ATTACHMENT 5

Stormwater Management Reports

July 8, 2026

CAPE COD CANAL PIPELINE REPLACEMENT PROJECT

STORMWATER REPORT FOR THE PAVE PAWS METER STATION

SAGAMORE, MA

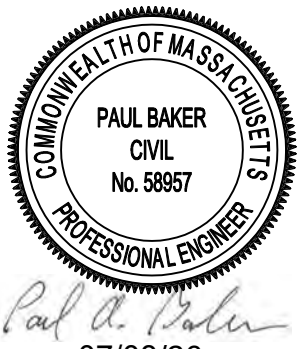
Prepared For: Algonquin Gas Transmission, LLC

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

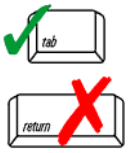
1 Checklist for Stormwater Report

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.

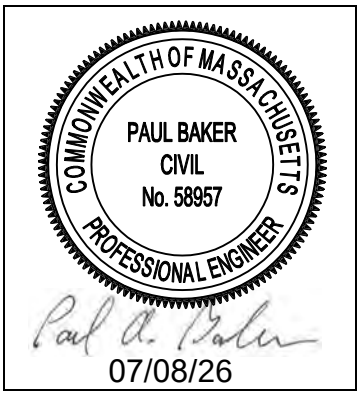
Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the 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).

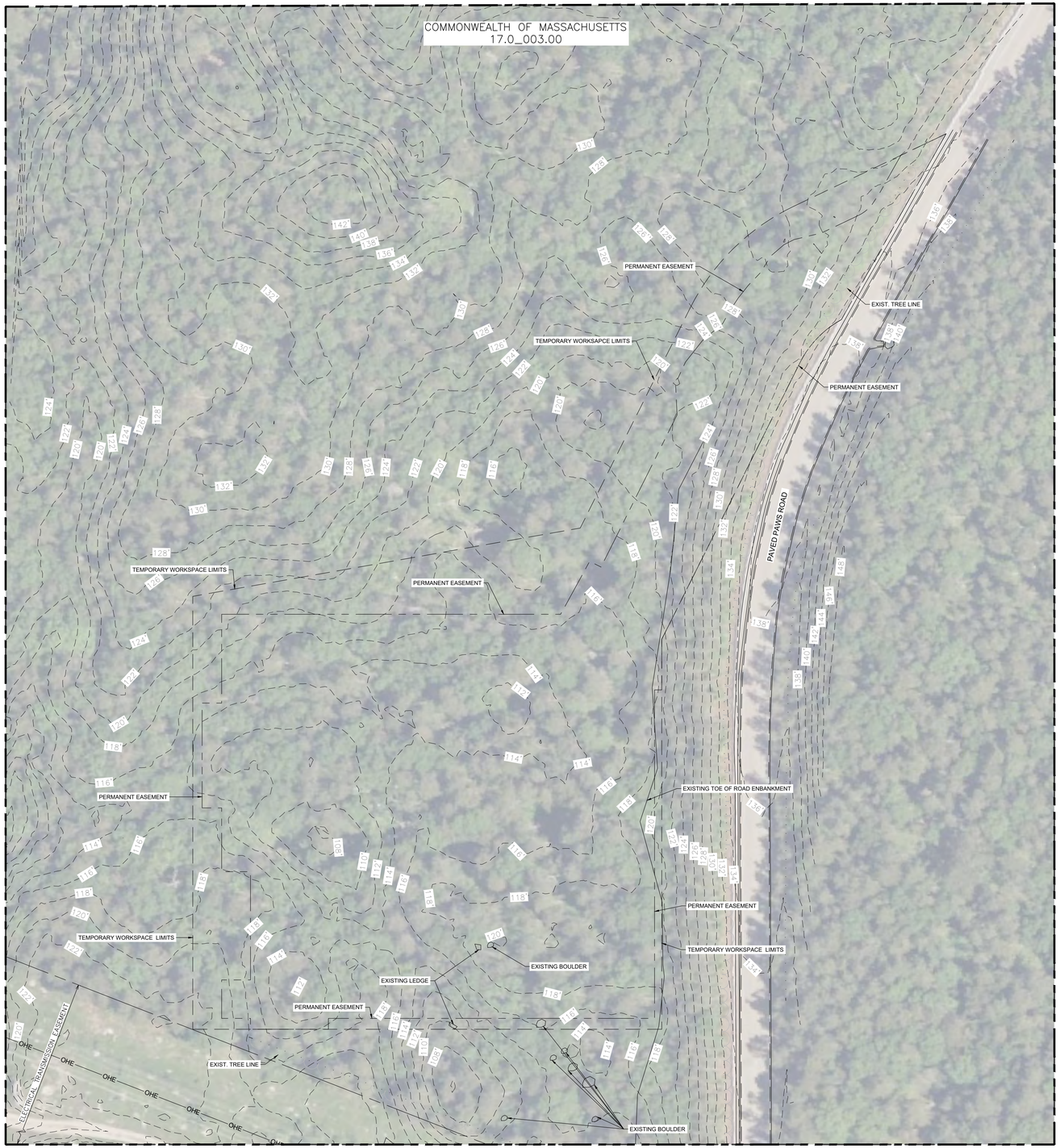
The nearest mapped Special Flood Hazard Area is associated with the Cape Cod Canal, where Zone AE is mapped along the canal corridor. Zone AE represents areas subject to inundation during the 1-percent-annual-chance flood event for which Base Flood Elevations (BFEs) have been established. This flood 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

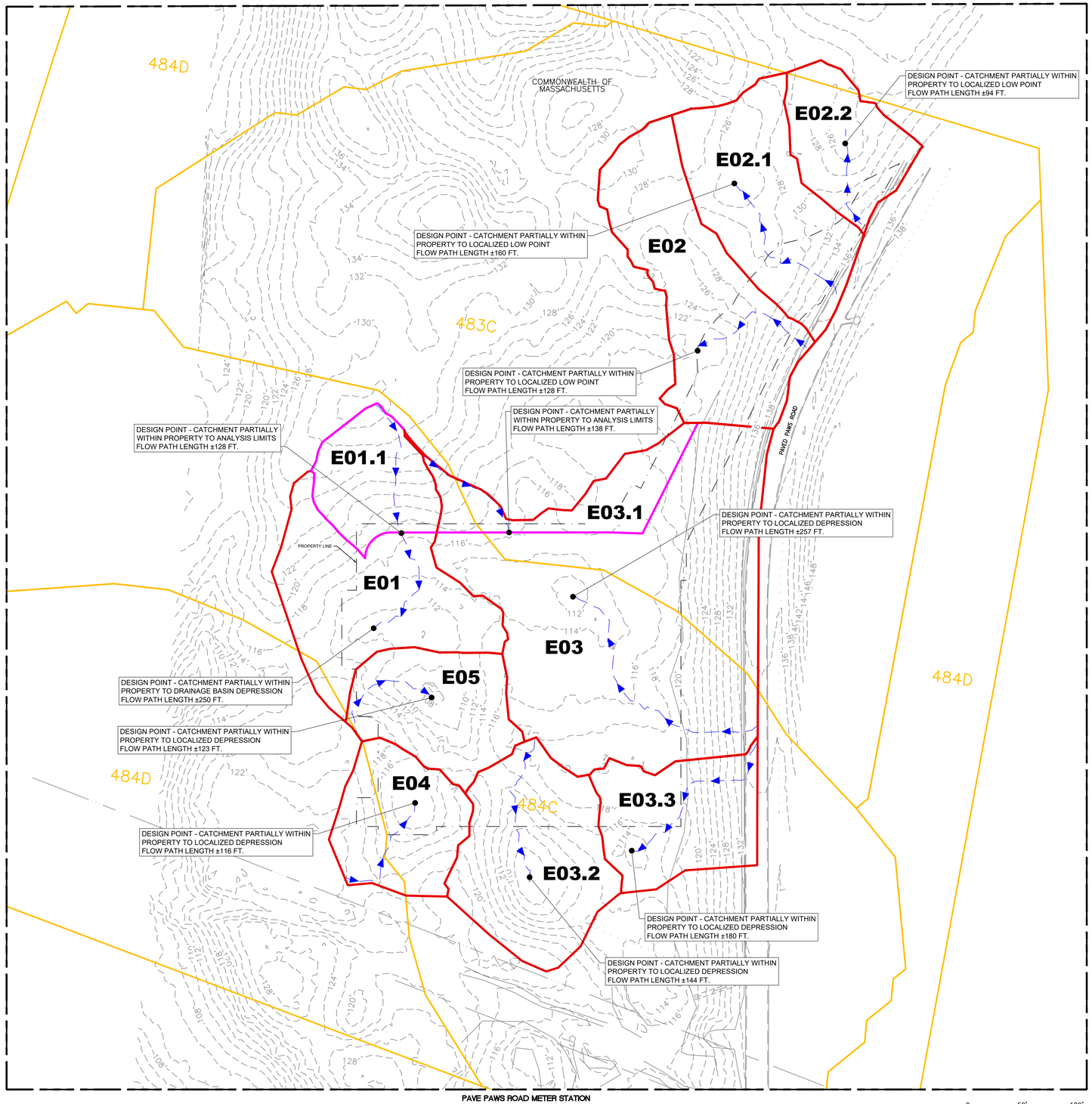
audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

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

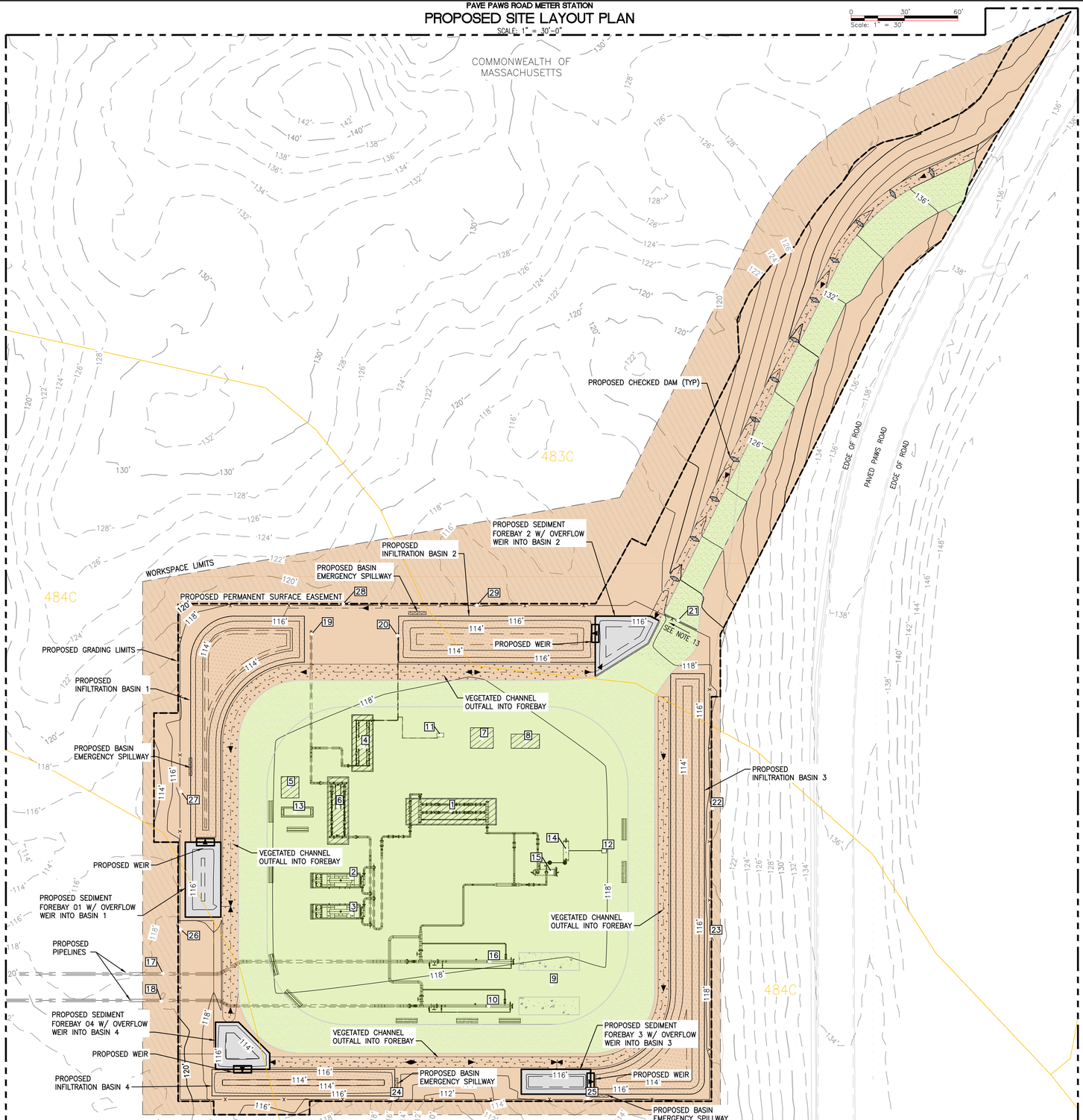
ENBRIDGE
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

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

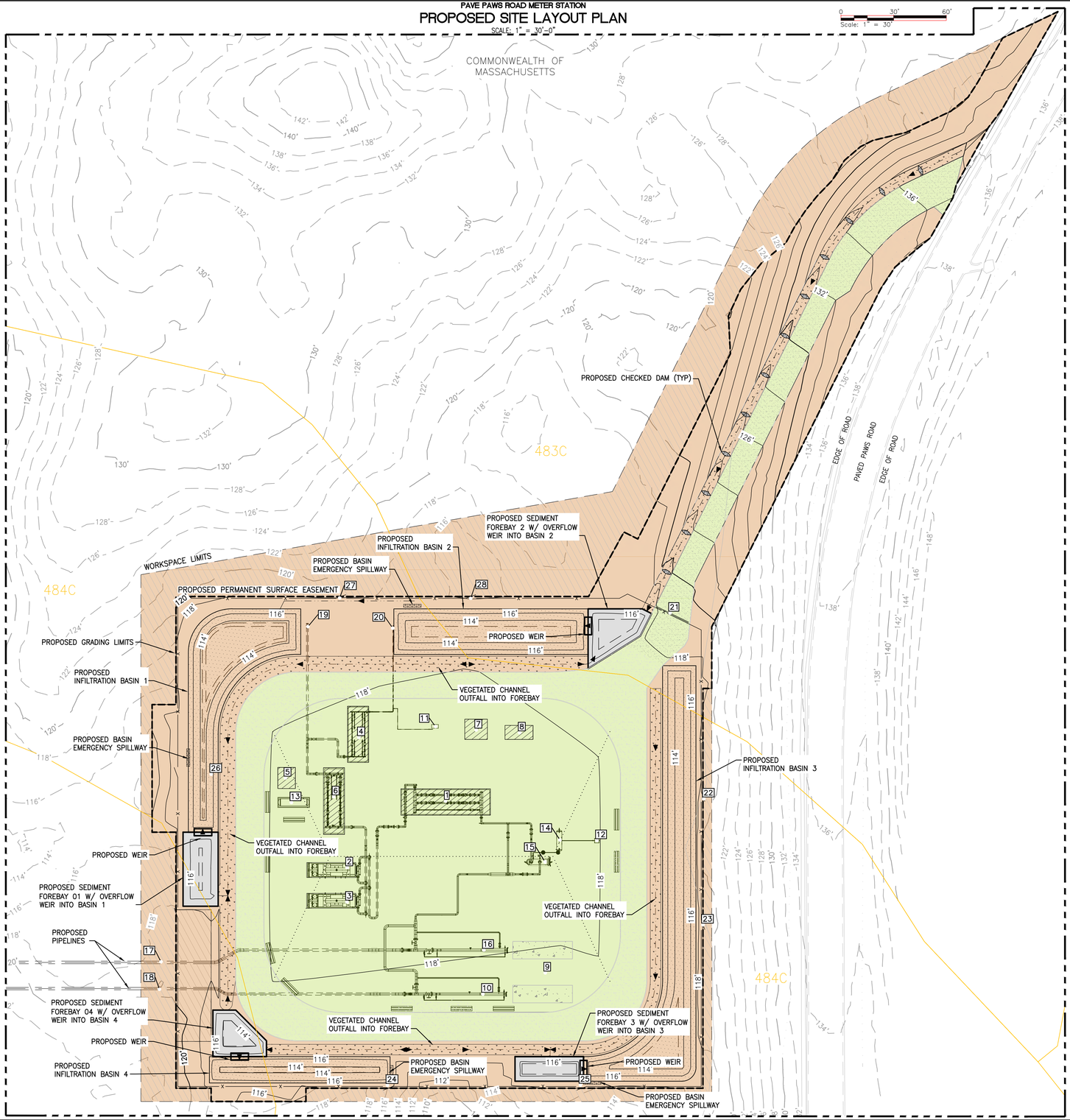
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

