39
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	68.55
Max HGL Depth Attained (ft)	5.55
Average HGL Elevation Attained (ft)	67.59
Average HGL Depth Attained (ft)	4.59
Time of Max HGL Occurrence (days hh:mm)	0 16:08
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : BASIN-2

Input Data

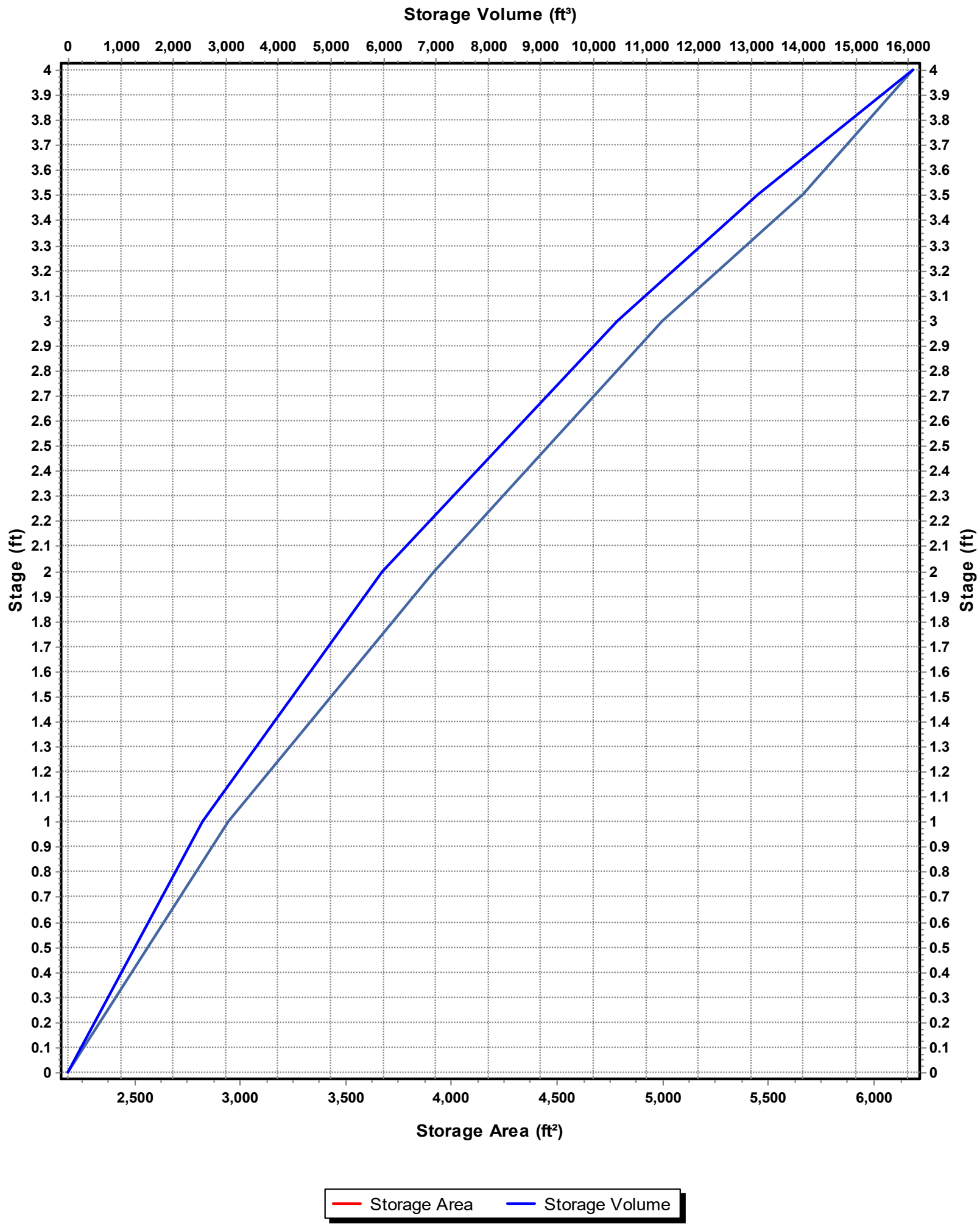
Invert Elevation (ft)	63.00
Max (Rim) Elevation (ft)	67.00
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	63.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : POND-2

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	2186.8	0
1	2944.52	2565.66
2	3920.59	5998.22
3	5001.46	10459.25
3.5	5669	13126.87
4	6188.64	16091.28

Storage Area Volume Curves



Storage Node : BASIN-2 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-B2	Trapezoidal	No	66.50	3.50	10.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	5.26
Peak Lateral Inflow (cfs)	0
Peak Outflow (cfs)	0.12
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	66.52
Max HGL Depth Attained (ft)	3.52
Average HGL Elevation Attained (ft)	65.87
Average HGL Depth Attained (ft)	2.87
Time of Max HGL Occurrence (days hh:mm)	0 18:32
Total Exfiltration Volume (1000-ft³)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Exist-Catch-Basin

Input Data

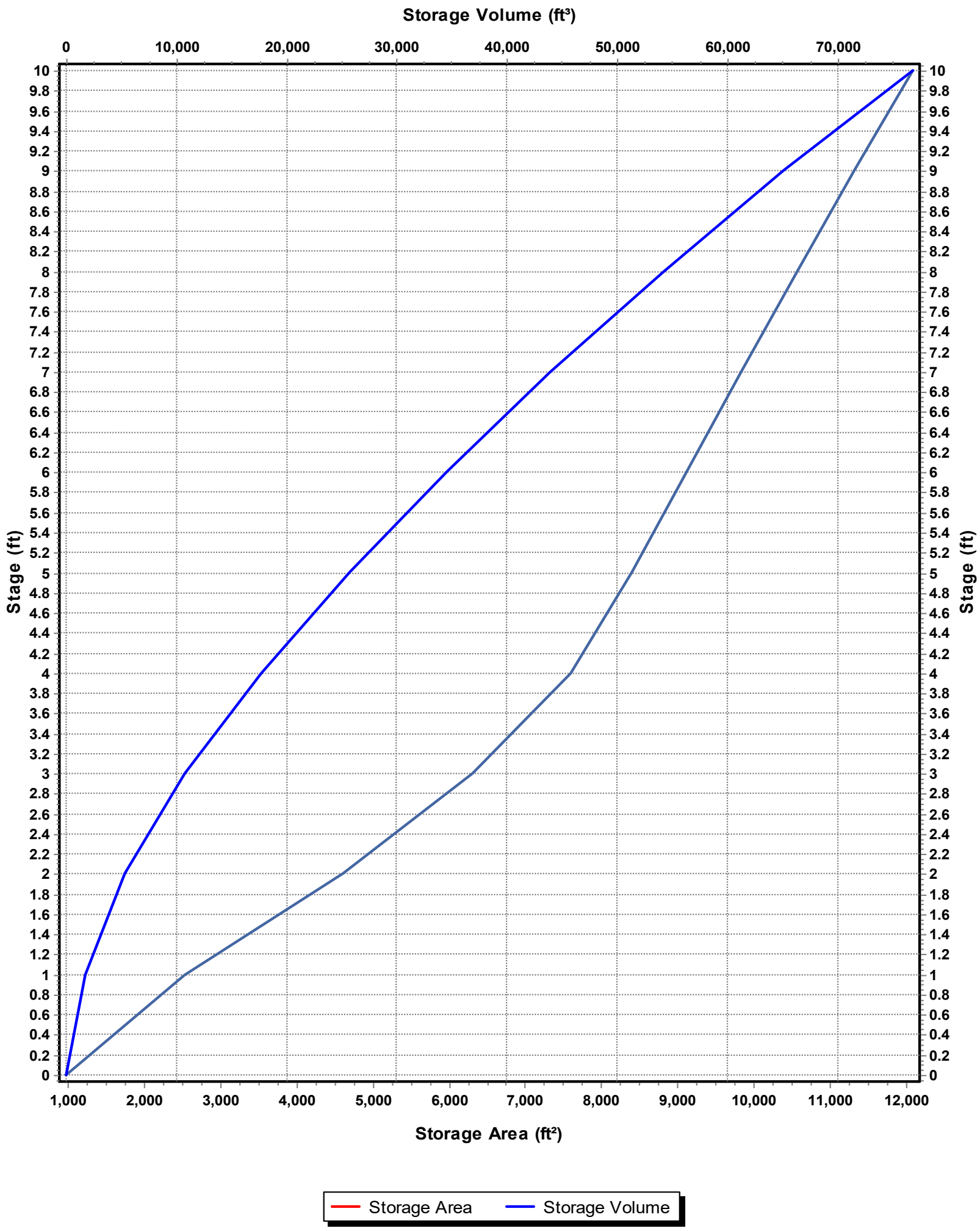
Invert Elevation (ft)	43.00
Max (Rim) Elevation (ft)	53.00
Max (Rim) Offset (ft)	10.00
Initial Water Elevation (ft)	43.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : EXISTING POND.South

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	974.38	0
1	2524.45	1749.42
2	4602.46	5312.88
3	6308.57	10768.4
4	7605.38	17725.38
5	8399.21	25727.68
6	9117.86	34486.22
7	9840.94	43965.62
8	10576.98	54174.58
9	11329.31	65127.73
10	12097.94	76841.36

Storage Area Volume Curves



Storage Node : Exist-Catch-Basin (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Exist-Catch-Basin-Weir	Trapezoidal	No	52.50	9.50	5.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	4.45
Peak Lateral Inflow (cfs)	4.45
Peak Outflow (cfs)	0
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	48.57
Max HGL Depth Attained (ft)	5.57
Average HGL Elevation Attained (ft)	47.48
Average HGL Depth Attained (ft)	4.48
Time of Max HGL Occurrence (days hh:mm)	1 01:45
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : Existing-Catch-Basin

Input Data

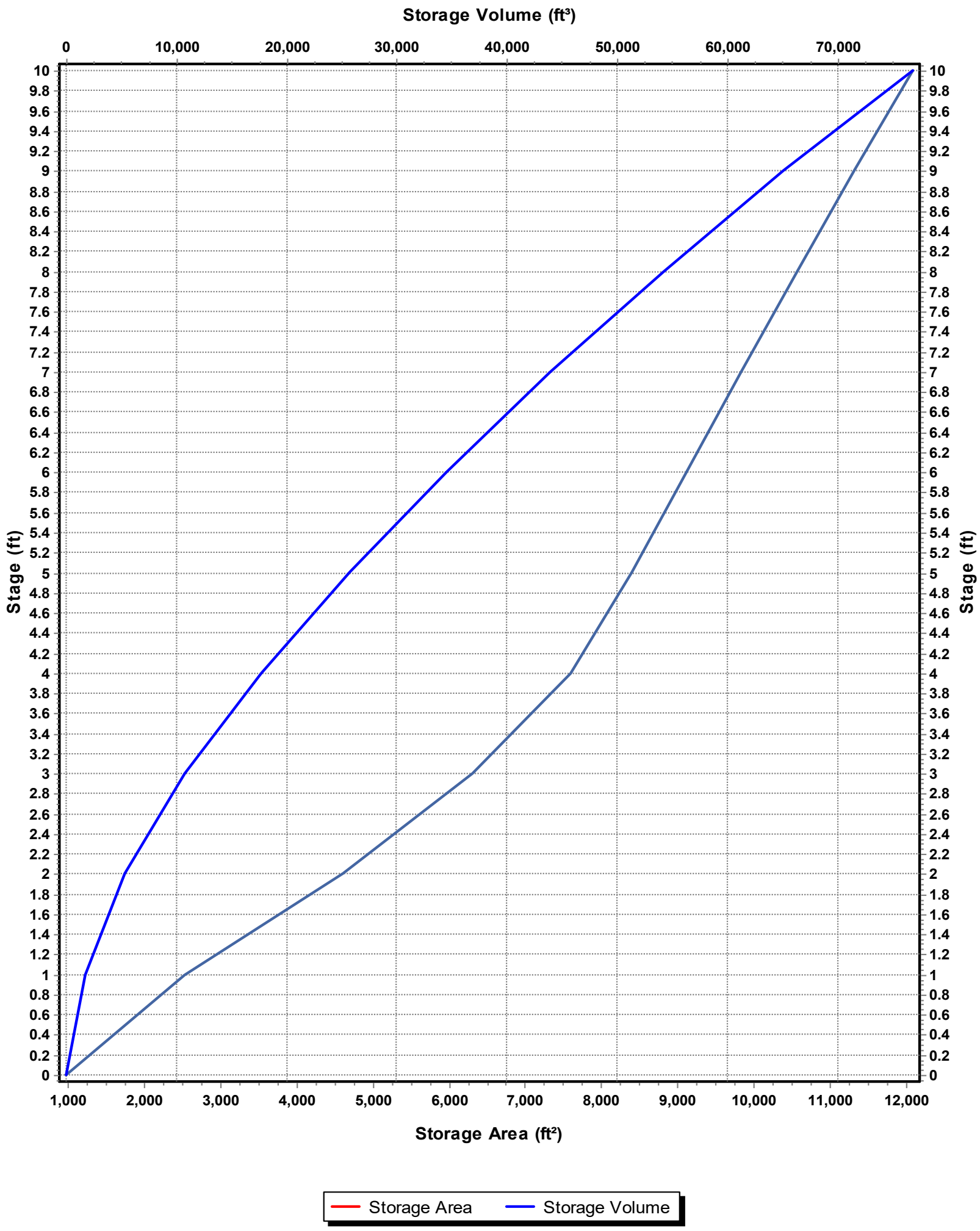
Invert Elevation (ft)	43.00
Max (Rim) Elevation (ft)	53.00
Max (Rim) Offset (ft)	10.00
Initial Water Elevation (ft)	43.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : EXISTING POND.South

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	974.38	0
1	2524.45	1749.42
2	4602.46	5312.88
3	6308.57	10768.4
4	7605.38	17725.38
5	8399.21	25727.68
6	9117.86	34486.22
7	9840.94	43965.62
8	10576.98	54174.58
9	11329.31	65127.73
10	12097.94	76841.36

Storage Area Volume Curves



Storage Node : Existing-Catch-Basin (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Existing-Catch-Basin-Weir	Trapezoidal	No	52.50	9.50	5.00	0.50	3.33

Output Summary Results

Peak Inflow (cfs)	4.75
Peak Lateral Inflow (cfs)	1.48
Peak Outflow (cfs)	0
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	49.19
Max HGL Depth Attained (ft)	6.19
Average HGL Elevation Attained (ft)	47.77
Average HGL Depth Attained (ft)	4.77
Time of Max HGL Occurrence (days hh:mm)	3 00:00
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : FOREBAY-1

Input Data

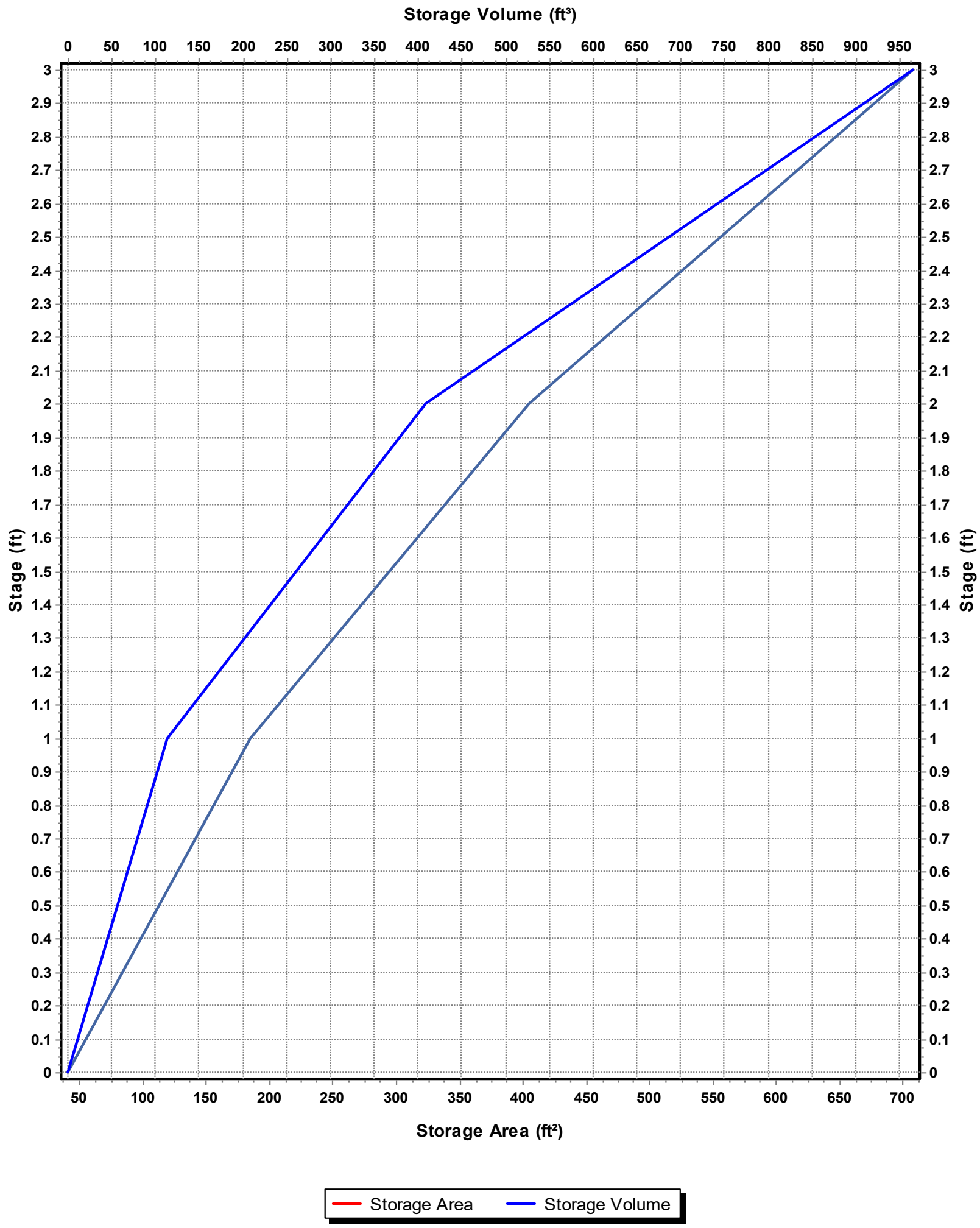
Invert Elevation (ft)	66.00
Max (Rim) Elevation (ft)	70.00
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	66.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : FOREBAY-1

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	41.13	0
1	185.44	113.29
2	405.49	408.76
3	708.15	965.58

Storage Area Volume Curves



Storage Node : FOREBAY-1 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-F1	Trapezoidal	No	67.00	1.00	4.00	3.00	3.33

Output Summary Results

Peak Inflow (cfs)	7.98
Peak Lateral Inflow (cfs)	7.04
Peak Outflow (cfs)	7.95
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	68.57
Max HGL Depth Attained (ft)	2.57
Average HGL Elevation Attained (ft)	68.15
Average HGL Depth Attained (ft)	2.15
Time of Max HGL Occurrence (days hh:mm)	1 00:57
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : FOREBAY-1-2

Input Data

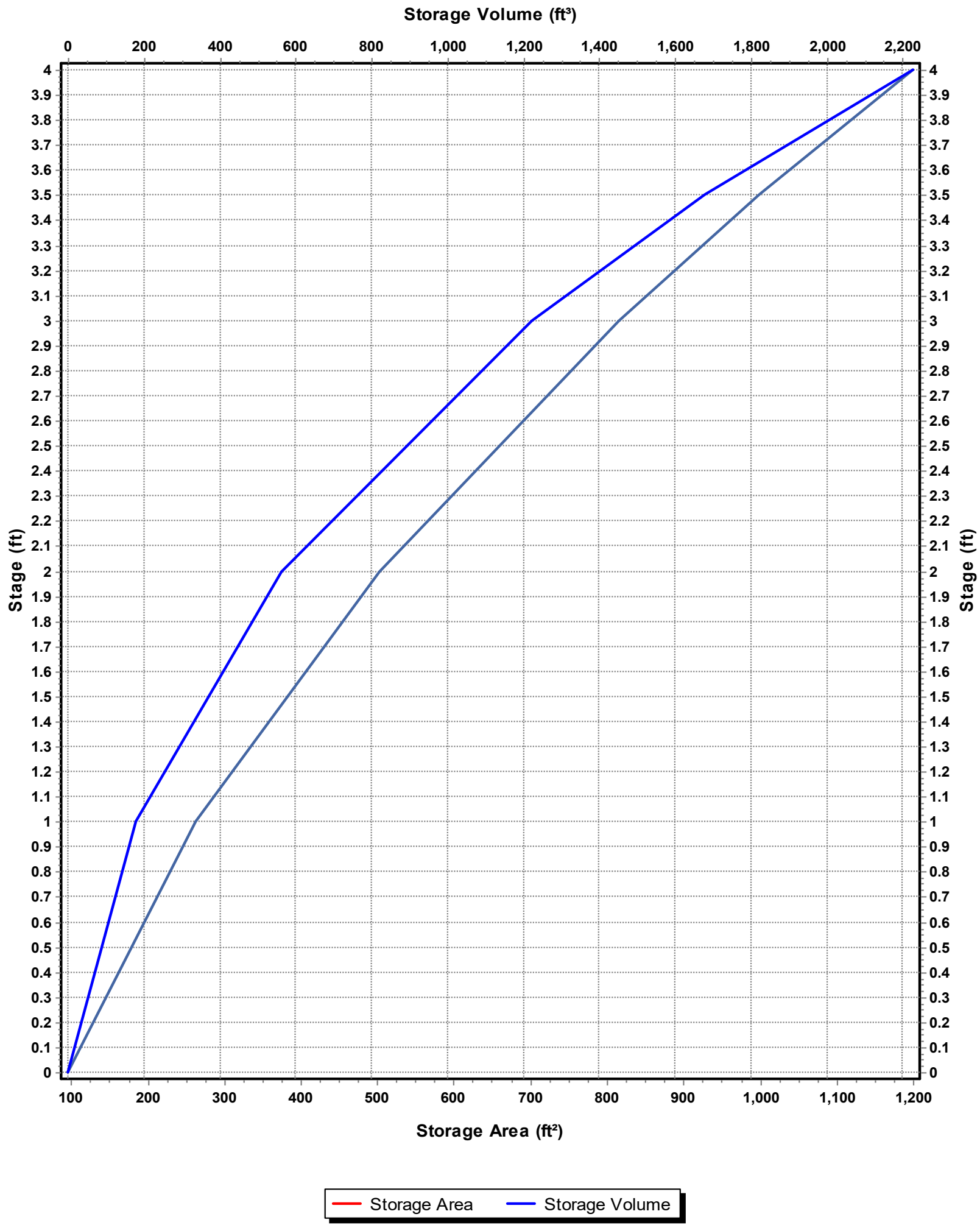
Invert Elevation (ft)	62.00
Max (Rim) Elevation (ft)	66.00
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	62.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : FOREBAY-3

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	96	0
1	264	180
2	504	564
3	816	1224
3.5	999	1677.75
4	1200	2227.5

Storage Area Volume Curves



Storage Node : FOREBAY-1-2 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-F1-2	Trapezoidal	No	63.00	1.00	2.00	3.00	3.33

Output Summary Results

Peak Inflow (cfs)	4.33
Peak Lateral Inflow (cfs)	4.33
Peak Outflow (cfs)	4.29
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	63.64
Max HGL Depth Attained (ft)	1.64
Average HGL Elevation Attained (ft)	62.89
Average HGL Depth Attained (ft)	0.89
Time of Max HGL Occurrence (days hh:mm)	0 12:10
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : FOREBAY-2

Input Data

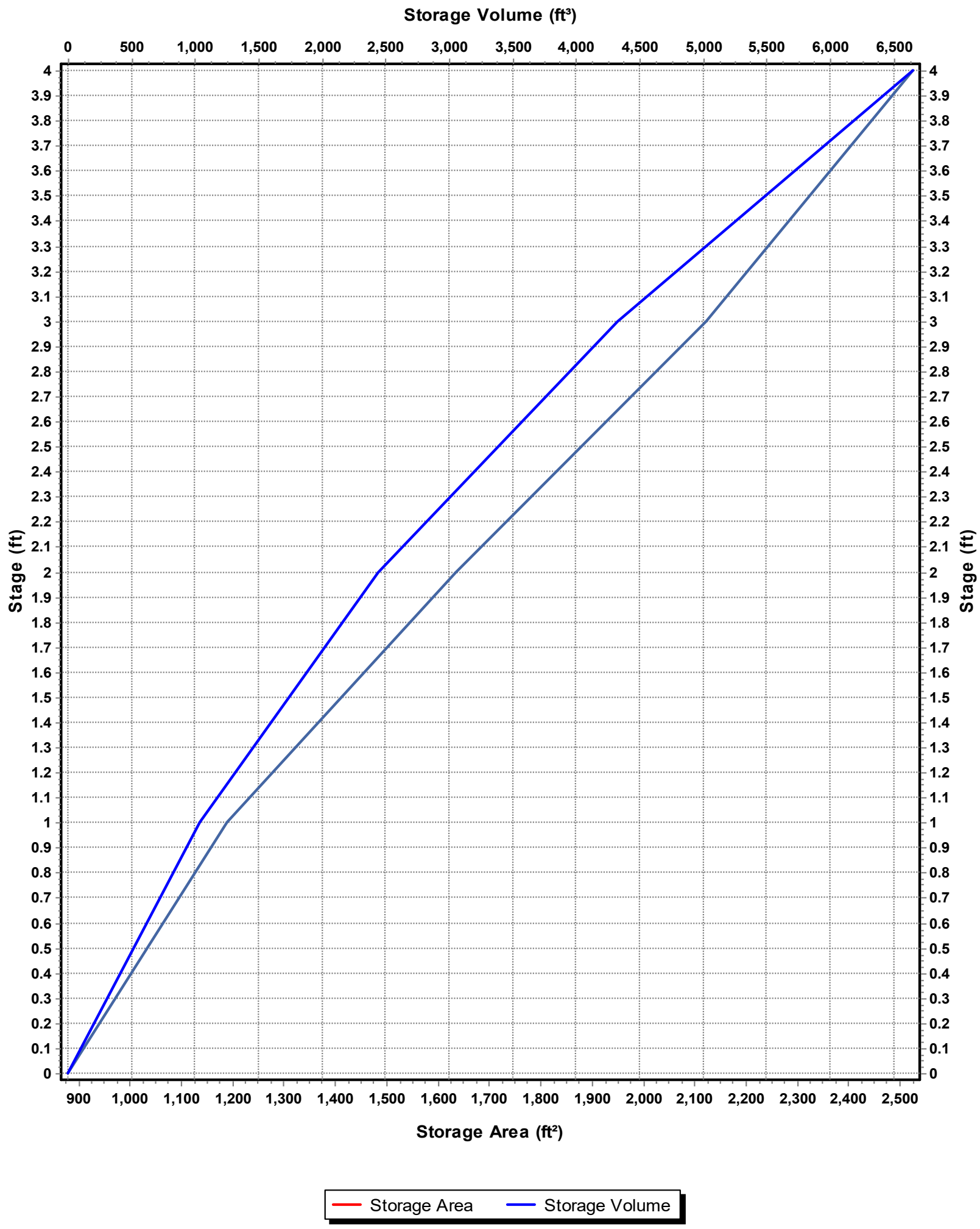
Invert Elevation (ft)	65.00
Max (Rim) Elevation (ft)	69.00
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	65.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : FOREBAY-2

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	880.04	0
1	1189.5	1034.77
2	1635.09	2447.07
3	2123.92	4326.58
4	2526	6651.54

Storage Area Volume Curves



Storage Node : FOREBAY-2 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-F2	Trapezoidal	No	68.00	3.00	10.00	1.00	3.33

Output Summary Results

Peak Inflow (cfs)	5.38
Peak Lateral Inflow (cfs)	5.38
Peak Outflow (cfs)	5.26
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	68.29
Max HGL Depth Attained (ft)	3.29
Average HGL Elevation Attained (ft)	67.56
Average HGL Depth Attained (ft)	2.56
Time of Max HGL Occurrence (days hh:mm)	0 12:10
Total Exfiltration Volume (1000-ft^3)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Attachment D - Standard 3 Supporting Information

NRCS Soil Report

Site Specific Geotechnical Engineering Report

Drawdown Analysis

Recharge Volume

NRCS Soils Report

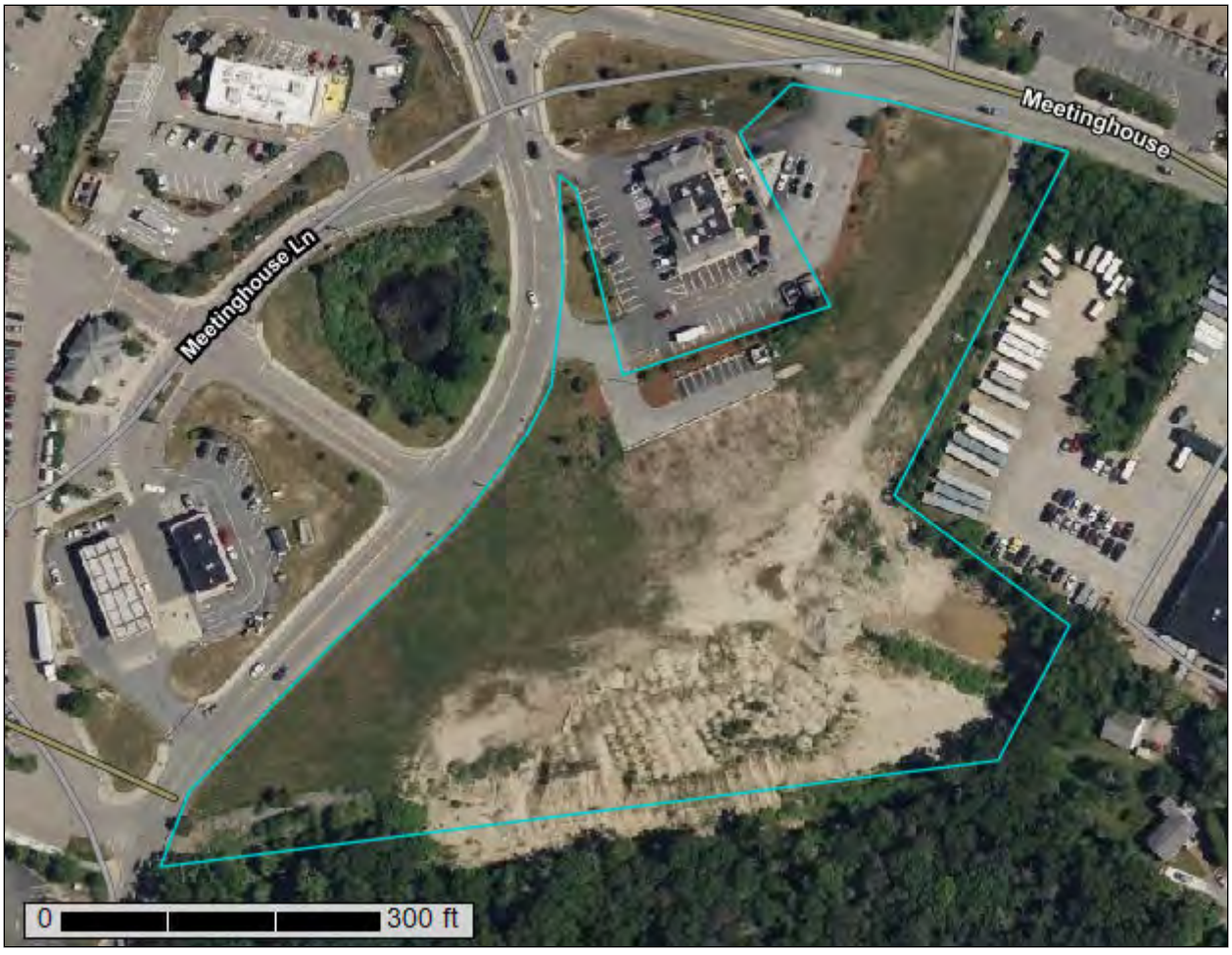
United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Barnstable County, Massachusetts



June 24, 2026

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require

alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

Contents

Preface.....2
How Soil Surveys Are Made.....5
Soil Map.....8
Soil Map.....9
Legend.....10
Map Unit Legend.....11
Map Unit Descriptions.....11
Barnstable County, Massachusetts.....13
254B—Merrimac fine sandy loam, 3 to 8 percent slopes.....13
430B—Barnstable sandy loam, 3 to 8 percent slopes.....14
431C—Barnstable sandy loam, 8 to 15 percent slopes, very stony.....16
References.....18

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map



Map Scale: 1:1,890 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 25 50 100 150

Feet
0 50 100 200 300

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 19N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:25,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Barnstable County, Massachusetts
Survey Area Data: Version 24, Sep 5, 2025

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jun 10, 2022—Jun 30, 2022

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
254B	Merrimac fine sandy loam, 3 to 8 percent slopes	3.3	48.0%
430B	Barnstable sandy loam, 3 to 8 percent slopes	0.0	0.3%
431C	Barnstable sandy loam, 8 to 15 percent slopes, very stony	3.6	51.8%
Totals for Area of Interest		**6.9**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or

landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Barnstable County, Massachusetts

254B—Merrimac fine sandy loam, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 2tyqs
Landscape: Outwash plains, valleys
Elevation: 0 to 1,290 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 240 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Merrimac and similar soils: 86 percent
Minor components: 14 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Merrimac

Setting

Landscape: Outwash plains, valleys
Landform: Moraines, Eskers, Kames, Outwash plains, Outwash terraces
Landform position (two-dimensional): Summit, shoulder, backslope, footslope
Landform position (three-dimensional): Side slope, crest, riser, tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loamy glaciofluvial deposits derived from granite, schist, and gneiss over sandy and gravelly glaciofluvial deposits derived from granite, schist, and gneiss

Typical profile

Ap - 0 to 10 inches: fine sandy loam
Bw1 - 10 to 22 inches: fine sandy loam
Bw2 - 22 to 26 inches: stratified gravel to gravelly loamy sand
2C - 26 to 65 inches: stratified gravel to very gravelly sand

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to very high (1.42 to 99.90 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 2 percent
Maximum salinity: Nonsaline (0.0 to 1.4 mmhos/cm)
Sodium adsorption ratio, maximum: 1.0
Available water supply, 0 to 60 inches: Low (about 4.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2s

Hydrologic Soil Group: A
Ecological site: F145XY008MA - Dry Outwash
Hydric soil rating: No

Minor Components

Sudbury
Percent of map unit: 5 percent
Landscape: Lake plains, valleys
Landform: Deltas, Terraces, Outwash plains
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Tread, dip
Down-slope shape: Concave
Across-slope shape: Linear
Hydric soil rating: No

Hinckley
Percent of map unit: 5 percent
Landscape: Outwash plains, valleys
Landform: Deltas, Kames, Eskers, Outwash plains
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Head slope, nose slope, side slope, crest, rise
Down-slope shape: Convex
Across-slope shape: Convex, linear
Hydric soil rating: No

Windsor
Percent of map unit: 3 percent
Landscape: Valleys
Landform: Dunes, Deltas, Outwash terraces, Outwash plains
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Tread, riser
Down-slope shape: Convex, linear
Across-slope shape: Convex, linear
Hydric soil rating: No

Walpole
Percent of map unit: 1 percent
Landscape: Outwash plains
Landform: Depressions
Landform position (three-dimensional): Tread
Down-slope shape: Concave
Across-slope shape: Concave
Ecological site: F144AY028MA - Wet Outwash
Hydric soil rating: Yes

430B—Barnstable sandy loam, 3 to 8 percent slopes

Map Unit Setting
National map unit symbol: 98ps

Elevation: 0 to 1,000 feet
Mean annual precipitation: 40 to 50 inches
Mean annual air temperature: 48 to 54 degrees F
Frost-free period: 160 to 240 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Barnstable and similar soils: 75 percent
Minor components: 25 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Barnstable

Setting

Landform: Ground moraines
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Friable loamy ablation till over reworked sandy glaciofluvial deposits

Typical profile

H1 - 0 to 1 inches: sandy loam
H2 - 1 to 23 inches: sandy loam
H3 - 23 to 64 inches: coarse sand

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 4.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2s
Hydrologic Soil Group: A
Ecological site: F149BY011MA - Well Drained Till Uplands
Hydric soil rating: No

Minor Components

Plymouth

Percent of map unit: 8 percent
Hydric soil rating: No

Nantucket

Percent of map unit: 7 percent
Hydric soil rating: No

Merrimac

Percent of map unit: 5 percent

Hydric soil rating: No

Carver

Percent of map unit: 5 percent
Hydric soil rating: No

431C—Barnstable sandy loam, 8 to 15 percent slopes, very stony

Map Unit Setting

National map unit symbol: 98pw
Elevation: 0 to 1,000 feet
Mean annual precipitation: 40 to 50 inches
Mean annual air temperature: 48 to 54 degrees F
Frost-free period: 160 to 240 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Barnstable and similar soils: 70 percent
Minor components: 30 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Barnstable

Setting

Landform: Ground moraines
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Friable loamy ablation till over reworked sandy glaciofluvial deposits; loamy ablation till over reworked sandy outwash

Typical profile

H1 - 0 to 1 inches: sandy loam
H2 - 1 to 23 inches: sandy loam
H3 - 23 to 64 inches: coarse sand

Properties and qualities

Slope: 8 to 15 percent
Surface area covered with cobbles, stones or boulders: 2.0 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 4.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: A
Ecological site: F149BY011MA - Well Drained Till Uplands
Hydric soil rating: No

Minor Components

Nantucket

Percent of map unit: 10 percent
Hydric soil rating: No

Plymouth

Percent of map unit: 10 percent
Hydric soil rating: No

Carver

Percent of map unit: 10 percent
Hydric soil rating: No

References

American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deep-water habitats of the United States. U.S. Fish and Wildlife Service FWS/OBS-79/31.

Federal Register. July 13, 1994. Changes in hydric soils of the United States.

Federal Register. September 18, 2002. Hydric soils of the United States.

Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.

National Research Council. 1995. Wetlands: Characteristics and boundaries.

Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_054262

Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service, U.S. Department of Agriculture Handbook 436. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053577

Soil Survey Staff. 2010. Keys to soil taxonomy. 11th edition. U.S. Department of Agriculture, Natural Resources Conservation Service. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053580

Tiner, R.W., Jr. 1985. Wetlands of Delaware. U.S. Fish and Wildlife Service and Delaware Department of Natural Resources and Environmental Control, Wetlands Section.

United States Army Corps of Engineers, Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Waterways Experiment Station Technical Report Y-87-1.

United States Department of Agriculture, Natural Resources Conservation Service. National forestry manual. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2_053374

United States Department of Agriculture, Natural Resources Conservation Service. National range and pasture handbook. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/landuse/rangepasture/?cid=stelprdb1043084

United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053624

United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf

Boring Logs

Between March 3 and March 7, 2025, GeoEngineers performed a geotechnical subsurface exploration program consisting of five (5) borings (designated MR-03, MR-04, MR-04A, MR-05, and MR-06) advanced to depths between 14 and 121 feet below ground surface (bgs) by Geologic Earth Exploration, Inc. (Geologic) of Norfolk, Massachusetts. The borings were advanced using either casing and mud rotary, or hollow-stem auger drilling methods with a track mounted Acker Rebel drill rig. The borings were continuously monitored by a representative from our firm who logged and classified the soils encountered, obtained representative soil samples, observed groundwater conditions, and prepared logs for the explorations.

The boring logs are based on our interpretation of the field and laboratory data and indicate the various types of soils and groundwater conditions encountered. The logs also indicate the depths at which these soils or their characteristics change, although the change may be gradual. If the change occurred between samples, it was interpreted. The densities noted in the boring logs are based on the blow count data obtained in the borings and judgment based on the conditions encountered.

The soils encountered in the borings were generally sampled at the surface continuously until 10 feet bgs, then at 5-foot vertical intervals thereafter with a 2-inch outside-diameter split-barrel standard penetration test (SPT) sampler. The disturbed samples were obtained by driving the sampler 24 inches into the soil with a 140-pound automatic hammer free-falling 30 inches. The number of blows required for each 6 inches of penetration was recorded. The blow count (“N-value”) of the soil was calculated as the number of blows required for the middle 12 inches of penetration. This resistance, or N-value, provides a measure of the relative density of granular soils and the relative consistency of cohesive soils. Where very dense soil conditions precluded driving the full 24 inches, the penetration resistance for the partial penetration was entered on the logs. The blow counts are shown in the boring logs at the respective sample depths. Auger refusal was encountered at 14 feet bgs while drilling boring MR-04. An offset boring, MR-04A, was augured without sampling to 15 feet, at which depth sampling continued.

Observations of groundwater conditions were made during drilling. The groundwater conditions encountered during drilling are presented in the boring logs. Groundwater conditions observed during drilling represent a short-term condition and may or may not be representative of the long-term groundwater conditions at the site. Drilling fluid (water or bentonite slurry) was introduced while drilling and may affect groundwater observations. Groundwater conditions observed during drilling should be considered approximate.

Site Specific Geotechnical Report

Geotechnical Engineering Report

Cape Canal Bridge Relocation Project
Mainland Sagamore Meter & Regulating Station
Barnstable County, Massachusetts

for
Enbridge, Inc.

April 21, 2025

239 Causeway Street, Suite 400
Boston, Massachusetts 02114
617.749.9220

GeoEngineers USA

Geotechnical Engineering Report

Cape Canal Bridge Relocation Project
Mainland Sagamore Meter & Regulating Station
Barnstable County, Massachusetts

File No. 15556-039-00
April 21, 2025

Prepared for:

Enbridge, Inc.
915 North Eldridge Parkway, Suite 1100
Houston, Texas 77079

Attention: Cindy Dilber

Prepared by:

GeoEngineers USA, PC
239 Causeway Street, Suite 400
Boston, Massachusetts 02114
617.749.9220

Alexander H. Macon
Staff Geotechnical Engineer 2

Heidi P. Cashman, PE
Associate Geotechnical Engineer

AHM:HPC:dt

Disclaimer: Any electronic form, facsimile, or hard copy of the original document (email, text, table, and/or figure), if provided, and any attachments are only a copy of the original document. The original document is stored by GeoEngineers USA, PC and will serve as the official document of record.

GeoEngineers USA

Table of Contents

Executive Summary ES-1
1.0 Introduction 1
2.0 Site Location and Project Understanding 1
3.0 Subsurface Exploration Program 1
3.1. Subsurface Exploration 1
3.2. Laboratory Testing 2
4.0 Site Conditions 3
4.1. Surface Conditions 3
4.2. Geologic setting 3
4.2.1. Surficial Material 3
4.2.2. Bedrock Geology 3
4.3. Subsurface Conditions 3
4.3.1. Soil Conditions 3
4.3.2. Groundwater Conditions 5
5.0 Geotechnical Recommendations 5
5.1. Seismic Design Parameters 6
5.1.1. Seismic Site Class and Design Parameters 6
5.1.2. Liquefaction Potential 6
5.2. Foundation Design recommendations 6
5.2.1. Option 1 - Ground Improvement 6
5.2.2. Option 2 - Deep Foundation Elements 8
5.2.3. Allowable Bearing Pressure 9
5.2.4. Shallow Foundation Dimensions 9
5.2.5. Shallow Foundation Settlement 9
5.2.6. Slab-on-Grade 10
5.2.7. Gravel Roads 10
5.3. Earthwork 10
5.3.1. Subgrade Preparation 10
5.3.2. Structural Fill 11
5.3.3. Structural Fill Placement and Compaction Criteria 12
5.3.4. Weather Conditions 12
5.4. Material Reuse and Management 13
5.4.1. Onsite Soil Reuse 13
5.5. Excess Soil Management 13
5.6. Temporary Construction Dewatering 13
6.0 Limitations 14
7.0 References 14

List of Figures

Figure 1. Vicinity Map
Figure 2. Boring Location Map

Appendices

Appendix A. Subsurface Explorations and Laboratory Testing
Figure A-1. Key to Exploration Logs
Figures A-2 through A-6. Logs of Borings
Laboratory Test Results
Appendix B. Report Limitations and Guidelines for Use

Executive Summary

The proposed site development involves the construction of a Meter and Regulating (M&R) facility on the mainland side of the Sagamore Bridge to facilitate a new horizontal directional drilling (HDD) gas line crossing the Cape Cod Canal. The site is currently unimproved landscaping with evidence of historical filling along the eastern portion of the site.

Based on our understanding of the Site concepts and our review of the subsurface conditions, we recommend that the M&R station be supported by conventional spread footings and slab-on-grade bearing on improved ground or supported by deep foundation elements such as drilled or driven piles. Ground improvement if selected may consist of aggregate piers or rigid inclusions installed directly beneath foundation elements and slabs.

Obstructions/boulders were encountered during our exploration program and should be anticipated to be encountered during construction. Localized obstruction/boulder removal or predrilling, is anticipated to facilitate foundation, slab, and ground improvement/deep foundation construction. Should driven piles be selected, refusal of driven pile elements shallower than the anticipated bearing layer should be expected requiring coordination, when encountered, and potential supplemental foundation installation.

Additional design considerations and recommendations are provided in Section 5.0 of this report.

1.0 Introduction

This report presents the results of GeoEngineers USA, PC (GeoEngineers) geotechnical engineering services for the proposed Metering and Regulating (M&R) Station development at the mainland side of the Sagamore Bridge at Canal Street and Commerce Way in Bourne, Massachusetts (the Site). The Site is shown relative to surrounding physical features in Figure 1, Vicinity Map, and Figure 2, Boring Location Map.

The purpose of this report is to provide geotechnical engineering recommendations for the design and construction of the planned mainland side of the Sagamore Bridge M&R station development. Our services have been completed in general accordance with our signed agreement dated October 31, 2023, and revised April 4, 2025. This report is subject to the attached limitations.

2.0 Site Location and Project Understanding

The Site consists of unimproved landscaping bound by Meetinghouse Lane and a commercial building to the north, industrial properties to the east, undeveloped woodland and wetlands to the south, and Canal Street to the west. Existing noteworthy features beyond the Site boundaries include the Cape Cod Canal and the existing Sagamore Bridge approximately 0.25 miles south and southwest of the Site, respectively.

Project concepts are still in development; however, we understand Site improvements will consist of removal of woodland and the construction of a single-story at grade regulator and odorizer building with associated equipment pads. The planned M&R station will also include a meter skid, heaters, filter separator, receiver trap, and associated gravel roadways.

Building loads are unavailable at this time, however based on discussions with the project team, and experience with similar structures of this type, we anticipate individual column loads of less than 50 kips, and wall loads of less than 4 kips/linear-foot. Building loads once available should be provided to GeoEngineers to confirm our recommendations herein.

3.0 Subsurface Exploration Program

3.1. SUBSURFACE EXPLORATION

Between March 3 and March 7, 2025, GeoEngineers performed a geotechnical subsurface exploration program consisting of five (5) borings (designated MR-03, MR-04, MR-04A, MR-05, and MR-06) advanced to depths between 14 and 121 feet below ground surface (bgs) by Geologic Earth Exploration, Inc. (Geologic) of Norfolk, Massachusetts. The borings were advanced using either casing and mud rotary, or hollow-stem auger drilling methods with a track mounted Acker Rebel drill rig. The borings were continuously monitored by a representative from our firm who logged and classified the soils encountered, obtained representative soil samples, observed groundwater conditions, and prepared logs for the explorations.

Soils encountered in the borings were visually classified in general accordance with the classification system described in Figure A-1. A key to the boring log symbols is also presented in Figure A-1. The logs of

the borings are presented in Figures A-2 through A-6 within Appendix A. The boring logs are based on our interpretation of the field and laboratory data and indicate the various types of soils and groundwater conditions encountered. The logs also indicate the depths at which these soils or their characteristics change, although the change may be gradual. If the change occurred between samples, it was interpreted. The densities noted in the boring logs are based on the blow count data obtained in the borings and judgment based on the conditions encountered.

The soils encountered in the borings were generally sampled at the surface continuously until 10 feet bgs, then at 5-foot vertical intervals thereafter with a 2-inch outside-diameter split-barrel standard penetration test (SPT) sampler. The disturbed samples were obtained by driving the sampler 24 inches into the soil with a 140-pound automatic hammer free-falling 30 inches. The number of blows required for each 6 inches of penetration was recorded. The blow count ("N-value") of the soil was calculated as the number of blows required for the middle 12 inches of penetration. This resistance, or N-value, provides a measure of the relative density of granular soils and the relative consistency of cohesive soils. Where very dense soil conditions precluded driving the full 24 inches, the penetration resistance for the partial penetration was entered on the logs. The blow counts are shown in the boring logs at the respective sample depths. Auger refusal was encountered at 14 feet bgs while drilling boring MR-04. An offset boring, MR-04A, was augured without sampling to 15 feet, at which depth sampling continued.

Observations of groundwater conditions were made during drilling. The groundwater conditions encountered during drilling are presented in the boring logs. Groundwater conditions observed during drilling represent a short-term condition and may or may not be representative of the long-term groundwater conditions at the site. Drilling fluid (water or bentonite slurry) was introduced while drilling and may affect groundwater observations. Groundwater conditions observed during drilling should be considered approximate.

Logs of the test borings are provided in Appendix A, Subsurface Exploration and Laboratory Testing.

3.2. LABORATORY TESTING

Twenty (22) soil samples were submitted to Geotesting Express of Acton, Massachusetts for geotechnical laboratory testing in accordance with the standards provided in ASTM International (ASTM) and American Association of State Highway and Transportation Officials (AASHTO) procedures. Two (2) composite samples were created of representative soil samples from MR-04/MR-04A and MR-06, and the following laboratory tests were conducted.

- Three (3) Standard Classifications, per ASTM D2488
- One (1) grain-size analysis (fines content only), per ASTM D1140.
- Eleven (11) grain-size analysis (sieve only), per ASTM D6913.
- Four (4) organic content determinations, per ASTM D2974.
- Fifteen (15) moisture content determinations, per ASTM D2216.
- Three (3) unit weight determinations, per ASTM D7263.
- Two (2) soil electric resistivity tests on the composite samples, per AASHTO T288.
- Two (2) sulfate determinations on the composite samples, per ASTM D516.

- Two (2) chloride determinations on the composite samples, per ASTM D512.
- Two (2) pH determinations on the composite samples, per ASTM D4972.

Laboratory test results are provided in Appendix A, Subsurface Exploration and Laboratory Testing.

4.0 Site Conditions

4.1. SURFACE CONDITIONS

Site survey information is unavailable at this time. The Site is generally flat and slopes down steeply (30 to 50 feet) along the east and south edge of the Site towards the undeveloped woodland. Fill stockpiles consisting of soil containing debris, and apparent reworked natural sands, are present along the southern and eastern edges of the Site and are evidence of historical filling of the Site to raise existing grades. An existing dirt road is present along the northeastern edge of the site.

4.2. GEOLOGIC SETTING

4.2.1. Surficial Material

Surficial geologic mapping indicates that late Wisconsin Age (75,000 to 11,000 years ago) glacial stratified coarse deposits of gravel and sand are the predominant surficial materials present at the Site. The glacial deposits are typically composed of at least 50 percent gravel-size clasts; cobbles and boulders predominate; with minor amounts of sand within gravel layers, and minor layers of sand. The gravel layers are generally poorly sorted, and bedding is commonly distorted and faulted due to post-depositional collapse related to the melting of ice. The sand and gravel deposits occur as mixtures of gravel and sand within individual layers and as layers of sand alternating with layers of gravel. The sand and gravel layers generally range between 25 and 50 percent gravel particles and between 50 and 75 percent sand particles. Sand deposits are composed mainly of very coarse to fine sand, commonly in well-sorted layers and may contain up to 25 percent gravel. Finer layers may contain some very fine sand, silt, and clay. The thickness of the glacial deposits is expected to be over 100 feet, overlying the bedrock described below (Stone, et al, 2019), (Hartshorn, et al, 1991).

4.2.2. Bedrock Geology

Geologic mapping indicates the primary bedrock present at the Site is Proterozoic Age (2,500 to 542 million years ago) plutonic and metamorphic rocks consisting primarily of granite, gneiss, and schist (undivided) (Zen, et al, 1983).

4.3. SUBSURFACE CONDITIONS

4.3.1. Soil Conditions

In general, the soil conditions observed at the Site consist of topsoil, underlain by fill and natural sand and gravel deposits. Details of the subsurface strata from the explorations by GeoEngineers are summarized below from the ground surface down:

- **Topsoil:** A topsoil layer was encountered within borings MR-05 and MR-06 and was generally observed at ground surface across the Site. The topsoil was observed to be approximately 6-inches thick.

The topsoil layer primarily consists of silty fine to medium-grained sand with varying amounts of gravel and slag, and trace amounts of organic matter (i.e. roots).

- **Fill:** A fill layer was observed at ground surface along the eastern portion of the site (within borings MR-03, MR-04/MR-04A) or below the topsoil, within all exploration locations. The bottom of the fill layer varies from 24 feet to 25 feet bgs along the western portion of the Site, to 30 feet and deeper than 32 feet (depth explored) bgs along the eastern portion of the Site. Boring MR-04/MR-04A was terminated within fill at 32 feet bgs, therefore the fill layer depths may be deeper than reported herein.

  The fill layer primarily consists of fine to coarse-grained sand, with varying amounts of silt and gravel. The N-values in the fill material vary from very loose to very dense, and generally indicate the fill is of variable density. The higher, dense to very dense, N-values within the fill are likely the result of debris such as brick or asphalt blocking the sampler. Gravel contents in the fill samples selected for grain-size analyses ranged from about 4 to 27 percent. Fines content in the fill samples selected for grain-size analyses ranged from about 12 to 23 percent. Moisture content in the fill samples selected for analyses ranged from about 3 to 15 percent. The unit weight of a fill sample selected for analysis was estimated to be about 117 pounds per cubic foot (pcf). Auger refusal at 14 feet bgs within boring MR-04 is evidence of obstructions such as cobbles, boulders, or debris within the fill. Drill rig chatter was observed while drilling throughout the fill at all boring locations and may indicate the presence of gravel, cobbles, and/or boulder-sized material/debris within the fill layer.

  Non-soil constituents within the fill consist of trace amounts of asphalt, brick, organics, wood, and roots. Slag was observed within the topsoil overlying the fill in boring MR-05 and may be representative of slag present within the underlying fill. Organics, wood, and roots were observed within the fill in boring MR-03 at 30 feet bgs; MR-04/MR-04A from 0 feet to 2 feet, 15 feet to 17 feet, and 25 feet to 27 feet bgs; MR-05 from 4 feet to 6 feet, and 20 feet to 22 feet bgs; and MR-06 from 19 feet to 21 feet bgs. Organic content in the fill samples selected for organic content determination ranged from about 1.0 to 5.0 percent.

- **Natural Sand and Gravel Deposits:** Natural sand and gravel deposits were observed underlying the fill within all borings, except MR-04/MR-04A, and extended to the depth explored of 121 feet bgs within boring MR-06. All borings except MR-04/MR-04A were terminated within the natural sand and gravel deposits at depths ranging from 32 to 121 feet bgs, therefore the natural sand layer depths may be deeper than reported herein.

  The natural sand and gravel deposits primarily consist of fine to coarse-grained sand with varying amounts of silt and gravel. The N-values in the natural sand material vary from medium dense to very dense. Gravel contents in the natural sand samples selected for grain-size analyses ranged from about 0 to 41 percent. Fines content in the natural sand samples selected for grain-size analyses ranged from about 6 to 26 percent. Moisture content in the natural sand samples selected for analyses ranged from about 2 to 23 percent. The unit weight of the natural sand and gravel samples selected for analysis ranged from 106 to 123 pcf. Drill rig chatter was observed while drilling throughout the natural sand and gravel deposits within borings MR-03, MR-05, and MR-06 and may indicate the presence of gravel, cobbles, and/or boulder-sized material within the natural sand and gravel layer.

  A distinct gravel layer was observed within the natural sand and gravel deposits in boring MR-06 from 49 feet to 54 feet bgs. Gravel content of the gravel layer within the natural sand and gravel deposit sample selected for grain-size analyses was about 72 percent.

4.3.2. Groundwater Conditions

Groundwater was observed during drilling at approximately 75 feet bgs at boring MR-06. It should be noted that groundwater observations made during drilling should not be considered to be representative of stabilized groundwater levels. Water is introduced as drilling fluid during the drilling process and can influence observations relating to groundwater.

It should be noted that groundwater levels will vary depending on tidal action, seasonal variations in temperature and precipitation, and can also be influenced by subsurface utilities, construction activities and other factors.

Additional details are included in the logs of the test borings provided in Appendix A, Subsurface Exploration and Laboratory Testing.

5.0 Geotechnical Recommendations

Below is a summary of the primary geotechnical considerations associated with design and development of the Site. Additional details are provided in subsequent sections of this report.

- The existing fill material is highly variable in density, thickness, and kind, and contains deleterious organic material subject to decay, potentially causing long-term settlement. Therefore, the existing fill material is unsuitable for foundation support in its existing condition. The existing fill should be improved to allow for shallow foundation support, or the foundation type should bypass the fill (i.e. be of drilled or driven pile type) and bear in the natural sand and gravel deposits.
- The existing fill material contains non-soil constituents, such as slag and asphalt. As such any soil exported from the site should be characterized by a Licensed Site Professional (LSP), as required per the Massachusetts Contingency Plan (MCP). LSP services are outside the scope of this report, however, they can be provided upon request. Should the soils be determined to be environmentally impacted, careful consideration should be used when selecting the foundation type to minimize soil export.
- The proposed structures can be supported by conventional shallow spread footings and a slab-on-grade, bearing on improved ground. Alternatively, the proposed structures can be supported by deep foundations (drilled or driven piles).
- Improved ground may consist of fill improved with ground improvement elements such as aggregate piers or rigid inclusions installed directly beneath foundation elements.
- Obstructions/boulders are anticipated within the fill material, as evidenced from drilling action and auger refusal during our field exploration program. Obstructions/boulders encountered may cause shallow refusal during ground improvement or driven foundation installation. For ground improvement, pre-augering at locations where obstructions are known or encountered during installation, will likely be required. For driven piles, refusal of driven pile elements shallower than the anticipated bearing layer will require coordination between the pile designer and structural engineer and evaluated to determine if potential supplemental foundation installation is required.

5.1. SEISMIC DESIGN PARAMETERS

5.1.1. Seismic Site Class and Design Parameters

The Massachusetts State Building Code 10th edition (MSBC10) incorporates the 2021 International Building Code (2021 IBC) by reference with state specific amendments. We have considered the soil conditions encountered in the borings to be consistent and representative of the soil conditions in the top 100 feet of soil at the Site. Given this, it is GeoEngineers' opinion that the Site is best characterized as Site Class D. The 2021 IBC seismic design parameters are presented in Table 1.

TABLE 1. 2021 IBC SEISMIC DESIGN PARAMETERS

2021 IBC PARAMETER	RECOMMENDED VALUE
Mapped Spectral Acceleration for short periods, (S_S):	0.180
Mapped Spectral Acceleration for 1-sec period, (S_1):	0.052
Site Class:	D
Site Coefficient, (F_a):	1.6
Site Coefficient, (F_v):	2.4
5% damped design spectral response acceleration at short periods, (S_{DS}):	0.192
5% damped design spectral response acceleration at 1-sec periods, (S_{D1}):	0.083
Anticipated Risk Category:	IV
Seismic Design Category:	C

Note:
The anticipated risk category is based on the assumption that the M&R stations are critical to national defense and would be part of the gas line supplying the military base Joint Base Cape Cod. Should a lower anticipated risk category of III be permitted, a seismic design category of B can be justified.

5.1.2. Liquefaction Potential

The soils encountered at the site are not considered susceptible to liquefaction based on the criteria set forth in section 1806.4 of MSBC10.

5.2. FOUNDATION DESIGN RECOMMENDATIONS

We recommend the proposed structures be supported on one (1) of two (2) foundation options, (1) conventional shallow spread footings bearing directly on improved ground, or (2) deep foundations consisting of drilled or driven piles extending to a bearing layer (i.e. the natural sand and gravel deposits). Foundations should not bear directly on topsoil, unimproved fill, or obstructions/boulders. Preliminary ground improvement recommendations are provided in Section 5.2.1 Ground Improvement. Alternatively, preliminary deep foundation recommendations are provided in Section 5.2.2 Deep Foundations. Additional construction recommendations for subgrade preparation are provided in Section 5.3 Earthwork and Subgrade Preparation.

5.2.1. Option 1 - Ground Improvement

With the implementation of ground improvement elements, such as aggregate piers or rigid inclusions, the proposed structures can generally be supported on conventional spread footing foundations bearing

directly on improved ground. Structural connections are not required between the ground improvement elements and the foundations. The ground improvement elements are installed beneath foundations and slab, as required. The number of ground improvement elements required is determined by the ground improvement designer and depends upon the loading conditions and subsurface conditions. Load transfer platforms, generally consisting of a 6- to 12-inch-thick pad of crushed stone or gravel, are typically required between the top of the ground improvement element and the footings above. Load testing consisting of footing load tests or ground improvement element load tests are typically performed prior to the complete installation of the ground improvement on test/sacrificial elements to confirm the ground improvement bearing capacities.

The ground improvement element diameter, spacing, grout mix (if applicable), strength, locations, and details on the load transfer platform requirements should be designed by a Professional Engineer licensed in Massachusetts and submitted to the design team for review and comment.

AGGREGATE PIERS

Aggregate piers are typically constructed by vibrating or ramming a mandrel into the ground to a targeted depth (i.e. the natural sand and gravel deposits), as the mandrel is extracted the hole is backfilled with crushed stone placed in lifts compacted with the mandrel. The crushed stone densifies the surrounding soil. In areas where organics or loose fills are present, grouting of the aggregate piers may provide additional stability in the organic and loose fill areas and address long term settlement concerns. For more information on settlement concerns see Section 5.2.5. Settlement.

RIGID INCLUSIONS

Rigid inclusions are typically constructed by vibrating or ramming a mandrel into the ground to a targeted depth (i.e. the natural sand and gravel deposits). As the mandrel is extracted the hole is backfilled with cement-based grout placed by the mandrel. A bulb is developed at the base of the element and a straight shaft is built up to grade. Typically, rigid inclusions have higher design capacities when compared to grouted aggregate piers. In areas where organics or loose fills are present, rigid inclusions provide additional stability and address long term settlement concerns. For more information on settlement concerns see Section 5.2.5. Settlement.

OBSTRUCTION REMOVAL/PRE DRILLING

Obstructions/boulders are anticipated within the fill as evidenced based on auger refusal and drilling action during our field exploration program. Some obstruction/boulder removal should be anticipated during ground improvement installation. Obstruction/boulder removal, if shallow, may be performed with conventional excavation equipment, and deep obstruction/boulder removal may be performed by predrilling of ground improvement elements.

When excavating foundations, obstruction/boulder removal may again be required to provide a level bearing surface required to achieve the bottom of footing elevation. Should obstructions/boulders be encountered at the bottom of footing elevation, the obstructions/boulders should be evaluated on a case-by-case basis by a qualified geotechnical engineer to limit the disturbance of the installed ground improvement elements. Generally, obstructions/boulders at foundation elevations should be removed to allow placement of a minimum of 12 inches of Gravel Fill to provide a soil cushion between the bottom of footing and boulder surface to minimize the potential for hard spots below the footing and the potential for differential settlement.

DESIGN COORDINATION

Additional budget should be carried to allow for the ground improvement contractor to coordinate with the structural and geotechnical engineers, and ground improvement designer.

Additional coordination efforts between the HDD installer and the ground improvement contractor will be required to prevent the ground improvement elements from interfering with the HDD alignment/connection at the M&R stations.

5.2.2. Option 2 - Deep Foundation Elements

The proposed structures can generally be supported on deep foundation elements, such as drilled or driven piles extending to a bearing layer (i.e. the natural sand and gravel deposits). The deep foundation elements are drilled or driven beneath structural elements to support each column, footing, wall, or structure loads. The number of deep foundation elements required within a pile cap depends upon the loading conditions, subsurface conditions, and deep foundation designer.

The element diameter, spacing, grout mix (if applicable), strength, reinforcement, locations, and details on the structural connections should be designed by a Professional Engineer licensed in Massachusetts and submitted to the design team for review and comment.

DRIVEN PILES

Driven deep foundations such as timber piles, concrete piles, or steel piles, are typically driven into the ground using vibratory or impact hammers mounted on crane rigs. Driven piles are driven into the soil bearing layer (i.e. the natural sand and gravel deposits) until desired capacities are achieved. We anticipate that properly designed and constructed end-bearing driven piles could provide an ultimate (i.e. unfactored) axial compression capacity on the order of 25 to 100 kips. Once a desired foundation type is selected and structural demands are better defined, detailed analysis should be performed to determine the specific driven pile design(s).

Pile load testing consisting of Pile Driving Analyzer (PDA) tests are performed while driven piles are installed, and confirmation of axial capacities are provided during installation.

Driven piles are typically more expensive than ground improvement elements, however more cost effective than drilled piles. Driven pile installation is typically quick when compared to drilled piles. However, driven piles may achieve refusal shallower than the targeted bearing layer, based on the presence of obstructions, or break during installation. Where driven piles do not reach the targeted bearing layer, additional coordination between the structural engineer and deep foundation will be required, which may entail installation of additional piles. Driven piles do not generate soil cuttings which would require disposal or reuse on site.

DRILLED PILES

Drilled piles, such as drilled micropiles or auger-cast piles, are typically drilled into the ground using a specialty drill rig and steel casing (for micropiles). Upon reaching the desired bearing depth the hole or steel casing (for micropiles) are filled with high-strength grout and steel reinforcement. We anticipate that properly designed and constructed end-bearing drilled piles could provide an ultimate (i.e. unfactored) axial compression capacity on the order of 60 to 120 kips, higher capacities can be achieved by increasing the

drilled pile length or diameter. Once a desired foundation type is selected and structural demands are better defined, detailed analysis should be performed to determine the specific driven pile design(s).

Pile testing, consisting of static pile load tests on specified test piles are performed after drilled piles are installed, and provide confirmation of axial capacities after installation. Additional pile quality testing such as Crosshole Sonic Logging (CSL) tests could be performed to determine pile integrity.

Drilled piles are typically the least cost effective option as installation is slow when compared to ground improvement or driven piles. However, drilled piles can typically be installed through obstructions and can provide higher axial capacities. Drilled piles will generate soil cuttings which will require disposal or reuse on site.

DESIGN COORDINATION

Additional coordination efforts between the HDD installer and deep foundation contractor will be required to prevent the deep foundation elements from interfering with the HDD alignment/connection at the M&R stations.

5.2.3. Allowable Bearing Pressure

For foundations supported on ground improvement elements (Option 1) as recommended in this report, we recommend using an allowable soil bearing pressure for improved soils of 4 kips per square foot (ksf). The ground improvement should be designed to achieve this bearing pressure. Net allowable bearing pressures will vary based upon ground improvement element type and design. The allowable soil bearing pressure applies to the total of dead and long-term live loads.

Upon the project team's selection of the preferred foundation type, GeoEngineers can refine the foundation recommendations provided herein and assist with ground improvement or deep foundation design, if requested.

5.2.4. Shallow Foundation Dimensions

The minimum recommended lateral dimension for isolated spread footings is 36 inches, while continuous wall footings should be at least 18 inches wide. Footings in areas exposed to freezing temperatures should be founded at least 4 feet below exterior finished grade for frost protection. Interior footings, in areas not exposed to freezing temperatures, should be at least 24 inches below finished floor grade, or a depth that provides at least 12 inches between the top of footing and finished floor elevation, whichever is deeper. A minimum 12-inch soil cushion should be provided between the bottom of the footing and top of any obstructions/boulders.

5.2.5. Shallow Foundation Settlement

Provided that topsoil is removed, ground improvement is performed, and that the subgrade is prepared as recommended herein, we estimate that the total post-construction settlement, based on assumed column loads, will be less than 1 inch. Post-construction, differential settlements are estimated to be less than 0.5 inches between adjacent columns but will vary based on live load distribution and column spacing. It should be noted that long-term settlement caused by organic matter decay will occur in addition to the settlement anticipated herein. Due to the nature of the fill and organic matter encountered in the

explorations, long-term settlement from organic matter decay is difficult to estimate. Both foundation options provided herein should minimize the effects of long-term settlement on the proposed structures.

5.2.6. Slab-on-Grade

The slab-on-grade should bear on a minimum of 12 inches of base course (Gravel Fill) placed over improved ground. For slabs designed as a beam on an elastic foundation, a modulus of subgrade reaction of 150 pounds per cubic inch (pci) may be used for subgrade soils prepared as recommended herein.

5.2.7. Gravel Roads

All surficial topsoil should be removed from proposed gravel roads subgrade. Exposed fill material subgrades should be proofrolled, and soft or loose areas identified during proof-compaction should be over-excavated and replaced with Gravel Fill as specified in Section 5.3 Earthwork and Subgrade Preparation.

Geogrid such as Tensar NX750, or equivalent, should be placed over the prepared subgrade materials (fill material), and overlain with a minimum of 12-inches of Gravel Fill material. The Gravel Fill material will bind together better than the native on-site soils, and (in combination with the geogrid) will distribute vehicular loads and minimize settlement over time. The Gravel Fill material should conform with MassDOT Item M2.01.7-1, dense-graded crushed stone, see Section 5.4.2 Structural Fill. If settlement control is not considered critical, the geogrid can be omitted and a filter fabric placed over the prepared subgrade materials (fill material). The filter fabric would then be overlain with a minimum of 12-inches of Gravel Fill material.

It should be noted that the gravel road will require regular maintenance, with additional gravel placement and regrading, following potential rutting and long-term settlement, to maintain access to the site.

5.3. EARTHWORK

5.3.1. Subgrade Preparation

The following paragraphs describe the recommended earthwork procedures for preparation of the building areas.

- The existing topsoil and unimproved fill are considered unsuitable materials. The topsoil should be removed in its entirety from the proposed building/structures footprint and at least 5 feet beyond.
- Following removal of the unsuitable materials noted above and prior to placing raise-in-grade fill, the exposed subgrade within the building footprint and 5 feet beyond the exterior walls, and gravel drive areas, should be proof-compacted with at least eight (8) passes of a 20-ton smooth-drum, vibratory roller until visibly firm and stable as observed by the Geotechnical Engineer or their qualified representative. Any soft or loose areas identified during proof-compaction should be over-excavated and replaced with Gravel Fill as specified herein.
- Footing subgrades should be excavated with a smooth-edge bucket to limit disturbance to the underlying subgrade. If footings are excavated with a toothed bucket, the subgrade should be compacted with at least six (6) passes of a 1,000-pound vibratory plate compactor, or equivalent effort, until the subgrade is visibly firm and stable as observed by the Geotechnical Engineer or his/her

qualified representative. Footings should bear directly on improved ground or Gravel Fill placed directly over the natural sand and gravel deposits.

- Localized areas of obstructions/boulders are anticipated below within the proposed building and structures and should be removed using large excavators or mechanical means (i.e. hoe-ramming) to at least 12 inches below the base course for slabs and 12 inches below the bottom of footing in the building areas.
- Where obstructions/boulders are present at the footing subgrade, the obstructions/boulders should be removed 12 inches below the bottom of footing and replaced with a soil cushion of compacted Gravel Fill. Footings should bear directly on soil, to avoid the potential for differential settlement due to hard spots below the footing.
- Raise-in-grade fill placed within the building pad to achieve Site grades should consist of Structural Fill, as specified herein. Structural Fill should be placed in 12-inch-thick, loose lifts and compacted to at least 95 percent of its maximum dry density as determined by ASTM D1557, Method C (modified proctor).
- For the slab-on-grade, the exposed subgrade (for base course) should be proof-compacted with at least eight (8) passes of a 20-ton smooth-drum, vibratory roller until visibly firm and stable as observed by the Geotechnical Engineer or their qualified representative. The final 12 inches of soil directly below the slab-on-grade should consist of Gravel Fill as defined herein and compacted to at least 95 percent of its maximum dry density as determined by ASTM D1557 Method C (Modified Proctor).
- The excavated on-site soils may be re-used as raise-in-grade fill, provided it meets the requirements for Structural Fill provided herein. Raise-in-grade fill and backfill should be placed and compacted in maximum 12-inch-thick loose lifts and compacted as specified herein.
- Temporary cut slopes of natural material below proposed footings for building foundations should be conducted at a 1.5H:1V slope angle (or shallower) to maintain a safe excavation.

5.3.2. Structural Fill

Raise-in-grade fill placed within the building pad and Site areas should consist of Structural Fill as described below:

- Gravel Fill to serve as the base course for slabs should consist of hard, inert, durable gravel and sand. The material should be free from organics, clay, loam, sticks, snow/ice, debris, and other deleterious materials. Gravel Fill should be processed to meet the gradation requirements for MassDOT Item M2.01.7-1, dense-graded crushed stone.
- Soil material generated from on-site cut areas, free of organics and other deleterious material, may be used as raise-in-grade fill below the base course layer. On-site fill should have a maximum particle size of 6 inches. On-site fill meeting the gradation requirements below and free from roots and organics, may be used as general raise-in-grade fill below building and Site areas.

SIEVE SIZE	PERCENT PASSING BY WEIGHT
6-inch	100
1-inch	85-100
No. 4	20-90

SIEVE SIZE	PERCENT PASSING BY WEIGHT
No. 40	10-75
No. 200	0-40*

Note:
Silt content of the fill may vary. The on-site inorganic fill material is intended to be re-used as backfill below the base course layer provided it is screened of organics and placed and compacted as specified herein.

- Structural Fill imported from off-site sources and used as backfill within the building areas, and as general raise in grade fill in non-building areas (below base course) should consist of the following:

SIEVE SIZE	PERCENT PASSING BY WEIGHT
4-inch	100
1-inch	70-100
No. 40	30-60
No. 200	0-10

- Structural Fill placed within irregularly shaped utility trenches or trenches not accessible to compaction equipment should consist of Controlled Density Fill (CDF) consisting of high slump Portland Cement Concrete (PCC) with a compressive strength less than 150 pci at 28 days; otherwise, the trench should be backfilled in accordance with the project specifications.

5.3.3. Structural Fill Placement and Compaction Criteria

Structural Fill should be mechanically compacted to a firm, non-yielding (stable) condition. Structural Fill should be placed in loose lifts approximately 12 inches thick. Each lift should be conditioned to the proper moisture content and compacted as specified herein before placing subsequent lifts. Structural Fill should be compacted to the following criteria:

- Structural Fill should be compacted to at least 95 percent of its maximum dry density as determined by ASTM D1557 Method C, Modified Proctor.

5.3.4. Weather Conditions

The fill and natural sand and gravel layers contain a sufficient percentage of fines and should be considered sensitive to moisture and frost susceptible. When the moisture content of these soils is more than a few percent above the optimum moisture content, these soils become unstable, and operation of equipment on these soils and compaction of these soils is difficult. Additionally, disturbance of near-surface soils should be expected if earthwork is completed during periods of wet weather. During wet weather, we recommend the following:

- The ground surface in and around the work area should be graded so that surface water is directed away from the work area. The ground surface should be graded such that areas of ponded water do not develop. The contractor should take measures to prevent surface water from collecting in excavations and trenches. Measures should be implemented to remove surface water from the work area, and it should not be directed towards downslope structures, unless properly collected and conveyed to appropriate catch basins.
- Earthwork activities should not take place during periods of moderate to heavy precipitation.

- Slopes with exposed soils should be covered with plastic sheeting or similar means.
- The contractor should take necessary measures to prevent on-site soils and soils to be used as fill from becoming wet or unstable. These measures may include temporary construction dewatering, the use of plastic sheeting, sumps with pumps, and grading. The Site soils should not be left uncompacted and exposed to moisture. Sealing the surficial soils by rolling with a smooth-drum roller prior to periods of precipitation will reduce the extent to which these soils become wet or unstable.
- The contractor should cover all soil stockpiles that will be used as structural fill with plastic sheeting.
- Construction traffic should be restricted to specific areas of the Site, preferably areas that are surfaced with materials not susceptible to wet weather disturbance.
- Construction activities should be scheduled so that the length of time that soils are left exposed to moisture is reduced to the extent practicable.
- Footings and backfill should not be placed over a subgrade with standing water, or that is frozen.

In the event that standing water is present on the subgrade, the water should be removed from the surface and any soft and yielding soils should be removed or allowed to dry prior to the placement of backfill. In the event that the subgrade is frozen, the soil that is frozen should be removed, or thawed, and re compacted prior to placement of backfill.

5.4. MATERIAL REUSE AND MANAGEMENT

5.4.1. Onsite Soil Reuse

Based on available data, we anticipate that the on-site soils (inorganic fill and natural sand and gravel deposits, free of organics and other deleterious materials) may be suitable for reuse below the proposed building and structures provided they can be placed and compacted in accordance with the project specifications and recommendations herein. Fill may be sensitive to excess moisture as described herein.

We anticipate reusing the fill material, therefore the fill material will need to be staged, then screened of organics. Only when screened of organics is the fill suitable for reuse beneath slabs, structures, and other Site areas as raise in-grade fill. Fill is not suitable for reuse below footings. Fill containing organics is suitable for re-use in landscaped areas.

5.5. EXCESS SOIL MANAGEMENT

The on-site fill should be re-used on site to the extent practical. The excess soil that may be generated during earthwork and needs to be removed from the Site may need to be characterized with environmental analytical laboratory testing prior to off-site disposal – depending on the requirements of the facility that will receive the soil. Soil disposal should be performed in compliance with local, state, and federal regulations, the environmental regulations set forth by MassDEP.

5.6. TEMPORARY CONSTRUCTION DEWATERING

Groundwater, while encountered deep at the Site, may still impact Site construction activities during the wet seasons due to surficial runoff and ponding. As such localized dewatering may be necessary for deep construction activities (i.e., deep excavations). We anticipate that dewatering can be achieved by installing sumps at low points in the excavation. Sumps should be constructed with crushed stone wrapped in a

geotextile fabric. Groundwater is anticipated to be recharged on Site to the ground surface, and should be performed in accordance with local, State, and Federal regulations.

6.0 Limitations

We have prepared this report for Enbridge, Inc., who may distribute copies of this report to their authorized agents and regulatory agencies, as may be required for the project.

Within the limitations of scope, schedule, and budget, our services have been executed in accordance with generally accepted practices in the field of geotechnical engineering in this area at the time this report was prepared. The conclusions, recommendations, and opinions presented in this report are based on our professional knowledge, judgment, and experience. No warranty or other conditions, express or implied, should be understood.

Any electronic form, facsimile, or hard copy of the original document (email, text, table and/or figure), if provided, and any attachments, should be considered a copy of the original document. The original document is stored by GeoEngineers USA, PC and will serve as the official document of record.

Please refer to Appendix B entitled "Report Limitations and Guidelines for Use" for additional information pertaining to use of this report.

7.0 References

ASCE 7-16, 2017. "Minimum Design Loads for Buildings and Other Structures," American Society of Civil Engineers.

ASTM D-1557, 2012. "Standard Testing Method for Laboratory Compaction Characteristics of Soil Using Modified Effort," ASTM International.

Commonwealth of Massachusetts Department of Transportation (MassDOT), 2022, "Standard Specifications for Highways and Bridges."

Hartshorn, J.H., Thompson, W.B., Chapman, W.F., Black, R.F., Richmond, G.M., Grant, D.R., And Fullerton, D.S., 1991, Quaternary Geologic Map of The Boston 4 Degrees X 6 Degrees Quadrangle, United States and Canada, U.S. Geological Survey, Miscellaneous Investigations Series Map I-1420 (Nk-19), Scale 1:1,000,000.