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

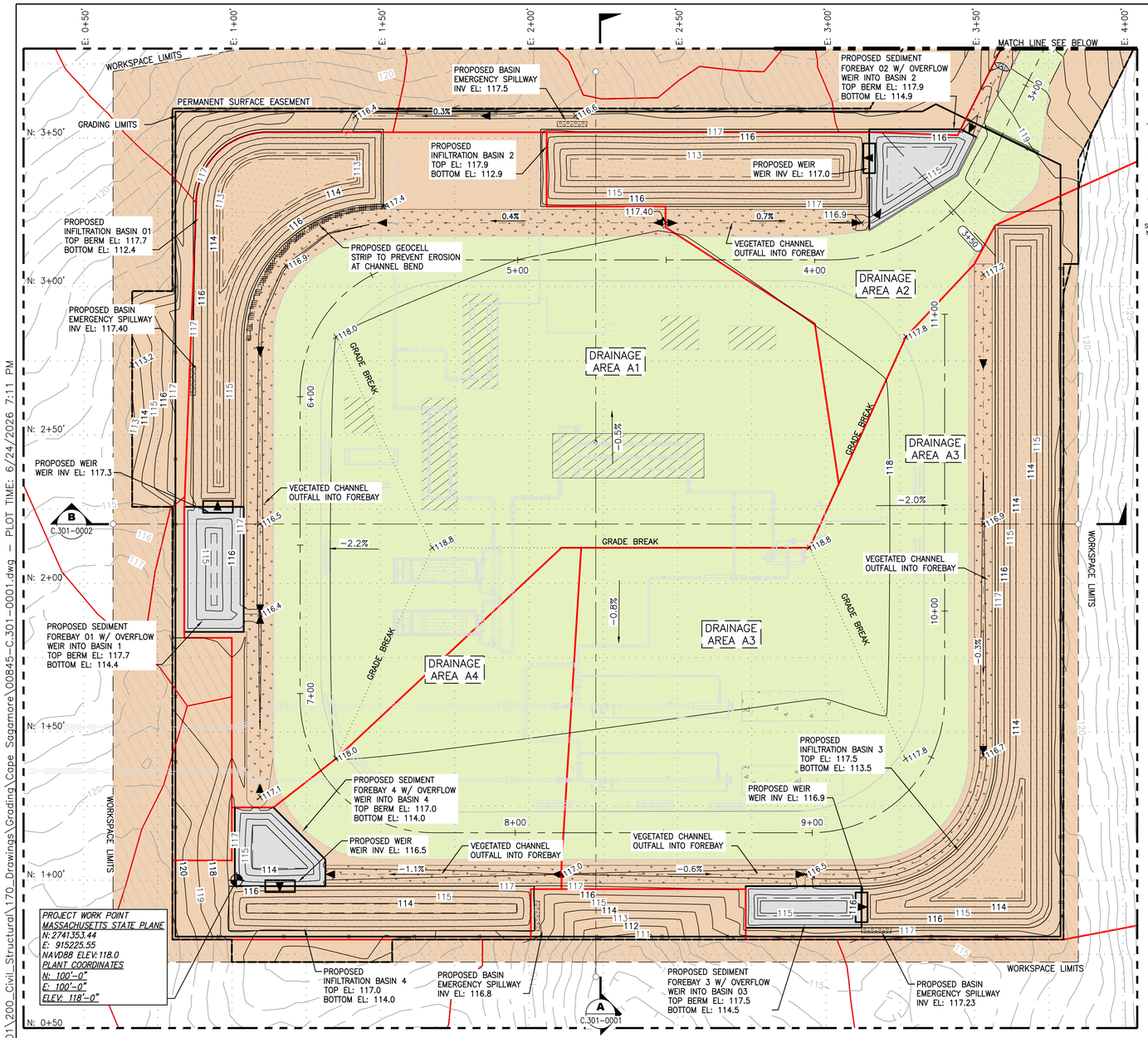
DRAWN BY:	JA	05/15/26
DESIGN CHECKER:	DT	06/24/26
DESIGN ENGINEER:	PB	06/24/26
PROJECT MANAGER:	AC	06/24/26

CAPE COD CANAL PIPELINE RELOCATION PROJECT
PAVE PAWS ROAD METER STATION
M&R 00845
TITLE: PROPOSED SITE LAYOUT PLAN
LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

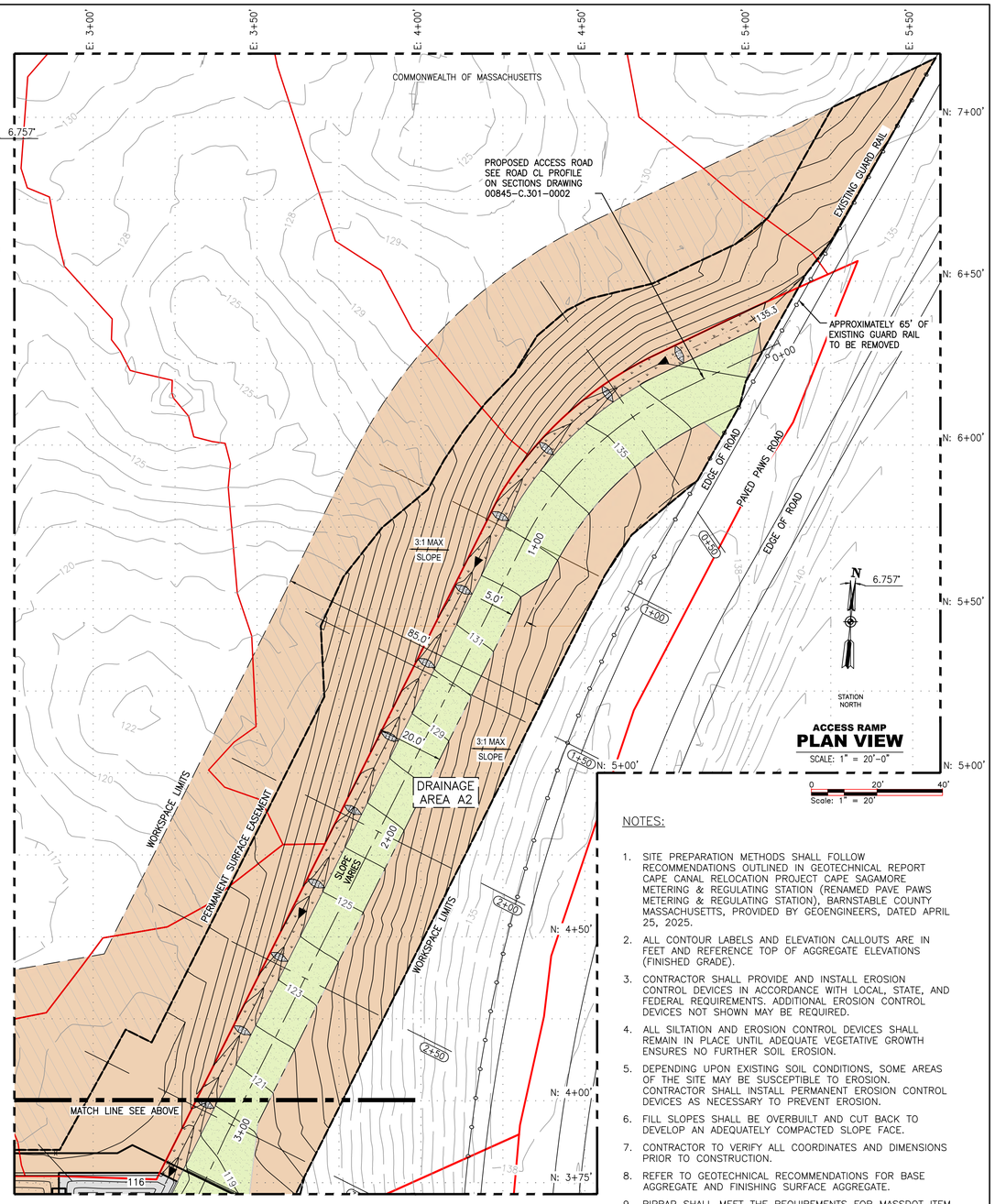
ENBRIDGE
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

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

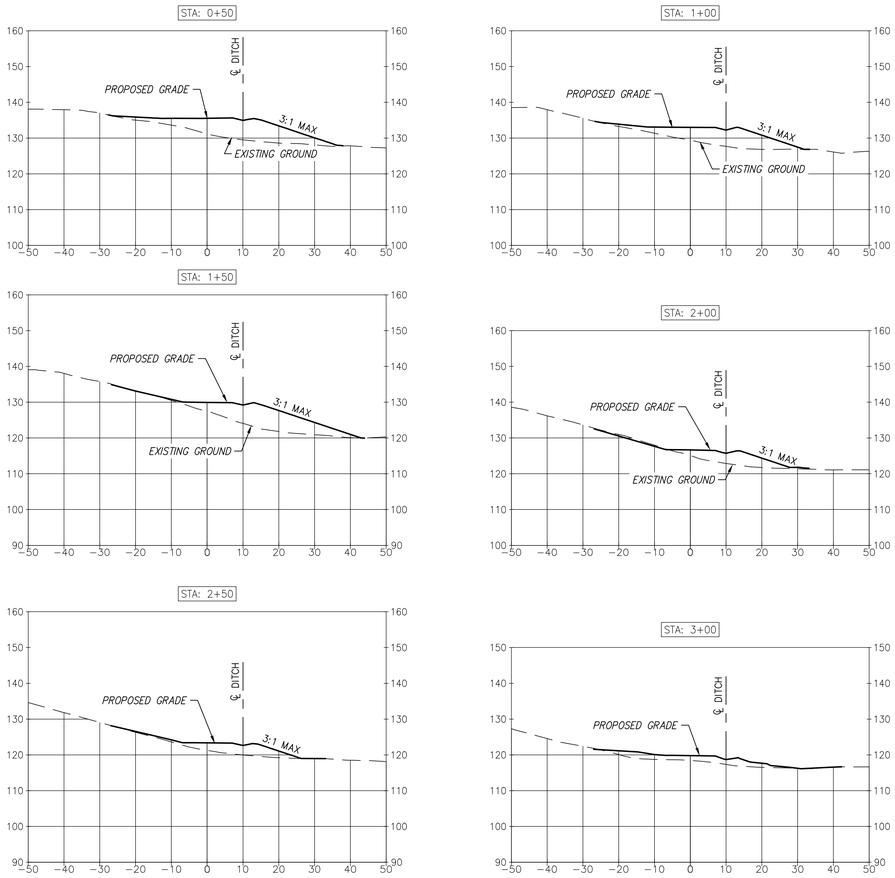
audubon Engineering
3505 W. SAM HOUSTON PKWY. N., SUITE 100
HOUSTON, TX 77043
PHONE: (281) 669-0590

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

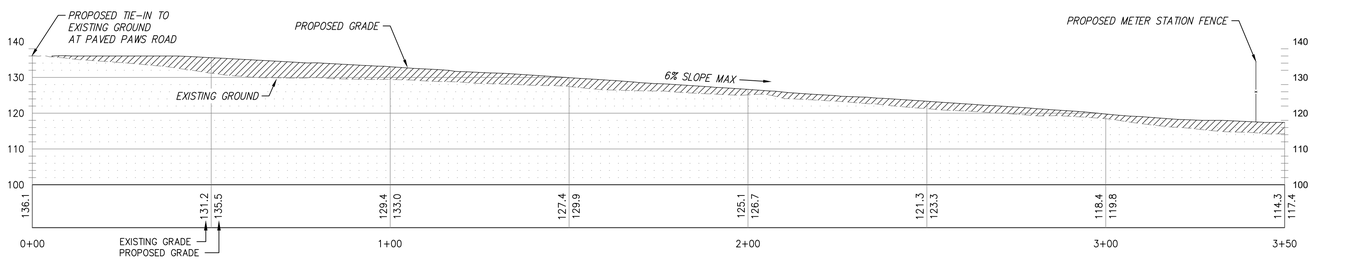
S:\AE\Projects\Enbridge\Mass\026356-001\200_Civil_Structural\170_Drawings\Grading\Cape Sagamore\00845-C.301-0001.dwg – PLOT TIME: 6/24/2026 7:11 PM



REFER TO GRADING PLAN 00845-C.301-0001

ACCESS ROAD RAMP CROSS SECTIONS

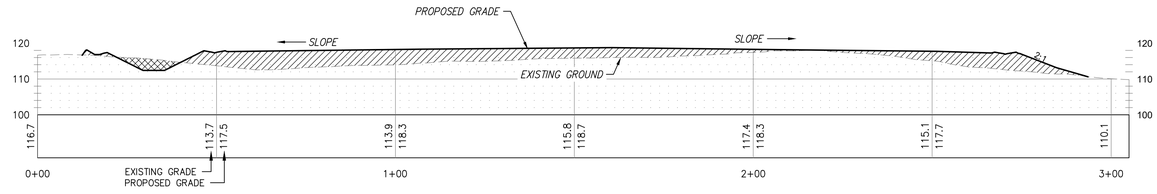
HORZ. & VERT. SCALE: 1" = 20'-0"



REFER TO GRADING PLAN 00845-C.301-0001

ACCESS ROAD RAMP C/L PROFILE

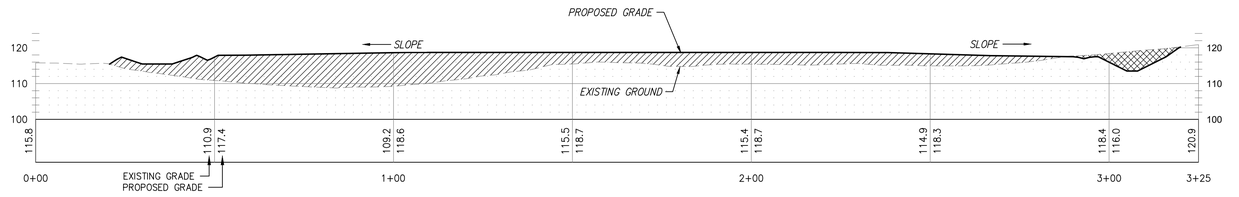
SCALE: 1" = 20'-0"



REFER TO GRADING PLAN 00845-C.301-0001

SECTION A

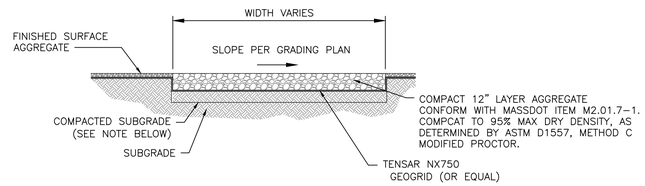
SCALE: 1" = 20'-0"



REFER TO GRADING PLAN 00845-C.301-0001

SECTION B

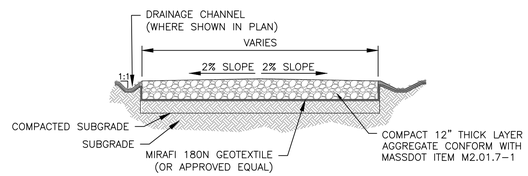
SCALE: 1" = 20'-0"



DETAIL B – TYPICAL AGGREGATE DRIVE AISLE

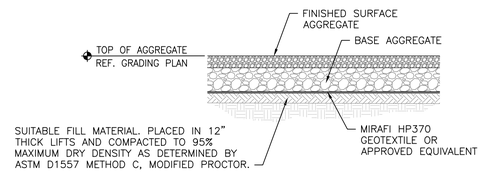
SCALE: NOT TO SCALE

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

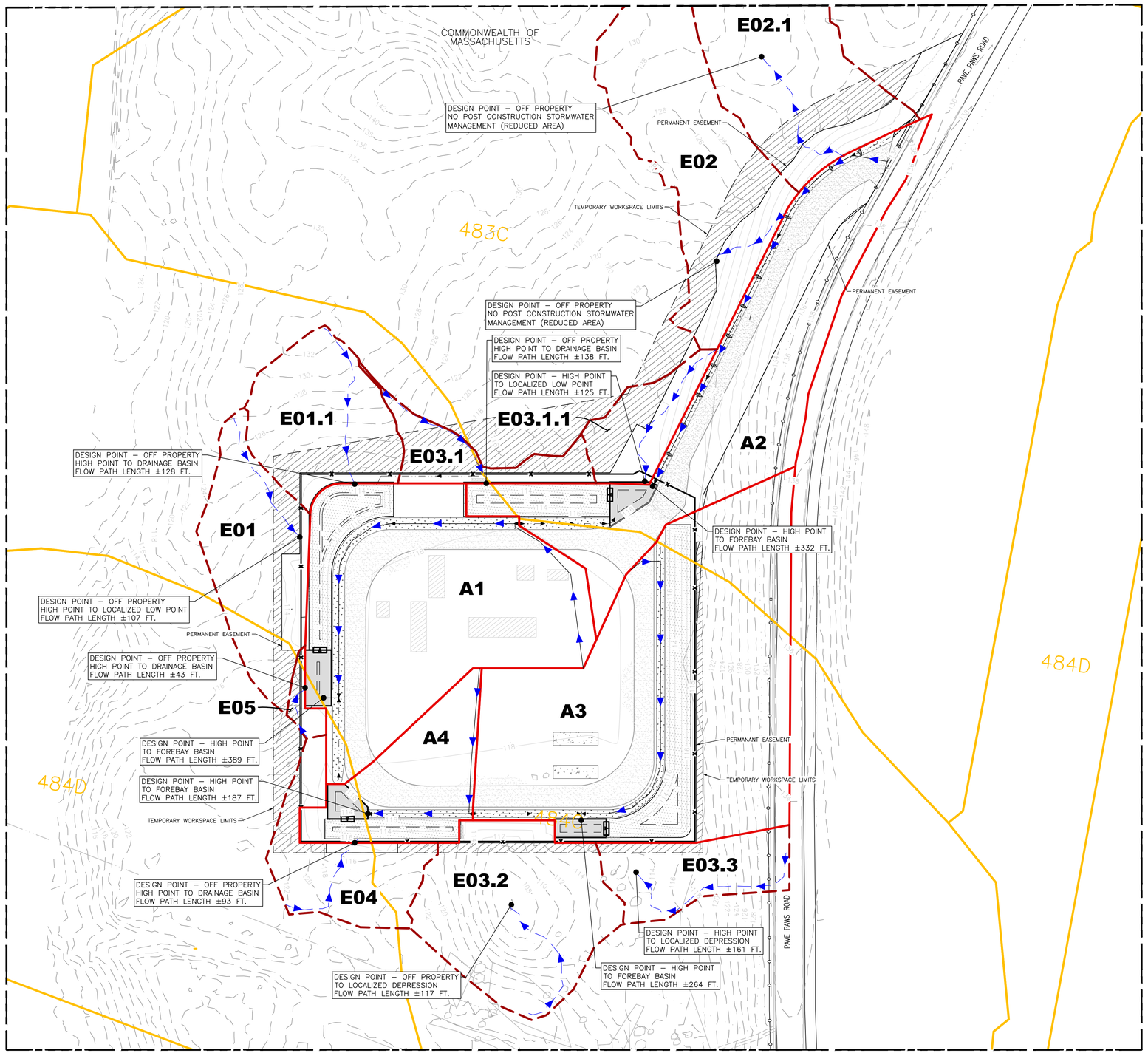
CAPE COD CANAL PIPELINE RELOCATION PROJECT
PAVE PAWS ROAD METER STATION
M&R 0845
TITLE: GRADING CROSS SECTIONS

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

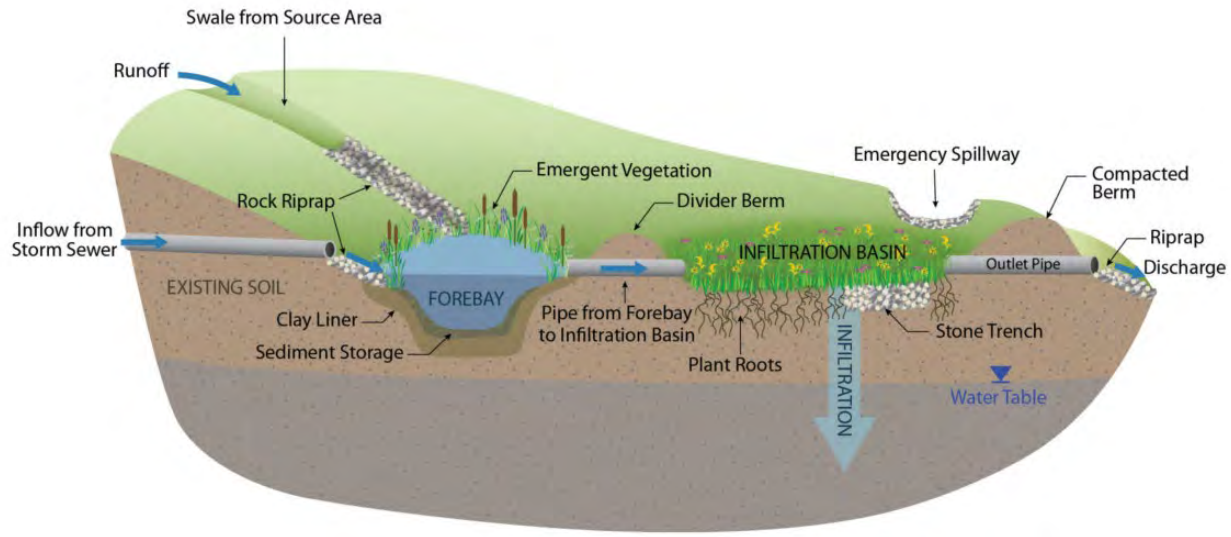


Illustration by Geosyntec Consultants, Inc.

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)

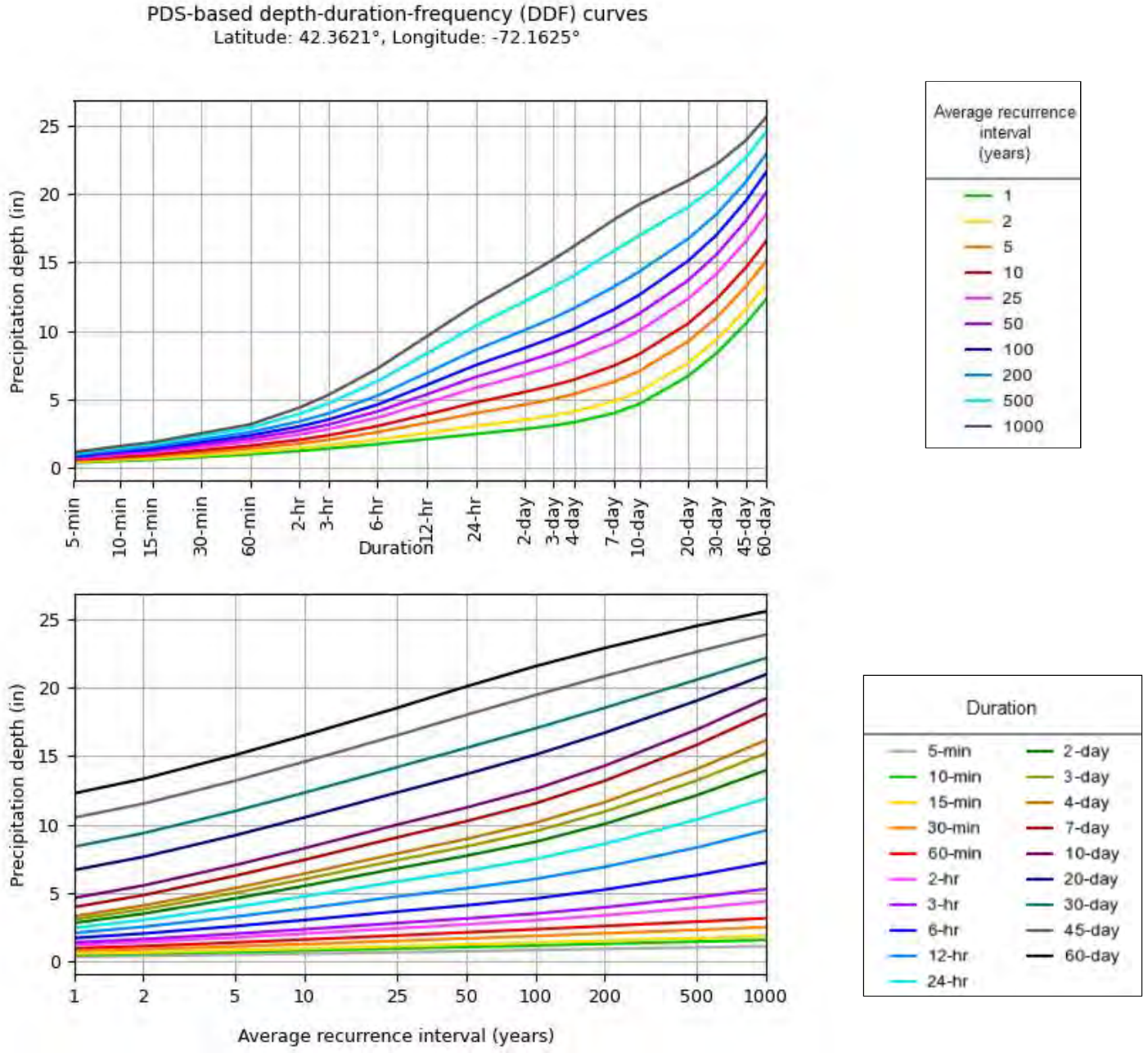
[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

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



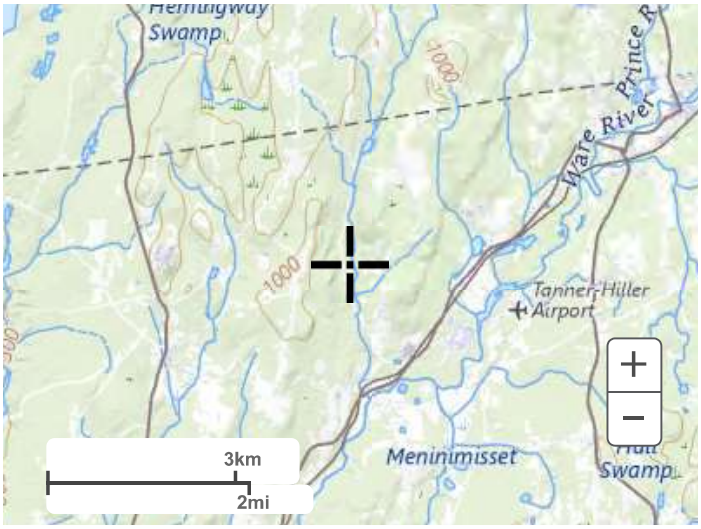
NOAA Atlas 14, Volume 10, Version 3

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

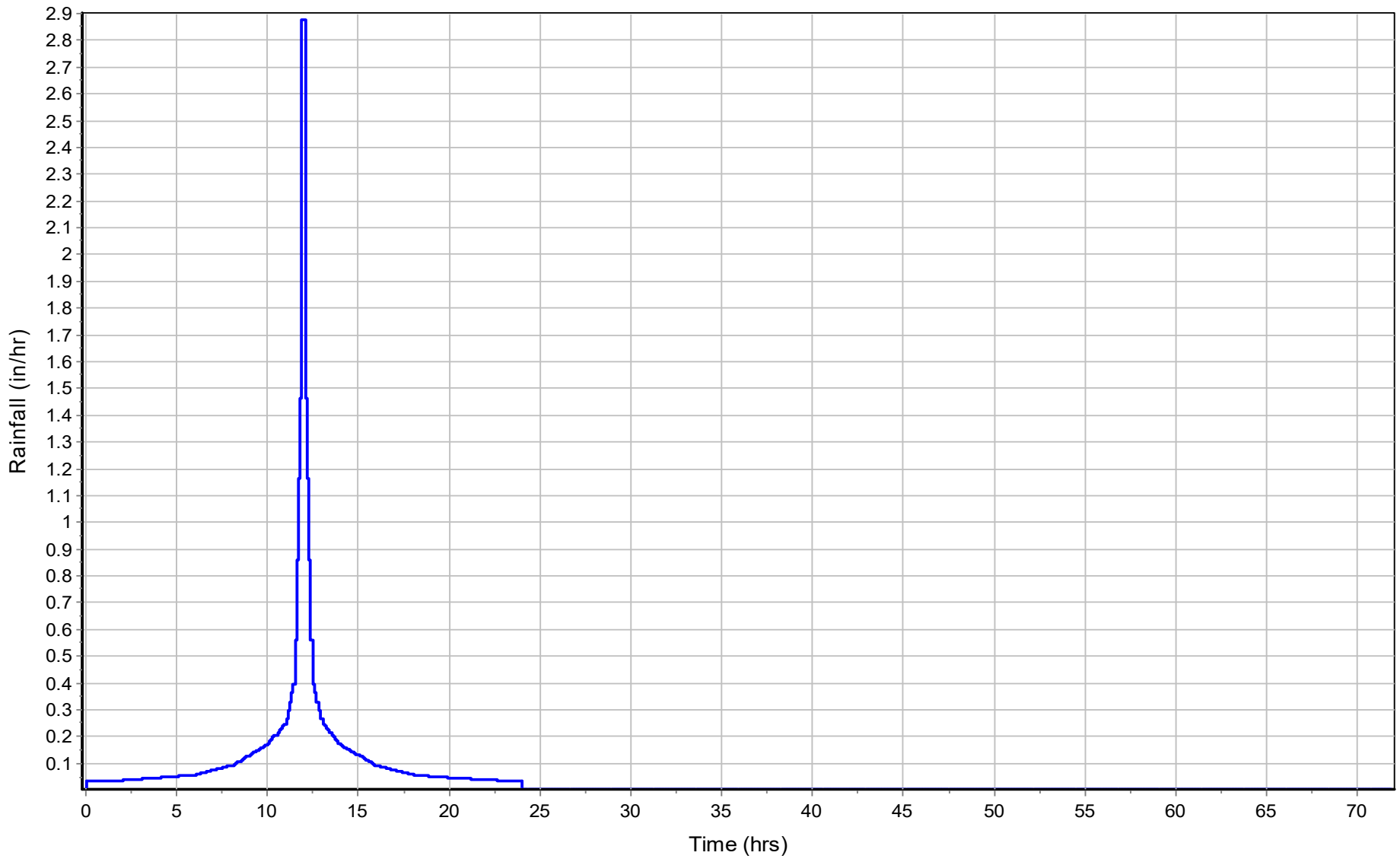
Total TOC (min) 5.38

Subbasin Runoff Results

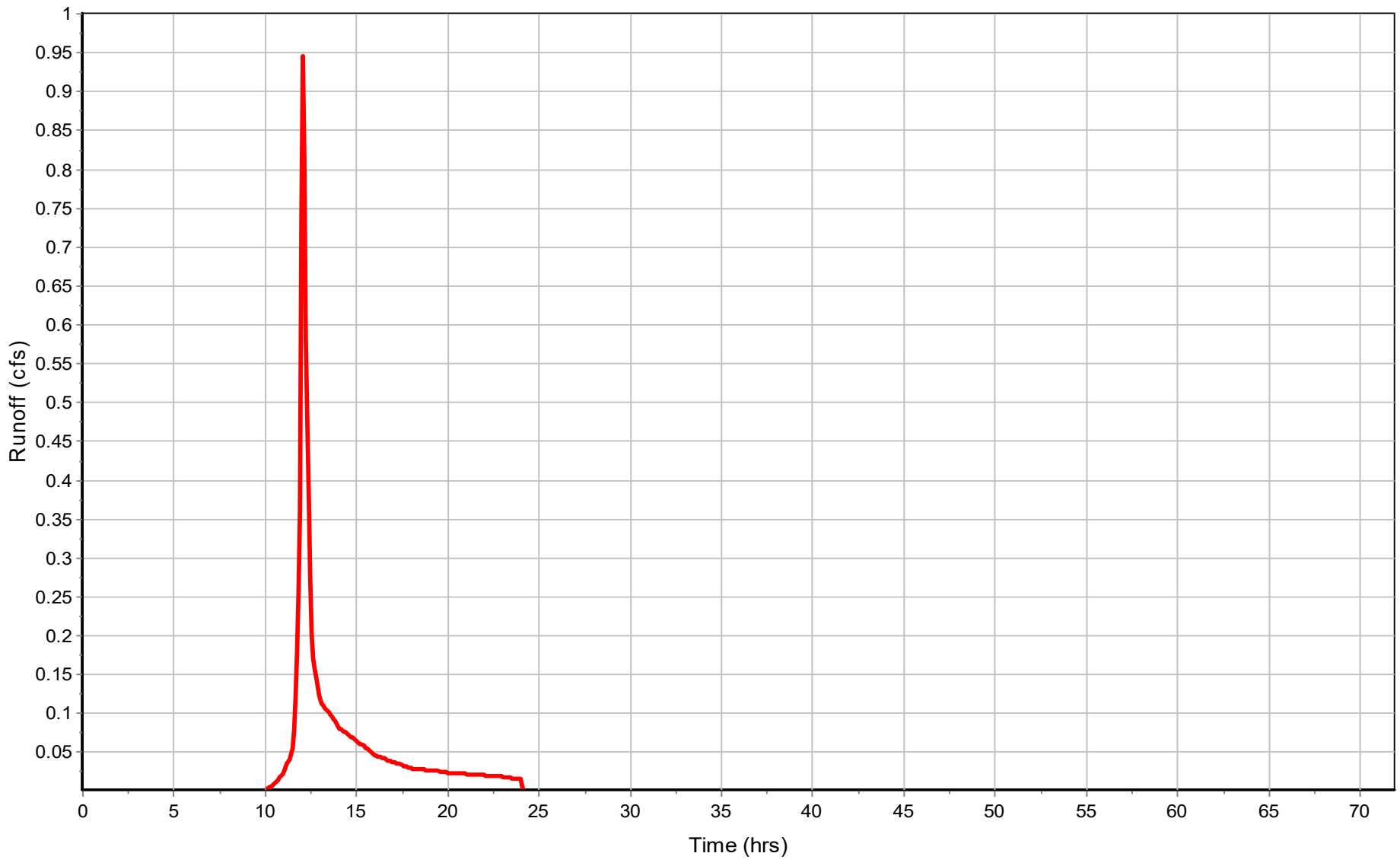
Total Rainfall (in)	3.02
Total Runoff (in)	1.31
Peak Runoff (cfs)	0.99
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:05:23