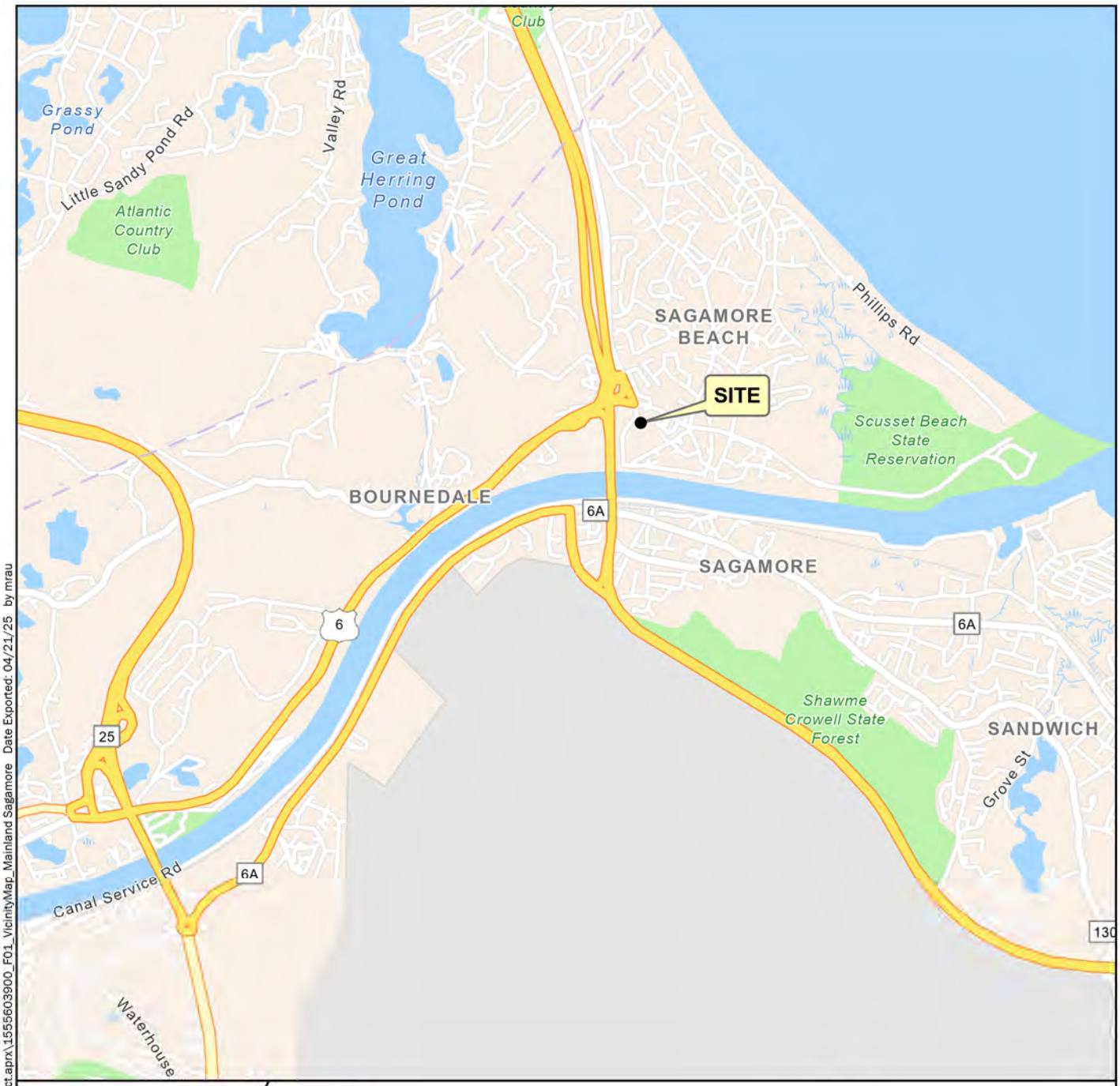
International Code Council, 2021, "International Building Code."

Massachusetts State Building Code, 2021, "780 CMR Tenth Edition."

Stone, J.R., Stone, B.D., Digiacomo-Cohen, M.L., And Mabee, S.B., 2019, Surficial Materials of Massachusetts—A 1:24,000-Scale Geologic Map Database, U.S. Geological Survey, Scientific Investigations Map Sim-3402, Scale 1: 24,000.

Zen, E-An, Goldsmith, Richard, Ratcliffe, N.M., Robinson, Peter, Stanley, R.S., Hatch, N.L., Shride, A.F., Weed, E.G.A., and Wones, D.R., 1983, Bedrock Geologic Map of Massachusetts, U.S. Geological Survey, Scale 1:250,000.

Figures





N

0 2,000

Feet

Source(s):
- ESRI

Coordinate System: NAD 1983 StatePlane Massachusetts Mainland FIPS 2001 Feet

Disclaimer: This figure was created for a specific purpose and project. Any use of this figure for any other project or purpose shall be at the user's sole risk and without liability to GeoEngineers. The locations of features shown may be approximate. GeoEngineers makes no warranty or representation as to the accuracy, completeness, or suitability of the figure, or data contained therein. The file containing this figure is a copy of a master document, the original of which is retained by GeoEngineers and is the official document of record.

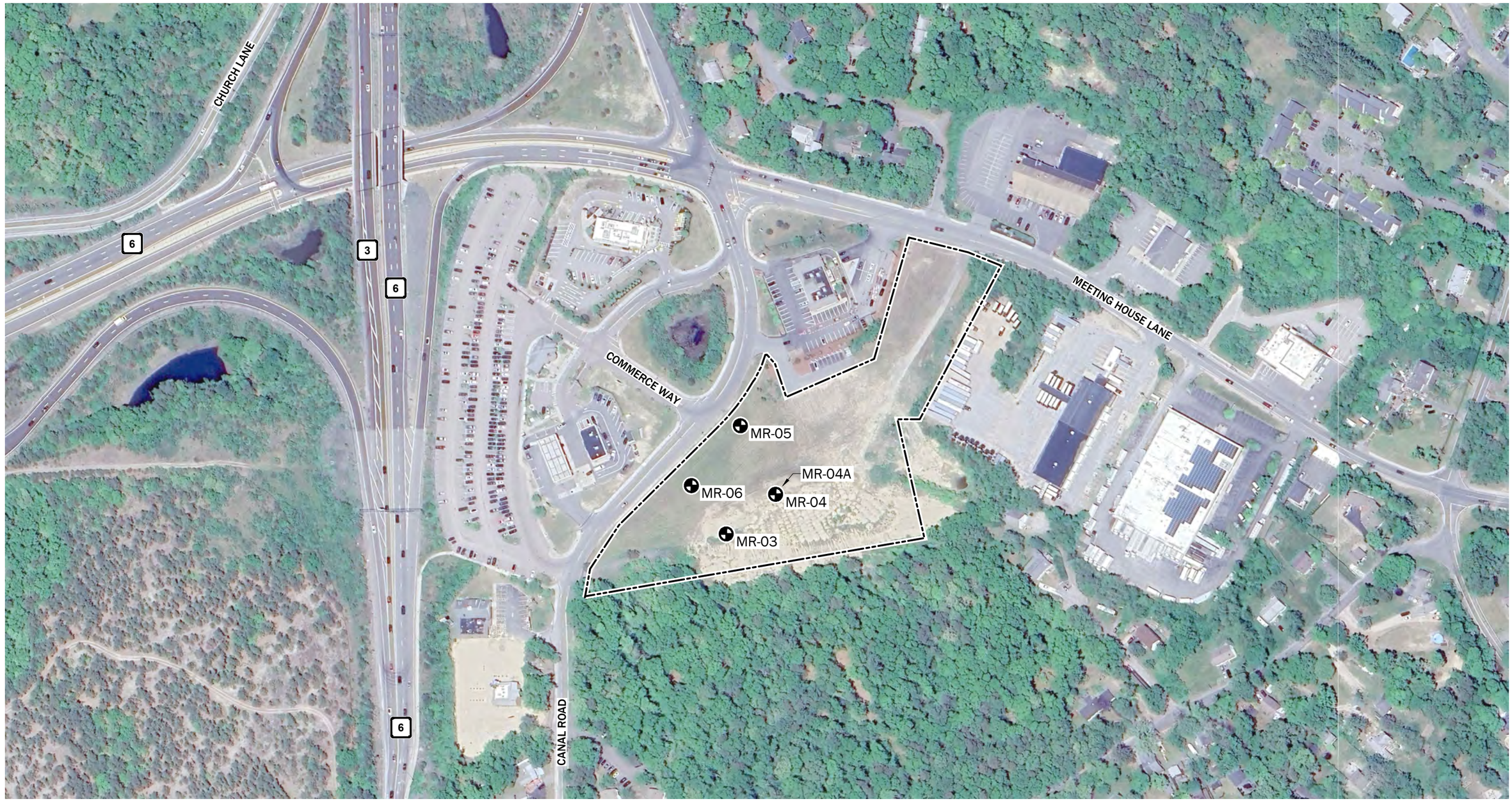
Vicinity Map

Cape Canal Bridge Replacement Project
Mainland Sagamore M & R Station
Barnstable County, Massachusetts

GeoEngineers USA

Figure 1

P:\15\15556039\GIS\15556039_Project\15556039_Project\15556039_Project.aprx\1555603900_F01_VicinityMap_Mainland Sagamore Date Exported: 04/21/25 by mrau



Note(s):
1. GeoEngineers, USA, P.C. has not verified the field location of the existing utilities.

Source(s):
- Aerial from Google Earth Pro, dated 05/27/23.

Coordinate System: MA State Plane, Mainland Zone, NAD83, US Foot

Disclaimer: This figure was created for a specific purpose and project. Any use of this figure for any other project or purpose shall be at the user's sole risk and without liability to GeoEngineers USA, P.C. The locations of features shown may be approximate. GeoEngineers, USA, P.C makes no warranty or representation as to the accuracy, completeness, or suitability of the figure, or data contained therein. The file containing this figure is a copy of a master document, the original of which is retained by GeoEngineers and is the official document of record.

Legend
- Boring Location
- Site Boundary

N

0 200
Feet

Boring Location Map

Cape Cann Bridge Replacement Project
Mainland Sagamore M & R Station
Barnstable County, Massachusetts

GeoEngineers USA

Figure 2

TJP : BTL
P:\15\15556039\CAD\00\HDD\Mainland Sagamore\15556039OO_F2 BLM.dwg\TAB:FIGURE 2 modified on Apr 18, 2025 - 3:01pm MRAU

Appendix A
Subsurface Exploration and Laboratory Testing

Appendix A
Field Explorations and Laboratory Testing

FIELD EXPLORATIONS

We explored subsurface conditions at the site between March 3 and March 7, 2025 by drilling five (5) geotechnical borings (MR-03, MR-04, MR-04A, MR-05, and MR-06). The geotechnical borings were drilled to depths of up to approximately 14 and 121 feet below ground surface (bgs) with a track-mounted drill rig. The locations of the borings are shown in the attached Boring Location Map, Figure 2. The Massachusetts DigSafe utility locating agency was contacted to locate utilities in the project area prior to the start of the exploratory borings.

A GeoEngineers representative observed field activities, classified the soil encountered, obtained representative samples, and prepared a log of each exploration. The soils encountered were classified visually in general accordance with American Society for Testing and Materials (ASTM) D2487, which is described in Figure A-1.

In general, soil samples were obtained from the borings continuously to a depth of 10-feet and then at 5-foot-depth intervals using 2-inch I.D. split-spoon samplers. The split-spoon samplers were driven 24 inches during Standard Penetration Tests (SPT), using a 140-pound automatic hammer with a 30-inch drop. The number of hammer blows required to drive the sampler the middle 12-inches was recorded on field logs. Each boring was backfilled upon completion with drilling cuttings and cement-bentonite grout.

The relative density of the SPT samples recovered at each interval was evaluated based on correlations with lab and field observations in general accordance with the values outlined in Table A-1 below.

TABLE A-1 CORRELATION BETWEEN BLOW COUNTS AND RELATIVE DENSITY[1]

COHESIVE SOILS (CLAY/SILT)						
Parameter	Very Soft	Soft	Medium Stiff	Stiff	Very Stiff	Hard
Blows, N	< 2	2 – 4	4 – 8	8 – 16	16 – 32	> 32
COHESIONLESS SOILS (GRAVEL/SAND/SILTY SAND)[2]						
Parameter	Very Loose	Loose	Medium Dense		Dense	Very Dense
Blows, N	0 – 4	4 – 10	10 – 30		30 – 50	> 50

Notes:

[1]After Terzaghi, K and Peck, R.B., "Soil Mechanics in Engineering Practice," John Wiley & Sons, Inc., 1962.

[2]Classification applies to soils containing additional constituents; that is, organic clay, silty or clayey sand, etc.

The exploration logs are presented in Figures A-2 through A-6. The logs are based on our interpretation of the field data and indicate the various types of soil encountered while indicating the approximate depths at which the subsurface conditions change. Unless noted on the boring logs, the lines between soil units represent approximate boundaries. The transition between materials may be gradual or may occur between recovered samples. Additionally, the boring logs represent conditions observed at the time of drilling and have been edited to incorporate results of the laboratory tests performed as appropriate.

LABORATORY TESTING

General

Soil samples obtained from the borings were transported to Geocomp Corporation's GeoTesting Express' laboratory in Acton, Massachusetts and examined to confirm or modify field classifications. Representative soil samples were selected for laboratory testing consisting of standard classification, sieve analyses, moisture content determination, unit weight determination, resistivity testing, sulfate determination, chloride determination, and pH determination. The laboratory testing procedures are discussed in more detail below. A summary of the lab results is shown in the attached Laboratory Test Results.

Standard Classification of Soils

Standard classification of soils was performed on selected coarse-grained samples in general accordance with ASTM D2488. The results of the classification are in general accordance with the Unified Soil Classification System (USCS) and are presented in the attached Laboratory Test Results.

Sieve Analysis

Sieve analyses were performed on selected coarse-grained samples in general accordance with ASTM D6913 or ASTM D1140. The results of the sieve analyses were plotted and classified in general accordance with the Unified Soil Classification System (USCS) and are presented in the attached Laboratory Test Results. The percentage passing the U.S. No. 200 sieve is shown on the boring logs at the respective sample depths.

Organic Content

Organic content determinations were performed on selected coarse-grained samples in general accordance with ASTM D2974. The results of the organic content determinations are shown on the boring logs at the respective sample depths and presented in the attached Laboratory Test Results.

Moisture Content

Moisture content determinations were performed on selected coarse-grained samples in general accordance with ASTM D2216. The results of the moisture content determinations are shown on the boring logs at the respective sample depths and presented in the attached Laboratory Test Results.

Unit Weight Determination

Unit weight determinations were performed on selected coarse-grained samples in general accordance with ASTM D7263. The results of the unit weight determinations are presented in the attached Laboratory Test Results.

Soil Resistivity

Laboratory measurements of soil resistivity in general accordance with AASHTO T288 were performed on selected samples. The results of the soil resistivity testing are shown are presented in the attached Laboratory Test Results.

Sulfate Determination

Sulfate determinations were performed on selected coarse-grained samples in general accordance with ASTM D516. The results of the sulfate content determinations are presented in the attached Laboratory Test Results.

Chloride Determination

Chloride determinations were performed on selected coarse-grained samples in general accordance with ASTM D512. The results of the chloride content determinations are presented in the attached Laboratory Test Results.

pH Determination

pH determinations were performed on selected coarse-grained samples in general accordance with ASTM D4972. The results of the pH determinations are presented in the attached Laboratory Test Results.

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES
	MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
MORE THAN 50% RETAINED ON NO. 200 SIEVE	SAND AND SANDY SOILS	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS
				SP	POORLY-GRADED SANDS, GRAVELLY SAND
	MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS, ROCK FLOUR, CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
MORE THAN 50% PASSING NO. 200 SIEVE	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS AND SILTS OF MEDIUM TO HIGH PLASTICITY
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: Multiple symbols are used to indicate borderline or dual soil classifications

ADDITIONAL MATERIAL SYMBOLS

SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
	AC	Asphalt Concrete
	CC	Cement Concrete
	CR	Crushed Rock/ Quarry Spalls
	SOD	Sod/Forest Duff
	TS	Topsoil

Groundwater Contact

Measured groundwater level in exploration, well, or piezometer

Measured free product in well or piezometer

Graphic Log Contact

Distinct contact between soil strata

Approximate contact between soil strata

Material Description Contact

Contact between geologic units

Contact between soil of the same geologic unit

Sampler Symbol Descriptions

Modified California Sampler (6-inch sleeve) or Dames & Moore

Standard Penetration Test (SPT)

Shelby tube

Piston

Direct-Push

Bulk or grab

Continuous Coring

Blowcount is recorded for driven samplers as the number of blows required to advance sampler 12 inches (or distance noted). See exploration log for hammer weight and drop.

"P" indicates sampler pushed using the weight of the drill rig.

"WOH" indicates sampler pushed using the weight of the hammer.

Laboratory / Field Tests

%F	Percent fines
%G	Percent gravel
AL	Atterberg limits
CA	Chemical analysis
CP	Laboratory compaction test
CS	Consolidation test
DD	Dry density
DS	Direct shear
HA	Hydrometer analysis
MC	Moisture content
MD	Moisture content and dry density
Mohs	Mohs hardness scale
OC	Organic content
PM	Permeability or hydraulic conductivity
PI	Plasticity index
PL	Point load test
PP	Pocket penetrometer
SA	Sieve analysis
TX	Triaxial compression
UC	Unconfined compression
UU	Unconsolidated undrained triaxial compression
VS	Vane shear

Sheen Classification

NS	No Visible Sheen
SS	Slight Sheen
MS	Moderate Sheen
HS	Heavy Sheen

NOTE: The reader must refer to the discussion in the report text and the logs of explorations for a proper understanding of subsurface conditions. Descriptions on the logs apply only at the specific exploration locations and at the time the explorations were made; they are not warranted to be representative of subsurface conditions at other locations or times.

Key to Exploration Logs

GeoEngineers USA

Figure A-1

Drilled: Start 3/6/2025 End 3/6/2025	Total Depth (ft): 39	Logged By: AM Checked By: HPC	Driller: Geologic Earth Exploration, Inc.	Drilling Method: Hollow-stem Auger	
Surface Elevation (ft): 71.79 Vertical Datum: NAVD88		Hammer Data: Autohammer 140 (lbs) / 30 (in) Drop		Drilling Equipment: Acker Rebel	
Latitude: 41.7802 Longitude: -70.5409		System Datum: Mass State Plane Mainland NAD83 (feet)		Groundwater not observed at time of exploration	

Notes:

Elevation (feet)	Depth (feet)	FIELD DATA: Interval	Recovered (in)	Blows/foot	Sample Name Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
70	0		11	1-4-6-6 (10)	S-1		SP	Light brown fine to coarse sand with trace silt and trace fine gravel (loose, moist) (fill)			
			8	3-3-2-2 (5)	S-2			Becomes fine to medium sand			
	5		1	4-5-5-3 (10)	S-3						Moderate rig chatter from 4 to 8 feet
65			16	3-2-2-2 (4)	S-4			Becomes very loose			
				2-1-1-1 (2)	S-5			No recovery			
	10										
60											
	15		2	9-4-5-5 (9)	S-6		SP-SM	Light brown fine to medium sand with silt and trace fine gravel (loose, moist) (fill)			
55											
	20		1	1-2-2-2 (4)	S-7		SM	Brown silty fine to coarse sand with gravel (very loose, moist) (fill)			Moderate rig chatter from 20 to 25 feet
50											
	25		9	80-23-21-22 (44)	S-8 MC, SA		SP-SM	Brown fine to coarse sand with silt and gravel (dense, moist) (fill)	5.2	11.5	Moderate rig chatter from 25 to 26 feet % Gravel = 27.2
45											
	30		21	4-8-12-11 (20)	S-9 MC, %OC		SP	Brown to light brown fine to medium sand with silt and trace organic matter (roots) (medium dense, moist)	5.4		Moderate rig chatter from 30 to 35 feet Organic content % = 0.5
40											
	35										

Note: See Figure A-1 for explanation of symbols.
Coordinates Data Source: Horizontal approximated based on survey data completed by Enbridge. Vertical approximated based on survey data completed by Enbridge.

Date:4/21/25 Path:P:\15\15556039\GINT\15556039.GPJ DBLibrary/Library:GEOUSA_DF_STD_US.GLB/GEI8_GEOTECH_STANDARD_%F_NO_GW_4BC

Log of Boring MR-3

GeoEngineers USA

Project: Cape Canal Bridge Relocation - M&R Stations
Project Location: Barnstable County, Massachusetts
Project Number: 15556-039-00

Figure A-2
Sheet 1 of 2

Elevation (feet)	Depth (feet)	FIELD DATA: Interval	Recovered (in)	Blows/foot	Sample Name Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
	35		0	10-13-14-16 (27)	S-10			No recovery			
-35			11	27-23-28 (51)	S-11 MC, SA		SP-SM	Light brown gravelly fine to medium sand with silt (very dense, moist)	2.2	8.9	% Gravel = 40.9

Boring terminated at 39 feet below ground surface.
Backfilled to grade with drilling cuttings.

Date:4/21/25 Path:P:\15\15556039\GINT\15556039OO.GPJ DBLibrary/Library:GEOUSA_DF_STD_US.GLB/GEI8_GEOTECH_STANDARD_%F_NO_GW_4BC

Log of Boring MR-3 (continued)

GeoEngineers USA

Project: Cape Canal Bridge Relocation - M&R Stations
Project Location: Barnstable County, Massachusetts
Project Number: 15556-039-00

Drilled	Start 3/7/2025	End 3/7/2025	Total Depth (ft)	14	Logged By / Checked By	AM / HPC	Driller	Geologic Earth Exploration, Inc.	Drilling Method	Hollow-stem Auger
Surface Elevation (ft) / Vertical Datum	70.81 NAVD88		Hammer Data	Autohammer 140 (lbs) / 30 (in) Drop	Drilling Equipment	Acker Rebel				
Latitude / Longitude	41.7805 -70.5405		System Datum	Mass State Plane Mainland NAD83 (feet)	Groundwater not observed at time of exploration					

Notes:

Elevation (feet)	Depth (feet)	FIELD DATA: Interval	Recovered (in)	Blows/foot	Sample Name / Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
70	0		12	1-3-11-17 (14)	S-1		SM	Light brown to gray silty fine to coarse sand with trace fine gravel and trace organic matter (roots) (medium dense, moist) (fill)			Moderate rig chatter from 0 to 3 feet
			12	14-19-15-13 (34)	S-2 MC, SA, DD			Becomes fine to medium, no gravel (dense, moist)			% Gravel = 0.0; Dry density = 117.4
65	5		4	5-6-5-5 (11)	S-3			Becomes with trace fine gravel and medium dense			
			8	3-3-4-4 (7)	S-4			Becomes loose			
			16	2-2-3-2 (5)	S-5						
60	10							Boring terminated at 14 feet below ground surface due to auger refusal. Backfilled to grade with drilling cuttings.			Moderate rig chatter from 13 to 14 feet. Auger refusal at 14 feet below ground surface, offset boring.

Note: See Figure A-1 for explanation of symbols.
Coordinates Data Source: Horizontal approximated based on survey data completed by Enbridge. Vertical approximated based on survey data completed by Enbridge.

Log of Boring MR-4

GeoEngineers USA

Project: Cape Canal Bridge Relocation - M&R Stations
Project Location: Barnstable County, Massachusetts
Project Number: 15556-039-00

Figure A-3
Sheet 1 of 1

Date:4/21/25 Path:P:\15\15556039\GINT\1555603900.GPJ DBLibrary/Library:GEOUSA_DF_STD_US.GLB/GEI8_GEOTECH_STANDARD_%F_NO_GW_4BC

Drilled: Start 3/7/2025 End 3/7/2025	Total Depth (ft): 32	Logged By: AM Checked By: HPC	Driller: Geologic Earth Exploration, Inc.	Drilling Method: Hollow-stem Auger	
Surface Elevation (ft): 70.748 Vertical Datum: NAVD88		Hammer Data: Autohammer 140 (lbs) / 30 (in) Drop		Drilling Equipment: Acker Rebel	
Latitude: 41.7805 Longitude: -70.5405		System Datum: Mass State Plane Mainland NAD83 (feet)		Groundwater not observed at time of exploration	

Notes:

Elevation (feet)	Depth (feet)	FIELD DATA: Interval Recovered (in)	FIELD DATA: Blows/foot	FIELD DATA: Sample Name Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
70	0									Boring offset from MR-04 and drilled down to 15 feet below ground surface to continue sampling. Light rig chatter from 0 to 5 feet.
65	5									
60	10									
55	15	13	3-6-5-14 (11)	S-1 MC, OC		SM	Dark gray silty fine to medium sand with organic matter (roots and wood) and trace brick (medium dense, moist) (fill)	11.7		Organic content % = 5.0
						SP	Light brown fine to medium sand with trace silt and organic matter (roots) (medium dense, moist) (fill)			
50	20	14	3-2-3-4 (5)	S-2		SM	Brown to light gray silty fine to medium sand with trace fine gravel (loose, moist) (fill)			
45	25	14	3-5-4-7 (9)	S-3 MC, OC			Becomes gray with trace organic matter (wood)	12		Moderate rig chatter at 27 feet Organic content % = 1.1
40	30	19	13-12-7-7 (19)	S-4			Becomes fine to coarse sand and medium dense			
							Boring terminated at 32 feet below ground surface. Backfilled to grade with drilling cuttings.			

Note: See Figure A-1 for explanation of symbols.
Coordinates Data Source: Horizontal approximated based on survey data completed by Enbridge. Vertical approximated based on survey data completed by Enbridge.

Log of Boring MR-4A

GeoEngineers USA

Project: Cape Canal Bridge Relocation - M&R Stations
Project Location: Barnstable County, Massachusetts
Project Number: 15556-039-00

Figure A-4
Sheet 1 of 1

Date:4/21/25 Path:P:\15\15556039\GINT\1555603900.GPJ DBLibrary/Library:GEOUSA_DF_STD_US.GLB/GEI8_GEOTECH_STANDARD_%F_NO_GW_4BC

Drilled: Start 3/6/2025 End 3/6/2025	Total Depth (ft): 32	Logged By: AM Checked By: HPC	Driller: Geologic Earth Exploration, Inc.	Drilling Method: Hollow-stem Auger	
Surface Elevation (ft): 71.79 Vertical Datum: NAVD88	Hammer Data: Autohammer 140 (lbs) / 30 (in) Drop	Drilling Equipment: Acker Rebel			
Latitude: 41.7808 Longitude: -70.5408	System Datum: Mass State Plane Mainland NAD83 (feet)	Groundwater not observed at time of exploration			

Notes:

Elevation (feet)	Depth (feet)	Interval	Recovered (in)	Blows/foot	Sample Name Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
70	0		16	2-4-14-8 (18)	S-1 MC, SA		TS	Approximately 6 inches of dark brown silty fine to medium sand with fine gravel, trace roots, trace slag (medium dense, moist) (topsoil)	2.9	11.8	Light rig chatter from 0 to 4 feet % Gravel = 13.1
							SP-SM				
			4	22-17-17-17 (34)	S-2			Brown silty fine to coarse sand with gravel (medium dense, moist) Becomes dense			
	5		13	12-17-37-9 (54)	S-3			Becomes with trace organic matter (roots)			Moderate rig chatter from 4 to 8 feet
65			0	16-16-6-7 (22)	S-4		SP	Black fine to coarse sand with trace silt, trace fine gravel and asphalt (very dense, moist) (fill) No recovery (medium dense)			
			0	11-6-4-4 (10)	S-5			No recovery (loose)			
60	10		1	3-4-5-7 (9)	S-6		SM	Brown silty fine to coarse sand (loose, moist) (fill)			
55	15		1	6-5-5-13 (10)	S-7			Becomes with fine gravel			
50	20		24	2-2-2-13 (4)	S-8			Becomes light brown, fine to medium, with trace organic matter and very loose			
							SM	Light gray to brown silty fine to medium sand with trace organic matter (wood) (loose, moist) (fill)			
45	25		12	33-56-36-60/5" (92)	S-9		SP	Light brown gravelly fine to coarse sand with trace silt (very dense, moist)			Light rig chatter from 26 to 27½ feet. Inferred boulders from 26 to 27½ feet
40	30		13	58-30-23-25 (53)	S-10 MC, SA		SM	Light brown silty fine to coarse sand with fine gravel (very dense, moist)	4.2	14.7	% Gravel = 6.3

Boring terminated at 32 feet below ground surface.
Backfilled to grade with drilling cuttings.

Note: See Figure A-1 for explanation of symbols.
Coordinates Data Source: Horizontal approximated based on survey data completed by Enbridge. Vertical approximated based on survey data completed by Enbridge.

Log of Boring MR-5

GeoEngineers USA

Project: Cape Canal Bridge Relocation - M&R Stations
Project Location: Barnstable County, Massachusetts
Project Number: 15556-039-00

Figure A-5
Sheet 1 of 1

Date:4/21/25 Path:P:\15\15556039\GINT\15556039GPJ DBLibrary/Library:GEOUSA_DF_STD_US.GLB/GEI8_GEOTECH_STANDARD_%F_NO_GW_4BC

Drilled: Start 3/3/2025 End 3/5/2025	Total Depth (ft): 121	Logged By: AM / Checked By: HPC	Driller: Geologic Earth Exploration, Inc.	Drilling Method: Drive-and-Wash	
Surface Elevation (ft): 74.97 Vertical Datum: NAVD88		Hammer Data: Autohammer 140 (lbs) / 30 (in) Drop		Drilling Equipment: Acker Rebel	
Latitude: 41.7805 Longitude: -70.5412		System Datum: Mass State Plane Mainland NAD83 (feet)		See "Remarks" section for groundwater observed	
Notes:					

Elevation (feet)	Depth (feet)	Interval	Recovered (in)	Blows/foot	Sample Name Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
	0		6	2-3-2-1 (5)	S-1A S-1B		TS	Dark brown silty fine to medium sand with organic matter (roots) (loose, moist) (topsoil)			
							SM				
			16	11-26-24-50/5" (50)	S-2		SM	Light brown silty fine to medium sand (loose, moist) (fill)			Light rig chatter from 2 to 8 feet
70	5		12	19-19-18-17 (37)	S-3 MC, SA			Light grayish brown silty fine to medium sand with gravel (very dense, moist) (fill) Becomes light gray and dense	9.4	17	% Gravel = 8.2
			11	23-27-22-21 (49)	S-4						
65	10		6	8-7-5-4 (12)	S-5 MC, %F		SM	Light gray silty fine to medium sand with trace gravel (medium dense, moist) (fill)	13.1	21.1	
60	15		6	2-3-3-4 (6)	S-6		SP-SM	Light gray fine to medium sand with silt and trace gravel (loose, moist)			Moderate rig chatter at 16 feet Inferred cobbles from 16 to 16½ feet
55	20		5	5-4-4-2 (8)	S-7 MC, SA, %OC		SM	Gray-dark brown silty fine to medium sand with trace fine gravel and trace organic matter (roots) (loose, moist) (fill)			% Gravel = 3.8; Organic content % = 1.0 Light rig chatter from 20 to 24 feet
50	25		6	11-9-8-7 (17)	S-8 MC, SA, DD		SM	Light brown silty fine to medium sand with fine gravel (medium dense, moist)	8.7	13.7	% Gravel = 6.9; Dry Density = 123.3
45	30		9	11-15-15-29 (30)	S-9 MC, SA, DD		SP-SM	Light brown fine to medium sand with silt and fine gravel (dense, moist)	16.6	5.7	% Gravel = 8.2; Dry density = 105.8
40	35		0	11-12-11-13 (23)	S-10			No recovery (medium dense)			Loss of water from 34 to 39 feet

Note: See Figure A-1 for explanation of symbols.
Coordinates Data Source: Horizontal approximated based on survey data completed by Enbridge. Vertical approximated based on survey data completed by Enbridge.

Date:4/21/25 Path:P:\15\15556039\GINT\15556039000.GPJ DBLibrary/Library:GEOUSA_DF_STD_US.GLB/GEI8_GEOTECH_STANDARD_%F_NO_GW_4BC

Log of Boring MR-6

GeoEngineers USA

Project: Cape Canal Bridge Relocation - M&R Stations
Project Location: Barnstable County, Massachusetts
Project Number: 15556-039-00

Elevation (feet)	Depth (feet)	Interval	Recovered (in)	Blows/foot	Sample Name / Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
	35										
			9	11-15-13-10 (28)	S-11		SP-SM	Light brown fine to coarse sand with trace silt and gravel (medium dense, moist)			
35	40		1	9-24-27-27 (51)	S-12			Becomes very dense			
											Moderate rig chatter from 43 to 54 feet Inferred boulder from 43 to 44 feet
30	45		5	11-10-9-15 (19)	S-13			Becomes medium dense			
											Loss of water at 46 feet
25	50		8	14-17-20-21 (37)	S-14 MC, SA		GP	Light brown fine gravel with sand and trace silt (dense, moist)	8.1	3.6	Loss of water at 49 feet Added drilling mud % Gravel = 72.0
20	55		11	14-11-14-32 (25)	S-15A S-15B		SP	Light brown fine to medium sand with trace silt (medium dense, moist)			
							SM	Light brown silty fine to medium sand and trace gravel (medium dense, moist)			
15	60		18	18-8-30-32 (38)	S-16		SP	Light brown fine to medium sand with trace silt (dense, moist)			
											Light rig chatter from 62½ to 63½ feet Inferred boulder
10	65		17	40-35-35-32 (70)	S-17		SM	Light brown silty fine to medium sand with gravel (very dense, moist)			
											Moderate rig chatter from 68 to 68½ feet Inferred cobbles
5	70		19	28-33-41-55 (74)	S-18		SP-SM	Light brown fine to medium sand with silt and trace gravel (very dense, moist)			
											Moderate intermittent rig chatter from 72 to 73½ feet Inferred nested cobbles
0	75		21	58-40-36-44 (76)	S-19		SP	Orange-brown fine to coarse sand with gravel and trace silt (very dense, wet)			
											Groundwater observed at approximately 75 feet Moderate rig chatter from 75 to 77 feet

Date:4/21/25 Path:P:\15\15556039\GINT\15556039.GPJ DBLibrary/Library:GEOUSA_DF_STD_US.GLB/GEI8_GEOTECH_STANDARD_%F_NO_GW_4BC

Log of Boring MR-6 (continued)

GeoEngineers USA

Project: Cape Canal Bridge Relocation - M&R Stations
Project Location: Barnstable County, Massachusetts
Project Number: 15556-039-00

Figure A-6
Sheet 2 of 4

Elevation (feet)	Depth (feet)	Interval Recovered (in)	Blows/foot	Sample Name Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
-5	80	17	51-28-33-34 (61)	S-20		SP-SM	Light brown fine to medium sand with silt and gravel (very dense, moist)			
										Moderate rig chatter from 83 to 83½ feet Inferred cobbles
-10	85	15	36-23-32-54 (55)	S-21		SP	Light brown fine to medium sand with trace silt (very dense, wet)			
										Moderate rig chatter from 86 to 86½ feet and 88 to 88½ feet
-15	90	18	28-35-29-42 (64)	S-22						
-20	95	18	35-47-47-99 (94)	S-23						
										Light rig chatter at 98 feet
-25	100	10	27-38-34-50 (72)	S-24 MC, SA		SM	Light brown silty fine to medium sand with trace fine gravel (very dense, wet)	23.1	26.4	% Gravel = 0.1
-30	105	14	34-35-28-50 (63)	S-25		SP-SM	Light brown fine to medium sand with silt and trace fine gravel (very dense, wet)			
-35	110	16	39-33-28-63 (61)	S-26						
										Light rig chatter at 111 feet
-40	115	21	29-37-33-41 (70)	S-27						

Date:4/21/25 Path:P:\15\15556039\GINT\15556039.GPJ DBLibrary/Library:GEOUSA_DF_STD_US.GLB/GEI8_GEOTECH_STANDARD_%F_NO_GW_4BC

Log of Boring MR-6 (continued)

GeoEngineers USA

Project: Cape Canal Bridge Relocation - M&R Stations
Project Location: Barnstable County, Massachusetts
Project Number: 15556-039-00

Elevation (feet)	Depth (feet)	FIELD DATA: Interval	FIELD DATA: Recovered (in)	FIELD DATA: Blows/foot	FIELD DATA: Sample Name / Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
-45	120		16	31-22-27-32 (49)	S-28			Becomes dense			

Boring terminated at 121 feet below ground surface.
Backfilled with tremied grout (cement-bentonite mix)

Date:4/21/25 Path:P:\15\15556039\GINT\15556039OO.GPJ DBLibrary/Library:GEOUSA_DF_STD_US.GLB/GEI8_GEOTECH_STANDARD_%F_NO_GW_4BC

Log of Boring MR-6 (continued)

GeoEngineers USA

Project: Cape Canal Bridge Relocation - M&R Stations
Project Location: Barnstable County, Massachusetts
Project Number: 15556-039-00

Client:	GeoEngineers, Inc.				
Project:	Cape Cod - En bridge				
Location:	MA			Project No:	GTX-320749
Boring ID:	---	Sample Type:	---	Tested By:	ajl
Sample ID:	---	Test Date:	03/26/25	Checked By:	ank
Depth :	---	Test Id:	808033		

Moisture Content of Soil and Rock - ASTM D2216

Boring ID	Sample ID	Depth	Description	Moisture Content, %
[redacted]				
MR-03	S- 11	37-39	Moist, light brownish gray sand with silt and gravel	2.2
MR-03	S- 8	25-27	Moist, yellowish brown sand with silt and gravel	5.2
MR-03	S- 9	30-32	Moist, yellowish brown sand with silt	5.4
MR-04	S- 2	2-4	Moist, dark grayish brown silty sand	10.7
MR-04A	S- 1A	15-17	Moist, dark grayish brown sand with silt and organics	11.7
MR-04A	S- 3	25-27	Moist, light olive brown silty sand	12.0
MR-05	S- 10	30-32	Moist, brown sand with silt	4.2
MR-05	S- 1	0-2	Moist, light brown silty sand	2.9
MR-06	S- 24	99-101	Moist, light olive brown silty sand	23.1

Notes: Temperature of Drying : 110° Celsius

Client:	GeoEngineers, Inc.				
Project:	Cape Cod - En bridge				
Location:	MA			Project No:	GTX-320749
Boring ID:	---	Sample Type:	---	Tested By:	ajl
Sample ID:	---	Test Date:	03/25/25	Checked By:	ank
Depth :	---	Test Id:	808067		

Moisture Content of Soil and Rock - ASTM D2216

Boring ID	Sample ID	Depth	Description	Moisture Content, %
MR-06	S- 14	49-51	Moist, grayish brown gravel with sand	8.1
MR-06	S- 7	19-21	Moist, dark grayish brown silty sand	15.2
MR-06	S- 3	4-6	Moist, olive brown silty sand	9.4
MR-06	S- 8	24-26	Moist, yellowish brown silty sand	8.7
MR-06	S- 9	29-31	Moist, brown sand with silt	16.6
MR-06	S- 5	8-10	Moist, light olive brown silty sand with gravel	13.1
[redacted]				
[redacted]				
[redacted]				

Notes: Temperature of Drying : 110° Celsius

Client:	GeoEngineers, Inc.				
Project:	Cape Cod - En bridge				
Location:	MA			Project No:	GTX-320749
Boring ID:	---	Sample Type:	---	Tested By:	cam
Sample ID:	---	Test Date:	03/27/25	Checked By:	ank
Depth :	---	Test Id:	808037		

Moisture, Ash, and Organic Matter - ASTM D2974

Boring ID	Sample ID	Depth	Description	Moisture Content, %	Ash Content, %	Organic Matter, %
MR-03	S-9	30-32	Moist, yellowish brown sand with silt	5	99.5	.5
MR-04A	S-1A	15-17	Moist, dark grayish brown sand with silt and organics	12	95.0	5.0
MR-04A	S-3	25-27	Moist, light olive brown silty sand	12	98.9	1.1
MR-06	S-7	19-21	Moist, dark grayish brown silty sand	15	99.0	1.0

Notes: Moisture content determined by Method A and reported as a percentage of oven-dried mass;
dried to a constant mass at temperature of 105º C
Ash content and organic matter determined by Method C; dried to constant mass at temperature 440º C

Client:	GeoEngineers, Inc.				
Project:	Cape Cod - En bridge				
Location:	MA			Project No:	GTX-320749
Boring ID:	---	Sample Type:	---	Tested By:	ajl
Sample ID:	---	Test Date:	03/31/25	Checked By:	ank
Depth :	---	Test Id:	808070		

pH of Soil by ASTM D4972

Boring ID	Sample ID	Depth	Visual Description	pH of Soil in Distilled Water	pH of Soil in Calcium Chloride
[redacted]					
MR-04	S-1, S-2, S-3, S-4, S-5	Composite	Moist, very dark grayish brown silty sand with gravel	5.2	4.7
MR-06	S-8, S-9, S-11, S-12, S-13	Composite	Moist, grayish brown silty sand with gravel	6.8	6.0
[redacted]					

Notes: Sample Preparation: screened through #10 sieve

Method A, pH meter used

Client:	GeoEngineers, Inc.				
Project:	Cape Cod - En bridge				
Location:	MA			Project No:	GTX-320749
Boring ID:	MR-06	Sample Type:	Jar	Tested By:	ajl
Sample ID:	S-5	Test Date:	03/28/25	Checked By:	ank
Depth :	8-10	Test Id:	808094		
Test Comment:	---				
Visual Description:	Moist, light olive brown silty sand with gravel				
Sample Comment:	---				

Amount of Material Passing #200 Sieve - ASTM D1140

Boring ID	Sample ID	Depth	Visual Description	Fines, %
MR-06	S-5	8-10	Moist, light olive brown silty sand with gravel	21.2

Notes: Tests performed using Method B - washing using a wetting agent
Dry mass of test specimen was determined directly

Client:	GeoEngineers, Inc.				
Project:	Cape Cod - En bridge				
Location:	MA			Project No:	GTX-320749
Boring ID:	---	Sample Type:	---	Tested By:	ajl
Sample ID:	---	Test Date:	03/24/25	Checked By:	ank
Depth :	---	Test Id:	808068		

Laboratory Determination of Density (Unit Weight) of Soil Specimens by ASTM D7263

Boring ID	Sample ID	Depth	Visual Description	Bulk Density pcf	Moisture Content %	Dry Density pcf	*
MR-04	S- 2	2-4	Moist, dark grayish brown silty sand	130.1	10.74	117.4	(2)
MR-06	S- 8	24-26	Moist, yellowish brown silty sand	134.1	8.740	123.3	(3)
MR-06	S- 9	29-31	Moist, brown sand with silt	123.4	16.60	105.8	(4)

* Sample Comments

(1): Method B-Volumetric, Reconstituted (compacted)

(2): Method B-Volumetric, Reconstituted (compacted)

(3): Method B-Volumetric, Reconstituted (compacted)

(4): Method B-Volumetric, Reconstituted (compacted)

(5): Method B-Volumetric, Reconstituted (compacted)

Notes: Moisture Content determined by ASTM D2216.

Client:	Geo Engineer, Inc.
Project:	Cape Cod-En Bridge
Location:	MA
GTX#:	320749
Test Date:	04/01/25
Due Date:	04/03/25
Tested By:	NMK
Checked By:	ank

Minimum Laboratory Soil Resistivity by AASHTO T 288

Boring ID	Sample ID	Depth, ft.	Sample Description	Electrical Resistivity, ohm-cm	Electrical Conductivity, $(ohm\text{-}cm)^{-1}$
[redacted]					
MR-04	S-1, S-2, S-3, S-4, S-5	Composite	Moist, very dark grayish brown silty sand with gravel	5,033	1.99E-04
MR-06	S-8, S-9, S-11, S-12, S-13	Composite	Moist, grayish brown sand with gravel	15,093	6.63E-05
[redacted]					

Notes: Test Equipment: Nilsson Model 400 Soil Resistance Meter, MC Miller Soil Box

Water added to sample to create a thick slurry prior to testing (saturated condition).

Electrical Conductivity is calculated as inverse of Electrical Resistivity (per ASTM G57)

Test conducted in standard laboratory atmosphere: 68-73 F

Client:	GeoEngineers, Inc.				
Project:	Cape Cod - En bridge				
Location:	MA			Project No:	GTX-320749
Boring ID:	MR-06	Sample Type:	Jar	Tested By:	ajl
Sample ID:	S-8	Test Date:	03/27/25	Checked By:	ank
Depth :	24-26	Test Id:	808242		
Test Comment:	---				
Visual Description:	Moist, yellowish brown silty sand				
Sample Comment:	---				

Description and Classification of Soils (Visual-Manual) - ASTM D2488

Parameter	Result
Group Name	Silty sand
Group Symbol	ML-SM
% Cobbles/Boulders	0
% Gravel	7
% Sand	79
% Fines	14
Angularity (coarse grained)	SUBANGULAR
Shape (coarse grained)	N/A
Maximum Particle Size (mm)	9.5
Hardness (coarse grained)	HARD
Plasticity (fine grained)	NONPLASTIC
Dry Strength (fine grained)	NONE
Dilatancy (fine grained)	RAPID
Toughness (fine grained)	---
Color	Yellowish brown
Odor	NONE
Moisture	MOIST
Reaction with HCL	NONE
Consistency (intact,fine grained)	---
Structure (intact)	---
Cementation (intact, coarse grained)	---

Client:	GeoEngineers, Inc.				
Project:	Cape Cod - En bridge				
Location:	MA			Project No:	GTX-320749
Boring ID:	MR-04	Sample Type:	Jar	Tested By:	ajl
Sample ID:	S-2	Test Date:	03/27/25	Checked By:	ank
Depth :	2-4	Test Id:	808060		
Test Comment:	---				
Visual Description:	Moist, dark grayish brown silty sand				
Sample Comment:	---				

Description and Classification of Soils (Visual-Manual) - ASTM D2488

Parameter	Result
Group Name	Silty sand
Group Symbol	ML-SM
% Cobbles/Boulders	0
% Gravel	0
% Sand	71
% Fines	29
Angularity (coarse grained)	SUBANGULAR
Shape (coarse grained)	N/A
Maximum Particle Size (mm)	2
Hardness (coarse grained)	HARD
Plasticity (fine grained)	NONPLASTIC
Dry Strength (fine grained)	NONE
Dilatancy (fine grained)	RAPID
Toughness (fine grained)	---
Color	Dark grayish brown
Odor	NONE
Moisture	MOIST
Reaction with HCL	NONE
Consistency (intact,fine grained)	---
Structure (intact)	---
Cementation (intact, coarse grained)	---

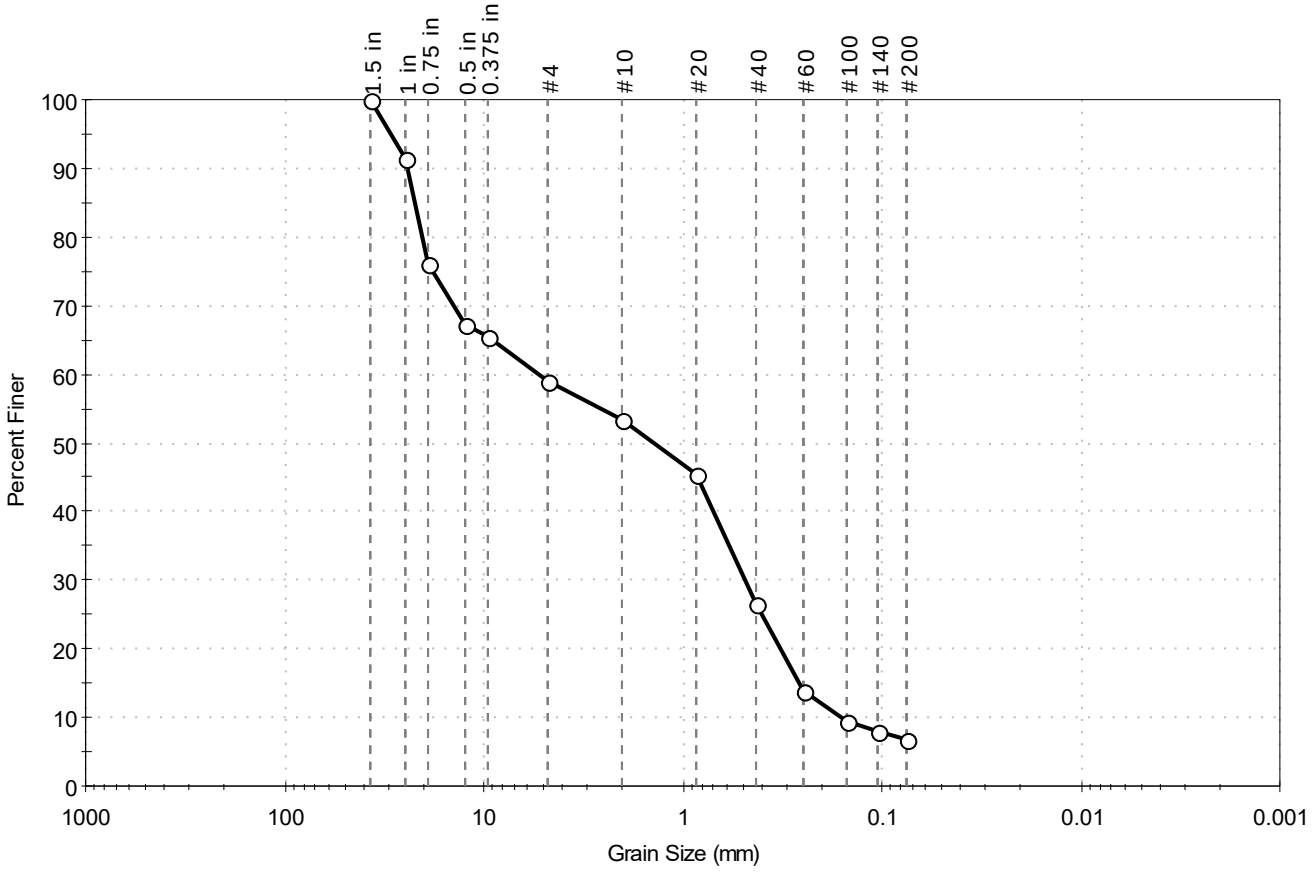
Client:	GeoEngineers, Inc.				
Project:	Cape Cod - En bridge				
Location:	MA			Project No:	GTX-320749
Boring ID:	MR-06	Sample Type:	Jar	Tested By:	ajl
Sample ID:	S-9	Test Date:	04/03/25	Checked By:	ank
Depth :	29-31	Test Id:	808049		
Test Comment:	---				
Visual Description:	Moist, brown sand with silt				
Sample Comment:	---				

Description and Classification of Soils (Visual-Manual) - ASTM D2488

Parameter	Result
Group Name	Sand with silt
Group Symbol	SP-SM
% Cobbles/Boulders	0
% Gravel	8.2
% Sand	86.1
% Fines	5.7
Angularity (coarse grained)	ANGULAR
Shape (coarse grained)	FLAT AND ELONGATED
Maximum Particle Size (mm)	9.5
Hardness (coarse grained)	HARD
Plasticity (fine grained)	NONPLASTIC
Dry Strength (fine grained)	LOW
Dilatancy (fine grained)	RAPID
Toughness (fine grained)	---
Color	Brown
Odor	NONE
Moisture	MOIST
Reaction with HCL	NONE
Consistency (intact,fine grained)	---
Structure (intact)	---
Cementation (intact, coarse grained)	---

Client:	GeoEngineers, Inc.				
Project:	Cape Cod - En bridge				
Location:	MA			Project No:	GTX-320749
Boring ID:	MR-03	Sample Type:	Jar	Tested By:	ajl
Sample ID:	S-11	Test Date:	03/28/25	Checked By:	ank
Depth :	37-39	Test Id:	808030		
Test Comment:	---				
Visual Description:	Moist, light brownish gray sand with silt and gravel				
Sample Comment:	---				

Particle Size Analysis - ASTM D6913



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	40.9	52.2	6.9

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1.5 in	37.50	100		
1 in	25.00	91		
0.75 in	19.00	76		
0.5 in	12.50	67		
0.375 in	9.50	65		
#4	4.75	59		
#10	2.00	53		
#20	0.85	45		
#40	0.42	26		
#60	0.25	14		
#100	0.15	9		
#140	0.11	8		
#200	0.075	6.9		

Coefficients

D_{85} = 22.3054 mm	D_{30} = 0.4839 mm
D_{60} = 5.2529 mm	D_{15} = 0.2634 mm
D_{50} = 1.3843 mm	D_{10} = 0.1617 mm
C_u = 32.485	C_c = 0.276

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-b (1))

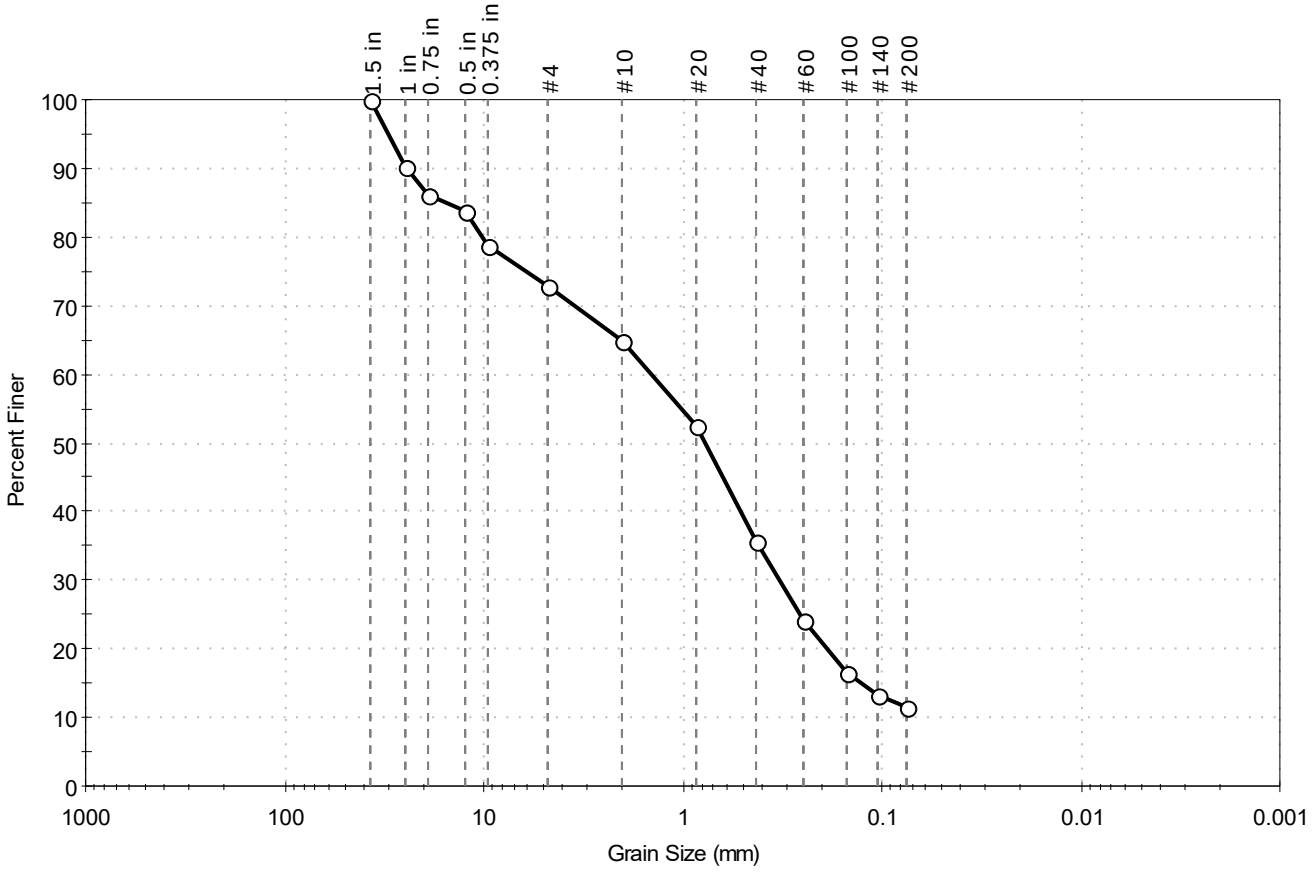
Sample / Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

Client:	GeoEngineers, Inc.				
Project:	Cape Cod - En bridge				
Location:	MA			Project No:	GTX-320749
Boring ID:	MR-03	Sample Type:	Jar	Tested By:	ajl
Sample ID:	S-8	Test Date:	03/28/25	Checked By:	ank
Depth :	25-27	Test Id:	808085		
Test Comment:	---				
Visual Description:	Moist, yellowish brown sand with silt and gravel				
Sample Comment:	---				

Particle Size Analysis - ASTM D6913



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	27.2	61.3	11.5

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1.5 in	37.50	100		
1 in	25.00	90		
0.75 in	19.00	86		
0.5 in	12.50	84		
0.375 in	9.50	79		
#4	4.75	73		
#10	2.00	65		
#20	0.85	53		
#40	0.42	36		
#60	0.25	24		
#100	0.15	16		
#140	0.11	13		
#200	0.075	11		

Coefficients

D_{85} = 15.5435 mm	D_{30} = 0.3268 mm
D_{60} = 1.4150 mm	D_{15} = 0.1275 mm
D_{50} = 0.7632 mm	D_{10} = N/A
C_u = N/A	C_c = N/A

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

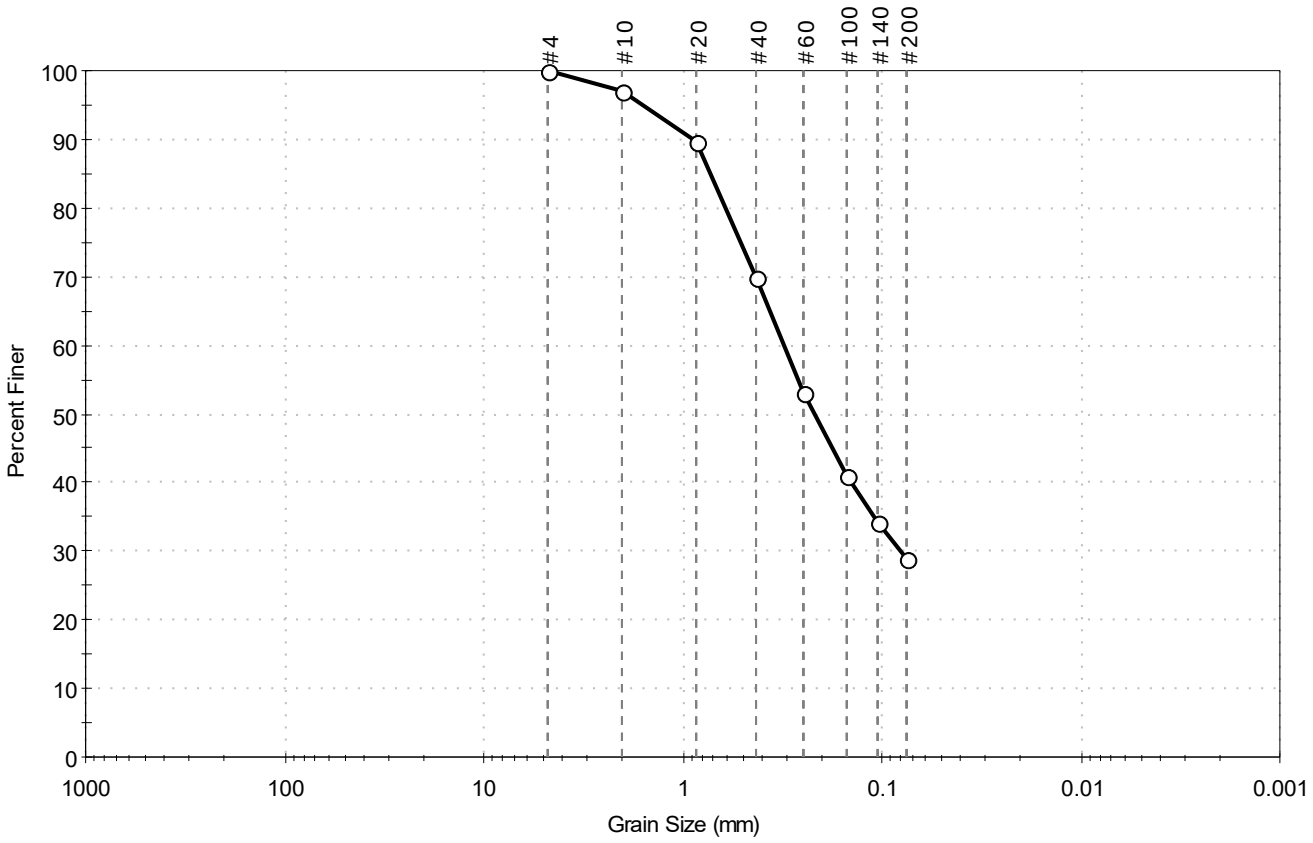
Sample / Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

Client:	GeoEngineers, Inc.				
Project:	Cape Cod - En bridge				
Location:	MA			Project No:	GTX-320749
Boring ID:	MR-04	Sample Type:	Jar	Tested By:	ajl
Sample ID:	S-2	Test Date:	03/26/25	Checked By:	ank
Depth :	2-4	Test Id:	808057		
Test Comment:	---				
Visual Description:	Moist, dark grayish brown silty sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D6913



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	71.2	28.8

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	97		
#20	0.85	90		
#40	0.42	70		
#60	0.25	53		
#100	0.15	41		
#140	0.11	34		
#200	0.075	29		

Coefficients

D_{85} = 0.7235 mm	D_{30} = 0.0808 mm
D_{60} = 0.3110 mm	D_{15} = N/A
D_{50} = 0.2190 mm	D_{10} = N/A
C_u = N/A	C_c = N/A

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample / Test Description

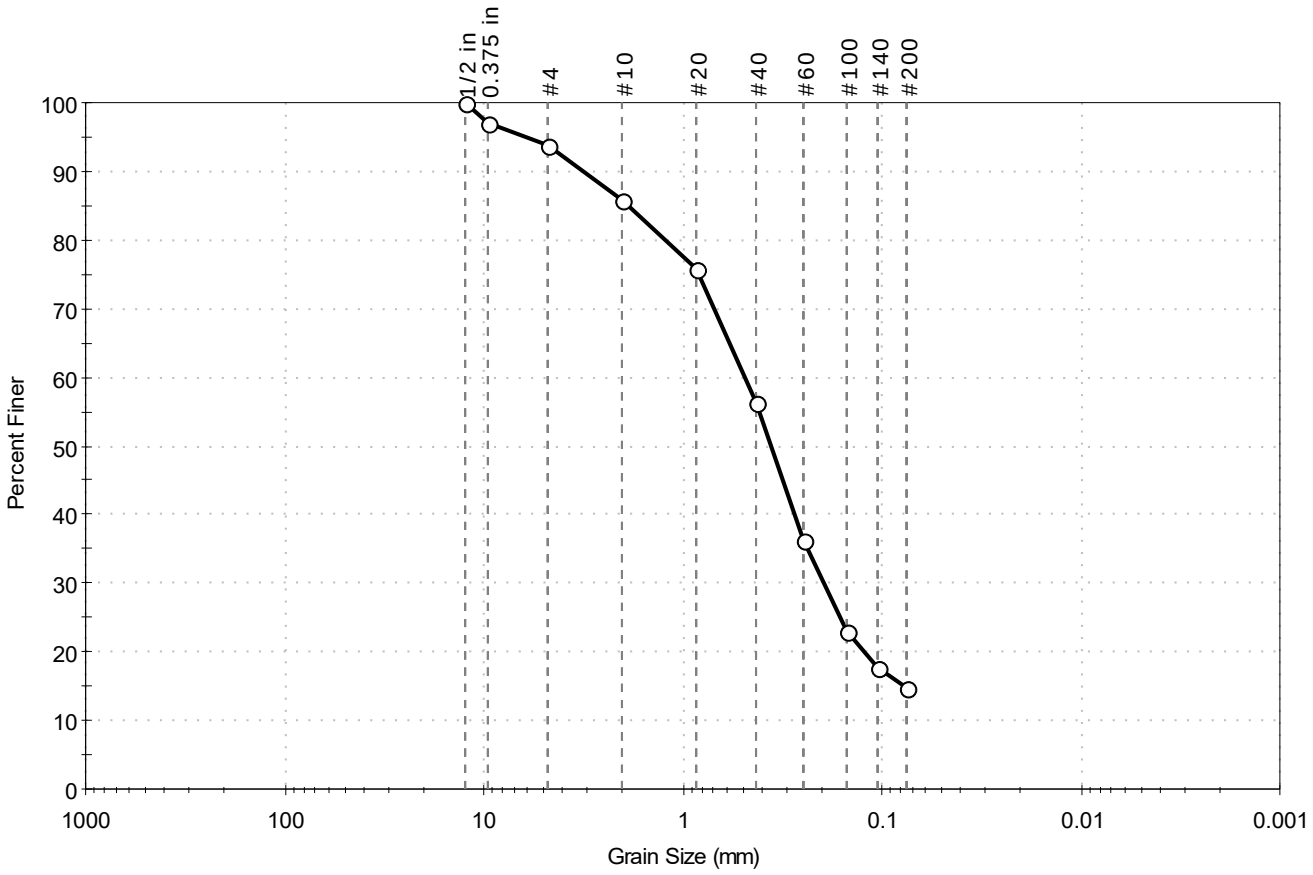
Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

printed 4/1/2025 12:18:41 PM

Client:	GeoEngineers, Inc.				
Project:	Cape Cod - En bridge				
Location:	MA			Project No:	GTX-320749
Boring ID:	MR-05	Sample Type:	Jar	Tested By:	ajl
Sample ID:	S-10	Test Date:	03/28/25	Checked By:	ank
Depth :	30-32	Test Id:	808700		
Test Comment:	---				
Visual Description:	Moist, brown silty sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D6913



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	6.3	79.0	14.7

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1/2 in	12.50	100		
0.375 in	9.50	97		
#4	4.75	94		
#10	2.00	86		
#20	0.85	76		
#40	0.42	56		
#60	0.25	36		
#100	0.15	23		
#140	0.11	18		
#200	0.075	15		

Coefficients

D_{85} = 1.8503 mm
D_{30} = 0.1962 mm
D_{60} = 0.4827 mm
D_{15} = 0.0777 mm
D_{50} = 0.3584 mm
D_{10} = N/A
C_u = N/A
C_c = N/A

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

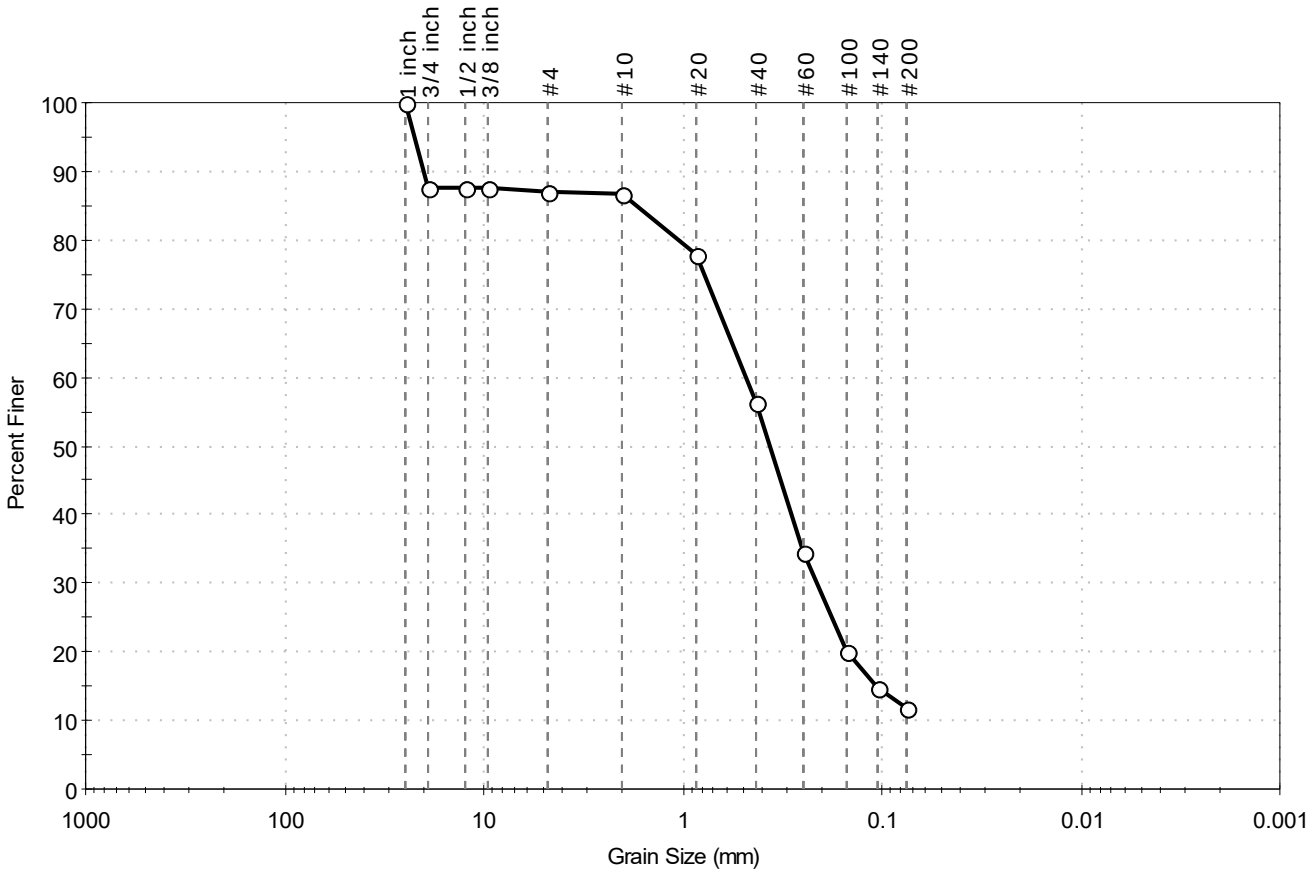
Sample / Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

Client:	GeoEngineers, Inc.				
Project:	Cape Cod - En bridge				
Location:	MA			Project No:	GTX-320749
Boring ID:	MR-05	Sample Type:	Jar	Tested By:	ajl
Sample ID:	S-1	Test Date:	03/28/25	Checked By:	ank
Depth :	0-2	Test Id:	808701		
Test Comment:	---				
Visual Description:	Moist, light brown sand with silt				
Sample Comment:	---				

Particle Size Analysis - ASTM D6913



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	13.1	75.1	11.8

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1 inch	25.00	100		
3/4 inch	19.00	88		
1/2 inch	12.50	88		
3/8 inch	9.50	88		
#4	4.75	87		
#10	2.00	87		
#20	0.85	78		
#40	0.42	56		
#60	0.25	35		
#100	0.15	20		
#140	0.11	15		
#200	0.075	12		

Coefficients

D_{85} = 1.7032 mm	D_{30} = 0.2127 mm
D_{60} = 0.4790 mm	D_{15} = 0.1082 mm
D_{50} = 0.3645 mm	D_{10} = N/A
C_u = N/A	C_c = N/A

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample / Test Description

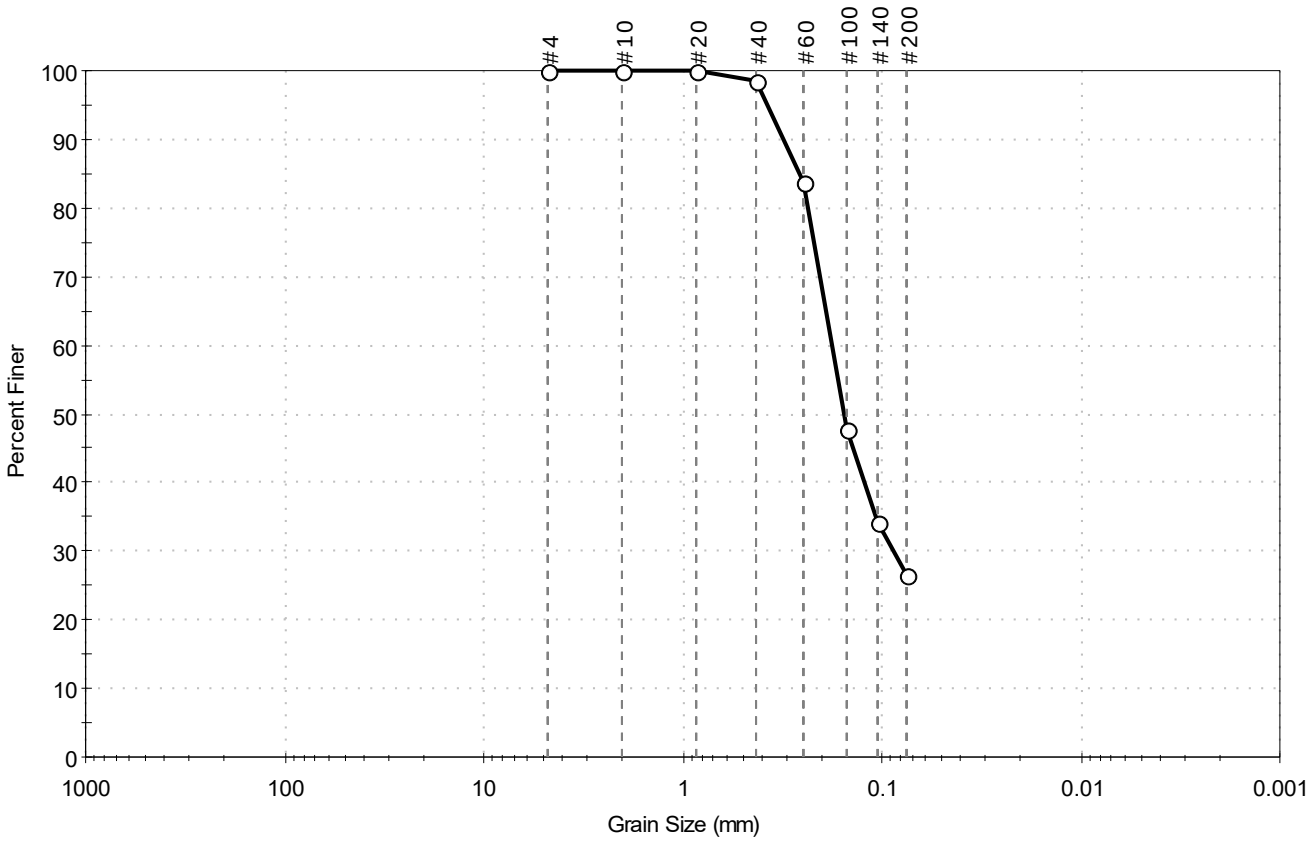
Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

printed 4/1/2025 12:18:43 PM

Client:	GeoEngineers, Inc.				
Project:	Cape Cod - En bridge				
Location:	MA			Project No:	GTX-320749
Boring ID:	MR-06	Sample Type:	Jar	Tested By:	ajl
Sample ID:	S-24	Test Date:	03/28/25	Checked By:	ank
Depth :	99-101	Test Id:	808029		
Test Comment:	---				
Visual Description:	Moist, light olive brown silty sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D6913



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.1	73.5	26.4

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	99		
#60	0.25	84		
#100	0.15	48		
#140	0.11	34		
#200	0.075	26		

Coefficients

D_{85} = 0.2609 mm	D_{30} = 0.0877 mm
D_{60} = 0.1786 mm	D_{15} = N/A
D_{50} = 0.1550 mm	D_{10} = N/A
C_u = N/A	C_c = N/A

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

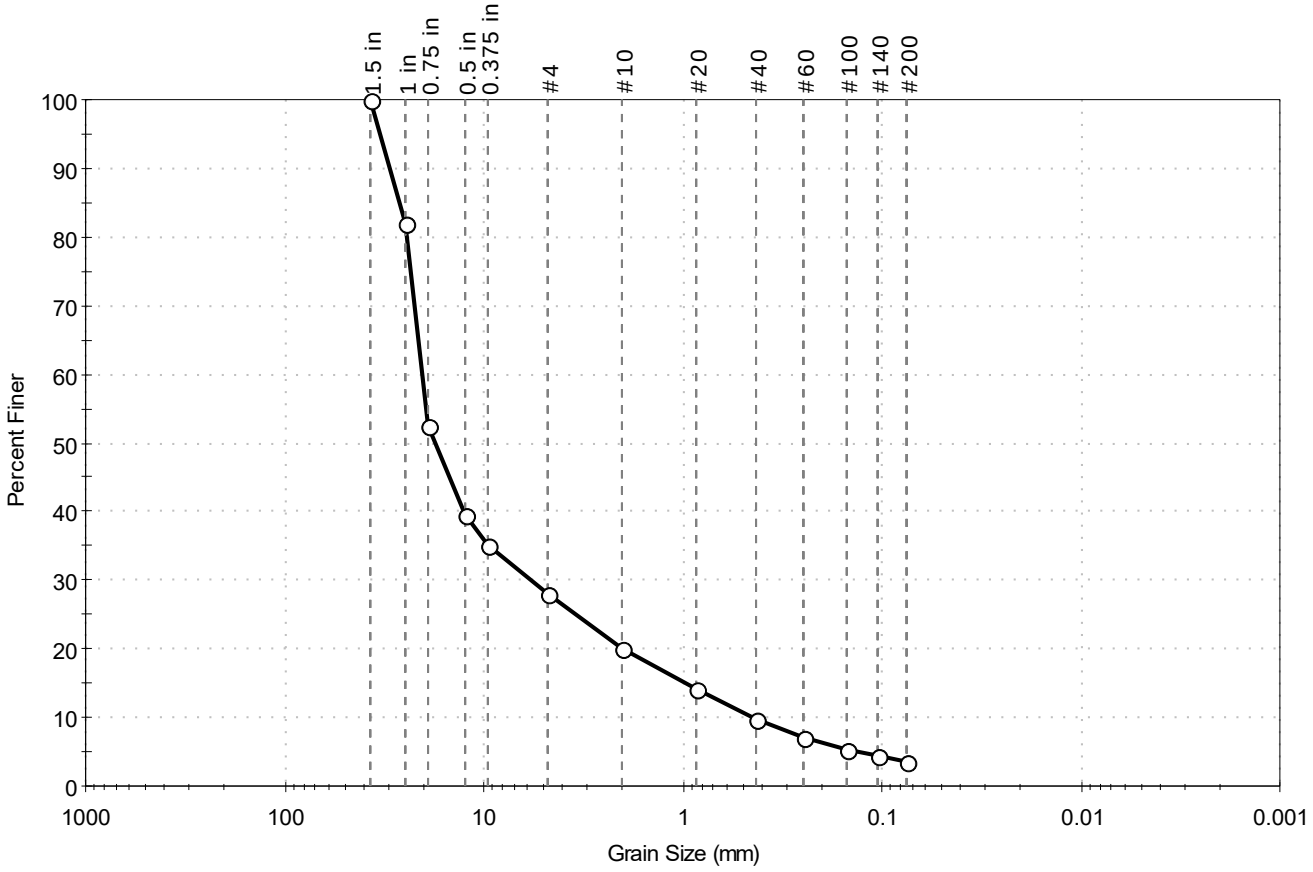
Sample / Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

Client:	GeoEngineers, Inc.				
Project:	Cape Cod - En bridge				
Location:	MA			Project No:	GTX-320749
Boring ID:	MR-06	Sample Type:	Jar	Tested By:	ajl
Sample ID:	S-14	Test Date:	03/28/25	Checked By:	ank
Depth :	49-51	Test Id:	808028		
Test Comment:	---				
Visual Description:	Moist, grayish brown gravel with sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D6913



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	72.0	24.4	3.6

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1.5 in	37.50	100		
1 in	25.00	82		
0.75 in	19.00	53		
0.5 in	12.50	39		
0.375 in	9.50	35		
#4	4.75	28		
#10	2.00	20		
#20	0.85	14		
#40	0.42	10		
#60	0.25	7		
#100	0.15	5		
#140	0.11	4		
#200	0.075	3.6		

Coefficients

D_{85} = 26.7153 mm	D_{30} = 5.7329 mm
D_{60} = 20.3681 mm	D_{15} = 0.9542 mm
D_{50} = 17.5289 mm	D_{10} = 0.4348 mm
C_u = 46.845	C_c = 3.711

Classification

ASTM — Poorly graded GRAVEL with Sand (GP)

AASHTO — Stone Fragments, Gravel and Sand (A-1-a (1))

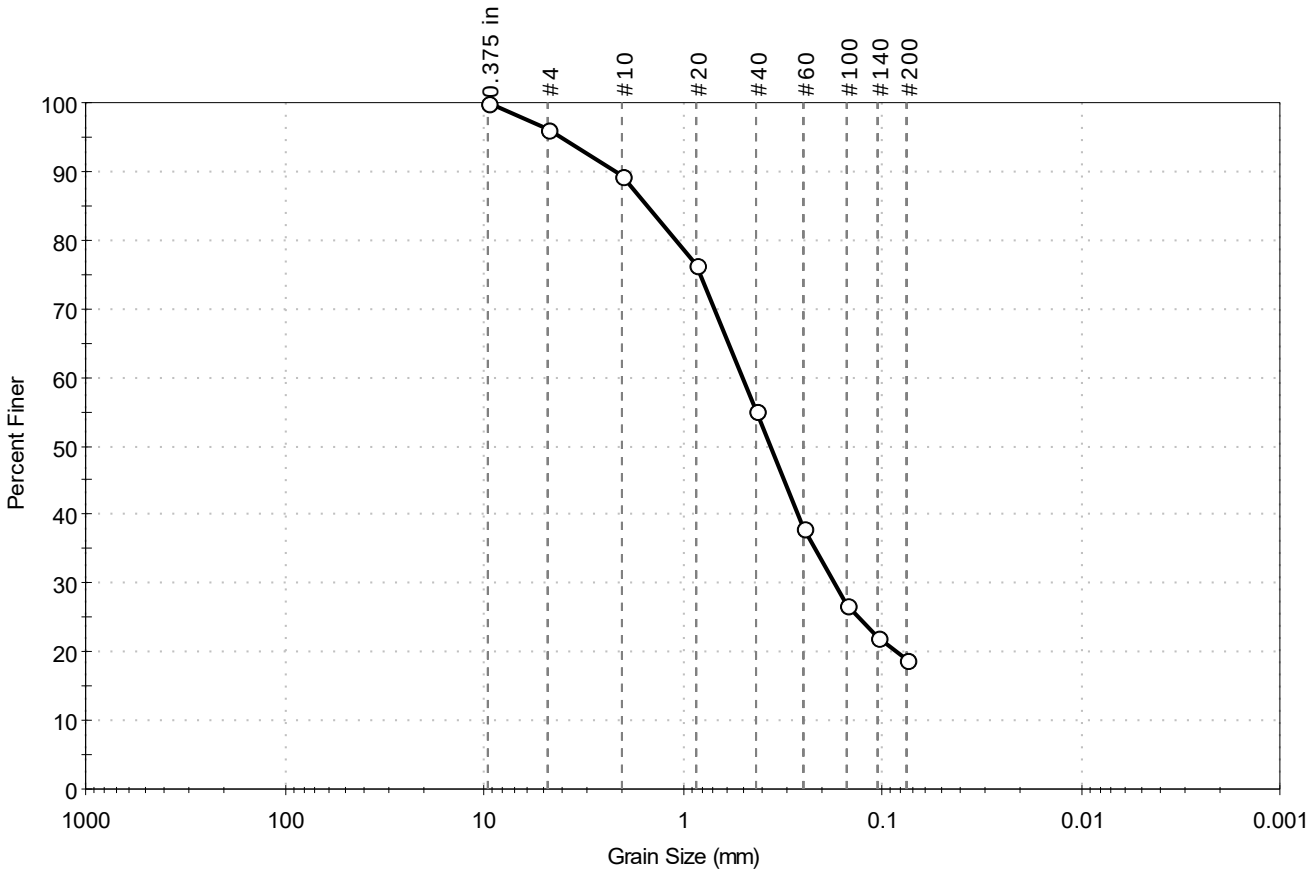
Sample / Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

Client:	GeoEngineers, Inc.				
Project:	Cape Cod - En bridge				
Location:	MA			Project No:	GTX-320749
Boring ID:	MR-06	Sample Type:	Jar	Tested By:	ajl
Sample ID:	S-7	Test Date:	03/28/25	Checked By:	ank
Depth :	19-21	Test Id:	808433		
Test Comment:	---				
Visual Description:	Moist, dark grayish brown silty sand				
Sample Comment:	Removed 1- 1/2" rock				

Particle Size Analysis - ASTM D6913



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	3.8	77.4	18.8

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	96		
#10	2.00	89		
#20	0.85	76		
#40	0.42	55		
#60	0.25	38		
#100	0.15	27		
#140	0.11	22		
#200	0.075	19		

Coefficients

D_{85} = 1.4940 mm	D_{30} = 0.1739 mm
D_{60} = 0.4988 mm	D_{15} = N/A
D_{50} = 0.3631 mm	D_{10} = N/A
C_u = N/A	C_c = N/A

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

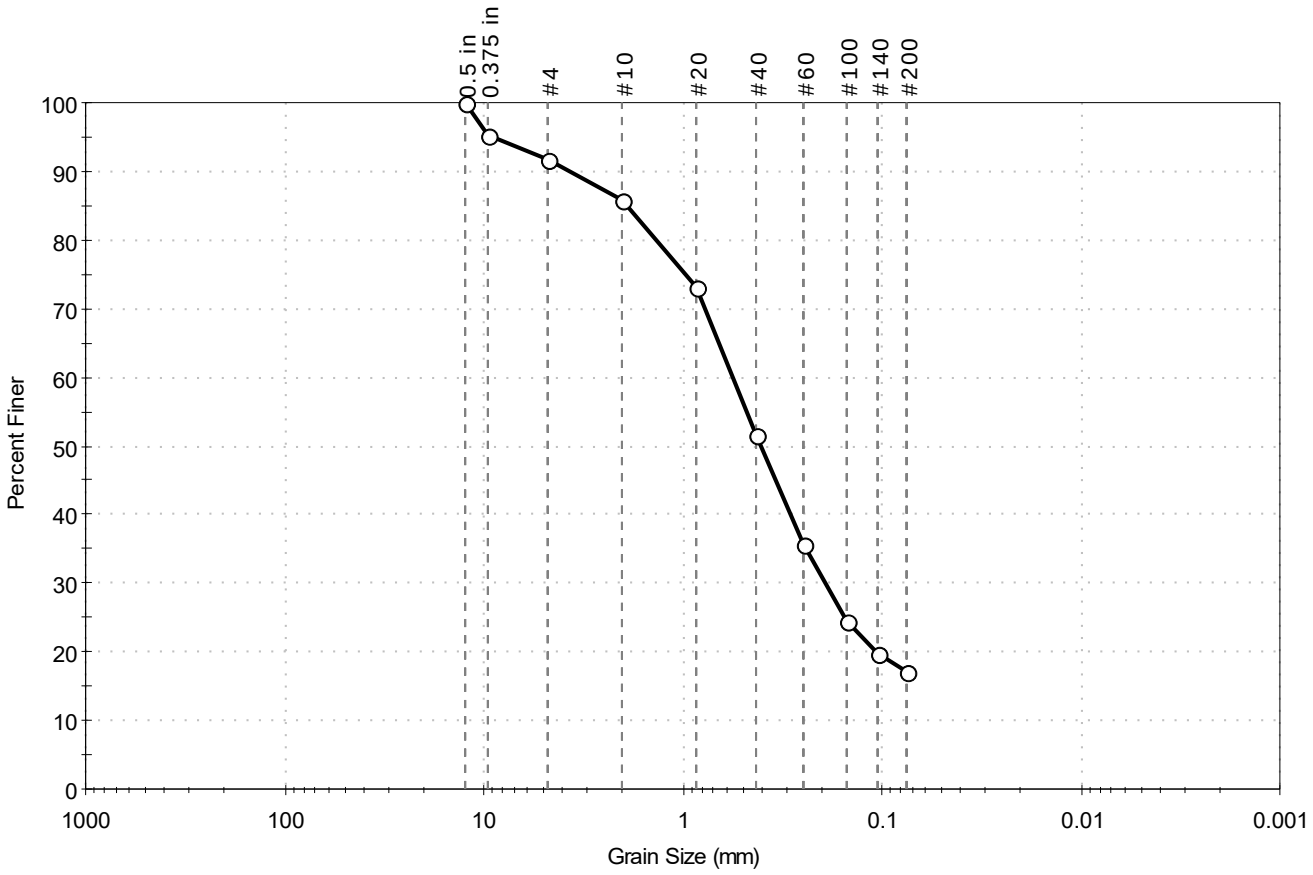
Sample / Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

Client:	GeoEngineers, Inc.				
Project:	Cape Cod - En bridge				
Location:	MA			Project No:	GTX-320749
Boring ID:	MR-06	Sample Type:	Jar	Tested By:	ajl
Sample ID:	S-3	Test Date:	03/28/25	Checked By:	ank
Depth :	4-6	Test Id:	808026		
Test Comment:	---				
Visual Description:	Moist, olive brown silty sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D6913



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	8.2	74.8	17.0

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.5 in	12.50	100		
0.375 in	9.50	95		
#4	4.75	92		
#10	2.00	86		
#20	0.85	73		
#40	0.42	52		
#60	0.25	36		
#100	0.15	25		
#140	0.11	20		
#200	0.075	17		

Coefficients

D_{85} = 1.8856 mm	D_{30} = 0.1923 mm
D_{60} = 0.5545 mm	D_{15} = N/A
D_{50} = 0.4012 mm	D_{10} = N/A
C_u = N/A	C_c = N/A

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

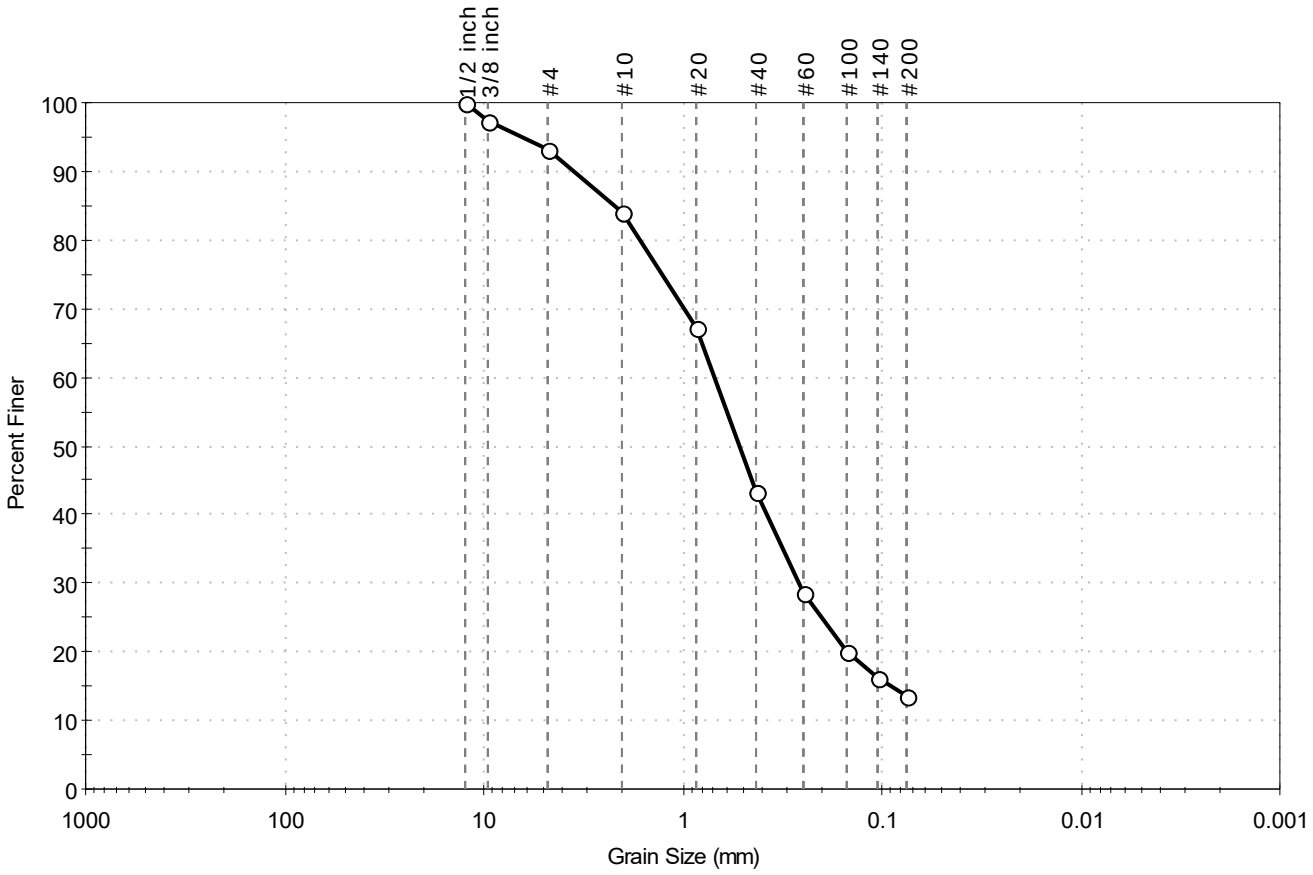
Sample / Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

Client:	GeoEngineers, Inc.				
Project:	Cape Cod - En bridge				
Location:	MA			Project No:	GTX-320749
Boring ID:	MR-06	Sample Type:	Jar	Tested By:	ajl
Sample ID:	S-8	Test Date:	03/26/25	Checked By:	ank
Depth :	24-26	Test Id:	808045		
Test Comment:	---				
Visual Description:	Moist, yellowish brown silty sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D6913



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	6.9	79.4	13.7

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1/2 inch	12.50	100		
3/8 inch	9.50	97		
#4	4.75	93		
#10	2.00	84		
#20	0.85	67		
#40	0.42	43		
#60	0.25	29		
#100	0.15	20		
#140	0.11	16		
#200	0.075	14		

Coefficients

D_{85} = 2.2029 mm
D_{30} = 0.2624 mm
D_{60} = 0.6904 mm
D_{15} = 0.0902 mm
D_{50} = 0.5161 mm
D_{10} = N/A
C_u = N/A
C_c = N/A

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

Sample / Test Description

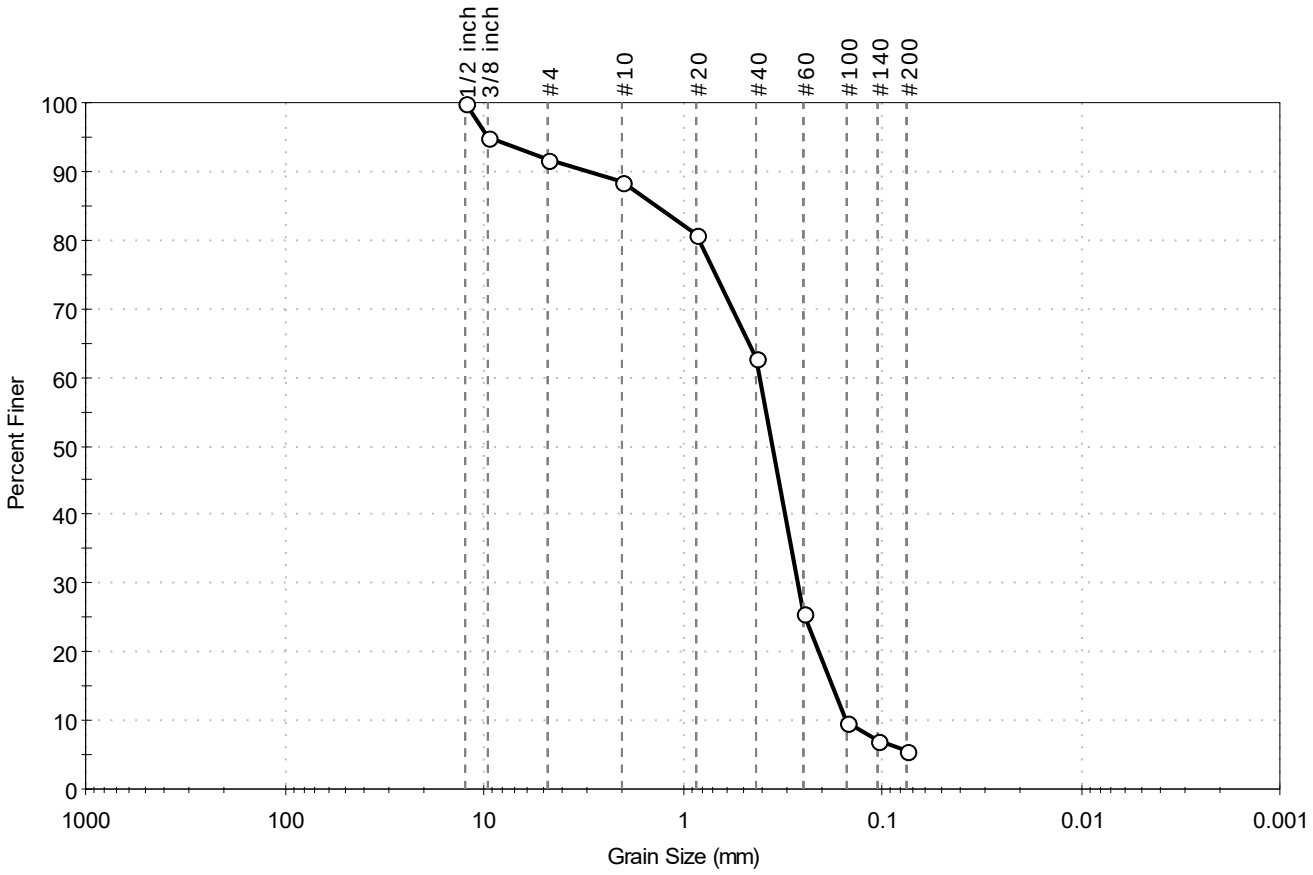
Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

printed 4/1/2025 12:18:46 PM

Client:	GeoEngineers, Inc.				
Project:	Cape Cod - En bridge				
Location:	MA			Project No:	GTX-320749
Boring ID:	MR-06	Sample Type:	Jar	Tested By:	ajl
Sample ID:	S-9	Test Date:	03/26/25	Checked By:	ank
Depth :	29-31	Test Id:	808046		
Test Comment:	---				
Visual Description:	Moist, brown sand with silt				
Sample Comment:	---				

Particle Size Analysis - ASTM D6913



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	8.2	86.1	5.7

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1/2 inch	12.50	100		
3/8 inch	9.50	95		
#4	4.75	92		
#10	2.00	88		
#20	0.85	81		
#40	0.42	63		
#60	0.25	26		
#100	0.15	10		
#140	0.11	7		
#200	0.075	5.7		

Coefficients

D_{85} = 1.3573 mm	D_{30} = 0.2660 mm
D_{60} = 0.4086 mm	D_{15} = 0.1779 mm
D_{50} = 0.3541 mm	D_{10} = 0.1516 mm
C_u = 2.695	C_c = 1.142

Classification

ASTM N/A

AASHTO Fine Sand (A-3 (1))

Sample / Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

PO Box 572455 / Salt Lake City UT 84157-2455 / USA
TEL +1 801 262 2448 · FAX +1 801 262 9870 · www.TEi-TS.com

GEOTESTING EXPRESS INCORPORATED
125 NAGOG PARK
ACTON MA 01720-3451
USA

Analysis No.	TS-A2512584
Report Date	31 March 2025
Date Sampled	24 March 2025
Date Received	27 March 2025
Where Sampled	Acton, MA USA
Sampled By	Client

This is to attest that we have examined: Soil: Project: Cape Cod – En Bridge; Site Location: - — -; Job Number: GTX-320749

When examined to the applicable requirements of:

ASTM D 512-12*	“Standard Test Methods for Chloride Ion in Water” Method B
ASTM D 516-22	“Standard Test Method for Sulfate Ion in Water”

Results:

ASTM D 512 - Chloride Method B

Sample		Results		Minimum Detection Limit
		ppm (mg/kg)	%[1]	
[redacted]				10.
MR--04		< 10.	< 0.0010	
S-1, S-2, S-3, S-4, S-5	Composite			
MR-06		< 10.	< 0.0010	
S-8, S-9, S-11, S-12, S-13	Composite			
[redacted]				

NOTE: [1]Percent by weight after drying and prepared as per the Standard. *Withdrawn 2021 without Replacement

Testing Services analytical Laboratory
3455 South 500 West
Salt Lake City, UT 84115-4234 USA
TEL: +1 801 262 2448
FAX: +1 801 262 9870

ASTM D 516 - Sulfates (Soluble)

Sample		Results		Minimum Detection Limit
		ppm (mg/kg)	%[1]	
[redacted]				10.
MR--04		< 10.	< 0.0010	
S-1, S-2, S-3, S-4, S-5	Composite			
MR-06		10.	0.0010	
S-8, S-9, S-11, S-12, S-13	Composite			
[redacted]				

NOTE: [1]Percent by weight after drying and prepared as per the Standard.

END OF ANALYSIS

USEPA Laboratory ID UT00930

Merrill Gee P.E. – Engineer in Charge

© 2025 by Testing Engineers International, Inc. CAVEAT: This certificate may not be reproduced except in full, without the expressed written consent of TEi-Testing Services, LLC. Note: The values in this certificate are the values obtained under standard test conditions as reported in the appropriate Report of Test and thus may be used for purposes of demonstrating compliance or for comparison with other units tested under the same standard. The results do not indicate the function of the sample(s) under nonstandard or field conditions. Statement of Risk: Client understands and agrees that declarations of conformity are made by directly comparing the measurement results against the test limits given in the standard without consideration to factors that may contribute to measurement uncertainty and accepts the shared risk that arises from this approach. This certificate gives the characteristics of the sample(s) submitted for testing only. It does not and may not be used to certify the characteristics of the product, nor to imply that the product in general meets the requirements of any standard, nor its acceptability in the marketplace. TEi stylized lettering and logo are registered trademarks, and use is by contract and/or written permission only. USEPA Laboratory ID UT00930 TEi-Testing Services is a wholly owned LLC of Testing Engineers International, Inc.

Appendix B
Report Limitations and Guidelines for Use

Appendix B
Report Limitations and Guidelines For Use[1]

This appendix provides information to help you manage your risks with respect to the use of this report.

READ THESE PROVISIONS CLOSELY

It is important to recognize that the geoscience practices (geotechnical engineering, geology, and environmental science) rely on professional judgment and opinion to a greater extent than other engineering and natural science disciplines, where more precise and/or readily observable data may exist. To help clients better understand how this difference pertains to our services, GeoEngineers includes the following explanatory "limitations" provisions in its reports. Please confer with GeoEngineers if you need to know more how these "Report Limitations and Guidelines for Use" apply to your project or site.

GEOTECHNICAL SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES, PERSONS, AND PROJECTS

This report has been prepared for Enbridge, Inc. and for the Project specifically identified in the report. The information contained herein is not applicable to other sites or projects.

GeoEngineers structures its services to meet the specific needs of its clients. No party other than the party to whom this report is addressed may rely on the product of our services unless we agree to such reliance in advance and in writing. Within the limitations of the agreed scope of services for the Project, and its schedule and budget, our services have been executed in accordance with our Agreement with Enbridge, Inc. dated October 31, 2023 and revised April 4, 2025 and generally accepted geotechnical practices in this area at the time this report was prepared. We do not authorize, and will not be responsible for, the use of this report for any purposes or projects other than those identified in the report.

A GEOTECHNICAL ENGINEERING OR GEOLOGIC REPORT IS BASED ON A UNIQUE SET OF PROJECT-SPECIFIC FACTORS

This report has been prepared for Enbridge Inc. for the proposed Mainland Sagamore M&R Station Site, in Bourne, Massachusetts. GeoEngineers considered a number of unique, project-specific factors when establishing the scope of services for this project and report. Unless GeoEngineers specifically indicates otherwise, it is important not to rely on this report if it was:

- Not prepared for you,
- Not prepared for your project,
- Not prepared for the specific site explored, or
- Completed before important project changes were made.

1 Developed based on material provided by GBA, GeoProfessional Business Association; www.geoprofessional.org.

For example, changes that can affect the applicability of this report include those that affect:

- The function of the proposed structure;
- Elevation, configuration, location, orientation, or weight of the proposed structure;
- Composition of the design team; or
- Project ownership.

If changes occur after the date of this report, GeoEngineers cannot be responsible for any consequences of such changes in relation to this report unless we have been given the opportunity to review our interpretations and recommendations. Based on that review, we can provide written modifications or confirmation, as appropriate.

ENVIRONMENTAL CONCERNS ARE NOT COVERED

Unless environmental services were specifically included in our scope of services, this report does not provide any environmental findings, conclusions, or recommendations, including but not limited to, the likelihood of encountering underground storage tanks or regulated contaminants.

SUBSURFACE CONDITIONS CAN CHANGE

This geotechnical or geologic report is based on conditions that existed at the time the study was performed. The findings and conclusions of this report may be affected by the passage of time, by man-made events such as construction on or adjacent to the site, new information or technology that becomes available subsequent to the report date, or by natural events such as floods, earthquakes, slope instability or groundwater fluctuations. If more than a few months have passed since issuance of our report or work product, or if any of the described events may have occurred, please contact GeoEngineers before applying this report for its intended purpose so that we may evaluate whether changed conditions affect the continued reliability or applicability of our conclusions and recommendations.

TOPSOIL

For the purposes of this report, we consider topsoil to consist of generally fine-grained soil with an appreciable amount of organic matter based on visual examination and to be unsuitable for direct support of the proposed improvements. However, the organic content and other mineralogical and gradational characteristics used to evaluate the suitability of soil for use in landscaping and agricultural purposes was not determined, nor considered in our analyses. Therefore, the information and recommendations in this report and our logs and descriptions should not be used as a basis for estimating the volume of topsoil available for such purposes.

GEOTECHNICAL AND GEOLOGIC FINDINGS ARE PROFESSIONAL OPINIONS

Our interpretations of subsurface conditions are based on field observations from widely spaced sampling locations at the site. Site exploration identifies the specific subsurface conditions only at those points where subsurface tests are conducted or samples are taken. GeoEngineers reviewed field and laboratory data and then applied its professional judgment to render an informed opinion about subsurface conditions at other locations. Actual subsurface conditions may differ, sometimes significantly, from the opinions

presented in this report. Our report, conclusions and interpretations are not a warranty of the actual subsurface conditions.

GEOTECHNICAL ENGINEERING REPORT RECOMMENDATIONS ARE NOT FINAL

We have developed the following recommendations based on data gathered from subsurface investigation(s). These investigations sample just a small percentage of a site to create a snapshot of the subsurface conditions elsewhere on the site. Such sampling on its own cannot provide a complete and accurate view of subsurface conditions for the entire site. Therefore, the recommendations included in this report are preliminary and should not be considered final. GeoEngineers' recommendations can be finalized only by observing actual subsurface conditions revealed during construction. GeoEngineers cannot assume responsibility or liability for the recommendations in this report if we do not perform construction observation.

We recommend that you allow sufficient monitoring, testing and consultation during construction by GeoEngineers to confirm that the conditions encountered are consistent with those indicated by the explorations, to provide recommendations for design changes if the conditions revealed during the work differ from those anticipated, and to evaluate whether earthwork activities are completed in accordance with our recommendations. Retaining GeoEngineers for construction observation for this project is the most effective means of managing the risks associated with unanticipated conditions. If another party performs field observation and confirms our expectations, the other party must take full responsibility for both the observations and recommendations. Please note, however, that another party would lack our project-specific knowledge and resources.

A GEOTECHNICAL ENGINEERING OR GEOLOGIC REPORT COULD BE SUBJECT TO MISINTERPRETATION

Misinterpretation of this report by members of the design team or by contractors can result in costly problems. GeoEngineers can help reduce the risks of misinterpretation by conferring with appropriate members of the design team after submitting the report, reviewing pertinent elements of the design team's plans and specifications, participating in pre-bid and pre-construction conferences, and providing construction observation.

DO NOT REDRAW THE EXPLORATION LOGS

Geotechnical engineers and geologists prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. The logs included in a geotechnical engineering or geologic report should never be redrawn for inclusion in architectural or other design drawings. Photographic or electronic reproduction is acceptable, but separating logs from the report can create a risk of misinterpretation.

GIVE CONTRACTORS A COMPLETE REPORT AND GUIDANCE

To help reduce the risk of problems associated with unanticipated subsurface conditions, GeoEngineers recommends giving contractors the complete geotechnical engineering or geologic report, including these "Report Limitations and Guidelines for Use." When providing the report, you should preface it with a clearly written letter of transmittal that:

- Advises contractors that the report was not prepared for purposes of bid development and that its accuracy is limited; and
- Encourages contractors to conduct additional study to obtain the specific types of information they need or prefer.

CONTRACTORS ARE RESPONSIBLE FOR SITE SAFETY ON THEIR OWN CONSTRUCTION PROJECTS

Our geotechnical recommendations are not intended to direct the contractor's procedures, methods, schedule, or management of the work site. The contractor is solely responsible for job site safety and for managing construction operations to minimize risks to on-site personnel and adjacent properties.

BIOLOGICAL POLLUTANTS

GeoEngineers' Scope of Work specifically excludes the investigation, detection, prevention, or assessment of the presence of Biological Pollutants. Accordingly, this report does not include any interpretations, recommendations, findings, or conclusions regarding the detecting, assessing, preventing or abating of Biological Pollutants, and no conclusions or inferences should be drawn regarding Biological Pollutants as they may relate to this project. The term "Biological Pollutants" includes, but is not limited to, molds, fungi, spores, bacteria, and viruses, and/or any of their byproducts.

A Client that desires these specialized services is advised to obtain them from a consultant who offers services in this specialized field.

INFORMATION PROVIDED BY OTHERS

GeoEngineers has relied upon certain data or information provided or compiled by others in the performance of our services. Although we use sources that we reasonably believe to be trustworthy, GeoEngineers cannot warrant or guarantee the accuracy or completeness of information provided or compiled by others.

Drawdown Analysis

Drawdown Analysis

Required Drawdown Time

Infiltration Basin	Bottom Area (sf)	100-Year Storage (cf)	Infiltration Rate (in/hr)	Drawdown Time (hr)
1	2423.03	23518.47	2.0	58.2
2	2186.81	11700.55	2.0	32.1

NRCS Web Soil Infiltration Data

NRCS Web Soil Map Symbol and Soil Name	Ksat rv (micro m/sec)	Ksat rv (in/hr)	Safety Factor (0.5)	Design Infiltration Rate
254B—Merrimac fine sandy loam, 3 to 8 percent slopes				
Merrimac	100	14.17	0.5	7.085
	100	14.17	0.5	7.085
	100	14.17	0.5	7.085
	100	14.17	0.5	7.085
430B—Barnstable sandy loam, 3 to 8 percent slopes				
Barnstable	28.23	4.00	0.5	2.000
	28.23	4.00	0.5	2.000
	91.74	13.00	0.5	6.500
431C—Barnstable sandy loam, 8 to 15 percent slopes, very stony				
Barnstable	28.23	4.00	0.5	2.000
	28.23	4.00	0.5	2.000
	91.74	13.00	0.5	6.500

Design Infiltration Rate = 2.0 in/hr

Recharge Volume

Recharge Volume Calculations

Proposed Impervious Surface Summary

Infiltration Basin	HSG	Area (sf)	Recharge Depth (in)	Required Volume (cf)	Provided Volume (cf)
1	A	31145.40	0.60	1557.27	25382.74
2	A	27007.20	0.60	1350.36	13126.86
Existing Catch Basin	A	13939.20	0.60	696.96	0.00

Total Required Recharge Volume = 3604.59 cf
Total Provided Recharge Volume = 38509.60 cf

Provided Storage Volumes

	Depth (ft)	Area (sf)	Cumulative Volume (cf)
Forebay 1	0.00	41.13	0.00
	1.00	185.44	113.29
	2.00	405.49	408.76
	3.00	708.15	965.58

	Depth (ft)	Area (sf)	Cumulative Volume (cf)
Forebay 2	0.00	880.04	0.00
	1.00	1189.50	1034.77
	2.00	1635.09	2447.07
	3.00	2123.92	4326.58
	4.00	2526.00	6651.54

	Depth (ft)	Area (sf)	Cumulative Volume (cf)
Forebay 1-2	0.00	96.00	0.00
	1.00	264.00	180.00
	2.00	504.00	564.00
	3.00	816.00	1224.00
	3.50	999.00	1677.75
	4.00	1200.00	2227.50

	Depth (ft)	Area (sf)	Cumulative Volume (cf)
Basin-1	0.00	2401.32	0.00
	1.00	3024.34	2712.83
	2.00	3828.08	6139.04
	3.00	4718.62	10412.39
	4.00	5693.33	15618.37
	5.00	6754.28	21842.18
	5.50	7407.96	25382.74
	6.00	8166.38	29276.33

	Depth (ft)	Area (sf)	Cumulative Volume (cf)
Basin-2	0.00	2186.80	0.00
	1.00	2944.52	2565.66
	2.00	3920.59	5998.22
	3.00	5001.46	10459.24
	3.50	5669.00	13126.86
	4.00	6188.64	16091.27

	Depth (ft)	Area (sf)	Cumulative Volume (cf)
Existing Catch Basin	0.00	974.38	0.00
	1.00	2524.45	1749.42
	2.00	4602.46	5312.88
	3.00	6308.57	10768.40
	4.00	7605.38	17725.38
	5.00	8399.21	25727.68
	6.00	9117.86	34486.21
	7.00	9840.94	43965.61
	8.00	10576.98	54174.57
	9.00	11329.31	65127.72
	10.00	12097.94	76841.35

Attachment E - Standard 4 Supporting Information

Long-Term Pollution Prevention Plan

Water Quality Volume Calculations

TSS Removal Work Sheet

Nitrogen Loading Calculations

Long – Term Pollution Prevention Plan

This Long-Term Pollution Prevention Plan has been developed to establish site management practices that improve the quality of stormwater discharges from the Project.

Pollutant Control Approach

Standard Gravel Areas

Gravel area maintenance involves regular raking to redistribute stones, removing debris with a leaf blower, and replenishing aggregate every 2–4 years to fix sinking or bare spots. For longevity, ensure proper drainage with a crown, clean debris from edges, and remove sediment to prevent clogging. Maintain Proper Grading on roads with a 3% grade to shed water and reduce erosion and sediment runoff.

Key Maintenance Activities:

- **Raking & Leveling:** Regularly rake in ruts and maintain a level surface, especially in high-traffic areas.
- **Debris Removal:** Use a leaf blower or rake to remove leaves and debris, preventing decomposition that creates soil for weeds.
- **Replenishing:** Top off gravel every 2-4 years as it settles or sinks into the ground.
- **Weed Management:** Pull weeds regularly and apply mulch glue or similar products to help keep gravel in place and reduce weed growth.
- **Drainage & Erosion Control:** Ensure the area has a slight slope (crown) to prevent standing water. Inspect for erosion and fill in low spots with clean, washed stone.
- **Edge Maintenance:** Clean edges to maintain a clear boundary.

O&M for Specific Gravel Uses:

- **Gravel Driveways:** Use a rake or land plane to keep the surface level and remove potholes. Maintain 3% grade to promote sheet flow and avoid erosion and sedimentation.
- **Pervious Gravel Areas:** Remove sediment that clogs voids to maintain infiltration. If clogged, remove the top layer of rock to wash or replace it.

Maintenance of Vegetated Areas

Proper maintenance of vegetated areas can prevent the pollution of stormwater runoff by controlling the source of pollutants such as suspended sediments, excess nutrients, and chemicals from landscape care products. Practices that should be followed under the regular maintenance of the vegetated landscape include:

- Inspect vegetated areas on a semi-annual basis and remove any litter.
- Maintain vegetated areas adjacent to pavement to prevent soil washout.

- Immediately clean any soil deposited on pavement.
- Re-seed bare areas; install appropriate erosion control measures when native soil is exposed or erosion channels are forming.

Management of Snow and Ice

Storage and Disposal

Snow shall be stockpiled on standard pavement surfaces so sand and salt may be swept in the spring or removed as snow melts and drains through the stormwater management system. Key practices for the safe storage and disposal of snow include:

- Under no circumstances shall snow be disposed or stored in wetland resource areas.
- Under no circumstances shall snow be disposed or stored in stormwater basins, ponds, rain gardens, swales, channels, or trenches.

Salt and Deicing Chemicals

The amount of salt and deicing chemicals to be used on the site shall be reduced to the minimum amount needed to provide safe pedestrian and vehicle travel. The following practices should be followed to control the amount of salt and deicing

materials that come into contact with stormwater runoff:

- Devices used for spreading salt and deicing chemicals should be capable of varying the rate of application based on the site specific conditions.
- Sand and salt should be stockpiled under covered storage facilities that prevent precipitation and adjacent runoff from coming in contact with the deicing materials

Spill Prevention and Response Plan

Initial Notification

In the event of a spill the facility and/or construction manager or supervisor will be notified immediately.

Facility Manager (name): Joseph Bruno

Construction Manager (name): Bill Rodgers

The designated Site Representative shall promptly notify emergency response personnel, including the Fire Department, as appropriate based on the nature and severity of the incident. Additional notifications to local authorities, including the Police Department, Health Department, and Conservation Commission, shall be made as necessary and in accordance with applicable regulatory requirements.

Emergency contact information for facility personnel, contractors, and response agencies shall be maintained on-site and updated prior to construction and facility operation

Further Notification

Based on the nature, size, and potential environmental impact of the spill or release, additional notifications may be made to appropriate local, state, and federal agencies, as well as qualified cleanup contractors and emergency response personnel.

Applicable regulatory notifications may include the Massachusetts Department of Environmental Protection (MassDEP), the National Response Center (NRC), and other agencies as required by law or permit conditions. Emergency response personnel and the designated Site Representative shall coordinate response actions and determine appropriate cleanup and reporting measures based on site conditions and regulatory requirements.

Emergency contact information shall be maintained at the site office and made readily accessible to project personnel during construction and facility operations. Spill incidents and corrective actions shall be documented and maintained as part of the project records, and spill reporting forms shall be completed as necessary.

Hazardous Waste / Oil Spill Report

Date: ____/____/_____ Time: _____ AM / PM

Exact location _____

Type of equipment:_____ Make:_____ Size:_____

License or S/N:_____ Weather Conditions:_____

On or near water ☐ Yes If yes, name of body of water:_____

☐ No

Type of chemical / oil spilled: _____

Amount of chemical / oil spilled: _____

Cause of spill: _____

_____

_____

Measures taken to contain or clean up spill: _____

_____

_____

Amount of chemical / oil recovered: _____ Method:_____

Material collected as a result of clean up

_____ drums containing: _____

_____ drums containing: _____

_____ drums containing: _____

Location and method of debris disposal:_____

Name and address of any person, firm, or corporation suffering damages:_____

_____

Procedures, method, and precautions instituted to prevent a similar occurrence from recurring: :_____

_____

Spill reported to General Office by:_____Time: _____AM / PM

Spill reported to DEP / National Response Center by:_____

DEP Date: ____/____/_____ Time:_____AM / PM Inspector:_____

NRC Date: ____/____/_____ Time:_____AM / PM Inspector: _____

Additional comments: _____

_____

Emergency Notification Phone Numbers

1. FACILITY MANAGER NAME: Joseph Bruno ALERNATE CONTACT: William Rogers	PHONE: 508-938-7710 CELL: 617-281-3984 PHONE: 508-699-5471 CELL: 781-844-2725
2. FIRE AND POLICE DEPARTMENT	EMERGENCY: 911
3. CLEANUP CONTRACTOR: TBD ADDRESS: _____ _____	PHONE: TBD
4. STATE DEPARTMENT OF ENVIRONMENTAL PROTECTION (DEP)/ DEPARTMENT OF ENVIRONMENTAL SERVICES (DES)	EMERGENCY PHONE: 508-946-2700
5. NATIONAL RESPONSE CENTER U.S ENVIRONMENTAL PROTECTION AGENCY: REGION 1	PHONE: (800) 424-8802 PHONE: 1-888-372-7341
6. BARNSTABLE HEATH DEPARTMENT BARNSTABLE CONSERVATION COMISSION:	PHONE: 508-862-4644 PHONE: 508-362-3828

Assessment – Initial Containment

- The supervisor or manager will assess the incident and initiate containment
- control measures with the appropriate spill containment equipment included in the spill kit kept on-site. A list of recommended spill equipment to be kept on site is included on the following page.
- Fire / Police Department: 911
- Municipality Health Department: (508) 862-4644
- Municipality Conservation Commission: (508) 862-4093

Stormwater Operation and Maintenance Plan

Project Information

Cape Cod Canal Pipeline Replacement Project

Site

Mainline Sagamore MR Station

Owner

Algonquin Gas Transmission, LLC

Site Supervisor

Name: Joseph Bruno (Area Manager) & William Rogers (Area Supervisor)

PHONE: 508-938-7710 & 508-699-5471

CELL: 617-281-3984 & 781-844-2725

Email: Joseph.Bruno@enbridge.com & William.Rogers@enbridge.com

Description of Stormwater Maintenance Measures

The following Operation and Maintenance (O&M) program is proposed to ensure the continued effectiveness of the stormwater management system. Attached to this plan are a Stormwater Best Management Practices Checklist and Maintenance Figure for use during the long term operation and maintenance of the stormwater management system.

The long term O&M of the stormwater management system is estimated to cost approximately $20,000 annually.

Grass Swales

Grass swales shall be inspected semi-annually and after storm events exceeding 1 inch of rainfall. Swales shall be maintained to ensure proper flow conveyance without erosion or standing water. Sediment and debris shall be removed as needed to maintain design capacity. Vegetation shall be mowed and maintained to promote uniform flow and infiltration. Eroded areas shall be repaired and stabilized.

Sediment Forebays

Sediment forebays shall be inspected semi-annually and after major storm events. Accumulated sediment shall be removed when it reaches 50% of the design storage capacity or as needed to maintain function. Inlet and outlet structures shall be checked for blockages or damage. Removed sediment shall be disposed of in accordance with applicable regulations.

Infiltration Basin

The infiltration basin shall be inspected semi-annually and after storm events exceeding 1 inch of rainfall. The basin shall be maintained to ensure proper infiltration, including removal of accumulated sediment, trash, and debris. Sediment shall be removed when accumulation exceeds 3 inches. The basin shall be evaluated if standing water persists longer than 72 hours, and corrective actions shall be implemented as needed. Vegetation shall be maintained to ensure proper function.

Inspections and Cleaning

A routine inspection and maintenance program shall be implemented in accordance with the Massachusetts Stormwater Management Standards (310 CMR 10.00). Inspection records shall include the date, inspector name, observations, and corrective actions taken. Maintenance activities, including sediment removal and repairs, shall be documented and retained on-site or made available upon request. Any deficiencies identified during inspections shall be corrected in a timely manner to ensure continued compliance.

Long Term Best Management Practices – Maintenance / Evaluation Checklist

Best Management Practices	Inspection Frequency	Date	Inspector	Minimum Maintenance and Key items to check	Cleaning/Repair needed	Date of Cleaning/ Repair	Preformed by:

Stormwater Control Manager: _____

Water Quality Volume Calculations

Water Quality Volume Calculations

Storage Volume Summary

Forebay	Treatment Depth (in)	Impervious Area (Acres)	Required Volume (cf)	Provided Volume (cf)
1	0.10	0.72	263.09	582.00
2	0.10	0.61	219.72	1034.77
3	0.10	0.43	157.54	180.00

Min. Storage Volume = 0.1-inch per impervious acre tributary to BMP (per Volume 2, Chapter 2, p.13 of the 2008 MA DEP Stormwater Management Handbook)

Basin	Treatment Depth (in)	Impervious Area (Acres)	Required Volume (cf)	Provided Volume (cf)
1	1.00	0.72	2630.86	25275.27
2	1.00	0.61	2197.17	13014.01
3	1.00	0.43	1575.44	0.00

Provided Storage Volumes

	Depth (ft)	Area (sf)	Cumulative Volume (cf)
Forebay 1	0.00	105.00	0.00
	1.00	273.00	189.00
	2.00	513.00	582.00
	3.00	825.00	1251.00

	Depth (ft)	Area (sf)	Cumulative Volume (cf)
Forebay 2	0.00	880.04	0.00
	1.00	1189.50	1034.77
	2.00	1635.09	2447.07
	3.00	2123.92	4326.58
	4.00	2526.00	6651.54

	Depth (ft)	Area (sf)	Cumulative Volume (cf)
Forebay 3	0.00	96.00	0.00
	1.00	264.00	180.00
	2.00	504.00	564.00
	3.00	816.00	1224.00
	3.50	999.00	1677.75
	4.00	1200.00	2227.50

	Depth (ft)	Area (sf)	Cumulative Volume (cf)
Basin-1	0.00	2423.03	0.00
	1.00	3003.19	2713.11
	2.00	3797.19	6113.30
	3.00	4689.52	10356.65
	4.00	5678.85	15540.84
	5.00	6762.81	21761.67
	5.50	7291.58	25275.27
	6.00	7833.62	29056.57

	Depth (ft)	Area (sf)	Cumulative Volume (cf)
Basin-2	0.00	2186.81	0.00
	1.00	2898.37	2542.59
	2.00	3881.89	5932.72
	3.00	5026.84	10387.08
	3.50	5480.88	13014.01
	4.00	6190.01	15931.73

	Depth (ft)	Area (sf)	Cumulative Volume (cf)
Existing Dry Basin	0.00	974.38	0.00
	1.00	2524.45	1749.42
	2.00	4602.46	5312.88
	3.00	6308.57	10768.40
	4.00	7605.38	17725.38
	5.00	8399.21	25727.68
	6.00	9117.86	34486.21
	7.00	9840.94	43965.61
	8.00	10576.98	54174.57
	9.00	11329.31	65127.72
	10.00	12097.94	76841.35

TSS Removal Worksheets

INSTRUCTIONS:
1. In BMP Column, click on Blue Cell to Activate Drop Down Menu
2. Select BMP from Drop Down Menu
3. After BMP is selected, TSS Removal and other Columns are automatically completed.

Version 1, Automated: Mar. 4, 2008

Location: Barnstable County - Drainage Area A1

TSS Removal Calculation Worksheet

B BMP[1]	C TSS Removal Rate[1]	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
Grass Channel	0.50	1.00	0.50	0.50
Sediment Forebay	0.25	0.50	0.13	0.38
Infiltration Basin	0.80	0.38	0.30	0.08
	0.00	0.08	0.00	0.08
	0.00	0.08	0.00	0.08

Total TSS Removal = 93%

Separate Form Needs to be Completed for Each Outlet or BMP Train

Project: MASS DOT Canal Bridges Relocation
Prepared By: Drake Trawhon
Date: 6/18/2026

*Equals remaining load from previous BMP (E) which enters the BMP

Non-automated TSS Calculation Sheet must be used if Proprietary BMP Proposed
1. From MassDEP Stormwater Handbook Vol. 1

INSTRUCTIONS:
1. In BMP Column, click on Blue Cell to Activate Drop Down Menu
2. Select BMP from Drop Down Menu
3. After BMP is selected, TSS Removal and other Columns are automatically completed.

Version 1, Automated: Mar. 4, 2008

Location: Barnstable County - Drainage Area A1-2

TSS Removal Calculation Worksheet

B BMP[1]	C TSS Removal Rate[1]	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
Grass Channel	0.50	1.00	0.50	0.50
Sediment Forebay	0.25	0.50	0.13	0.38
Extended Dry Detention Basin	0.50	0.38	0.19	0.19
	0.00	0.19	0.00	0.19
	0.00	0.19	0.00	0.19

Total TSS Removal = 81%

Separate Form Needs to be Completed for Each Outlet or BMP Train

Project: MASS DOT Canal Bridges Relocation
Prepared By: Drake Trawhon
Date: 6/18/2026

*Equals remaining load from previous BMP (E) which enters the BMP

Non-automated TSS Calculation Sheet must be used if Proprietary BMP Proposed
1. From MassDEP Stormwater Handbook Vol. 1

INSTRUCTIONS:
1. In BMP Column, click on Blue Cell to Activate Drop Down Menu
2. Select BMP from Drop Down Menu
3. After BMP is selected, TSS Removal and other Columns are automatically completed.

Version 1, Automated: Mar. 4, 2008

Location: Barnstable County - Drainage Area A2

TSS Removal Calculation Worksheet

B BMP[1]	C TSS Removal Rate[1]	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
Grass Channel	0.50	1.00	0.50	0.50
Sediment Forebay	0.25	0.50	0.13	0.38
Infiltration Basin	0.80	0.38	0.30	0.08
	0.00	0.08	0.00	0.08
	0.00	0.08	0.00	0.08

Total TSS Removal = 93%

Separate Form Needs to be Completed for Each Outlet or BMP Train

Project: MASS DOT Canal Bridges Relocation
Prepared By: Drake Trawhon
Date: 6/18/2026

*Equals remaining load from previous BMP (E) which enters the BMP

Non-automated TSS Calculation Sheet must be used if Proprietary BMP Proposed
1. From MassDEP Stormwater Handbook Vol. 1

Nitrogen Loading Calculations

NITROGEN LOADING CALCULATION

Based on Cape Cod Commission Technical Bulletin 91-001 (April 1992)

SECTION 1 — INPUT DATA

Property Information

Parameter	Description	Value	Units		Source / Notes	
Property Name	Project ID	Sagamore M&R	—		Source: Project data	
Town / Municipality	Cape Cod Commission town	Bourne	—		TB 91-001 Table 1	
Target NO_3-N Conc.	Max allowable concentration	**5**	ppm		TB 91-001, Section B.1	

Site Areas (Editable Inputs — Blue)

Surface Type	Description	Area (ft²)	Area (acres)		Notes	
Gravel Area	Impervious — site runoff	**61,929**	1.422		Source: Site plan	
Paved Area	Impervious — road runoff	**0**	0.000		Source: Site plan	
Pervious Area	Natural — recharge only	**107,441**	2.467		Source: Site plan	
Roof Area	Impervious — roof runoff	**1,494**	0.034		Enter if applicable	
Lawn Area	Fertilized turf	**0**	0.000		Enter if applicable	
TOTAL SITE AREA		**170,864**	**3.923**		**ft²**	

CCC Standard Parameters (per Technical Bulletin 91-001)

Parameter	Value	Units			Source	
Recharge — Impervious surfaces	**40**	in/yr			TB 91-001, Section B.5	
Recharge — Natural (Bourne)	**21**	in/yr			TB 91-001, Table 1	
NO_3-N conc. — Road/Gravel runoff	**1.5**	ppm			TB 91-001, Section B.5	
NO_3-N conc. — Roof runoff	**0.75**	ppm			TB 91-001, Section B.5	
NO_3-N conc. — Wastewater	**35**	ppm			TB 91-001, Section B.2	
Fertilizer application rate	**3**	lbs N/1000 ft²/yr			TB 91-001, Section B.4	
Fertilizer leaching rate	**0.25**	%			TB 91-001, Section B.4	
Unit conversion — L per ft³	**28.32**	L/ft³			Standard conversion	
Unit conversion — days per year	**365**	d/yr			Standard	
Unit conversion — ft per inch	0.083333333	ft/in			Standard	
mg per lb	**454000**	mg/lb			Standard	

SECTION 2 — MASS BALANCE CALCULATIONS

Surface / Source	Area or Flow	Units	Flow (L/d)	Conc. (mg/L)	Load (mg/d)	Notes
A. Impervious Surfaces						
Gravel Area	61929	ft²	16,016.71	1.50	24,025.06	Road runoff @ 1.5 ppm
Paved Area	0	ft²	0.00	1.50	0.00	Road runoff @ 1.5 ppm
Roof Area	1494	ft²	386.39	0.75	289.80	Roof runoff @ 0.75 ppm
Subtotal — Impervious			**16,403.10**	**—**	**24,314.85**	
B. Natural / Pervious Area (contributes to denominator only — N load = 0)						
Natural Area	107441.45	ft²	14,588.49	0.00	0.00	N load ignored per TB 91-001 B.5
C. Lawn Areas						
Lawn Area	0	ft²	0.00	N/A	0.00	3 lbs/1000ft²/yr × 25% leaching
D. Wastewater						
Wastewater Flow	0	L/d	0.00	35.00	0.00	Enter Title 5 flow (L/d) in col B

SECTION 3 — SUMMARY & RESULT

Component		Flow (L/d)		Load (mg/d)		
Impervious Surfaces (Gravel + Paved + Roof)		16,403.10		24,314.85		
Natural / Pervious Areas		14,588.49		0.00		
Lawn Areas		0.00		0.00		
Wastewater		0.00		0.00		
TOTAL		**30,991.59**		**24,314.85**		

Calculated NO_3-N Concentration	**0.78 ppm**	**ppm NO_3-N**
Target Concentration	**5.0 ppm**	**ppm NO_3-N (max)**
COMPLIANCE STATUS		**✓ COMPLIES — Below Target**

Attachment F - Standard 8 Supporting Information

Enbridge Standard Erosion and Sediment Control Plan Narrative

Site Specific Erosion and Sediment Control Plan

Enbridge Standard Erosion and Sediment Control Plan Narrative

Construction of the Mainland Sagamore Meter Station will be conducted in a manner that minimizes erosion, sedimentation, and off-site transport of disturbed soils. Erosion and sediment control measures will be installed prior to the commencement of earth-disturbing activities and will be maintained throughout construction until final stabilization is achieved.

Construction activities will be sequenced to limit the extent and duration of exposed soils to the maximum extent practicable. Clearing, grading, excavation, and fill operations will be performed in a controlled manner, and disturbed areas will be stabilized as soon as practicable following completion of construction activities.

Temporary erosion and sediment control measures will be implemented to intercept, contain, and manage stormwater runoff from disturbed areas during construction. These measures will be installed and maintained in accordance with the project plans, applicable permit requirements, and Algonquin Gas Transmission, LLC and Enbridge environmental construction procedures.

Routine inspections will be conducted during active construction to verify that erosion and sediment control measures remain functional and effective. Damaged, displaced, or ineffective controls will be repaired, replaced, or supplemented as necessary. Accumulated sediment will be removed from control measures when required to maintain their intended performance.

Temporary construction-related stormwater management practices, material storage areas, equipment staging areas, and concrete washout facilities will be managed to prevent sediment discharge and minimize impacts to adjacent properties, drainage features, wetlands, and other environmentally sensitive resources.

Upon completion of construction, all disturbed areas not required for permanent operations will be restored and stabilized through establishment of permanent vegetative cover or other approved stabilization methods. Temporary erosion and sediment control measures will remain in place until final stabilization has been achieved and the potential for erosion and sediment transport has been minimized.

The project will be constructed in accordance with the approved Erosion and Sediment Control Plan, applicable federal, state, and local requirements, and the environmental commitments applicable to the Cape Cod Canal Bridge Replacement Project.

Erosion and Sedimentation Control Measures

The following erosion and sedimentation controls were selected based on existing and proposed site conditions for use during the earthwork and construction phases of the project. In addition to those outlined below, additional practices are included in Enbridge's Standard Erosion and Sediment Control Manual.

Silt Fence/Straw Wattle

Straw wattle barriers will be placed to trap sediment transported by runoff before it reaches the drainage system or leaves the construction site. In areas where high runoff velocities or high sediment loads are expected, straw wattles will be backed up with silt fencing. This semipermeable barrier made of a synthetic porous fabric will provide additional protection. The silt fence and straw wattle barrier will be replaced as determined by periodic field inspections.

Catch Basin Protection

Newly constructed and existing nearby catch basins will be protected with silt sacks throughout construction.

Concrete Wash Area

The best management practice objectives for concrete washout are to (a) collect and retain all the concrete washout water and solids in leak proof containers, so that this caustic material does not reach the soil surface and then migrate to surface waters or into the ground water, and (b) recycle 100 percent of the collected concrete washout water and solids. Another objective is to support the diversion of recyclable materials from landfills.

Concrete washout facilities should be inspected daily and after heavy rains to check for leaks, identify any plastic linings and sidewalls have been damaged by construction activities, and determine whether they have been filled to over 75 percent capacity. When the washout container is filled to over 75 percent of its capacity, the washwater should be vacuumed off or allowed to evaporate to avoid overflows. Then when the remaining cementitious solids have hardened, they should be removed and recycled. Damages to the container should be repaired promptly. Before heavy rains, the washout container's liquid level should be lowered or the container should be covered to avoid an overflow during the rain storm.

Temporary Diversion Channels

Diversion channels will be used to collect runoff from construction areas and discharge to either sedimentation basins or protected catch basin inlets.

Vegetative Slope Stabilization

Stabilization of open soil surfaces will be implemented within 14 days after grading or construction activities have temporarily or permanently ceased, unless there is sufficient snow cover to prohibit implementation. Vegetative slope stabilization will be used to minimize erosion on slopes of 3:1 or flatter. Annual grasses, such as annual rye, will be used to ensure rapid germination and production of root mass. Permanent stabilization will be completed with the planting of perennial grasses or legumes. Establishment of temporary and permanent vegetative cover may be established by hydro-seeding or sodding. A suitable topsoil, good seedbed preparation, and

adequate lime, fertilizer and water will be provided for effective establishment of these vegetative stabilization methods. Mulch will also be used after permanent seeding to protect soil from the impact of falling rain and to increase the capacity of the soil

Maintenance

- The contractor or subcontractor will be responsible for implementing each control shown on the Sedimentation and Erosion Control Plan. In accordance with EPA regulations, the contractor must sign a copy of a certification to verify that a plan has been prepared and that permit regulations are understood.
- The on-site contractor will inspect all sediment and erosion control structures periodically and after each rainfall event. Records of the inspections will be prepared and maintained on-site by the contractor.
- Silt shall be removed from behind barriers if greater than 6-inches deep or as needed.
- Damaged or deteriorated items will be repaired immediately after
- identification.
- The underside of straw wattles should be kept in close contact with the earth and reset as necessary.
- Sediment that is collected in structures shall be disposed of properly and covered if stored on-site.
- Erosion control structures shall remain in place until all disturbed earth has been securely stabilized. After removal of structures, disturbed areas shall be regraded and stabilized as necessary.

Construction Best Management Practices - Maintenance/Evaluation Checklist

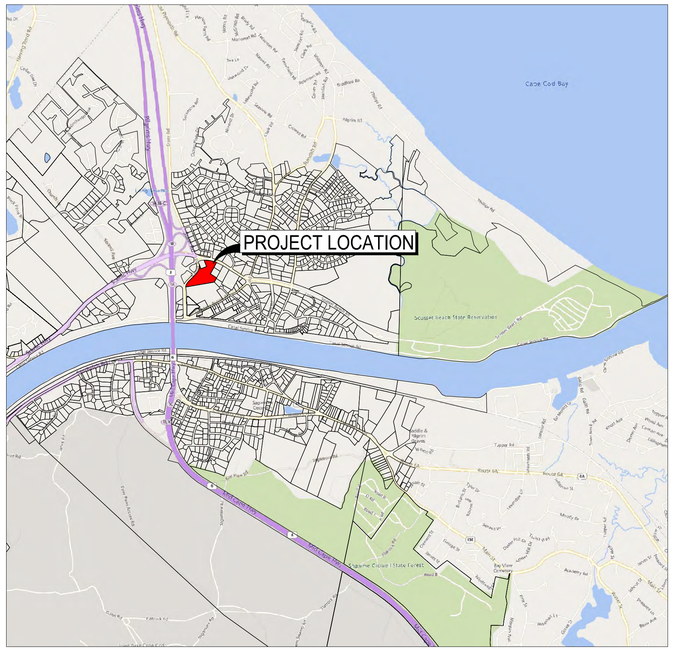
Best Management Practice	Inspection Frequency	Date Inspected	Inspector	Minimum Maintenance and Key Items to Check	Cleaning/Repair Needed ☐ yes ☐ no	Date of Cleaning/Repair	Performed by:
					☐ yes ☐ no		
					☐ yes ☐ no		
					☐ yes ☐ no		
					☐ yes ☐ no		
					☐ yes ☐ no		
					☐ yes ☐ no		
					☐ yes ☐ no		

Stormwater Control Manager _____

CAPE COD CANAL PIPELINE RELOCATION PROJECT
SAGAMORE M&R
STATION RELOCATION PROJECT
M&R 00051
BARNSTABLE COUNTY, MASSACHUSETTS
2026

DATE	ISSUE	APPROVALS				
		LEAD DFRS.	SECT. SUPV.	PROJ. ENG./ DESIGN ENG.	PROJ. MGR./ DESIGN MGR.	PROJECT DIRECTOR
06/18/2026	☒ ISSUED FOR PERMIT	CR	DT	PB	AC	
05/15/2026	☒ ISSUED FOR BID	CR	DT	PB	AC	

DWG. NO.	DRAWING TITLE
	CIVIL DRAWINGS
00051-C.015-0002	EROSION & SEDIMENT COVER SHEET
00051-C.020-0001	EROSION & SEDIMENT GENERAL NOTES
00051-C.320-0001	EXISTING CONDITIONS PLAN
00051-C.320-0002	EXISTING SUBCATCHMENT AREAS PLAN
00051-C.320-0003	PROPOSED SITE LAYOUT PLAN
00051-C.301-0001	GRADING PLAN
00051-C.301-0002	CIVIL ACCESS ROAD PLAN
00051-C.301-0003	CIVIL GRADING SECTIONS AND DETAILS
00051-C.320-0004	PROPOSED SUBCATCHMENT AREAS PLAN
00051-C.320-0005	CONSTRUCTION EROSION AND SEDIMENT CONTROL PLAN
00051-C.320-0006	DETAILS
00051-C.320-0007	DETAILS



VICINITY MAP

EXHIBIT A

SRO NO. XXXX

PLANT W.O. NO.

PIPELINE W.B.S. NO. 30002835

YEAR 2026

ENBRIDGE

Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
No. 58957
PROFESSIONAL ENGINEER

06/24/26

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		C	06/18/26	CR	DT	ISSUED FOR PERMIT
		B	05/15/26	CR	DT	ISSUED FOR BID
		A	05/15/26	CR	DT	ISSUED FOR PERMIT

audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

DRAWN BY:	CR	05/01/26	CAPE COD CANAL PIPELINE RELOCATION PROJECT SAGAMORE METER STATION M&R 00051
DESIGN CHECKER:	DT	06/18/26	
DESIGN ENGINEER:	PB	06/18/26	TITLE: EROSION & SEDIMENT COVER SHEET
PROJECT MANAGER:	AC	06/18/26	LOC.: BARNSTABLE COUNTY, MASSACHUSETTS
TITLE	INITIALS	DATE	

YEAR: 2026 | W.O.: | SCALE: NTS | DWG.: 00051-C.015-0002 | REV.: C

ENBRIDGE
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

S:\AE\Projects\Enbridge\Mass\026356-001\200_Civil_Structural\170_Drawings\E&S Plans\Sagamore M&R\00051-C.015-0002.dwg - PLOT TIME: 6/18/2026 12:03 PM

SEDIMENTATION AND EROSION CONTROL NOTES

IT IS THE INTENT OF THE CONTRACT PLANS AND DETAILS TO CONTROL EROSION AND SEDIMENTATION IN ALL PORTIONS OF THE SITE. THE CONTRACTOR IS TO IMPLEMENT THE EROSION AND SEDIMENTATION CONTROLS INDICATED ON THE PLANS, IN ACCORDANCE WITH THE FOLLOWING NOTES, BUT IS ALERTED TO THE FACT THAT ADDITIONAL MEASURES MAY BE REQUIRED TO COMPLY WITH THIS INTENT, AS FIELD CONDITIONS MAY WARRANT. SHOULD SUCH MEASURES BE DETERMINED TO BE REQUIRED OR ORDERED BY THE ENGINEER, THEY ARE TO BE IMPLEMENTED IMMEDIATELY. IN ADDITION, THE CONTRACTOR SHALL PREPARE AND SUBMIT FOR ENGINEER'S REVIEW A STORMWATER POLLUTION PREVENTION PLAN (SWPPP) AND FILE A NOTICE OF INTENT WITH THE U.S. EPA AS REQUIRED UNDER THE NPDES CONSTRUCTION GENERAL PERMIT PROGRAM. A COPY OF THE SWPPP SHALL BE KEPT ON-SITE AT ALL TIMES AND UPDATED AS REQUIRED.

1. THE CONTRACTOR SHALL BE RESPONSIBLE FOR IMPLEMENTING EROSION CONTROL MEASURES IN ORDER TO PREVENT THE OFF-SITE TRACKING OF EARTH, SEDIMENT, AND DEBRIS; AND FOR GENERALLY CONTROLLING THE EROSION AND SEDIMENT TRANSPORT DURING THE CONSTRUCTION PROCESS. SITE SPECIFIC CONDITIONS MAY REQUIRE MODIFICATIONS IN THE FIELD, BUT THE CONTRACTOR MUST ENSURE THAT THAT MEASURES IMPLEMENTED IN THE FIELD MEET THE MINIMUM REQUIREMENTS OF THESE PLANS.
2. ALL WORK SHALL BE IN ACCORDANCE WITH THE CONTRACT DOCUMENTS, THE PROVISIONS OF ALL APPLICABLE PERMITS AND APPROVALS ISSUED BY LOCAL, STATE, AND FEDERAL REGULATION FOR ACTIVITIES INVOLVING WETLANDS, WATERCOURSES AND/OR EROSION CONTROLS. ALL EROSION AND SEDIMENTATION CONTROL MEASURES SHALL BE CONSTRUCTED IN ACCORDANCE WITH THE MASSACHUSETTS EROSION AND SEDIMENT CONTROL GUIDELINES FOR URBAN AND SUBURBAN AREAS, FEBRUARY 2008 AND THE MASSACHUSETTS STORMWATER HANDBOOK VOLUME 1, AS AMENDED.
3. THE CONTRACTOR IS RESPONSIBLE FOR THE INSTALLATION OF SILT FENCES, SILT SOCK, AND CHECK DAMS. SUCH PRACTICES DIVERT FLOWS FROM EXPOSED SOILS, LIMIT RUNOFF AND THE DISCHARGE OF POLLUTANTS FROM EXPOSED AREAS OF THE SITE TO THE DEGREE ATTAINABLE. TEMPORARY EROSION AND SEDIMENTATION CONTROL MEASURES SHALL BE INSTALLED PRIOR TO THE COMMENCEMENT OF ANY SITE WORK, SHALL BE MAINTAINED DURING CONSTRUCTION, AND SHALL REMAIN IN PLACE UNTIL ALL SITE WORK IS COMPLETED AND GROUND COVER IS ESTABLISHED BY NEW SEEDLINGS). (AT LEAST 751 UNIFORM COVERAGE BY NEW SEEDLINGS).
4. IN GENERAL, WORK REQUIRING EROSION CONTROL INCLUDES EXCAVATIONS, FILLS, RETAINING WALLS, DRAINAGE, ROUGH AND FINISH GRADING, AND STOCKPILING OF EARTH.
5. AREAS SUBJECT TO EROSION SHALL BE MINIMIZED IN TERMS OF TIME AND AREA. DO NOT DISTURB VEGETATION AND TOPSOIL BEYOND THE PROPOSED LIMIT OF SILT FENCE ACTIVITIES.
6. A STABILIZED CONSTRUCTION ENTRANCE SHALL BE INSTALLED AT ALL POINTS OF ACCESS TO THE SITE TO MINIMIZE TRACKING OF SEDIMENT ONTO PUBLIC ROADWAY.
7. EROSION CONTROL MEASURE SHALL BE INCORPORATED IN THE SEQUENCE OF CONSTRUCTION TO PREVENT SEDIMENT LADEN WATER FROM LEAVING THE SITE.
8. EARTHWORK ACTIVITY SHALL BE PERFORMED IN A MANNER SUCH THAT RUNOFF IS DIRECTED TO PERIMETER CONTROL. IN NO CASE SHALL RUNOFF FROM ROADWAYS OR OTHER AREAS, UPGRADIENT FROM EMBANKMENTS, BE ALLOWED TO RUN DOWN ANY CUT OR FILL SLOPE, WITHOUT THE APPROVAL OF THE ENGINEER.
9. THE CONTRACTOR SHALL, AT ALL TIMES, HAVE A STOCKPILE OF HAY BALES, SILT FENCE, CRUSHED STONE, AND CATCH BASIN FILTER BAGS ADEQUATE TO REINFORCE/REPLACE EROSION AND SEDIMENT CONTROLS AS NEEDED.
10. ALL EROSION AND SEDIMENTATION CONTROL MEASURES SHALL BE MAINTAINED IN EFFECTIVE CONDITION THROUGHOUT THE CONSTRUCTION PERIOD SO THAT ALL AREAS ARE STABILIZED TO PREVENT THE MOVEMENT OF SOIL, SILT, SEDIMENT AND DEBRIS INTO DRAINAGE SYSTEMS OR WATERWAYS ON AND NEAR CONSTRUCTION ACTIVITY. THE CONTRACTOR SHALL INSPECT THE EROSION CONTROLS DAILY AND CLEAN ACCUMULATED MATERIALS FROM BEHIND THEM, AS NECESSARY. ALL EROSION AND SEDIMENTATION CONTROL MEASURES FOUND TO BE IN NEED OF REPAIR OR REPLACEMENT SHALL BE IMMEDIATELY CORRECTED, SO AS TO MAINTAIN THE INTEGRITY OF THE EROSION AND SEDIMENTATION CONTROL SYSTEM.
11. IN ORDER TO MINIMIZE EROSION AND SEDIMENT RUNOFF FROM THE SITE, THE CONTRACTOR SHOULD MAINTAIN EXISTING VEGETATION WHERE POSSIBLE AND STABILIZE THE DISTURBED PORTIONS OF THE SITE AS QUICKLY AS POSSIBLE. THE CONTRACTOR SHALL PHASE CONSTRUCTION TO MINIMIZE THE AREA OF DISTURBED EARTH OPEN TO THE ELEMENTS AT ANY GIVEN TIME. THIS SHALL BE ACHIEVED BY THE FOLLOWING METHODS OR OTHER BEST MANAGEMENT PRACTICES (BMP's):
    A. LOAMING AND SEEDING CUT SLOPES IMMEDIATELY UPON COMPLETION OF SUBGRADE PREPARATION, AND SECURING SUCH NEWLY ESTABLISHED SLOPES WITH EROSION CONTROL NETTING AND/OR MULCH.
    B. PLACING AND COMPACTING PAVEMENT GRAVEL BASE AND SUB- BASE IMMEDIATELY UPON COMPLETION OF SUBGRADE PREPARATION.
    C. LIMITING STRIPPING AND STOCKPILING OF LOAM TO AREAS SLATED FOR IMMEDIATE CONSTRUCTION AND STABILIZATION (I.E. PLACEMENT OF GRAVELS, LOAM AND SEED, EROSION CONTROL MATTING).
12. THE CONTRACTOR MUST ALSO ANTICIPATE INCREASED RUNOFF FROM STEEPER SLOPES AND DURING HIGH GROUNDWATER CONDITIONS.THIS MAY OCCUR DURING THE WET SEASON (TYPICALLY MARCH THROUGH APRIL) OR AFTER SIGNIFICANT PRECIPITATION EVENTS.
13. SEDIMENT REMOVED FROM CONTROL STRUCTURES SHALL BE DISPOSED OF LEGALLY OFF SITE. NO EQUIPMENT OR MATERIAL OF ANY KIND SHALL BE STOCKPILED OR DEPOSITED IN ANY REGULATED AREA, UNLESS SPECIFICALLY SHOWN ON THE CONTRACT PLANS OR AUTHORIZED BY PROJECT PERMITS/APPROVALS.
14. STOCKPILED SOIL SHALL BE SURROUNDED WITH SILTATION FENCES TO PREVENT AND CONTROL SILTATION AND EROSION. STOCKPILES THAT WILL REMAIN EXPOSED FOR MORE THAN 30 DAYS, SHALL BE STABILIZED WITH MULCH OR SEEDED FOR TEMPORARY VEGETATIVE COVER.
15. TEMPORARY STORAGE OF MATERIALS ON-SITE SHALL BE LOCATED GREATER THAN 1OO-FEET FROM WETLAND AREAS, AND AS APPROVED BY THE ENGINEER. EROSION CONTROLS INSTALLED ALONG WETLAND RESOURCE AREAS SHALL DEFINE THE LIMIT OF WORK AND SHALL NOT BE CROSSED. THERE SHALL BE NO LONG-TERM STORAGE OF MATERIAL ON -SITE OR ON -ROUTE. MATERIAL NOT USED ON -SITE OR ON -ROUTE SHALL BE TRUCKED TO AN ACCEPTABLE OFF-SITE DISPOSAL LOCATION.
16. ALL DISTURBED SURFACES SHALL BE STABILIZED WITHIN 14 DAYS AFTER CONSTRUCTION IN ANY PORTION OF THE SITE THAT HAS BEEN COMPLETED OR WHERE CONSTRUCTION HAS TEMPORARILY CEASED.
17. ALL AREAS OF DISTURBANCE MUST HAVE TEMPORARY OR FINAL STABILIZATION WITH MULCH OR MULCH NETTING, OR SEEDED FOR TEMPORARY VEGETATIVE COVER, WITHIN 14 DAYS OF THE INITIAL DISTURBANCE. AFTER THIS TIME, ANY DISTURBANCE IN THE AREA MUST BE STABILIZED AT THE END OF EACH WORK DAY. THE FOLLOWING EXCEPTIONS APPLY:
    A. STABILIZATION IS NOT REQUIRED IF WORK IS TO CONTINUE IN THE AREA WITHIN THE NEXT 24 HOURS AND THERE IS NO PRECIPITATION FORECAST FOR THE NEXT 24 HOURS
    B. STABILIZATION IS NOT REQUIRED IF THE WORK IS OCCURRING IN A SELF-CONTAINED EXCAVATION WITH A DEPTH OF 2 FEET OR GREATER.
18. THERE SHALL BE NO DIRECT DISCHARGE FROM ANY REQUIRED DEWATERING OPERATIONS INTO ANY WETLAND, WATERCOURSE, OR DRAINAGE SYSTEM AND THEN ONLY AS ALLOWED BY REGULATORY PERMITS. ANY DEWATERING DISCHARGE CONTAINING SETTLEABLE SOLIDS (SEDIMENTS) SHALL BE PASSED THROUGH A SEDIMENTATION CONTROL BASIN, FRACTIONATION TANK OR SIMILAR TREATMENT, APPROVED BY THE ENGINEER, TO REMOVE THESE SOLIDS. CONTRACTOR SHALL MAINTAIN SAID SEDIMENT CONTROL DEVICES THROUGHOUT THE ENTIRE DEWATERING OPERATION AND SHALL CEASE DEWATERING, IF DEFICIENCIES ARE NOTED, UNTIL THE DEFICIENCIES ARE CORRECTED.
19. CULVERT/PIPE INLETS AND OUTFALLS SHALL BE STABILIZED WITH STONE FOR PIPE ENDS OR OTHER APPROVED PERMANENT EROSION CONTROL MEASURES, IMMEDIATELY FOLLOWING PIPE INSTALLATION.
20. THE CONTRACTOR SHALL INSPECT ALL PORTIONS OF THE SITE IN ANTICIPATION OF RAINFALL EVENTS TO DETERMINE IF SITE GRADING IS SUFFICIENT TO PREVENT EROSION OF SLOPES AND/OR THE TRANSPORTATION OF SEDIMENTS TO WETLANDS OR WATERCOURSES, WITHIN THE PROJECT LIMITS. SHOULD ADDITIONAL MEASURES BE REQUIRED, THEY ARE TO BE IMPLEMENTED IMMEDIATELY. IN NO CASE SHALL THE INSTALLATION OF ADDITIONAL MEASURES, NECESSARY TO PROTECT SLOPES WITHIN THE PROJECT LIMITS, BE DELAYED BEYOND THE COMMENCEMENT OF PRECIPITATION.
21. EROSION CONTROL MEASURES SHALL BE INSPECTED EVERY WEEK AND WITHIN 24-HOUR OF AN EVENT GREATER THAN 0.25 INCHES. ANY NECESSARY REPLACEMENT OF REPAIR SHALL BE PERFORMED PROMPTLY BY THE CONTRACTOR
22. ALL DISTURBED EARTH SLOPES SHALL BE STABILIZED WITH PERMANENT VEGETATIVE COVER AS SOON AS POSSIBLE. DISTURBED AREAS, THAT ARE NOT SUBJECT TO CONSTRUCTION TRAFFIC, SHALL RECEIVE A PERMANENT OR TEMPORARY VEGETATIVE COVER AS SOON AS FINAL CONTOURS ARE ESTABLISHED. IF THE SEASON PREVEINTS THE ESTABLISHMENT OF A VEGETATIVE COVER, DISTURBED AREAS SHALL BE THOROUGHLY MULCHED. MULCHED AREAS SHALL BE SEEDED AS SOON AS WEATHER CONDITIONS ALLOW.
23. ALL SLOPES STEEPER THAN 2H:1V SHALL BE COVERED WITH MODIFIED ROCKFILL AND AN APPROVED EROSION CONTROL MATTING.
24. CONTRACTOR SHALL REMOVE ALL SEDIMENTATION CONTROL SYSTEMS, REMOVE ALL ACCUMULATED SEDIMENTS, AND SEED THE DISTURBED AREAS, WHEN THE CONTROL SYSTEMS ARE NO LONGER REQUIRED. CONTRACTOR SHALL REQUEST AND RECEIVE PERMISSION FROM THE ENGINEER PRIOR TO REMOVING ANY CONTROL SYSTEM.
25. THE CONTRACTOR SHALL REMOVE AND DISPOSE OF ALL SILT AND DEBRIS RESULTING FROM CONSTRUCTION OPERATIONS FROM EACH DRAINAGE STRUCTURE UPON COMPLETION OF THE PROJECT.
26. OBJECTS AND/OR AREAS DAMAGED BY THE CONTRACTOR'S OPERATIONS SHALL BE RESTORED TO THEIR ORIGINAL CONDITION AND ELEVATION.
27. ALL DISTURBED AREAS NOT OCCUPIED BY PAVEMENT, SIDEWALK OR RIPRAP SHALL BE COVERED WITH 4" (MIN.) OF LOAM AND SEED.
28. PERMANENT SEEDING SHALL OCCUR BETWEEN MARCH 1 AND JUNE 15, OR BETWEEN AUGUST 15 AND OCTOBER 15.
29. THE CONTRACTOR SHALL MODIFY, REPAIR, OR INSTALL ADDITIONAL EROSION AND SEDIMENTATION CONTROL MEASURES AS NECESSARY TO PREVENT SEDIMENT FROM LEAVING THE SITE AT NO ADDITIONAL COST.

A. GENERAL CONSTRUCTION NOTES

1. SITE PREPARATION, GRADING AND DRAINAGE SHALL BE IN ACCORDANCE WITH THESE GENERAL NOTES, APPROVED CONSTRUCTION DRAWINGS AND PROJECT SPECIFICATIONS. FOR EARTHWORK REQUIREMENTS AND THE CONSTRUCTION OF STRUCTURAL SUBGRADES, IF IN CONFLICT WITH THESE GENERAL NOTES, THE GEOTECHNICAL REPORT SHALL GOVERN IN DETAILS.
2. CONTRACTOR SHALL COMPLY WITH OSHA REGULATIONS, STATE SPECIFIC LAWS AND COMPANY SAFETY STANDARDS AT ALL TIMES.
3. CONTRACTOR SHALL OBTAIN ALL REQUIRED PERMITS PRIOR TO STARTING CONSTRUCTION. CONTRACTOR SHALL HAVE A COPY OF ALL DRIVEWAY PERMITS ON SITE AT ALL TIMES DURING CONSTRUCTION OF DRIVES AND DRIVEWAY CULVERTS.
4. CONTRACTOR TO PROVIDE ALL MATERIAL NECESSARY FOR INSTALLATION.
5. ALL PROJECT MATERIALS OR FOR THE REPAIR OF EXISTING ELEMENTS SHALL BE NEW PRODUCTS AND FREE FROM DEFECTS PER PROJECT SPECIFICATIONS.
6. PRIOR TO BACKFILLING PONDS, CREEKS, DITCHES, OR OTHER RUNOFF CHANNELS, ALL ACCUMULATED SEDIMENT, ORGANIC MATERIAL, AND DEBRIS SHALL BE REMOVED AND DISPOSED OF AS DIRECTED BY THE COMPANY.
7. WASTE MATERIALS INCLUDING PAVEMENT REMOVED DURING CONSTRUCTION, WASTE PIPING AND SUPPLIES AND CONSTRUCTION DEBRIS SHALL BECOME THE PROPERTY OF THE CONTRACTOR AND SHALL BE REMOVED FROM THE PROJECT SITE AND DISPOSED OF PROPERLY BY THE CONTRACTOR.
8. EARTHWORK QUANTITIES SHOWN ARE APPROXIMATE AND ARE PROVIDED FOR INFORMATION PURPOSES ONLY. QUANTITIES DO NOT ACCOUNT FOR SHRINKAGE, SWELL (BULK) FACTORS, LOSS OF MATERIAL, OR REMOVAL/REPLACEMENT OF UNSUITABLE MATERIALS ENCOUNTERED IN THE FIELD. FOUNDATION AREAS WERE NOT ACCOUNTED FOR IN THE EARTHWORK ANALYSIS CALCULATION. THE CONTRACTOR SHALL VERIFY ALL QUANTITIES AND CONDITIONS PRIOR TO CONSTRUCTION.