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

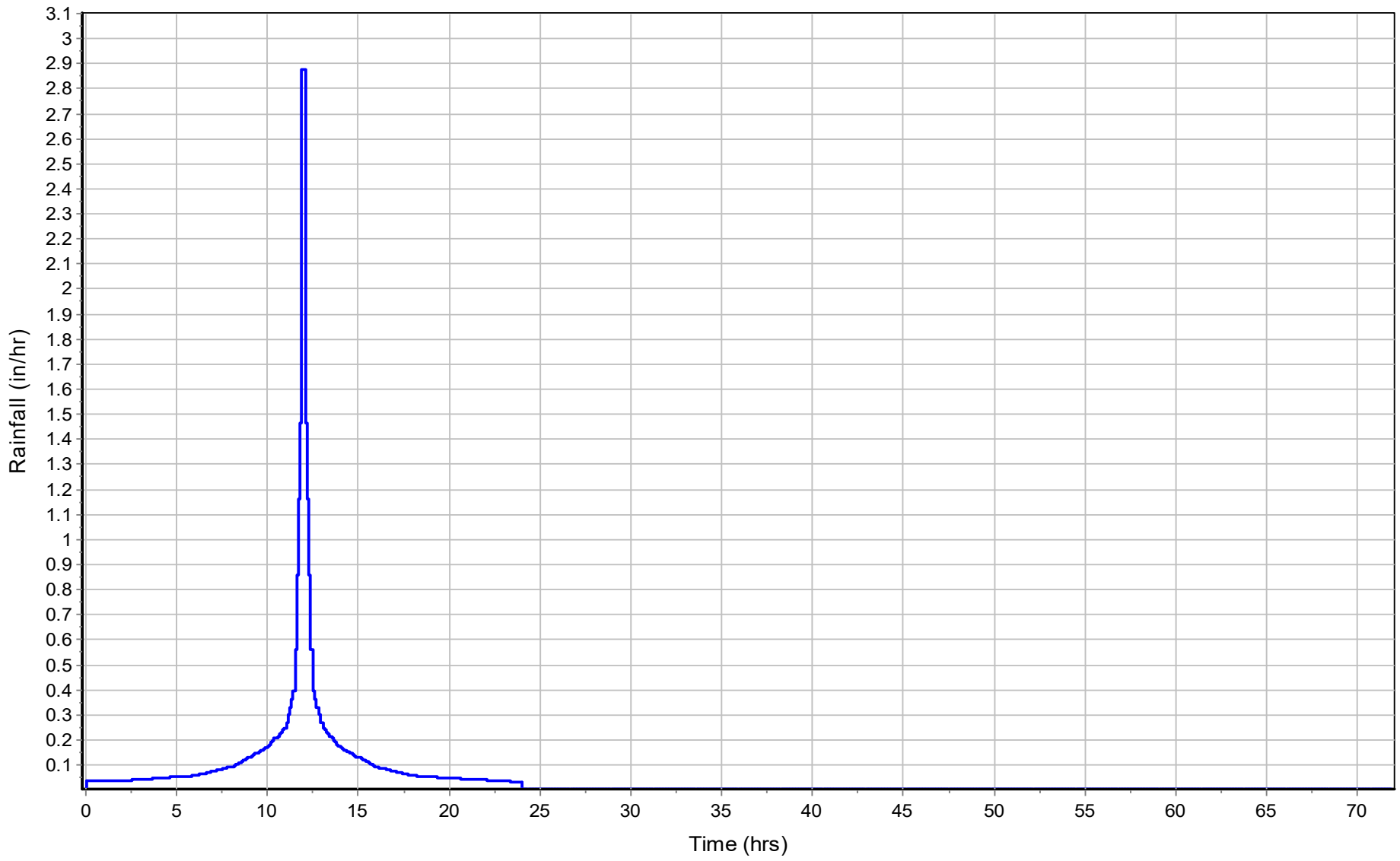
Total TOC (min) 0.79

Subbasin Runoff Results

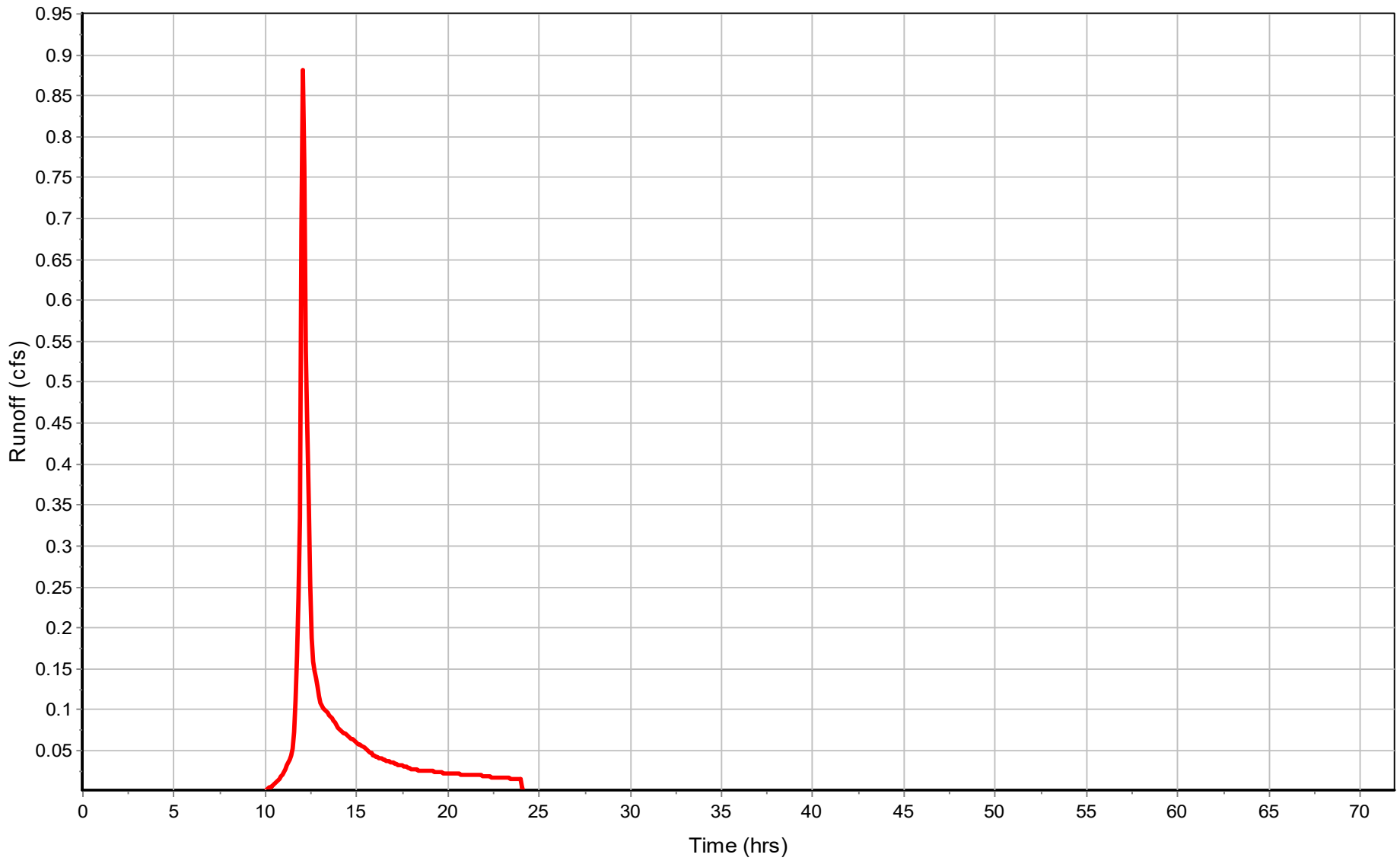
Total Rainfall (in) 3.02
Total Runoff (in) 1.31
Peak Runoff (cfs) 0.92
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:00:47

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

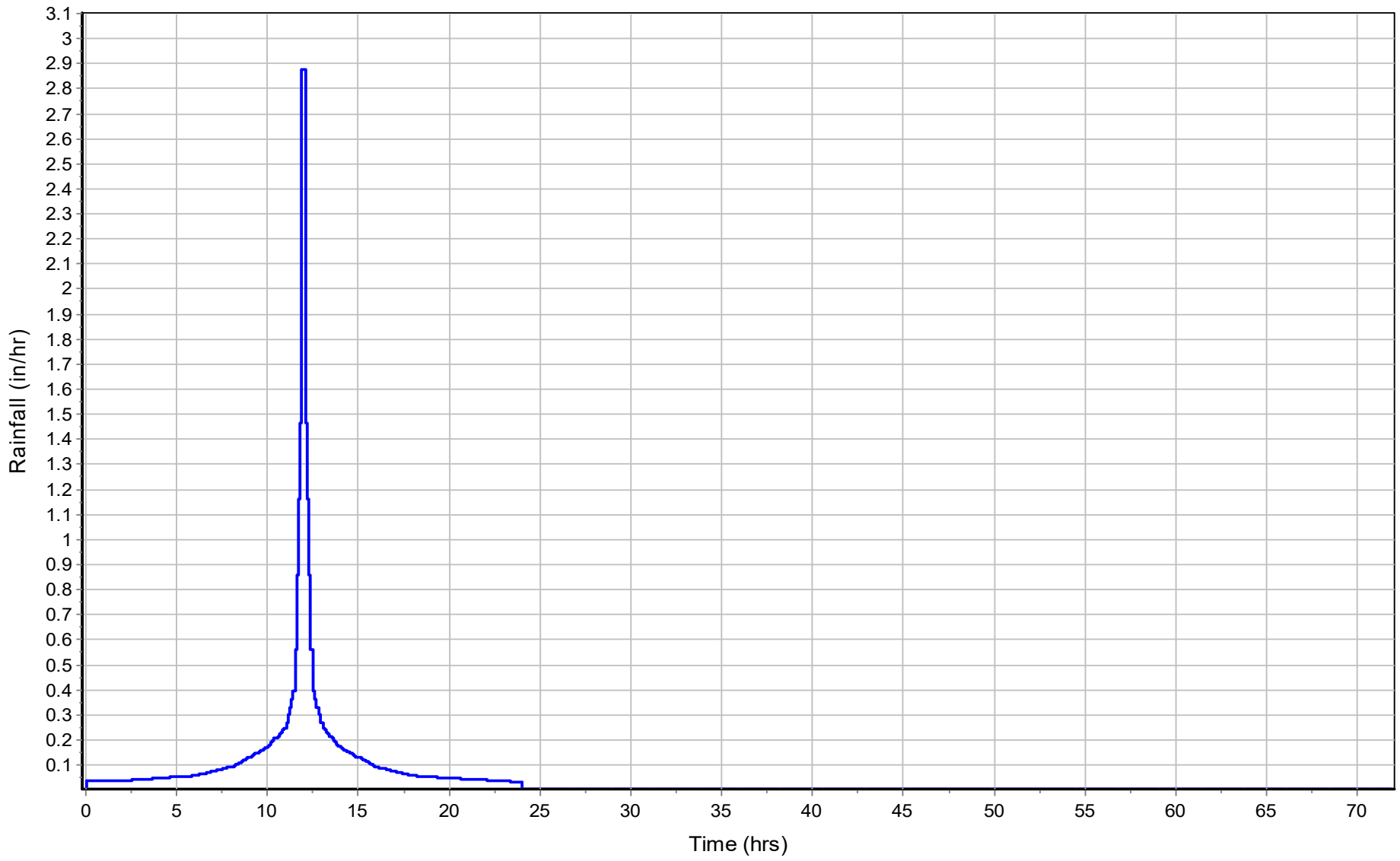
Total TOC (min) 28.81

Subbasin Runoff Results

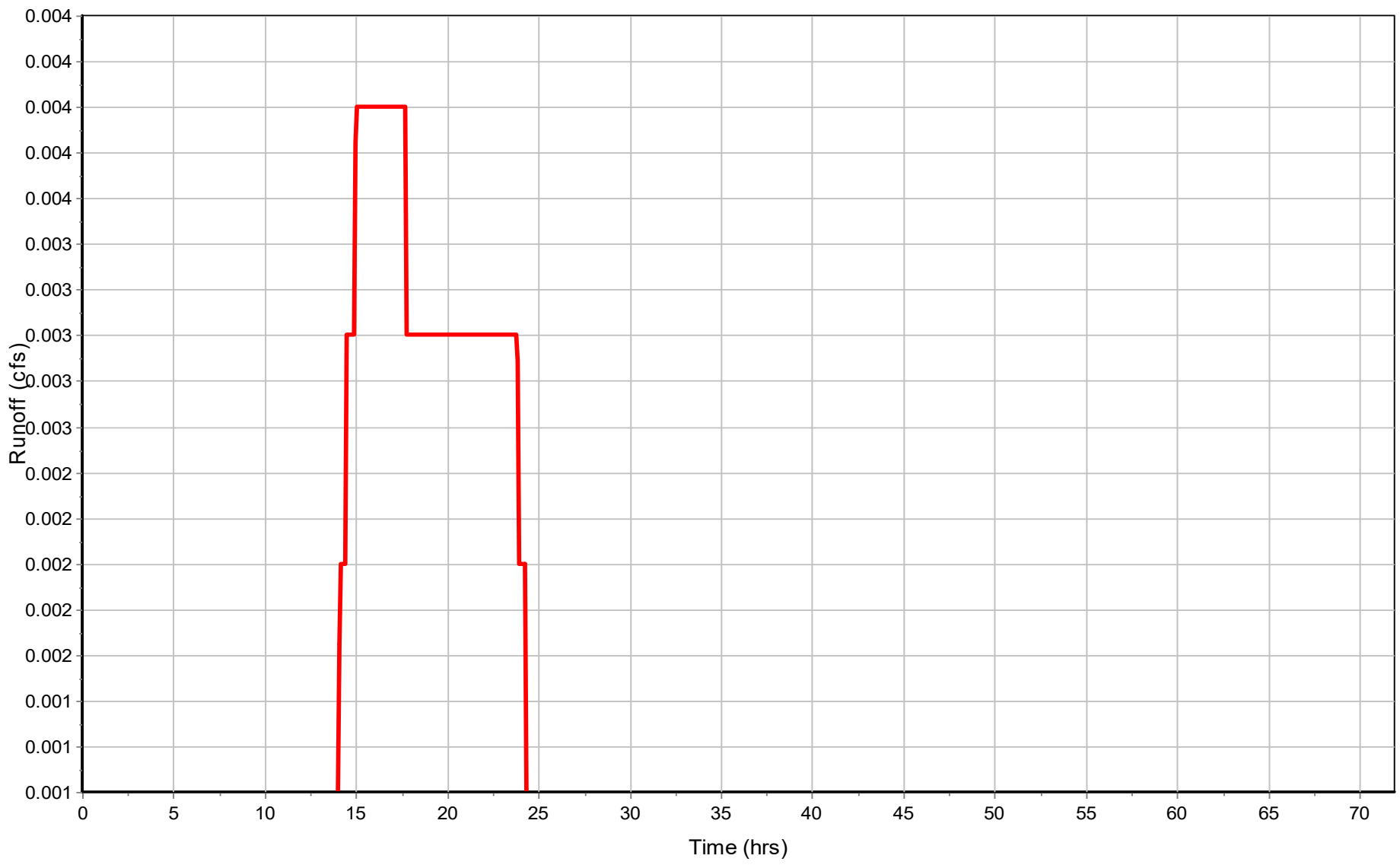
Total Rainfall (in) 3.02
Total Runoff (in) 0.04
Peak Runoff (cfs) 0
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:28:49