B. UTILITIES, RIGHT-OF-WAY AND EASEMENTS

1. THE CONTRACTOR SHALL VERIFY THE LOCATIONS, ELEVATIONS AND DIMENSIONS OF ALL EXISTING UTILITIES, STRUCTURES, ETC. AFFECTING HIS WORK PRIOR TO CONSTRUCTION.
2. CONTRACTOR SHALL NOTIFY THE LOCAL JURISDICTIONAL AUTHORITY BEFORE ANY WORK IS WITHIN THE STREET RIGHT-OF-WAY OR EASEMENTS.
3. CONTRACTOR SHALL GIVE NOTICE TO ALL AUTHORIZED INSPECTORS, SUPERINTENDENTS AND PERSONS IN CHARGE OF PUBLIC AND PRIVATE UTILITIES AFFECTED BY HIS OPERATIONS PRIOR TO STARTING WORK.
4. CONTRACTOR SHALL VERIFY THE LOCATIONS OF EXISTING UNDERGROUND UTILITIES PRIOR TO COMMENCING CONSTRUCTION AND SHALL REPORT DISCREPANCIES TO THE COMPANY REPRESENTATIVE IMMEDIATELY.
5. CONTRACTOR TO PROTECT ACTIVE UTILITY LINES OR ELECTRICAL CONDUITS SHOWN ON THE DRAWINGS OR OTHERWISE MADE KNOWN TO THE CONSTRUCTION MANAGEMENT PRIOR TO COMMENCING WORK.
6. ALL UTILITIES SHALL BE KEPT IN OPERATION EXCEPT WITH THE EXPRESS WRITTEN CONSENT OF THE UTILITY OWNER. IT SHALL BE THE CONTRACTOR'S RESPONSIBILITY TO PRESERVE EXISTING UTILITIES.
7. CONTRACTOR SHALL LOCATE ALL UNDERGROUND PIPELINES AND PROTECT THEM DURING CONSTRUCTION FROM IMPOSING HEAVY LOADS FROM SITE PREPARATION ACTIVITIES, MACHINERY AND ANY OTHER EQUIPMENT THAT MAY DAMAGE EXISTING FACILITIES. CONTRACTOR SHALL BE FULLY RESPONSIBLE FOR ANY DAMAGES DURING CONTRUCTION AND REPAIR IN ACCORDANCE WITH THE OWNING AUTHORITIES WITH NO COST TO THE OWNER.
8. ALL GRADING EXCAVATION WORK TO BE PERFORMED WITHIN PIPELINE RIGHT-OF-WAY OR EASEMENTS OR WITHIN 25 FT, MEASURED AT RIGHT ANGLES, OF PIPELINES, SHALL BE IN THE PRESENCE OF COMPANY REPRESENTATIVE.
9. WORK SHALL BE STOPPED IF ANY UNDERGROUND UTILITIES ARE ENCOUNTERED DURING EARTHWORK OPERATIONS AND THE COMPANY REPRESENTATIVE SHALL BE NOTIFIED FOR SPECIFIC DIRECTION.
10. CONTRACTOR SHALL LOCATE ALL OVERHEAD ELECTRICAL POWER LINES IN THE PROPERTY PRIOR TO BEGINNING ANY CONSTRUCTION. FEDERAL AND STATE REGULATIONS RELATED TO HEALTH AND SAFETY SHALL BE FOLLOWED FOR ANY WORK RELATED TO OVERHEAD ELECTRICAL POWER LINES.
11. CONTRACTOR SHALL BE FULLY RESPONSIBLE FOR ANY AND ALL DAMAGE TO FACILITIES, PROPERTY, UNDERGROUND UTILITIES AND TO EXISTING PUBLIC OR PRIVATE UTILITY LINES, INCLUDING BUT NOT LIMITED TO PIPELINES, WATER LINES, WASTEWATER COLLECTION SYSTEMS AND STORM SEWERS, DURING CONSTRUCTION. ALL DAMAGE SHALL BE REPAIRED IN ACCORDANCE WITH THE OWNING AUTHORITY, WITH NO COST TO THE OWNER.
12. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ANY REPAIR OR REPLACEMENT TO MEET THE STANDARDS OF THE APPROPRIATE REGULATORY AGENCY FOR ANY PAVEMENT, DRIVEWAYS, SIDEWALKS, CURBS AND OTHER EXISTING STRUCTURE THAT SUBJECTED TO MODIFICATION OR DAMAGED DURING OR AS A RESULT OF CONSTRUCTION.
13. THE CONTRACTOR SHALL BE RESPONSIBLE FOR CONTACTING THE APPROPRIATE UTILITY COMPANY OR OWNER AS APPLICABLE TO STABILIZE UTILITY POLES AND REMOVE AND REPLACE EXISTING GUY WIRES AS NECESSARY FOR CONSTRUCTION. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ALL COST ASSOCIATED WITH THE WORK.

C. CLEARING AND GRUBBING

1. CONTRACTOR SHALL BE RESPONSIBLE FOR CLEARING AND GRUBBING TO THE GRADING AREA LIMITS SHOWN ON THE CONSTRUCTION DRAWINGS AND FURTHER DESCRIBED BELOW. CONTRACTOR TO SPREAD ORGANIC SOILS FROM VEGETATION STRIP IN AREAS DESIGNATED BY THE OWNER REPRESENTATIVE.
2. UNLESS NOTED IN THE GEOTECHNICAL REPORT, STRIPPING OF TOP SOIL SHALL BE AT A MINIMUM DEPTH OF 12 IN. OR AS DIRECTED BY THE GEOTECHNICAL ENGINEER OR HIS DIRECT REPRESENTATIVE.
3. IN AREAS WHERE TREES, SHRUBS, GROWTH OR OTHER ITEMS ARE DESIGNATED TO REMAIN BY CONSTRUCTION MANAGEMENT, SELECTED CLEARING SHALL BE DONE AND ADEQUATELY PROTECTED FROM CONSTRUCTION EQUIPMENT WITHIN THE SURROUNDING AREAS.
4. CONTRACTOR SHALL STRIP ALL TREES, SHRUBS, VEGETATION, ORGANICS, LOOSE TOPSOIL AND OTHER DEBRIS FROM GRADING AREA. CLEAN OUT ROOTS 0.5 IN. IN DIAMETER AND LARGER TO A DEPTH OF 12 IN. BELOW EXISTING GROUND SURFACE OR SUBGRADE OF NEWLY GRADED SURFACE, WHICHEVER IS LOWER.
5. CONTRACTOR TO CLEAR UNDERGROWTH & DEAD WOOD MATERIALS WITHOUT DISTURBING THE SUBSOIL.
6. APPLY HERBICIDE TO REMAINING STUMPS INHIBITING GROWTH AS REQUIRED.
7. CONTRACTOR TO DISPOSE OF TOP SOIL, RUBBISH, DEBRIS, AND OTHER OBJECTIONABLE MATERIAL TO DESIGNATED DISPOSAL AREAS AS DIRECTED BY THE COMPANY.
8. UPON COMPLETION OF WORK, NO MATERIAL RESULTING FROM CLEARING AND GRUBBING OPERATIONS SHALL REMAIN WITHIN THE LIMITS OF THE SITE, EXCEPT IN THE DESIGNATED AREA.

D. SITE PREPARATION, EXCAVATION, SUBGRADE AND BACKFILL

1. CONTRACTOR SHALL EXCAVATE AND GRADE THE SITE AS DETAILED IN THE CONSTRUCTION DRAWINGS AND FOLLOW SPECIFICATIONS PER GEOTECHNICAL REPORT RECOMMENDATIONS.
2. EXPOSED SUBGRADE SHALL BE PROOF ROLLED IN ACCORDANCE WITH MASSACHUSETTS ITEM 170. WEAK OR SOFT ZONE MATERIALS SHALL BE REMOVED AND REPLACED/COMPACTED WITH APPROVED FILL MATERIAL.
3. UNLESS NOTED IN THE GEOTECHNICAL REPORT, ALL FILL MATERIAL SHALL:
    - BE COMPACTED IN LOOSE LIFTS 6 IN. OR LESS.
    - NOT EXCEED A SLOPE OF 1:10 BETWEEN DIFFERING TRANSITION FILL DEPTHS.
    - BE COMPACTED TO A MINIMUM OF 95% BUT NOT GREATER THAN 98% OF THE MAXIMUM DRY DENSITY AS DETERMINED BY THE STANDARD PROCTOR TEST (ASTM D-698).
    - HAVE MOISTURE CONTENT CONTROLLED AT THE TIME OF COMPACTION BETWEEN OPTIMUM AND 4% ABOVE OPTIMUM MOISTURE CONTENT.
    - THE CONTRACTOR SHALL IMPORT ALL FILL MATERIAL FROM AN APPROVED BORROW SITE, AND THIS MATERIAL SHALL MEET THE REQUIREMENTS OF THE PROJECT GEOTECHNICAL REPORT PREPARED BY GEOENGINEERS USA, PC. IMPORT MATERIAL SHALL BE APPROVED BY THE GEOTECHNICAL ENGINEER OF RECORD AND MEET THE REQUIREMENTS FOR LIQUID LIMIT (LL), PLASTIC LIMIT (PL) AND GRADATION.
4. PRIOR TO FILL PLACEMENT, THE TOP 12 IN. OF THE GROUND SURFACE IN FILL AREAS SHALL BE SCARIFIED, MOISTURE CONDITIONED AND RECOMPACTED PER GEOTECH RECOMMENDATIONS.
5. BACKFILL SHALL BE FREE FROM ORGANIC MATERIAL OR ANY OTHER DELETERIOUS MATTER.
6. PRIOR TO PERFORMING SOIL COMPACTION, MOISTURE CONDITION OR AERATE EACH LIFT AS NECESSARY TO PROVIDE THE REQUIRED MOISTURE CONTENT.
7. DO NOT PLACE BACKFILL OR FILL MATERIAL ON SURFACES THAT ARE MUDDY, FROZEN, OR CONTAIN FROST OR ICE.
8. MECHANICAL TAMPING OF BACKFILL AND FILL SHALL BE DONE WITH SUITABLE SIZED TAMPING FOOT SO AS TO PROVIDE UNIFORM COMPACTION.
9. INSPECTION AND FREQUENT TESTING BY QUALIFIED PERSONNEL DURING FILL COMPACTION IS NECESSARY TO ENSURE PROPER MOISTURE CONTENT AND DEGREE OF COMPACTION. CERTIFICATION SHALL BE OBTAINED FROM THE INSPECTING AGENCY THAT ALL FILL, BACKFILL AND SUBGRADE MATERIALS ARE IN COMPLIANCE WITH THE MOISTURE CONTENT AND COMPACTION RECOMMENDATIONS.
10. THE GEOTECHNICAL ENGINEER OR HIS DIRECT REPRESENTATIVE WILL MONITOR THE FILL OPERATION, IDENTIFY SOIL TYPES, AND MAKE RECOMMENDATIONS CONCERNING SELECTION AND PLACEMENT OF SOILS.
11. EXCESS EXCAVATION SHALL BE DISPOSED TO DESIGNATED DISPOSAL AREAS AS DIRECTED BY THE COMPANY.

E. WATER MANAGEMENT AND CONTROL

1. ADEQUATE DRAINAGE SHALL BE MAINTAINED AT ALL TIMES DURING CONSTRUCTION ACTIVITY. EARTHWORK SHALL BE ACCOMPLISHED IN SUCH A WAY TO ELIMINATE ACCUMULATION OF RAINWATER AND GROUNDWATER. THE CONTRACTOR SHALL INSTALL TEMPORARY MEASURES FOR MANAGING STORMWATER RUN-OFF FROM THE CUT OR FILL AREAS AS REQUIRED, MINIMIZING EROSION TO MEET NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) REQUIREMENTS.
2. CONTRACTOR SHALL PREVENT WATER FROM PONDING ON SITE AND SHALL NOT BLOCK DRAINAGE FROM OR DIRECT EXCESS DRAINAGE ONTO ADJACENT PROPERTY.
3. CONTRACTOR SHALL PROVIDE TEMPORARY PUMPING FACILITIES TO DRAIN THE WATER DURING CONSTRUCTION.
4. DEWATERING OF GROUNDWATER FOR EXCAVATIONS SHALL BE ACCOMPLISHED BY DEWATERING AT LEAST 3 FT BELOW THE BOTTOM OF THE EXCAVATION.
5. REMOVE ALL WATER, INCLUDING GROUNDWATER AND RAINWATER, TO A DESIGNATED LOCATION USING PUMPS, DRAINS OR OTHER APPROVED METHODS.
6. CONTRACTOR SHALL KEEP ALL EXCAVATIONS AND SITE CONSTRUCTION FREE FROM WATER. MAINTAIN TRENCH DRY AT ALL TIMES AND PROVIDE AUTOMATIC OR CONTINUOUS TRENCH PUMPS, AND WELL POINTS IF NECESSARY, TO OBTAIN DRY BEDDING CONDITIONS.

F. SURVEY BEARINGS & ELEVATION DATUM

1. ALL COORDINATES AND ELEVATIONS ARE REFERENCED TO NAD83 MASSACHUSETTS STATE PLANE COORDINATES, MAINLAND ZONE, US FOOT.

G. GEOTECHNICAL REPORT

1. THE GEOTECHNICAL ENGINEERING REPORT ENTITLED "CAPE CANAL BRIDGE RELOCATION PROJECT MAINLAND SAGAMORE METERING & REGULATING STATION" PREPARED BY GEOENGINEERS USA, PC. PROJECT NO. 15556-039-00, DATED APRIL 21, 2025.

H. SOIL TYPES

ID #	DESCRIPTION
430B	BARNSTABLE LOAMY SAND OR SANDY LOAM, 3 TO 8 PERCENT SLOPES
431C	BARNSTABLE VERY STONY SANDY LOAM, 8 TO 15 PERCENT SLOPES
254B	MERRIMAC FINE SANDY LOAM, 3 TO 8 PERCENT SLOPES

THE ABOVE INFORMATION WAS OBTAINED FROM THE SOIL SURVEY GEOGRAPHIC (SSURGO) DATABASE FOR BARNSTABLE COUNTY, MASSACHUSETTS.

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
No. 58957
PROFESSIONAL ENGINEER

06/24/26

ISSUED FOR PERMIT
06/18/2026

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		C	06/18/26	CR	DT	ISSUED FOR PERMIT
		B	05/15/26	CR	DT	ISSUED FOR BID
		A	05/15/26	CR	DT	ISSUED FOR PERMIT

audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

DRAWN BY:	CR	05/15/26	CAPE COD CANAL PIPELINE RELOCATION PROJECT
DESIGN CHECKER:	DT	06/18/26	SAGAMORE M&R RELOCATION
DESIGN ENGINEER:	PB	06/18/26	M&R 00051
PROJECT MANAGER:	AC	06/18/26	TITLE: EROSION & SEDIMENT GENERAL NOTES
LOC.: BARNSTABLE COUNTY, MASSACHUSETTS			

ENBRIDGE
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

TITLE	INITIALS	DATE	YEAR: 2026	W.O.:	SCALE: AS NOTED	DWG.: 00051-C.020-0001	REV.: C

S:\AE\Projects\Enbridge\Mass\026356-001\200_Civil_Structural\170_Drawings\E&S Plans\Sagamore M&R\00051-C.020-0001.dwg — PLOT TIME: 6/24/2026 10:33 AM



PROPOSED SAGAMORE METER STATION SITE

EXISTING CONDITIONS PLAN

SCALE: 1" = 40'-0"

0 40' 80'
Scale: 1" = 40'

N
10.03°
STATION NORTH

NOTES:

1. ALL CONTOUR LABELS AND ELEVATION CALLOUTS ARE IN FEET.
2. PROPOSED SITE BOUNDARY IS BASED ON GROUND SURVEY CONDUCTED BY BRADY CONSULTING, L.L.C. ON OCTOBER 2, 2025
3. SUPPLEMENTAL TAX PARCEL DATA IS SHOWN FOR REFERENCE ONLY AND WAS OBTAINED FROM THE CAPE COD COMMISION OPEN GIS DATA HUB WEBSITE. PROJECT AREA IS WITHIN THE COMMONWEALTH OF MASSACHUSETTS PROPERTY.
4. PROPERTY CONVEYED TO ALGONQUIN GAS TRANSMISSION, LLC.
5. TOPOGRAPHIC SURVEY INFORMATION WAS PROVIDED BY ALGONQUIN GAS TRANSMISSION, LLC. ALL COORDINATES AND DISTANCES SHOWN HEREON ARE REFERENCED TO THE MASSACHUSETTS STATE PLANE COORDINATE SYSTEM, US FEET.ELEVATIONS ARE REFERENCED TO NAVD 88.
6. ADDITIONAL CONTOUR DATA WAS OBTAINED FROM 2022 USGS LIDAR POINT CLOUD DATA SETS.
7. THIS PROPERTY IS LOCATED IN ZONE X (AREA OF MINIMAL FLOOD HAZARD) AS DEPICTED ON FLOOD INSURANCE RATE MAP 25001C0318K DATED JULY 6, 2021.
8. ACCORDING TO MASSGIS THE SITE AND 3RD PARTY CONSULTANT NATURAL RESOURCE STUDY IS NOT WITHIN THE NATURAL HERITAGE AND ENDANGERED SPECIES PROGRAM (NHESP), PRIORITY HABITATS OF RARE WILDLIFE, OR THE NHESP ESTIMATED HABITATS OF RARE WILDLIFE.
9. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT NATURAL RESOURCE STUDY THE SITE THERE IS A WETLAND WITHIN 100 FEET OF THE PROJECT LIMITS. SEE SITE LAYOUT FOR BMPS.
10. SUBJECT SITE IS IN THE BUSINESS 2 (B2) DISTRICT AS DEPICTED ON THE TOWN OF BOURNE ZONING MAP.
11. THIS PLAN SET IS PRELIMINARY. FOR PERMITTING PURPOSES ONLY. THIS PLAN IS NOT INTENDED FOR CONSTRUCTION PURPOSES.

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
No. 58957
PROFESSIONAL ENGINEER
06/24/26

ISSUED FOR PERMIT
06/18/2026

LEGEND

EDGE OF GRAVEL	MAJOR CONTOUR	PROPERTY LINE
EXISTING OVERHEAD ELECTRIC	MINOR CONTOUR	GIS PARCEL LINES
EXISTING UG ELECTRIC	BOTTOM OF SLOPE	EXISTING RIP RAP
EDGE OF ROAD	EDGE OF WATER	DIRT MOUND (DEPOSITED)
WETLAND	100 FT WETLAND BUFFER	EXISTING STRUCTURE

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		C	06/18/26	CR	DT	ISSUED FOR PERMIT
		B	05/15/26	CR	DT	ISSUED FOR BID
		A	05/15/26	CR	DT	ISSUED FOR PERMIT

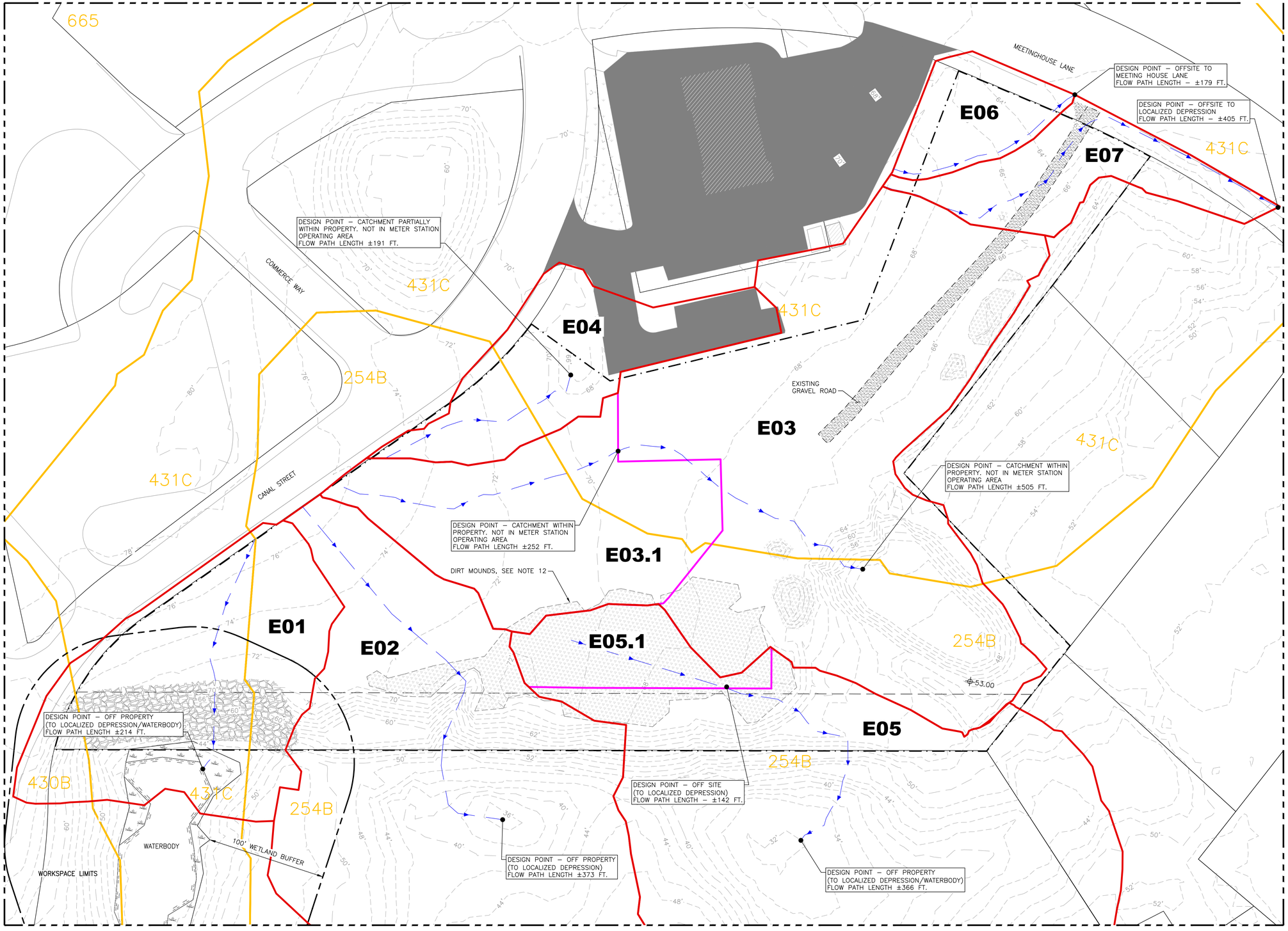
audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

TITLE	INITIALS	DATE
DRAWN BY:	CR	05/08/26
DESIGN CHECKER:	AE	06/18/26
DESIGN ENGINEER:	DT	06/18/26
PROJECT MANAGER:	AC	06/18/26

CAPE COD CANAL PIPELINE RELOCATION PROJECT
SAGAMORE M&R RELOCATION
M&R 00051
TITLE: EXISTING CONDITIONS PLAN
LOC.: BARNSTABLE COUNTY, MASSACHUSETTS
YEAR: 2026 | W.O.: | SCALE: AS NOTED | DWG.: 00051-C.320-0001 | REV.: C

ENBRIDGE
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

S:\AE\Projects\Enbridge\Mass\026356-001\200_Civil_Structural\170_Drawings\E&S Plans\Sagamore M&R\00051-C.320-0001.dwg – PLOT TIME: 6/23/2026 9:20 PM



PROPOSED SAGAMORE METER STATION SITE

EXISTING SUBCATCHMENT AREAS PLAN

SCALE: 1" = 40'

0 40' 80'
Scale: 1" = 40'

N

10.03°

STATION NORTH

NOTES:

1. ALL CONTOUR LABELS AND ELEVATION CALLOUTS ARE IN FEET.
2. PROPOSED SITE BOUNDARY IS BASED ON GROUND SURVEY CONDUCTED BY BRADY CONSULTING, L.L.C. ON OCTOBER 2, 2025
3. SUPPLEMENTAL TAX PARCEL DATA IS SHOWN FOR REFERENCE ONLY AND WAS OBTAINED FROM THE CAPE COD COMMISSION OPEN GIS DATA HUB WEBSITE.
4. PROPERTY CONVEYED TO ALGONQUIN GAS TRANSMISSION, LLC.
5. TOPOGRAPHIC SURVEY INFORMATION WAS PROVIDED BY ALGONQUIN GAS TRANSMISSION, LLC. ALL COORDINATES AND DISTANCES SHOWN HEREON ARE REFERENCED TO THE MASSACHUSETTS STATE PLANE COORDINATE SYSTEM, US FEET.ELEVATIONS ARE REFERENCED TO NAVD 88.
6. ADDITIONAL CONTOUR DATA WAS OBTAINED FROM 2022 USGS LIDAR POINT CLOUD DATA SETS.
7. THIS PROPERTY IS LOCATED IN ZONE X (AREA OF MINIMAL FLOOD HAZARD) AS DEPICTED ON FLOOD INSURANCE RATE MAP 25001C0318K DATED JULY 6, 2021.
8. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT NATURAL RESOURCE STUDY THE SITE IS NOT WITHIN THE NATURAL HERITAGE AND ENDANGERED SPECIES PROGRAM (NHESP), PRIORITY HABITATS OF RARE WILDLIFE, OR THE NHESP ESTIMATED HABITATS OF RARE WILDLIFE.
9. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THE SITE THERE IS A WETLAND WITHIN 100 FEET OF THE PROJECT LIMITS. SEE SITE LAYOUT FOR BMPS.
10. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THE SITE IS NOT LOCATED WITHIN AN AREA OF CRITICAL ENVIRONMENTAL CONCERN.
11. THIS PLAN SET IS PRELIMINARY. FOR PERMITTING PURPOSES ONLY. THIS PLAN IS NOT INTENDED FOR CONSTRUCTION PURPOSES.
12. THE EXISTING DRAINAGE AREAS AND FLOW PATHS ACCOUNTS FOR THE PRESENCE OF EXCESS FILL (DIRT) MOUNDS THAT EXIST ON THIS SITE.
13. REFER TO THE "EROSION & SEDIMENT GENERAL NOTES" (DWG. 00051–C.020–0001) FOR SOIL TYPES INFORMATION.

LEGEND

- PROPERTY LINE
- MAJOR CONTOUR — 70' —
- MINOR CONTOUR — 72' —
- TIME OF CONCENTRATION LINE
- SUBCATCHMENT AREA BOUNDARY
- ANALYSIS AREA BOUNDARY
- NRCS SOIL BOUNDARY
- GIS PARCEL LINES
- EXISTING BUILDING
- EXISTING PAVED AREA
- EXISTING DIRT MOUNDS
- EXISTING GRAVEL
- WETLAND
- 100 FT WETLAND BUFFER

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
No. 58557
PROFESSIONAL ENGINEER

06/24/26

ISSUED FOR PERMIT
06/18/2026

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		C	06/18/26	CR	DT	ISSUED FOR PERMIT
		B	05/15/26	CR	DT	ISSUED FOR BID
		A	05/15/26	CR	DT	ISSUED FOR PERMIT

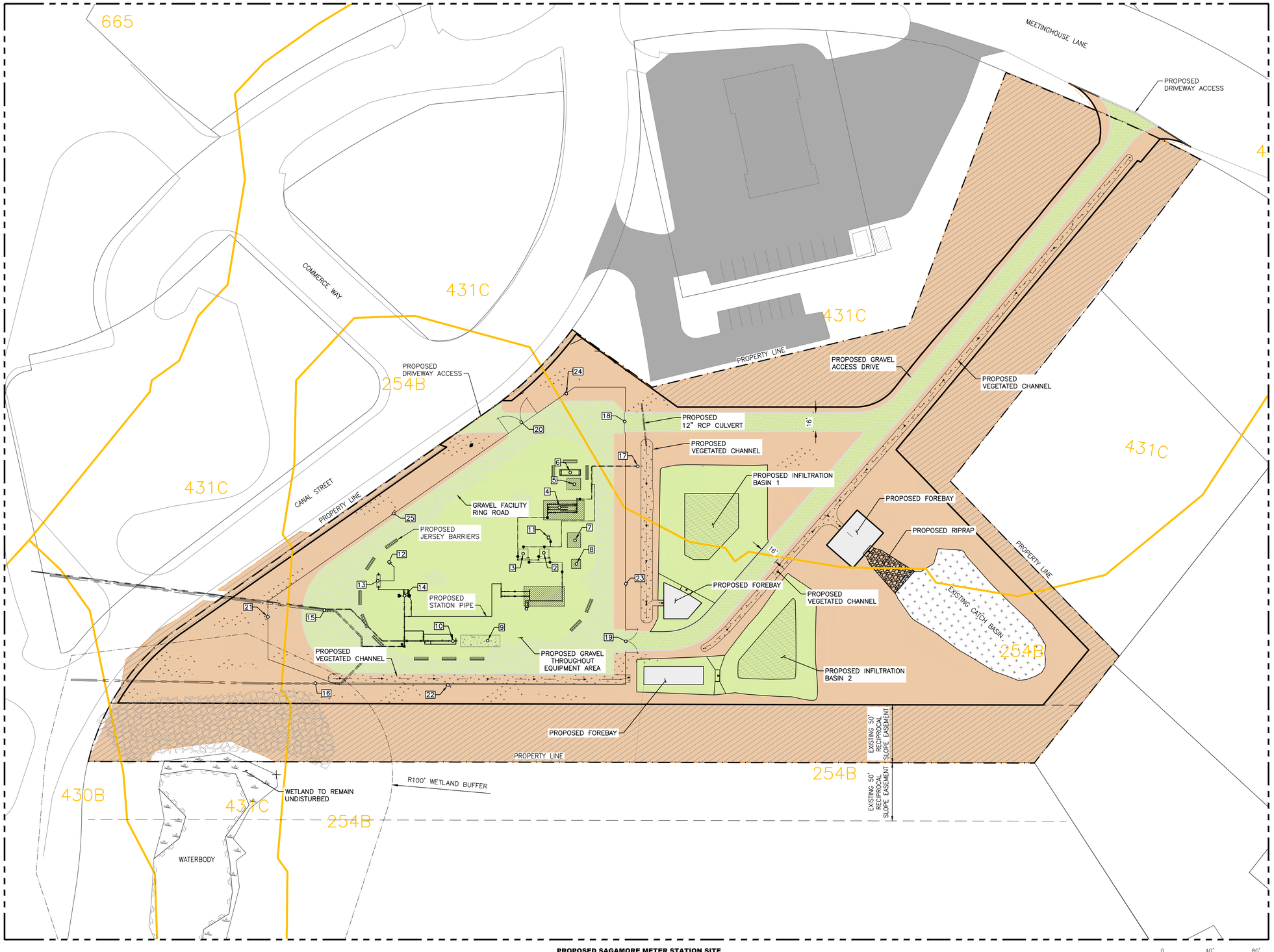
audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

DRAWN BY:	CR	05/15/26	CAPE COD CANAL PIPELINE RELOCATION PROJECT
DESIGN CHECKER:	DT	06/18/26	SAGAMORE M&R RELOCATION
DESIGN ENGINEER:	PB	06/18/26	M&R 00051
PROJECT MANAGER:	AC	06/18/26	TITLE: EXISTING SUBCATCHMENT AREAS PLAN
TITLE	INITIALS	DATE	LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

YEAR: 2026 | W.O.: | SCALE: 1"=40' | DWG.: 00051–C.320–0002 | REV.: C

ENBRIDGE
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

S:\AE\Projects\Enbridge\Mass\026356-001\200_Civil_Structural\170_Drawings\E&S Plans\Sagamore M&R\00051-C.320-0002.dwg – PLOT TIME: 6/18/2026 10:54 AM



NOTES:

1. ALL CONTOUR LABELS AND ELEVATION CALLOUTS ARE IN FEET.
2. PROPOSED SITE BOUNDARY IS BASED ON GROUND SURVEY CONDUCTED BY BRADY CONSULTING, L.L.C. ON OCTOBER 2, 2025
3. SUPPLEMENTAL TAX PARCEL DATA IS SHOWN FOR REFERENCE ONLY AND WAS OBTAINED FROM THE CAPE COD COMMISSION OPEN GIS DATA HUB WEBSITE. PROJECT AREA IS WITHIN THE COMMONWEALTH OF MASSACHUSETTS PROPERTY.
4. PROPERTY CONVEYED TO ALGONQUIN GAS TRANSMISSION, LLC.
5. TOPOGRAPHIC SURVEY INFORMATION WAS PROVIDED BY ALGONQUIN GAS TRANSMISSION, LLC. ALL COORDINATES AND DISTANCES SHOWN HEREON ARE REFERENCED TO THE MASSACHUSETTS STATE PLANE COORDINATE SYSTEM, US FEET. ELEVATIONS ARE REFERENCED TO NAVD 88.
6. CONTOUR DATA WAS OBTAINED FROM 2022 USGS LIDAR POINT CLOUD DATA SETS.
7. THIS PROPERTY IS LOCATED IN ZONE X (AREA OF MINIMAL FLOOD HAZARD) AS DEPICTED ON FLOOD INSURANCE RATE MAP 25001C0318K DATED JULY 6, 2021.
8. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT NATURAL RESOURCE STUDY THE SITE IS NOT WITHIN THE NATURAL HERITAGE AND ENDANGERED SPECIES PROGRAM (NHESP), PRIORITY HABITATS OF RARE WILDLIFE, OR THE NHESP ESTIMATED HABITATS OF RARE WILDLIFE.
9. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT, THERE IS A WETLAND WITHIN 100 FEET OF THE PROJECT LIMITS. SEE SITE LAYOUT FOR BMPS.
10. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THE SITE IS NOT LOCATED WITHIN AN AREA OF CRITICAL ENVIRONMENTAL CONCERN.
11. THIS PLAN SET IS PRELIMINARY. FOR PERMITTING PURPOSES ONLY. THIS PLAN IS NOT INTENDED FOR CONSTRUCTION PURPOSES.
12. SEE GRADING PLAN DRAWING 00051-C.301-0001 FOR DETAILS ON SITE GRADING AND STORM WATER MANAGEMENT.
13. REFER TO THE "EROSION & SEDIMENT GENERAL NOTE" (DWG. 00051-C.020-0001) FOR SOIL TYPES INFORMATION.

KEY NOTE ID	
POINT #	DESCRIPTION
1	32'x12' METER BUILDING
2	VERTICAL HEATER
3	VERTICAL HEATER
4	32'x12' REGULATOR BUILDING
5	12'x10' ODORIZIER BUILDING
6	TANK
7	10'x12' N.G. EGM BUILDING
8	8'x8' ENBRIDGE EGM BUILDING
9	34'x10' MAINTANANCE SLAB
10	PIPELINE TRAP
11	NG GENERATOR
12	TRUCK BOX
13	AUXILIARY SUMP
14	FILTER SEPARATOR
15	INCOMING HDD BUNDLE

KEY NOTE ID	
POINT #	DESCRIPTION
16	INCOMING G024 PIPELINE
17	FUTURE NG PIPELINE
18	SLIDING GATE
19	SECONDARY SWING GATE
20	SECONDARY DRIVE GATE*
21	EGRESS GATE
22	EGRESS GATE
23	EGRESS GATE
24	EGRESS GATE
25	EGRESS GATE

* SLIDE GATE OPTIONAL

LEGEND

- PROPOSED ACCESS ROAD
- PROPOSED CONCRETE
- PROPOSED STRUCTURE
- PROPOSED ROCK (FACILITY)
- PROPOSED VEGETATED
- PROPOSED INFILTRATION BASIN
- PROPOSED SEDIMENT FOREBAY
- EXISTING BASIN
- EXISTING BUILDING
- EXISTING PAVED AREA
- WETLAND
- WORKSPACE
- INFILTRATION >2.4"/HR
- INFILTRATION <2.4"/HR
- VENDOR SUPPLIED EQUIPMENT
- PROPOSED FENCE
- PROPOSED UG PIPING
- PROPERTY LINE
- GIS TAX PARCELS
- NRCS SOIL BOUNDARY
- WORKSPACE LIMITS
- PROPOSED GRADE LIMITS
- EDGE OF ROAD
- EDGE OF WATER
- EXISTING MAJOR CONTOUR 70
- EXISTING MINOR CONTOUR 72
- PROPOSED MAJOR CONTOUR 70
- PROPOSED MINOR CONTOUR 72
- PROPOSED FLOW LINE
- PROPOSED WIER

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
No. 58957
PROFESSIONAL ENGINEER
06/24/26

ISSUED FOR PERMIT
06/18/2026

0 40' 80'
Scale: 1" = 40'

PROPOSED SAGAMORE METER STATION SITE
PROPOSED SITE LAYOUT PLAN
SCALE: 1" = 40'-0"

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		C	06/18/26	CR	DT	ISSUED FOR PERMIT
		B	05/15/26	CR	DT	ISSUED FOR BID
		A	05/15/26	CR	DT	ISSUED FOR PERMIT

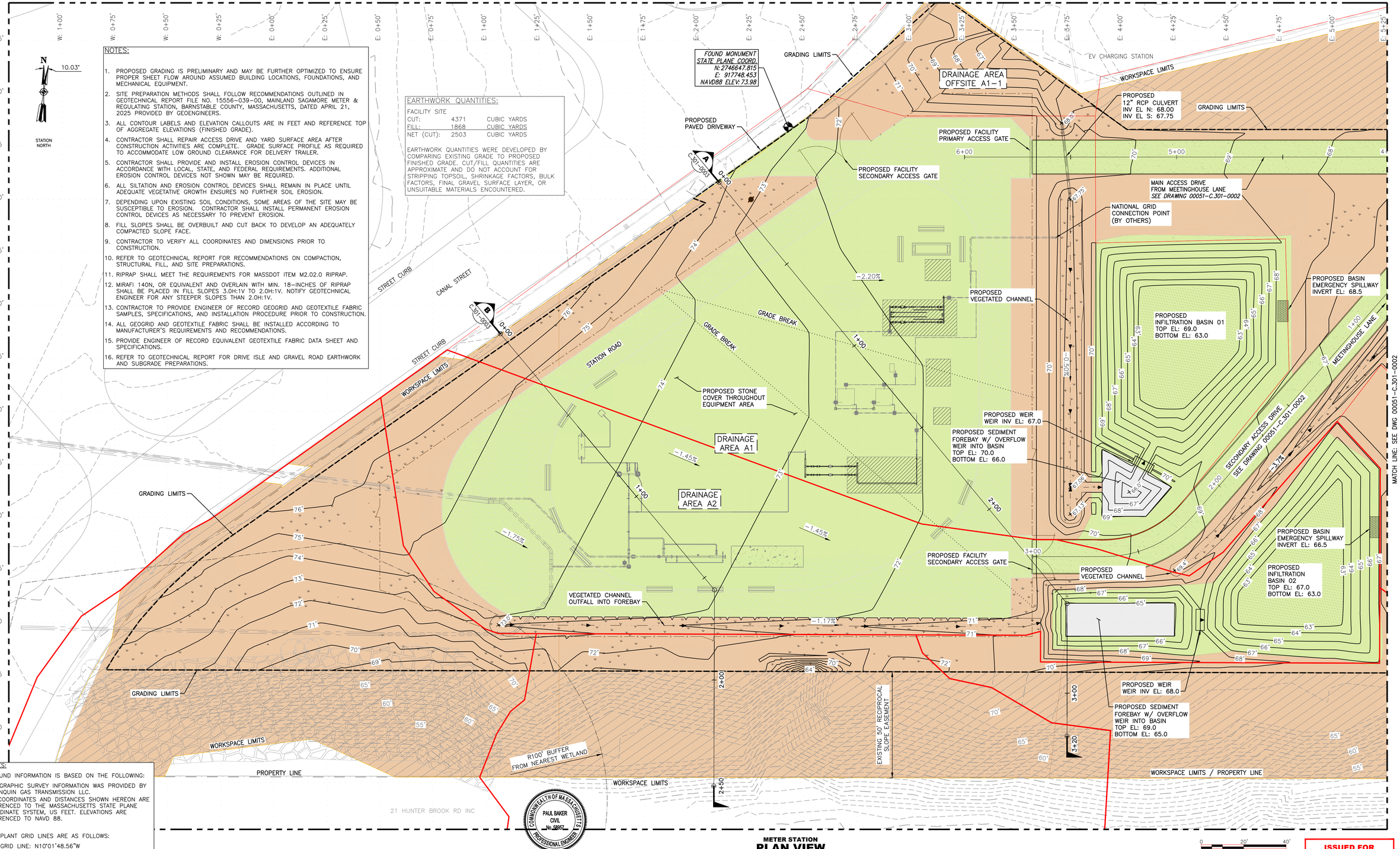
audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

DRAWN BY:	CR	05/15/26	CAPE COD CANAL PIPELINE RELOCATION PROJECT
DESIGN CHECKER:	DT	06/18/26	SAGAMORE M&R RELOCATION
DESIGN ENGINEER:	PB	06/18/26	M&R 00051
PROJECT MANAGER:	AC	06/18/26	TITLE: PROPOSED SITE LAYOUT PLAN
TITLE	INITIALS	DATE	LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

YEAR: 2026 | W.O.: | SCALE: AS NOTED | DWG.: 00051-C.320-0003 | REV.: C

ENBRIDGE
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

S:\AE\Projects\Enbridge\Mass\026356-001\200_Civil_Structural\170_Drawings\E&S Plans\Sagamore M&R\00051-C.320-0003.dwg – PLOT TIME: 6/24/2026 10:44 AM



SURVEY NOTES:

1. BACKGROUND INFORMATION IS BASED ON THE FOLLOWING:
   - 1.1. TOPOGRAPHIC SURVEY INFORMATION WAS PROVIDED BY ALGONQUIN GAS TRANSMISSION LLC.
   - 1.2. ALL COORDINATES AND DISTANCES SHOWN HEREON ARE REFERENCED TO THE MASSACHUSETTS STATE PLANE COORDINATE SYSTEM, US FEET. ELEVATIONS ARE REFERENCED TO NAVD 88.
2. BEARING PLANT GRID LINES ARE AS FOLLOWS:
   - 2.1. N-S GRID LINE: N10°01'48.56"W
   - 2.2. E-W GRID LINE: S66°53'18.0"E

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
No. 58957
PROFESSIONAL ENGINEER
06/24/26

METER STATION
PLAN VIEW
SCALE: 1" = 20'-0"

0 20' 40'
Scale: 1" = 20'

ISSUED FOR PERMIT
06/18/2026

LEGEND

PROPOSED ACCESS ROAD
PROPOSED CONCRETE
PROPOSED STRUCTURE
PROPOSED ROCK (FACILITY)
EXISTING GAS LINE GAS GAS
PROPOSED FENCE
EXISTING CONTOUR LINE
FINISH CONTOUR LINE 70
DRAINAGE AREA BOUNDARY
PERMANENT EASEMENT
LIMITS OF GRADING
PROPOSED VEGETATED
PROPOSED INFILTRATION BASIN
PROPOSED SEDIMENT FOREBAY
WORKSPACE LIMITS
INFILTRATION >2.4"/HR
PROPOSED FLOW LLINE
PROPOSED EMERGENCY SPILLWAY
PROPOSED WEIR
TOP OF SLOPE
INFILTRATION <2.4"/HR

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		E	06/18/26	CR	DT	ISSUED FOR PERMIT
		D	05/15/26	CR	DT	ISSUED FOR BID
00051-C.320-0007	DETAILS	C	05/15/26	CR	DT	ISSUED FOR PERMIT
00051-C.320-0006	DETAILS	B	03/03/26	CR	PB	ISSUED FOR REVIEW – 90% REVIEW
00051-C.301-0002	CIVIL ACCESS ROAD PLAN	A	05/29/25	CR	PB	ISSUED FOR REVIEW – 60% REVIEW

audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

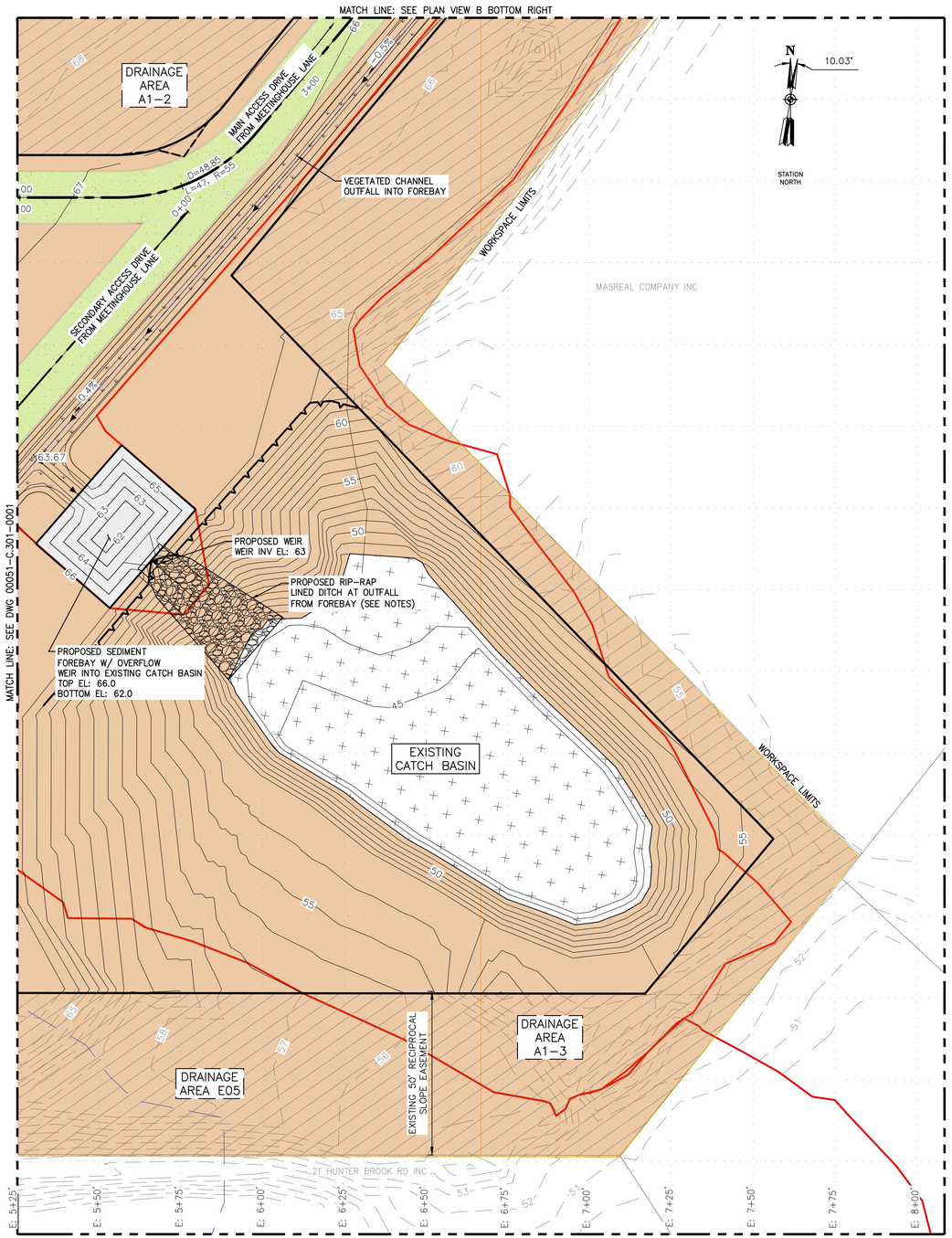
DRAWN BY:	CR	04/20/25	
DESIGN CHECKER:	AE	06/18/26	
DESIGN ENGINEER:	PB	06/18/26	
PROJECT MANAGER:	AC	06/18/26	
TITLE	INITIALS	DATE	

CAPE COD CANAL PIPELINE RELOCATION PROJECT
SAGAMORE M&R RELOCATION
M&R 00051
TITLE: GRADING PLAN
LOC.: BARNSTABLE COUNTY, MASSACHUSETTS
YEAR: 2026 W.O.: SCALE: AS NOTED

ENBRIDGE
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400
DWG.: 00051-C.301-0001 REV.: E

S:\AE\Projects\Enbridge\Mass\026356-001\200_Civil_Structural\170_Drawings\Grading\Mainland Sagamore\00051-C.301-0001.dwg - PLOT TIME: 6/24/2026 10:21 AM

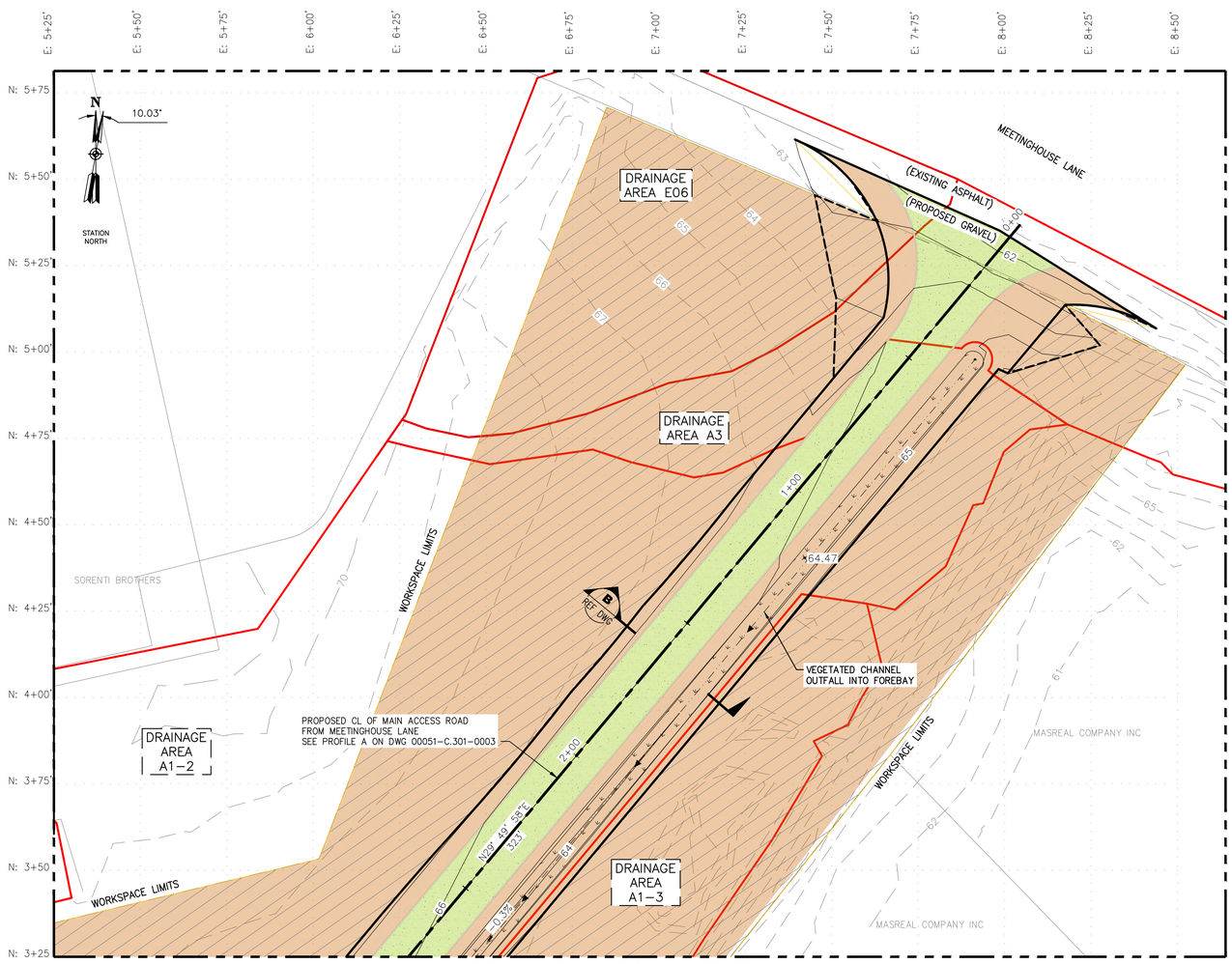
S:\AE\Projects\Enbridge\Mass\026356-001\200_Civil_Structural\170_Drawings\Grading\Mainland Sagamore\00051-C.301-0002.dwg — PLOT TIME: 6/24/2026 12:49 AM



PLAN VIEW A

SCALE: 1" = 20'-0"

Scale: 1" = 20'



PLAN VIEW B

SCALE: 1" = 20'-0"

Scale: 1" = 20'

NOTES:

1. PROPOSED GRADING IS PRELIMINARY AND MAY BE FURTHER OPTIMIZED TO ENSURE PROPER SHEET FLOW AROUND ASSUMED BUILDING LOCATIONS, FOUNDATIONS, AND MECHANICAL EQUIPMENT.
2. SITE PREPARATION METHODS SHALL FOLLOW RECOMMENDATIONS OUTLINED IN GEOTECHNICAL REPORT FILE NO. 15556-039-00, MAINLAND SAGAMORE METER & REGULATING STATION, BARNSTABLE COUNTY, MASSACHUSETTS, DATED APRIL 21, 2025 PROVIDED BY GEOENGINEERS.
3. ALL CONTOUR LABELS AND ELEVATION CALLOUTS ARE IN FEET AND REFERENCE TOP OF AGGREGATE ELEVATIONS (FINISHED GRADE).
4. CONTRACTOR SHALL REPAIR ACCESS DRIVE AND YARD SURFACE AREA AFTER CONSTRUCTION ACTIVITIES ARE COMPLETE. GRADE SURFACE PROFILE AS REQUIRED TO ACCOMMODATE LOW GROUND CLEARANCE FOR DELIVERY TRAILER.
5. CONTRACTOR SHALL PROVIDE AND INSTALL EROSION CONTROL DEVICES IN ACCORDANCE WITH LOCAL, STATE, AND FEDERAL REQUIREMENTS. ADDITIONAL EROSION CONTROL DEVICES NOT SHOWN MAY BE REQUIRED.
6. ALL SILTATION AND EROSION CONTROL DEVICES SHALL REMAIN IN PLACE UNTIL ADEQUATE VEGETATIVE GROWTH ENSURES NO FURTHER SOIL EROSION.
7. DEPENDING UPON EXISTING SOIL CONDITIONS, SOME AREAS OF THE SITE MAY BE SUSCEPTIBLE TO EROSION. CONTRACTOR SHALL INSTALL PERMANENT EROSION CONTROL DEVICES AS NECESSARY TO PREVENT EROSION.
8. FILL SLOPES SHALL BE OVERBUILT AND CUT BACK TO DEVELOP AN ADEQUATELY COMPACTED SLOPE FACE.
9. CONTRACTOR TO VERIFY ALL COORDINATES AND DIMENSIONS PRIOR TO CONSTRUCTION.
10. REFER TO GEOTECHNICAL REPORT FOR RECOMMENDATIONS ON COMPACTION, STRUCTURAL FILL, AND SITE PREPARATIONS.
11. RIPRAP SHALL MEET THE REQUIREMENTS FOR MASSDOT ITEM M2.02.0 RIPRAP.
12. MIRAFI 140N, OR EQUIVALENT AND OVERLAIN WITH MIN. 18-INCHES OF RIPRAP SHALL BE PLACED IN FILL SLOPES 3.0H:1V TO 2.0H:1V. NOTIFY GEOTECHNICAL ENGINEER FOR ANY STEEPER SLOPES THAN 2.0H:1V.
13. CONTRACTOR TO PROVIDE ENGINEER OF RECORD GEOGRID AND GEOTEXTILE FABRIC SAMPLES, SPECIFICATIONS, AND INSTALLATION PROCEDURE PRIOR TO CONSTRUCTION.
14. ALL GEOGRID AND GEOTEXTILE FABRIC SHALL BE INSTALLED ACCORDING TO MANUFACTURER'S REQUIREMENTS AND RECOMMENDATIONS.
15. PROVIDE ENGINEER OF RECORD EQUIVALENT GEOTEXTILE FABRIC DATA SHEET AND SPECIFICATIONS.
16. REFER TO GEOTECHNICAL REPORT FOR DRIVE ISLE AND GRAVEL ROAD EARTHWORK AND SUBGRADE PREPARATIONS.

EARTHWORK QUANTITIES:

ACCESS ROAD

STRIPPED MATERIAL (CUT):	677.0 CUBIC YARDS
6" ROCK SURFACE FILL:	270.8 CUBIC YARDS
9" SUBBASE FILL:	406.2 CUBIC YARDS
NET (FILL):	677.0 CUBIC YARDS

EARTHWORK QUANTITIES WERE DEVELOPED BY COMPARING EXISTING GRADE TO PROPOSED FINISHED GRADE. STONE COVERAGE AND CUT/FILL QUANTITIES ARE APPROXIMATE AND DO NOT ACCOUNT FOR STRIPPING TOPSOIL, SHRINKAGE FACTORS, BULK FACTORS, FINAL GRAVEL SURFACE LAYER, OR UNSUITABLE MATERIALS ENCOUNTERED.

SURVEY NOTES:

1. BACKGROUND INFORMATION IS BASED ON THE FOLLOWING:
   - 1.1. TOPOGRAPHIC SURVEY INFORMATION WAS PROVIDED BY ALGONQUIN GAS TRANSMISSION LLC.
   - 1.2. ALL COORDINATES AND DISTANCES SHOWN HEREON ARE REFERENCED TO THE MASSACHUSETTS STATE PLANE COORDINATE SYSTEM, US FEET. ELEVATIONS ARE REFERENCED TO NAVD 88.
2. BEARING PLANT GRID LINES ARE AS FOLLOWS:
   - 2.1. N-S GRID LINE: N10°01'48.56"W
   - 2.2. E-W GRID LINE: S66°53'18.0"E

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
No. 59957
PROFESSIONAL ENGINEER
06/24/26

ISSUED FOR PERMIT
06/18/2026

LEGEND

PROPOSED ACCESS ROAD	PROPOSED FENCE	PROPOSED VEGETATED	PROPOSED FLOW LLINE
PROPOSED CONCRETE	EXISTING CONTOUR LINE	PROPOSED INFILTRATION BASIN	PROPOSED EMERGENCY SPILLWAY
PROPOSED STRUCTURE	FINISH CONTOUR LINE	PROPOSED SEDIMENT FOREBAY	PROPOSED WEIR
PROPOSED ROCK (FACILITY)	DRAINAGE AREA BOUNDARY	WORKSPACE LIMITS	TOP OF SLOPE
	PROPERTY LINE	INFILTRATION >2.4"/HR	INFILTRATION <2.4"/HR
	LIMITS OF GRADING		

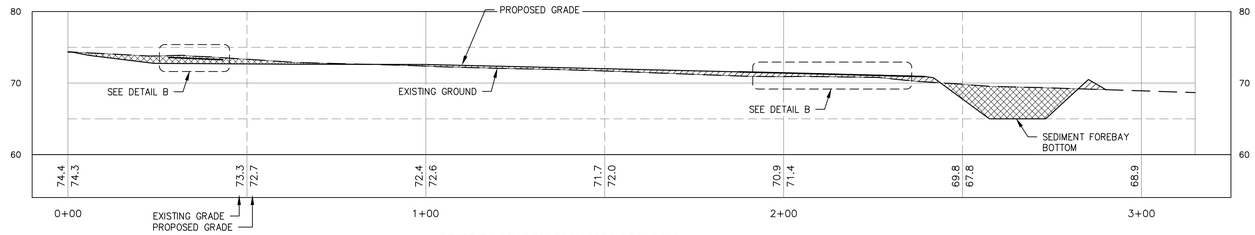
DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		E	06/18/26	CR	DT	ISSUED FOR PERMIT
		D	05/15/26	CR	DT	ISSUED FOR BID
		C	05/15/26	CR	DT	ISSUED FOR PERMIT
00051-C.301-0003	CIVIL GRADING SECTIONS AND DETAILS	B	03/03/26	CR	PB	ISSUED FOR REVIEW – 90% REVIEW
00051-C.301-0001	CIVIL GRADING PLAN	A	05/29/25	CR	PB	ISSUED FOR REVIEW – 60% REVIEW

audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

DRAWN BY:	CR	05/08/25	CAPE COD CANAL PIPELINE RELOCATION PROJECT
DESIGN CHECKER:	DT	06/18/26	SAGAMORE M&R RELOCATION
DESIGN ENGINEER:	PB	06/18/26	M&R 00051
PROJECT MANAGER:	AC	06/18/26	TITLE: CIVIL ACCESS ROAD PLAN
TITLE	INITIALS	DATE	LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

YEAR: 2026 | W.O.: | SCALE: AS NOTED | DWG.: 00051-C.301-0002 | REV.: E

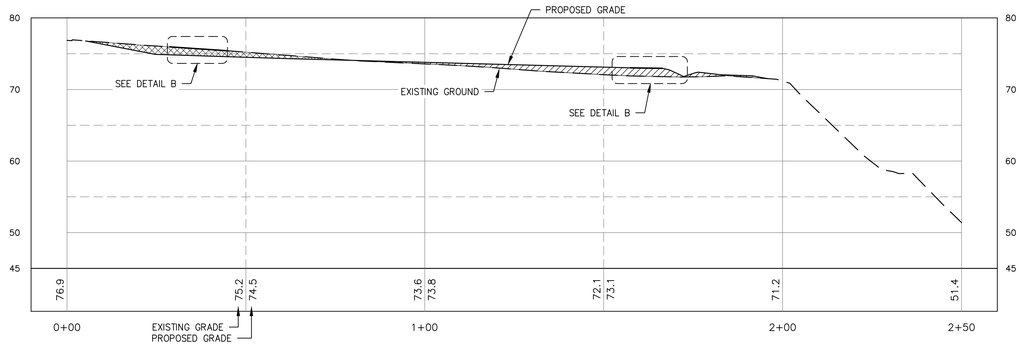
ENBRIDGE
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713.627.5400



REFER TO GRADING PLAN 0051-C.301-0001

SECTION A

SCALES: HORIZ. 1" = 20'-0" / VERT. 1" = 10'-0"



REFER TO GRADING PLAN 0051-C.301-0001

SECTION B

SCALES: HORIZ. 1" = 20'-0" / VERT. 1" = 10'-0"

```
BEGIN SAGAMORE M&R CL OF PRIMARY DRIVEWAY
   N 2,746,994.2540   E 918,257.6723                    0+00.00

LINE (1)
   S29° 49' 58"W    322.98'
   N 2,746,714.0789   E 918,097.0011                    3+22.98
LINE (1)

CURVE (2)
   BC    N 2,746,714.0789   E 918,097.0011              3+22.98
   CTR   N 2,746,742.5009   E 918,049.9140
   PI    N 2,746,692.6923   E 918,084.0920

      DIRECTION BACK   S31° 06' 55"W
         RADIUS        55.00'
         DELTA         48°51'16"(RT)
         LENGTH        46.90'
         TANGENT       24.98'
         CHORD DIRECTION     S55° 32' 33"W   DISTANCE   45.49'
      DIRECTION AHEAD S79° 58' 11"W

   EC    N 2,746,688.3415   E 918,059.4932              3+69.87
CURVE (2)

LINE (3)
   S79° 58' 11"W    230.22'
   N 2,746,648.2456   E 917,832.7959                    6+00.00
LINE (3)

   N 2,746,648.2456   E 917,832.7959                    6+00.00
END SAGAMORE M&R CL OF PRIMARY DRIVEWAY
**********************************************************

ALIGNMENT LENGTH: 600.00'
```

```
BEGIN SECONDARY DRIVEWAY
   N 2,746,687.8206   E 918,081.2041                    0+00.00

LINE (1)
   S31° 01' 52.19"W    219.273'
   N 2,746,499.9284   E 917,968.1679                    2+19.27
LINE (1)

CURVE (2)
   BC    N 2,746,499.9284   E 917,968.1679              2+19.27
   CTR   N 2,746,528.2811   E 917,921.0391
   PI    N 2,746,478.4810   E 917,955.2652

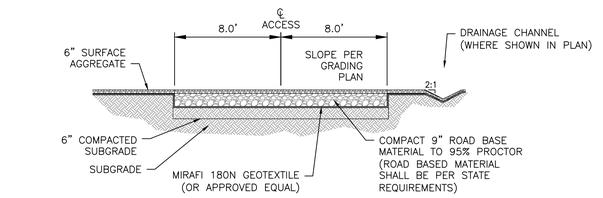
      DIRECTION BACK   S31° 01' 52.19"W
         RADIUS        55.000'
         DELTA         48°56'19"(RT)
         LENGTH        46.978'
         TANGENT       25.029'
         CHORD DIRECTION     S55° 30' 01.82"W   DISTANCE   45.563'
      DIRECTION AHEAD S79° 58' 11.44"W

   EC    N 2,746,474.1217   E 917,930.6183              2+66.25
CURVE (2)

LINE (3)
   S79° 58' 11.44"W    33.749'
   N 2,746,468.2437   E 917,897.3850                    3+00.00
LINE (3)

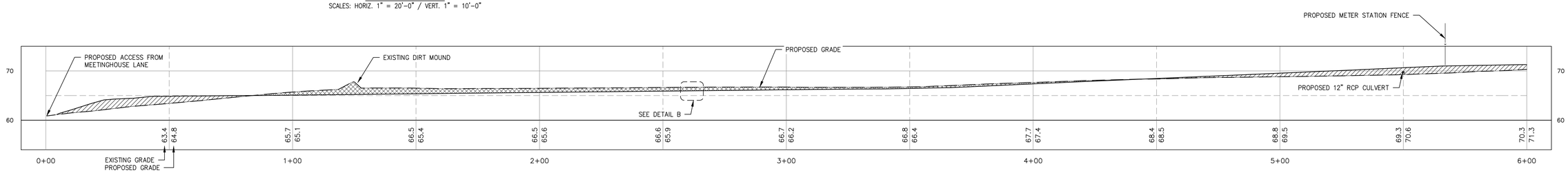
   N 2,746,468.2437   E 917,897.3850                    3+00.00
END SECONDARY DRIVEWAY
**********************************************************

ALIGNMENT LENGTH: 300.000'
```



DETAIL B – TYPICAL AGGREGATE ACCESS/FACILITY ROAD

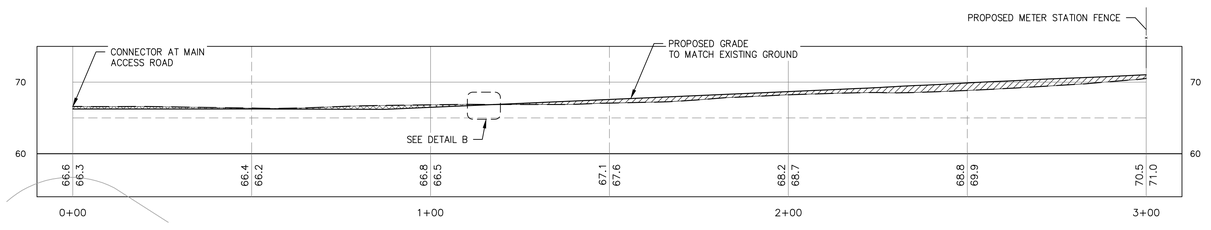
SCALE: NOT TO SCALE



REFER TO GRADING PLAN 00051-C.301-0001 AND 0002

MAIN ACCESS DRIVEWAY C/L PROFILE - A

SCALES: HORIZ. 1" = 20'-0" / VERT. 1" = 10'-0"



REFER TO GRADING PLAN 00051-C.301-0001 AND 0002

SECONDARY ACCESS DRIVEWAY C/L PROFILE - B

SCALES: HORIZ. 1" = 20'-0" / VERT. 1" = 10'-0"

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
No. 58957
PROFESSIONAL ENGINEER
06/24/26

ISSUED FOR PERMIT
06/18/2026

0 10' 20'
Scale: 1" = 10'
0 20' 40'
Scale: 1" = 20'

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		E	06/18/26	CR	DT	ISSUED FOR PERMIT
		D	05/15/26	CR	DT	ISSUED FOR BID
		C	05/15/26	CR	DT	ISSUED FOR PERMIT
00051-C.301-0002	CIVIL ACCESS ROAD PLAN	B	03/03/26	CR	PB	ISSUED FOR REVIEW – 90% REVIEW
00051-C.301-0001	CIVIL GRADING PLAN	A	05/29/25	CR	PB	ISSUED FOR REVIEW – 60% REVIEW

audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

TITLE	INITIALS	DATE
DRAWN BY:	CR	05/08/25
DESIGN CHECKER:	DT	06/18/26
DESIGN ENGINEER:	PB	06/18/26
PROJECT MANAGER:	AC	06/18/26

CAPE COD CANAL PIPELINE RELOCATION PROJECT
SAGAMORE M&R RELOCATION
M&R 00051

TITLE: CIVIL GRADING SECTIONS AND DETAILS

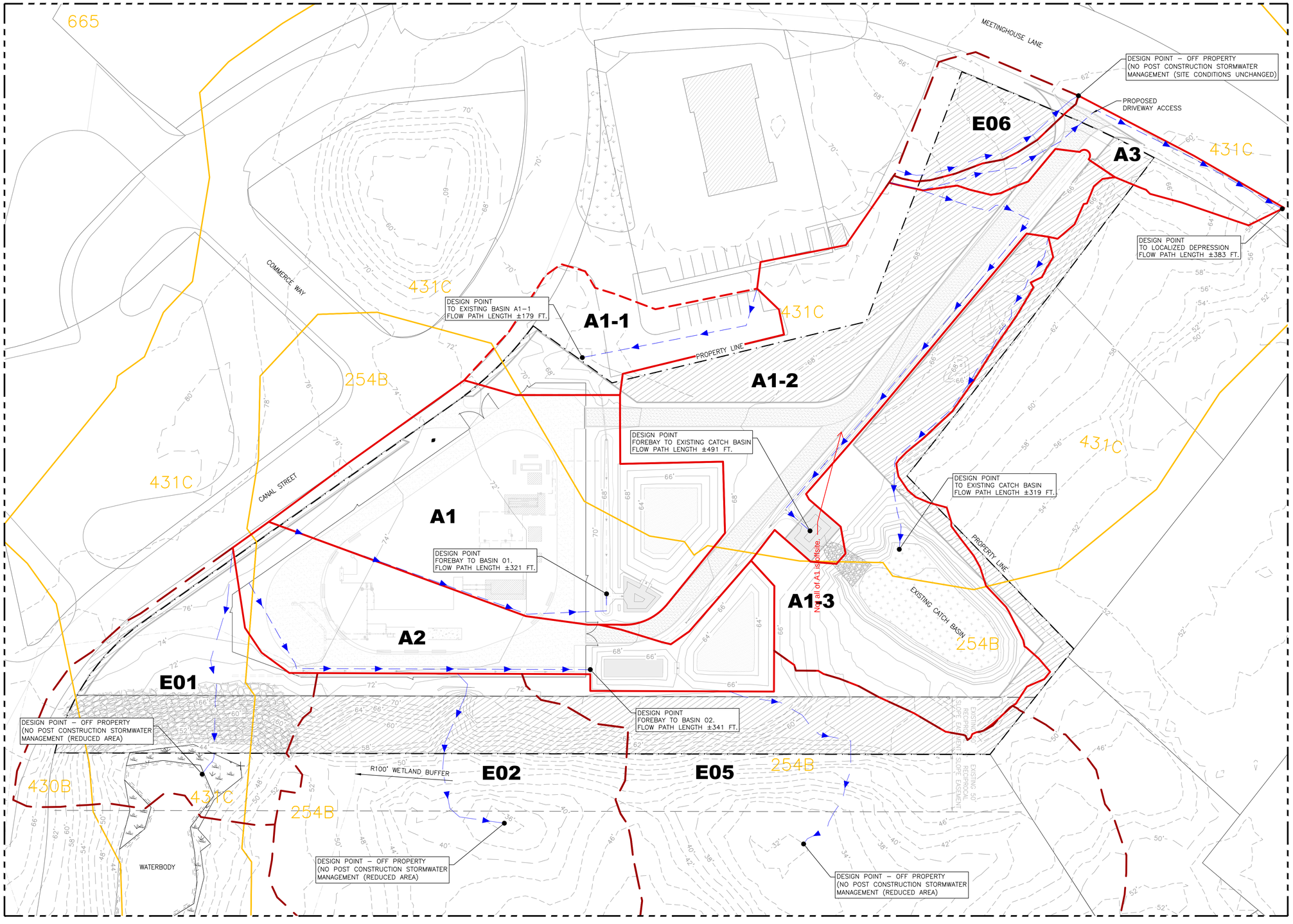
LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

YEAR: 2026 | W.O.: | SCALE: AS NOTED | DWG.: 00051-C.301-0003 | REV.: E

ENBRIDGE

Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

S:\AE\Projects\Enbridge\Mass\026356-001\200_Civil_Structural\170_Drawings\Grading\Mainland Sagamore\00051-C.301-0003.dwg – PLOT TIME: 6/18/2026 2:23 PM



PROPOSED SAGAMORE METER STATION SITE

PROPOSED SUBCATCHMENT AREAS PLAN

SCALE: 1" = 40'

0 40' 80'
Scale: 1" = 40'

STATION NORTH

NOTES:

1. ALL CONTOUR LABELS AND ELEVATION CALLOUTS ARE IN FEET.
2. PROPOSED SITE BOUNDARY IS BASED ON GROUND SURVEY CONDUCTED BY BRADY CONSULTING, L.L.C. ON OCTOBER 2, 2025
3. SUPPLEMENTAL TAX PARCEL DATA IS SHOWN FOR REFERENCE ONLY AND WAS OBTAINED FROM THE CAPE COD COMMISSION OPEN GIS DATA HUB WEBSITE.
4. PROPERTY CONVEYED TO ALGONQUIN GAS TRANSMISSON, LLC.
5. TOPOGRAPHIC SURVEY INFORMATION WAS PROVIDED BY ALGONQUIN GAS TRANSMISSION, LLC. ALL COORDINATES AND DISTANCES SHOWN HEREON ARE REFERENCED TO THE MASSACHUSETTS STATE PLANE COORDINATE SYSTEM, US FEET. ELEVATIONS ARE REFERENCED TO NAVD 88.
6. ADDITIONAL CONTOUR DATA WAS OBTAINED FROM 2022 USGS LIDAR POINT CLOUD DATA SETS.
7. THIS PROPERTY IS LOCATED IN ZONE X (AREA OF MINIMAL FLOOD HAZARD) AS DEPICTED ON FLOOD INSURANCE RATE MAP 25001C0318K DATED JULY 6, 2021.
8. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT NATURAL RESOURCE STUDY THE SITE IS NOT WITHIN THE NATURAL HERITAGE AND ENDANGERED SPECIES PROGRAM (NHESP), PRIORITY HABITATS OF RARE WILDLIFE, OR THE NHESP ESTIMATED HABITATS OF RARE WILDLIFE.
9. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THE SITE THERE IS A WETLAND WITHIN 100 FEET OF THE PROJECT LIMITS. SEE SITE LAYOUT FOR BMPS.
10. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THE SITE IS NOT LOCATED WITHIN AN AREA OF CRITICAL ENVIRONMENTAL CONCERN.
11. THIS PLAN SET IS PRELIMINARY. FOR PERMITTING PURPOSES ONLY. PROPOSED GRADING MAY BE FURTHER OPTIMIZED TO ENSURE PROPER SHEET FLOW AROUND ASSUMED BUILDING LOCATIONS, FOUNDATIONS, AND MECHANICAL EQUIPMENT. THIS PLAN IS NOT INTENDED FOR CONSTRUCTION PURPOSES.
13. REFER TO THE "EROSION & SEDIMENT GENERAL NOTES" (DWG. 00051–C.020–0001) FOR SOIL TYPES INFORMATION.

LEGEND

- PROPOSED ACCESS ROAD
- PROPOSED CONCRETE
- PROPOSED STRUCTURE
- PROPOSED ROCK (FACILITY)
- PROPOSED VEGETATED
- PROPOSED INFILTRATION BASIN
- PROPOSED SEDIMENT FOREBAY
- EXISTING BASIN
- PROPOSED ROCK
- EXISTING BUILDING
- EXISTING PAVED AREA
- WETLAND
- PROPERTY LINE
- GIS TAX PARCELS
- NRCS SOIL BOUNDARY
- WORKSPACE LIMITS
- PROPOSED GRADE LIMITS
- EDGE OF ROAD
- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- SUBCATCHMENT AREA BOUNDARY (PROP)
- SUBCATCHMENT AREA BOUNDARY (EXIST)
- TIME OR CONCENTRATION LINE
- PROPOSED WIER

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
No. 59957
PROFESSIONAL ENGINEER
06/24/26

ISSUED FOR PERMIT
06/18/2026

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		C	06/18/26	CR	DT	ISSUED FOR PERMIT
		B	05/15/26	CR	DT	ISSUED FOR BID
		A	05/15/26	CR	DT	ISSUED FOR PERMIT

audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

DRAWN BY:	CR	05/15/26	
DESIGN CHECKER:	AE	06/18/26	
DESIGN ENGINEER:	DT	06/18/26	
PROJECT MANAGER:	AC	06/18/26	
TITLE	INITIALS	DATE	

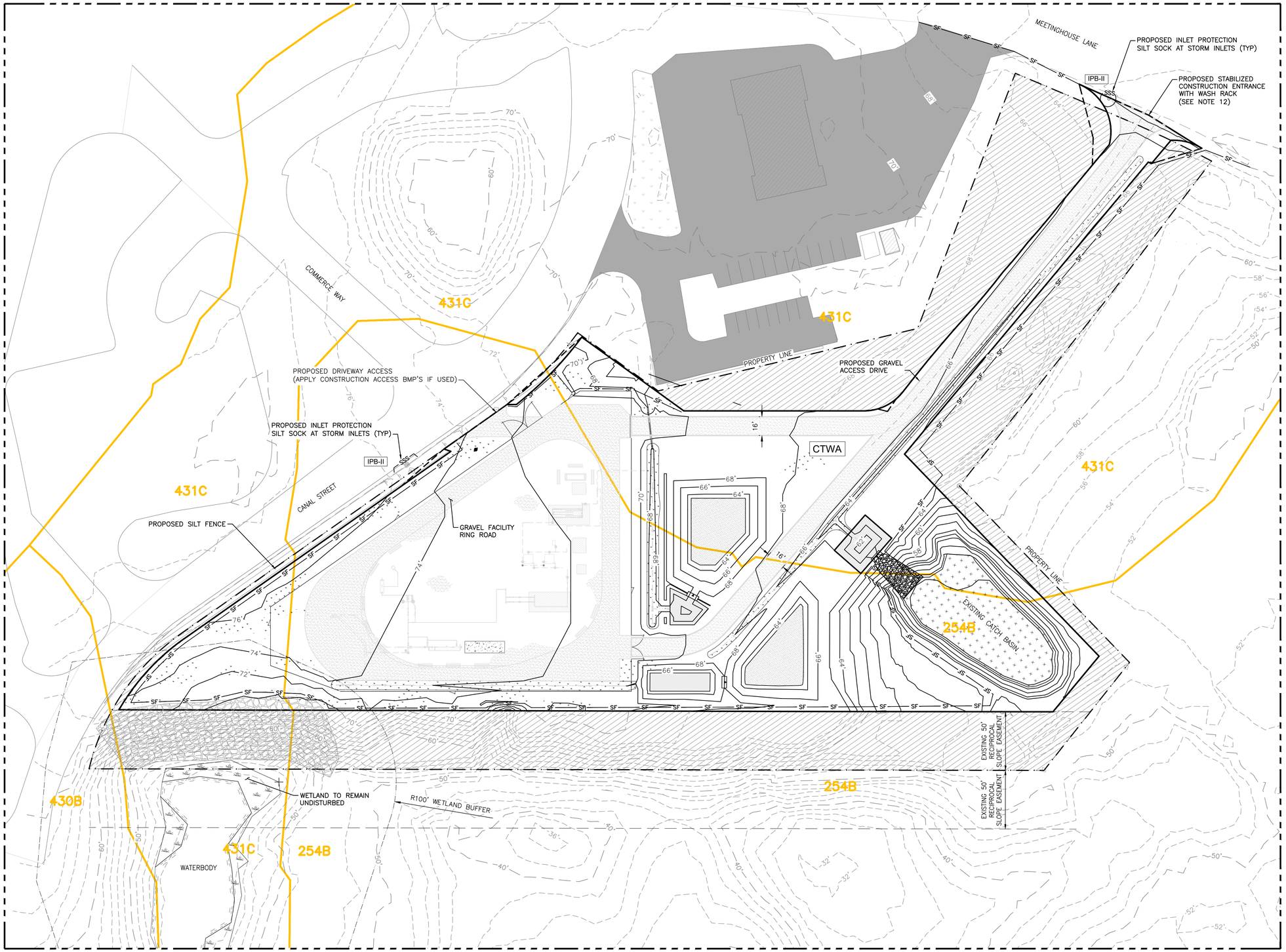
CAPE COD CANAL PIPELINE RELOCATION PROJECT
SAGAMORE M&R RELOCATION
M&R 00051
TITLE: PROPOSED SUBCATCHMENT AREAS PLAN

LOC.: BARNSTABLE COUNTY, MASSACHUSETTS
YEAR: 2026 | W.O.: | SCALE: 1"=40'

ENBRIDGE
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

DWG.: 00051–C.320–0004 | REV.: C

S:\AE\Projects\Enbridge\Mass\026356-001\200_Civil_Structural\170_Drawings\E&S Plans\Sagamore M&R\00051-C.320-0004.dwg – PLOT TIME: 6/24/2026 10:27 AM



NOTES:

1. ALL CONTOUR LABELS AND ELEVATION CALLOUTS ARE IN FEET.
2. PROPOSED SITE BOUNDARY IS BASED ON GROUND SURVEY CONDUCTED BY BRADY CONSULTING, L.L.C. ON OCTOBER 2, 2025
3. SUPPLEMENTAL TAX PARCEL DATA IS SHOWN FOR REFERENCE ONLY AND WAS OBTAINED FROM THE CAPE COD COMMISSION OPEN GIS DATA HUB WEBSITE.
4. PROPERTY CONVEYED TO ALGONQUIN GAS TRANSMISSION, LLC.
5. TOPOGRAPHIC SURVEY INFORMATION WAS PROVIDED BY ALGONQUIN GAS TRANSMISSION, LLC. ALL COORDINATES AND DISTANCES SHOWN HEREON ARE REFERENCED TO THE MASSACHUSETTS STATE PLANE COORDINATE SYSTEM, US FEET. ELEVATIONS ARE REFERENCED TO NAVD 88.
6. CONTOUR DATA SHOWN IS BASED ON THE TOPOGRAPHIC SURVEY REFERENCED ABOVE. ADDITIONAL CONTOUR DATA WAS OBTAINED FROM 2022 USGS LIDAR POINT CLOUD DATA SETS.
7. THIS PROPERTY IS LOCATED IN ZONE X (AREA OF MINIMAL FLOOD HAZARD) AS DEPICTED ON FLOOD INSURANCE RATE MAP 25001C0318K DATED JULY 6, 2021.
8. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT NATURAL RESOURCE STUDY THE SITE IS NOT WITHIN THE NATURAL HERITAGE AND ENDANGERED SPECIES PROGRAM (NHESP), PRIORITY HABITATS OF RARE WILDLIFE, OR THE NHESP ESTIMATED HABITATS OF RARE WILDLIFE.
9. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THE SITE THERE IS A WETLAND WITHIN 100 FEET OF THE PROJECT LIMITS. SEE SITE LAYOUT FOR BMPS.
10. ACCORDING TO MASSGIS AND 3RD PARTY CONSULTANT THE SITE IS NOT LOCATED WITHIN AN AREA OF CRITICAL ENVIRONMENTAL CONCERN.
11. THIS PLAN SET IS PRELIMINARY. FOR PERMITTING PURPOSES ONLY. PROPOSED GRADING MAY BE FURTHER OPTIMIZED TO ENSURE PROPER SHEET FLOW AROUND ASSUMED BUILDING LOCATIONS, FOUNDATIONS, AND MECHANICAL EQUIPMENT. THIS PLAN IS NOT INTENDED FOR CONSTRUCTION PURPOSES.
12. REFER TO DRAWINGS 00051-C.320-0006 THRU 0007 FOR BMP DETAILS.
13. REFER TO THE "EROSION & SEDIMENT CONTROL GENERAL NOTES" (DWG. 00051-C.020-0001) FOR SOIL TYPE INFORMATION.
14. PROPOSED TEMPORARY WORKSPACE ACREAGE: 5.99 (260915 SQFT)
15. TEMPORARY STOCK PILE LOCATIONS TO BE LOCATED WITHIN THE TEMPORARY WORKSPACE SHOWN ON THE PLANS AND COORDINATED WITH THE ON-SITE INSPECTOR. REFER TO DETAIL ON DRAWING 00051-C.320-0006.
16. REFER TO THE "EROSION & SEDIMENT GENERAL NOTES" (DWG. 00051-C.020-0001) FOR SOIL TYPES INFORMATION.