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

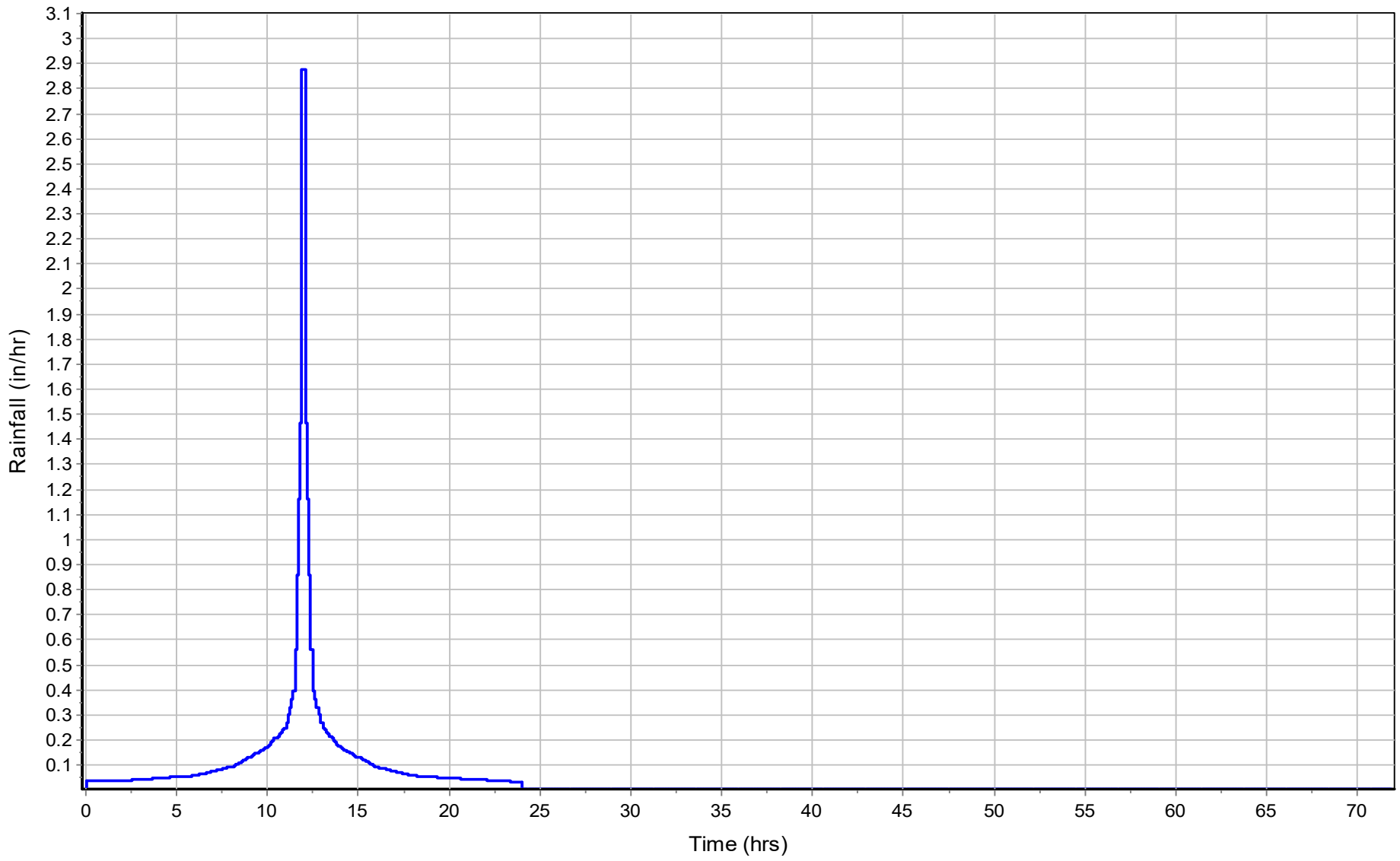
Total TOC (min) 17.94

Subbasin Runoff Results

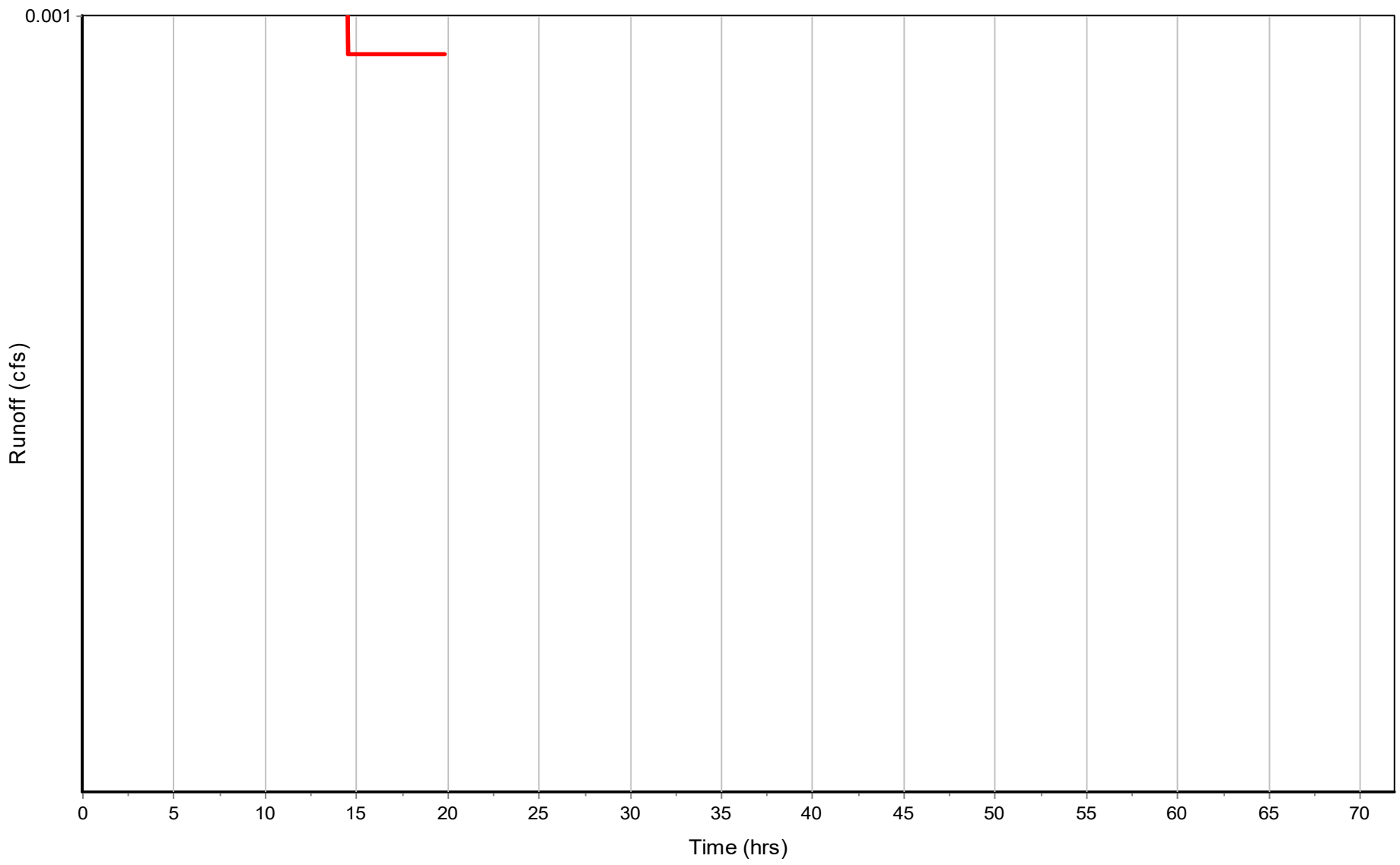
Total Rainfall (in) 3.02
Total Runoff (in) 0.02
Peak Runoff (cfs) 0
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:17:56

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

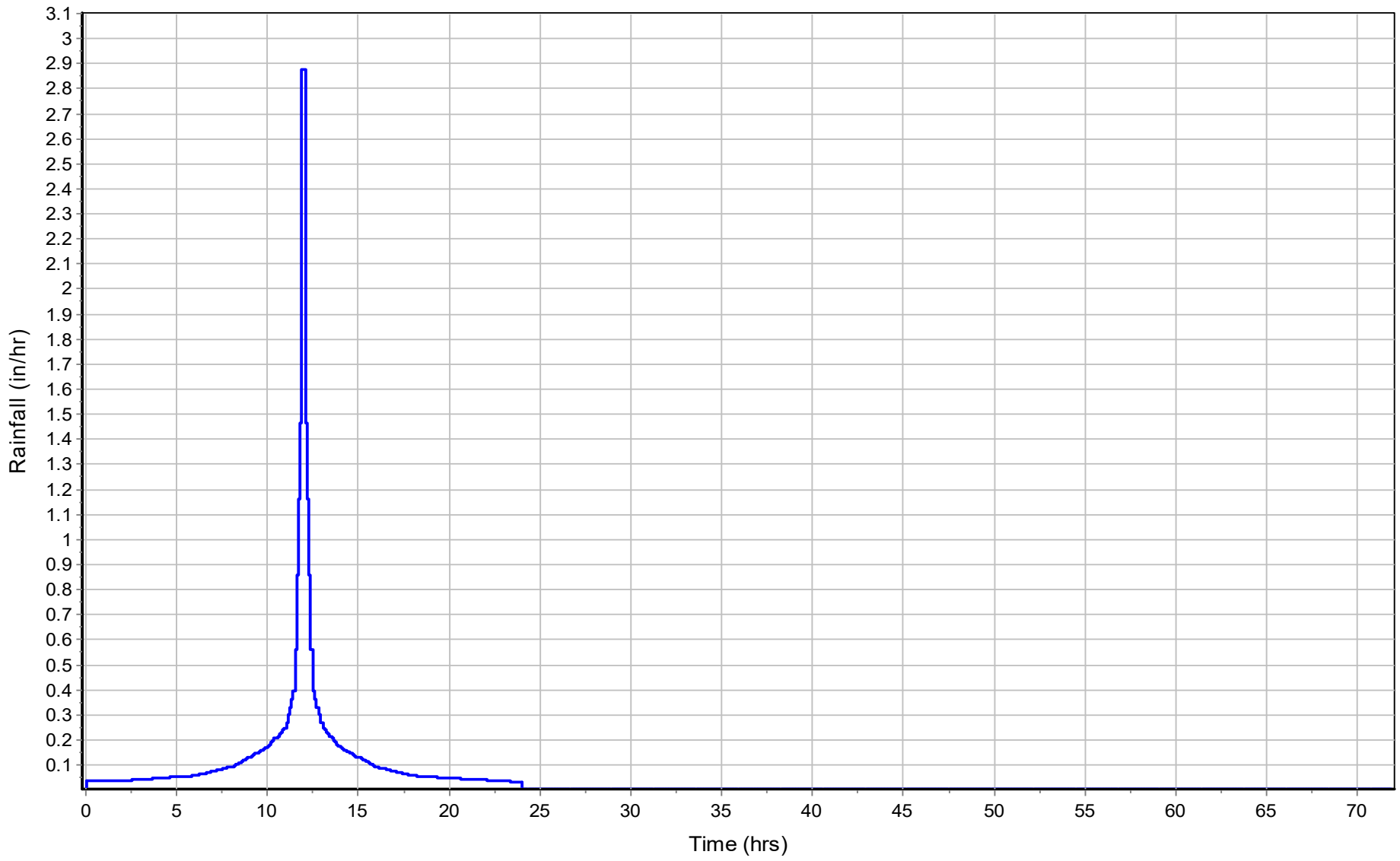
Total TOC (min) 17.48

Subbasin Runoff Results

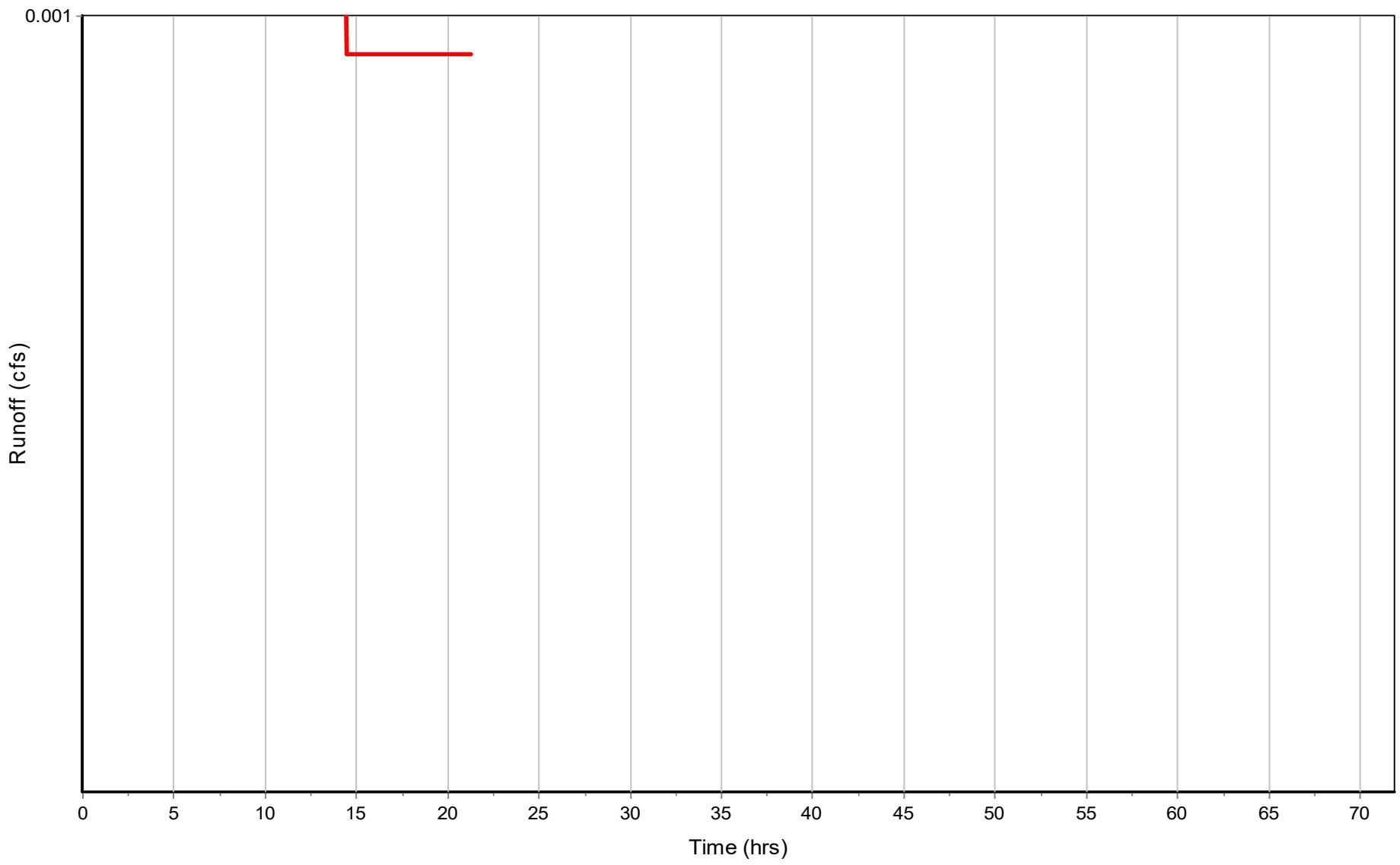
Total Rainfall (in) 3.02
Total Runoff (in) 0.03
Peak Runoff (cfs) 0
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:17:29