LEGEND

- PROPOSED ACCESS ROAD
- PROPOSED CONCRETE
- PROPOSED STRUCTURE
- PROPOSED ROCK (FACILITY)
- PROPOSED VEGETATED
- PROPOSED INFILTRATION BASIN
- EXISTING CATCH BASIN
- PROPOSED SEDIMENT FOREBAY
- PROPOSED ROCK
- EXISTING BUILDING
- EXISTING PAVED AREA
- WETLAND
- CONSTRUCTION TRUCK WASH AREA (CTWA)
- INLET PROTECTION BARRIER (IPB-II)
- PROPOSED FENCE
- PROPERTY LINE
- GIS TAX PARCELS
- NRCS SOIL BOUNDARY
- WORKSPACE LIMITS
- PROPOSED GRADE LIMITS
- EDGE OF ROAD
- EDGE OF WATER
- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- PROPOSED SILT FENCE (SF)
- PROPOSED SILT SOCK (SSS)
- PROPOSED WIER

PAUL BAKER CIVIL No. 58857 COMMONWEALTH OF MASSACHUSETTS PROFESSIONAL ENGINEER

06/24/26

ISSUED FOR PERMIT
06/18/2026

PROPOSED SAGAMORE METER STATION SITE

CONSTRUCTION EROSION AND SEDIMENT CONTROL PLAN

SCALE: 1" = 40'

Scale: 1" = 40'

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
00051-C.320-0007	DETAILS	C	06/18/26	CR	DT	ISSUED FOR PERMIT
00051-C.320-0006	DETAILS	B	05/15/26	CR	DT	ISSUED FOR BID
00051-C.020-0001	GENERAL NOTES	A	05/15/26	CR	DT	ISSUED FOR PERMIT

audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

DRAWN BY:	CR	05/15/26	
DESIGN CHECKER:	DT	06/18/26	
DESIGN ENGINEER:	PB	06/18/26	
PROJECT MANAGER:	AC	06/18/26	
TITLE	INITIALS	DATE	

CAPE COD CANAL PIPELINE RELOCATION PROJECT
SAGAMORE M&R RELOCATION
M&R 00051
TITLE: CONSTRUCTION EROSION AND SEDIMENT CONTROL PLAN

YEAR: 2026 | W.O.: | SCALE: AS NOTED

ENBRIDGE
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

DWG.: 00051-C.320-0005 | REV.: C

S:\AE\Projects\Enbridge\Mass\026356-0011\200_Civil_Structural\170_Drawings\E&S Plans\Sagamore M&R\00051-C.320-0005.dwg - PLOT TIME: 6/24/2026 9:42 AM

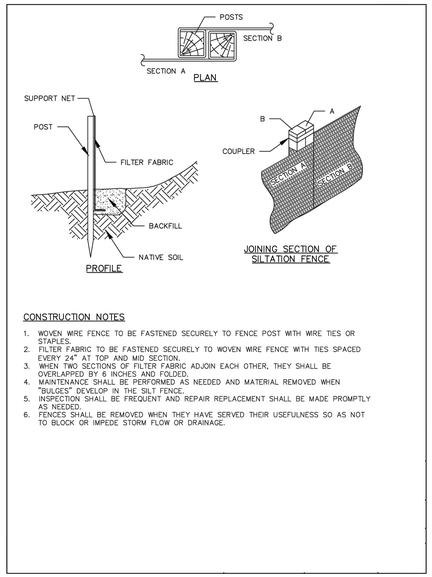
E&S CONSTRUCTION SEQUENCE AND MAINTENANCE

THE FOLLOWING CONSTRUCTION SEQUENCING AND EROSION AND SEDIMENTATION CONTROL MEASURES HAVE BEEN DEVELOPED TO MINIMIZE EROSION, SEDIMENT TRANSPORT, AND IMPACTS TO ADJACENT DRAINAGE SYSTEMS AND RESOURCE AREAS DURING ALL PHASES OF CONSTRUCTION. THE CONTRACTOR SHALL BE RESPONSIBLE FOR MAINTAINING ALL EROSION AND SEDIMENTATION CONTROLS THROUGHOUT CONSTRUCTION AND IMPLEMENTING ADDITIONAL MEASURES AS NECESSARY TO PREVENT OFF-SITE SEDIMENT TRANSPORT. THE SEQUENCE OF WORK SHALL GENERALLY PROCEED AS FOLLOWS:

- INSTALL CONSTRUCTION LIMIT SILT FENCING AND STABILIZED CONSTRUCTION ENTRANCES PRIOR TO THE COMMENCEMENT OF CLEARING OR EARTHWORK ACTIVITIES. CRUSHED STONE CONSTRUCTION ENTRANCE APRONS SHALL BE MAINTAINED TO MINIMIZE SEDIMENT TRACKING ONTO ADJACENT ROADWAYS.
- INSTALL PERIMETER EROSION AND SEDIMENTATION CONTROLS INCLUDING FIBER ROLLS AND SILT FENCE BARRIERS AT THE DOWNGRADIENT LIMITS OF DISTURBANCE AND AROUND SENSITIVE RESOURCE AREAS. IN AREAS SUBJECT TO CONCENTRATED RUNOFF OR HIGHER SEDIMENT LOADING, FIBER ROLLS SHALL BE SUPPLEMENTED WITH SILT FENCING FOR ADDITIONAL PROTECTION.
- INSTALL CATCH BASIN PROTECTION MEASURES, INCLUDING SILT SACKS WITHIN EXISTING AND NEWLY CONSTRUCTED CATCH BASINS, PRIOR TO NEARBY EARTH DISTURBANCE ACTIVITIES, IF APPLICABLE.
- ESTABLISH DESIGNATED CONCRETE WASHOUT AREAS IN APPROPRIATE UPLAND LOCATIONS TO CONTAIN CONCRETE WASH WATER AND SOLIDS GENERATED DURING CONSTRUCTION ACTIVITIES. CONCRETE WASHOUT FACILITIES SHALL BE LEAK PROOF AND MAINTAINED THROUGHOUT THE DURATION OF THE PROJECT.
- CONDUCT CLEARING AND GRUBBING OPERATIONS ONLY WITHIN APPROVED LIMITS OF DISTURBANCE. EXISTING VEGETATION OUTSIDE THE WORK LIMITS SHALL REMAIN PROTECTED TO THE MAXIMUM EXTENT PRACTICABLE.
- STRIP AND STOCKPILE TOPSOIL IN DESIGNATED STABILIZED AREAS UNTIL HAULED OFF. ANY STOCKPILED SOILS REMAINING INACTIVE SHALL BE COVERED OR TEMPORARILY STABILIZED TO MINIMIZE EROSION AND FUGITIVE DUST.
- TEMPORARY CHANNELS TO BE GRADED IN ONCE PERMANENT VEGETATED CHANNELS ARE INSTALLED.
- PERFORM EXCAVATION, GRADING, AND UTILITY INSTALLATION ACTIVITIES IN PHASES TO MINIMIZE THE EXTENT OF EXPOSED SOILS AT ANY ONE TIME.
- UTILIZE WATER TRUCKS OR OTHER DUST SUPPRESSION METHODS AS NECESSARY DURING EXCAVATION, GRADING, AND CONSTRUCTION OPERATIONS TO MINIMIZE DUST.
- INSTALL UNDERGROUND DRAINAGE INFRASTRUCTURE, STORMWATER MANAGEMENT SYSTEMS, AND ASSOCIATED DRAINAGE APPURTENANCES AS GRADING PROGRESSES.
- STABILIZE DISTURBED SOIL AREAS WITHIN FOURTEEN (14) DAYS AFTER CONSTRUCTION ACTIVITIES HAVE TEMPORARILY OR PERMANENTLY CEASED, UNLESS WEATHER CONDITIONS PROHIBIT STABILIZATION ACTIVITIES. TEMPORARY VEGETATIVE STABILIZATION SHALL INCLUDE HYDROSEEDING, TEMPORARY SEEDING, MULCH, OR EROSION CONTROL BLANKET APPLICATIONS AS APPROPRIATE.
- IMPLEMENT VEGETATIVE SLOPE STABILIZATION MEASURES ON SLOPES 2:1 OR FLATTER USING TEMPORARY ANNUAL GRASSES AND PERMANENT PERENNIAL SEED MIXES TO MINIMIZE EROSION AND PROMOTE LONG-TERM STABILIZATION.
- COMPLETE FINAL GRADING ACTIVITIES AND ESTABLISH PERMANENT STABILIZATION MEASURES INCLUDING PERMANENT SEEDING, LANDSCAPING, MULCH, EROSION CONTROL BLANKETS, AND OTHER APPROVED STABILIZATION METHODS.
- REMOVE ACCUMULATED SEDIMENT FROM TEMPORARY CONTROLS AND DRAINAGE STRUCTURES AS NECESSARY THROUGHOUT CONSTRUCTION.
- REMOVE TEMPORARY EROSION AND SEDIMENTATION CONTROLS ONLY AFTER ALL DISTURBED AREAS HAVE ACHIEVED PERMANENT STABILIZATION. DISTURBED AREAS RESULTING FROM REMOVAL ACTIVITIES SHALL BE REGRADED AND STABILIZED AS NECESSARY.

THE CONTRACTOR SHALL PERFORM ROUTINE INSPECTION AND MAINTENANCE OF ALL EROSION AND SEDIMENTATION CONTROL MEASURES THROUGHOUT CONSTRUCTION, INCLUDING BUT NOT LIMITED TO THE FOLLOWING:

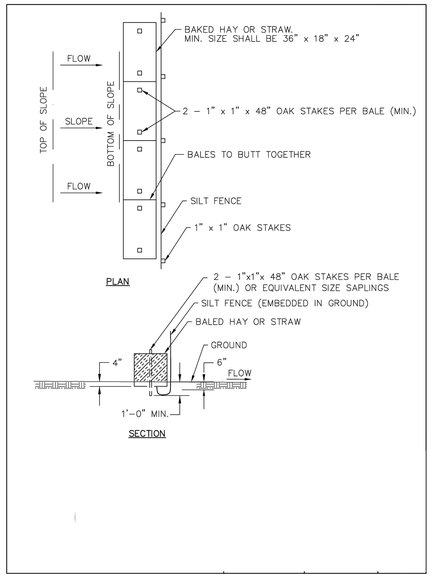
- INSPECT ALL EROSION AND SEDIMENTATION CONTROL MEASURES PERIODICALLY AND AFTER EACH RAINFALL EVENT. INSPECTION RECORDS SHALL BE MAINTAINED ONSITE BY THE CONTRACTOR.
- REPAIR OR REPLACE DAMAGED OR DETERIORATED EROSION CONTROL MEASURES IMMEDIATELY UPON IDENTIFICATION.
- REMOVE ACCUMULATED SEDIMENT FROM BEHIND SILT FENCE BARRIERS, STRAW WATTLES, AND OTHER SEDIMENT CONTROLS WHEN SEDIMENT REACHES APPROXIMATELY SIX INCHES IN DEPTH OR AS NECESSARY TO MAINTAIN FUNCTIONALITY.
- MAINTAIN STRAW WATTLES IN CONTINUOUS CONTACT WITH THE GROUND SURFACE AND RESET OR REPLACE AS NECESSARY.
- INSPECT AND MAINTAIN CATCH BASIN PROTECTION MEASURES REGULARLY AND REMOVE ACCUMULATED SEDIMENT AS REQUIRED.
- MAINTAIN STABILIZED CONSTRUCTION ENTRANCES AND REPLACE CRUSHED STONE AS SEDIMENT ACCUMULATES.
- INSPECT CONCRETE WASHOUT FACILITIES DAILY AND AFTER STORM EVENTS TO ENSURE ADEQUATE CONTAINMENT CAPACITY AND PREVENT LEAKAGE OR OVERFLOW. CONCRETE WASHOUT MATERIALS SHALL BE PROPERLY REMOVED AND RECYCLED OR DISPOSED OF IN ACCORDANCE WITH APPLICABLE REGULATIONS.
- MAINTAIN TEMPORARY AND PERMANENT VEGETATIVE STABILIZATION MEASURES, INCLUDING RESEEDING AND REPAIR OF ERODED AREAS AS NECESSARY.
- PROPERLY DISPOSE OF SEDIMENT AND DEBRIS REMOVED FROM EROSION CONTROL STRUCTURES AND COVER MATERIALS IF TEMPORARILY STORED ONSITE.
- MAINTAIN ALL EROSION AND SEDIMENTATION CONTROL MEASURES UNTIL FINAL SITE STABILIZATION HAS BEEN ACHIEVED.



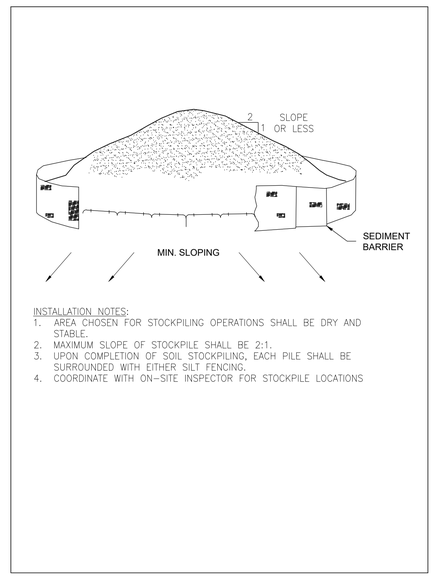
CONSTRUCTION NOTES

1. WOVEN WIRE FENCE TO BE FASTENED SECURELY TO FENCE POST WITH WIRE TIES OR STAPLES.
2. FILTER FABRIC TO BE FASTENED SECURELY TO WOVEN WIRE FENCE WITH TIES SPACED EVERY 24" AT TOP AND MID SECTION.
3. WHEN TWO SECTIONS OF FILTER FABRIC ADJOIN EACH OTHER, THEY SHALL BE OVERLAPPED BY 6 INCHES AND FOLDED.
4. MAINTENANCE SHALL BE PERFORMED AS NEEDED AND MATERIAL REMOVED WHEN "BULGES" DEVELOP IN THE SILT FENCE.
5. INSPECTION SHALL BE FREQUENT AND REPAIR REPLACEMENT SHALL BE MADE PROMPTLY AS NEEDED.
6. FENCES SHALL BE REMOVED WHEN THEY HAVE SERVED THEIR USEFULNESS SO AS NOT TO BLOCK OR IMPEDE STORM FLOW OR DRAINAGE.

SILTATION FENCE



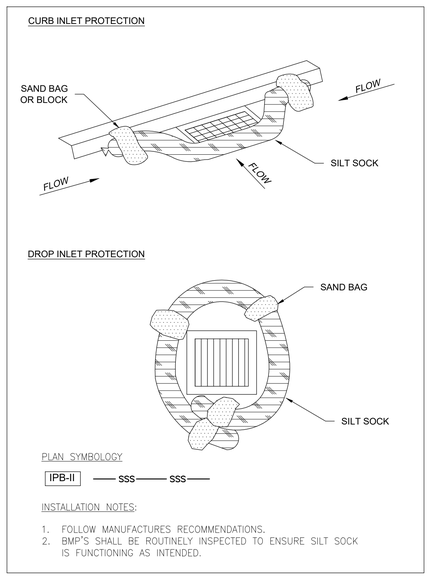
HAYBALES AND SILT FENCE



INSTALLATION NOTES:

1. AREA CHOSEN FOR STOCKPILING OPERATIONS SHALL BE DRY AND STABLE.
2. MAXIMUM SLOPE OF STOCKPILE SHALL BE 2:1.
3. UPON COMPLETION OF SOIL STOCKPILING, EACH PILE SHALL BE SURROUNDED WITH EITHER SILT FENCING.
4. COORDINATE WITH ON-SITE INSPECTOR FOR STOCKPILE LOCATIONS

TEMPORARY STOCKPILE DETAIL



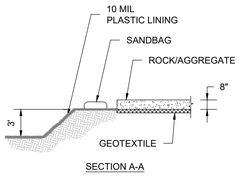
PLAN SYMBOLOGY

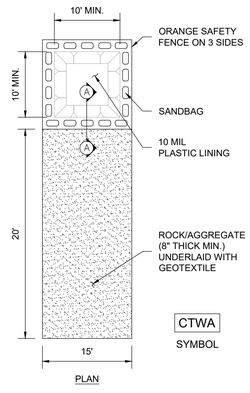
IPB-II — SSS — SSS

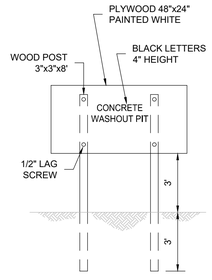
INSTALLATION NOTES:

1. FOLLOW MANUFACTURES RECOMMENDATIONS.
2. BMP'S SHALL BE ROUTINELY INSPECTED TO ENSURE SILT SOCK IS FUNCTIONING AS INTENDED.

SILT SOCK INLET PROTECTION



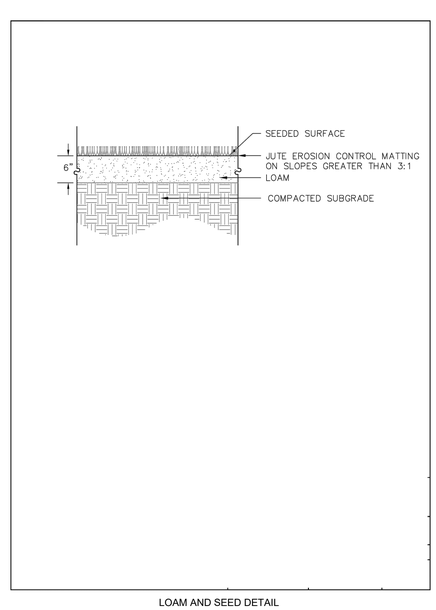




GENERAL NOTES:

1. POST A SIGN READING "CONCRETE WASHOUT PIT" NEXT TO THE PIT.
2. VERBALLY INSTRUCT THE CONCRETE TRUCK DRIVERS WHERE THE PIT IS AND TO WASHOUT THEIR TRUCKS IN THE PIT AND NOWHERE ELSE.
3. UPON THE CONCRETE SETTING UP (CURING, DRYING OUT), THE CONCRETE WASTE SHALL BE REMOVED FROM THE PROJECT SITE AND DISPOSED OF PROPERLY BY THE CONTRACTOR. AFTER REMOVAL OF THE CONCRETE WASTE, THE WASHOUT PIT SHALL BE FILLED WITH CLEAN FILL MATERIAL AND COMPACTED TO IN-SITU CONDITIONS, OR AS DIRECTED BY THE PROJECT SPECIFICATIONS.
4. CONCRETE WASHOUT PITS SHALL NOT BE LOCATED DIRECTLY ADJACENT TO, NOR AT ANY TIME DRAIN INTO THE STORM SEWER SYSTEM OR ANY OTHER SWALE, DITCH, OR WATERWAY.
5. CONSTRUCT ENTRY ROAD AND BOTTOM OF WASHOUT AREA TO SUPPORT EXPECTED LOADINGS FROM TRUCKS EQUIPMENT.

CONCRETE TRUCK WASHOUT AREA
SCALE: N.T.S.



LOAM AND SEED DETAIL

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
No. 58957
PROFESSIONAL ENGINEER
06/24/26

ISSUED FOR PERMIT
06/18/2026

NOTES:

1. SEE CONSTRUCTION EROSION AND SEDIMENT CONTROL PLAN DRAWING 00051-C.320-0005.
2. CONTRACTOR TO EVALUATE PROJECT AREA TO IMPLEMENT BMPS IN AREAS THAT BEST FIT FOR THE CURRENT CONDITIONS. CONSULT WITH THE ONSITE INSPECTOR FOR ANY ADJUSTMENTS AND/OR ADDITIONS TO THE CONSTRUCTION STORMWATER MANAGEMENT PLAN.

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		C	06/18/26	CR	DT	ISSUED FOR PERMIT
		B	05/15/26	CR	DT	ISSUED FOR BID
		A	05/15/26	CR	DT	ISSUED FOR PERMIT

audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

TITLE	INITIALS	DATE
DRAWN BY:	CR	05/15/26
DESIGN CHECKER:	DT	06/18/26
DESIGN ENGINEER:	PB	06/18/26
PROJECT MANAGER:	AC	06/18/26

CAPE COD CANAL PIPELINE RELOCATION PROJECT
SAGAMORE M&R RELOCATION
M&R 00051
TITLE: DETAILS

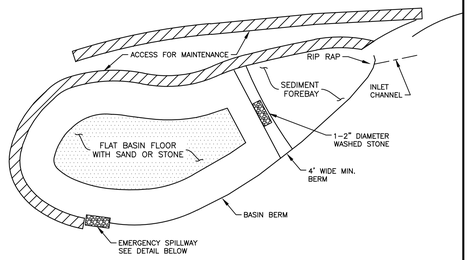
LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

YEAR: 2026 | W.O.: | SCALE: N.T.S.

ENBRIDGE
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

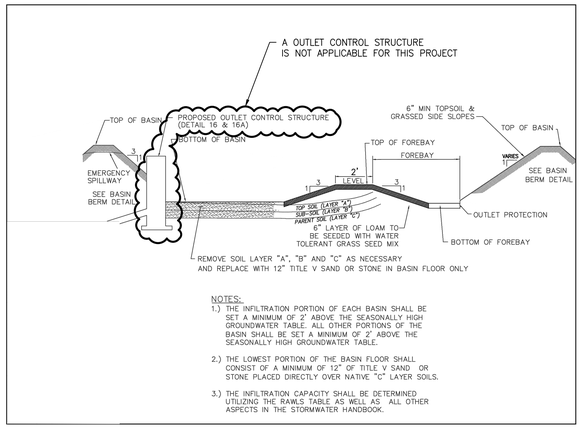
DWG.: 00051-C.320-0006 | REV.: C

S:\AE\Projects\Enbridge\Mass\026356-001\200_Civil_Structural\170_Drawings\E&S Plans\Sagamore M&R\00051-C.320-0006.dwg - PLOT TIME: 6/23/2026 10:52 PM



NOTE:
THE INFILTRATION BASIN SHALL BE DESIGNED BY A PROFESSIONAL ENGINEER, AND SHALL COMPLY WITH ALL ASPECTS OF THE MA-DEP STORMWATER HANDBOOK.

INFILTRATION BASIN DETAIL

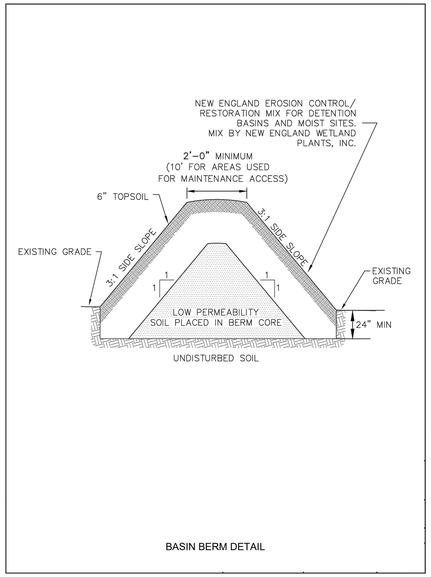


NOTES:
1.) THE INFILTRATION PORTION OF EACH BASIN SHALL BE SET A MINIMUM OF 2' ABOVE THE SEASONALLY HIGH GROUNDWATER TABLE. ALL OTHER PORTIONS OF THE BASIN SHALL BE SET A MINIMUM OF 2' ABOVE THE SEASONALLY HIGH GROUNDWATER TABLE.

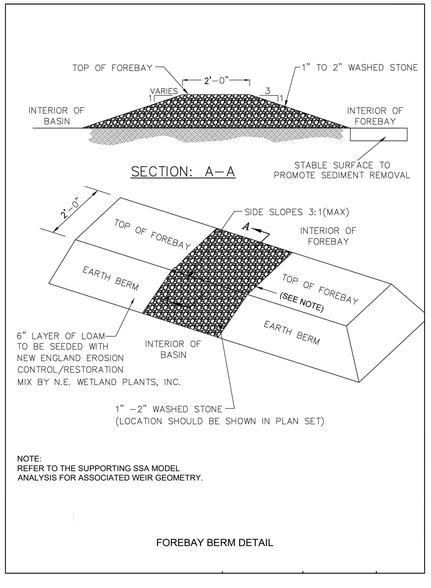
2.) THE LOWEST PORTION OF THE BASIN FLOOR SHALL CONSIST OF A MINIMUM OF 12" OF TITLE V SAND OR STONE PLACED DIRECTLY OVER NATIVE "C" LAYER SOILS.

3.) THE INFILTRATION CAPACITY SHALL BE DETERMINED UTILIZING THE RAWLS TABLE AS WELL AS ALL OTHER ASPECTS IN THE STORMWATER HANDBOOK.

INFILTRATION BASIN CROSS SECTION

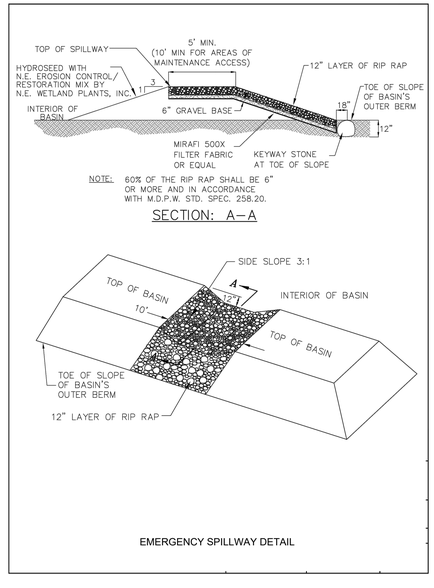


BASIN BERM DETAIL



NOTE:
REFER TO THE SUPPORTING SSA MODEL ANALYSIS FOR ASSOCIATED WEIR GEOMETRY.

FOREBAY BERM DETAIL



EMERGENCY SPILLWAY DETAIL

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
No. 58957
PROFESSIONAL ENGINEER
06/24/26

ISSUED FOR PERMIT
06/18/2026

NOTES:
1. SEE CONSTRUCTION EROSION AND SEDIMENT CONTROL PLAN DRAWING 00051-C.320-0005.
2. CONTRACTOR TO EVALUATE PROJECT AREA TO IMPLEMENT BMPS IN AREAS THAT BEST FIT FOR THE CURRENT CONDITIONS. CONSULT WITH THE ONSITE INSPECTOR FOR ANY ADJUSTMENTS AND/OR ADDITIONS TO THE CONSTRUCTION STORMWATER MANAGEMENT PLAN.

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		C	06/18/26	JA	DT	ISSUED FOR PERMIT
		B	05/15/26	VN	DT	ISSUED FOR BID
		A	05/15/26	CR	DT	ISSUED FOR PERMIT

audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

DRAWN BY:	CR	05/15/26	CAPE COD CANAL PIPELINE RELOCATION PROJECT
DESIGN CHECKER:	AE	06/18/26	SAGAMORE M&R RELOCATION
DESIGN ENGINEER:	DT	06/18/26	M&R 00051
PROJECT MANAGER:	AC	06/18/26	TITLE: DETAILS
LOC.: BARNSTABLE COUNTY, MASSACHUSETTS			

TITLE	INITIALS	DATE	YEAR:	W.O.:	SCALE:	DWG.:	REV.:
			2026		N.T.S.	00051-C.320-0007	C

ENBRIDGE
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

S:\AE\Projects\Enbridge\Mass\026356-001\200_Civil_Structural\170_Drawings\E&S Plans\Sagamore M&R\00051-C.320-0007.dwg - PLOT TIME: 6/23/2026 9:25 PM

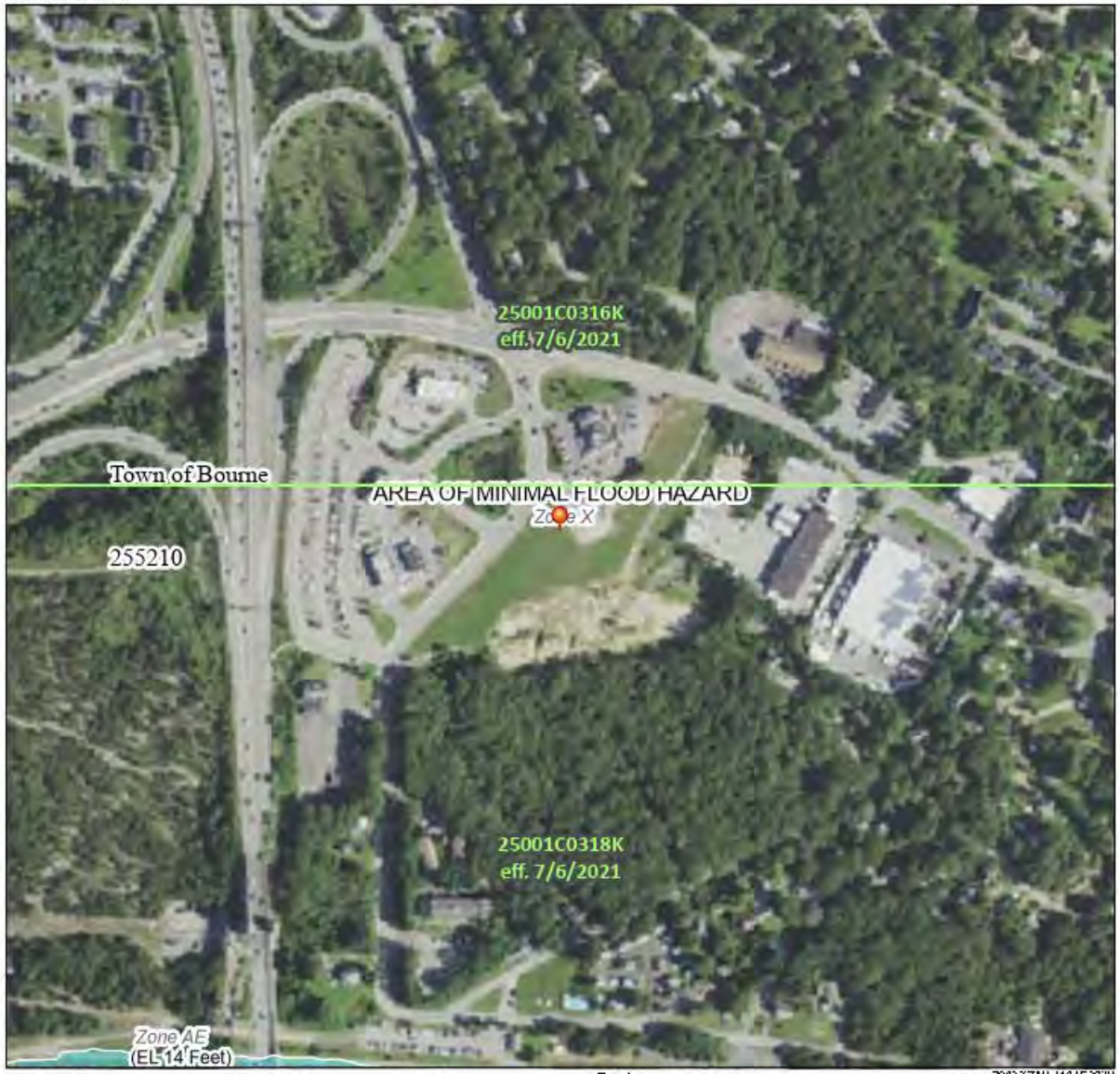
Attachment G – Standard 9 Supporting Documentation

FEMA Flood Mapping

National Flood Hazard Layer FIRMette

FEMA

70°32'45"W 41°47'5"N



0 250 500 1,000 1,500 2,000 Feet

1:6,000

70°32'7"W 41°46'38"N

Basemap Imagery Source: USGS National Map 2023

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- 20.2 / 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
- Coastal Transect
- 513 Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 4/14/2026 at 9:43 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

ATTACHMENT 6

Traffic Management Plan

GENERAL NOTES

1. ALL CONSTRUCTION SIGNING, TEMPORARY TRAFFIC CONTROL DEVICES, AND ROADSIDE ELEMENTS SHALL CONFORM WITH THE 2009 MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES (MUTCD) AS AMENDED, THE MASSDOT STANDARD DETAILS AND DRAWINGS FOR THE DEVELOPMENT OF TEMPORARY TRAFFIC CONTROL PLANS, THE LATEST REVISIONS OF THE AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO) ROADSIDE DESIGN GUIDE, AASHTO POLICY ON GEOMETRIC DESIGN OF HIGHWAYS AND STREETS, AND THE AASHTO MANUAL FOR ASSESSING SAFETY HARDWARE (MASH).
2. ACCESS/ EGRESS AND LANE/SHOULDER CLOSURES ON STATE HIGHWAYS SHALL BE IN ACCORDANCE WITH THE MASSDOT PERMIT UNLESS APPROVED BY THE PERMIT ENGINEER.
3. REFLECTORIZED CONES SHALL BE A MINIMUM OF 36 INCHES IN HEIGHT.
4. CONES MAY BE USED IN LIEU OF DRUMS OUTSIDE OF TAPER AREAS.
5. ALL DRUMS SHALL BE APPROXIMATELY PLACED AND MOVED AS NECESSARY TO MAINTAIN SAFE AND REASONABLE ABUTTER ACCESS. WORK MAY REQUIRE ADDITIONAL SIGNS, DRUMS AND OTHER TRAFFIC CONTROL DEVICES, GRADING AND TEMPORARY PAVEMENT FOR PASSAGE OF PEDESTRIAN, VEHICULAR AND EMERGENCY TRAFFIC THROUGH THE WORK AREAS, BOTH DURING AND AFTER WORKING HOURS, TO MAINTAIN SUCH ACCESS.
6. 11' MINIMUM LANE WIDTHS SHALL BE MAINTAINED UNLESS OTHERWISE NOTED.
7. TEMPORARY TRAFFIC CONTROL DEVICES AND SIGNS SHALL BE COVERED OR REMOVED DURING NON-WORKING HOURS WHEN NOT IN USE.
8. SIGNS INSTALLED ON PORTABLE STANDS REQUIRE 12 INCH MINIMUM MOUNTING HEIGHT FROM THE ROADWAY SURFACE TO THE BOTTOM OF THE SIGN.
9. SIGNS INSTALLED ON PORTABLE STANDS PLACED AMONG CHANNELIZATION DEVICES REQUIRE A 36 INCH MINIMUM MOUNTING HEIGHT FROM THE ROADWAY SURFACE TO THE BOTTOM OF THE SIGN.
10. SIGNS MOUNTED ON POSTS REQUIRE A MINIMUM 84 INCH MOUNTING HEIGHT FROM THE ROADWAY OR SIDEWALK SURFACE TO THE BOTTOM OF THE SIGN. CONTRACTOR SHALL MAINTAIN A MINIMUM SIDEWALK HORIZONTAL CLEAR WIDTH OF 36" AT ALL TIMES.
11. ALL SIGNS SHALL BE MOUNTED ON THEIR OWN MASH CRASH TESTED SIGN SUPPORTS AND INSTALLED IN ACCORDANCE WITH THE MUTCD. SIGNS SHALL NOT BE MOUNTED TO OR LEANED AGAINST DRUMS OR CONES.
12. CONTRACTOR SHALL SECURE WORK AREAS BY APPROPRIATE MEANS, TO PREVENT UNAUTHORIZED ACCESS AT ALL TIMES.
13. CONTRACTOR SHALL HAVE TRUCK MOUNTED ATTENUATORS (1 PER CLOSED LANE OR USABLE SHOULDER) IN ADVANCE OF WORK AREA FOR ALL TEMPORARY WORK ZONES ON ROUTE 6, 25 AND 28 OR AS DIRECTED BY THE PERMIT ENGINEER.
14. PROVIDE CLEAR ZONES AROUND TRUCK MOUNTED ATTENUATORS AS REQUIRED BY THE MANUFACTURER.

TEMPORARY TRAFFIC CONTROL SIGN SUMMARY

IDENTIFICATION NUMBER	SIZE OF SIGN WIDTH	SIZE OF SIGN HEIGHT	TEXT	TEXT DIMENSIONS (INCHES) LETTER HEIGHT	VERTICAL SPACING	ARROW RTE. MKR.	COLOR BACKGROUND	COLOR LEGEND	COLOR BORDER	UNIT AREA (S.F.)
MA-R2-10a	48"	36"	WORK ZONE / SPEEDING FINES DOUBLED	AS PER MASSDOT STANDARD			FLUORESCENT ORANGE / WHITE	BLACK	BLACK	12.00
MA-R2-10e	36"	48"	END ROAD WORK / DOUBLE FINES END				FLUORESCENT ORANGE / WHITE	BLACK	BLACK	12.00
R9-9	24"	12"	SIDEWALK CLOSED	SEE FHWA "STANDARD HIGHWAY SIGNS, 2004 EDITION"; AS AMENDED			WHITE	BLACK	BLACK	2.00
R9-11L	24"	18"	SIDEWALK CLOSED AHEAD / CROSS HERE				WHITE	BLACK	BLACK	3.00
R9-11aR	24"	12"	SIDEWALK CLOSED / CROSS HERE				WHITE	BLACK	BLACK	2.00
W4-2R	36"	36"					FLUORESCENT ORANGE	BLACK	BLACK	9.00
W20-1c	36"	36"	ROAD WORK AHEAD				FLUORESCENT ORANGE	BLACK	BLACK	9.00
W20-4c	36"	36"	ONE LANE ROAD AHEAD				FLUORESCENT ORANGE	BLACK	BLACK	9.00
W20-5cR	36"	36"	RIGHT LANE CLOSED AHEAD				FLUORESCENT ORANGE	BLACK	BLACK	9.00
MA-W20-7b	36"	36"	POLICE OFFICER AHEAD	AS PER MASSDOT STANDARD			FLUORESCENT ORANGE	BLACK	BLACK	9.00
W21-5aR	36"	36"	RIGHT SHOULDER CLOSED	SEE FHWA "STANDARD HIGHWAY SIGNS, 2004 EDITION"; AS AMENDED			FLUORESCENT ORANGE	BLACK	BLACK	9.00
W21-5bR	36"	36"	RIGHT SHOULDER CLOSED AHEAD				FLUORESCENT ORANGE	BLACK	BLACK	9.00
M4-9bL	30"	24"	DETOUR	SEE FHWA "STANDARD HIGHWAY SIGNS, 2004 EDITION"; AS AMENDED			FLUORESCENT ORANGE	BLACK	BLACK	5.00
M4-9bR	30"	24"	DETOUR				FLUORESCENT ORANGE	BLACK	BLACK	5.00
SP-1	36"	36"	TRUCKS ENTERING AND EXITING	4"C 4"C 4"C 4"C	2" 2" 2"	N/A	FLUORESCENT ORANGE	BLACK	BLACK	9.00

NOTES:
1. HIGH INTENSITY REFLECTIVE SHEETING SHALL BE USED FOR ALL SIGNS. SEE FHWA "STANDARD HIGHWAY SIGNS, 2004 EDITION" FOR TEXT DIMENSIONS, AS AMENDED; THE 1977 MASSHIGHWAY DEPARTMENT CONSTRUCTION AND TRAFFIC STANDARD DETAILS, AS AMENDED, FOR SIGNS AND SUPPORTS; THE MASSHIGHWAY DEPARTMENT SIGN LISTINGS 1993 EDITION, AS AMENDED; THE 2009 MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES FOR MOUNTING REQUIREMENTS; AND THE 2017 MassDOT STANDARD SIGNS BOOK, AS AMENDED.
2. ALL SIGNS SHOWN GRAPHICALLY FOR INFORMATION ONLY. SIGN VENDOR SHALL FABRICATE ALL SIGNS IN ACCORDANCE WITH THE APPLICABLE STANDARDS.

LEGEND

P	POLICE OFFICER
S	TRAFFIC SIGNAL
●	REFLECTORIZED DRUM
	TEMPORARY CONSTRUCTION SIGN
	TYPE III BARRICADE
	WORK AREA (PUBLIC ACCESS RESTRICTED)
	SIDEWALK CLOSURE
	CONSTRUCTION ACCESS/EGRESS
	ARROW BOARD (AB) (RIGHT OR LEFT)
TMA	TRUCK MOUNTED ATTENTUATOR
←	TRAFFIC FLOW
NTS	NOT TO SCALE

ADVANCE SIGN SPACING

	DISTANCE BETWEEN SIGNS (FEET)		
ROADWAY	A	B	C
ROUTE 6, 6A, 25, 28	500	500	500
ALL OTHER ROADWAYS	350	350	350

LANE TAPER LENGTH FORMULAS

L= TAPER LENGTH IN FEET

W= WIDTH OF ROADWAY TO BE SHIFTED OR REDIRECTED IN FEET

S= POSTED SPEED LIMIT IN MPH

POSTED SPEED	
40 MPH OR LESS	GREATER THAN 40 MPH
$L=\frac{WS^2}{60}$	L= WS

BUFFER SPACING

SPEED (MPH)	DISTANCE (FEET)
25	155
30	200
35	250
40	305
45	360
50	425
55	495

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION

vhb
260 Arsenal PL #2
PO Box 9151
Watertown, MA 02471
617.924.1770

DESIGN CHECKER:	AA	11/26/2025	CAPE COD CANAL PIPELINE RELOCATION PROJECT PROPOSED 8" G-11, 18" G-24, 18" G-31, 16" G-32 PIPELINES AND REMOVAL OF 8" G-8C & 8" G-8L PIPELINES TMP - GENERAL NOTES, LEGEND & SIGN SUMMARY
DESIGN ENGINEER:	AA	11/26/2025	
PROJECT MANAGER:	AA	11/26/2025	LOC.: BARNSTABLE COUNTY, MASSACHUSETTS
TITLE	INITIALS	DATE	YEAR: 2025 / W.O.: AFE 30002835 / SCALE: NTS / DWG.: GSYS-P.514-001 / REV.:C

ENBRIDGE
Algonquin Gas Transmission, LLC
890 Winter Street #300, Waltham, MA 02451 (617) 254-4050



NOTE:
1. RECORD BASELINE AND SHLO ARE SCHEMATICALLY SHOWN FOR REFERENCE PURPOSES ONLY.

© 2025 Microsoft Corporation © 2025 Maxar ©CNES (2025) Distribution Airbus DS

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION

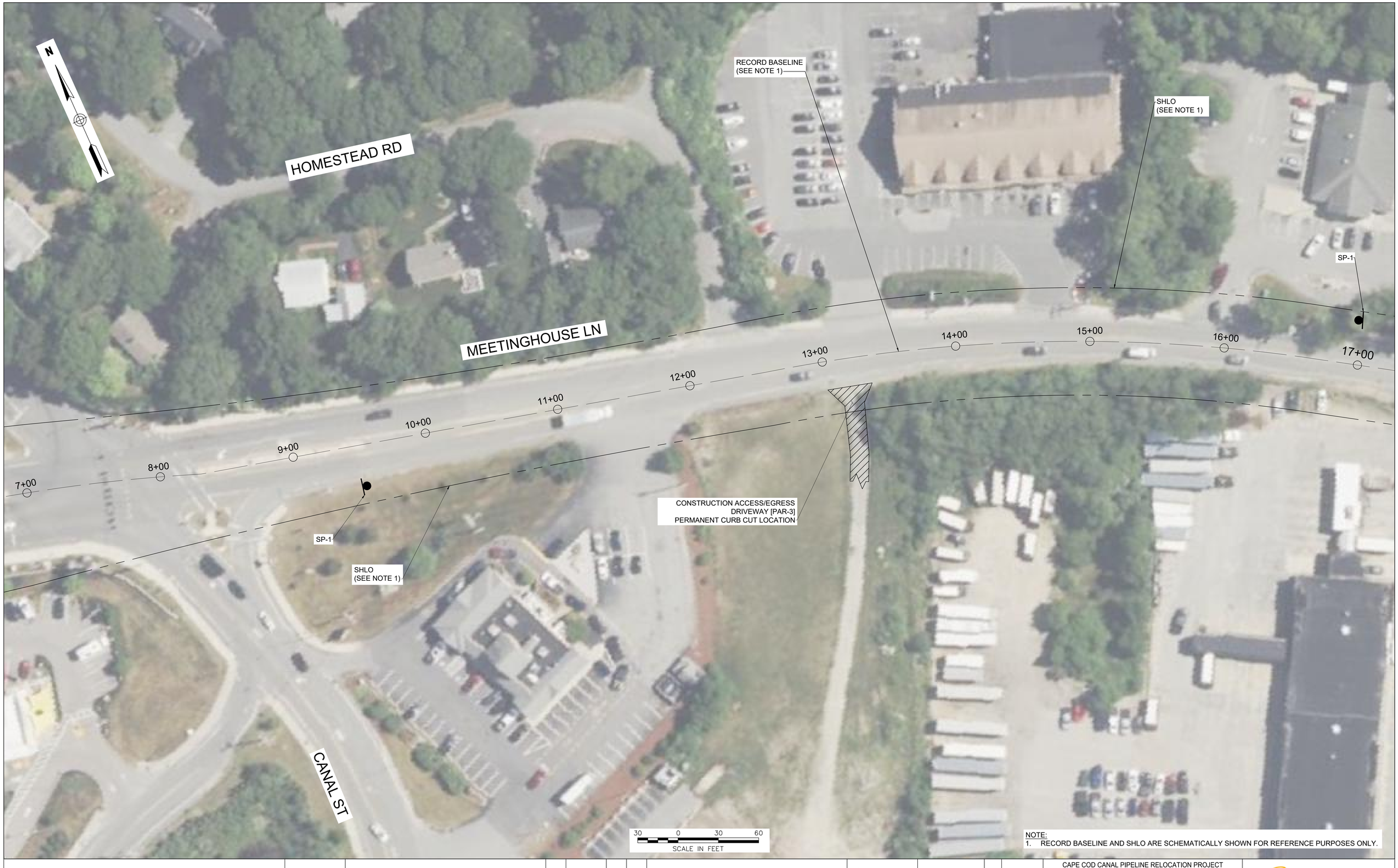
vhb
260 Arsenal PL #2
PO Box 9151
Watertown, MA 02471
617.924.1770

DESIGN CHECKER:	AA	11/26/2025
DESIGN ENGINEER:	AA	11/26/2025
PROJECT MANAGER:	AA	11/26/2025
TITLE	INITIALS	DATE

CAPE COD CANAL PIPELINE RELOCATION PROJECT
PROPOSED 8" G-11, 18" G-24, 18" G-31, 16" G-32 PIPELINES
AND REMOVAL OF 8" G-8C & 8" G-8L PIPELINES
TITLE: TMP - MID CAPE CONNECTOR (PAR 2)

ENBRIDGE
Algonquin Gas Transmission, LLC
890 Winter Street #300, Waltham, MA 02451 (617) 254-4050

YEAR: 2025 | W.O.: AFE 30002835 | SCALE: 1:50 | DWG.: GSYS-P.514-002 | REV.:C



NOTE:
1. RECORD BASELINE AND SHLO ARE SCHEMATICALLY SHOWN FOR REFERENCE PURPOSES ONLY.

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION

vhb
260 Arsenal PL #2
PO Box 9151
Watertown, MA 02471
617.924.1770

DESIGN CHECKER:	AA	11/26/2025
DESIGN ENGINEER:	AA	11/26/2025
PROJECT MANAGER:	AA	11/26/2025
TITLE	INITIALS	DATE

CAPE COD CANAL PIPELINE RELOCATION PROJECT
PROPOSED 8" G-11, 18" G-24, 18" G-31, 16" G-32 PIPELINES
AND REMOVAL OF 8" G-8C & 8" G-8L PIPELINES
TMP - MEETINGHOUSE LN (PAR 3)

LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

YEAR: 2025 | W.O.: AFE 30002835 | SCALE: 1:30

ENBRIDGE

Algonquin Gas Transmission, LLC
890 Winter Street #300, Waltham, MA 02451 (617) 254-4050

DWG.: GSYS-P.514-003 | REV.:C



NOTES:
1. RECORD BASELINE AND SHLO ARE SCHEMATICALLY SHOWN FOR REFERENCE PURPOSES ONLY.
2. PERMANENT CONSTRUCTION DRIVEWAY SHALL BE CONSTRUCTED IN ACCORDANCE WITH MASSDOT STANDARD DETAILS AND APPROVED BY MASSDOT.

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION

vhb
260 Arsenal PL #2
PO Box 9151
Watertown, MA 02471
617.924.1770

DESIGN CHECKER:	AA	11/26/2025
DESIGN ENGINEER:	AA	11/26/2025
PROJECT MANAGER:	AA	11/26/2025
TITLE	INITIALS	DATE

CAPE COD CANAL PIPELINE RELOCATION PROJECT
PROPOSED 8" G-11, 18" G-24, 18" G-31, 16" G-32 PIPELINES
AND REMOVAL OF 8" G-8C & 8" G-8L PIPELINES
TMP - CANAL ST (PAR 4)

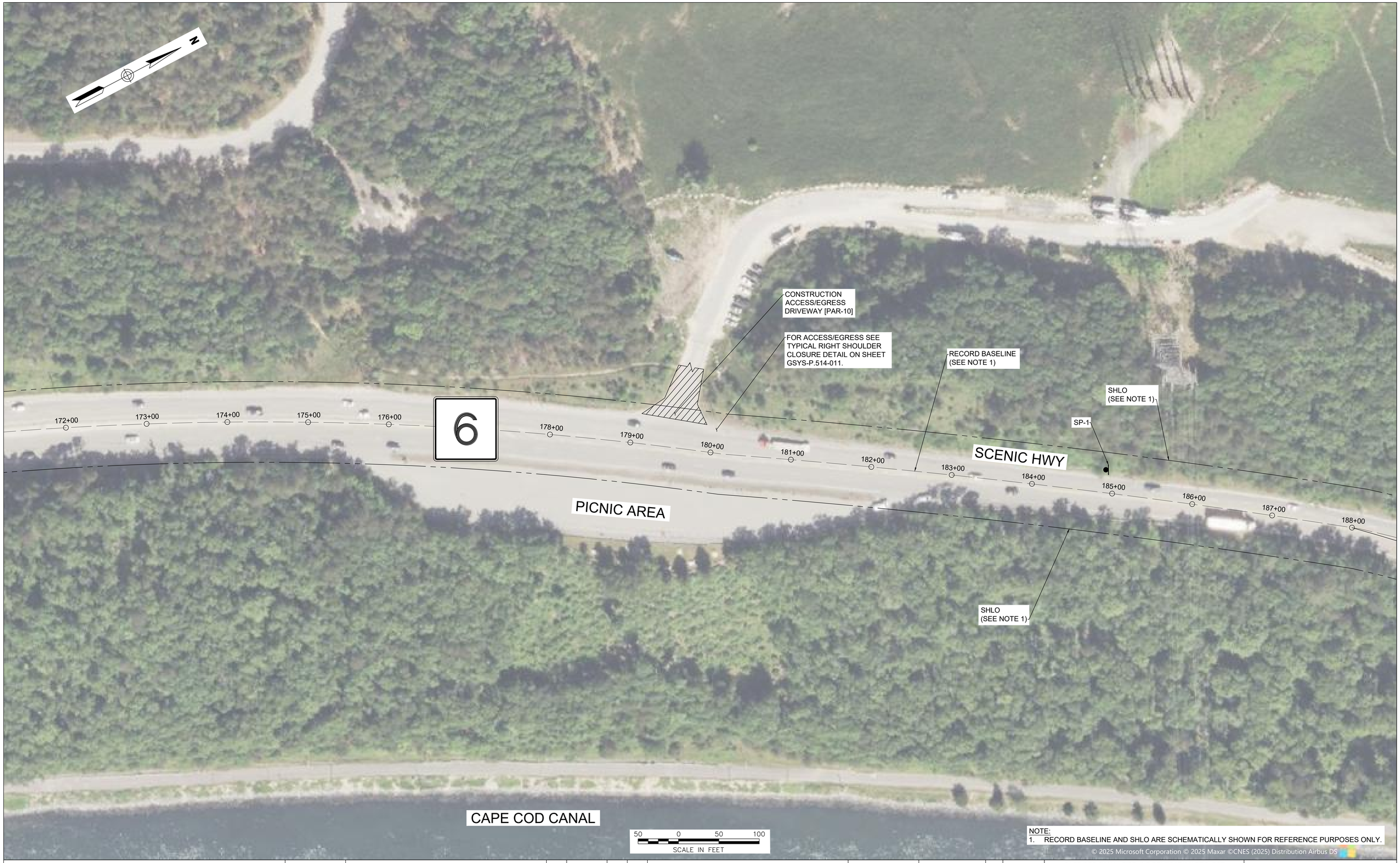
LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

YEAR: 2025 | W.O.: AFE 30002835 | SCALE: 1:30

ENBRIDGE

Algonquin Gas Transmission, LLC
890 Winter Street #300, Waltham, MA 02451 (617)-254-4050

DWG.: GSYS-P.514-004 | REV.:C



NOTE:
1. RECORD BASELINE AND SHLO ARE SCHEMATICALLY SHOWN FOR REFERENCE PURPOSES ONLY.

© 2025 Microsoft Corporation © 2025 Maxar ©CNES (2025) Distribution Airbus DS

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION

vhb
260 Arsenal PL #2
PO Box 9151
Watertown, MA 02471
617.924.1770

DESIGN CHECKER:	AA	11/26/2025
DESIGN ENGINEER:	AA	11/26/2025
PROJECT MANAGER:	AA	11/26/2025
TITLE	INITIALS	DATE

CAPE COD CANAL PIPELINE RELOCATION PROJECT
PROPOSED 8" G-11, 18" G-24, 18" G-31, 16" G-32 PIPELINES
AND REMOVAL OF 8" G-8C & 8" G-8L PIPELINES
TMP - SCENIC HWY (PAR 10)

LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

YEAR: 2025 | W.O.: AFE 30002835 | SCALE: 1:50 | DWG.: GSYS-P.514-005 | REV.:C

ENBRIDGE

Algonquin Gas Transmission, LLC
890 Winter Street #300, Waltham, MA 02451 (617) 254-4050



NOTE:
1. RECORD BASELINE AND SHLO ARE SCHEMATICALLY SHOWN FOR REFERENCE PURPOSES ONLY.

© 2025 Microsoft Corporation © 2025 Maxar ©CNES (2025) Distribution Airbus DS

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION

vhb
260 Arsenal PL #2
PO Box 9151
Watertown, MA 02471
617.924.1770

CAPE COD CANAL PIPELINE RELOCATION PROJECT
PROPOSED 8" G-11, 18" G-24, 18" G-31, 16" G-32 PIPELINES
AND REMOVAL OF 8" G-8C & 8" G-8L PIPELINES
TMP - SANDWICH RD (PAR 13)

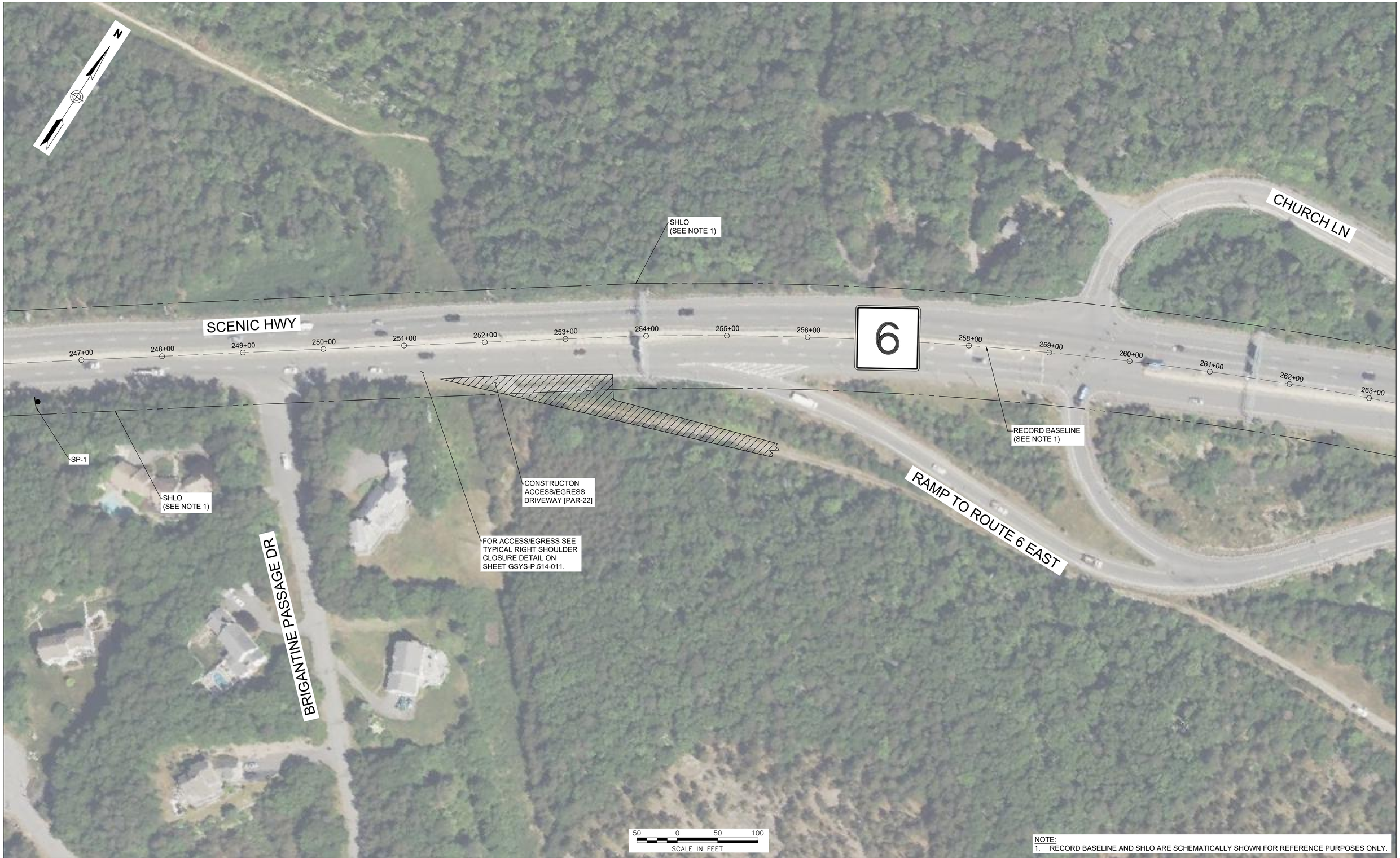
ENBRIDGE

	INITIALS	DATE
DESIGN CHECKER:	AA	11/26/2025
DESIGN ENGINEER:	AA	11/26/2025
PROJECT MANAGER:	AA	11/26/2025

LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

Algonquin Gas Transmission, LLC
890 Winter Street #300, Waltham, MA 02451 (617)-254-4050

TITLE	YEAR: 2025	W.O.: AFE 30002835	SCALE: 1:50	DWG.: GSYS-P.514-006	REV.:C



NOTE:
1. RECORD BASELINE AND SHLO ARE SCHEMATICALLY SHOWN FOR REFERENCE PURPOSES ONLY.

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION

vhb
260 Arsenal PL #2
PO Box 9151
Watertown, MA 02471
617.924.1770

DESIGN CHECKER:	AA	11/26/2025
DESIGN ENGINEER:	AA	11/26/2025
PROJECT MANAGER:	AA	11/26/2025
TITLE	INITIALS	DATE

CAPE COD CANAL PIPELINE RELOCATION PROJECT
PROPOSED 8" G-11, 18" G-24, 18" G-31, 16" G-32 PIPELINES
AND REMOVAL OF 8" G-8C & 8" G-8L PIPELINES
TMP - SCENIC HWY (PAR 22)

LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

YEAR: 2025 | W.O.: AFE 30002835 | SCALE: 1:50 | DWG.: GSYS-P.514-007 | REV.:C

ENBRIDGE
Algonquin Gas Transmission, LLC
890 Winter Street #300, Waltham, MA 02451 (617) 254-4050



NOTE:
1. RECORD BASELINE AND SHLO ARE SCHEMATICALLY SHOWN FOR REFERENCE PURPOSES ONLY.

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION

vhb
260 Arsenal PL #2
PO Box 9151
Watertown, MA 02471
617.924.1770

TITLE	INITIALS	DATE
DESIGN CHECKER:	AA	11/26/2025
DESIGN ENGINEER:	AA	11/26/2025
PROJECT MANAGER:	AA	11/26/2025

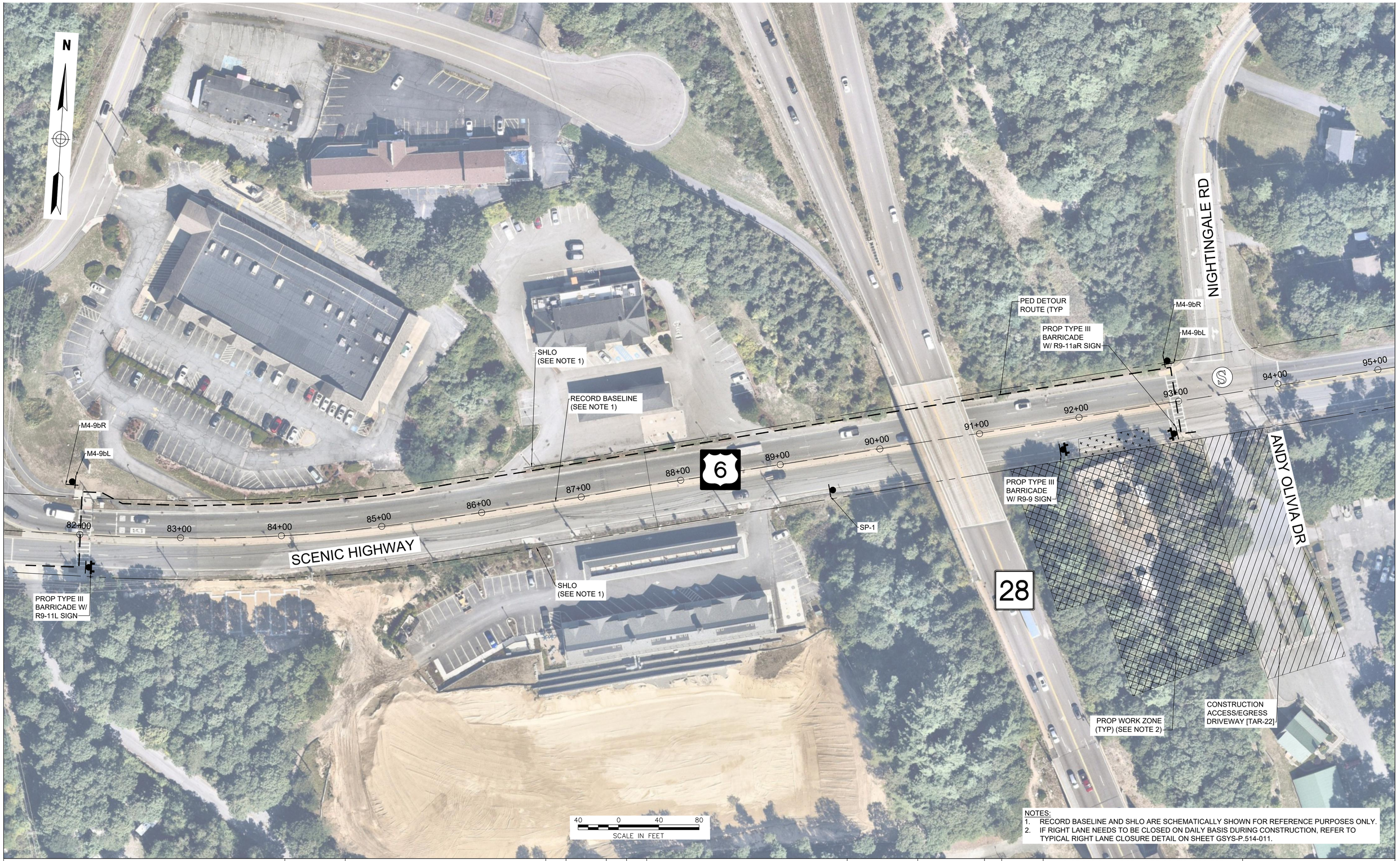
CAPE COD CANAL PIPELINE RELOCATION PROJECT
PROPOSED 8" G-11, 18" G-24, 18" G-31, 16" G-32 PIPELINES
AND REMOVAL OF 8" G-8C & 8" G-8L PIPELINES
TMP - ROUTE 25 (TAR 19)

LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

YEAR: 2025 | W.O.: AFE 30002835 | SCALE: 1:50

ENBRIDGE
Algonquin Gas Transmission, LLC
890 Winter Street #300, Waltham, MA 02451 (617) 254-4050

DWG.: GSYS-P.514-008 | REV.:C



NOTES:
1. RECORD BASELINE AND SHLO ARE SCHEMATICALLY SHOWN FOR REFERENCE PURPOSES ONLY.
2. IF RIGHT LANE NEEDS TO BE CLOSED ON DAILY BASIS DURING CONSTRUCTION, REFER TO TYPICAL RIGHT LANE CLOSURE DETAIL ON SHEET GSYS-P.514-011.

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION

vhb
260 Arsenal PL #2
PO Box 9151
Watertown, MA 02471
617.924.1770

TITLE	INITIALS	DATE
DESIGN CHECKER:	AA	11/26/2025
DESIGN ENGINEER:	AA	11/26/2025
PROJECT MANAGER:	AA	11/26/2025

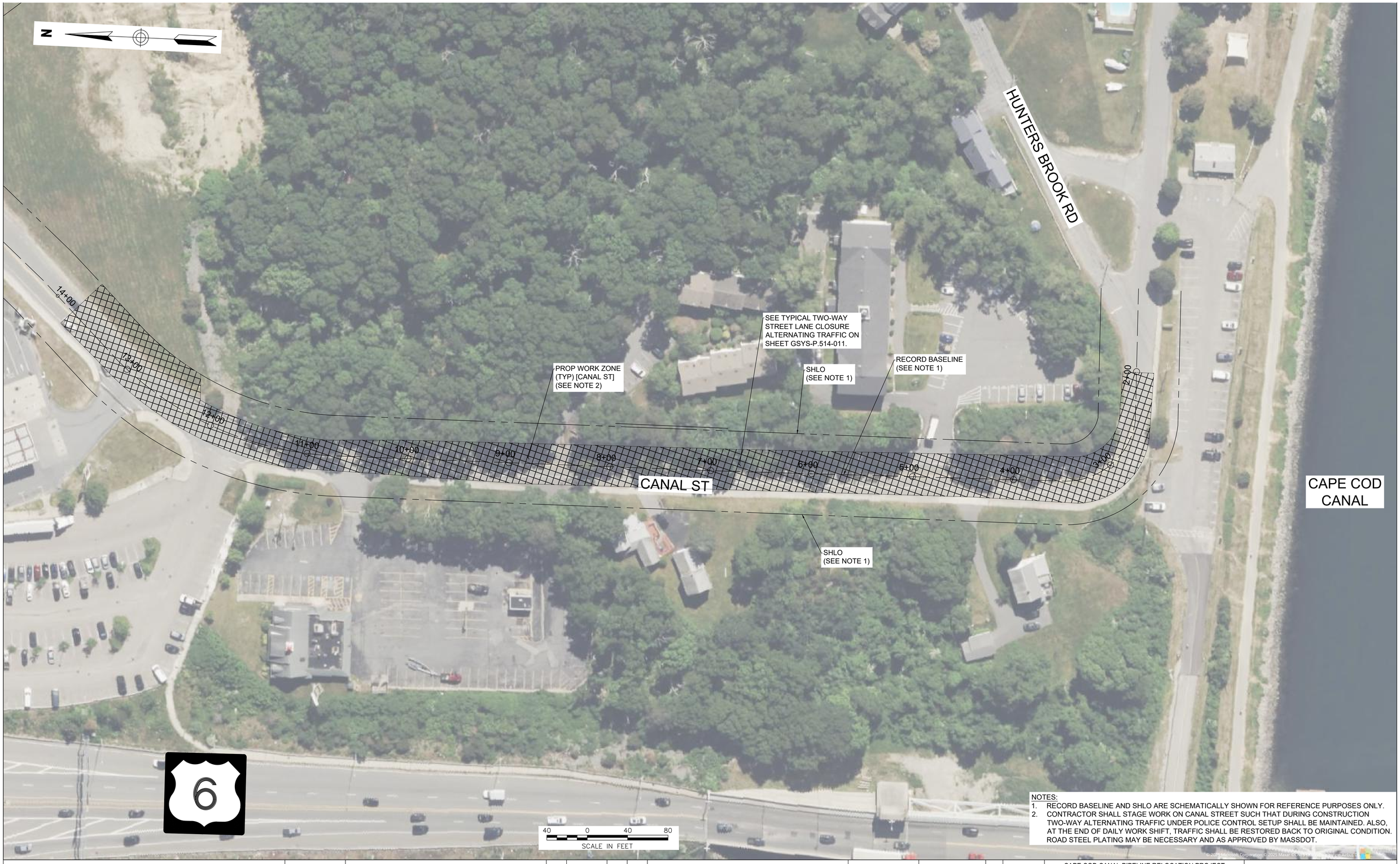
CAPE COD CANAL PIPELINE RELOCATION PROJECT
PROPOSED 8" G-11, 18" G-24, 18" G-31, 16" G-32 PIPELINES
AND REMOVAL OF 8" G-8C & 8" G-8L PIPELINES
TMP - SCENIC HWY (TAR-22)

LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

YEAR: 2025 | W.O.: AFE 30002835 | SCALE: 1:40

ENBRIDGE
Algonquin Gas Transmission, LLC
890 Winter Street #300, Waltham, MA 02451 (617) 254-4050

DWG.: GSYS-P.514-009 | REV.:C



NOTES:
1. RECORD BASELINE AND SHLO ARE SCHEMATICALLY SHOWN FOR REFERENCE PURPOSES ONLY.
2. CONTRACTOR SHALL STAGE WORK ON CANAL STREET SUCH THAT DURING CONSTRUCTION TWO-WAY ALTERNATING TRAFFIC UNDER POLICE CONTROL SETUP SHALL BE MAINTAINED. ALSO, AT THE END OF DAILY WORK SHIFT, TRAFFIC SHALL BE RESTORED BACK TO ORIGINAL CONDITION. ROAD STEEL PLATING MAY BE NECESSARY AND AS APPROVED BY MASSDOT.

© 2025 Microsoft Corporation © 2025 Maxar ©CNES (2025) Distribution Airbus DS

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION

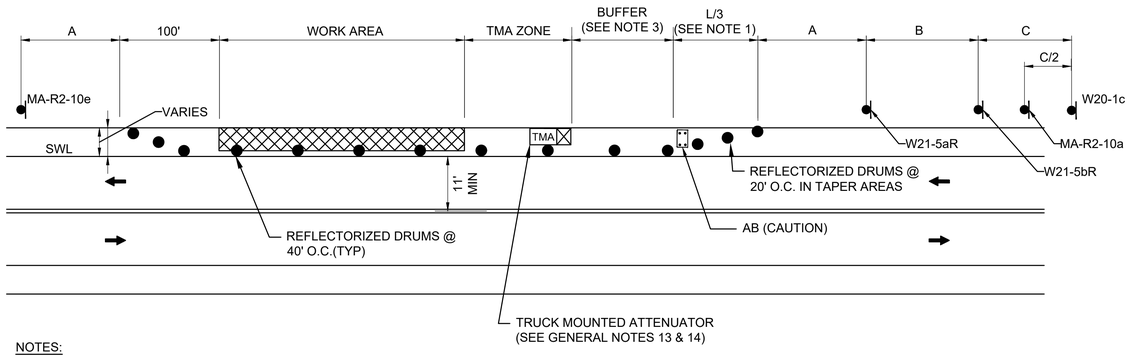
vhb
260 Arsenal PL #2
PO Box 9151
Watertown, MA 02471
617.924.1770

DESIGN CHECKER:	AA	11/26/2025	CAPE COD CANAL PIPELINE RELOCATION PROJECT PROPOSED 8" G-11, 18" G-24, 18" G-31, 16" G-32 PIPELINES AND REMOVAL OF 8" G-8C & 8" G-8L PIPELINES TMP - CANAL STREET
DESIGN ENGINEER:	AA	11/26/2025	
PROJECT MANAGER:	AA	11/26/2025	LOC.: BARNSTABLE COUNTY, MASSACHUSETTS
TITLE	INITALS	DATE	YEAR: 2025 W.O.: AFE 30002835 SCALE: 1:40

ENBRIDGE

Algonquin Gas Transmission, LLC
890 Winter Street #300, Waltham, MA 02451 (617) 254-4050

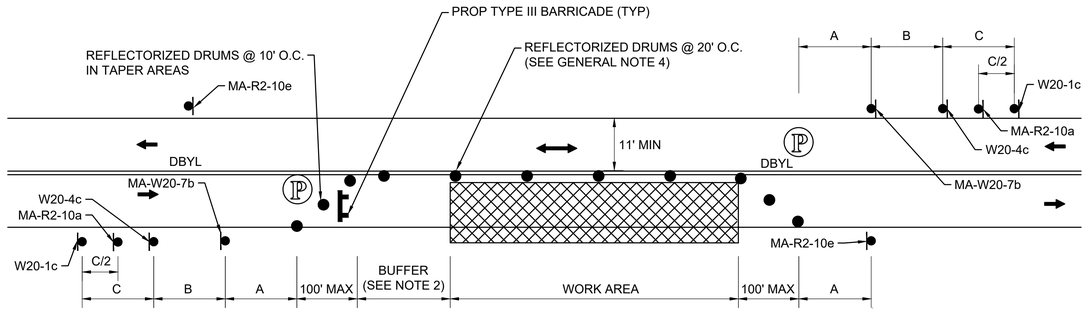
DWG.: GSYS-P.514-010 REV.:C



NOTES:
1. SEE TAPER LENGTH FORMULA ON GSYS-P.514-001.
2. SEE ADVANCE SIGN SPACING CHART ON GSYS-P.514-001.
3. SEE BUFFER CHART ON GSYS-P.514-001.
4. AT THE END OF WORK SHIFT, CONTRACTOR TO RESTORE TRAFFIC BACK TO ORIGINAL CONDITION.

TYPICAL SHOULDER CLOSURE - RIGHT [PAR-7 (ROUTE 28),TAR-19 (ROUTE 25), PAR-10 (ROUTE 6 WESTBOUND); PAR-22 (ROUTE 6 EASTBOUND)]

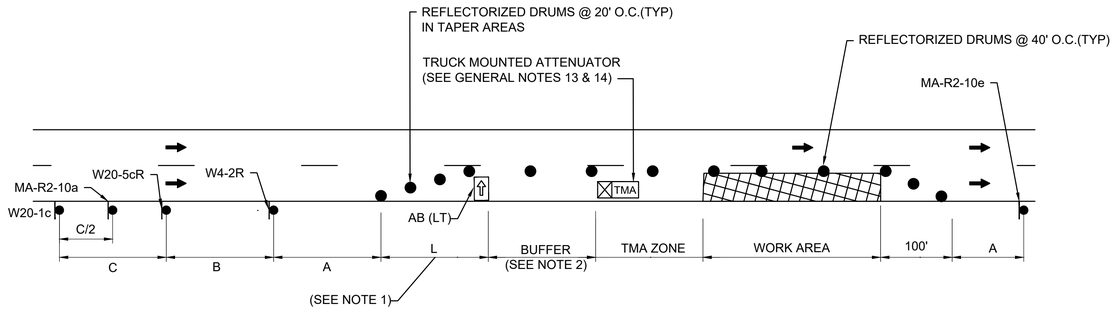
SCALE: NTS



NOTES:
1. REFER TO ADVANCE SIGN SPACING TABLE ON GSYS-P.514-001.
2. SEE BUFFER CHART ON GSYS-P.514-001.
3. AT THE END OF WORK SHIFT, CONTRACTOR SHALL RESTORE TRAFFIC BACK TO ORIGINAL CONDITION.

TYPICAL TWO-WAY STREET LANE CLOSURE ALTERNATING TRAFFIC [CANAL ST]

SCALE: NTS



NOTES:
1. SEE TAPER LENGTH FORMULA ON GSYS-P.514-001.
2. SEE BUFFER SPACING CHART ON GSYS-P.514-001.
3. SEE ADVANCE SIGN SPACING TABLE ON GSYS-P.514-001.
4. AT THE END OF WORK SHIFT, CONTRACTOR SHALL RESTORE TRAFFIC BACK TO ORIGINAL CONDITION.

ONE LANE CLOSURE - RIGHT [TAR-22 (ROUTE 6 EASTBOUND)]
TEMPORARY SETUP MASSDOT PERMITTED WORK HOURS [PAR-7 & TAR-13 (ROUTE 28)]

SCALE: NTS

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION

vhb
260 Arsenal PL #2
PO Box 9151
Watertown, MA 02471
617.924.1770

DESIGN CHECKER:	AA	11/26/2025	CAPE COD CANAL PIPELINE RELOCATION PROJECT PROPOSED 8" G-11, 18" G-24, 18" G-31, 16" G-32 PIPELINES AND REMOVAL OF 8" G-8C & 8" G-8L PIPELINES TMP - TYPICAL DETAILS
DESIGN ENGINEER:	AA	11/26/2025	
PROJECT MANAGER:	AA	11/26/2025	LOC.: BARNSTABLE COUNTY, MASSACHUSETTS
TITLE	INITIALS	DATE	YEAR: 2025 / W.O.: AFE 30002835 / SCALE: NTS / DWG.: GSYS-P.514-011 / REV.:C

ENBRIDGE
Algonquin Gas Transmission, LLC
890 Winter Street #300, Waltham, MA 02451 (617) 254-4050



NOTE:

1. AT THE END OF WORK SHIFT, CONTRACTOR SHALL RESTORE TRAFFIC BACK TO ORIGINAL CONDITION.
2. THE TEMPORARY LANE CLOSURE AS SHOWN HEREON SHALL BE IN ACCORDANCE WITH THE MASSDOT PERMIT UNLESS OTHERWISE APPROVED BY THE PERMIT ENGINEER.

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION

vhb
260 Arsenal PL #2
PO Box 9151
Watertown, MA 02471
617.924.1770

TITLE	INITIALS	DATE
DESIGN CHECKER:	AA	11/26/2025
DESIGN ENGINEER:	AA	11/26/2025
PROJECT MANAGER:	AA	11/26/2025

CAPE COD CANAL PIPELINE RELOCATION PROJECT
PROPOSED 8" G-11, 18" G-24, 18" G-31, 16" G-32 PIPELINES
AND REMOVAL OF 8" G-8C & 8" G-8L PIPELINES
TMP - BOURNE ROTARY RIGHT LANE CLOSURE SETUP

LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

YEAR: 2025 | W.O.: AFE 30002835 | SCALE: 1:40 | DWG.: GSYS-P.514-012 | REV.:C

ENBRIDGE
Algonquin Gas Transmission, LLC
890 Winter Street #300, Waltham, MA 02451 (617) 254-4050



NOTE:

1. AT THE END OF WORK SHIFT, CONTRACTOR SHALL RESTORE TRAFFIC BACK TO ORIGINAL CONDITION.
2. THE TEMPORARY LANE CLOSURE AS SHOWN HEREON SHALL BE IN ACCORDANCE WITH THE MASSDOT PERMIT UNLESS OTHERWISE APPROVED BY THE PERMIT ENGINEER.

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION

vhb
260 Arsenal PL #2
PO Box 9151
Watertown, MA 02471
617.924.1770

DESIGN CHECKER:	AA	11/26/2025	CAPE COD CANAL PIPELINE RELOCATION PROJECT PROPOSED 8" G-11, 18" G-24, 18" G-31, 16" G-32 PIPELINES AND REMOVAL OF 8" G-8C & 8" G-8L PIPELINES TMP - BOURNE ROTARY RIGHT LANE CLOSURE SETUP
DESIGN ENGINEER:	AA	11/26/2025	
PROJECT MANAGER:	AA	11/26/2025	LOC.: BARNSTABLE COUNTY, MASSACHUSETTS
TITLE	INITIALS	DATE	YEAR: 2025 / W.O.: AFE 30002835 / SCALE: 1:40 / DWG.: GSYS-P.514-013 / REV.:C

ENBRIDGE
Algonquin Gas Transmission, LLC
890 Winter Street #300, Waltham, MA 02451 (617) 254-4050



NOTE:
1. RECORD BASELINE AND SHLO ARE SCHEMATICALLY SHOWN FOR REFERENCE PURPOSES ONLY.

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION

vhb
260 Arsenal PL #2
PO Box 9151
Watertown, MA 02471
617.924.1770

DESIGN CHECKER:	AA	11/26/2025
DESIGN ENGINEER:	AA	11/26/2025
PROJECT MANAGER:	AA	11/26/2025
TITLE	INITIALS	DATE

CAPE COD CANAL PIPELINE RELOCATION PROJECT
PROPOSED 8" G-11, 18" G-24, 18" G-31, 16" G-32 PIPELINES
AND REMOVAL OF 8" G-8C & 8" G-8L PIPELINES
TMP - MACARTHUR BLVD (TAR 13)

LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

YEAR: 2025 | W.O.: AFE 30002835 | SCALE: 1:50

ENBRIDGE
Algonquin Gas Transmission, LLC
890 Winter Street #300, Waltham, MA 02451 (617) 254-4050

DWG.: GSYS-P.514-014 | REV.:C



NOTE:
1. RECORD BASELINE AND SHLO ARE SCHEMATICALLY SHOWN FOR REFERENCE PURPOSES ONLY.

DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION

vhb
260 Arsenal PL #2
PO Box 9151
Watertown, MA 02471
617.924.1770

DESIGN CHECKER:	AA	11/26/2025
DESIGN ENGINEER:	AA	11/26/2025
PROJECT MANAGER:	AA	11/26/2025
TITLE	INITIALS	DATE

CAPE COD CANAL PIPELINE RELOCATION PROJECT
PROPOSED 8" G-11, 18" G-24, 18" G-31, 16" G-32 PIPELINES
AND REMOVAL OF 8" G-8C & 8" G-8L PIPELINES
TMP - MACARTHUR BLVD (PAR-7)

LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

YEAR: 2025 | W.O.: AFE 30002835 | SCALE: 1:50

ENBRIDGE

Algonquin Gas Transmission, LLC
890 Winter Street #300, Waltham, MA 02451 (617) 254-4050

DWG.: GSYS-P.514-015 | REV.:C

ATTACHMENT 7

Algonquin Dust Control Plan



CAPE COD CANAL PIPELINE RELOCATION PROJECT

Dust Control Plan

June 2025

TABLE OF CONTENTS

1.0 INTRODUCTION 1

2.0 APPLICABILITY 1

3.0 DUST EMISSIONS AND CONTROL MEASURES 1

4.0 RESPONSIBILITY AND AUTHORITY 2

5.0 RECORDKEEPING AND MONITORING 2

1.0 INTRODUCTION

The purpose of this *Dust Control Plan* ("Plan") is to inform the contractor and its subcontractors of required measures to reduce the impact of dust on nearby communities (i.e., off-site receptors including residences, businesses) and on-site workers as a result of construction and soil handling activities. Additionally, this Plan helps prevent the off-site spread of dust that may result from construction activities. This Plan describes control measures to be implemented before, after, and while conducting any dust generating operation. The Plan requires monitoring, corrective actions to abate emission of dust and documentation of control measures taken.

2.0 APPLICABILITY

The Plan is applicable to any fugitive dust emissions associated with construction vehicle movement and with trenching, backfilling, and other earthmoving activities, including routine use of unpaved roads, soil excavation, and handling of any other dusty materials.

3.0 DUST EMISSIONS AND CONTROL MEASURES

Algonquin's Construction Contractor ("Contractor") will visually monitor the presence of airborne dust at the downwind boundary of the work sites. If excessive airborne dust is detected at the boundary of the work sites or if complaints are received, the Contractor should check for the presence of airborne dust on the upwind side of the construction area and implement dust control measures if construction activity is clearly the major contributing factor to increased dust emissions downwind. The Contractor will discontinue construction activities if generation of dust cannot be controlled to avoid soiling of structures or personal belongings on adjacent properties.

The Contractor will take measures to reduce dust generation and employ practices to prevent excessive fugitive dust emissions (e.g., visible dust clouds). No dust control measures are generally required during precipitation events. Dust control measures are required especially during warm dry weather and those days with strong winds. A source of clean, potable water or calcium chloride must be made available to wet down exposed soil surfaces. Dust control measures include but are not limited to:

Soil Excavation and Handling

- Load haul trucks such that the load is below the freeboard;
- Prevent spillage;
- Apply water or calcium chloride when needed prior to disturbance and during disturbance to prevent dust generation;
- Maintain existing ground coverings (e.g., existing pavement) until disturbance is required for construction and stabilize exposed soil with gravel or other stabilizing material, if dust generation is observed; and
- Discontinue construction activities if generation of dust cannot be controlled to avoid soiling of structures or personal belongings on adjacent properties.

Unpaved Haul and Access Roads

- Apply water or calcium chloride when needed;
- Control and immediately remove any track-out;
- Cover loads, as appropriate;
- Maintain appropriate low vehicle speeds in unpaved areas; and
- Route vehicles and equipment to covered surfaces (e.g., paved or graveled) when possible.

4.0 RESPONSIBILITY AND AUTHORITY

The Contractor Superintendent, the Environmental Inspector ("EI"), and the on-site Algonquin's Chief Inspector will share the authority to determine if/when water needs to be reapplied for dust control and to determine if/when additional mitigation will be needed.

The Contractor will furnish, operate, and maintain equipment and employ methods to minimize the migration of dust beyond the boundaries of the work site. The Contractor also will provide a copy of the Plan to all applicable site subcontractors. The Contractor Superintendent will be responsible for implementing the Plan. The EI has stop work authority for any non-compliance issues.

5.0 RECORDKEEPING AND MONITORING

The Contractor will document in their daily report the actual application or implementation of the control measures delineated in the Plan or otherwise.

ATTACHMENT 8

Waste Management Plan

Waste Management Plan for Construction Projects

Effective January 2011

Updated: May 2019

Environmental Construction Permitting
1100-915 N. Eldrige Parkway
Houston, TX 77079

ABBREVIATIONS AND DEFINITIONS

Company – Any Enbridge, Inc. personnel that may include, but is not limited to, Houston Environmental, Regional Environmental, Environmental Construction Permitting, Transmission Field Staff, Transmission Technical Staff, Engineering & Construction personnel

Contractor – Any personnel hired by Enbridge, Inc. to perform the project work

Hazardous Waste – Any liquid, solid, contained gas, sludge substance, mixture of substances, or other waste that poses a dangerous or potentially harmful risk to human health or the environment due to its physical or chemical properties. This includes waste with properties such as ignitability, corrosivity, reactivity and/or toxicity, waste that is or contains substances listed in hazardous waste regulations, and waste derived from certain industrial processes, as defined in hazardous waste regulations. In certain states, waste with 50 ppm or greater PCBs is considered hazardous waste.

Non-hazardous Waste – Any liquid, solid, contained gas, sludge substance, mixture of substance, or other waste that does not pose a dangerous or potentially harmful risk to human health or the environment due to its physical or chemical properties. This includes domestic solid wastes such as office trash, paper, and food packaging, as well as industrial waste such as construction debris, oily waste, empty product drums, concrete, non-hazardous spent blasting media, used oil filters, uncontaminated concrete or soil, rock, asphalt, plastic, used straw bales, used silt fence and similar waste.

PCB Waste – Any liquid, solid, contained gas, or sludge substance waste that contains polychlorinated biphenyls (PCBs).

Plan – Waste Management Plan

Recyclable Material – Any uncontaminated material which can be re-used intact, processed, refined, or reclaimed. Examples are excavated fill, rock, wood chips, used oil, used glycol, scrap metal, tires, paper, glass, filters, and similar waste.

Solid Waste - The term "solid waste," used in Subtitle D, refers almost exclusively to non-hazardous solid waste. Subtitle D covers all wastes not regulated by Subtitle C, which regulates hazardous waste. Subtitle D covers certain hazardous wastes which are excluded from Subtitle C, including household hazardous waste and hazardous wastes generated by small quantity generators. Section 100(27) of the Resource Conservation and Recovery Act (RCRA) defines solid waste as:

> Garbage (e.g., milk cartons and coffee grounds), refuse (e.g., metal scrap, wall board, and empty containers), sludge from a waste treatment plant, a water supply treatment plant, or an air pollution control facility (e.g., scrubber sludge). Other discarded material, including solid, semi-solid, liquid, or contained gaseous material resulting from industrial, commercial, mining, agricultural, and community activities (e.g., boiler slag or fly ash).

A good definition of municipal solid waste is that it includes durable goods, non-durable goods, containers and packaging, food wastes and yard trimmings, and miscellaneous inorganic wastes.

Subtitle D Landfill – Subtitle D landfills are typically municipal solid waste landfills (MSWLFs) and receive household waste. MSWLFs can also receive non-hazardous sludge, industrial solid waste, and construction and demolition debris. All MSWLFs must comply with the federal regulations in 40 CFR Part 258 (Subtitle D of RCRA) or equivalent state regulations. Federal MSWLF standards include:

- **Location restrictions**—ensure that landfills are built in suitable geological areas away from faults, wetlands, flood plains, or other restricted areas.
- **Composite liners requirements**—include a flexible membrane (geomembrane) overlaying two feet of compacted clay soil lining the bottom and sides of the landfill, protect groundwater and the underlying soil from leachate releases.
- **Leachate collection and removal systems**—sit on top of the composite liner and removes leachate from the landfill for treatment and disposal.

- **Operating practices**—include compacting and covering waste frequently with several inches of soil to help reduce odor; control litter, insects, and rodents; and protect public health.
- **Groundwater monitoring requirements**—requires testing groundwater wells to determine whether waste materials have escaped from the landfill.
- **Closure and postclosure care requirements**—include covering landfills and providing long-term care of closed landfills.
- **Corrective action provisions**—control and clean up landfill releases and achieves groundwater protection standards.
- **Financial assurance**—provides funding for environmental protection during and after landfill closure (i.e., closure and postclosure care).

Waste Material Storage Containers – Anything that adequately and safely contains waste per Enbridge, Inc. guidelines and federal, state, and local guidelines; examples are, but not limited to, roll-off containers and frac tanks.

Waste Material – any excess liquid or solid material that will not be reused and needs to be discarded or has been identified for disposal.

PURPOSE/PLAN OBJECTIVE

Enbridge, Inc. ("the Company") has prepared this Waste Management Plan ("the Plan") for construction projects in the United States. The purpose of this plan is to ensure the proper management and documentation of all waste generated during construction projects.

Waste disposal planning and waste minimization are important elements of any successful project. The Company should work closely with the selected Contractor to verify that all construction waste material is properly estimated prior to starting any construction project and that recycling or disposal options are identified in advance of starting the project.

All Company and Contractor personnel will be trained on the awareness level for this Plan. The Plan does not cover health and safety concerns associated with handling, storage, transportation, and disposing of non-hazardous or hazardous materials.

This Plan outlines both Contractor and Company responsibility for management of non-hazardous and hazardous waste. If the waste type is unknown, the Company will work with the Contractor to determine the waste type through sampling, historical data, or other documented resources.

In the absence of a Contractor, Company personnel are responsible for managing and disposing of the waste generated as a result of construction activities.

Note: Whenever possible, the Company prefers to reuse or recycle, sell or donate all waste construction materials. Construction and demolition waste can include untreated wood, wood chips, metal, glass, rubber, uncontaminated concrete, uncontaminated soil, rock, stone, asphalt, plastics, sheetrock, and drilling mud or bentonite clay/fluid. To do so, the proper Company approvals must be obtained to ensure the receiving facility, location and/or site meets the appropriate federal and state regulations.

NON-HAZARDOUS WASTE

Contractor Responsibility

The Contractor will be responsible for handling, managing, and disposing of all non-hazardous waste associated with the project. The Contractor will perform the following tasks:

- Maintain good housekeeping on the site;
- Ensure that all drums, product containers, roll-off boxes and frac tanks are properly labeled in accordance with federal, state, and local requirements. At a minimum all drums, product containers, roll-off boxes and frac tanks must be labeled with the name of the contents, including trash and construction waste/debris. Empty containers shall be labeled as "empty". All drums used for waste storage, other than those used for domestic trash, shall be labeled with start accumulation date.
- Properly store waste material on-site according to federal, state, and local regulations and Company policies while awaiting disposal;
- Identify all disposal locations to be used for construction waste disposal, recycling, and/or reuse (donation/selling)
- Profile all waste material for disposal acceptance at the appropriate Company approved landfill (non-hazardous waste must be disposed of in a Subtitle D landfill), or, if the material is uncontaminated and recyclable, obtain the proper Company approval to recycle, sell or donate the material;
- Transport and coordinate disposal of waste material at the appropriate landfill, recycling, or treatment facility;
- Keep all waste streams separate from generation through handling, storage, and transport;
- Arrange clean-up of waste material storage containers;
- Bring in clean fill from appropriate origin as necessary; and
- Maintain records of all waste disposals associated with the construction project and provide these records to the Company.

Company Responsibility

The Company will be responsible for oversight of the Contractor and its waste management as it relates to the adherence of Company policies. The Company will perform the following tasks:

- Sample and analyze the waste material, as necessary, for disposal profiling at the appropriate landfill or recycling facility;
- Classify the waste material per the sampling results or other means such as process knowledge;

- Complete the applicable evaluation report if the material is to be recycled or reused, sold or donated;
- Provide the proper training to Company personnel for handling non-hazardous waste material;
- Ensure all records of waste transportation and disposal are obtained from the Contractor; and
- Enter all waste transportation and disposal information into EPASS.

Monitor storage of wastes to ensure wastes are stored in compliance with company policies.

HAZARDOUS WASTE

Contractor Responsibility

The Contractor will be responsible for properly storing all hazardous waste associated with the project. The Contractor will perform the following tasks:

- Properly label and store waste material on-site according to federal, state, and local regulations while awaiting characterization and disposal;
- Keep all waste streams separate from generation through handling, storage, and transport;
- Provide documented clean fill from appropriate origin as necessary; and
- Decontaminate equipment that has come into contact with hazardous or PCB waste as per the Company policies.

Company Responsibility

The Company will be responsible for classification, handling, managing, and disposing of all hazardous waste associated with the project as stated in Company policies. The Company will perform the following tasks:

- Sample and analyze the waste material, as necessary, for disposal profiling at the appropriate treatment, storage and disposal (TSD) facility licensed to accept hazardous waste;
- Classify the waste material per the sampling results or process knowledge;
- Profile all waste material for disposal acceptance at the appropriate Company-approved TSD facility;
- Coordinate and schedule transportation and disposal of hazardous waste material at the appropriate facility;
- Provide the proper training to Company personnel for handling hazardous waste material; and
- Enter all waste transportation and disposal information into EPASS.
- Monitor storage of wastes to ensure wastes are stored in compliance with company policies.

UNEXPECTED CONTAMINATION ENCOUNTER

Prior to construction the Company will identify potential sources of unexpected contamination within the project area based on the surrounding area and/or past history.

If unexpected contamination is encountered during the project:

Contractor Responsibility

- Stop work and leave the potentially contaminated area, moving up wind;
- Notify the Chief Inspector immediately; and
- Re-enter the area ONLY after the Company has provided verbal approval.

Note: Do not unnecessarily handle any contaminated materials. Equipment that may have come in contact with the contamination should not be removed from the area.

Note: Follow appropriate best management practices, any health and safety plan and procedures, and company policies if unexpected contamination is encountered.

Company Responsibility

- Assure that the work area is marked or roped off to prevent unauthorized entry;
- Assess the situation and determine the source of the contamination, if possible;
- Gather as much available information about the contamination without unnecessary handling or exposure to the contaminated material;
- Make necessary internal and external notifications;
- Determine sampling requirements;
- Arrange for response and sampling from a licensed waste company;
- Determine onsite monitoring requirements; and
- Coordinate disposal of contaminated material, if necessary, based on analytical results.

Note: Until hazards are determined, ONLY site personnel who have current hazardous waste operations (HAZWOPER) training may enter the contaminated area to control or clean up the area.

Note: DO NOT backfill any encountered contamination. Once contamination has been encountered, it is our environmental responsibility to properly respond and manage the situation.

- Manage wastes in accordance with Company policies; and
- Once the site has been deemed safe for re-entry notify the Contractor to proceed with construction in the area.

PROJECT CLOSE-OUT & DOCUMENTATION – ALL WASTE

Contractor Responsibility

When the Contractor is handling, managing and disposing of waste material, the Contractor shall be responsible for providing the Company with the following documentation:

- Bills-of-lading and/or manifests, material shipping logs, or other waste transportation papers;
- Loading and disposal tickets from landfills or treatment facilities;
- Certifications of clean fill brought on-site for use; and
- Acceptance letters for waste disposal.

ATTACHMENT 9

Nighttime Construction Plan

CAPE COD CANAL PIPELINE RELOCATION PROJECT

Nighttime Construction Management Plan

FERC Docket No. CP25-552-000

Algonquin Gas Transmission, LLC

February 2026

TABLE OF CONTENTS

1.0 INTRODUCTION **1**

2.0 PROJECT DESCRIPTION **1**

3.0 REGULATORY CONTEXT AND APPLICABILITY **2**

3.1 Federal Regulations **2**

3.2 State Regulations **3**

3.3 Local Regulations **3**

4.0 NIGHTTIME NOISE ANALYSIS **4**

4.1 Project Construction Sites Where Night Work May Occur **4**

4.2 General Construction Noise **4**

4.3 Expected and Potential Nighttime Activities **4**

4.3.1 Horizontal Directional Drilling 5

4.3.2 Final Tie-Ins 6

4.3.3 Hydrostatic/ Pneumatic Pressure Testing 7

4.3.4 M&R Station Construction 9

5.0 NIGHTTIME NOISE MITIGATION MEASURES **10**

5.1 Activity Specific Mitigation Measures **10**

5.1.1 Horizontal Directional Drilling 10

5.1.2 Final Tie-In 10

5.1.3 Hydrostatic/ Pneumatic Pressure Testing 10

5.1.4 M&R Station Construction 11

5.2 General Construction Noise Mitigation **11**

5.2.1 Engine-Powered and Continuously Operating Equipment 11

5.2.2 Vehicle Movements and Backup Alarm Minimization 11

5.2.3 Material Handling and Trucking 12

5.2.4 Temporary Barriers and Site Layout Planning 12

1.0 INTRODUCTION

Algonquin Gas Transmission, LLC ("Algonquin") has developed this Nighttime Construction Management Plan (the "Plan") for the Cape Cod Canal Pipeline Relocation Project (the "Project") in Bourne, Massachusetts. The purpose of this plan is to establish procedures and measures for managing construction activities that may occur during nighttime hours (7:00 p.m. to 7:00 a.m.) to minimize impacts to nearby receptors. Algonquin plans to conduct construction activities between 7:00 a.m. and 7:00 p.m., Monday through Saturday, with work on Sundays on an as-needed basis due to permit requirements, "make-up" days caused by inclement weather or other construction delays.

Construction delays resulting in the need for nighttime work may be due to several factors including, but not limited to, complications during the HDD process (such as hole collapse, broken tool retrieval, etc.), local or state work hour restrictions dictating nighttime work, inadvertent release clean up during HDD, and/or military activities on the JBCC property that could interrupt construction schedules. Algonquin's Project must be completed before the CCBP is scheduled to start. Construction delays during the execution of Algonquin's project could impact the CCBP starting as scheduled, therefore any construction delays during Algonquin's Project must be compensated to the extent practicable. Algonquin will have to work continuously (24-hour work) as construction delays arise throughout the Project in order to keep CCBP on MassDOT's schedule.

The Plan is intended to identify anticipated nighttime activities, outline management and mitigation measures, and ensure that nighttime construction is conducted in a manner that protects public health and safety, reduces noise and other disturbances to the extent practicable and complies with applicable regulatory requirements. Although the Plan provides a comprehensive assessment of activities that may require nighttime work, there may be other activities not listed in this Plan.

The Plan will be maintained on-site at applicable construction locations and will be available to, and implemented by, all personnel engaged in nighttime work. Any construction activities conducted during nighttime hours would be managed in accordance with the procedures of this Plan and any subsequent updates.

2.0 PROJECT DESCRIPTION

The Project will remove, abandon, and relocate segments of Algonquin's existing natural gas pipeline infrastructure in the Town of Bourne to accommodate the requirements of the Cape Cod Bridge Program (CCBP) and to continue providing uninterrupted natural gas service to National Grid by replacing National Grid's two existing pipelines, one located on the Bourne Bridge and one on the Sagamore Bridge, with new natural gas infrastructure designed to meet the same

natural gas capacity requirements. This Project is needed because the USACE determined that, as part of the replacement or rehabilitation of the Bourne and Sagamore Bridges by the CCBP, pipeline utilities that have facilities attached to the bridges cannot reinstall those facilities to the new bridges but rather must relocate them.

Natural gas supply is currently transported from the Algonquin interstate pipeline system to two existing National Grid delivery points in the Town of Bourne, located on the "mainland" north of Cape Cod Canal. One delivery point is an existing metering and regulating (M&R) station located at the intersection of the U.S. Route 6 and Massachusetts Route 25 at the Bourne Bridge (Bourne M&R Station), which supplies National Grid's Bourne Take Station. The second delivery point is an existing M&R station located south of U.S. Route 6 and Massachusetts Route 3 interchange at the Sagamore Bridge (Sagamore M&R Station) and supplies National Grid's Sagamore Take Station. National Grid Transports this gas across the Cape Cod Canal to its customers via two high-pressure 10-inch diameter pipelines, one of which is attached to the Bourne Bridge, with the other attached to the Sagamore Bridge. These attached pipelines, as well as the joining M&R/ Take station sites and segments of connecting pipe, cannot remain in their existing locations and must be relocated to accommodate the CCBP requirements. MassDOT and Algonquin entered into an agreement whereby Algonquin will construct two replacement pipelines and associated facilities to provide the same natural gas transportation capacity for National Grid's distribution system on Cape Cod as currently exists.

In summary, Algonquin proposes to remove, abandon, and relocate its existing, previously certificated facilities (including pipeline segments and M&R stations) to avoid conflicts with the CCBP development areas while continuing to provide uninterrupted natural gas service to the National Grid distribution system on both sides of the Cape Cod Canal, which powers homes and businesses throughout Cape Cod. Following the completion of the Project, Algonquin's design capacity to transport natural gas to the National Grid delivery points will remain unchanged.

3.0 REGULATORY CONTEXT AND APPLICABILITY

3.1 Federal Regulations

The project is subject to the FERC noise regulation governing interstate gas transmission. The FERC noise regulation is receptor based, and limits sound levels at the surrounding NSAs. NSAs are typically residences, schools, churches or hospitals. The FERC noise limits apply at the NSA structure.

The FERC limit for noise from nighttime construction work is 55 dBA L_{dn} or 10 dB above the measured nighttime level if the existing sound level exceeds 55 dba L_{dn}. This limit is applicable to construction activities performed between 10:00 p.m. and 7:00 a.m.

The 2017 FERC Guidance Manual for Environmental Report Preparation states, "Construction activity that would or may occur during nighttime hours should be performed with the goal that the activity contribute noise levels below 55 dba L_{dn} and 78.6 L_{eq}, or no more than 10 dBA over background if ambient noise levels are above 55 dBA L_{dn}." If construction activities are limited to daytime hours, with no significant noise production at night, then there is no specific sound level target for those activities.

3.2 State Regulations

The Massachusetts Department of Environmental Protection (MassDEP) regulates noise under its Air Pollution Control Regulations. In these regulations, an "air contaminant" is defined to include sound, and a condition of "air pollution" includes the presence of an air contaminant in such concentration and duration as to "cause a nuisance" or "unreasonably interfere with the comfortable enjoyment of life and property" (310 CMR 7.00).

MassDEP's regulations at 310 CMR 7.10 prohibit "unnecessary emissions" of noise. MassDEP Policy interprets a violation of this noise regulation to have occurred if the source causes either:

1. an increase in the broadband sound pressure level of more than 10 dBA above the ambient, or
2. a "pure tone" condition.

"Ambient" is defined as the background A-weighted sound level that is exceeded 90 percent of the time, measured during equipment operating hours (L90). A "pure tone" condition occurs when any octave band sound pressure level exceeds both of the two adjacent octave band sound pressure levels by 3dB or more.

These noise limits are MassDEP policy and are applicable both at a facility property line and at the nearest residences. As a policy and not regulation, MassDEP may waive these limits in certain cases at property line locations where the adjacent land uses are not considered noise sensitive, such as an adjacent industrial or agricultural parcel.

3.3 Local Regulations

All M&R stations and HDD sites associated with the Project are located in the Towne of Bourne. The Town of Bourne bylaws include some discussion of disturbances in n §3.1.23. This section of the bylaws prohibits "…any unnecessary, loud, excessive or unusual noises…" that are "plainly audible" at a distance of 150 feet from the source. However, there are no quantitative sound level limits. Both disturbance and audibility are subjective terms and are therefore not appropriate for establishing engineering standards. Therefore, for this analysis, the quantitative limits set forth by FERC and MassDEP which are designed to be protective of the public will be assumed to also prevent disturbances as discussed in the Town of Bourne bylaws.

4.0 NIGHTTIME NOISE ANALYSIS

4.1 Project Construction Sites Where Night Work May Occur

Although the need for nighttime construction activities may take place throughout the Project construction workspace, there are certain locations where nighttime work is anticipated.

Potential nighttime work areas associated with the two HDDs the Cape Cod Canal HDD entry and exit points and the Sagamore HDD entry and exit points as well as final tie-in locations in multiple locations throughout the Project workspace.

Nighttime work may be necessary during any of the three phases of hydrostatic or pneumatic testing, which would involve the full pipeline alignment. Specific testing locations will be identified following the construction contractor award. The Project will require contractors to select testing and construction locations that maximize separation from nearby noise-sensitive areas (NSAs), to the extent practicable, in order to minimize potential nighttime noise impacts.

Nighttime work may also occur during construction of the meter and regulator (M&R) stations. Table 4.1 summarizes all potential nighttime construction activities associated with the Project.

4.2 General Construction Noise

General construction noise during nighttime hours is expected to consist primarily of routine, non-specialized equipment and activities necessary to support ongoing work. These may include the operation of light plants required for safe illumination, intermittent truck traffic for material delivery or haul-off, non-destructive examinations (NDEs), and use of standard construction equipment such as loaders, generators, and small excavators. These sounds are considered typical of constructions sites and are not tied to any specific expected operation; however, they may be audible at varying distances depending on equipment type, duration of use, and surrounding terrain. The Project will implement reasonable noise-minimization practices to limit the potential for disturbance during any nighttime activities as outlined in Section 5.2.

4.3 Expected and Potential Nighttime Activities

Nighttime construction activities are anticipated to occur primarily during three project components: horizontal directional drilling (HDD), final pipeline tie-in activities, hydrostatic or pneumatic pressure testing of HDD sections, pipeline, and facilities, and construction activities at the meter and regulator (M&R) stations. Other construction activities that require continuous work (24-hour work) and may extend beyond normal construction hours and into Sunday, as necessary, include welding activities; x-ray activities, including nondestructive testing of welds; depressurizing of pipelines; painting/coating of piping; dewatering and drying of test sections, conventional bore pits, and trench or bell holes ahead of mainline installation crews; maintaining

water pumps through the construction crossing cycle at wetlands, water bodies, and residential construction to ensure public safety; aboveground facilities construction (including but not limited to electrical, welding, earth disturbance, and hydrotesting); trenching activities; the Canal Street pipe lay; drilling operations for pullback; holiday detection (jeeping the pipe); final pipeline tie-in; and commissioning, line purge, and line fill activities. Equipment maintenance and service activities may also occur before and after standard work hours

In addition, unplanned or corrective activities—such as spill response, equipment maintenance, or certain HDD-related operations—may necessitate work beyond daytime hours to ensure safe operations and maintain project schedule continuity.

The following sections analyze the four primary activities that may require nighttime work.

4.3.1 Horizontal Directional Drilling

Activity Description and Location

Nighttime construction will likely be necessary at the Horizontal Directional Drilling entry and exit sites. HDD will occur at the Canal HDD entry and exit sites , as well as at the Sagamore HDD entry and exit sites, and consists of three steps including drilling, reaming and pull back. Drilling is the process of using a steerable drill head to drill a small-diameter pilot hole along the designated underground path from the entry point to exit point. Reaming is the process in which, after the pilot hole reaches the exit point, larger cutting tools called reamers are pulled back through the hole to gradually enlarge it until it is big enough for the pipe. Finally, pull-back is the process by which prefabricated pipe sections are positioned at the exit side and attached to the drill string, then pulled back through the enlarged hole to the entry point.

Potential Nighttime Work Scenarios

During the drilling and reaming phases, HDD operations must continue once initiated because borehole stability depends on continuous circulation of drilling fluid. Interruption of circulation reduces hydrostatic support, allows cuttings to settle, and may result in bore collapse, pack-off, loss of drilling fluid returns, or stuck tooling. Maintaining consistent drilling fluid pressure and flow is critical to stabilizing the bore walls, transporting cuttings to the surface, and preventing material from sloughing into the bore. Extended interruptions can compromise bore integrity and require substantial corrective actions.

Similarly, once the pull-back phase begins, the operation must proceed as a continuous and uninterrupted activity to ensure bore stability and successful pipeline installation. Pausing pull-back operations can increase drag forces, reduce bore support, or allow material to accumulate around the pipe, potentially resulting in pipe seizure.

Duration

If HDD operations extend into nighttime hours, the work would be performed continuously on a 24-hour schedule for an estimated duration of two to three months.

Anticipated Noise Making Equipment

Both the HDD entry and exit sites may utilize several types of equipment during temporary construction activities; however not all equipment listed is anticipated to be required at every location. Potential equipment includes light plants, generators, mud pumps, a mud system, the drill rig and associated power unit, D-6 dozer(s), welding truck(s), and excavators.

Potential Impacts

Algonquin evaluated nighttime construction noise impacts at the HDD entry and exit sites for both HDD crossings. The calculated increases above existing nighttime ambient sound levels attributable to nighttime HDD activities are below 10 dBA at all noise-sensitive areas (NSAs) for both the Sagamore Bridge HDD entry and exit sites. Therefore, no additional noise mitigation is required to comply with FERC regulatory sound level limits at the Sagamore Bridge HDD locations.

At the Canal HDD entry site, modeled sound levels at nearby NSAs attributable to nighttime HDD activities are below the FERC limit of 55 dBA Ldn, indicating that additional noise mitigation is not required at this location. However, modeled sound levels at NSA CX2 attributable to nighttime HDD activities at the Canal HDD exit site are expected to exceed the FERC regulatory limit of 55 dBA Ldn. Accordingly, additional noise mitigation is recommended for nighttime HDD activities at this site. Noise mitigation measures for NSA CX2 are described in Section 5.1.1.

4.3.2 Final Tie-Ins

Activity Description and Location

Final tie-ins occur where a newly installed pipeline segment is physically connected to existing sections of pipeline. This process typically involves precise alignment of pipe ends followed by welding and inspection to ensure structural integrity and system continuity.

Potential Nighttime Work Scenarios

Once the final tie-in process begins, work is expected to proceed without interruption due to safety, quality, and pipeline integrity considerations. During tie-in activities, the pipeline is in a temporary non-standard condition that is not intended to persist for extended periods. Suspending work during this phase can prolong exposure to conditions that increase the risk of leaks, structural failure, or unintended pressure migration.

In addition, partially completed welds may be exposed to moisture, contamination, or temperature fluctuations if work is paused, potentially affecting weld quality. Delays can also introduce additional thermal cycling, which may compromise weld integrity. For these reasons,

tie-in activities may extend into nighttime hours to ensure safe and proper completion once initiated.

Duration

If tie-in activities extend beyond 7:00 p.m., they are not expected to continue on a continuous 24-hour basis. Any nighttime work would be short-term, temporary, and limited to the duration necessary to safely complete the tie-in.

Anticipated Noise Making Equipment

Potential noise-generating equipment associated with final tie-in activities may include light plants, a welding unit or welding truck, and excavators with white noise back-up alarms, and a D-6 dozer. Additional minor support equipment, such as small generators, may also be used.

Potential Impacts

Overall noise levels at tie-in sites are expected to be lower than those generated during HDD operations. Standard construction noise mitigation methods will be implemented to minimize and avoid potential impacts on nearby NSAs as described in Section 3.5.2.

4.3.3 Hydrostatic/ Pneumatic Pressure Testing

Activity Description and Location

Pressure testing will be conducted to verify the integrity of the pipeline before it is placed into service. The process begins with pressurization, during which the pipeline is filled with water (for hydrostatic testing) or air/ nitrogen (for pneumatic testing) and gradually brought up to the required test pressure. The pressure is then held for a specified duration while the pipeline is monitored for any signs of leakage or pressure loss. After the test is complete, the system undergoes pressure-down, where the internal pressure is safely reduced. The final step is drying, during which any remaining moisture is removed from the pipeline using mechanical drying equipment to ensure the line is clean, dry, and ready for commissioning.

Pressure testing activities may occur at multiple locations along the pipeline alignment. The number and locations of test sections have not yet been finalized; however, Algonquin will require the contractor to select test sections and associated pressure-testing locations that maximize distance from nearby NSAs, to the extent practicable.

Potential Nighttime Work Scenarios

Pressurization of pipeline segments may need to begin during early morning hours (e.g., 3:00 a.m. to 4:00 a.m.) to take advantage of the natural increase in ambient temperature following sunrise. Initiating pressurization during this period helps stabilize internal pressure as temperatures rise, improving test reliability.

Pressure testing activities may extend into nighttime hours due to the overall duration of the testing sequence, which typically requires approximately 12 to 13 hours to complete when conducted without interruption. Depending on the start time, site conditions, and any minor delays, the required pressure-hold period may extend beyond daylight hours, resulting in testing activities continuing into the nighttime period to ensure completion of the test.

Pipeline drying following pressure testing may also extend into nighttime hours. Drying requires the pipeline to reach and maintain specific internal temperature and humidity conditions to effectively remove residual moisture. Once initiated, the drying process must proceed continuously; pausing drying allows the pipeline to equilibrate with ambient temperature and dew point conditions, reducing drying efficiency and potentially allowing moisture to re-enter or condense within the pipeline.

Duration

Pressure testing is typically conducted as a single, continuous operation for each pipeline segment and generally requires approximately 12 to 13 hours to complete, including pressurization, stabilization, and the pressure-hold period. Filling the pipeline with water will occur the day prior to the test. Each test segment must be completed without interruption to maintain test integrity and is typically performed once prior to placing the segment into service.

When the test is complete, the pressure-down step may generate a brief period of elevated noise lasting up to approximately 20 minutes as pressure is safely released.

The duration of pipeline drying will vary depending on the length of the pipeline segment, ambient temperature and humidity, the drying method used, and the amount of residual moisture remaining after testing. Drying must continue uninterrupted until moisture specifications are met, which may require several hours or, in some cases, extend over multiple days.

Anticipated Noise Making Equipment

Drying operations will require the use of high-capacity generators to power heating or air-moving equipment. These generators and equipment produce a steady noise and are expected to operate continuously throughout the drying process. Although this equipment can produce moderate sound levels, they will be operated and, where practicable, positioned to minimize noise exposure to nearby NSAs, consistent with the Project's noise mitigation measures (see Section 5.1.3).

Potential Impacts

Potential noise impacts associated with pressure-testing activities are expected to be minimal. Equipment used during pipeline filling, pressurization, and the pressure-hold period generally produces low to moderate noise levels comparable to typical construction support equipment and is not anticipated to result in measurable noise impacts at nearby NSAs.

The highest noise levels during pressure testing are expected to occur during the pressure-down phase, when the test medium is safely released from the pipeline. This activity may generate a short-duration increase in noise, characterized by a brief "whooshing" sound similar to a controlled high-pressure air release. The pressure-down event is typically short in duration, lasting only a few minutes, and noise levels attenuate rapidly with distance. As a result, pressure-down noise is not expected to cause significant disturbance at nearby NSAs. Applicable noise mitigation measures are described in Section 5.1.3.

4.3.4 M&R Station Construction

Activity Description and Location

Construction of the meter and regulator (M&R) stations is expected to occur primarily during daytime hours; however, certain circumstances may require limited nighttime work. The Project includes four M&R stations: the Sagamore M&R Station, Pave Paw Road M&R Station, Bourne M&R Station, and Bourne Rotary M&R Station. Station location details can be found in the Sound Level Impact Assessment Report in Attachment A.

Reason for nighttime work

Construction delays during execution of Algonquin's Project could affect the ability of the Cape Cod Bridge Project (CCBP) to commence operations as scheduled. To avoid cascading schedule impacts, delays encountered during construction may necessitate extending work into nighttime hours, to the extent practicable, in order to maintain overall project timelines and sequencing.

Duration

The duration of any nighttime construction at the M&R stations would depend on the nature and extent of the delay and the specific tasks required to return the Project to the planned construction schedule. Nighttime work would be limited to the minimum duration necessary to mitigate delays and restore normal daytime construction activities.

Anticipated Noise Making Impacts

Only standard construction equipment will be used in the construction of each M&R station with no dynamic compaction or pile driving expected. Each of the M&R Construction sites may utilize several types of equipment during temporary construction activities; however not all equipment listed is anticipated to be required at every location. Potential equipment includes light plants, generators, welding machines, water pumps, light vehicles, sandblasting, and excavators.

Potential Impacts

Potential impacts at the M&R station locations during construction could include short-term increases in sound levels at the NSAs. Algonquin evaluated potential impacts due to temporary nighttime construction at each of these locations. At three of the four M&R stations, existing

ambient sound levels exceed 55 dBA L_{dn}; therefore, nighttime construction noise would be limited to no more than 10 dBA above existing ambient levels at those locations. The sound level at the Pave Paw Road M&R Station may not exceed 55 dBA L_{dn}.

5.0 NIGHTTIME NOISE MITIGATION MEASURES

5.1 Activity Specific Mitigation Measures

5.1.1 Horizontal Directional Drilling

All HDD entry and exit sites are expected to meet the FERC sound level limits without additional mitigation, with exception of the Canal HDD exit site. At this location, unmitigated nighttime sound levels at noise-sensitive area (NSA) CX2 are expected to exceed the FERC limit of 55 dBA L_{dn}. Therefore, noise mitigation will be required during nighttime HDD activities at the Canal HDD exit site.

For temporary construction activities, installation of noise barriers along the perimeter of the work area represents the most effective and commonly used mitigation measure. Noise modeling conducted by Epsilon Associates, Inc. included a 16-foot-tall temporary noise barrier located along the north side of the Canal HDD exit work area. Modeling results indicate that this barrier configuration would reduce sound levels at NSA CX2 to comply with the FERC regulatory limit of 55 dBA L_{dn}. Multiple barrier configurations may be capable of achieving similar noise reductions, and the final barrier location and design may be adjusted if the construction site layout changes. The modeled barrier layout is shown in Figure 6-1 of Attachment A.

5.1.2 Final Tie-In

Final tie-in activities are not expected to exceed FERC's regulatory sound level requirements. These activities will also comply with the general construction noise mitigation measures described in Section 5.2, which incorporate best management practices to minimize noise generation and reduce potential impacts on nearby NSAs.

5.1.3 Hydrostatic/ Pneumatic Pressure Testing

Pressure testing activities, including pressurization, pressure-down, and drying, are not expected to exceed FERC regulatory sound level limits. Noise generated during pressurization and the pressure-hold period is generally limited to support equipment and is anticipated to remain within typical construction sound levels.

The pressure-down phase may produce a short-duration increase in noise similar to a controlled high-pressure air release. This activity is brief, typically lasting no more than approximately 20 minutes, and will be conducted at locations that maximize distance from nearby NSAs, to the extent practicable.

Drying operations may utilize high-capacity compressors or generators that produce moderate, steady noise. Drying equipment and pressure-release components will be located as far from NSAs as practicable to minimize potential disturbance. Equipment will be operated in accordance with standard noise mitigation practices, including directing exhaust away from sensitive receptors, maintaining equipment in good working order, and positioning vehicles or other equipment to provide temporary shielding where feasible.

5.1.4 M&R Station Construction

Noise modeling conducted by Algonquin indicates that construction activities at all M&R station locations are expected to comply with FERC sound level limits without the need for additional mitigation. M&R station construction will also adhere to the general construction noise mitigation measures described in Section 5.2, which include best management practices to minimize noise generation and reduce potential impacts on nearby NSAs.

5.2 General Construction Noise Mitigation

The preferred and most effective method of nighttime noise mitigation is to conduct construction activities during daytime hours. Accordingly, all construction activities will be planned and scheduled for daytime operation as the primary and preferred approach, whenever practicable.

When nighttime construction is required due to safety considerations, technical constraints, quality control requirements, or to maintain project schedule, reasonable and practicable noise reduction measures will be implemented to minimize potential impacts on nearby NSAs.

5.2.1 Engine-Powered and Continuously Operating Equipment

To reduce noise from stationary and continuously operating equipment, the following measures will be implemented as necessary:

- All internal combustion equipment will be equipped with properly functioning mufflers.
- Equipment will be maintained in good repair and operated according to manufacturers' recommendations.
- Continuously operated diesel-powered equipment, such as compressors, pumps, and generators, will be located as far as practicable from NSAs or otherwise shielded.
- Equipment panels and enclosures will be kept closed and latched, as these components typically provide noise attenuation.

5.2.2 Vehicle Movements and Backup Alarm Minimization

To reduce noise generated from vehicle movement and safety alarms, the following practices will be implemented as necessary:

- Vehicle and equipment idling will be minimized to the extent practicable.
- Pull-through access routes will be used where feasible to reduce backing maneuvers and associated alarm activation.

- Backup alarm noise will be minimized while maintaining compliance with OSHA requirements, including:
    - Consideration of ambient-sensing or broadband (“white noise”) backup alarms.
    - Use of spotters to support backing operations and reduce alarm duration.
    - Use of hand signals, radios, or spotters in place of horns)where safe to do so), or shouting for communication during nighttime operations.

5.2.3 Material Handling and Trucking

To limit noise produced during material handling and general construction activity, the following practices will be implemented as necessary:

- Construction materials will be handled and transported in a manner that minimizes noise.
- Loading, unloading, and material handling activities will be scheduled to minimize nighttime noise where practicable.
- Slamming of dump truck tailgates will be minimized.
- Daytime scheduling will continue to be prioritized for material deliveries whenever feasible.

5.2.4 Temporary Barriers and Site Layout Planning

To further reduce nighttime noise impacts, the following practices will be implemented as necessary:

- Temporary noise barriers will be installed, or existing natural or structural features will be utilized, to shield NSAs from direct nighttime noise transmission where feasible.
- Noise-generating equipment will be positioned to maximize distance from NSAs during night work.
- Equipment will be oriented such that exhaust outlets and primary noise-generating components face away from NSAs whenever practicable during nighttime activities.

TABLE 4.1

Potential Nighttime Construction Noise Activities for the Cape Cod Bridge Relocation Project

Activity	Work Task	Anticipated Locations	Anticipated Work Hours	Estimated Duration	Primary Noise Source(s)	Mitigation Measures
Horizontal Directional Drilling (HDD)	Drilling Reaming Pull Back	Canal HDD Entry Canal HDD Exit Sagamore HDD Entry Sagamore HDD Exit	24-hour Operation	~3 Months	Light Plant Mud Pump Generator Mud System Drill Rig Drill Rig Power Unit D-6 Dozer Welding Truck Excavator	Activity-specific mitigation
Final Tie Ins	Welding	Multiple locations including but not limited to Canal HDD Entry/Exit and Sagamore HDD Entry/Exit	May extend past 7:00 p.m.	~2 days per tie-in	Welding truck Excavator Support Equipment	General Noise Mitigation
Pressure Testing	Pressurization	Throughout the pipeline alignment, away from NSAs as feasible.	May begin before 7:00 a.m.	~13 Hrs	Support Equipment	General Noise Mitigation
	Pressure Down		May extend past 7:00 p.m.	~ 20 min	Pressure release	Activity Specific
	Drying		24-hour operation	Hours to Days	Compressors; generators	Activity Specific
M&R Station Construction	Station construction activities	Sagamore M&R Station Bourne M&R Station Bourne Rotary M&R Station Pave Paws M&R Station	May extend past 7:00 p.m.	Variable	Standard construction support equipment	General Noise Mitigation

Notes

- "Activity-specific mitigation" refers to measures described in Section 5.1.
- "General noise mitigation" refers to best management practices described in Section 5.2.
- Nighttime work is anticipated to occur only when necessary for safety, technical feasibility, quality control, or schedule considerations.

ATTACHMENT 10

Wetland Protection Act Resource Areas, Buffer Zones, and Isolated Vegetated Wetland Alterations

Table 1. Summary of WPA Resource Area, Buffer Zone, and IVW Alterations

Resource Area	Feature ID	Regulatory Citation	Facility / Activity	Plan Sheet	Existing Condition	Temporary Surface Alteration	Permanent Surface Alteration	Permanent Easement or Maintenance Area	Flood Storage Alteration	Vegetation Conversion	Construction Method	Avoidance / Minimization Measure	Restoration Method	Performance Standard Finding
COASTAL WETLAND RESOURCE AREAS														
Land Under the Ocean	Cape Cod Canal / Waterbody B2	310 CMR 10.25	G-31 Pipeline HDD beneath Cape Cod Canal	Attachment 1, Figure 5.3-4, Sheets 3 and 4; Attachment 4 HDD Plan and Profile	Tidal canal bottom; estuarine deepwater habitat; approximately 32 feet deep at mean sea level	0 square feet of surface alteration; resource crossed subsurface by HDD; approximately 732 linear feet / 1,650 square feet crossed	0 square feet	0 square feet	No volumetric change	None	HDD approximately 87 feet below canal bed	Trenchless crossing avoids canal bed and bank disturbance; Best Drilling Practices Plan for inadvertent returns	No surface restoration required within LUO; contingency response and cleanup if inadvertent return occurs.	Meets 310 CMR 10.25 because the Project will not alter bottom topography, circulation, sediment grain size, water quality, or marine fisheries habitat under normal HDD construction.
Land Containing Shellfish	Cape Cod Canal / Waterbody B2	310 CMR 10.34	G-31 Pipeline HDD beneath shellfish-suitable area	Attachment 1, Figure 5.3-4, Sheets 3 and 4; Attachment 4 HDD Plan and Profile	Land Under the Ocean mapped as suitable for blue mussel	0 square feet of surface alteration; resource crossed subsurface by HDD; approximately 182 linear feet / 410 square feet crossed	0 square feet	0 square feet	No volumetric change	None	HDD beneath canal bed and banks	No in-water work; no bottom disturbance; Best Drilling Practices Plan for inadvertent returns	No shellfish relocation or substrate restoration proposed because no bottom disturbance is anticipated.	Meets 310 CMR 10.34 because shellfish habitat and productivity will not be altered under normal HDD construction.
Coastal Bank	Cape Cod Canal Coastal Bank	310 CMR 10.30	TWS for G-24/G-11 pipeline work and removal of cathodic protection near Sagamore Bridge	Attachment 1, Figure 5.3-4, Sheet 1	Armored and maintained canal embankment, including riprap, mowed grass, shrubs, service road, and recreational path areas	55,232 square feet of potential construction surface alteration	0 square feet	0 square feet	No volumetric change identified	Temporary disturbance to maintained grass/shrub areas; no permanent conversion proposed	Excavation/removal of buried cathodic protection components and associated temporary workspace	Limit of work, erosion controls along canal side, no in-water work, restoration to preconstruction contours	Restore Coastal Bank to preconstruction contours and revegetate/stabilize disturbed surface areas.	Meets 310 CMR 10.30(6) through (8) because bank stability will be maintained and no adverse effect occurs to rare species habitat.
Coastal Bank crossed by HDD	Cape Cod Canal Coastal Bank at G-31 crossing	310 CMR 10.30	G-31 Pipeline HDD beneath Coastal Bank	Attachment 1, Figure 5.3-4, Sheets 3 and 4; Attachment 4 HDD Plan and Profile	Sloped canal embankments with top of Coastal Bank delineated above service roads	0 square feet of surface alteration	0 square feet	0 square feet	No volumetric change	None	HDD below bank and canal	Trenchless method avoids direct bank disturbance; monitoring and inadvertent-return response plan	No surface restoration required unless contingency disturbance occurs.	Meets 310 CMR 10.30 because no adverse effect on bank stability is anticipated.
Land Subject to Coastal Storm Flowage	FEMA Zone AE along Cape Cod Canal	310 CMR 10.04 definition; no specific performance standards	TWS for G-24/G-11 pipeline work near Sagamore Bridge	Attachment 1, Figure 5.3-4, Sheet 1	Zone AE with BFE 15 feet NAVD88; bike path, maintained grass embankments, and adjacent canal-side areas	21,119 square feet	0 square feet	0 square feet	No cut/fill or volumetric change identified	Temporary disturbance to maintained surface vegetation only	TWS for pipe/cathodic protection removal and related construction	Restore grades; avoid permanent fill; implement erosion and sediment controls	Return workspace to preconstruction contours and stabilize/revegetate disturbed areas.	No specific LSCSF performance standard applies, but the work is not expected to affect storm flowage, flood control, or storm damage prevention given no grade or volume change is proposed.
Land Subject to Coastal Storm Flowage	FEMA Zone AE along G-31 HDD crossing	310 CMR 10.04 definition; no specific performance standards	G-31 HDD workspace / canal crossing area	Attachment 1, Figure 5.3-4, Sheets 3 and 4; Attachment 4 HDD Plan and Profile	Zone AE with BFE 15 feet NAVD88 along both canal shorelines	0 square feet	0 square feet	0 square feet	No cut/fill or volumetric change identified	None identified	HDD with upland entry/exit workspaces and monitoring travel lanes	HDD avoids surface alteration of canal and coastal storm-flowage areas	Restore any upland disturbed workspace to preconstruction contours and stabilize.	No specific LSCSF performance standard applies.

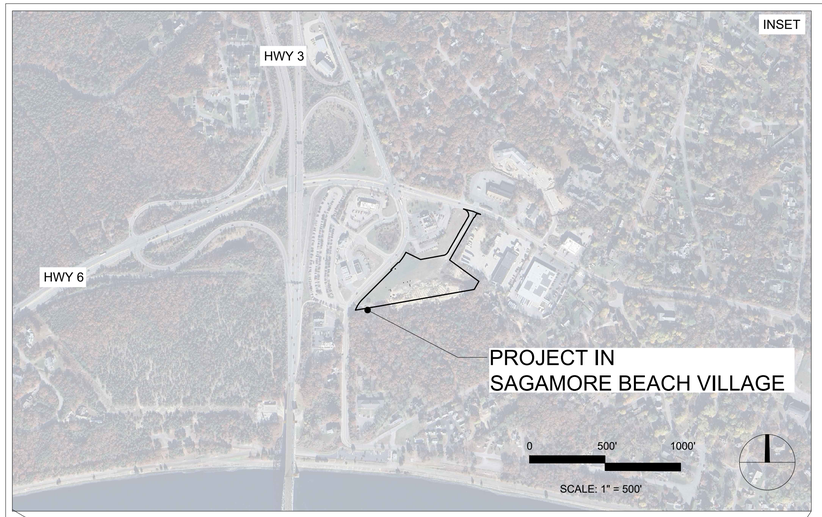
Resource Area	Feature ID	Regulatory Citation	Facility / Activity	Plan Sheet	Existing Condition	Temporary Surface Alteration	Permanent Surface Alteration	Permanent Easement or Maintenance Area	Flood Storage Alteration	Vegetation Conversion	Construction Method	Avoidance / Minimization Measure	Restoration Method	Performance Standard Finding
INLAND WETLAND RESOURCE AREAS														
Bordering Land Subject to Flooding	Nightingale Pond floodplain	310 CMR 10.57(4)(a)	TWS for G-8L/G-8C pipeline removal	Attachment 1, Figure 5.3-4, Sheet 7	FEMA Zone A associated with Nightingale Pond; pitch pine–oak woodland floodplain setting	52 square feet temporary construction disturbance	0 square feet	0 square feet; easement maintenance through BLSF to cease after removal	No permanent flood-storage loss; no permanent fill or topographic change proposed	Limited temporary vegetation disturbance; long-term maintenance of the pipeline ROW will cease	Pipe exposure/removal, backfill, and restoration	Minimize work area; maintain existing contours; use erosion controls and restore grades	Backfill trench, restore preconstruction contours, stabilize, and revegetate.	Meets 310 CMR 10.57(4)(a) because no compensatory storage is required given no flood storage will be lost and flows will not be restricted.
Isolated Land Subject to Flooding	W5	310 CMR 10.57(4)(b) and (c)	ATWS for Cape Cod Canal HDD / G-31 Pipeline	Attachment 1, Figure 5.3-4, Sheet 3	Approximately 76,832 square feet of ILSF located within an inactive gravel/sand quarry; a portion (36,154.8 square feet) of this ILSF has been delineated as an IVW	42,709 square feet temporary construction disturbance	0 square feet	0 square feet	No flood-storage alteration proposed; preconstruction contours to be restored	Temporary disturbance to PEM vegetation; no permanent conversion proposed	Temporary work area, construction matting as needed, HDD support/staging	Use mats, minimize grading, preserve hydrology, maintain erosion controls, avoid permanent fill	Remove mats, restore contours, stabilize soils, allow wetland vegetation to re-establish, monitor as required.	Meets 310 CMR 10.57(4)(b) and (c) because there will be no filling, groundwater impairment, or vernal-pool habitat impairment.
BVW Buffer Zone	W14 Buffer Zone	310 CMR 10.55 resource area; Buffer Zone review under 310 CMR 10.02 and 10.05	TWS for Sagamore M&R Station removal, G-24 pipeline work, and Sagamore M&R Station area	Attachment 1, Figure 5.3-4, Sheet 1	Buffer Zone of PFO BVW W14; includes Canal Street area, riprap slope vicinity, open land, and portions of station/workspace	Approximately 4,095 square feet of forest cover disturbance in Buffer Zone; a total of 34,034 square feet temporary construction disturbance	0 square feet of direct BVW alteration	2,501 square feet proposed new permanent easement in W14 Buffer Zone on previously disturbed land for the portions of the Sagamore M&R Station site for a total of 8,695 square feet.	No flood-storage alteration identified	Temporary forest/tree clearing in Buffer Zone; no direct BVW conversion	Station removal, pipeline relocation/removal, temporary access/workspace	Reduce workspace, maintain erosion controls, avoid direct BVW alteration, site work in previously disturbed/open areas where practicable	Restore TWS, stabilize soils, allow forest/shrub vegetation to revegetate where compatible with easement and safety requirements.	No direct BVW performance-standard trigger because no BVW alteration is proposed; Buffer Zone work will protect adjacent BVW interests through erosion control, stabilization, and restoration.
BVW Buffer Zone	W1 Buffer Zone	310 CMR 10.55 resource area; Buffer Zone review under 310 CMR 10.02 and 10.05	PAR-20	Attachment 1, Figure 5.3-4, Sheet 2, applicable PAR-20 sheet to confirm	Buffer Zone of BVW W1; existing access road / utility corridor setting	1,783 square feet temporary construction disturbance	0 square feet direct BVW alteration	1,782.6 square feet permanently maintained area (PAR-20), consisting of minor road improvements as required, site access.	No flood-storage alteration	Limited maintained-road/access condition; no direct BVW alteration	Access road use or improvement	Use existing access route; limit disturbance; install erosion controls; avoid direct wetland alteration	Stabilize and restore disturbed shoulder/edge areas as needed; maintain road surface for access.	No direct BVW performance-standard trigger because no BVW alteration is proposed; Buffer Zone activities will be conditioned to protect W1.
Inland Bank Buffer Zone	Nightingale Pond / Waterbody B3	310 CMR 10.54; Buffer Zone review under 310 CMR 10.02 and 10.05	TWS for G-8C/G-8L pipeline removal	Attachment 1, Figure 5.3-4, Sheet 7	100-foot Buffer Zone of Inland Bank associated with Nightingale Pond; includes existing maintained ROW and woodland	41,389 square feet Buffer Zone construction disturbance; approximately 5,197 square feet of temporary forest cover impact	0 square feet direct Inland Bank alteration identified	0 square feet permanent surface alteration identified	No flood-storage alteration proposed	Temporary forest cover disturbance; no permanent conversion identified	Existing pipeline removal, trench backfill, and restoration	Use existing ROW where possible; reduce workspace; erosion controls; no work below top of bank	Backfill trench, restore contours, stabilize soils, and allow vegetation to recover.	No direct Inland Bank performance-standard triggered given no work occurs below top of bank; no Inland Bank alteration.
ISOLATED VEGETATED WETLANDS														
Isolated Vegetated Wetland	W2 *	Not a WPA resource area	G-31 Pipeline installation	Attachment 1, Figure 5.3-4, Sheet 2	Approximately 0.11-acre PSS isolated vegetated wetland in existing maintained utility corridor; does not meet ILSF criteria	4,464 square feet temporary construction disturbance	0 square feet wetland loss stated	3,429 square feet permanently maintained easement area	No flood-storage alteration	PSS wetland within permanent easement maintained consistent with pipeline vegetation requirements	Open-trench pipeline installation through existing utility corridor	Workspace controls, topsoil segregation where appropriate, matting as needed, restoration to contours	Restore contours, replace topsoil, stabilize, and allow PSS wetland vegetation to re-establish subject to operational vegetation restrictions.	Not a WPA performance-standard resource area.
Isolated Vegetated Wetland	W12 *	Not a WPA resource area	TWS for G-8C/G-8L pipeline removal	Attachment 1, Figure 5.3-4, Sheet 7	Approximately 0.39-acre PSS/PFO isolated vegetated wetland between Deseret Drive and Route 28 northbound off-ramp	2,395 square feet temporary construction disturbance	0 square feet wetland loss stated	0 square feet	No flood-storage alteration	Temporary disturbance to PSS/PFO vegetation; no permanent conversion proposed	Pipe exposure/removal, temporary matting as needed, backfill and restoration	Reduce workspace, use mats as needed, restore contours, prevent sediment/pollutant release	Backfill trench, restore contours, stabilize soils, allow wetland vegetation to re-establish, monitor as required.	Not a WPA performance-standard resource area.

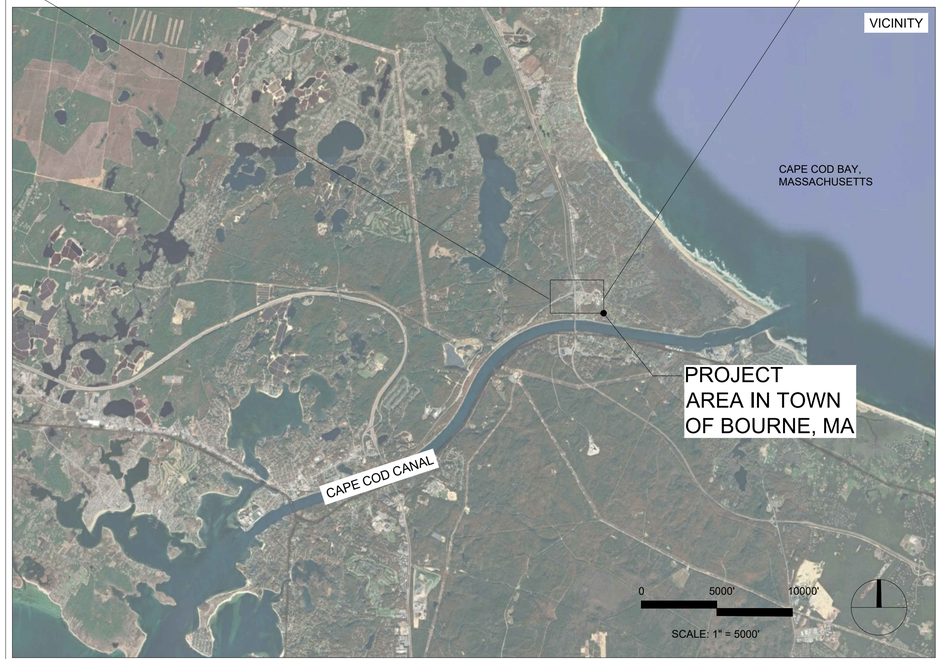
Notes: BFE = base flood elevation; BLSF = Bordering Land Subject to Flooding; BVW = Bordering Vegetated Wetland; FEMA = Federal Emergency Management Agency; HDD = horizontal directional drill; ILSF = Isolated Land Subject to Flooding; IVW = isolated vegetated wetland; LCS = Land Containing Shellfish; LSCSF = Land Subject to Coastal Storm Flowage; LUO = Land Under the Ocean; PEM = palustrine emergent; PFO = palustrine forested; PSS = palustrine scrub-shrub; TWS = temporary workspace.

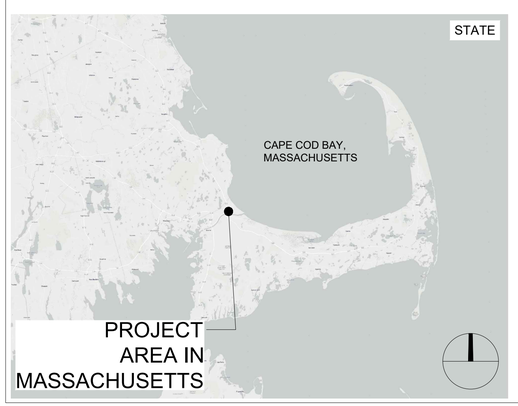
* Only W5 meets the WPA criteria for ILSF. W2 and W12 are IVWs that do not meet the ILSF storage and depth criteria and are included for transparency.

ATTACHMENT 11

Landscape Screening Plan







PROJECT AREA:

PROJECT SITE IS LOCATED IN THE GREATER CAPE COD BAY REGION OF MASSACHUSETTS IN THE SAGAMORE BEACH VILLAGE OF THE TOWN OF BOURNE. PARCEL IS IN B-2 BUSINESS ZONING.

CONDITIONS:

ELEVATION: 62 FT
CLIMATE: MARITIME
PRECIPITATION: 47.04 INCHES
AVERAGE SUMMER TEMPS: 62.6F - 68.8F
AVERAGE WINTER TEMPS: 30.9F - 36.5F
AVERAGE SNOWFALL: 26.6 INCHES

ECOLOGY:

COASTAL PLAIN UPLAND FORMED BY RECEDING GLACIERS.
SANDY ACIDIC NUTRIENT-POOR SOILS IN PINE BARREN ECO-REGION.
VEGETATION TYPES: COASTAL PITCH PINE, SCRUB OAK

SOURCES: 6/18/25 HABITAT ASSESSMENT, NOAA, US FOREST SERVICE, PINE BARREN ALLIANCE, BOURNE, NEW ENGLAND WETLAND PLANTS

ABBREVIATIONS FOR REFERENCE

&	AND	FL	FLOW LINE	REF	REFERENCE
@	AT	FO	FACE OF	REV	REVISION, REVISED
CL/	CENTER LINE	FOC	FACE OF CONCRETE	REQD	REQUIRED
#	POUND OR NUMBER OR SIZE OF REINFORCING BAR	FOF	FACE OF FINISH	ROW	RIGHT OF WAY
AB	AGGREGATE BASE	FS	FINISH SURFACE	SB	SOLID BLOCKING
AC	ASPHALT CONCRETE	FT	FOOT OR FEET	SC	SEALED CONCRETE
ADA	AMERICAN DISABILITY ACT	FTG	FOOTING	SCHED	SCHEDULE
ADJ	ADJACENT	GA	GAGE	SD	STORM DRAIN
AGG	AGGREGATE	GALV	GALVANIZED	SDMH	STORM DRAIN MANHOLE
APPROX	APPROXIMATE	GB	GRADE BREAK	SF	SQUARE FEET
BLDG	BUILDING	GC	GENERAL CONTRACTOR	SHT	SHEET
BC	BOTTOM OF CURB	GR	GRADE	SIM	SIMILAR
BEL	BELOW	GV	GAS VALVE	SJ	SCORE JOINT
BETW, B/W	BETWEEN	H	HIGH	SLNT	SEALANT
BM	BENCHMARK	HB	HOSE BIB	SPECS	SPECIFICATIONS
BO	BOTTOM OF	HT	HEIGHT	SMA	STREAM MANAGEMENT AREA
BOW	BACK OF WALK	HORIZ	HORIZONTAL	SQ	SQUARE
BS	BOTH SIDES	ID	INTERIOR DIAMETER	SS	STAINLESS STEEL
BW	BOTTOM OF WALL	IN	INCH	SSMH	SANITARY SEWER MANHOLE
CB	CATCH BASIN	INCL	INCLUDE, INCLUDED. INCLUDING	SST	STAINLESS STEEL
CLR	CLEAR	INV	INVERT	STA	STATION
CONC	CONCRETE	LF	LINEAR FEET	STD	STANDARD
CONT	CONTINUE	LOD	LIMITS OF DISTURBANCE	STL	STEEL
CONTR	CONTRACT, CONTRACTOR	MAX	MAXIMUM	STRL	STRUCTURAL
CTR	CENTER	MH	MAN HOLE	SYM	SYMMETRICAL, SYMMETRY
D	DEPTH, DIAMETER	MIN	MINIMUM	SWLK	SIDEWALK
DBH	DIAMETER BREAST HEIGHT	MISC	MISCELLANEOUS	T&B	TOP AND BOTTOM
DEMO	DEMOLITION, DEMOLISH	MTL	METAL	TBD	TO BE DETERMINED
DIA	DIAMETER	(N)	NEW	TC	TOP OF CURB
DIM	DIMENSION	NIC	NOT IN CONTRACT	THK	THICK
DN	DOWN	NO	NUMBER	TO	TOP OF
DTL	DETAIL	NOM	NOMINAL	TOC	TOP OF CONCRETE
DWG	DRAWING	O/	OVER	TOS	TOP OF SLOPE
(E)	EXISTING	OC	ON CENTER	TW	TOP OF WALL
EA	EACH	OD	OUTSIDE DIAMETER	TYP	TYPICAL
EJ	EXPANSION JOINT	PA	PLANTING AREA	U/G. UG	UNDERGROUND
ELEV	ELEVATION	PL	PROPERTY LINE	UL	UNDERWRITERS LABORATORY
EQ	EQUAL	PROP	PROPERTY	UON, UNO	UNLESS OTHERWISE NOTED
EW	EACH WAY	PVG	PAVING	VERT	VERTICAL
EXP	EXPANSION	PVMT	PAVEMENT	VIF	VERIFY IN FIELD
EXT	EXTERIOR	PVR	PAVER	W	WIDE, WIDTH
FDN	FOUNDATION	R, RP	RADIUS, RADIUS POINT	W/O	WITHOUT
FG	FINISH GRADE	RAD	RADIUS	WT	WEIGHT
FIN	FINISH	RCP	REINFORCED CONCRETE PIPE	WV	WATER VALVE

SHEET INDEX

L001: COVER SHEET

L002: SITE CONTEXT

L003: LANDSCAPE NOTES

L101: PLANTING PLAN AREA 1

L102: PLANTING PLAN AREA 2

L103: RESTORATION SEEDING PLAN

L501: PLANTING DETAILS

L601: PLANTING SCHEDULE

LANDSCAPE ARCHITECT CONTACT INFORMATION:
NAME: TONY SOMERS
COMPANY: SWCA ENVIRONMENTAL CONSULTANTS
ADDRESS: 15 RESEARCH DRIVE, AMHERST, MA 01002
EMAIL: TONY.SOMERS@SWCA.COM
PHONE: 413.658.2067
DRAFTER: TODD SIEFKE
DRAFTER CONTACT: 626.848.6889

PROJECT ENGINEER CONTACT INFORMATION:
*TO BE DETERMINED AT A LATER DATE

OWNER/DEVELOPER CONTACT INFORMATION:
ALGONQUIN GAS TRANSMISSION, LLC
(905) 465-4500

MAINTENANCE PROVIDER CONTACT INFORMATION:
* TO BE DETERMINED AT A LATER DATE

WATER PROVIDER CONTACT INFORMATION:
* TO BE PROVIDED AT A LATER DATE

LANDSCAPE CALCULATIONS
LANDSCAPE AREA: 52,490.8 SQ FT (1.213 ACRE)

VEGETATION GOALS FROM TOWN OF BOURNE LOCAL COMPREHENSIVE PLAN:

Wildlife and Plant Habitat Goal

The Wildlife and Plant Habitat goal of the Bourne Local Comprehensive Plan is to restore and protect the natural environment to the greatest extent possible while accommodating the needs of residents and visitors for housing, transportation, recreation, and economic opportunity.

Wildlife and Plant Habitat Policies

- Manage natural habitats that support diverse communities of local wildlife and plant species.
- Promote best management practices to protect wildlife and plant habitat from the adverse impacts of development.
- Prevent, minimize, or reverse invasive species incursions.

Wildlife and Plant Habitat Actions

- Post biologically sensitive areas to prevent damage from walkers and cyclists.
- Support and work to implement the Massachusetts Endangered Species Act (MESA) by streamlining local review procedures with MESA review of projects.
- Develop strategies to control and remove invasive species on publicly owned land.
- Plant native vegetation as needed to enhance or restore wildlife habitat.
- Cluster development away from the most sensitive areas of a site.
- Keep identified wildlife migration corridors unimpeded by development or fencing.
- Promote best management practices to protect wildlife and plant habitat from adverse impacts.
- Minimize clearing and grading of development sites.
- Preserve critical wildlife and plant habitats during the design/permitting stage of developments.
- Acquire conservation easements over private land to preserve wildlife corridors.
- Revise regulations to protect wetland buffers or create buffers where none exist.

Prepared by:
SWCA®
ENVIRONMENTAL CONSULTANTS
SWCA Environmental Consultants
15 Research Drive
Amherst, MA 01002
(p) 413.256.0202
(f) 413.256.1092
www.swca.com

Prepared for:
ALGONQUIN GAS TRANSMISSION, LLC

Key Map:



NOTES:

LEGEND:

Stamp:



Project Title:
CAPE COD CANAL
PIPELINE
RELOCATION PROJECT

0 MEETINGHOUSE LN,
BOURNE, MA

Sheet Title:
LANDSCAPE
COVER SHEET

Date:	9/11/2025
Scale:	As Shown
Drawn by:	TRS
Checked by:	APS
File #	65956.00

REVISIONS

Date:	By:	Note:
7/23/26	TRS	Changes to LOD

Sheet No:
L001



EXISTING VIEW 1. LOOKING EAST AT PARCEL FROM INTERSECTION



EXISTING VIEW 2. LOOKING SOUTH AT NEW ENTRY FROM PARKING LOT

MCDONALD'S

DUNKIN DONUTS

DRAINAGE AREA

ENTRY ROAD

35,015 SF

UPS SHIPPING

5,524 SF

30'

15'

10' SECURITY CAMERA CLEARANCE

TEMPORARY WORK AREA

PERMANENT WORK AREA

MARYLOU'S COFFEE & SHELL GAS

(N) SECURITY FENCE; MIN. 8FT CHAIN-LINK W/ 3-STRANDS OF BARBED WIRE

11,782 SF

UNDERGROUND PIPES. AVOID BIG TREES WITHIN THIS BULBOUT

EXISTING FORESTED AREA

LANDSCAPE OBJECTIVE:

1. SCREEN SECURITY FENCING AROUND NEW M&R EQUIPMENT WITH VEGETATION
2. SCREEN ROAD LEADING TO M&R EQUIPMENT WITH VEGETATION
3. BEAUTIFY AND CREATE HABITAT USING NATIVE PLANTS OF THE CAPE COD REGION
4. COMPLY WITH TOWN OF BOURNE B2 ZONING REGULATIONS
5. VEGETATION TO BE LOW MAINTENANCE AND WITHOUT IRRIGATION

NOTE: SATELLITE IMAGE MAY NOT LINE UP EXACTLY DUE TO DISTORTION

Prepared by:

SWCA®
ENVIRONMENTAL CONSULTANTS
SWCA Environmental Consultants

15 Research Drive
Amherst, MA 01002
(p) 413.256.0202
(f) 413.256.1092
www.swca.com

Prepared for:

ALGONQUIN GAS TRANSMISSION, LLC

Key Map:



NOTES:

N

0 40' 80'

SCALE: 1" = 40'

LEGEND:

SCREENING AREA 1 (L101)

546.39 LF - 18 TREES REQ
182 SHRUBS REQ

SCREENING AREA 2 (L102)

467.3 LF - 15 TREES REQ
155 SHRUBS REQ

Stamp:



Project Title:

CAPE COD CANAL PIPELINE RELOCATION PROJECT

0 MEETINGHOUSE LN, BOURNE, MA

Sheet Title:

SITE CONTEXT

Date:	9/11/2025
Scale:	As Shown
Drawn by:	TRS
Checked by:	APS
File #	65956.00

REVISIONS

Date:	By:	Note:
7/23/26	TRS	Changes to LOD

Sheet No:

L002

STABILIZATION AND PLANTING NOTES:

1. REMOVE OBSTRUCTIONS, AS REQUIRED, TO PERMIT INSTALLATION OF NEW CONSTRUCTION. CUT MINOR ROOTS OF TREES INDICATED TO REMAIN IN A CLEAN AND CAREFUL MANNER WHERE SUCH ROOTS AND BRANCHES OBSTRUCT INSTALLATION OF NEW CONSTRUCTION.
2. REPAIR OR REPLACE EXISTING TREES AND VEGETATION THAT ARE DAMAGED BY CONSTRUCTION OPERATIONS IN A MANNER ACCEPTABLE TO THE LANDSCAPE ARCHITECT.

SEEDING AND MANAGEMENT GUIDANCE

SEEDING CHRONOLOGY/TIMING

THE FOLLOWING METHODOLOGY PROVIDES SEQUENCING FOR ESTABLISHING THE SEED MIXES PRESCRIBED HEREIN. THIS PROCESS SHOULD BEGIN FOLLOWING FINAL GRADING.

LIVE OR SPRING SEEDING: "LIVE SEEDING" TAKES PLACE WHEN SOIL TEMPERATURES ARE CONSISTENTLY ABOVE 55 DEGREES FAHRENHEIT AND SEED CAN ACTIVELY GERMINATE WITHOUT THE RISK OF A HARD FREEZE. IN THE PROJECT REGION LIVE SEEDING IS RECOMMENDED BETWEEN APRIL 15 AND JUNE 15. PLANTING AFTER MID-JUNE IS NOT RECOMMENDED SINCE NEWLY ESTABLISHED PLANTINGS LACK ROOT DEPTH AND ARE SUSCEPTIBLE TO BURNOUT RELATED TO DROUGHT CONDITIONS.

DORMANT SEEDING: THE OPTIMAL TIME TO "DORMANT SEED" PRESCRIBED NATIVE GRASSES AND FORBS IS WHEN SOIL TEMPERATURES ARE CONSISTENTLY BELOW 55 DEGREES FAHRENHEIT, APPROXIMATELY BETWEEN NOVEMBER 15 AND APRIL 15 IN THE PROJECT REGION. SEEDING WHEN SNOW IS ON THE GROUND SHOULD BE AVOIDED SINCE IT REDUCES SEED-TO-SOIL CONTACT AND EXPOSES THE SEED TO PREDATION. DURING THIS PERIOD, THE PRESCRIBED COOL SEASON NURSE CROP AND NATIVE COOL SEASON SPECIES WILL ESTABLISH; HOWEVER, WARM SEASON GRASSES AND FORBS WILL GERMINATE IN THE SPRING WHEN SOIL TEMPERATURES RISE. DORMANT SEEDING ENABLES COLD STRATIFICATION OF THE SEED AND ALLOWS THE SEED THE EARLIEST GERMINATION POSSIBLE GOING INTO THE LIVE SEEDING PERIOD.

TEMPORARY COVER CROP/STABILIZATION SEED MIXES: COOL-SEASON GRASSES SHOULD BE INSTALLED AS NEEDED WHEN ADEQUATE SOIL MOISTURE IS PRESENT, AND SOIL TEMPERATURES ARE ABOVE 55 DEGREES FAHRENHEIT. TEMPORARY SEEDING IS NOT RECOMMENDED BETWEEN DECEMBER 1 AND MARCH 1.

WEATHER FORECASTS SHOULD BE MONITORED AS SUPPLEMENTAL WATERING MAY BE NECESSARY DURING PROLONGED DRY PERIODS.

SOIL SCARIFICATION/ SEED BED PREPARATION

SEED BED PREPARATION IS THE PROCESS OF SCARIFYING AND LOOSENING THE SOIL SURFACE IN ORDER TO CREATE A LOOSE, FRIABLE, SOIL SURFACE. THE SOIL SURFACE SHOULD BE A UNIFORM PLANAR SURFACE THAT IS FLAT AND WITHOUT EXCESSIVE RIDGES, FURROWS, RUTS OR MOUNDS AND LOW SPOTS WHERE WATER CAN COLLECT. SOIL SCARIFICATION SHOULD ONLY OCCUR WHEN WEATHER, SOIL CONDITIONS, AND CONSTRUCTION PHASING ALLOWS FOR NO LONGER THAN 48 HOURS BETWEEN SCARIFICATION (THE BEGINNING OF THE SEEDING PROCESS) AND COVERING THE SEED WITH HYDROMULCH. THE SOIL SHOULD BE SCARIFIED TO MAXIMUM DEPTH OF 3 INCHES (SEE BELOW).

SEED APPLICATION

A WELL-PREPARED SEED BED PROVIDES A LOOSE FRIABLE SOIL SURFACE FOR WHICH THE SEED CAN BE SOWN INTO. SEED APPLICATION IS A TWO-PART PROCESS: 1) SEED APPLICATION AT PROPER RATES PER ACRE, AND 2) SOW THE SEED INTO THE SOIL 1/8" TO ¼" DEPTH MAXIMUM.

BROADCAST: A SPREADER EQUIPPED WITH AN AGITATOR (NEAR THE SEED RATE APERTURE) IS REQUIRED FOR SUCCESSFUL BROADCAST PLANTING OF DIVERSE SEED MIXES WITH VARIED SEED SIZES. CHECK THE SEED LABEL PRIOR TO OPENING THE BULK BAG TO CONFIRM THE CORRECT SEED IS BEING APPLIED TO THE SPECIFIED LOCATION. CHECK THE BULK BAGS OF SEED TO CONFIRM IF ALL SEED SPECIES ARE WITHIN EACH BAG OR IF IN BAGS SEPARATED BY SIZE OR CHAFF. IF SEPARATED, BLEND THE APPROPRIATE BAGS FOR EACH PLANTING AREA WITHIN THE SPREADER HOPPER OR IN A CLEAN DRUM/BARREL PRIOR TO SEEDING. ONCE THE SEED IS SPREAD THE SEED MUST BE SOWN INTO THE SOIL TO THE DEPTH ABOVE IN ORDER TO INCREASE CHANCES OF GERMINATION WITH SEED-TO-SOIL CONTACT AND BY KEEPING SOIL MOISTURE CLOSE TO THE SEED. THE BROADCASTED SEED CAN BE SOWN BY A NUMBER OF WAYS INCLUDING "TRACKED" IN WITH A LOW PSI RUBBER TIRE OR TRACKED MACHINE WITH OVERLAPPING PASSES, USE OF A CULTIPACKER, OR HEAVY ROLLER. BROADCAST SEED SHALL BE COVERED WITH HYDROMULCH.

PLANT SUCCESSION NOTES

IT IS POSSIBLE THAT SOME SEEDED AREAS MIGHT BECOME DOMINATED BY NATIVE PLANT SPECIES EXISTING IN THE SOIL SEED BANK. THIS INCLUDES BENEFICIAL NATIVE GRASSES AND FORBS. THESE ARE STILL BENEFICIAL SPECIES TO WILDLIFE AND COMPATIBLE WITH PRESCRIBED SEED MIXES. LIKEWISE, IT IS POSSIBLE THAT PERENNIAL GRASS AND FORB SPECIES MAY NOT BECOME APPARENT DURING THE FIRST GROWING SEASON, TAKING UP TO THREE YEARS TO BECOME ESTABLISHED. ANNUAL FORBS SHOULD BECOME ESTABLISHED WITHIN THE FIRST GROWING SEASON. SPECIFIC MANAGEMENT PRACTICES DETAILED BELOW WILL ENSURE ESTABLISHMENT OF ALL SEED MIXES OVER TIME.