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

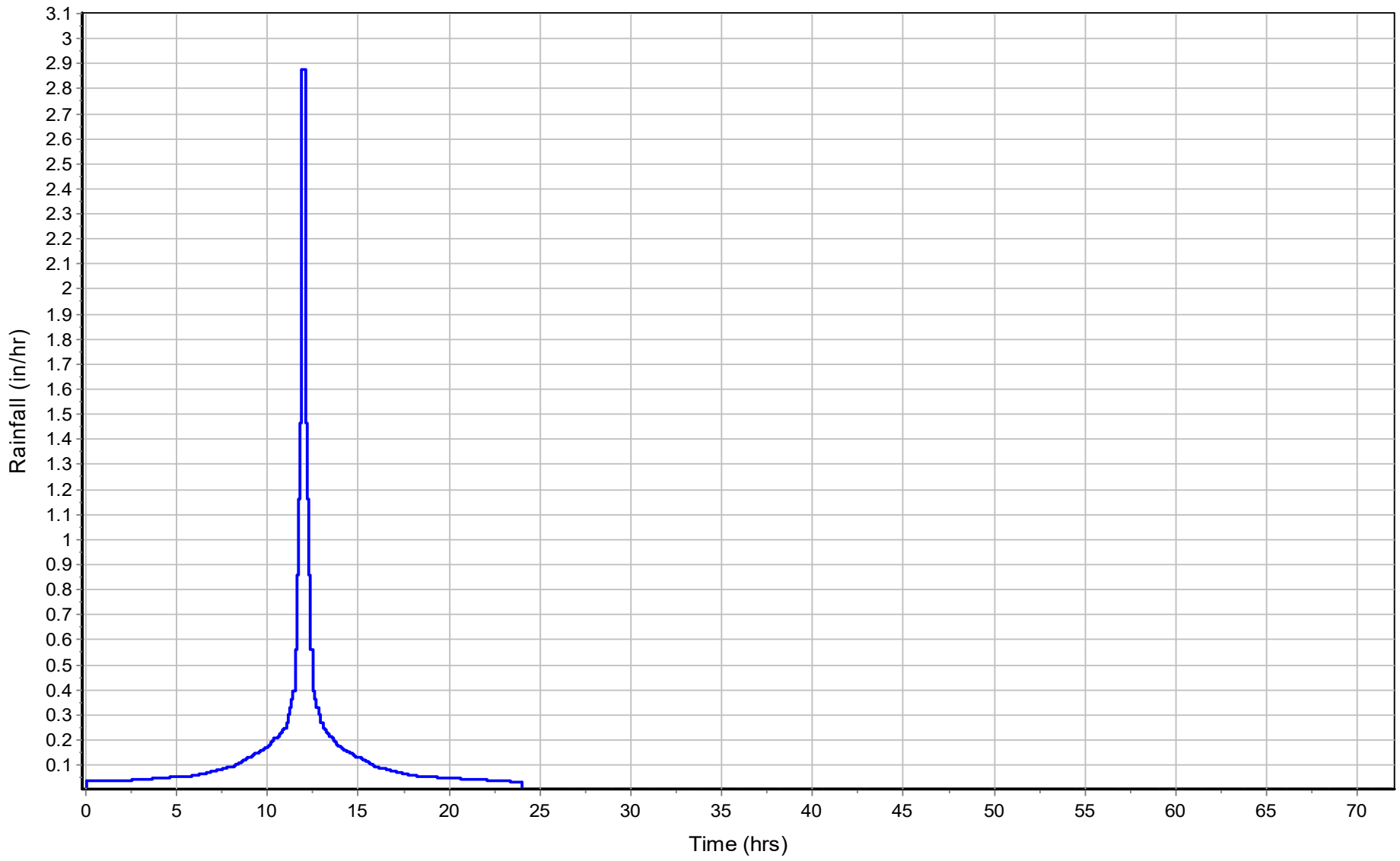
Total TOC (min) 21.50

Subbasin Runoff Results

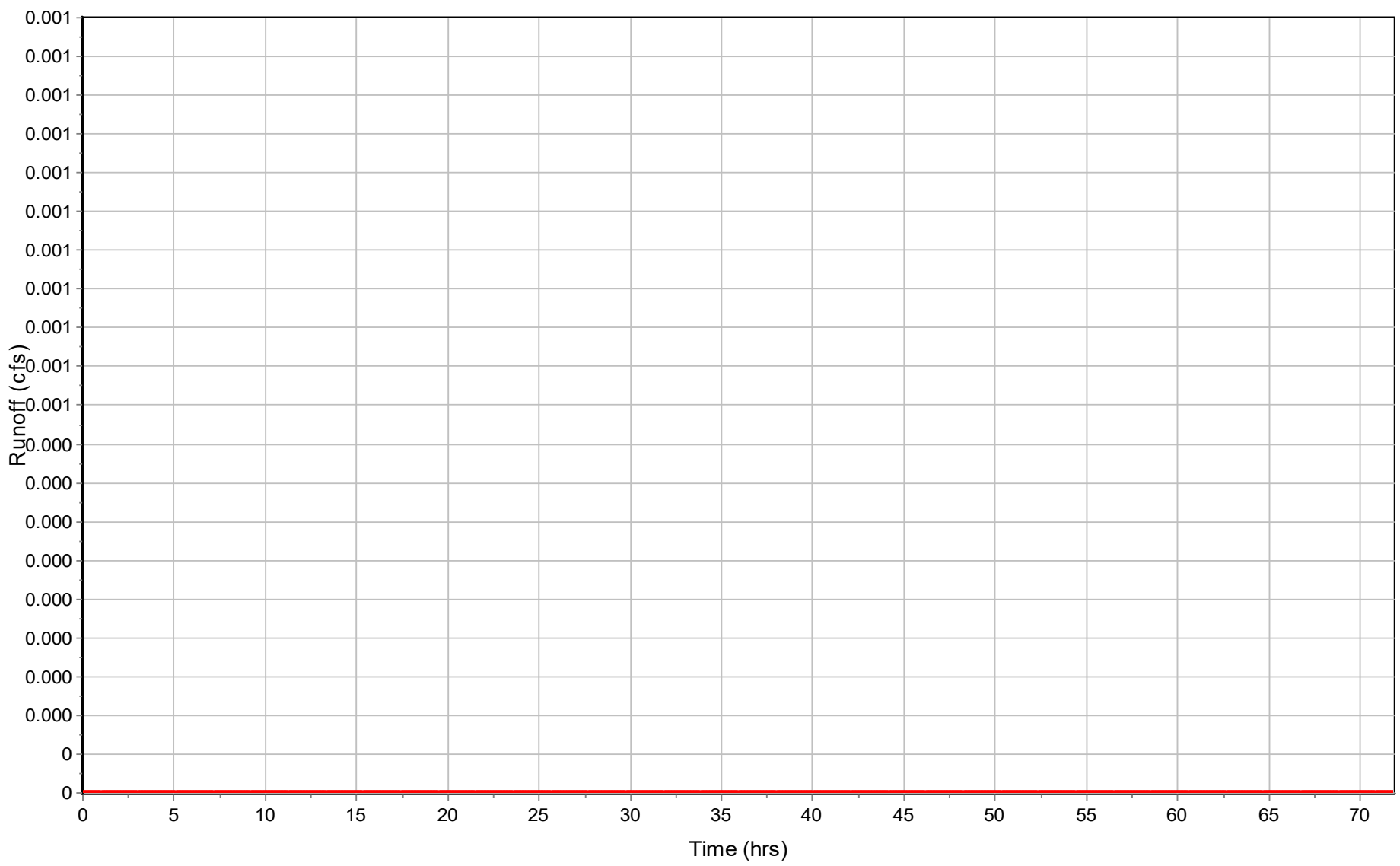
Total Rainfall (in) 3.02
Total Runoff (in) 0
Peak Runoff (cfs) 0
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:21:30

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

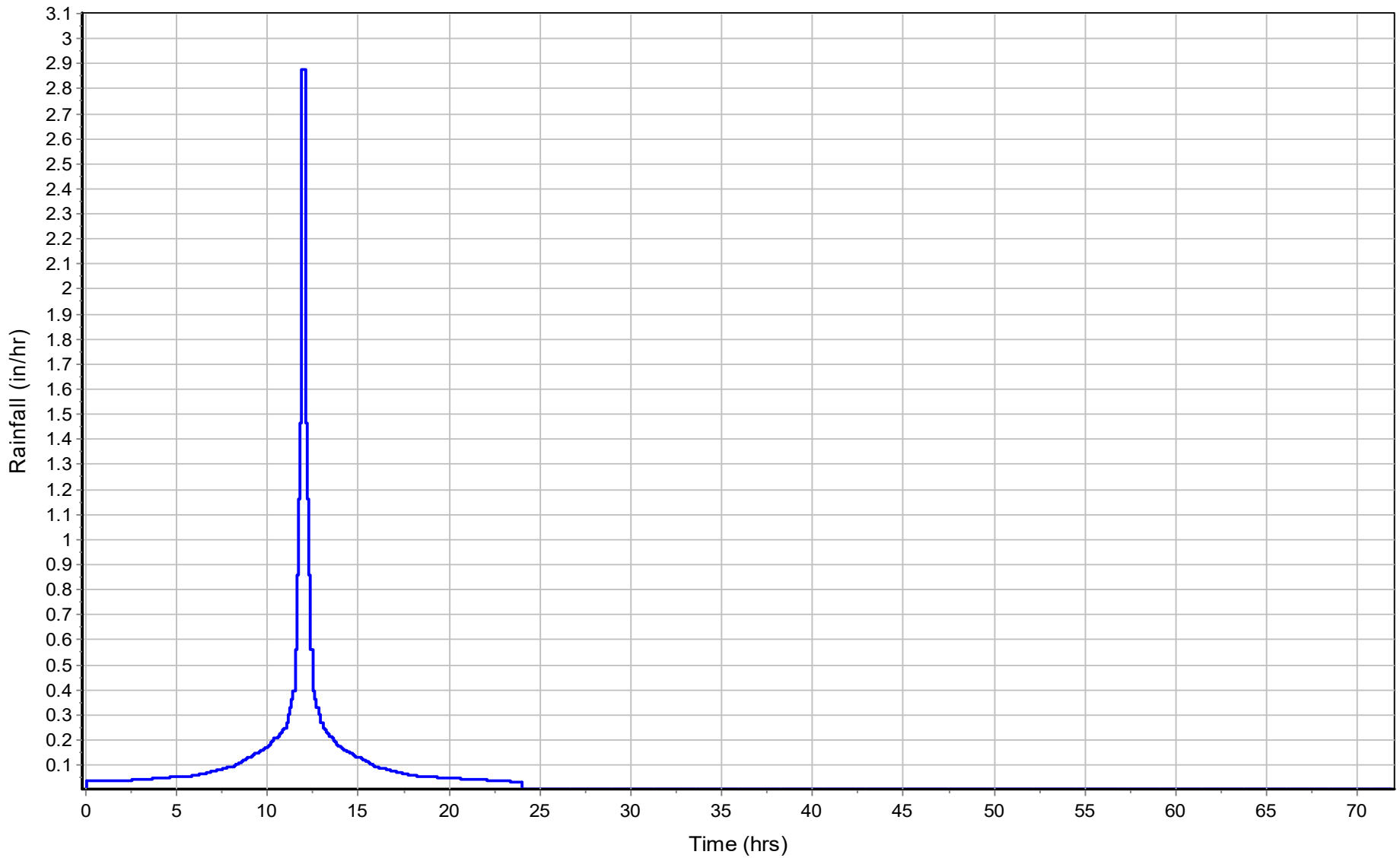
Total TOC (min) 9.01

Subbasin Runoff Results

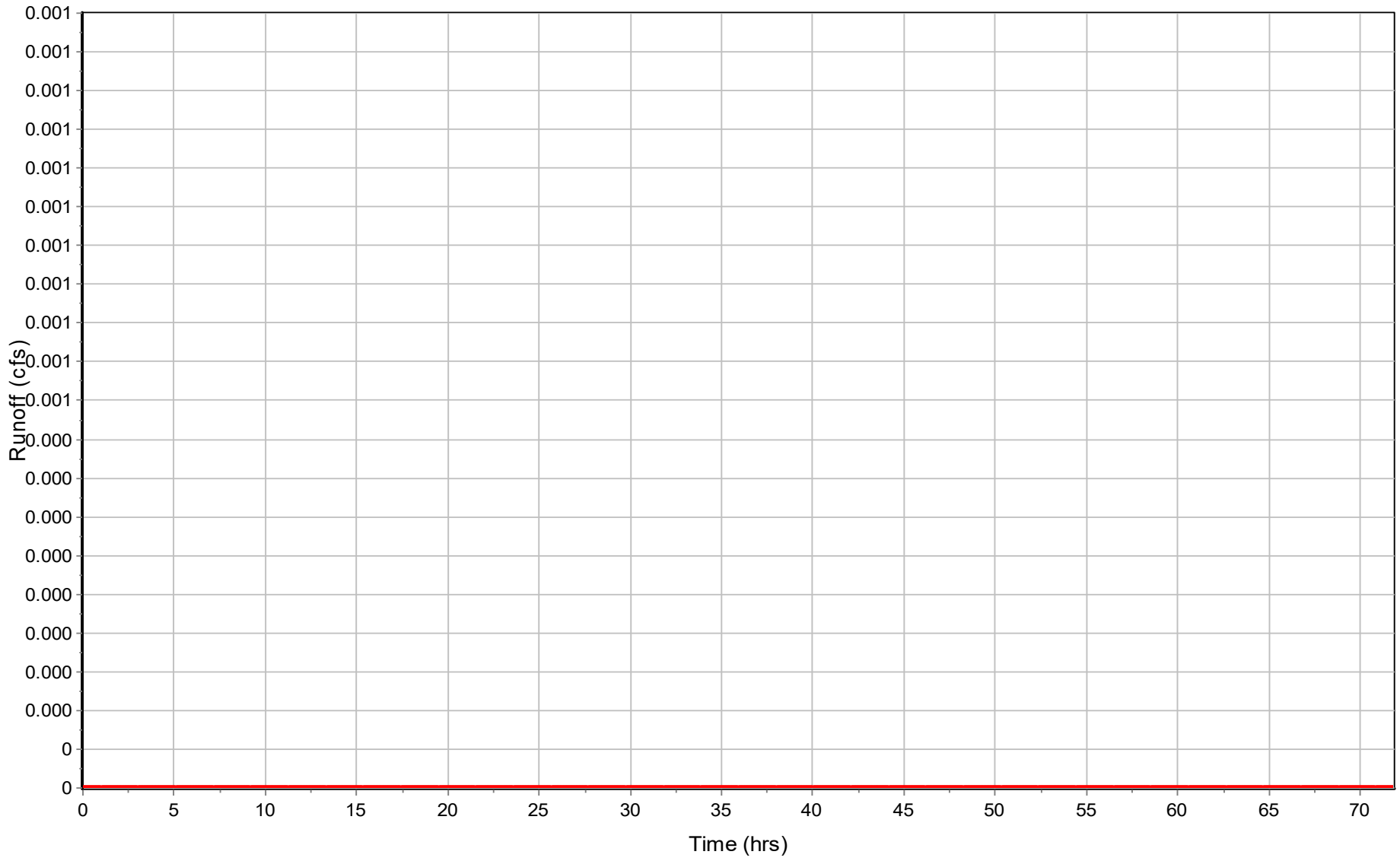
Total Rainfall (in) 3.02
Total Runoff (in) 0
Peak Runoff (cfs) 0
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:09:01