WOODY PLANT ESTABLISHMENT

THE FOLLOWING APPROACH PROVIDES SEQUENCING FOR ESTABLISHING WOODY VEGETATION.

1. PLANTING HOLE PREPARATION - DETERMINE THE CORRECT PLANTING HOLE DEPTH BY MEASURING FROM THE PLANT TRUNK FLARE TO THE BOTTOM OF THE ROOTBALL; THE UPPERMOST STRUCTURAL ROOTS IN THE ROOTBALL WITHIN 1-3 INCHES OF THE SOIL SURFACE MEASURE 2-5 INCHES FROM THE TRUNK; THE PLANTING HOLE SHOULD BE APPROXIMATELY 3-5 TIMES THE WIDTH OF THE CONTAINER WITH OUTWARD SLOPING SIDES.
2. SETTING THE PLANT - CAREFULLY SET THE PLANT AT APPROXIMATELY 0-2 INCHES ABOVE THE EXISTING GRADE, REMOVE CONTAINER, AND RESET ROOTBALL IN PLANTING HOLE.
3. SETTING BACKFILLED SOIL - WATER BACKFILL SOIL HALFWAY THROUGH THE BACKFILL PROCESS AND ALLOW IT TO DRAIN; WHEN THE WATER HAS DRAINED AWAY RESUME BACKFILLING AND WATER THOROUGHLY AGAIN; DO NOT TAMP OR COMPACT BACKFILL. SMOOTH OUT SURFACE SOIL AND ENSURE TRUNK FLARE IS EXPOSED AND STRUCTURAL ROOTS ARE WITHIN 3-INCHES OF SOIL MEASURED 4-INCHES FROM THE TRUNK.
4. USE OF FERTILIZERS - SLOW-RELEASE FERTILIZER, SUCH AS OSMOCOTE, SHOULD BE INCLUDED DURING THE INSTALLATION OF ALL CONTAINERS AND GALLON CONTAINER MATERIAL.

MAINTENANCE AND MONITORING

5. FOR BEST MANAGEMENT PRACTICES THAT ARE NOT TO REMAIN IN PLACE AS A PART OF FINAL STABILIZATION SUCH AS SILT FENCE AND OTHER TEMPORARY MEASURES, BEST MANAGEMENT PRACTICES SHOULD BE REMOVED WHEN ALL LAND DISTURBING ACTIVITIES HAVE CEASED AND AREAS HAVE BEEN PERMANENTLY STABILIZED.
6. A SIMPLE SITE INSPECTION PERFORMED BY SOMEONE WITH KNOWLEDGE OF THE ORIGINAL DESIGN OF THE PROJECT IS THE MOST COST EFFECTIVE AND IS GENERALLY CONSIDERED SUFFICIENT MONITORING. THIS INSPECTION SHOULD INCLUDE OBSERVING INSTALLED VEGETATION AND OVERALL ENVIRONMENTAL CONDITIONS. TAKING PICTURES ALONG WITH NOTES IS THE BEST WAY TO DOCUMENT ANY PROBLEMS OBSERVED. PERIODIC PICTURES OF THE SAME AREA WILL MAKE IT EASIER TO IDENTIFY CHANGING CHARACTERISTICS.
7. MONITORING IS OF GREATEST IMPORTANCE DURING THE FIRST TWO YEARS AFTER CONSTRUCTION. INSPECTIONS SHOULD BE CONDUCTED AFTER HIGH-WATER EVENTS OR HEAVY STORM ACTION. DURING PERIODS OF LOW-WATER LEVELS, VISUAL MONITORING SHOULD CONFIRM IF SUPPLEMENTAL WATERING IS REQUIRED, HOWEVER, ULTIMATE CONTROL FOR SUPPLEMENTAL WATERING WILL BE THE RESPONSIBILITY OF THE CONTRACTOR.
8. AN EVALUATION OF VEGETATIVE GROWTH SHOULD BE PART OF EVERY INSPECTION. ADDITIONAL PLANTING MAY BE NEEDED DEPENDING ON THE GROWTH OF THE PLANTS WITHIN THE FIRST TWO YEARS.

RESTORATION NOTES

9. THE AREAS OF RESTORATION TREATMENT ARE APPROXIMATE. ADJUST TREATMENTS AS REQUIRED IN THE FIELD BASED ON THE DETAILS SHOWN ON THIS PAGE.
10. ALL CONSTRUCTION STAGING AND EROSION CONTROL MEASURES SHALL BE IN PLACE BEFORE COMMENCING WORK.
11. THE CONTRACTOR SHALL CONFINE CONSTRUCTION OPERATIONS AND ACTIVITIES TO THE SITE AS SHOWN ON THE DRAWINGS. STORAGE AND PROTECTION OF MATERIALS OFF THE SITE WILL BE BY OTHER ARRANGEMENTS OF THE CONTRACTOR.
12. ALL MATERIALS (TOPSOIL, OTHER) SHALL BE ADEQUATELY STOCKPILED USING APPROPRIATE EROSION CONTROL MEASURES.
13. ALL EROSION CONTROL MATERIALS SHALL BE PROPERLY STOCKPILED AND HANDLED TO PREVENT DAMAGE TO THE APPROVED AND INSPECTED MATERIAL.
14. MAINTAIN THE CONSTRUCTION STAGING AREA CLEAN AND FREE OF TRASH AND EXCESS DEBRIS FOR THE DURATION OF THE PROJECT.
15. CONTRACTOR SHALL BE RESPONSIBLE FOR DAMAGES TO EXISTING UTILITIES, ROADS, AND ACCESS AREAS. DAMAGES SHALL BE REPAIRED IN ACCORDANCE WITH THE UTILITY OWNER.
16. CONTRACTOR SHALL COMPLY WITH THE LATEST EDITION OF OSHA REGULATIONS AND THE STATE OF MASSACHUSETTS LAWS CONCERNING EXCAVATION, CLEARING AND GRUBBING AND OTHER WORK INHERENT TO THE PROJECT.
17. CONTRACTOR WILL DETERMINE THE ACCEPTABILITY FOR THE REUSE OF STRUCTURAL SOILS. UNACCEPTABLE MATERIAL WILL BE REMOVED AND STORED ON-SITE AT A LOCATION TO BE DETERMINED. MATERIAL FOUND TO BE ACCEPTABLE FOR REUSE SHALL BE STOCKPILED ON SITE WITH APPROPRIATE EROSION CONTROL MEASURE(S) IN PLACE.
18. UTILITIES SHOWN ARE EITHER APPROXIMATE OR NOT LOCATED AT ALL (BOTH ABOVE AND BELOW GROUND) WITHIN THE PROJECT AREA. THE CONTRACTOR SHALL NOTIFY THE APPROPRIATE UTILITIES TO VERIFY THE EXACT LOCATIONS IN THE FIELD PRIOR TO COMMENCING WORK. THE CONTRACTOR SHALL NOTIFY DIGSAFE AT LEAST 48 HOURS PRIOR TO COMMENCING WORK. THE CONTRACTOR SHALL ENSURE ADEQUATE TIME TO LOCATE UTILITIES PRIOR TO COMMENCING WORK.
19. THE CONTRACTOR IS RESPONSIBLE FOR MAINTAINING ADEQUATE EROSION CONTROL MEASURES THROUGHOUT THE DURATION OF THE PROJECT, INCLUDING DAILY INSPECTION AND ANY OF THE REPORTING REQUIREMENTS PER THE PROJECT PERMIT PROVISIONS.

SITE PREPARATION NOTES

20. THE CONTRACTOR SHALL ENSURE THAT ALL LOCAL AND STATE PERMITS HAVE BEEN OBTAINED PRIOR TO CONSTRUCTION.
21. THE CONTRACTOR IS RESPONSIBLE FOR COMPLYING WITH ALL LOCAL, STATE, AND FEDERAL REGULATIONS.
22. THE CONTRACTOR SHALL FURNISH ALL LABOR, EQUIPMENT AND MATERIAL TO COMPLETE THE WORK AS SHOWN ON THE DRAWINGS OR SPECIFIED HEREIN. THE PREPARATION OF NEW PLANTING EXCAVATIONS, DISPOSAL OF UNUSABLE PLANTS, PLANT DEBRIS AND LEFT-OVER SOIL ON OR OFF THE SITE AS DIRECTED BY THE OWNER;FURNISHING EROSION CONTROL MEASURES; WATERING AND MAINTENANCE OF WORK UNTIL FINAL ACCEPTANCE.
23. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE REMOVAL AND DISPOSAL OFF THE SITE OF ROOTS, STUMPS, EXCESS SOIL AND OTHER DEBRIS RESULTING FROM EXCAVATIONS FOR CONTRACTOR'S OPERATIONS. DEBRIS SHALL BE HAULED TO LOCATIONS DESIGNATED BY THE OWNER.
24. WARRANTY: WATERING AND MAINTENANCE OF WORK FOR TWO YEARS FROM SUBSTANTIAL COMPLETION OF THE CONTRACT.
25. THE CONTRACTOR SHALL CONFINE CONSTRUCTION OPERATIONS TO THE LIMITS SHOWN ON THE PLAN.
26. THE CONTRACTOR SHALL INSTALL ALL EROSION CONTROL MEASURES AS DESCRIBED IN CONSTRUCTION NOTES AND SHOWN ON THE PLANS PRIOR TO THE START OF ANY CONSTRUCTION OR SURFACE DISTURBANCE.
27. ALL REFUSE AND DEBRIS TO BE REMOVED SHALL BE PROPERLY DISPOSED OF IN ACCORDANCE WITH ALL LOCAL, STATE AND FEDERAL REGULATIONS.

SEQUENCING NOTES

28. SECURE ALL EXISTING EROSION CONTROLS PRIOR TO SITE WORK. ADD NEW EROSION CONTROLS AS NEEDED. CLEAR AND GRUB AREA TO BE PLANTED.
29. SCARIFY TOP 6" OF EXISTING SOILS AND ESTABLISH BASE GRADES FOR APPLICATION OF 4" OF TOPSOIL.
30. APPLY TOPSOIL TO ELEVATIONS SHOWN ON PLAN.
31. STAKE OUT AND PLANT TREES AND SHRUBS AS SHOWN ON PLANS.
32. SEED AND MULCH ALL AREAS AROUND PLANT INSTALLED PLAN MATERIAL LEAVING SPACE BETWEEN VACCINIUM ANGUSTIFOLIUM (LOWBUSH BLUEBERRY) UNSEEDED TO ENCOURAGE PLANTS TO GROW INTO A MAT.
33. WATER DAILY UNTIL GRASS IS ESTABLISHED.
34. PULL ANY INVASIVE SPECIES BY HAND, DISPOSE IN PLASTIC TRASH BAGS.

APPLICABLE DESIGN GUIDELINES FROM BOURNE ZONING BY LAWS - 3500 LANDSCAPING AND SCREENING

MET	PENDING	SECTION	SUBSECTION	REGULATION
		3510	**PARKING LOT AND BUFFER PLANTINGS**	
x			3512 - Plants	Shall include both trees and shrubs. Trees must be at least 3" caliper, native to the area, and at least 30 feet tall at maturity. Shrubs must be at least 36" at maturity and native to the area.
				Number of trees in planting area equals planting area length (feet) divided by 30,. The number of shrubs equals planting area length (feet) divided by 3. Plants grouped not evenly spaced.
	x		3514 - Existing Vegetation	If located within 25 feet of a street, no existing tree of >6" caliper, dense hedgerow of four or more feet in both depth and height, or existing earth berm providing similar screening shall be removed or have grade change more than 1 foot unless dictated by plant health, safety or identification of premises.
		3520	**EROSION CONTROL**	
	x		3520 - Erosion Control	All slopes exceeding 15% resulting from site grading shall be covered with loam to 4" and planted with vegetation or retaining wall
		3530	**SCREENING**	
x			3530 - Screening	Machinery (and other utility structures listed) shall be screened from view of abutting properties by a wall, stockade fence, or densely planted trees or natural vegetation
		3550	**CORNER VISIBILITY**	
x			3550 - Corner Visibility	At corners no obstruction shall be allowed to block vision between 2.5-8 feet aove the street grade with an area formed by the intersecting street lines and a straight line joining points on said street lines 20 feet back from their point of intersection

Prepared by:
SWCA®
ENVIRONMENTAL CONSULTANTS
SWCA Environmental Consultants
15 Research Drive
Amherst, MA 01002
(p) 413.256.0202
(f) 413.256.1092
www.swca.com

Prepared for:

ALGONQUIN GAS TRANSMISSION, LLC

Key Map:



NOTES:

LEGEND:

Stamp:



Project Title:

CAPE COD CANAL PIPELINE RELOCATION PROJECT

0 MEETINGHOUSE LN, BOURNE, MA

Sheet Title:

LANDSCAPE NOTES

Date:	9/11/2025
Scale:	As Shown
Drawn by:	TRS
Checked by:	APS
File #	65956.00

REVISIONS

Date:	By:	Note:
7/23/26	TRS	Changes to LOD

Sheet No:

L003

PLANTING PLAN AREA 1 SCHEDULE

SYMBOL	CODE	BOTANICAL NAME	COMMON NAME	SIZE	CANOPY	QTY
EVERGREEN TREES						
	JUN EAS	JUNIPERUS VIRGINIANA	EASTERN REDCEDAR	3" CAL.	15'	6
CANOPY TREES						
	PW	PRUNUS SEROTINA	BLACK CHERRY	3` HT.	50'	1
UNDERSTORY TREES						
	AL	AMELANCHIER LAEVIS	ALLEGHENY SERVICEBERRY MULTI-TRUNK	5` HT.	20'	6
	HAM VIR	HAMAMELIS VIRGINIANA	COMMON WITCH HAZEL	3" CAL.	17'	3
	OV	OSTRYA VIRGINIANA	AMERICAN HOPHORNBEAM	5` HT.	18'	3

SYMBOL	CODE	BOTANICAL NAME	COMMON NAME	SIZE	SPACING	QTY
SHRUBS						
	COR RE5	CORNUS SERICEA	RED TWIG DOGWOOD	5 GAL.	96" o.c.	8
	PTE WES	PTERIDIUM AQUILINUM	WESTERN BRACKEN FERN	5 GAL.	48" o.c.	31
	RHO PER	RHODODENDRON PERICLYMENOIDES	PINXTERBLOOM AZALEA	5 GAL.	96" o.c.	12

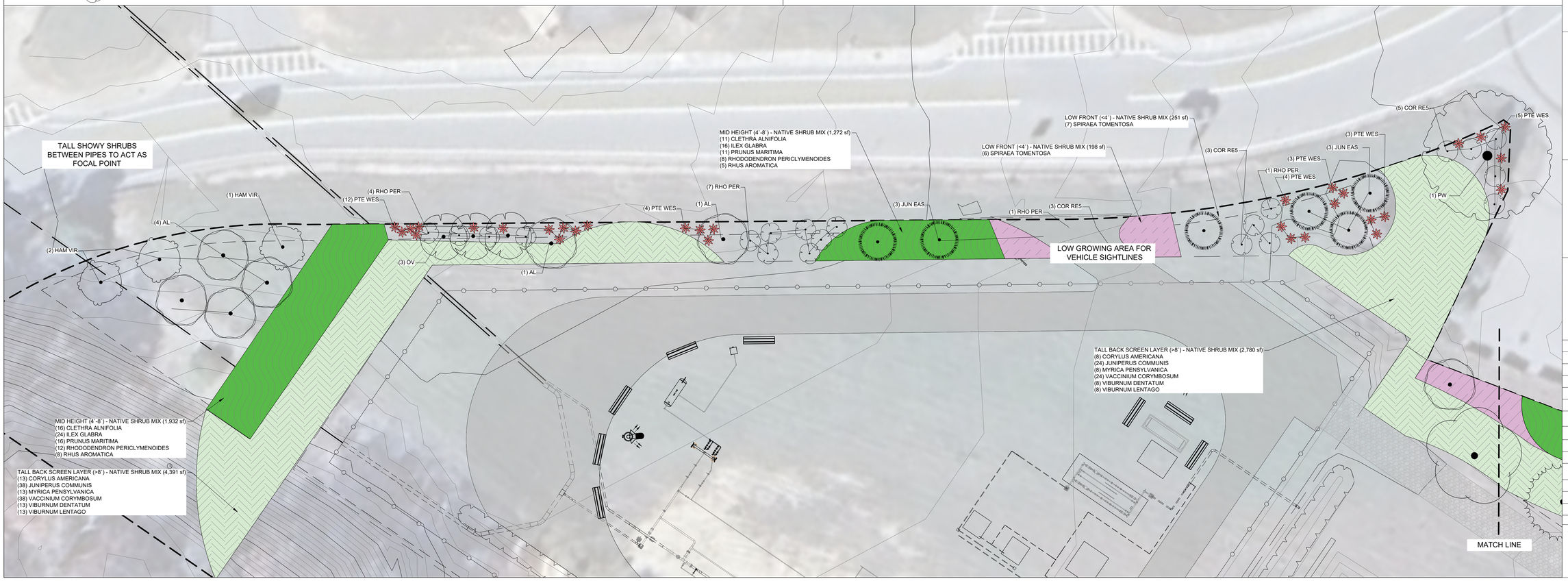
SHRUB AREAS

	TALL BACK SCREEN LAYER (>8`) - NATIVE SHRUB MIX				7,171 SF
COR AM2	CORYLUS AMERICANA	AMERICAN HAZELNUT	---	10% @ 72" o.c.	21
JUN JUN	JUNIPERUS COMMUNIS	COMMON JUNIPER	---	30% @ 72" o.c.	62
MYR PE2	MYRICA PENSYLVANICA	NORTHERN BAYBERRY	---	10% @ 72" o.c.	21
VAC HI2	VACCINIUM CORYMBOSUM	HIGHBUSH BLUEBERRY	---	30% @ 72" o.c.	62
VIB AR2	VIBURNUM DENTATUM	VIBURNUM	---	10% @ 72" o.c.	21
VIB LE3	VIBURNUM LENTAGO	NANNYBERRY	---	10% @ 72" o.c.	21
	MID HEIGHT (4`-8`) - NATIVE SHRUB MIX				2,880 SF
CLE AL4	CLETHRA ALNIFOLIA	SUMMERSWEET	---	20% @ 60" o.c.	24
ILE GLA	ILEX GLABRA	INKBERRY HOLLY	---	30% @ 60" o.c.	36
PRU MA3	PRUNUS MARITIMA	BEACH PLUM	---	20% @ 60" o.c.	24
RHO PE2	RHODODENDRON PERICLYMENOIDES	PINXTERBLOOM AZALEA	---	15% @ 60" o.c.	18
RHU AR2	RHUS AROMATICA	FRAGRANT SUMAC	---	10% @ 60" o.c.	12
	LOW FRONT (<4`) - NATIVE SHRUB MIX				537 SF
SPI TO3	SPIRAEA TOMENTOSA	STEEPLEBUSH	---	72" o.c.	15

PLANTING AREA 1 REQUIREMENTS

546.39 LF - 18 TREES REQ
182 SHRUBS REQ

IN PLAN: 19 TREES
388 SHRUBS (SHRUBS PREFERENCED TO KEEP LIMIT ON HEIGHT)



Prepared by:

SWCA®
ENVIRONMENTAL CONSULTANTS
SWCA Environmental Consultants

15 Research Drive
Amherst, MA 01002
(p) 413.256.0202
(f) 413.256.1092
www.swca.com

Prepared for:

ALGONQUIN GAS TRANSMISSION, LLC

Key Map:



NOTES:

0 20' 40'

SCALE: 1" = 20'

LEGEND:

Stamp:



Project Title:

CAPE COD CANAL PIPELINE RELOCATION PROJECT

0 MEETINGHOUSE LN, BOURNE, MA

Sheet Title:

PLANTING PLAN AREA 1

Date:	9/11/2025
Scale:	As Shown
Drawn by:	TRS
Checked by:	APS
File #	65956.00

REVISIONS

Date:	By:	Note:
7/23/26	TRS	Changes to LOD

Sheet No:

L101

PLANTING PLAN AREA 2 SCHEDULE

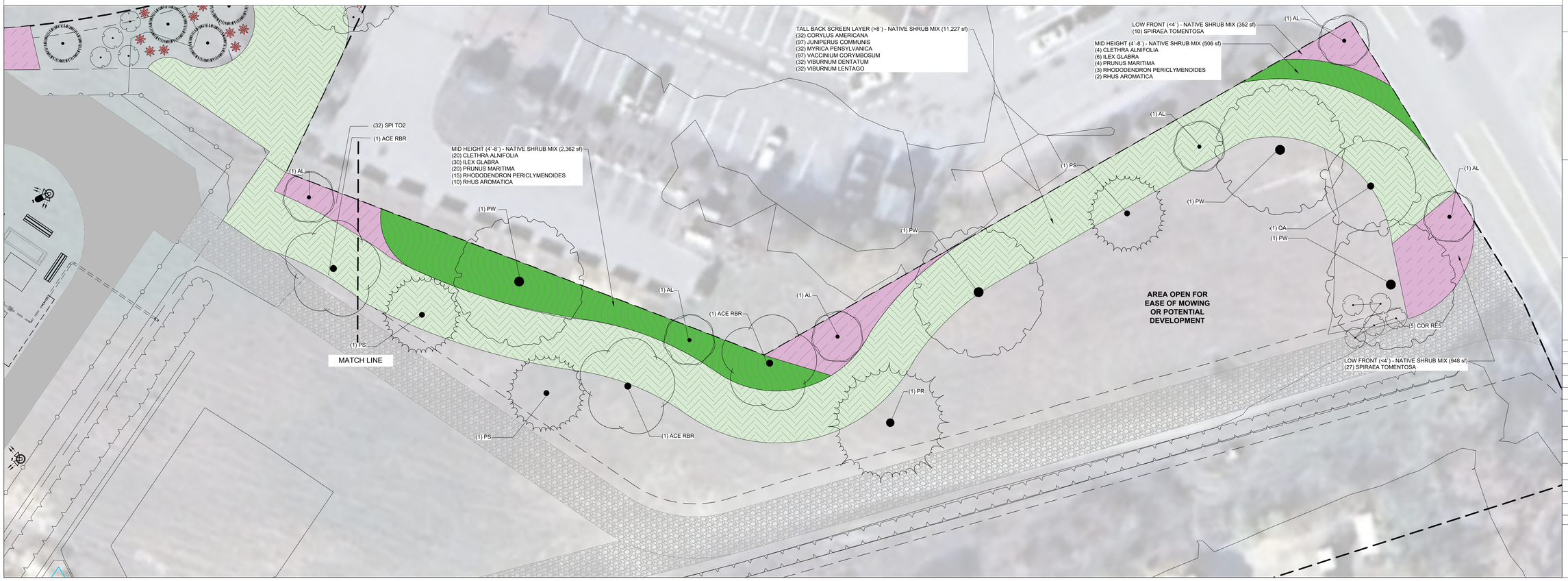
SYMBOL	CODE	BOTANICAL NAME	COMMON NAME	SIZE	CONTAINER	CANOPY	QTY
EVERGREEN TREES							
	PR	PINUS RIGIDA	PITCH PINE	4 - 6' HT.		50'	1
CANOPY TREES							
	ACE RBR	ACER RUBRUM	RED MAPLE	3" CAL.	POT	35'	3
	PS	PINUS STROBUS	WHITE PINE	1.5" CAL.		30'	3
	PW	PRUNUS SEROTINA	BLACK CHERRY	3` HT.		50'	4
	QA	QUERCUS ALBA	WHITE OAK	1.5" CAL.		40'	1
UNDERSTORY TREES							
	AL	AMELANCHIER LAEVIS	ALLEGHENY SERVICEBERRY MULTI-TRUNK	5` HT.		20'	6

SYMBOL	CODE	BOTANICAL NAME	COMMON NAME	SIZE	CONTAINER	SPACING	QTY
SHRUBS							
	COR RE5	CORNUS SERICEA	RED TWIG DOGWOOD	5 GAL.		96" o.c.	5
SHRUB AREAS							
	SPI TO2	SPIRAEA TOMENTOSA	STEEPLEBUSH	1 GAL.		48" o.c.	82
		TALL BACK SCREEN LAYER (>8`) - NATIVE SHRUB MIX					11,227 SF
	COR AM2	CORYLUS AMERICANA	AMERICAN HAZELNUT	---		10% @ 72" o.c.	32
	JUN JUN	JUNIPERUS COMMUNIS	COMMON JUNIPER	---		30% @ 72" o.c.	97
	MYR PE2	MYRICA PENSYLVANICA	NORTHERN BAYBERRY	---		10% @ 72" o.c.	32
	VAC HI2	VACCINIUM CORYMBOSUM	HIGHBUSH BLUEBERRY	---		30% @ 72" o.c.	97
	VIB AR2	VIBURNUM DENTATUM	VIBURNUM	---		10% @ 72" o.c.	32
	VIB LE3	VIBURNUM LENTAGO	NANNYBERRY	---		10% @ 72" o.c.	32
		MID HEIGHT (4`-8`) - NATIVE SHRUB MIX					2,868 SF
	CLE AL4	CLETHRA ALNIFOLIA	SUMMERSWEET	---		20% @ 60" o.c.	24
	ILE GLA	ILEX GLABRA	INKBERRY HOLLY	---		30% @ 60" o.c.	36
	PRU MA3	PRUNUS MARITIMA	BEACH PLUM	---		20% @ 60" o.c.	24
	RHO PE2	RHODODENDRON PERICLYMENOIDES	PINXTERBLOOM AZALEA	---		15% @ 60" o.c.	18
	RHU AR2	RHUS AROMATICA	FRAGRANT SUMAC	---		10% @ 60" o.c.	12
		LOW FRONT (<4`) - NATIVE SHRUB MIX					1,300 SF
	SPI TO3	SPIRAEA TOMENTOSA	STEEPLEBUSH	---		72" o.c.	37

PLANTING AREA 2 REQUIREMENTS

467.3 LF - 15 TREES REQ
155 SHRUBS REQ

IN PLAN: 18 TREES
560 SHRUBS (SHRUBS PREFERENCED TO KEEP LIMIT ON HEIGHT - SMALLER SHRUBS SPACED CLOSER)



Prepared by:

SWCA®
ENVIRONMENTAL CONSULTANTS
SWCA Environmental Consultants

15 Research Drive
Amherst, MA 01002
(p) 413.256.0202
(f) 413.256.1092
www.swca.com

Prepared for:

ALGONQUIN GAS TRANSMISSION, LLC

Key Map:



NOTES:

N

0 20' 40'

SCALE: 1" = 20'

LEGEND:

Stamp:



Project Title:

CAPE COD CANAL PIPELINE RELOCATION PROJECT

0 MEETINGHOUSE LN, BOURNE, MA

Sheet Title:

PLANTING PLAN AREA 2

Date:	9/11/2025
Scale:	As Shown
Drawn by:	TRS
Checked by:	APS
File #	65956.00

REVISIONS

Date:	By:	Note:
7/23/26	TRS	Changes to LOD

Sheet No:

L102

SEEDING SCHEDULE

AREA TO BE SEEDED:

26,143.5 SQ FT
23LB/ACRE X .6 ACRE = 13.8 LBS APPLICATION
$89.50/LB X 13.8 LBS = $1,235.10

FOR PURPOSES OF EROSION CONTROL, VEGETATIVE GROUND COVER AND ECOLOGICAL RESTORATION.



PHOTO SELECTIONS OF SEED MIX

SOURCE: NORTH CAROLINA EXTENSION; LEFT TO RIGHT - ELYMUS CANADENSIS, FESTUCA RUBRA, SCHIZACHYRIUM SCOPARIUM, ASCLEPIAS TUBEROSA, HELIOPSIS HELIANTHOIDES

NEW ENGLAND WETLAND PLANTS, INC

14 Pearl Lane South Hadley, MA 01075
PHONE: 413-548-8000 FAX 413-549-4000
EMAIL: INFO@NEWP.COM WEB ADDRESS: WWW.NEWP.COM

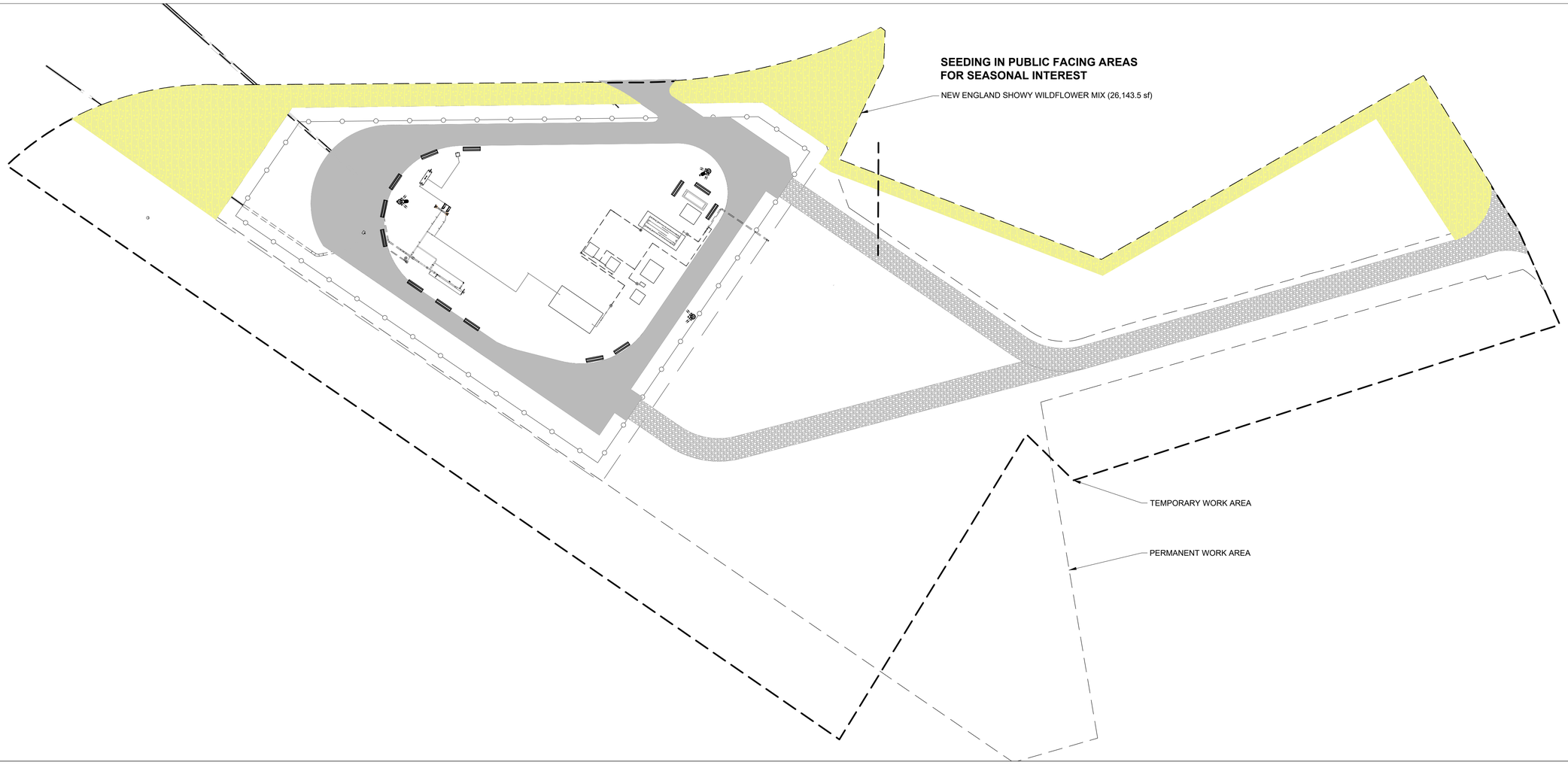
New England Showy Wildflower Mix

Botanical Name	Common Name	Indicator
Schizachyrium scoparium	Little Bluestem	FACU
Chamaecrista fasciculata	Partridge Pea	FACU
Sorghastrum nutans	Indian Grass	UPL
Festuca rubra	Red Fescue	FACU
Elymus canadensis	Canada Wild Rye	FACU+
Elymus riparius	Riverbank Wild Rye	FACW
Heliopsis helianthoides	Ox Eye Sunflower	UPL
Coreopsis lanceolata	Lance Leaved Coreopsis	FACU
Rudbeckia hirta	Black Eyed Susan	FACU-
Liatris spicata	Spiked Gayfeather/Marsh Blazing Star	FAC+
Asclepias syriaca	Common Milkweed	FACU-
Vernonia noveboracensis	New York Ironweed	FACW+
Aster novae-angliae (Symphyotrichum novae-anglia	New England Aster	FACW-
Eupatorium purpureum (Eutrochium maculatum)	Purple Joe Pye Weed	FAC
Asclepias tuberosa	Butterfly Milkweed	NI
Solidago juncea	Early Goldenrod	
Eupatorium perfoliatum	Boneset	FACW

APPLY: 23 LBS/ACRE :1900 sq ft/lb

The New England Showy Wildflower mix includes a selection of native wildflowers and grasses that will mature into a colorful and vibrant native meadow. It is appropriate seed mix for roadsides, commercial landscaping, parks, golf courses, and industrial sites. Always apply on clean bare soil. The mix may be applied by mechanical spreader, or on small sites it can be spread by hand. Lightly rake, or roll to ensure proper seed to soil contact. Best results are obtained with a Spring or late Fall dormant seeding. Late Spring and early Summer seeding will benefit with a light mulching of weed-free straw to conserve moisture. If conditions are drier than usual, watering may be required. Late Fall and Winter dormant seeding require an increase in the seeding rate. Fertilization is not required unless the soils are particularly infertile. Preparation of a clean weed free seed bed is necessary for optimal results.

New England Wetland Plants, Inc. may modify seed mixes at any time depending upon seed availability. The design criteria and ecological function of the mix will remain unchanged. Price is $/bulk pound, FOB warehouse, Plus SH and applicable taxes.



Prepared by:
SWCA®
ENVIRONMENTAL CONSULTANTS
SWCA Environmental Consultants
15 Research Drive
Amherst, MA 01002
(p) 413.256.0202
(f) 413.256.1092
www.swca.com

Prepared for:

ALGONQUIN GAS TRANSMISSION, LLC

Key Map:



NOTES:

0 40' 80'

SCALE: 1" = 40'

LEGEND:

Stamp:



Project Title:

CAPE COD CANAL
PIPELINE
RELOCATION PROJECT

0 MEETINGHOUSE LN,
BOURNE, MA

Sheet Title:

RESTORATION
SEEDING PLAN

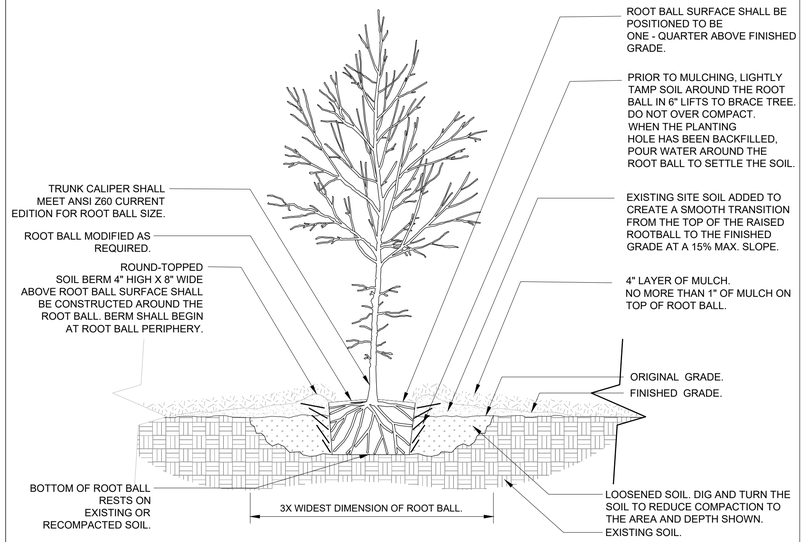
Date:	9/11/2025
Scale:	As Shown
Drawn by:	TRS
Checked by:	APS
File #	65956.00

REVISIONS

Date:	By:	Note:
7/23/26	TRS	Changes to LOD

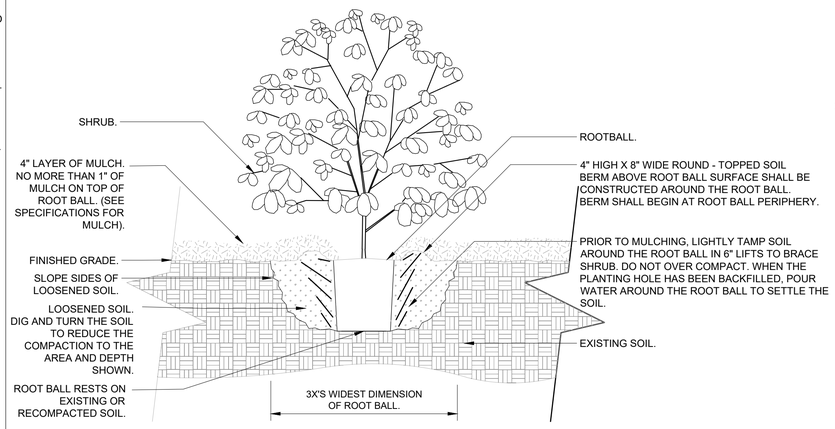
Sheet No:

L103



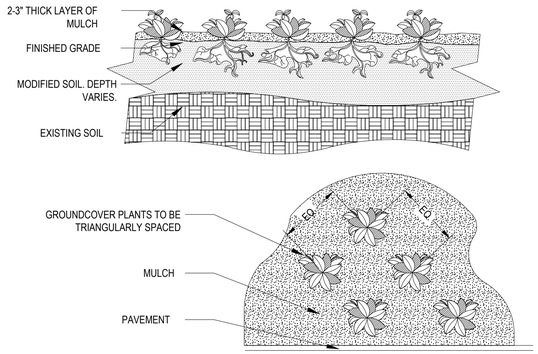
NOTES:
1- TREES SHALL BE OF QUALITY PRESCRIBED IN CROWN OBSERVATIONS AND ROOT OBSERVATIONS DETAILS AND SPECIFICATIONS.

1 TREE PLANTING NOT TO SCALE

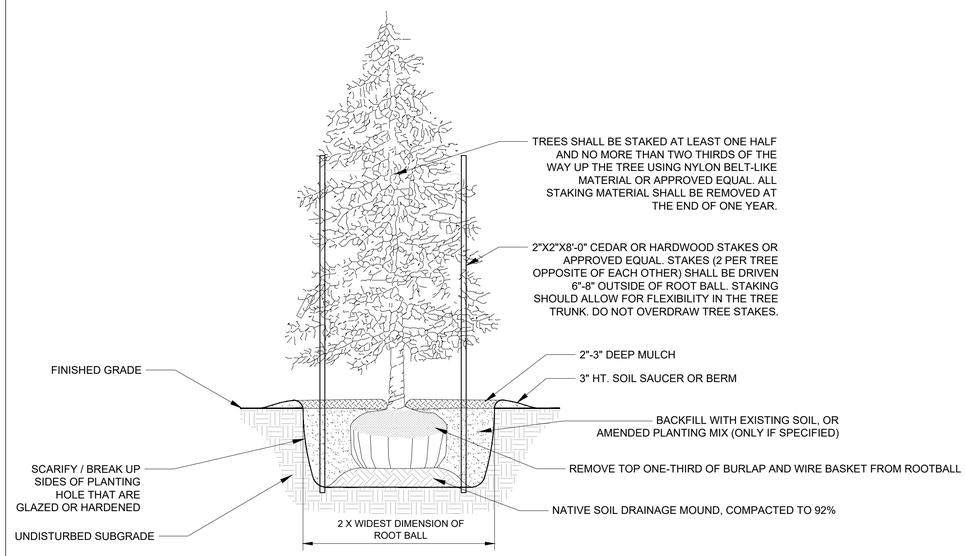


NOTES:
1- SHRUBS SHALL BE OF QUALITY PRESCRIBED IN THE ROOT OBSERVATIONS DETAIL AND SPECIFICATIONS.

2 SHRUB PLANTING AND LAYOUT NOT TO SCALE



SHRUB PLANTING LAYOUT



NOTES:
1. TREES SHALL BEAR SAME RELATIONSHIP TO FINISH GRADE AS IN THE NURSERY.
2. NEVER CUT A LEADER
3. TREES SHALL BE PLUMB & STRAIGHT.
4. TREES 6'-0" IN HEIGHT, 2 1/2" IN CAL., OR LARGER SHALL BE GUYED AND STAKED WITH 2 EQUALLY SPACED STAKES

3 EVERGREEN TREE PLANTING AND STAKING NOT TO SCALE

Prepared by:
SWCA®
ENVIRONMENTAL CONSULTANTS
SWCA Environmental Consultants
15 Research Drive
Amherst, MA 01002
(p) 413.256.0202
(f) 413.256.1092
www.swca.com

Prepared for:
ALGONQUIN GAS TRANSMISSION, LLC

Key Map:


NOTES:

LEGEND:

Stamp:


Project Title:
CAPE COD CANAL PIPELINE RELOCATION PROJECT
0 MEETINGHOUSE LN, BOURNE, MA

Sheet Title:
LANDSCAPE DETAILS

Date:	9/11/2025
Scale:	As Shown
Drawn by:	TRS
Checked by:	APS
File #	65956.00

REVISIONS

Date:	By:	Note:
7/23/26	TRS	Changes to LOD

Sheet No:
L501

TOTAL PLANT SCHEDULE

SYMBOL	CODE	BOTANICAL NAME	COMMON NAME	SIZE	CONTAINER	CANOPY	QTY	PLANTING AREA 1	PLANTING AREA 2
CANOPY TREES									
	ACE RBR	ACER RUBRUM	RED MAPLE	3" CAL.	POT	35'	3		3
	PS	PINUS STROBUS	WHITE PINE	1.5" CAL.		30'	3		3
	PW	PRUNUS SEROTINA	BLACK CHERRY	3` HT.		50'	5	1	4
	QA	QUERCUS ALBA	WHITE OAK	1.5" CAL.		40'	1		1
EVERGREEN TREES									
	JUN EAS	JUNIPERUS VIRGINIANA	EASTERN REDCEDAR	3" CAL.		15'	6	6	
	PR	PINUS RIGIDA	PITCH PINE	4 - 6` HT.		50'	1		1
UNDERSTORY TREES									
	AL	AMELANCHIER LAEVIS	ALLEGHENY SERVICEBERRY MULTI-TRUNK	5` HT.		20'	12	6	6
	HAM VIR	HAMAMELIS VIRGINIANA	COMMON WITCH HAZEL	3" CAL.		17'	3	3	
	OV	OSTRYA VIRGINIANA	AMERICAN HOPHORNBEAM	5` HT.		18'	3	3	

SYMBOL	CODE	BOTANICAL NAME	COMMON NAME	SIZE	CONTAINER	SPACING	QTY	PLANTING AREA 1	PLANTING AREA 2
SHRUBS									
	COR RE5	CORNUS SERICEA	RED TWIG DOGWOOD	5 GAL.		96" o.c.	16	8	5
	PTE WES	PTERIDIUM AQUILINUM	WESTERN BRACKEN FERN	5 GAL.		48" o.c.	31	31	
	RHO PER	RHODODENDRON PERICLYMENOIDES	PINXTERBLOOM AZALEA	5 GAL.		96" o.c.	12	12	
SHRUB AREAS									
	SPI TO2	SPIRAEA TOMENTOSA	STEEPLEBUSH	1 GAL.		48" o.c.	82		82
		TALL BACK SCREEN LAYER (>8`) - NATIVE SHRUB MIX					18,398 SF	7,171 SF	11,227 SF
	COR AM2	CORYLUS AMERICANA	AMERICAN HAZELNUT	---		10% @ 72" o.c.	53	21	32
	JUN JUN	JUNIPERUS COMMUNIS	COMMON JUNIPER	---		30% @ 72" o.c.	159	62	97
	MYR PE2	MYRICA PENSYLVANICA	NORTHERN BAYBERRY	---		10% @ 72" o.c.	53	21	32
	VAC HI2	VACCINIUM CORYMBOSUM	HIGHBUSH BLUEBERRY	---		30% @ 72" o.c.	159	62	97
	VIB AR2	VIBURNUM DENTATUM	VIBURNUM	---		10% @ 72" o.c.	53	21	32
	VIB LE3	VIBURNUM LENTAGO	NANNYBERRY	---		10% @ 72" o.c.	53	21	32
		MID HEIGHT (4`-8`) - NATIVE SHRUB MIX					5,748 SF	2880 SF	2,868 SF
	CLE AL4	CLETHRA ALNIFOLIA	SUMMERSWEET	---		20% @ 60" o.c.	48	24	24
	ILE GLA	ILEX GLABRA	INKBERRY HOLLY	---		30% @ 60" o.c.	72	36	36
	PRU MA3	PRUNUS MARITIMA	BEACH PLUM	---		20% @ 60" o.c.	48	24	24
	RHO PE2	RHODODENDRON PERICLYMENOIDES	PINXTERBLOOM AZALEA	---		15% @ 60" o.c.	36	18	18
	RHU AR2	RHUS AROMATICA	FRAGRANT SUMAC	---		10% @ 60" o.c.	24	12	12
		LOW FRONT (<4`) - NATIVE SHRUB MIX					1,749 SF	537 SF	1,300 SF
	SPI TO3	SPIRAEA TOMENTOSA	STEEPLEBUSH	---		72" o.c.	52	15	37


RED MAPLE


WHITE PINE


STEEPLEBUSH


SERVICEBERRY


NORTHERN BAYBERRY


RHODODENDRON


INKBERRY HOLLY


SUMMERSWEET

PHOTO SELECTIONS OF PLANTS

SOURCE: NORTH CAROLINA EXTENSION

Prepared by:

SWCA®
ENVIRONMENTAL CONSULTANTS
SWCA Environmental Consultants

15 Research Drive
Amherst, MA 01002
(p) 413.256.0202
(f) 413.256.1092
www.swca.com

Prepared for:

ALGONQUIN GAS TRANSMISSION, LLC

Key Map:



NOTES:

LEGEND:

Stamp:



Project Title:

CAPE COD CANAL
PIPELINE
RELOCATION PROJECT

0 MEETINGHOUSE LN,
BOURNE, MA

Sheet Title:

PLANTING
SCHEDULE

Date:	9/11/2025
Scale:	As Shown
Drawn by:	TRS
Checked by:	APS
File #	65956.00

REVISIONS

Date:	By:	Note:
7/23/26	TRS	Changes to LOD

Sheet No:

L601

ATTACHMENT 12

Quantitative Carbon Analysis

Quantitative Carbon Analysis Forest Clearing and Soil Disturbance

Cape Cod Canal Pipeline Relocation Project Carbon Accounting

Bourne, Barnstable County, Massachusetts

JUNE 2026

PREPARED FOR

Algonquin Natural Gas, LLC

PREPARED BY

SWCA Environmental Consultants

EXECUTIVE SUMMARY

The proposed Cape Cod Canal Pipeline Relocation Project (hereafter the Project) is designed to accommodate the replacement of the Bourne Bridge and the Sagamore Bridge while continuing to provide uninterrupted natural gas service to the National Grid distribution system on both sides of the Cape Cod Canal.

To accomplish this goal, a total of 44.8 acres of forested land will be clear cut along the pipeline rights-of-way, within the metering and regulating station footprints, and within construction workspaces. Of the 44.8 total acres, 24.4 acres will be allowed to revert to forest after construction activities conclude; 13.0 acres will be maintained as low-growing vegetation (scrub-shrub habitat); and 7.4 acres will be converted to paved or gravel surfaces. An additional 1.4 acres of non-forested land will be disturbed for Project-related trenching.

This analysis was prepared to inform the Massachusetts Environmental Protection Act office of the change in greenhouse gas (GHG) emissions that may be brought about by the Project. Following the Council on Environmental Quality's January 2023 Interim National Environmental Policy Act Guidance on Greenhouse Gas Emissions,[1] this includes an analysis of the net GHG emissions.

From a GHG accounting perspective, the Project is likely to bring about the following changes.

1. Approximately 8,720 metric tons of CO_2e currently sequestered in live forest biomass, forest and non-forest soil, dead wood, and litter may be released due to vegetation clearing and/or soil disturbance.
2. The conversion of wooded habitat to scrub-shrub habitat or paved/gravel surfaces will reduce the rate of future CO_2e sequestration within 18.3 acres of the Project footprint. However, in the 24.4 acres of the Project footprint that will revert to forest, future sequestration rates will increase. The net effect of the Project over all 44.8 acres is to increases future CO_2e sequestration by approximately 965 metric tons over 50 years.

Overall, the Project is expected to increase CO_2e emissions by approximately 7,755 metric tons over its 50-year lifespan. This equates to approximately 155 metric tons CO_2e annually, which is equivalent to the annual emissions associated with about six and a half Massachusetts households (EOEEA 2025; U.S. Census Bureau 2024).

[1] 88 Federal Register 1196. Available at: https://www.federalregister.gov/documents/2023/01/09/2023-00158/national-environmental-policy-act-guidance-on-consideration-of-greenhouse-gas-emissions-and-climate.

CONTENTS

1 Purpose and Need 1
2 Methodological Overview 1
3 Detailed Calculations 2
3.1 Release of Currently Sequestered Carbon 2
3.1.1 Carbon At Risk of Release 4
3.1.2 Proportion of At-Risk Carbon Released to the Air over 50 Years 5
3.1.3 Project-Related Release of Carbon and CO_2e from the Affected Footprint 6
3.2 Habitat Conversion 6
3.2.1 Paved or Gravel Surfaces Replace Forest 8
3.2.2 Scrub-Shrub Replaces Forest 8
3.2.3 Replacing 100-Year-Old Forest with Young Forest 9
3.2.4 Project-Related Change in Future Carbon Sequestration 9
4 Summary 10
5 Literature Cited 11

Figures

Figure 1. Annual Forest Sequestration Rates 9

Tables

Table 1. Project-Related Release of Currently Sequestered Carbon 3
Table 2. Estimated Future Carbon Sequestration for a 100-Year-Old Forest. 7
Table 3. Change in Carbon Sequestration Rates by Habitat Conversion Scenario 7
Table 4. Net Change in CO_2e Emissions due to the Project 10

1 PURPOSE AND NEED

The proposed Cape Cod Canal Pipeline Relocation Project (hereafter the Project) is designed to accommodate the replacement of the Bourne Bridge and Sagamore Bridge while continuing to provide uninterrupted natural gas service to the National Grid distribution system on both sides of the Cape Cod Canal.

The Project is located entirely in the Town of Bourne, Barnstable County, Massachusetts and includes two components.

- Algonquin's G-31 pipeline will replace National Grid's existing supply of natural gas that currently crosses over the Cape Cod Canal via a National Grid pipeline that is attached to the Sagamore Bridge. The G-31 pipeline includes the installation of approximately 2.17 miles of 18-inch diameter pipeline that will transport natural gas from the vicinity of an existing valve site located at the junction of Algonquin's multiple G-System pipelines southeast across the Cape Cod Canal to its terminus at the proposed Pave Paws Road Metering and Regulating (M&R) Station.
- Algonquin's G-32 pipeline will replace National Grid's existing supply of natural gas that currently crosses over the Cape Cod Canal via a National Grid pipeline that is attached to the Bourne Bridge. The G-32 pipeline includes the installation of approximately 3.07 miles of 16-inch diameter pipeline. The G-32 pipeline will transport natural gas from the proposed Pave Paws Road M&R Station to the proposed Bourne Rotary M&R Station. The G-32 pipeline will not cross the Cape Cod Canal; instead, the natural gas will be delivered to Bourne Rotary M&R Station via an interconnection with the G-31 pipeline at the Pave Paws Road M&R Station.

A total of 44.8 acres of forested land will be cut along the pipeline rights-of-way, within the M&R station footprints, and within construction workspaces. Of the 44.8 total acres, 24.4 acres will revert to forest once construction activities conclude; 13.0 acres will be maintained as low-growing vegetation (scrub-shrub habitat); and 7.4 acres will be converted to paved or gravel surfaces. An additional 1.4 acres of non-forested land will be disturbed for Project-related trenching.

This analysis was prepared to inform the Massachusetts Environmental Protection Act office of the change in greenhouse gas (GHG) emissions that may be brought about by the Project.

2 METHODOLOGICAL OVERVIEW

This assessment is designed to provide the best practical estimate of the net change in GHG emissions brought about by Project-related tree clearing and soil disturbance. The estimate considers multiple biophysical and behavioral processes that will have a material effect on the actual Project-related change in GHG emissions. In preparing this estimate it is acknowledged that the scientific community has studied some processes extensively and so their effects are characterized with a relatively high degree of precision; other processes have been subject to less study and so are characterized with less precision.

Project-related changes in GHG emissions are estimated as a function of two processes:

1. Some carbon currently sequestered in live forest biomass, forest soil, dead wood, and litter may be released to the atmosphere due to the tree clearing process. Additionally, some carbon currently sequestered in non-forest soil may be released due to trenching to install or remove pipeline segments.

2. When mature trees are cleared and younger trees or scrub/shrub species are allowed to replace them, the rate at which carbon is sequestered in the future will change. When forested acres are converted to paved or gravel surfaces, future carbon sequestration within the acreage is eliminated.

The methods used to quantify the change in GHG emission associated with each process are outlined in Sections 3.1 and 3.2, respectively.

Note that the estimates provided in this assessment are based on a 50-year time horizon because the Project is expected to be operational for 50 years. The selection of a time horizon is important for two reasons.

1. As described in Section 3.1.2, the proportion of carbon that is currently sequestered in the affected forest and will be released to the atmosphere depends on half-life functions: the more time aboveground biomass, belowground biomass, and dead wood are allowed to decay, the more carbon will be released to the atmosphere.
2. As described in Section 3.2.3, a forest's carbon sequestration rate changes as the forest ages. The forest currently in the Project footprint is relatively old and so has a relatively low annual carbon sequestration rate. The forest that regrows within the 24.4 acres that are allowed to revert to forest will, after a few years, have a relatively high annual carbon sequestration rate. If we measure the net change in future carbon sequestration over a 50-year time horizon, the change is positive (i.e., more carbon will be sequestered over the next 50 years with the Project than without).

3 DETAILED CALCULATIONS

3.1 Release of Currently Sequestered Carbon

Table 1 illustrates the calculations used to estimate the amount of currently sequestered carbon potentially released because of the Project. The reasoning behind each input and calculation is described in the remainder of this section.

Table 1. Project-Related Release of Currently Sequestered Carbon

Carbon Pool	Acres	Carbon At Risk of Release (metric tons per acre)	Proportion of At-Risk Carbon Released to the Air over 50 Years Due to the Project	Project-Related Release of Carbon from the Affected Footprint (metric tons)*	Project-Related Release of CO_2e from the Affected Footprint (metric tons)*
Aboveground Live Biomass	44.8	31.3	100%	1,404.3	5,145.7
Belowground Live Biomass	44.8	6.0	73.3%	195.5	716.4
Soil Organic Carbon					
Forested Land	44.8	47.6	8.0%	170.7	625.5
Non-Forested Land	1.4	0.4	100%	0.6	1.8
Dead Wood	44.8	6.7	100%	301.1	1,103.3
Litter	44.8	6.9	100%	307.5	1,126.9
			Total	**2,379.8**	**8,719.7**

* Due to intermediate rounding, these values differ slightly from the products of the reported values.

3.1.1 Carbon At Risk of Release

Living trees and plants absorb carbon dioxide (CO_2) from the air. As part of the photosynthetic process, the oxygen and carbon molecules are separated; the oxygen is released back into the air while the carbon becomes part of the tree or plant itself. In a functioning forest, the carbon removed from the air is stored in one of five pools: 1) aboveground live biomass, 2) belowground live biomass (roots), 3) soil organic carbon, 4) dead wood, or 5) forest litter. When trees are cleared from an area, some of the stored carbon that would otherwise remain sequestered in the five pools may be released back into the atmosphere as carbon dioxide.

The amount of carbon currently sequestered in each carbon pool was estimated using the U.S. Forest Service (USFS) EVALIDator application. EVALIDator produces a variety of population estimates based on current data from the Forest Inventory and Analysis Database (FIADB) (USFS 2024).

EVALIDator allows the user to specify circles on a map and then reports estimates of sequestered carbon in test plots within the circle. For this analysis, data were obtained from one circle with a 4-mile radius. The center of the circle was placed between the proposed Bourne Rotary M&R Station and the propose Pave Paws Road M&R Station.[2] The 4-mile radius includes all proposed tree clearing activities. The EVALIDator estimates for each carbon pool are reported in Table 1 under "Carbon at Risk of Release (metric tons per acre)."

Estimates of the amount of carbon stored in forest soil tend to vary between sources. Catanzaro and D'Amato (2019) cite data from the USFS (2018) in reporting the amount of carbon stored in forest soils for three mature (80- to 100-year-old) New England hardwood forest types: 28 metric tons per acre for northern hardwood, 27 metric tons per acre for oak-pine, and 21 metric tons per acre for oak-hickory. Thompson et al. (2020) reports that an acre of generic forest soil in Massachusetts may contain as much as 112.9 metric tons of soil organic carbon; this is considerably more than the USFS (2018) reports for mature hardwood forests in New England. Indeed, on pages 54 and 55 of their report, Thompson et al. note that the 112.9 estimate "is much higher than most other forest estimates from the region." They go on to site studies at the Harvard Forest in central Massachusetts and at the Hubbard Brook experimental forest in New Hampshire where soil organic content was more in line with USFS reports. Thus, although the value in Table 1, 47.6 metric tons per acre, falls between the two disparate estimates included in the literature, we believe it is more likely to overstate the carbon at risk of release than to understate the carbon at risk of release.

3.1.1.1 CARBON RELEASED FROM NON-FOREST SOIL

Activities that expose sub-surface soil to the air, such as trenching to install or remove pipeline segments, may result in the release of some carbon that would otherwise remain sequestered in the soil. The quantity of soil carbon likely to be released due to the Project's trenching activities is a function of the following bullets.

- The total length of pipeline installation or removal is 7.5 miles. Of the 7.5 miles of pipeline, 1.0 mile will be installed via HDD and will not require trenching. Of the remaining 6.5 miles, 2.7 miles of pipeline will be installed in land that is currently forested. Trenching that will occur on forested land is excluded from this calculation because the release of soil carbon from forested areas is already included in Section 11.4. Therefore, 3.8 miles of trenching will occur to install or remove pipelines from non-forested land.

[2] The center of the circle was placed at 41.7537 degrees north, 70.5587 degrees west.

- The width of a trench depends on the diameter of the pipeline being installed or removed. Pipelines of various diameters will be installed and removed as part of the Project, which include 8 inches (3 foot wide), 16 inches (3 foot wide), with the widest of which has a diameter of 18 inches (3-4 foot wide). This calculation conservatively assumes that all Project trenches will be three feet wide.
    - Based on the two preceding bullets, Project trenching will cover approximately 1.4 acres.
- Digging a trench exposes soil to the atmosphere in a similar manner to agricultural tilling, which has been heavily studied. Srivastava (2025) compared conventional tillage to no-till practices and reported that conventional tillage releases 1.3 metric tons CO_2e per acre more than zero tillage. Dietz et al. (2024) reported that maize grown with conventional tillage reduced soil carbon by approximately 1.2 metric tons CO_2e per acre. This calculation selects 1.3 metric tons CO_2e per acre as an approximation of the rate of soil carbon released due to trenching.

Based on the preceding observations and assumptions, the amount of CO_2e released due to Project-related trenching is calculated as 1.3 metric tons CO_2e per acre × 1.4 acres ≈ 1.8 metric tons CO_2e.

3.1.2 Proportion of At-Risk Carbon Released to the Air over 50 Years

Existing literature was reviewed to estimate the proportion of carbon currently sequestered in each carbon pool likely to be released to the air over the 50-year Project lifespan. These estimates are reported in Table 1, and the basis of each estimate is described in the following bullets.

- Russell et al. (2014) report that hardwood left to decay has a half-life of 10 years. This implies that, over 50 years, 96.9% of the carbon stored in this pool would be released into the air while 3.1% would remain sequestered. Enbridge anticipates that its contractors, in accordance with 310 CMR 16.03(2)(c)7, will employ some combination of on-site chipping of felled trees for use on site or transport of wood to a wood waste reclamation facility. Regardless of the location, the wood will be processed to smaller pieces than the downed woody debris studied by Russel et al. (2014), and that these smaller pieces will decay at a faster rate. Thus, Table 1 conservatively[3] reports that 100% of the carbon at-risk at risk of release that is currently stored as ***aboveground live forest biomass*** will be released to the air because of the Project.
- Not all carbon stored as belowground live biomass will be released over the 50-year project lifespan. Lundholm et al. (2020) reported a weighted average half-life of 17.5 years. This implies that, over 50 years, 86.2% of the carbon stored in this pool will be released while 13.8% remains sequestered. Additionally, only 85% of the carbon released when belowground biomass decays will enter the atmosphere. The remaining 15% is metabolized by heterotrophs in the soil and eventually contributes to soil organic carbon through a biophysical process known as fragmentation (Bond-Lamberty and Gower 2008). Thus, Table 1 reports that 73.3% of the at-risk carbon currently stored as ***belowground live forest biomass*** will be released to the air because of

[3] The term conservatively is used to communicate the belief that our approach is more likely to overstate than understate the net change in carbon released from this pool because of the project. Our belief is based on the fact that this calculation implicitly assumes that all live forest biomass (i.e., wood) will be left to decompose. If any of the wood is brought to market as timber, the carbon in that wood will remain sequestered. If any of the forest biomass is brought to market as pulp, mulch, or fuel, it will offset, to some extent, carbon that would have been released elsewhere in the supply chain via a process called leakage. The Intergovernmental Panel on Climate Change (IPCC) Special Report on Land Use, Land Use Change and Forestry defines leakage as "…the indirect impact that…an activity in a certain place at a certain time has on carbon storage at another place or time" (IPCC 2000, section 2.3.5.2, p. 71). From an economics perspective, leakage occurs when a project causes a shift in market equilibria that results in market participants behaving in a manner that offsets (either partially or in its entirety) a change in GHG emission that would otherwise be brought about by a project. Streck (2022) is an informative primer on leakage.

the project. This is calculated as the product of a 0.862 probability of release and a 0.85 probability that release will be to the air.

- Activities that expose sub-surface soil to the air, such as tree cutting, may result in the release of some carbon that would otherwise remain sequestered in the soil. Thompson et al. (2020), reports that tree cutting associated with commercial forestry is not likely to release carbon from forest soil. Thompson et al. (2020) note that their conclusion is consistent with the observation that, when measured, the carbon content of soils in yards did not differ from the carbon content of soils in forests adjacent to those yards. However, on page 55 of their report, Thompson et al. also note that in assuming commercial tree clearing does not cause any release of carbon stored in forest soils, they may understate the potential for carbon release. This concern was based on a metanalysis by Nave et al. (2010), which studied "harvest impacts on soil carbon in temperate forests worldwide [and] found that, on average, harvesting reduced soil carbon stocks by 8%, though the impacts can be ephemeral." Thus, Table 1 conservatively reports that 8% of the at-risk carbon currently stored in ***forest soils*** will be released to the air because of the Project.
- Dead wood will be handled in the same manner as aboveground live biomass, in accordance with 310 CMR 16.03(2)(c)7. Like aboveground live biomass, 100% of the carbon stored in ***dead wood*** will be released to the air over 50 years.
- Carbon stored in forest the litter pool is constantly being released into the air or soil through decomposition and constantly being replenished as leaves or needles drop. While leaves and needles enter and exit the litter pool frequently, the litter pool for a mature forest can be conceptualized as being at a steady state with approximately 6.9 metric tons C per acre. When a forest is cleared, the carbon stored in the litter pool will be released over the course of a few years. Thus, Table 1 reports that 100% of the at-risk carbon currently stored in ***forest litter*** will be released to the air because of the Project.

3.1.3 Project-Related Release of Carbon and CO_2e from the Affected Footprint

The Project-related release of carbon from the affected footprint is conservatively calculated as the product of two Table 1 inputs: a) *carbon at risk of release denominated as metric tons per acre*; and b) *the proportion of at-risk carbon released to the air over 50 years due to the Project*.

The Project-related release of CO_2e from the affected footprint is calculated *as the Project-related release of carbon from the affected footprint ÷ 0.27292 tons of carbon per ton of* CO_2.

3.2 Habitat Conversion

A forest sequesters carbon at a rate dependent on its age. Young forests tend to have a low standing stock of carbon sequestered; however, they sequester carbon at a relatively high annual rate. In contrast, mature forests are characterized by a relatively high standing stock of carbon but a low annual sequestration rate.

This analysis assumes the approximate age of forests currently within the Project footprint is 100 years.[4] After construction, the forest in the 24.4 acres that are allowed to revert to forest will be 0 years old.

[4] Catanzaro and D'Amato (2019) report that 100-year-old forests in the Northeast generally store between 60 and 80 metric tons carbon per acre. EVALIDator data indicates that forests in the Project vicinity store 98.5 metric tons carbon per acre; however, soil carbon estimates reported by Catanzaro and D'Amato (2019) are typically about 20 metric tons lower than those reported by EVALIDator. Thus, assuming the forests in the Project vicinity are 100 years old is in line with Catanzaro and D'Amato (2019).

We rely on a model developed by Zhou et al. (2015) to estimate a forests annual carbon sequestration rate as a function of the forest's age. The model indicates that the existing forest's carbon sequestration rate is 1.97 metric tons CO_2e per acre per year. If the forest is not cut, over 50 years this rate will slowly decreases to 1.96 metric tons CO_2e per acre per year. The amount of CO_2e that would be sequestered by an acre of forest in the Project's footprint over the next 50 years, assuming the acre is not cut, is presented in Table 2. The Project acreage is separated by habitat conversion type to incorporate into Table 3, below.

Table 2. Estimated Future Carbon Sequestration for a 100-Year-Old Forest.

Habitat Scenario	Acres	CO_2e Sequestered by Forest over 50 Years (metric tons per acre) Assuming No Tree Cutting	Total CO_2e Sequestered by Forest in the Project Footprint over 50 Years (metric tons) Assuming No Tree Cutting[1]
Paved/Gravel Surface Replaces Forest	7.4	100.1	740.6
Scrub-Shrub Replaces Forest	13.0	100.1	1,301.0
Young Forest Replaces Old Forest	24.4	100.1	2,442,0
Total	44.8	**100.1**	**4,483.6**

[1] Calculated as the product of the Acres and CO_2e Sequestered by Forest over 50 Years (metric tons per acre) columns.

When mature trees are cleared, future rates of carbon sequestration will depend on how the acreage develops in the future. The amount of CO_2e sequestered over the next 50 years by the habitat that will replace the forest within the Project footprint is presented in columns 3 and 4 of Table 3. Column 6 of Table 3 reports the net change in future CO_2e sequestration which is calculated as the difference between Column 5 and Column 4.

Table 3. Change in Carbon Sequestration Rates by Habitat Conversion Scenario

Habitat Conversion Scenario	Acres	CO_2e Sequestered by New Habitat over 50 Years (metric tons per acre)	CO_2e Sequestered by New Habitat over 50 Years for Project Footprint (metric tons)[1]	CO_2e Sequestered by Forest in the Project Footprint over 50 Years (metric tons) Assuming No Tree Cutting[2]	Net Change in Future CO_2e Sequestration (metric tons)
Paved/Gravel Surface Replaces Forest	7.4	0.0	0.0	740.6	-740.6
Scrub-Shrub Replaces Forest	13.0	3.0	39.0	1,301.0	-1,262.0
Young Forest Replaces Old Forest	24.4	221.7	5,409.2	2,442.0	2,967.2
Total	44.8		**5,448.2**	**4,483.6**	**964.6**

[1] Calculated as the product of the *Acres* and *CO_2e Sequestered by New Habitat over 50 Years (metric tons per acre)* columns. The value presented for the *Young Forest Replaces Old Forest* row does not equal the product of the previous two columns due to rounding.

[2] Values taken from Table 2.

The reasoning behind each input and calculation in Table 3 is described in the remainder of Section 3.2.

If age is back calculated using EVALIDator carbon pools and the Zhou et al. (2015) model, the forest is estimated to be approximately 115 years old. Carbon sequestration rates for 100- and 115-year-old forests are similar.

3.2.1 Paved or Gravel Surfaces Replace Forest

Areas covered by gravel or pavement do not sequester carbon. Therefore, the Project will reduce the amount of carbon that would have otherwise been sequestered in 7.4 acres of forest when these acres are converted to paved or gravel surfaces. Over 50 years, 740.6 metric tons CO_2e that would have been sequestered but for the Project will remain in the atmosphere.

3.2.2 Scrub-Shrub Replaces Forest

When mature trees and vegetation are removed and replaced with scrub-shrub habitat, the annual rate of future carbon sequestration is reduced from approximately 1.97 metric tons CO_2e per acre to 0.06 metric ton per acre. The carbon sequestration rate of scrub-shrub habitat is not well documented and the 0.06 metric ton CO_2e per acre-year used here was determined based on the following observations.

- Maryland Department of Natural Resources (2017), Gregg et al (2021), and Anderson (2021) estimate sequestration rates for scrub-shrub habitat. Their estimates range from 0.74 to 1.48 metric ton CO_2e per acre-year; however, these estimates may not be applicable to the Project for several reasons. First, carbon sequestration rates vary by region, and none of these studies were conducted in the U.S. Northeast. Second, the Maryland Department of Natural Resources (2017) estimate of 1.48 metric tons CO_2e per acre-year is derived from the USFS Carbon Online Estimator, which is no longer supported. The species composition and time horizon for this estimate are unknown. Third, Gregg et al (2021) and Anderson (2021) estimate carbon sequestration in successional habitats in which forest colonizes pasture or grassland. Their estimates (1.03 and 1.48 metric tons CO_2e per acre-year, respectively) likely overstate carbon sequestration because they include young successional forest, whereas trees within the Project's managed scrub-shrub habitat will be cut. Therefore, the carbon sequestration rates reported in these three studies were not used in this analysis.

- The USFS EVALIDator web application includes carbon stock estimates for forest understory, defined as live seedlings, shrubs, and bushes. EVALIDator understory data is location-specific, has a known time horizon, and does not include tree carbon beyond that in seedlings. Therefore, relative to the three studies discussed in the preceding bullet, EVALIDator data is more applicable to the Project's managed scrub-shrub habitat. The rest of this subsection describes how the EVALIDator understory data was incorporated in this analysis.

Understory carbon stocks (aboveground and belowground) were obtained from EVALIDator. Understory carbon stocks vary by tree density, so only "nonstocked" FAIDB plots were selected to resemble the Project's managed scrub-shrub habitat.[5] Due to the sparsity of nonstocked plots in Massachusetts, this analysis uses statewide estimates from Connecticut, Maine, Massachusetts, New Hampshire, New York, Pennsylvania, Rhode Island, and Vermont. The average aboveground and belowground CO_2e stored in a 50-year-old nonstocked forest understory was 3.07 metric tons per acre. Assuming that the carbon sequestration rate is uniform across time,[6] the annual sequestration rate used in this analysis is determined as 3.07 metric tons CO_2e per acre divided by 50 years, or approximately 0.06 metric tons CO_2e per acre-year.

[5] "Nonstocked" is defined as an area in which trees occupy between 0% and 9% of the land.

[6] Carbon sequestration rates are not uniform across the age of a forest stand. As illustrated in Figure 1, sequestration rates for a forest are greatest when the forest is relatively young (15 to 30 years old). As a forest reaches maturity, the carbon sequestration rate reaches an equilibrium. However, scrub-shrub species are faster-growing than trees, so the carbon sequestration rate for scrub-shrub habitat reaches equilibrium relatively quickly. Although the exact shape of the sequestration curve for scrub-shrub is not known, using the average over 50 years (0.06 metric tons CO_2e per acre-year) does not affect the final estimate.

Scrub-shrub habitat will replace 13.0 acres of forested land after construction. Therefore, over 50 years, 1,262.0 tons CO_2e that would have been sequestered but for the Project will remain in the atmosphere.

3.2.3 Replacing 100-Year-Old Forest with Young Forest

When mature trees and vegetation are removed and young trees are allowed to regrow, the net change in future carbon sequestration will vary over time. Initially, sequestration rates in young forests are very low; however, after about 2 or 3 years the rate of carbon sequestration increases rapidly. Depending on the species composition, sequestration rates generally peak before a forest is 100 years old.

Figure 1 depicts how a forest's sequestration rate changes with age, as modeled by Zhou et al. (2015). The green line represents the slowly decreasing average annual carbon sequestration rate of a forest as it increases in age from 100 to 150 years old. The purple line illustrates rapidly evolving annual carbon sequestration rate associated with a forest as it increases in age from 0 to 50.

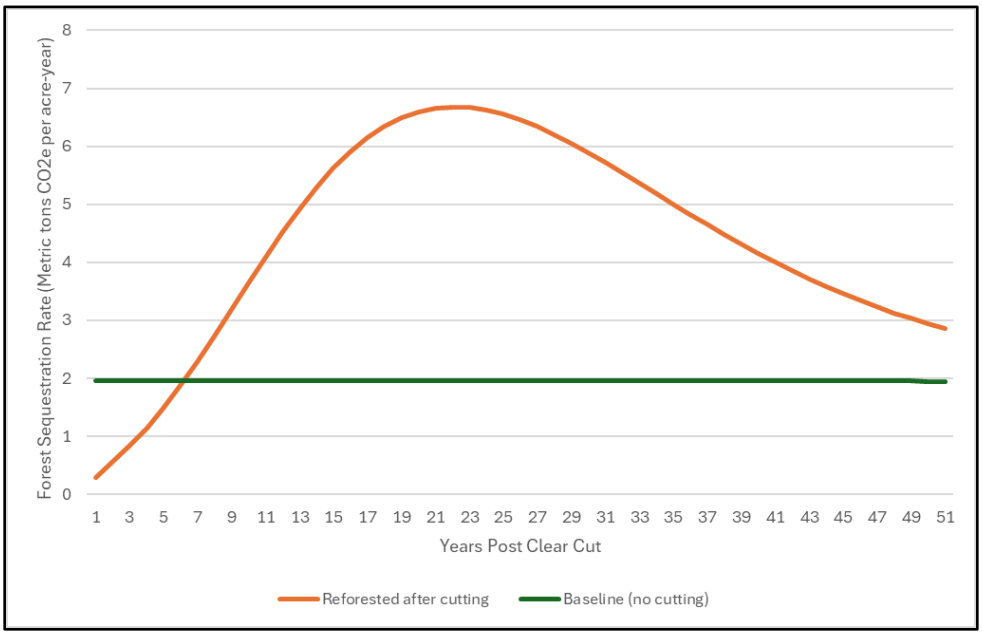


Figure 1. Annual Forest Sequestration Rates

A total of 24.4 acres of forest will be clear cut and allowed to regrow after construction. Without the Project, these 24.4 acres are expected to sequester 2,442.0 metric tons CO_2e over 50 years. When these 24.4 acres are cut and allowed to regrow, 5,409.2 metric tons CO_2e are expected to be sequestered over 50 years. Therefore, for the 50 years following construction, carbon sequestration in these 24.4 acres will increase by 2,967.2 metric tons CO_2e due to the Project.

3.2.4 Project-Related Change in Future Carbon Sequestration

The Project-related change in future carbon sequestration within the affected footprint is 964.6 metric tons CO_2e. This is calculated as the sum of net change in each of the three habitat conversion scenarios (-740.6 metric tons CO_2e in forest converted to paved/gravel surface) + (-1,262.0 metric tons CO_2e in forest converted to scrub-shrub) + (2,967.2 metric tons in areas where young forest replaces older forest) = 964.6 metric tons CO_2e.

4 SUMMARY

The Project is designed to accommodate the replacement of the Bourne Bridge and the Sagamore Bridge while continuing to provide uninterrupted natural gas service to the National Grid distribution system on both sides of the Cape Cod Canal.

To accomplish this goal, a total of 44.8 acres of forested land will be clear cut along the pipeline rights-of-way, within the M&R station footprints, and within construction workspaces. Of the 44.8 total acres, 24.4 acres will revert to forest once construction activities conclude; 13.0 acres will be maintained as low-growing vegetation (scrub-shrub habitat); and 7.4 acres will be converted to paved or gravel surfaces. An additional 1.4 acres of non-forested land will be disturbed for Project-related trenching.

From a GHG accounting perspective, the Project is likely to bring about a change in CO_2e emissions reported in Table 4 and summarized in the following bullets.

1. Up to 8,719.7 metric tons of CO_2e currently sequestered in live biomass, forest and non-forest soil, dead wood, and litter may be released due to vegetation clearing and/or soil disturbance.
2. The conversion of mature forest habitat to young forest (24.4 acres), scrub-shrub (13.0 acres), and paved/gravel surface (7.4 acres) will increase future CO_2e sequestration by approximately 964.6 metric tons over 50 years.

Table 4. Net Change in CO_2e Emissions due to the Project

Project-Related Release of CO_2e from the Affected Footprint (metric tons)	CO_2e Not Sequestered by Forest over 50 Years due to the Project (metric tons)	CO_2e Sequestered by New Habitat over 50 Years for Project Footprint (metric tons)	Net Change in CO_2e Emissions (metric tons)[1]
8,719.7	4,483.6	5,448.2	7,755.1

[1] Calculated as 8,719.7 + 4,483.6 – 5,448.2 = 7,755.1.

As reported in Table 4, the Project is expected to increase CO_2e emissions by approximately 7,755 metric tons over its 50-year lifespan. This equates to approximately 155 metric tons CO_2e annually, which is equivalent to the annual emissions associated with about six and a half Massachusetts households.[7]

[7] The EOEEA (2025) reports that the total gross emissions in Massachusetts were 66,859,515 metric tons CO_2e in 2021 (the most recent year for which they have data). The U.S. Census Bureau (2024) reports that Massachusetts has approximately 2.8 million households. Dividing 66,859,515 metric tons CO_2e gross emissions by 2.8 million households, each Massachusetts household is associated with approximately 23.9 tons of annual CO_2e emissions.

5 LITERATURE CITED

Anderson, P. 2021. Carbon and ecosystems: restoration and creation to capture carbon. Available at: https://cieem.net/wp-content/uploads/2021/05/Carbon-and-habitats-paper-v3.pdf. Accessed December 14, 2025.

Bond-Lamberty, B., and S. Gower. 2008. Decomposition and Fragmentation of Coarse Woody Debris: Re-visiting a Boreal Black Spruce Chronosequence. *Ecosystems* 11(6):831–840. Available at: https://www.researchgate.net/publication/225747510_Decomposition_and_Fragmentation_of_Coarse_Woody_Debris_Re-visiting_a_Boreal_Black_Spruce_Chronosequence. Accessed September 3, 2025.

Catanzaro, P., and A. D'Amato. 2019. Forest Carbon: An essential natural solution for climate change. Available at: https://masswoods.org/sites/default/files/pdf-doc-ppt/Forest%20Carbon%202022/index.pdf. Accessed September 3, 2025.

Dietz, C.L., R.D. Jackson, M.D. Ruark, and G.R. Sanford. 2024. Soil carbon maintained by perennial grassland over 30 years but lost in field crop systems in a temperate Mollisol. *Communications Earth and Environment* 5(360). Available at: https://www.nature.com/articles/s43247-024-01500-w. Accessed November 14, 2025.

Executive Office of Energy and Environmental Affairs (EOEEA). 2025. Massachusetts Clean Energy and Climate Metrics. Available at: https://www.mass.gov/info-details/massachusetts-clean-energy-and-climate-metrics. Accessed September 3, 2025.

Gregg, R., J. Elias, I. Alonso, I. Crosher, P. Muto, and M. Morecroft. 2021. Carbon storage and sequestration by habitat: a review of the evidence (second edition). Natural England Research Report NERR094.

Intergovernmental Panel on Climate Change (IPCC). 2000. Special Report on Land Use, Land Use Change, and Forestry, edited by R.T. Watson, I.R. Noble, B. Bolin, N.H. Ravindranath, D.J. Verado, and D.J. Dokken. Available at: http://www.grida.no/climate/ipcc/land_use/index.htm. Accessed September 4, 2025.

Lundholm, A., K. Black, E. Corrigan, and M. Nieuwenhuis. 2020. Evaluating the Impact of Future Global Climate Change and Bioeconomy Scenarios on Ecosystem Services Using a Strategic Forest Management Decision Support System. *Frontiers in Ecology and Evolution* 8:200. Available at: https://www.frontiersin.org/articles/10.3389/fevo.2020.00200/full. Accessed September 3, 2025.

Maryland Department of Natural Resources. 2017. Accounting for Ecosystem Services in Charles County, Maryland. Available at: https://dnr.maryland.gov/ccs/Documents/Charles_Co_Ecosystem_Service_Report_Final.pdf. Accessed December 17, 2025.

Nave, L., E. Vance, C. Swanston, and P. Curtis. 2010. Harvest impacts on soil carbon storage in temperate forests. *Forest Ecology and Management* 259: 857-866. Available at: https://www.nrs.fs.usda.gov/pubs/jrnl/2010/nrs_2010_nave_001.pdf. Accessed September 3, 2025.

Russell, M.B., C.W. Woodall, S. Fraver, A.W. D'Amato, G.M. Domke, and K.E. Skog. 2014. Residence times and decay rates of downed woody debris biomass/carbon in eastern US forests. *Ecosystems* 17:765–777.

Srivastava, R.K. 2025. Conservation Tillage Practices on GHG Emissions, Soil Health and Overall Agricultural Sustainability. *Soil Use and Management* 41(2). Available at: https://bsssjournals.onlinelibrary.wiley.com/doi/10.1111/sum.70096. Accessed November 14, 2025.

Streck C. 2022. Shades of REDD+: We Have to Talk About Leakage. Available at: Shades of REDD+We Have to Talk About Leakage - Ecosystem Marketplace. Available at: https://www.ecosystemmarketplace.com/articles/shades-of-reddwe-have-to-talk-about-leakage/. Accessed September 4, 2025.

Thompson, J.R., Laflower, D., Plisinski, J., and M.G. Maclean. 2020. Land Sector Report: A Technical Report of the Massachusetts 2050 Decarbonization Roadmap Study. Available online at https://www.mass.gov/doc/land-sector-technical-report/download. Accessed September 3, 2025.

U.S. Census Bureau. 2024. Total Households in Massachusetts: 2023 American Community Survey 1-Year Estimates. Available at: https://data.census.gov/all?q=how+many+households+in+MA. Accessed September 3, 2025.

U.S. Forest Service (USFS). 2018. Forest Inventory and Analysis DataMart. Available at: https://apps.fs.usda.gov/fia/datamart/datamart.html. Accessed September 3, 2025.

———. 2024. EVALIDator Version 2.1.5. Available at: https://apps.fs.usda.gov/fiadb-api/evalidator. Accessed September 3, 2025.

Zhou, Tao, P. Shi, G. Jia, Y. Dai, X. Zhao, W. Shangguan, L. Du, H. Wu, and Y. Luo. 2015. Age-dependent forest carbon sink: Estimation via inverse modeling. Available at: https://agupubs.onlinelibrary.wiley.com/doi/full/10.1002/2015JG002943. Accessed September 3, 2025.

ATTACHMENT 14

Abutter Information

REQUEST FOR CERTIFIED ABUTTERS LIST

REQUESTED BY:

NAME: Richard Paquette - SWCA

ADDRESS: 8 Science Park Rd

CITY: Scarborough, ME ZIP: 04901

PHONE: 207-520-4614

EMAIL: richard.paquette@swca.com; jacob.hargis@swca.com

PURPOSE OF CERTIFIED ABUTTERS LIST:

Cape Cod Commission Developments of Regional Impact (DRI) submittal to Cape Cod Commission

SUBJECT PROPERTY:

LOCATION Multiple - See attached shapefile

MAP/PARCEL Multiple - See attached shapefile

Check appropriate purpose:

Planning Board
- ☐ Special Permit
- ☐ Sub-division
- ☐ Waiver of SP/SPR
- ☐ Site Plan Review
- ☐ Public Roads Policy

Zoning Board of Appeals
- ☐ Variance
- ☐ Special Permit
- ☐ Appeal B.I. Decision

● Cape Cod Commission

Board of Selectmen:
- ☐ Special Permit
- ☐ Liquor License

☐ Board of Health

Conservation Commission
- ☐ RDA
- ☐ NOI

☐ Community Outreach

Assessors Office Use Only

ABUTTERS:

MAP/PARCEL	MAP/PARCEL	MAP/PARCEL

TOWN OF BOURNE
Board of Assessors
24 Perry Avenue
Buzzards Bay, MA 02532
(508) 759-0600 Ext. 1510



Ellen Doyle Sullivan, Chair
Peter Loughman, Clerk
Michael Leitzel, Member

Rui Pereira, MAA
Director of Assessing

July 15, 2026

SWCA – Richard Paquette
8 Science Park Rd
Scarborough, ME 04901

Re: Abutters List for Multiple Locations

As required by the Cape Cod Commission, Chapter 716, Section 5, paragraph 2D this is to certify that the attached list of names and addresses constitutes all the parties in interest as shown on the most recent tax list of the Town of Bourne.

Abutting properties are found on Town Maps 6.0, 7.0, 9.0, 10.0, 11.0, 11.2, 11.4, 12.1, 15.0, 16.0, 17.0, 20.0, 20.4, 21.0, 23.0, 24.0, 25.0, 28.0 & 44.0. List included.

The filing fee of $25.00 has been received by the Bourne Assessor's Office.

Please be advised that this abutters list is valid for 30 days from the date of this letter. If the list expires, it may be recertified upon payment of an additional filing fee.

See enclosed for abutters mailing addresses.

Board of Assessors

List Enclosed

Extract: ABUTTERS LIST
Database: Live
Filter:
Sort:

Report #24: Owner Listing Report

Fiscal Year 2027

Bourne MA

Key	Parcel ID	Owner	Location	LCt/Cl	Bk-Pg(Cert) /Dt	Mailing Street	Mailing City	ST	Zip Cd/County
946	6.0-5-0	TOWN OF BOURNE	0 LITTLE BLACK POND RD	Y 9320	162602 8/29/2001	24 PERRY AVENUE	BUZZARDS BAY	MA	02532-3496
955	6.0-8-6	SORENTI MARY L REVOC TRUST	1 FRANK CIR	N 1300	36936/184 4/23/2025	PO BOX 25	SAGAMORE BEACH	MA	02562
956	6.0-8-7	SORENTI MARY L REVOC TRUST	3 FRANK CIR	N 1010	36936/186 4/23/2025	PO BOX 25	SAGAMORE BEACH	MA	02562
996	6.0-51-0	THONUS TRAVIS ALEXANDRA THONUS	3 HOMESTEAD RD	N 1010	36797/341 1/27/2025	3 HOMESTEAD RD	SAGAMORE BEACH	MA	02562
997	6.0-51-1	LYNCH JOHN A III & CAROL A	7 HOMESTEAD RD	N 1010	31800/159 1/25/2019	7 HOMESTEAD ROAD	SAGAMORE BEACH	MA	02562
998	6.0-51-2	CUNNINGHAM RICHARD & CATHERINE TRS CUNNINGHAM FAM REV TRUST	5 HOMESTEAD RD	N 1010	33683/23 1/14/2021	PO BOX 1696	SAGAMORE BEACH	MA	02562
1000	6.0-52-1	COMMONWEALTH OF MASSACHUSETTS DEPT OF PUBLIC WORKS	0 MEETINGHOUSE LN	N 9290	19152/41 10/20/2002	10 PARK PLAZA SUITE 6160	BOSTON	MA	02116-3973
1001	6.0-53-0	EAGLEWING MEADOWS LLC	15 MEETINGHOUSE LN	N 3260	25008/12 11/17/2010	C/O RICHARD HOGAN MANAGEMENT 10 OCEANA WAY STE 2	NORWOOD	MA	02062
1002	6.0-54-0	SORENTI BROTHERS INC DUNKIN DONUTS	24 MEETINGHOUSE LN	N 3260	1037/356 5/1/1959	PO BOX 1120	SAGAMORE BEACH	MA	02562
1003	6.0-57-0	MASREAL COMPANY INC C/O BT-NEWYO-LLC	44 MEETINGHOUSE LN	N 3370	4380/141	ATTN CORP REAL ESTATE (RPT) 55 GLENLAKE PARKWAY NE	ATLANTA	GA	30328
1004	6.0-84-0	LOWE DUNCAN L & KELLY L LOWE	4 HOMESTEAD RD	N 1010	12445/277 7/30/1999	P O BOX 256	SAGAMORE BEACH	MA	02562-0256
1005	6.0-85-0	NOLAN LESLIE A	6 HOMESTEAD RD	N 1010	25431/79 5/6/2011	6 HOMESTEAD RD	SAGAMORE BEACH	MA	02562
16832	6.0-260-0	COMMONWEALTH OF MASSACHUSETTS DEPT OF PUBLIC WORKS	0 MEETINGHOUSE LN	N 9290	19152/41 10/20/2004	10 PARK PLAZA SUITE 6160	BOSTON	MA	02116
1206	7.0-23-1	FORTY ONE MEETINGHOUSE LANE LLC	41 MEETINGHOUSE LN	N 3230	22802/304 4/2/2008	160 SPEEN ST STE 303	FRAMINGHAM	MA	01701-2003
1209	7.0-26-0	MASREAL COMPANY INC C/O BT-NEWYO LLC	44 MEETINGHOUSE LN	N 3900	4380/141	ATTN CORP REAL ESTATE (RPT) 55 GLENLAKE PARKAY NE	ATLANTA	GA	30328
1280	7.0-91-0	GATELY JOHN P JR & CAROL ANN GATELY TR CAP REALTY TRUST	45 MEETINGHOUSE LN	N 3500	27325/229 4/26/2013	27 CIRCUIT AVENUE	SCITUATE	MA	02066
1650	9.0-6-0	NSTAR GAS COMPANY	0 VALLEY RD	N 4230	21648/61 12/27/2006	PO BOX 270	HARTFORD	CT	06141-0270
1651	9.0-7-0	SMALL STEVEN R & MARY ELLEN SMALL	31 YEARLING RUN RD	N 1010	12360/276 6/24/1999	31 YEARLING RUN ROAD	BUZZARDS BAY	MA	02532-2259
1665	9.0-53-0	REDMOND EDWARD T & MARCIE TRS REDMOND FAMILY TRUST 2025	142 BOURNEDALE RD	N 1010	37171/205 9/8/2025	142 BOURNEDALE RD	BOURNE	MA	02532
1666	9.0-54-0	MORRISON LYLE & CONSTANCE TRS MORRISON FAMILY TRUST	140 BOURNEDALE RD	N 1010	36193/205 1/24/2024	140 BOURNEDALE RD	BUZZARDS BAY	MA	02532
1667	9.0-55-0	MCANAUGH TODD W & LAURIE A TRS MCANAUGH FAMILY NOMINEE TRUST	136 BOURNEDALE RD	N 1010	34264/325 7/1/2021	136 BOURNEDALE RD	BOURNE	MA	02532
1673	9.0-78-2	INGERSOLL DAVID S ETAL TRS BOURNEDALE REAL ESTATE TR	0 BOURNEDALE RD	N 7170	28945/48 6/17/2015	400 HEAD OF THE BAY RD	BUZZARDS BAY	MA	02532
14442	9.0-79-0	CHAYTOR JASON & MICHELLE FORTIN TR FORTIN-CHAYTOR FAM T	33 YEARLING RUN RD	N 1010	27177/286 3/4/2013	33 YEARLING RUN RD	BOURNE	MA	02532
14443	9.0-80-0	STAIGER PAUL J & TAMMY A STAIGER	35 YEARLING RUN RD	N 1010	12348/250 6/18/1999	35 YEARLING RUN RD	BOURNE	MA	02532
14444	9.0-81-0	CIMENO ANN LORRAINE	37 YEARLING RUN RD	N 1010	36659/1/3 11/5/2024	37 YEARLING RUN RD	BUZZARDS BAY	MA	02532

Key	Parcel ID	Owner	Location	LCt/Cl	Bk-Pg(Cert) /Dt	Mailing Street	Mailing City	ST	Zip Cd/County
14445	9.0-82-0	RODRIGUES ALBERT K TR ALBERT K RODRIGUES TRUST 2015	39 YEARLING RUN RD	N 1010	28662/7 2/3/2015	39 YEARLING RUN RD	BOURNE	MA	02532
14446	9.0-83-0	MACRAE DAVID B & MACRAE KARI D	41 YEARLING RUN RD	N 1010	20032/37 7/11/2005	41 YEARLING RUN ROAD	BOURNE	MA	02532
14447	9.0-84-0	BLANCHETTE PETER SCOTT & DONNA MARIE BLANCHETTE	43 YEARLING RUN RD	N 1010	36084/1 11/13/2023	43 YEARLING RUN RD	BOURNE	MA	02532
14448	9.0-85-0	ATWOOD WILLIAM C & LEANNE ATWOOD	44 YEARLING RUN RD	N 1010	33536/91 12/2/2020	44 YEARLING RUN RD	BOURNE	MA	02532
14449	9.0-86-0	ROBERTS DEBORAH L	42 YEARLING RUN RD	N 1010	35232/26 7/6/2022	42 YEARLING RUN RD	BOURNE	MA	02532
14450	9.0-87-0	CARLOW EARL P JR & SUZANNE CARLOW	40 YEARLING RUN RD	N 1010	12430/109 7/26/1999	40 YEARLING RUN RD	BUZZARDS BAY	MA	02532-2259
14455	9.0-88-0	PEURA JAYE M TR OF THE EBP FAMILY TRUST	38 YEARLING RUN RD	N 1010	14570/148 12/13/2001	38 YEARLING RUN ROAD	BUZZARDS BAY	MA	02532-2258
1678	10.0-5-0	TOWN OF BOURNE	0 BOURNEDALE RD	N 9320	14090/282 7/31/2001	24 PERRY AVE	BUZZARDS BAY	MA	02532-3496
1679	10.0-6-0	TOWN OF BOURNE CONSERVATION COMMISSION	0 BOURNEDALE RD	N 9320	20587/284 12/20/2005	24 PERRY AVE	BUZZARDS BAY	MA	02532
1680	10.0-7-0	COMMONWEALTH OF MASSACHUSETTS DIV OF FISHERIES AND WILDLIFE	195 BOURNEDALE RD	N 9110	00886/0128	195 BOURNEDALE ROAD	BOURNEDALE	MA	02532-2241
1681	10.0-9-0	INGERSOLL DAVID S ETAL TRS PANHANDLE TRUST	0 BOURNEDALE RD	N 0470	28945/6 6/17/2015	400 HEAD OF THE BAY RD	BUZZARDS BAY	MA	02532
1682	10.0-10-0	NEXTGRID PATRIOTS LLC	665 SCENIC HIGHWAY	N 4510	34911/145 2/16/2022	PO BOX 7775 #73069	SAN FRANCISCO	CA	94120
1683	10.0-10-1	CAPE COD AGGREGATES CORP	771 SCENIC HIGHWAY	N 4100	22533/248 12/13/2007	PO BOX 517	BARNSTABLE	MA	02630-0517
1713	10.0-43-0	QUINN DONALD P TRUSTEE MONUMENT RIVER REALTY TRUST	5 GLACIER WAY	N 1300	1850/136 5/1/1973	26 HOWLAND ST	PLYMOUTH	MA	02360
1714	10.0-44-0	BRUNO NICHOLAS III	3 GLACIER WAY	N 1010	12888/123 3/17/2000	3 GLACIER WAY	BOURNE	MA	02532
1715	10.0-45-0	HARPER SHARON M	1 GLACIER WAY	N 1010	35439/216 10/24/2022	1 GLACIER WAY	BOURNE	MA	02532
1716	10.0-47-0	BRUCE MATTHEW & EMMA TRS BRUCE FAMILY RLTY TRUST	2 GLACIER WAY	N 1010	34925/55 2/23/2022	2 GLACIER WAY	BOURNE	MA	02532
1717	10.0-48-0	MCDONALD THOMAS & NANCY TRS MCDONALD FAMILY REV TRUST	60 BOURNEDALE RD	N 1010	35949/182 8/21/2023	60 BOURNEDALE RD	BOURNE	MA	02532
1718	10.0-50-0	AFONKIN VADIM A	56 BOURNEDALE RD	N 1010	34252/272 6/29/2021	56 BOURNEDALE RD	BUZZARDS BAY	MA	02532
1719	10.0-51-0	BUZZARDS BAY WATER DISTRICT	0 BOURNEDALE RD	N 9380	02751/0145	PO BOX 243	BUZZARDS BAY	MA	02532
1720	10.0-52-0	BUZZARDS BAY WATER DISTRICT	0 BOURNEDALE RD	N 9390	02751/0145	PO BOX 243	BUZZARDS BAY	MA	02532
1725	10.0-57-0	HURLEY JOSEPH P ETUX SANDRA B HURLEY	134 BOURNEDALE RD	N 1010	24136/184 11/2/2009	134 BOURNEDALE RD	BOURNE	MA	02532
1754	10.0-138-0	KEHOE STEVEN E & NUET KEHOE	105 BOURNEDALE RD	N 1010	9924/304 11/10/1995	105 BOURNEDALE RD	BOURNEDALE	MA	02532-2209
1755	10.0-139-0	SILVA SHAWN M & JENNIE ROSE SMITH	103 BOURNEDALE RD	N 1010	33962/230 3/31/2021	103 BOURNEDALE RD	BUZZARDS BAY	MA	02532
1764	10.0-148-0	CROWN ATLANTIC COMPANY LLC	0 BOURNEDALE RD	N 4320	12225/315 4/27/1999	PMB 353 4017 WASHINGTON RD	MCMURRAY	PA	15317-2520

Key	Parcel ID	Owner	Location	LCt/Cl	Bk-Pg(Cert) /Dt	Mailing Street	Mailing City	ST	Zip Cd/County
1780	10.0-164-0	ACHSTETTER C RICHARD ROBERTA L ACHSTETTER	19 YEARLING RUN RD	N 1010	11411/157 5/7/1998	19 YEARLING RUN RD	BUZZARDS BAY	MA	02532-2259
15256	10.0-165-0	WRIGHT DOROTHY E TRS MACFARLANE FAMILY TRUST	21 YEARLING RUN RD	N 1010	36332/75 4/25/2024	21 YEARLING RUN RD	BOURNE	MA	02532
15257	10.0-166-0	WARRENSFORD THERESA ETUX LARRY WARRENSFORD & R FUCCI	29 YEARLING RUN RD	N 1010	29080/297 8/18/2015	29 YEARLING RUN RD	BOURNE	MA	02532
16481	10.0-168-0	ECONOMIDES JOHN T & PATRICIA A TRS OF ATHENS REALTY TRUST	803 SCENIC HIGHWAY	N 3260	19966/332 6/23/2005	PO BOX 325	BUZZARDS BAY	MA	02532
16871	10.0-169-0	ECONOMIDES JOHN & PATRICIA TRS JET REALTY TRUST	8 ACROPOLIS DR	N 1010	30921/261 11/27/2017	PO BOX 325	BUZZARDS BAY	MA	02532
1820	11.0-22-0	TOWN OF BOURNE	961 SCENIC HIGHWAY	Y 9320	162602 8/29/2001	24 PERRY AVENUE	BUZZARDS BAY	MA	02532-3496
1823	11.0-22-3	CHAPMAN BERTRAND G TRUST	2 BRIGANTINE PASSAGE DR	Y 1010	237293 10/9/2024	2 BRIGANTINE PASSAGE DR	BOURNE	MA	02532
1824	11.0-22-4	MATEU JOSEPH M & SANDWITH-MATEU PETRA	1 BRIGANTINE PASSAGE DR	Y 1010	173303 6/9/2004	1 BRIGANTINE PASSAGE DRIVE	BOURNE	MA	02532
1825	11.0-24-0	COMMONWEALTH OF MASS DEPT OF HIGHWAYS	0 SCENIC HIGHWAY	N 9240	21711/102 1/19/2007	10 PARK PLAZA ROOM 6160	BOSTON	MA	02116-3933
1826	11.0-25-0	TOWN OF BOURNE SAGAMORE FIRE STATION	1025 SCENIC HIGHWAY	N 9350	N/A/N/A	24 PERRY AVE	BUZZARDS BAY	MA	02532
1828	11.0-26-0	SORENTI ROW LLC	1 CANAL ST	N 3340	37447/59 2/2/2026	PO BOX 1695	SAGAMORE BEACH	MA	02562
1829	11.0-27-0	21 HUNTERS BROOK RD INC	21 CANAL ST	N 1300	30451/57 4/28/2017	PO BOX 260367	TAMPA	FL	33685
1830	11.0-29-0	10 REVA REALTY SAGAMORE LLC	10 CANAL ST	N 3260	36382/157 5/24/2024	251 NORTH PEARL ST	BROCKTON	MA	02301
1867	11.0-32-0	OSMANI DRITAN & ARJANA OSMANI	22 CANAL ST	Y 1010	239527 6/24/2025	5 GROUSE ST	W ROXBURY	MA	02132
1868	11.0-33-0	COMMONWEALTH OF MASSACHUSETTS DEPT OF TRANSPORTATION	34 CANAL ST	N 9240	37516/21 3/19/2026	ATTN RON SMITH 10 PARK PLAZA STE 7760	BOSTON	MA	02116
1869	11.0-33-1	SORENTI BROTHERS INC	30 CANAL ST	N 3900	22508/30 11/30/2007	P O BOX 1120	SAGAMORE BEACH	MA	02562
1870	11.0-34-0	SORENTI BROTHERS INC	0 CANAL ST	N 1320	25666/191 9/8/2011	PO BOX 1120	SAGAMORE BEACH	MA	02562
1871	11.0-35-0	TRIMBLE JENNIFER J	3 HUNTERS BROOK RD	N 1010	30960/347 12/13/2017	45 GILBERT STREET	MALDEN	MA	02148
1873	11.0-37-0	TODD KATHRYN & JEFFREY HARRIS TRS HARRIS FAMILY IRREV TRUST	21 HUNTERS BROOK RD	N 1010	29135/239 9/14/2015	21 HUNTERS BROOK RD	SAGAMORE BEACH	MA	02562
16432	11.0-38-4	SAKERS STEVE D & KRISTY A	0 JILLIAN DR	Y 1320	218263 12/27/2018	PO BOX 631	SAGAMORE	MA	02561
1883	11.0-109-0	SORENTI JOSEPH F TRUST	3 SORENTI AVE	N 1320	36967/310 5/9/2025	PO BOX 25	SAGAMORE BEACH	MA	02562
1884	11.0-110-0	SORENTI JOSEPH F TRUST	1011 SCENIC HIGHWAY	N 1320	36967/312 5/9/2025	PO BOX 25	SAGAMORE BEACH	MA	02562
1887	11.0-115-0	BROWN SHARON TUCKER	6 EASTING RD	N 1010	28555/127 12/8/2014	6 EASTING RD	BOURNE	MA	02532-2222
1929	11.0-160-0	HUNTERS BROOK LLC	0 CANAL ST	Y 1320	228914 1/19/2022	2 LYNXHOLM CT 2ND FLR	HYANNIS	MA	02601
1931	11.0-162-0	DELUCA PATRICIA J REVOC TRUST	3 BRIGANTINE PASSAGE DR	Y 1010	238262 1/30/2025	49 ORCHARD AVE	PROVIDENCE	RI	02906

Key	Parcel ID	Owner	Location	LCt/Cl	Bk-Pg(Cert) /Dt	Mailing Street	Mailing City	ST	Zip Cd/County
1932	11.0-163-0	LEPARDO LAUREN TR OF LOT 7 REALTY TRUST	5 BRIGANTINE PASSAGE DR	Y 1300	166031 7/25/2002	49 ORCHARD AVE	PROVIDENCE	RI	02906
1933	11.0-164-0	RUGGERI RICHARD S & MARYELLEN E HUNTER	7 BRIGANTINE PASSAGE DR	Y 1010	198932 10/6/2025	PO BOX 1448	SAGAMORE BEACH	MA	02562
1934	11.0-165-0	RUGGERI RICHARD S & NANCY I & MARYELLEN E HUNTER	0 BRIGANTINE PASSAGE DR	Y 1320	198932 12/10/2012	PO BOX 1448	SAGAMORE BEACH	MA	02562-1448
1938	11.0-169-0	NITSCHKE MARK P & CARA L TECENO-NITSCHKE	6 BRIGANTINE PASSAGE DR	Y 1010	240798 11/17/2025	6 BRIGANTINE PASSAGE	BOURNE	MA	02532
1939	11.0-170-0	WILLIAMS VINCENT A ETUX ROBIN A WILLIAMS	4 BRIGANTINE PASSAGE DR	Y 1010	208641 1/28/2016	4 BRIGANTINE PASSAGE DR	BOURNE	MA	02532
14456	11.0-172-0	ALGONQUIN GAS TRANSMISSION LLC	0 MEETINGHOUSE LN	N 3900	37507/81 3/13/2026	C/O KROLL LLC PO BOX 2629	ADDISON	TX	75001
16442	11.0-183-0	GARCIA HECTOR & JOSEFINA POBLETE	21 JILLIAN DR	Y 1010	231695 12/1/2022	21 JILLIAN DR	BOURNE	MA	02532
16443	11.0-184-0	TITCOMB IAN J A & JENNIFER C TITCOMB	23 JILLIAN DR	Y 1010	228309 11/19/2021	23 JILLIAN DR	BOURNE	MA	02532
16444	11.0-185-0	LINDE JAMES P	22 JILLIAN DR	Y 1010	228710 12/27/2021	22 JILLIAN DR	BOURNE	MA	02532
16445	11.0-186-0	BATCHELDER JASON C & LYNDSEY G	20 JILLIAN DR	Y 1010	219404 5/15/2019	20 JILLIAN DRIVE	BOURNE	MA	02532
1941	11.2-1-0	TREMBLEY KATHLEEN B & J KEVIN BRENNAN	0 HUNTERS BROOK RD	N 1320	33123/135 7/31/2020	103 RHINECLIFF ST	ARLINGTON	MA	02476
1960	11.2-4-0	CUNNINGHAM ANDREW J	30 HUNTERS BROOK RD	N 1010	29854/108 8/10/2016	30 HUNTERS BROOK RD	SAGAMORE BEACH	MA	02562
2005	11.4-52-0	DSM MB II LLC	1 FACTORY OUTLET RD	Y 3230	142936 12/30/2014	875 EAST STREET	TEWKSBURY	MA	01876
2077	12.1-1-0	MASREAL CO INC C/O BT-NEWYO LLC	48 MEETINGHOUSE LN	N 3160	1342/1190	ATTN CORP REAL ESTATE (RPT) 55 GLENLAKE PARKWAY NE	ATLANTA	GA	30328
2078	12.1-2-0	PETERSON SUSAN J	6 PATTY'S WAY	N 1010	26240/303 4/12/2012	6 PATTY'S WAY	SAGAMORE BEACH	MA	02562
2079	12.1-2-1	MEETINGHOUSE STORAGE LLC	54 MEETINGHOUSE LN	N 3160	15932/233 11/18/2002	54 A MEETINGHOUSE LANE	SAGAMORE BEACH	MA	02562
2202	12.1-110-0	OCONNOR EDWARD M & PATRICIA TR OCONNOR FAMILY REALTY TRUST	59 HUNTERS BROOK RD	N 1010	28748/350 3/20/2015	PO BOX 143	SAGAMORE BEACH	MA	02562
2203	12.1-111-0	BECKET ACADEMY INC	8 PATTY'S WAY	N 1010	32197/201 8/1/2019	PO BOX 325	ORFORD	NH	03777
2817	15.0-17-0	ALGONQUIN GAS TRANSMISSION LLC	0 SCENIC HIGHWAY	N 1320	37507/89 3/13/2026	C/O KROLL LLC PO BOX 2629	ADDISON	TX	75001
2819	15.0-20-0	ALGONQUIN GAS TRANSMISSION LLC	0 SCENIC HIGHWAY	N 1320	37507/89 3/13/2026	C/O KROLL LLC PO BOX 2629	ADDISON	TX	75001
2820	15.0-21-0	ALGONQUIN GAS TRANSMISSION LLC	0 SCENIC HIGHWAY	N 1320	37507/89 3/13/2026	C/O KROLL LLC PO BOX 2629	ADDISON	TX	75001
2821	15.0-25-0	ALGONQUIN GAS TRANSMISSION LLC	0 SCENIC HIGHWAY	N 1320	37507/89 3/13/2026	C/O KROLL LLC PO BOX 2629	ADDISON	TX	75001
2829	15.0-34-0	HEBB BRIAN E TR OF PINE TREE REALTY TRUST	0 DESERET DR	N 1320	14354/99+ 10/23/2001	498 NEWTOWN ROAD	LITTLETON	MA	01460-2206
16465	15.0-34-1	HEBB BRIAN E TR OF PINE TREE REALTY TRUST	0 DESERET DR	N 1320	14354/99+ 10/23/2001	498 NEWTOWN ROAD	LITTLETON	MA	01460-2206
16466	15.0-34-2	O'BRIEN AMY J	55 MIRASOL DR	N 1010	31434/270 7/30/2018	55 MIRASOL DRIVE	BOURNE	MA	02532

Key	Parcel ID	Owner	Location	LCt/Cl	Bk-Pg(Cert) /Dt	Mailing Street	Mailing City	ST	Zip Cd/County
16468	15.0-34-5	HEBB BRIAN E TR OF PINE TREE REALTY TRUST	0 DESERET DR	N 1320	14354/99+ 10/23/2001	498 NEWTOWN ROAD	LITTLETON	MA	01460-2206
2836	15.0-46-0	TRENT TRE MOLLY LLC	49 HEATHER HILL RD	N 1320	26988/288 12/27/2012	PO BOX 517	BARNSTABLE	MA	02630-0517
2837	15.0-47-0	TRENT TRE MOLLY LLC	51 HEATHER HILL RD	N 1320	26988/288 12/27/2012	PO BOX 517	BARNSTABLE	MA	02630-0517
2838	15.0-48-0	TRENT TRE MOLLY LLC	53 HEATHER HILL RD	N 1320	26988/288 12/27/2012	PO BOX 517	BARNSTABLE	MA	02630-0517
2839	15.0-49-0	TRENT TRE MOLLY LLC	55 HEATHER HILL RD	N 1320	26988/288 12/27/2012	PO BOX 517	BARNSTABLE	MA	02630-0517
2840	15.0-50-0	TRENT TRE MOLLY LLC	56 HEATHER HILL RD	N 1320	26988/288 12/27/2012	PO BOX 517	BARNSTABLE	MA	02630-0517
2841	15.0-51-0	TRENT TRE MOLLY LLC	54 HEATHER HILL RD	N 1320	26988/288 12/27/2012	PO BOX 517	BARNSTABLE	MA	02630-0517
2842	15.0-52-0	TRENT TRE MOLLY LLC	52 HEATHER HILL RD	N 1320	26988/288 12/27/2012	PO BOX 517	BARNSTABLE	MA	02630-0517
2843	15.0-53-0	TRENT TRE MOLLY LLC	4 MALLARD ST	N 1320	26988/288 12/27/2012	PO BOX 517	BARNSTABLE	MA	02630-0517
2844	15.0-54-0	TRENT TRE MOLLY LLC	50 HEATHER HILL RD	N 1320	26988/288 12/27/2012	PO BOX 517	BARNSTABLE	MA	02630-0517
2845	15.0-55-0	TRENT TRE MOLLY LLC	48 HEATHER HILL RD	N 1320	26988/288 12/27/2012	PO BOX 517	BARNSTABLE	MA	02630-0517
2846	15.0-56-0	TRENT TRE MOLLY LLC	9 TANAGER LN	N 1320	26988/288 12/27/2012	PO BOX 517	BARNSTABLE	MA	02630-0517
2847	15.0-57-0	TRENT TRE MOLLY LLC	11 TANAGER LN	N 1320	26988/288 12/27/2012	PO BOX 517	BARNSTABLE	MA	02630-0517
2848	15.0-58-0	TRENT TRE MOLLY LLC	15 TANAGER LN	N 1320	26988/288 12/27/2012	PO BOX 517	BARNSTABLE	MA	02630-0517
2849	15.0-59-0	TRENT TRE MOLLY LLC	16 TANAGER LN	N 1320	26988/288 12/27/2012	PO BOX 517	BARNSTABLE	MA	02630-0517
2851	15.0-61-0	MCENTEE JR PETER T & KAYLA	36 MIRASOL DR	N 1010	32484/87 11/21/2019	36 MIRASOL DRIVE	BOURNE	MA	02532
2852	15.0-62-0	LESEINSKIS VILIJA	46 MIRASOL DR	N 1010	24183/238 11/20/2009	46 MIRASOL DR	BOURNE	MA	02532
2853	15.0-63-0	TIERNEY ROBERT P & SUSAN SARD TIERNEY	51 MIRASOL DR	N 1010	33087/25 7/20/2020	51 MIRASOL DR	BOURNE	MA	02532
2854	15.0-64-0	KENNEDY MATTHEW H JR ETUX ANN MARIE KENNEDY	37 MIRASOL DR	N 1010	23935/128 7/31/2009	37 MIRASOL DR	BOURNE	MA	02532
2855	15.0-65-0	REID BRIAN & MARINA TURNER	31 MIRASOL DR	N 1010	31739/187 12/20/2018	31 MIRASOL DR	BOURNE	MA	02532
2856	15.0-66-0	HALLAHAN RYAN P & SHAWNA M DAVIS	15 MIRASOL DR	N 1010	20479/111 11/16/2005	15 MIRASOL DR	BUZZARDS BAY	MA	02532
2857	15.0-67-0	MCWILLIAMS FARRAH M	17 MIRASOL DR	N 1010	29084/115 8/19/2015	17 MIRASOL DR	BOURNE	MA	02532
2858	15.0-68-0	LANGILLE WILLIAM B TR OF THE WILLIAM LANGILLE FAMILY TRUST	19 MIRASOL DR	N 1010	22016/288 5/11/2007	19 MIRASOL DR	BOURNE	MA	02532
2859	15.0-69-0	NIVLING ERIC P	21 MIRASOL DR	N 1010	27835/25 11/20/2013	21 MIRASOL DR	BOURNE	MA	02532
2860	15.0-70-0	PETTINE CLIFFORD J & VIRGINIA	23 MIRASOL DR	N 1010	32346/65 10/1/2019	23 MIRASOL DRIVE	BOURNE	MA	02532

Key	Parcel ID	Owner	Location	LCt/Cl	Bk-Pg(Cert) /Dt	Mailing Street	Mailing City	ST	Zip Cd/County
2861	15.0-71-0	DEANE THURMAN R ETUX LISA A DEANE	25 MIRASOL DR	N 1010	21451/241 10/20/2006	25 MIRASOL DR	BOURNE	MA	02532
2862	15.0-72-0	SHUTE TYLER CHRISTOPHER & COURTNEY L HALPERN	27 MIRASOL DR	N 1010	35899/177 7/20/2023	27 MIRASOL DR	BOURNE	MA	02532
2863	15.0-73-0	HOLLOSI CHRISTINE ELIZABETH	29 MIRASOL DR	N 1010	36459/338 7/10/2024	29 MIRASOL DR	BOURNE	MA	02532
2864	15.0-74-0	WARD OWEN C SR & CAROLYN E TRS WARD REALTY TRUST	33 MIRASOL DR	N 1010	35454/333 10/31/2022	33 MIRASOL DR	BOURNE	MA	02532
2865	15.0-75-0	FALLON CHRISTINE A	35 MIRASOL DR	N 1010	24585/330 5/28/2010	35 MIRASOL DR	BOURNE	MA	02532
2866	15.0-76-0	CURRIER BRETT R ETUX MICHELLE M CURRIER	39 MIRASOL DR	N 1010	22554/49 12/19/2007	39 MIRASOL DR	BOURNE	MA	02532
2867	15.0-77-0	PETERS SHAWN D	41 MIRASOL DR	N 1010	25924/102 12/15/2011	41 MIRASOL DR	BOURNE	MA	02532
2868	15.0-78-0	MAURO JANET	43 MIRASOL DR	N 1010	31468/210 8/16/2018	43 MIRASOL DRIVE	BOURNE	MA	02532
2869	15.0-79-0	SILVA CLIFF M & SELINA G SILVA	45 MIRASOL DR	N 1010	33119/155 7/30/2020	45 MIRASOL DR	BOURNE	MA	02532
2870	15.0-80-0	COTE JESSICA C	47 MIRASOL DR	N 1010	32996/74 6/18/2020	47 MIRASOL DR	BOURNE	MA	02532
2871	15.0-81-0	ROSSI MATTHEW P	49 MIRASOL DR	N 1010	32282/275 9/9/2019	49 MIRASOL DRIVE	BOURNE	MA	02532
2872	15.0-82-0	LUECKE JANN HENDRIK ETUX KIANA OWZAR	53 MIRASOL DR	N 1010	24722/148 8/2/2010	53 MIRASOL DR	BOURNE	MA	02532
2878	15.0-88-0	HOWARD GARY & SHEILA HOWARD	50 MIRASOL DR	N 1010	33037/152 7/1/2020	50 MIRASOL DR	BOURNE	MA	02532
2879	15.0-89-0	PIERCE TYLER Y	48 MIRASOL DR	N 1010	24285/327 1/6/2010	48 MIRASOL DR	BOURNE	MA	02532
2880	15.0-90-0	WOOD-RUSSO LOIS M	44 MIRASOL DR	N 1010	31351/54 6/20/2018	44 MIRASOL DRIVE	BOURNE	MA	02532
2881	15.0-91-0	GRIFFIN AARON J	42 MIRASOL DR	N 1010	26119/321 2/29/2012	42 MIRASOL DR	BOURNE	MA	02532
2882	15.0-92-0	PALMER ROBERT & ANITA - TRS PALMER FAMILY LIVING TRUST	40 MIRASOL DR	N 1010	30519/332 5/30/2017	40 MIRASOL DR	BUZZARDS BAY	MA	02532
2883	15.0-93-0	APACHE REALTY TRUST	38 MIRASOL DR	N 1010	36480/36 7/23/2024	38 MIRASOL DR	BOURNE	MA	02532
2884	15.0-94-0	LEWIS DONALD R & SHARON ERLANDSON	34 MIRASOL DR	N 1010	33222/8 9/1/2020	34 MIRASOL DR	BOURNE	MA	02532
2885	15.0-95-0	DOODY ANDREW J ETUX PAMELA T DOODY	32 MIRASOL DR	N 1010	23071/244 7/30/2008	32 MIRASOL DR	BOURNE	MA	02532-5681
2886	15.0-96-0	MCGRADY THOMAS J & MARY S GARABEDIAN	30 MIRASOL DR	N 1010	21385/24 9/27/2006	30 MIRASOL DR	BOURNE	MA	02532
2887	15.0-97-0	BOYNTON JOANNE M	28 MIRASOL DR	N 1010	28789/161 4/8/2015	28 MIRASOL DR	BOURNE	MA	02532
2888	15.0-98-0	GAULIN LISA M	26 MIRASOL DR	N 1010	28350/268 8/28/2014	26 MIRASOL DR	BUZZARDS BAY	MA	02532
2889	15.0-99-0	WENZEL DANIEL M ETUX TARYN A WENZEL	22 MIRASOL DR	N 1010	26930/306 12/10/2012	22 MIRASOL DR	BOURNE	MA	02532
2890	15.0-100-0	CONTRINO ANTHONY & JULIE CONTRINO	20 MIRASOL DR	N 1010	34623/159 11/1/2021	20 MIRASOL DR	BOURNE	MA	02532

Key	Parcel ID	Owner	Location	LCt/Cl	Bk-Pg(Cert) /Dt	Mailing Street	Mailing City	ST	Zip Cd/County
2891	15.0-101-0	WU YUNKE ETUX JIE FANG	18 MIRASOL DR	N 1010	28231/210 6/27/2014	18 MIRASOL DR	BOURNE	MA	02532
2892	15.0-102-0	LUMSDEN GEOFFREY W ETUX MARIA K WYLAG-LUMSDEN	16 MIRASOL DR	N 1010	21616/188 12/15/2006	16 MIRASOL DR	BOURNE	MA	02532
2893	15.0-103-0	ROGERS JOSEPH T JR & LEAH M ROGERS	12 MIRASOL DR	N 1010	20490/70 11/18/2005	12 MIRASOL DR	BUZZARDS BAY	MA	02532
2894	15.0-104-0	DEMOURA ANDERSON MR ET UX NICOLE L DEMOURA	10 MIRASOL DR	N 1010	24278/336 12/31/2009	10 MIRASOL DR	BOURNE	MA	02532
2895	15.0-105-0	GUREVICH MARY ANN A.& LAWRENCE TRS OF GUREVICH TRUST	1 SETTLERS WAY	N 1010	30807/250 10/3/2017	1 SETTLERS WAY	BOURNE	MA	02532
2897	15.0-107-0	WHITE JAMES M JR	24 MIRASOL DR	N 1010	21698/274 1/16/2007	24 MIRASOL DR	BOURNE	MA	02532
2898	15.0-108-0	MAYNARD ZACHARY A	14 MIRASOL DR	N 1010	32154/249 7/15/2019	14 MIRASOL DR	BOURNE	MA	02532
2901	15.0-111-0	MATIAS JASON & STEFANIE TRS MATIAS TRUST	3 SETTLERS WAY	N 1010	30979/68 12/21/2017	3 SETTLERS WAY	BUZZARDS BAY	MA	02532
2902	15.0-112-0	ROSSIK MICHAEL F ETUX JOANNE E ROSSIK	5 SETTLERS WAY	N 1010	29757/338 6/28/2016	5 SETTLERS WAY	BOURNE	MA	02532
2903	15.0-113-0	BALDI JOHN P & CAROL A TRS BALDI FAMILY TRUST	7 SETTLERS WAY	N 1010	36913/309 4/8/2025	7 SETTLERS WAY	BOURNE	MA	02532
2971	15.0-181-0	FLETCHER MICHAEL A & KATHRYN K FLETCHER TRS FLETCHER FARM TR	0 BOURNEDALE RD	N 7180	9989/337 12/28/1995	201 BOURNEDALE RD	BUZZARDS BAY	MA	02532
3045	16.0-2-0	TRENT TRE MOLLY LLC	0 SCENIC HIGHWAY	N 1320	26988/288 12/27/2012	PO BOX 517	BARNSTABLE	MA	02630-0517
3046	16.0-4-0	OLIVIA GRACE LLC	0 SCENIC HIGHWAY	N 3930	35657/220 2/28/2023	1550 PHINNEYS LANE	BARNSTABLE	MA	02630
3047	16.0-5-0	TOWN OF BOURNE	771 SCENIC HIGHWAY	N 9320	13127/258 7/14/2000	24 PERRY AVE	BUZZARDS BAY	MA	02532
3054	16.0-12-0	NSTAR ELECTRIC CO	725 SCENIC HIGHWAY	N 4280	NA/NA 1/3/2007	PO BOX 270	HARTFORD	CT	06141-0270
3055	16.0-13-0	UNITED STATES OF AMERICA U S ARMY CORPS OF ENGINEERS	0 SCENIC HIGHWAY	N 9000	453/287	PO BOX 1555	BUZZARDS BAY	MA	02532-1555
3059	16.0-14-0	UNITED STATES OF AMERICA U S ARMY CORP OF ENGINEERS	231 SANDWICH RD	N 9000	00453/0287	PO BOX 1555	BUZZARDS BAY	MA	02532-1555
3060	16.0-15-0	COMMONWEALTH OF MASSACHUSETTS OFFICE OF TRANSP & CONSTR	0 SANDWICH RD	N 9240	03498/0109	10 PARK PLAZA SUITE 3170	BOSTON	MA	02116
3066	16.0-24-0	TRENT TRE MOLLY LLC	2 CRESTWOOD CIR	Y 1320	12/27/2012	PO BOX 517	BARNSTABLE	MA	02630-0517
3067	16.0-25-0	TRENT TRE MOLLY LLC	3 CRESTWOOD CIR	N 1320	26988/288 12/27/2012	PO BOX 517	BARNSTABLE	MA	02630-0517
3068	16.0-26-0	TRENT TRE MOLLY LLC	1 CRESTWOOD CIR	N 1320	26988/288 12/27/2012	PO BOX 517	BARNSTABLE	MA	02630-0517
3077	16.0-35-0	BOUCHARD MARK & ALLISON BOUCHARD	26 HEATHER HILL RD	N 1010	36662/231 11/7/2024	26 HEATHER HILL RD	BUZZARDS BAY	MA	02532
3078	16.0-36-0	DUCHINI LISA M ET VIR DANIEL DUCHINI	28 HEATHER HILL RD	N 1010	28536/113 11/28/2014	28 HEATHER HILL RD	BUZZARDS BAY	MA	02532
3079	16.0-37-0	ROSATI JASON THADDEUS	30 HEATHER HILL RD	N 1010	18931/197 8/12/2004	30 HEATHER HILL RD	BOURNE	MA	02532
3080	16.0-38-0	SHEPARDSON JOHN M	32 HEATHER HILL RD	N 1010	28638/110+12 1/20/2015	32 HEATHER HILL RD	BOURNE	MA	02532

Key	Parcel ID	Owner	Location	LCt/Cl	Bk-Pg(Cert) /Dt	Mailing Street	Mailing City	ST	Zip Cd/County
3081	16.0-39-0	PIRES FREDERICO & SAMANTHA PIRES	34 HEATHER HILL RD	N 1010	36303/137 4/9/2024	34 HEATHER HILL RD	BOURNE	MA	02532
3082	16.0-40-0	INGERSOLL TUDOR G TR OF 36 HEATHER HILL ROAD RLTY TR	36 HEATHER HILL RD	N 7200	16428/176 2/21/2003	400 HEAD OF THE BAY RD	BUZZARDS BAY	MA	02532
3083	16.0-41-0	TOWN OF BOURNE	33 HEATHER HILL RD	N 9300	11590/273 7/24/1998	24 PERRY AVE	BUZZARDS BAY	MA	02532
3084	16.0-42-0	TRENT TRE MOLLY LLC	31 HEATHER HILL RD	N 1320	26988/288 12/27/2012	PO BOX 517	BARNSTABLE	MA	02630-0517
3085	16.0-43-0	SMOLINSKY AUSTIN	29 HEATHER HILL RD	N 1010	33666/86 1/11/2021	17 SANDY LANE	BOURNE	MA	02532
3086	16.0-44-0	TRENT TRE MOLLY LLC	21 FAWN HOLLOW WAY	N 1320	26988/288 12/27/2012	PO BOX 517	BARNSTABLE	MA	02630-0517
3087	16.0-45-0	TRENT TRE MOLLY LLC	19 FAWN HOLLOW WAY	N 1320	26988/288 12/27/2012	PO BOX 517	BARNSTABLE	MA	02630-0517
3109	16.0-67-0	HAWORTH GREGG E	27 HEATHER HILL RD	N 1010	17864/187 10/30/2003	27 HEATHER HILL RD	BUZZARDS BAY	MA	02532
3110	16.0-68-0	TRENT TRE MOLLY LLC	18 FAWN HOLLOW WAY	N 1320	26988/288 12/27/2012	PO BOX 517	BARNSTABLE	MA	02630-0517
3129	16.0-87-0	TRENT TRE MOLLY LLC	1 SEAN CIR	N 1320	26988/288 12/27/2012	PO BOX 517	BARNSTABLE	MA	02630-0517
3130	16.0-88-0	TRENT TRE MOLLY LLC	3 SEAN CIR	N 1320	26988/288 12/27/2012	PO BOX 517	BARNSTABLE	MA	02630-0517
3131	16.0-89-0	TRENT TRE MOLLY LLC	2 SEAN CIR	N 1320	26988/288 12/27/2012	PO BOX 517	BARNSTABLE	MA	02630-0517
3132	16.0-90-0	TRENT TRE MOLLY LLC	41 HEATHER HILL RD	N 1320	26988/288 12/27/2012	PO BOX 517	BARNSTABLE	MA	02630-0517
3133	16.0-91-0	TRENT TRE MOLLY LLC	43 HEATHER HILL RD	N 1320	26988/288 12/27/2012	PO BOX 517	BARNSTABLE	MA	02630-0517
3134	16.0-92-0	TRENT TRE MOLLY LLC	45 HEATHER HILL RD	N 1320	26988/288 12/27/2012	PO BOX 517	BARNSTABLE	MA	02630-0517
3135	16.0-93-0	TRENT TRE MOLLY LLC	47 HEATHER HILL RD	N 1320	26988/288 12/27/2012	PO BOX 517	BARNSTABLE	MA	02630-0517
3136	16.0-94-0	TRENT TRE MOLLY LLC	46 HEATHER HILL RD	N 1320	26988/288 12/27/2012	PO BOX 517	BARNSTABLE	MA	02630-0517
3137	16.0-95-0	TRENT TRE MOLLY LLC	44 HEATHER HILL RD	N 1320	26988/288 12/27/2012	PO BOX 517	BARNSTABLE	MA	02630-0517
3138	16.0-96-0	TRENT TRE MOLLY LLC	42 HEATHER HILL RD	N 1320	26988/288 12/27/2012	PO BOX 517	BARNSTABLE	MA	02630-0517
3139	16.0-97-0	TRENT TRE MOLLY LLC	5 TANAGER LN	N 1320	26988/288 12/27/2012	PO BOX 517	BARNSTABLE	MA	02630-0517
3140	16.0-98-0	TRENT TRE MOLLY LLC	7 TANAGER LN	N 1320	26988/288 12/27/2012	PO BOX 517	BARNSTABLE	MA	02630-0517
3142	16.0-100-0	TRENT TRE MOLLY LLC	10 TANAGER LN	N 1320	26988/288 12/27/2012	PO BOX 517	BARNSTABLE	MA	02630-0517
3143	16.0-101-0	TRENT TRE MOLLY LLC	8 TANAGER LN	N 1320	26988/288 12/27/2012	PO BOX 517	BARNSTABLE	MA	02630-0517
3144	16.0-102-0	TRENT TRE MOLLY LLC	6 TANAGER LN	N 1320	26988/288 12/27/2012	PO BOX 517	BARNSTABLE	MA	02630-0517
3145	16.0-103-0	TRENT TRE MOLLY LLC	4 TANAGER LN	N 1320	26988/288 12/27/2012	PO BOX 517	BARNSTABLE	MA	02630-0517

Key	Parcel ID	Owner	Location	LCt/Cl	Bk-Pg(Cert) /Dt	Mailing Street	Mailing City	ST	Zip Cd/County
3146	16.0-104-0	TRENT TRE MOLLY LLC	40 HEATHER HILL RD	N 1300	26988/288 12/27/2012	PO BOX 517	BARNSTABLE	MA	02630-0517
3147	16.0-105-0	TRENT TRE MOLLY LLC	38 HEATHER HILL RD	N 1320	26988/288 12/27/2012	PO BOX 517	BARNSTABLE	MA	02630-0517
3155	17.0-3-0	COMMONWEALTH OF MASSACHUSETTS	0 ROUTE 6	N 9290	00000/0000	10 PARK PLACE	BOSTON	MA	02116
3156	17.0-5-0	COMMONWEALTH OF MASSACHUSETTS DEPT OF ENVIRONMENTAL MGMT	0 SANDWICH RD	N 9210	00553/0156	10 PARK PLAZA	BOSTON	MA	02116
3157	17.0-6-0	STROM CHERRIANN M, JILLIAN R STINNETT & STACEY M HAMLETT	7 EASTING RD	N 1010	36443/110 6/27/2024	7 EASTING RD	BOURNE	MA	02532
3162	17.0-11-0	TOWNSEND BRADFORD C & DEBORAH M TOWNSEND	10 HOBBLER RD	N 1010	13210/5 8/30/2000	10 HOBBLER RD	BOURNE	MA	02532-2223
3163	17.0-12-0	MANHARDT LYNN E	11 HOBBLER RD	N 1010	36551/58 9/5/2024	11 HOBBLER RD	BOURNE	MA	02532
3164	17.0-13-0	SEVEN HILLS COMMUNITY SERVICES INC	9 HOBBLER RD	Y 9590	 1/28/2005	81 HOPE AVE	WORCESTER	MA	01603
3165	17.0-14-0	FLANAGAN LAURIE & LEE	7 HOBBLER RD	N 1010	31085/201 2/15/2018	7 HOBBLER ROAD	BOURNE	MA	02532
3930	20.0-13-0	BOURNE RECREATION AUTHORITY BOURNE SCENIC PARK	370 SCENIC HIGHWAY	N 9580	2194/193 6/11/1975	231 SANDWICH RD	BOURNE	MA	02532
3931	20.0-14-0	GENCHAUSKAS STEVEN & PATRICE & MELISSA FISHER	2 NIGHTINGALE POND RD	N 1010	37224/344 10/6/2025	2 NIGHTINGALE POND RD	BOURNE	MA	02532
3932	20.0-15-0	DAVIS JOHN E & SUSANNE C DAVIS	385 SCENIC HIGHWAY	N 1010	22296/253 8/28/2007	385 SCENIC HWY	BUZZARDS BAY	MA	02532-5626
3949	20.0-32-0	WILLIAMS CATHY J	25 NIGHTINGALE POND RD	Y 1090	 1/2/2001	25 NIGHTINGALE POND RD	BUZZARDS BAY	MA	02532-5666
3968	20.0-54-0	TOWN OF BOURNE CONSERVATION COMMISSION	0 DESERET DR	N 9320	8713/321 8/5/1993	24 PERRY AVE	BUZZARDS BAY	MA	02532-3447
3977	20.0-63-0	MCINTYRE TAYLOR K JR & DEBORAH L MCINTYRE	26 DESERET DR	Y 1010	 8/29/2000	26 DESERET DR	BUZZARDS BAY	MA	02532-5671
3978	20.0-64-0	HARRINGTON BRUCE D	28 DESERET DR	N 1010	26544/283 7/31/2012	28 DESERET DR	BUZZARDS BAY	MA	02532
3979	20.0-65-0	JOHNSON RK & SR LIVING TRUST	30 DESERET DR	N 1010	36825/294 2/13/2025	30 DESERET DR	BOURNE	MA	02532
3980	20.0-66-0	DEITSCH JARROD	32 DESERET DR	N 1010	31796/48 1/23/2019	PO BOX 86	BUZZARDS BAY	MA	02532
3981	20.0-67-0	DRISCOLL SUSAN	29 DESERET DR	N 1010	33470/152 11/16/2020	29 DESERET DR	BUZZARDS BAY	MA	02532
3982	20.0-68-0	ALDEN JEFFREY S SR & LAURA J ALDEN	27 DESERET DR	N 1010	19015/208 9/9/2004	27 DESERET DRIVE	BOURNE	MA	02532
14457	20.0-85-0	TIERNEY MARY	10 NIGHTINGALE POND RD	N 1010	31947/47 4/12/2019	137 BAY STATE RD APT 1	BOSTON	MA	02215
14458	20.0-86-0	LEON GEORGE	20 NIGHTINGALE POND RD	N 1010	29627/248 5/4/2016	20 NIGHTINGALE POND RD	BOURNE	MA	02532
14459	20.0-87-0	SAWYER-BARNES KIMBERLY	30 NIGHTINGALE POND RD	N 1010	21145/312 6/30/2006	30 NIGHTINGALE POND RD	BUZZARDS BAY	MA	02532
4245	20.4-1-0	KEEPER II - BOURNE LLC	11 BOURNE BRIDGE APPROACH	N 3050	37082/132 7/17/2025	1 CITY CENTER, 4TH FLOOR	PORTLAND	ME	04101
4246	20.4-2-0	CHRISCO REALTY OF BOURNE LLC	343 SCENIC HIGHWAY	N 0310	19787/136 5/3/2005	C/O COUTO MANAGEMENT GROUP 169 MAIN ST	STONEHAM	MA	02180

Key	Parcel ID	Owner	Location	LCt/Cl	Bk-Pg(Cert) /Dt	Mailing Street	Mailing City	ST	Zip Cd/County
4248	20.4-6-0	340 MAIN STREET BOURNE LLC	340 MAIN ST	N 0310	31954/108 4/16/2019	561 THOMAS B LANDERS ROAD	EAST FALMOUTH	MA	02536
4249	20.4-7-0	CANAL SPORTSMAN CLUB	324 MAIN ST	N 3560	708/598 12/3/1948	PO BOX 241	BUZZARDS BAY	MA	02532
4347	21.0-36-0	MALONE SHELIA, JOHN D WHITE & MAURA BOYLE TRS JOHN D WHITE	34 WEATHERDECK DR	Y 1010	194536 6/21/2011	34 WEATHERDECK DR	BOURNE	MA	02532
4348	21.0-37-0	JOAKIM ANDREW & SARAH JOAKIM	32 WEATHERDECK DR	Y 1010	231374 10/24/2022	32 WEATHERDECK DR	BOURNE	MA	02532
4349	21.0-38-0	DILL MARYANN	30 WEATHERDECK DR	Y 1010	157436 4/28/2000	30 WEATHERDECK DR	BOURNE	MA	02532
4350	21.0-39-0	HOLLAND TIMOTHY P & CAROL B	28 WEATHERDECK DR	Y 1010	217248 9/7/2018	28 WEATHERDECK DRIVE	BOURNE	MA	02532
4351	21.0-40-0	GUSTAFSON JOHN K ETUX CHRISTINE M GUSTAFSON	26 WEATHERDECK DR	Y 1010	165454 5/31/2002	26 WEATHERDECK DRIVE	BOURNE	MA	02532-3307
4352	21.0-41-0	KATZE RONA B ETUX GILLES LOIGET	1 MIZZEN LN	Y 1010	161316 3/18/2016	1 MIZZEN LN	BOURNE	MA	02532
4353	21.0-42-0	DIRICO JT & LM SULLIVAN IRREV TRUST	24 WEATHERDECK DR	Y 1010	238662 3/19/2025	24 WEATHERDECK DR	BOURNE	MA	02532
4354	21.0-43-0	SORENSEN JAMES MICHAEL SR & DEBRA ANN MATHEWSON	25 WEATHERDECK DR	Y 1010	239298 5/30/2025	25 WEATHERDECK DR	BOURNE	MA	02532
4355	21.0-44-0	WALMAN THOMAS M & JUDITH A WALMAN	29 WEATHERDECK DR	Y 1010	174918 11/1/2004	29 WEATHERDECK DR	BOURNE	MA	02532
4356	21.0-45-0	PATEL CHETAN ETUX HERMANI PATEL	31 WEATHERDECK DR	Y 1010	203422 5/21/2014	31 WEATHERDECK DRIVE	BUZZARDS BAY	MA	02532
4376	23.0-3-0	COMMONWEALTH OF MASSACHUSETTS	0 SANDWICH RD	N 9240	N/A/N/A	10 PARK PLAZA	BOSTON	MA	02116
4886	24.0-13-0	FIDDLERS GREEN II LP	4 BOURNE ROTARY	N 3900	35078/59 4/27/2022	500 OCEAN DRIVE UNIT W-6-C	JUNO BEACH	FL	33408
4887	24.0-13-1	ROTARY DEVELOPMENT LLC	0 BOURNE ROTARY	N 3900	27740/218 10/4/2013	C/O RETAIL BUSINESS SERVICES PO BOX 6500	CARLISLE	PA	17013
4889	24.0-14-0	COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS	0 ROUTE 28	N 9290	02968/0002	10 PARK PLAZA SUITE 6160	BOSTON	MA	02116
4890	24.0-15-0	COMMONWEALTH OF MASSACHUSETTS MASSHIGHWAY DEPT,RIGHT OF WAY	5 BOURNE ROTARY	N 9240	00000/0000	10 PARK PLAZA SUITE 6160	BOSTON	MA	02116-3933
4891	24.0-16-0	COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS	0 BOURNE ROTARY	N 9290	02968/0002	10 PARK PLAZA SUITE 6160	BOSTON	MA	02116
4892	24.0-17-0	COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS	0 BOURNE ROTARY	N 9290	02968/0002	10 PARK PLAZA SUITE 6160	BOSTON	MA	02116
4893	24.0-18-0	KEYSTONE AMERICA INC C/O NICKERSON BOURNE FUNERAL	40 MACARTHUR BLVD	Y 3550	151934 2/4/1999	PO BOX 130548 9TH FLOOR	HOUSTON	TX	77219
4895	24.0-19-0	CUMBERLAND FARMS INC	6 MACARTHUR BLVD	N 3900	34550/115 10/7/2021	165 FLANDERS RD	WESTBOROUGH	MA	01581
4896	24.0-22-0	CUMBERLAND FARMS INC V 1258	4 MACARTHUR BLVD	N 3340	5105/2	165 FLANDERS RD	WESTBOROUGH	MA	01581
4897	24.0-23-0	CUMBERLAND FARMS INC	2 MACARTHUR BLVD	N 3260	34530/50 10/1/2021	165 FLANDERS RD	WESTBOROUGH	MA	01581
4898	24.0-25-0	SHREYA CORPORATION	108 TROWBRIDGE RD	N 3010	12770/118 1/7/2000	114 TROWBRIDGE RD	BOURNE	MA	02532
4908	24.0-39-0	FRANK BATTLES INC	50 MACARTHUR BLVD	Y 3300	135103 9/28/1994	50 MACARTHUR BLVD	BOURNE	MA	02532-3918

Extract: ABUTTERS LIST
Database: Live
Filter:
Sort:

Report #24: Owner Listing Report

Fiscal Year 2027

Bourne MA

Key	Parcel ID	Owner	Location	LCt/Cl	Bk-Pg(Cert) /Dt	Mailing Street	Mailing City	ST	Zip Cd/County
17152	24.0-43-0	FIDDLERS GREEN II LP	0 SANDWICH RD	N 3900	35078/59 4/27/2022	500 OCEAN DRIVE UNIT W-6-C	JUNO BEACH	FL	33408
18557	24.0-44-0	ROTARY DEVELOPMENT LLC	0 BOURNE ROTARY	N 3900	27740/218 10/4/2013	C/O RETAIL BUSINESS SERVICES PO BOX 6500	CARLISLE	PA	17013
5196	25.0-1-0	UPPER CAPE COD REGIONAL VOCATIONAL TECHNICAL SCHOOL	220 SANDWICH RD	N 9340	01354/0156	220 SANDWICH RD	BOURNE	MA	02532
5197	25.0-2-0	ROTARY DEVELOPMENT LLC	0 BOURNE ROTARY	N 3900	27740/218 10/4/2013	C/O RETAIL BUSINESS SERVICES PO BOX 6500	CARLISLE	PA	17013
5198	25.0-3-0	ROTARY DEVELOPMENT LLC	0 MACARTHUR BLVD	N 3920	27740/218 10/4/2013	C/O RETAIL BUSINESS SERVICES PO BOX 6500	CARLISLE	PA	17013
5199	25.0-4-0	ROTARY DEVELOPMENT LLC	0 MACARTHUR BLVD	N 3920	27740/218 10/4/2013	C/O RETAIL BUSINESS SERVICES PO BOX 6500	CARLISLE	PA	17013
5200	25.0-5-0	BOURNE WATER DISTRICT PLAN DTD 3/9/59	0 MACARTHUR BLVD	N 9390	01039/0477	PO BOX 1447	POCASSET	MA	02559-1447
5201	25.0-6-0	PARALLEL PRODUCTS SOLAR ENERGY LLC	53 MACARTHUR BLVD	N 4400	35085/122 4/29/2022	100 DUCHAINE BLVD	NEW BEDFORD	MA	02745
5203	25.0-8-0	CABLE HOLDCO EXCHANGE III LLC ATTN TAX DEPARTMENT	0 MACARTHUR BLVD	N 4320	22306/40 8/31/2007	1 COMCAST CENTER, 32ND FLR	PHILADELPHIA	PA	19103-2838
16852	25.0-22-0	PATEL PARIN & ANANDIBEN S PATEL	4 MIZZEN LN	Y 1010	230523 7/15/2022	4 MIZZEN LANE	BOURNE	MA	02532
16858	25.0-28-0	CORMACK NEIL J NINA CORMACK	16 MIZZEN LN	Y 1010	237935 12/18/2024	PO BOX 3094	BOURNE	MA	02532
16859	25.0-29-0	BENJAMIN KARNICK K ETUX LORI BENJAMIN	17 MIZZEN LN	Y 1010	201243 8/23/2013	17 MIZZEN LN	BOURNE	MA	02532
16860	25.0-30-0	VARELLA RICARDO MALTA	15 MIZZEN LN	Y 1010	181594 11/15/2006	15 MIZZEN LN	BOURNE	MA	02532
16861	25.0-31-0	DESIMONE MICHAEL JOHN & ANA LIZA FULAY DESIMONE	11 MIZZEN LN	Y 1010	179528 3/17/2006	11 MIZZEN LN	BOURNE	MA	02532
16862	25.0-32-0	DENNINGER DOUGLAS E LIVING TRU	9 MIZZEN LN	Y 1010	239495 6/20/2025	9 MIZZEN LN	BOURNE	MA	02532
16863	25.0-33-0	SINCLAIR DANIEL N	7 MIZZEN LN	Y 1010	241562 2/27/2026	7 MIZZEN LANE	BOURNE	MA	02532
16864	25.0-34-0	PATEL PARESH ETUX AMITA PATEL	5 MIZZEN LN	Y 1010	203421 5/21/2014	5 MIZZEN LN	BOURNE	MA	02532
16865	25.0-35-0	WHITE GEOFFREY M & MELISA A FRIZZI	3 MIZZEN LN	Y 1010	214404 10/19/2017	3 MIZZEN LANE	BOURNE	MA	02532
5969	28.0-18-0	BALLENTINE STEPHEN ETAL TRS OF THE BOURNE CONSERVATION TRUST	0 MACARTHUR BLVD	N 9500	24445/95 3/26/2010	PO BOX 203	CATAUMET	MA	02534-0203
9709	44.0-50-0	COMMONWEALTH OF MASSACHUSETTS MASS. MILITARY RESERVATION	0 OTIS A F BASE	N 9160	N/A/N/A	C/O COMMANDER 158 REILLY ST, BOX 3	OTIS ANGB	MA	02542-1330

Total Records 270

Extract: 23 CANAL ST 11/30
Database: Live
Filter:
Sort:

Report #24: Owner Listing Report

Fiscal Year 2027

Bourne MA

Key	Parcel ID	Owner	Location	LCt/Cl	Bk-Pg(Cert) /Dt	Mailing Street	Mailing City	ST	Zip Cd/County
1831	11.0-30-1	HUNTERS BROOK LLC	23 CANAL ST	N 1020	32032/159 5/20/2019	2 LYNXHOLM COURT 2ND FLOOR	HYANNIS	MA	02601
1832	11.0-30-2	HUNTERS BROOK LLC	23 CANAL ST	N 1020	N/A/N/A 5/20/2019	2 LYNXHOLM COURT 2ND FLOOR	HYANNIS	MA	02601
1833	11.0-30-3	HUNTERS BROOK LLC	23 CANAL ST	N 1020	32032/159 5/20/2019	2 LYNXHOLM COURT 2ND FLOOR	HYANNIS	MA	02601
1834	11.0-30-4	HUNTERS BROOK LLC	23 CANAL ST	N 1020	32032/159 5/20/2019	2 LYNXHOLM COURT 2ND FLOOR	HYANNIS	MA	02601
1835	11.0-30-5	HUNTERS BROOK LLC	23 CANAL ST	N 1020	32032/159 5/20/2019	2 LYNXHOLM COURT 2ND FLOOR	HYANNIS	MA	02601
1836	11.0-30-6	HUNTERS BROOK LLC	23 CANAL ST	N 1020	32032/159 5/20/2019	2 LYNXHOLM COURT 2ND FLOOR	HYANNIS	MA	02601
1837	11.0-30-7	HUNTERS BROOK LLC	23 CANAL ST	N 1020	32032/159 5/20/2019	2 LYNXHOLM COURT 2ND FLOOR	HYANNIS	MA	02601
1838	11.0-30-8	HUNTERS BROOK LLC	23 CANAL ST	N 1020	32032/159 5/20/2019	2 LYNXHOLM COURT 2ND FLOOR	HYANNIS	MA	02601
1839	11.0-30-9	HUNTERS BROOK LLC	23 CANAL ST	N 1020	32032/159 5/20/2019	2 LYNXHOLM COURT 2ND FLOOR	HYANNIS	MA	02601
1840	11.0-30-10	HUNTERS BROOK LLC	23 CANAL ST	N 1020	32032/159 5/20/2019	2 LYNXHOLM COURT 2ND FLOOR	HYANNIS	MA	02601
1841	11.0-30-11	HUNTERS BROOK LLC	23 CANAL ST	N 1020	32032/159 5/20/2019	2 LYNXHOLM COURT 2ND FLOOR	HYANNIS	MA	02601
1842	11.0-30-12	HUNTERS BROOK LLC	23 CANAL ST	N 1020	32032/159 5/20/2019	2 LYNXHOLM COURT 2ND FLOOR	HYANNIS	MA	02601

Total Records 12

Extract: 25 CANAL ST 11/31
Database: Live
Filter:
Sort:

Report #24: Owner Listing Report

Fiscal Year 2027

Bourne MA

Key	Parcel ID	Owner	Location	LCt/Cl	Bk-Pg(Cert) /Dt	Mailing Street	Mailing City	ST	Zip Cd/County
1843	11.0-31-1	GEORGE JOHN E TRS BOURNE INVESTMENT RLTY TR	25-A1 CANAL ST	N 1020	35509/75 11/29/2022	C/O MPM PO BOX 790	BUZZARDS BAY	MA	02532
1844	11.0-31-2	HARWOOD THOMAS F	25-A2 CANAL ST	N 1020	34261/211 6/30/2021	25 CANAL ST UNIT A2	SAGAMORE BEACH	MA	02562
1845	11.0-31-3	NERGARARIAN DAVID & TRACY	25-A3 CANAL ST	N 1020	31815/265 2/1/2019	PO BOX 208	NORTH EASTHAM	MA	02651
1846	11.0-31-4	25 CANAL REALTY LLC	25-A4 CANAL ST	N 1020	35962/218 8/29/2023	5 PRINCE WAY	SHARON	MA	02067
1847	11.0-31-5	MCHUGH MARY TR JOSEPH LYNCH SUPP NEEDS TR	25-A5 CANAL ST	N 1020	24680/203 7/14/2010	201 N MAIN ST	PROVIDENCE	RI	02903
1848	11.0-31-6	GEORGE JOHN E TR BOURNE INVESTMENT REALTY TRUST	25-A6 CANAL ST	N 1020	25885/13 12/1/2011	C/O MPM PO BOX 790	BUZZARDS BAY	MA	02532
1849	11.0-31-7	ASACK KAROLYN & WILLIAM CALLOW	25-B1 CANAL ST	N 1020	36222/162 2/14/2024	221 NORTH MAIN ST	WEST BRIDGEWATER	MA	02379
1850	11.0-31-8	SOUTHERLAND JOHN E	25-B2 CANAL ST	N 1020	16985/146 5/27/2003	PO BOX 740	SAGAMORE BEACH	MA	02562
1851	11.0-31-9	GEORGE JOHN E TR BOURNE INVESTMENT REALTY TRUST	25-B3 CANAL ST	N 1020	25885/13 12/1/2011	C/O MPM PO BOX 790	BUZZARDS BAY	MA	02532
1852	11.0-31-10	SILVA MARC F & ELIZABETH A	25-B4 CANAL ST	N 1020	32395/156 10/21/2019	12 OAKWOOD DRIVE	SAGAMORE BEACH	MA	02562
1853	11.0-31-11	HOLLSTEIN ROBERT & JEANNIE HOLLSTEIN	25-B5 CANAL ST	N 1020	34711/215 12/1/2021	505 SOUTH ST	RAYNHAM	MA	02767
1854	11.0-31-12	GEORGE JOHN E TR BOURNE INVESTMENT REALTY TRUST	25-B6 CANAL ST	N 1020	25885/13 12/1/2011	C/O MPM PO BOX 790	BUZZARDS BAY	MA	02532
1855	11.0-31-13	GEORGE JOHN E TR BOURNE INVESTMENT REALTY TRUST	25-C1 CANAL ST	N 1020	25885/13 12/1/2011	C/O MPM PO BOX 790	BUZZARDS BAY	MA	02532
1856	11.0-31-14	BAO LEDE ETUX DIAN TONG	25-C2 CANAL ST	N 1020	27093/335 1/31/2013	1989 MAIN STREET RTE 6A	WEST BARNSTABLE	MA	02668
1857	11.0-31-15	GEORGE JOHN E TR BOURNE INVESTMENT REALTY TRUST	25-C3 CANAL ST	N 1020	25885/13 12/1/2011	C/O MPM PO BOX 790	BUZZARDS BAY	MA	02532
1858	11.0-31-16	GEORGE JOHN E TR BOURNE INVESTMENT REALTY TRUST	25-C4 CANAL ST	N 1020	25885/13 12/1/2011	C/O MPM PO BOX 790	BUZZARDS BAY	MA	02532
1859	11.0-31-17	GEORGE JOHN E TR BOURNE INVESTMENT REALTY TRUST	25-C5 CANAL ST	N 1020	25885/13 12/1/2011	C/O MPM PO BOX 790	BUZZARDS BAY	MA	02532
1860	11.0-31-18	GEORGE JOHN E TR BOURNE INVESTMENT REALTY TRUST	25-C6 CANAL ST	N 1020	25885/13 12/1/2011	C/O MPM PO BOX 790	BUZZARDS BAY	MA	02532
1861	11.0-31-19	LACEY ROBERT L ETUX LAURA L LACEY	25-D1 CANAL ST	N 1020	21878/320 3/26/2007	25 CANAL RD UNIT D-1	SAGAMORE BEACH	MA	02562
1862	11.0-31-20	ZARELLA JAMES J	25-D2 CANAL ST	N 1020	20152/23 8/12/2005	PO BOX 441	SAGAMORE BEACH	MA	02562
1863	11.0-31-21	GEORGE JOHN E TR BOURNE INVESTMENT REALTY TRUST	25-D3 CANAL ST	N 1020	25885/13 12/1/2011	C/O MPM PO BOX 790	BUZZARDS BAY	MA	02532
1864	11.0-31-22	KING BRENDA L	25-D4 CANAL ST	N 1020	32275/277 9/6/2019	24 HARBOR HILL DR	BOURNE	MA	02532
1865	11.0-31-23	GEORGE JOHN E TR BOURNE INVESTMENT REALTY TRUST	25-D5 CANAL ST	N 1020	25885/13 12/1/2011	C/O MPM PO BOX 790	BUZZARDS BAY	MA	02532
1866	11.0-31-24	NERGARARIAN DAVID & TRACY	25-D6 CANAL ST	N 1020	30841/272 10/20/2017	PO BOX 208	NORTH EASTHAM	MA	02651

Total Records 24

Extract: 51 CANAL ST 11.2/3
Database: Live
Filter:
Sort:

Report #24: Owner Listing Report

Fiscal Year 2027

Bourne MA

Key	Parcel ID	Owner	Location	LCt/Cl	Bk-Pg(Cert) /Dt	Mailing Street	Mailing City	ST	Zip Cd/County
1942	11.2-3-1	WOZNIAK JAMEELI & STEVEN TRS WOZNIAK REALTY TRUST 2002	51-1 CANAL ST	N 1020	35107/136 5/10/2022	137 HAMPTON ST	AUBURN	MA	01501
1943	11.2-3-2	BEIRNE LINDA J	51-2 CANAL ST	N 1020	32755/50 3/13/2020	51 CANAL RD UNIT 2	SAGAMORE BEACH	MA	02562
1944	11.2-3-3	STONEBAT LLC	51-3 CANAL ST	N 1020	28903/84 5/29/2015	100-1 DOMINO DRIVE	CONCORD	MA	01742
1945	11.2-3-4	SETTERLUND JOHN F	51-4 CANAL ST	N 1020	8789/45 9/21/1993	51 CANAL ST	SAGAMORE BEACH	MA	02562
1946	11.2-3-5	POIRIER MICHAEL & AUDREY COOKE	51-5 CANAL ST	N 1020	36010/27 9/29/2023	57 WARREN ST	UPTON	MA	01568
1947	11.2-3-6	DUNNE FAMILY TRUST	51-6 CANAL ST	N 1020	37041/326 6/23/2025	5 TABOR RD	FORESTDALE	MA	02644
1948	11.2-3-7	ROSE KEITH L	51-7 CANAL ST	N 1020	37332/55 12/1/2025	51 CANAL ST UNIT 7	SAGAMORE BEACH	MA	02562
1949	11.2-3-8	XIA JIN	51-9 CANAL ST	N 1020	15846/268 11/1/2002	855 WORCESTER ROAD UNIT 15A	FRAMINGHAM	MA	01701
1950	11.2-3-9	POIRIER JOHN G TRS POIRIER LIVING TRUST	51-10 CANAL ST	N 1020	26394/327 6/7/2012	57 WARREN ST	UPTON	MA	01568-1559
1951	11.2-3-10	LILL EDWARD NOREEN LILL	51-11 CANAL ST	N 1020	11627/297 8/11/1998	38 STROBUS LANE	ASHLAND	MA	01721-1247
1952	11.2-3-11	PEARSON GARY P	51-12 CANAL ST	N 1020	14086/185 7/30/2001	46 COCHITUATE RD #309	FRAMINGHAM	MA	01701-7965
1953	11.2-3-12	SEARIAC WILLIAM P	51-13 CANAL ST	N 1020	33909/276 3/18/2021	PO BOX 812	SAGAMORE BEACH	MA	02562
1954	11.2-3-13	TREMBLEY KATHLEEN B & STEPHEN BRENNAN & J KEVIN BRENNAN	51-14 CANAL ST	N 1020	33123/90-92 7/31/2020	103 RHINECLIFF ST	ARLINGTON	MA	02476
1955	11.2-3-14	CONOVER HARRY M JR & MARJORIE A CONOVER	51-15 CANAL ST	N 1020	25361/304 4/4/2011	51 CANAL RD #15	SAGAMORE BEACH	MA	02562
1956	11.2-3-15	DILLON JOHN R & SARAH E DILLON	51-16 CANAL ST	N 1020	35383/300 9/23/2022	991 MADISON TERR NW	ACWORTH	GA	30102
1957	11.2-3-16	NELSON WALTER J TRS DAISY NOMINEE TRUST	51-17 CANAL ST	N 1020	31527/328 9/14/2018	803 SUMMER ST	BRIDGEWATER	MA	02324
1958	11.2-3-17	CONNNOLLY MICHAEL & SHARON CONNOLLY	51-18 CANAL ST	N 1020	37264/316 10/27/2025	PO BOX 16	SAGAMORE BEACH	MA	02562
1959	11.2-3-18	HORNE KENNETH F ETUX DEBORAH A HORNE	51-19 CANAL ST	N 1020	15047/34 4/12/2002	51 CANAL STREET UNIT 19	SAGAMORE BEACH	MA	02562-2403
17177	11.2-3-19	FORBES KASEY	51-8 CANAL ST	N 1020	20108/137 8/1/2005	PO BOX 1577	SAGAMORE BEACH	MA	02562

Total Records 19

Extract: 67 CANAL ST 12.1/39
Database: Live
Filter:
Sort:

Report #24: Owner Listing Report

Fiscal Year 2027

Bourne MA

Key	Parcel ID	Owner	Location	LCt/Cl	Bk-Pg(Cert) /Dt	Mailing Street	Mailing City	ST	Zip Cd/County
2123	12.1-39-1	YOUNG LINDA E	67 CANAL ST	N 1020	N/A/N/A 8/4/2011	5678 RIVIERA DRIVE	MILTON	FL	32583
2124	12.1-39-2	BRADFORD JOHN & SUSAN E LOUGHMAN	67 CANAL ST	N 1020	5529/199 12/30/1986	PO BOX 193	BUZZARDS BAY	MA	02532
2125	12.1-39-3	HUMES MICHAEL M & JANET S HUMES	67 CANAL ST	N 1020	35388/145 9/26/2022	11 PLYMOUTH ST	CARVER	MA	02330
2126	12.1-39-4	HUMES JANET S ETUX MICHAEL M HUMES	67 CANAL ST	N 1020	25970/227 12/30/2011	11 PLYMOUTH STREET	CARVER	MA	02330
2127	12.1-39-5	INFERRERA JOSEPH N	67 CANAL ST	N 1020	33494/34 11/20/2020	41 PEARL ST	N WEYMOUTH	MA	02191
2128	12.1-39-6	GILBRIDE CHERYL A	67 CANAL ST	N 1020	14574/340 12/14/2001	34 WILBUR ST	N EASTON	MA	02356
2129	12.1-39-7	BARON THOMAS R	67 CANAL ST	N 1020	19234/132 11/12/2004	67 CANAL ST # 7	SAGAMORE BEACH	MA	02562
2130	12.1-39-8	LOCONTE MICHELLE D TRS LOCONTE-STOHLBERG REV TRUST	67 CANAL ST	N 1020	37166/179 9/5/2025	66 IMBARO RD	HYDE PARK	MA	02136 1438
2131	12.1-39-9	PILLSBURY DONALD J& CONSTANCE DONALD S & MARK J PILLSBURY	67 CANAL ST	N 1020	32118/92 6/26/2019	1 DALE ROAD	HOPKINTON	MA	01748
2132	12.1-39-10	HUMES MICHAEL M ETUX JANET S HUMES	67 CANAL ST	N 1020	16216/25 1/10/2003	11 PLYMOUTH STREET	CARVER	MA	02330
2133	12.1-39-11	TALLY DAWN	67 CANAL ST	N 1020	34200/296 6/11/2021	67 CANAL ST UNIT 11	SAGAMORE BEACH	MA	02562
2134	12.1-39-12	GOMES JOHN F	67 CANAL ST	N 1020	6073/283 12/18/1987	9 CAROL COURT	PALM COAST	FL	32137-8122

Total Records 12