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

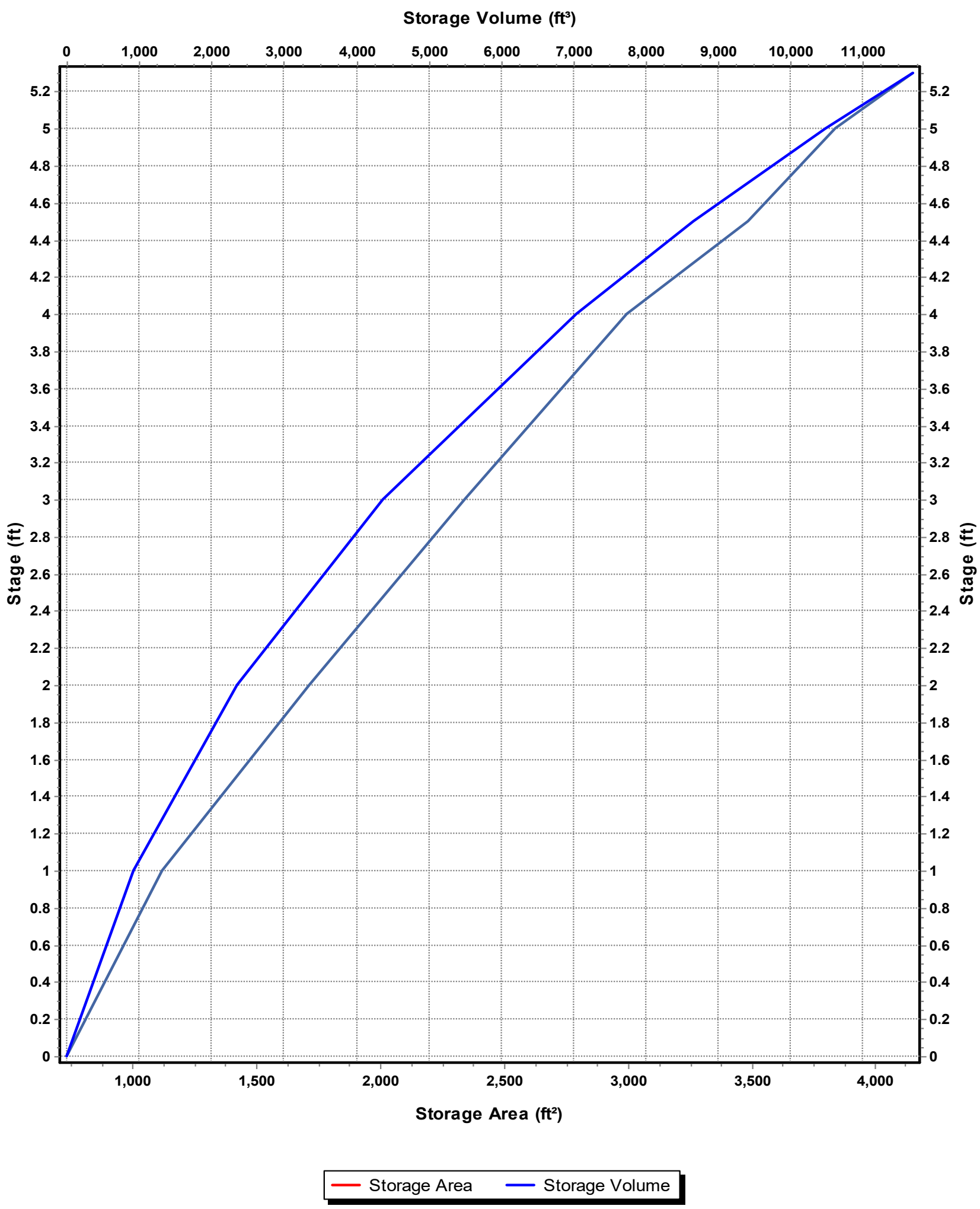
Invert Elevation (ft)	112.40
Max (Rim) Elevation (ft)	117.70
Max (Rim) Offset (ft)	5.30
Initial Water Elevation (ft)	112.40
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

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

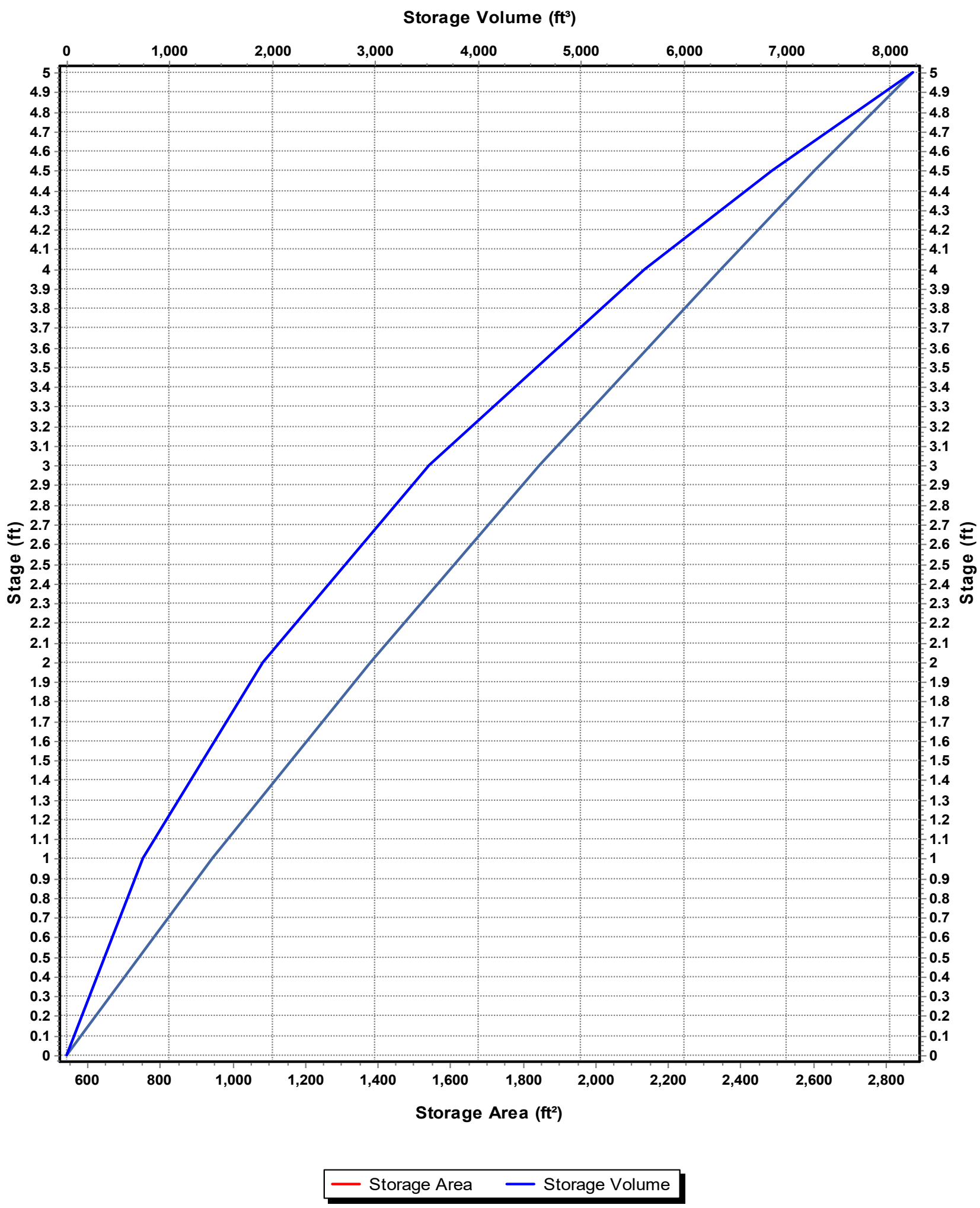
Invert Elevation (ft)	112.90
Max (Rim) Elevation (ft)	117.90
Max (Rim) Offset (ft)	5.00
Initial Water Elevation (ft)	112.90
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

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

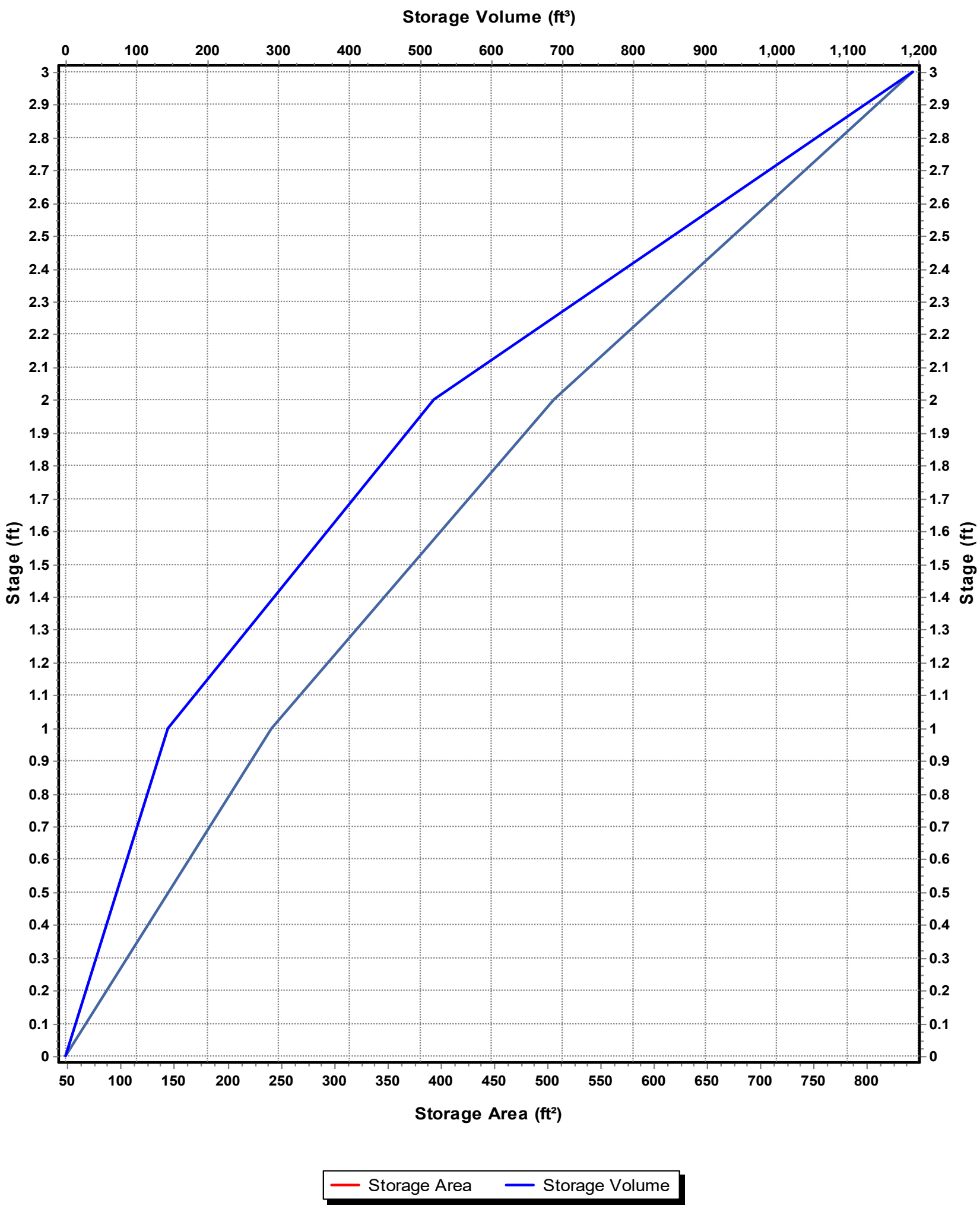
Invert Elevation (ft)	114.40
Max (Rim) Elevation (ft)	117.70
Max (Rim) Offset (ft)	3.30
Initial Water Elevation (ft)	114.40
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

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

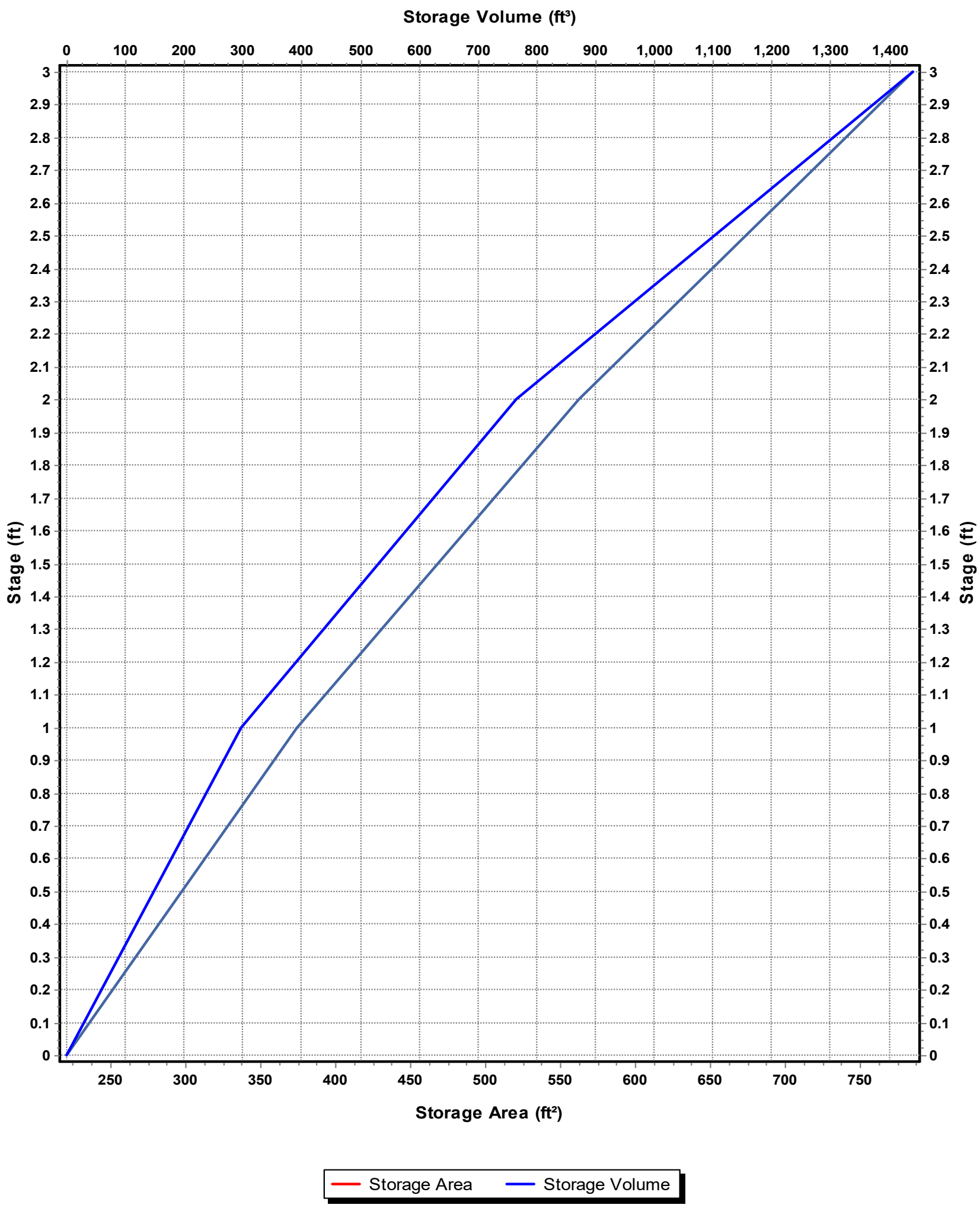
Invert Elevation (ft)	114.90
Max (Rim) Elevation (ft)	117.90
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.90
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

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

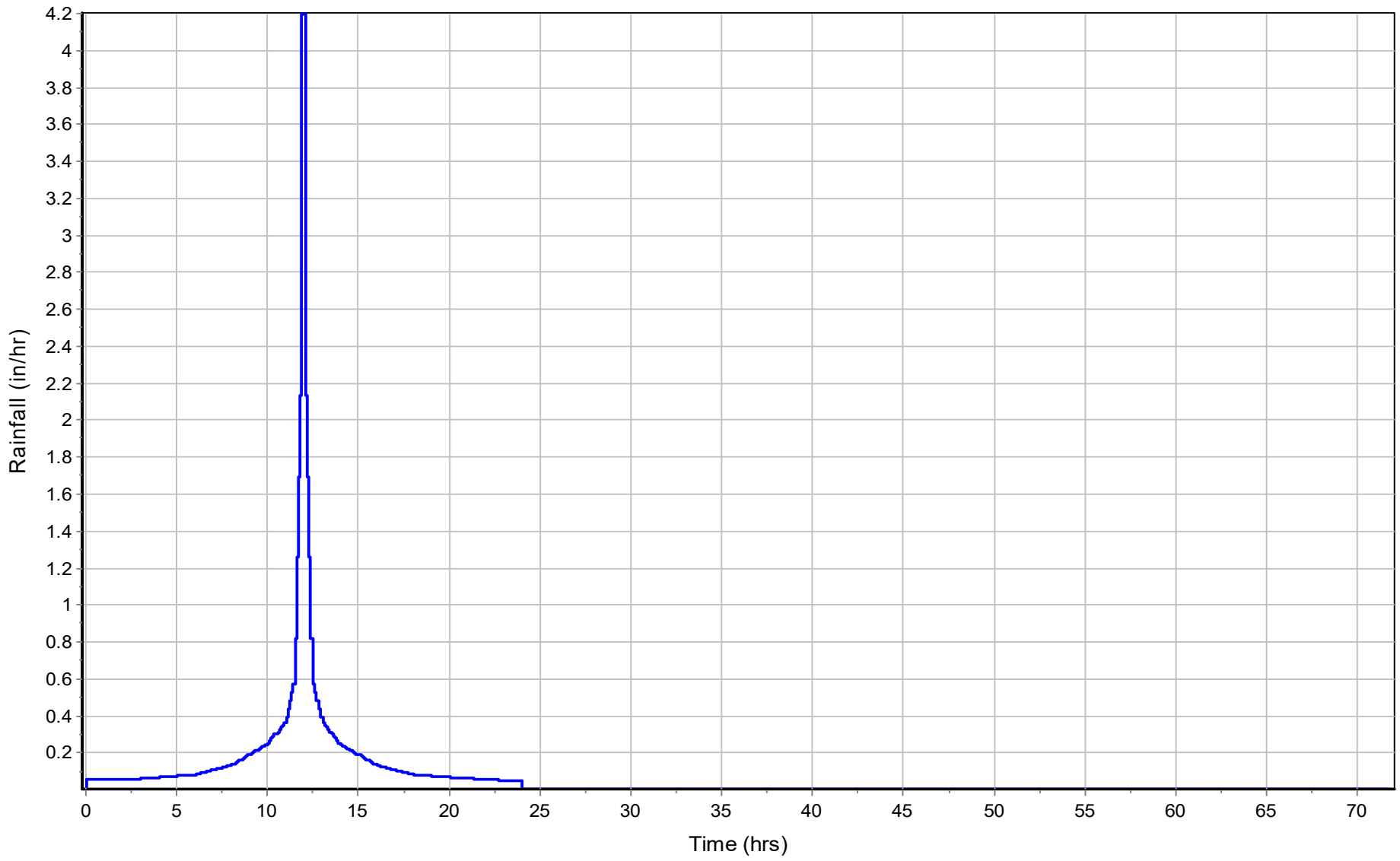
Total TOC (min) 5.38

Subbasin Runoff Results

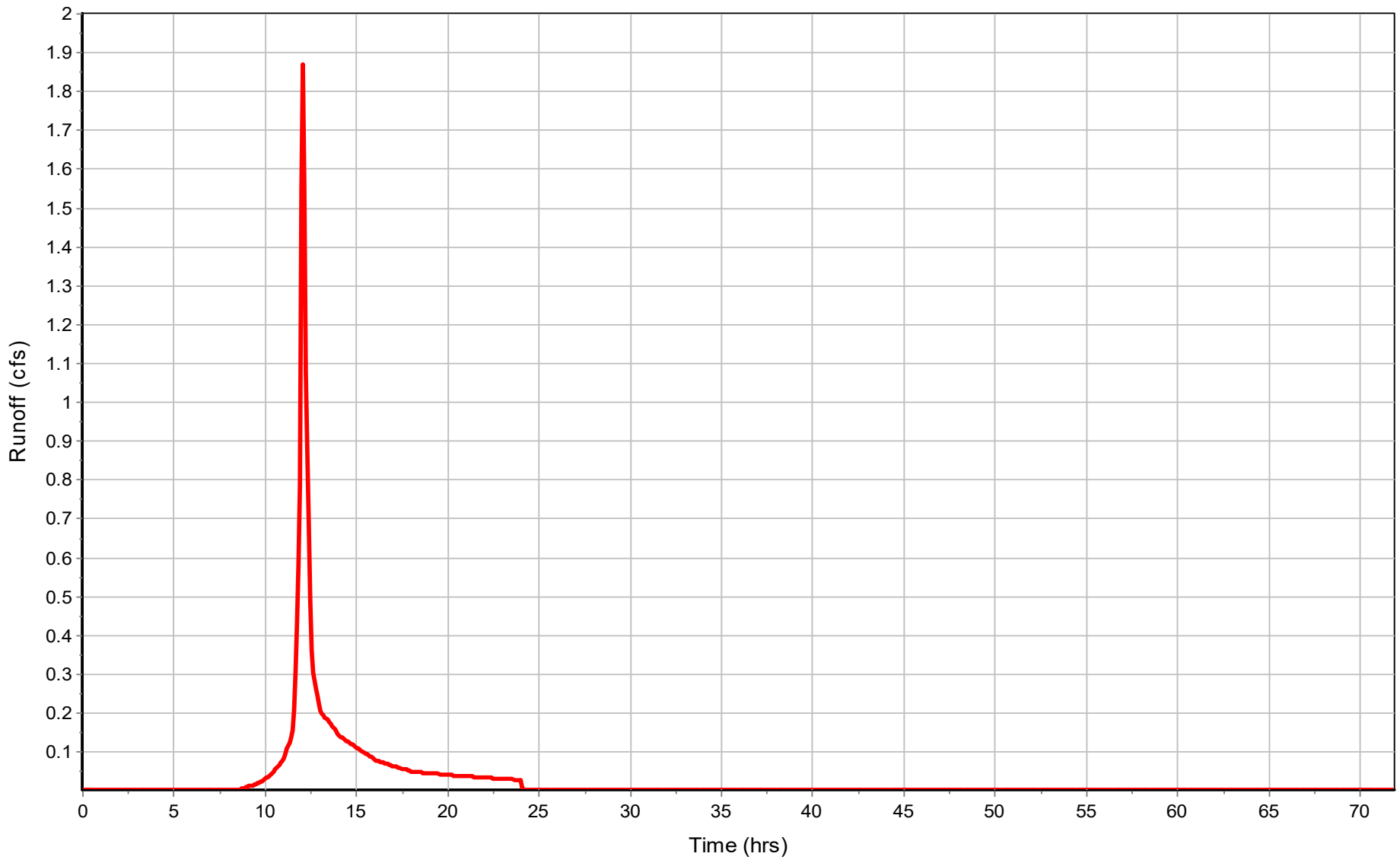
Total Rainfall (in)	4.99
Total Runoff (in)	2.53
Peak Runoff (cfs)	1.92
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:05:23

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

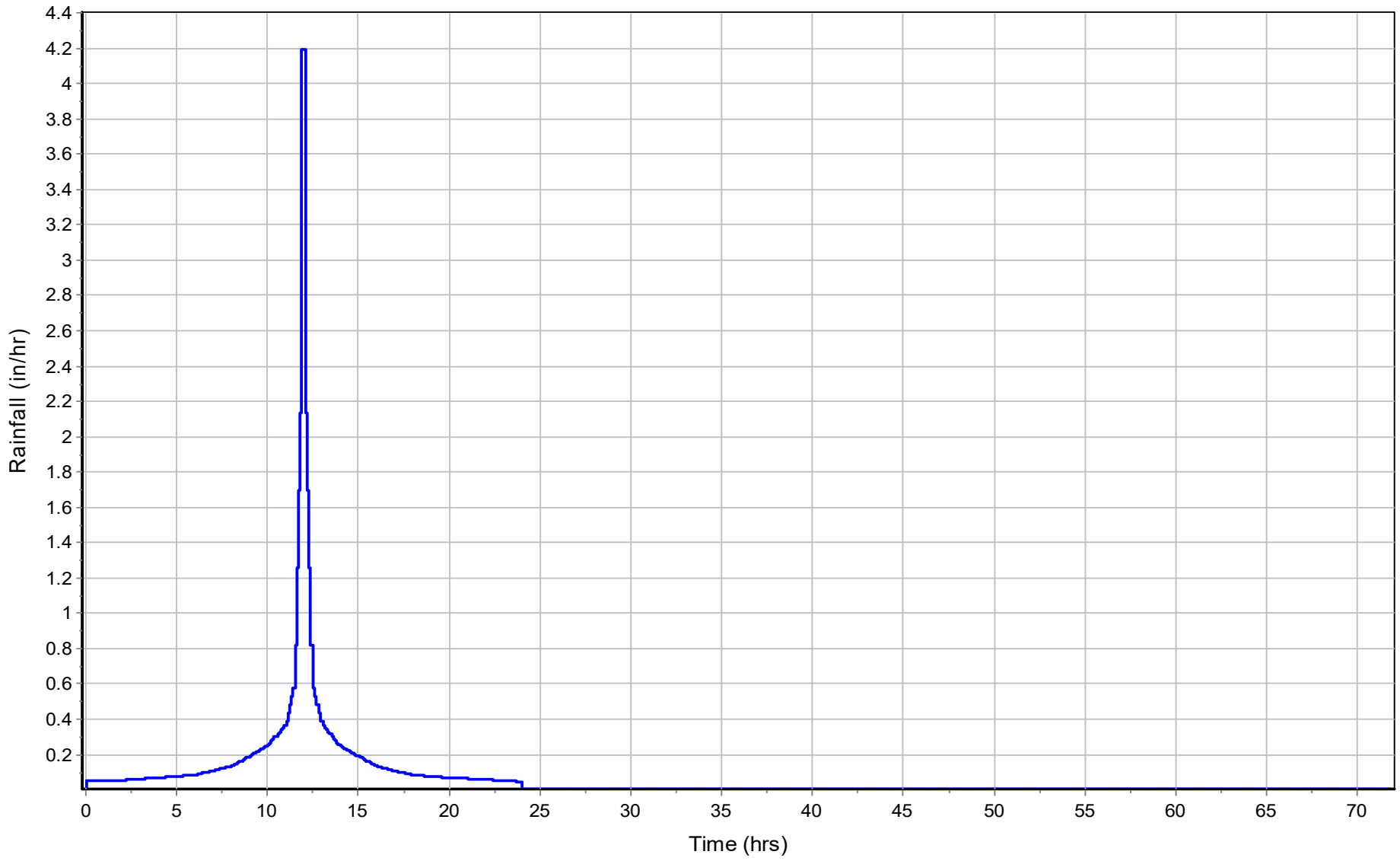
Total TOC (min) 0.79

Subbasin Runoff Results

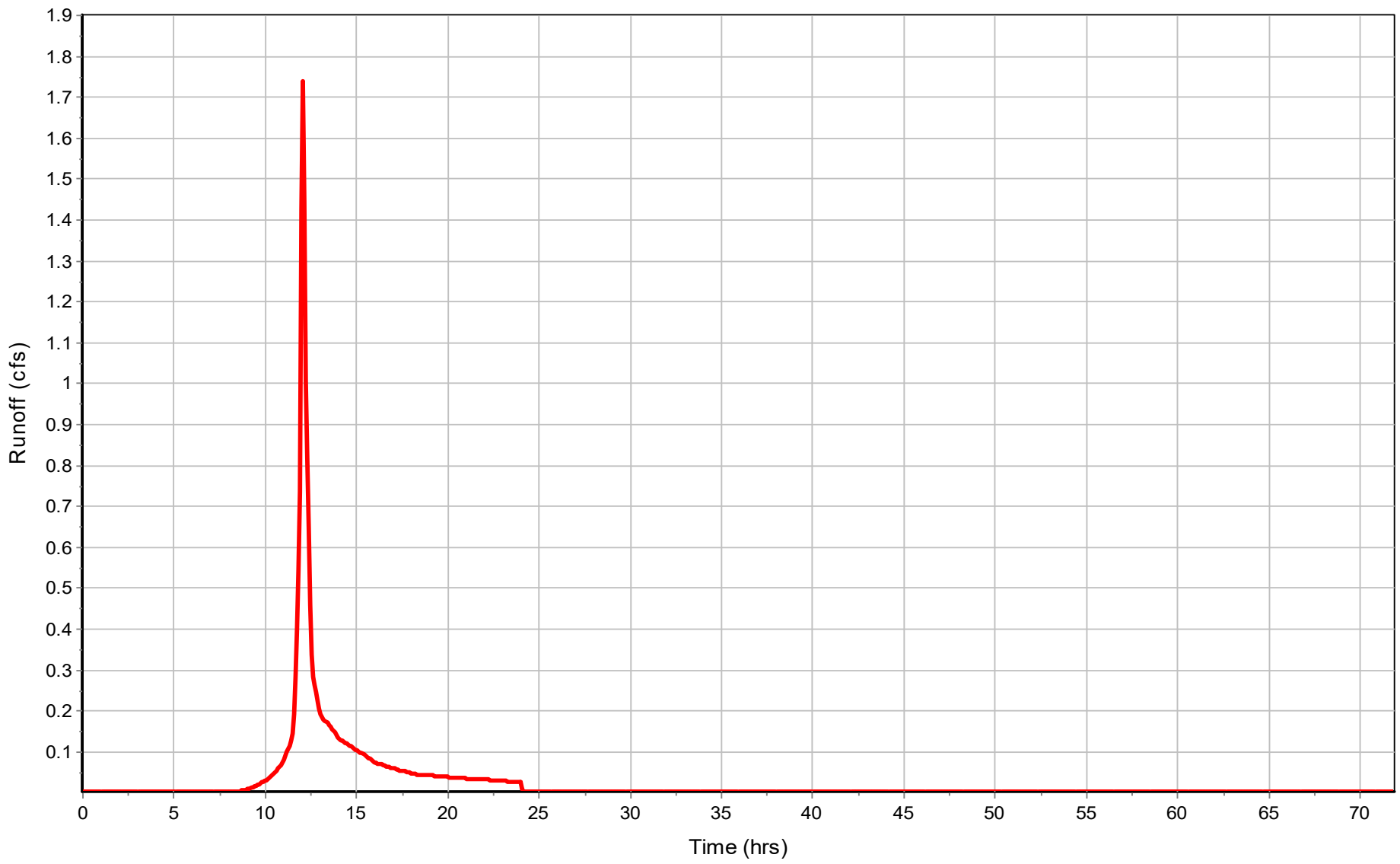
Total Rainfall (in) 4.99
Total Runoff (in) 2.53
Peak Runoff (cfs) 1.79
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:00:47

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

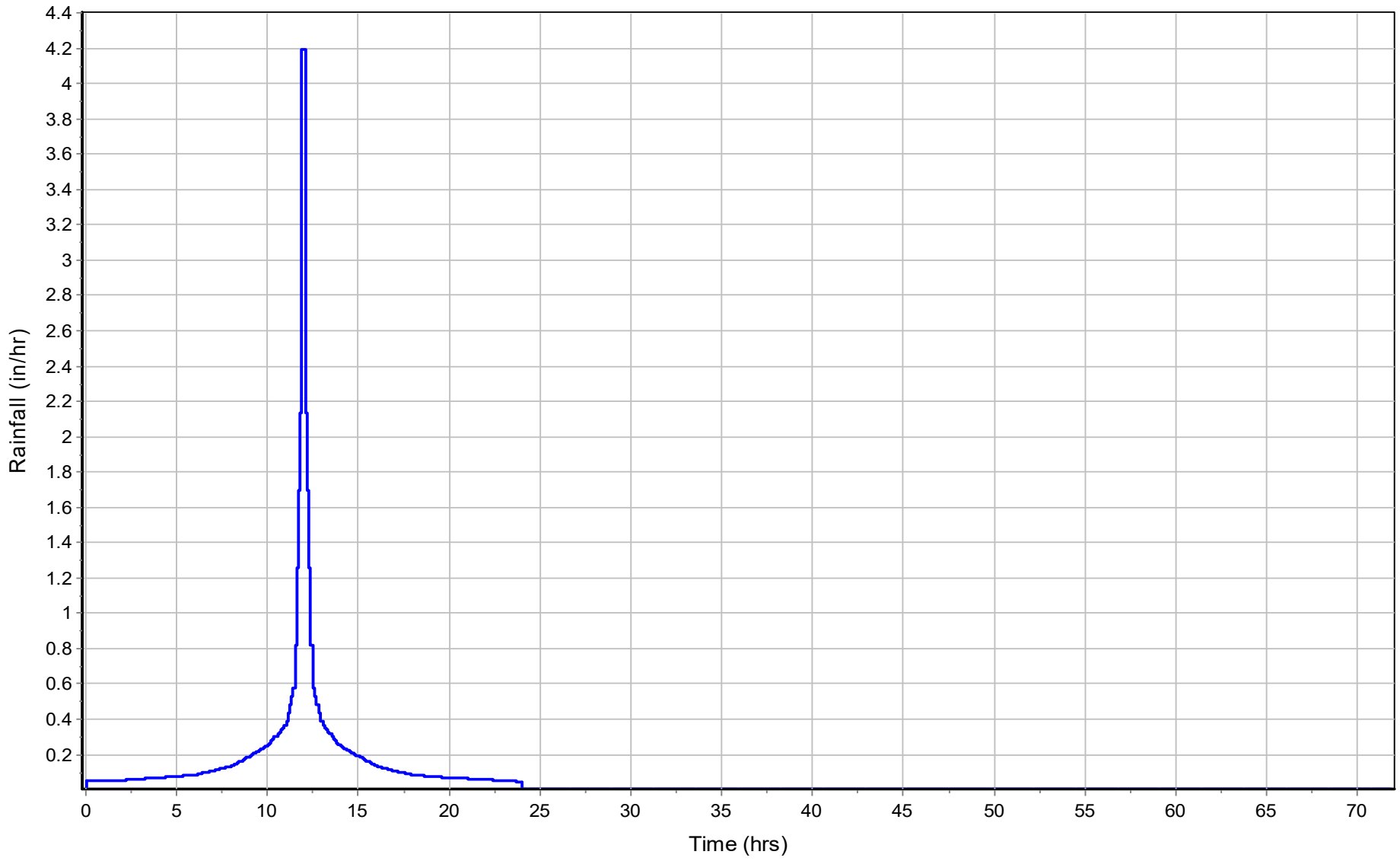
Total TOC (min) 28.81

Subbasin Runoff Results

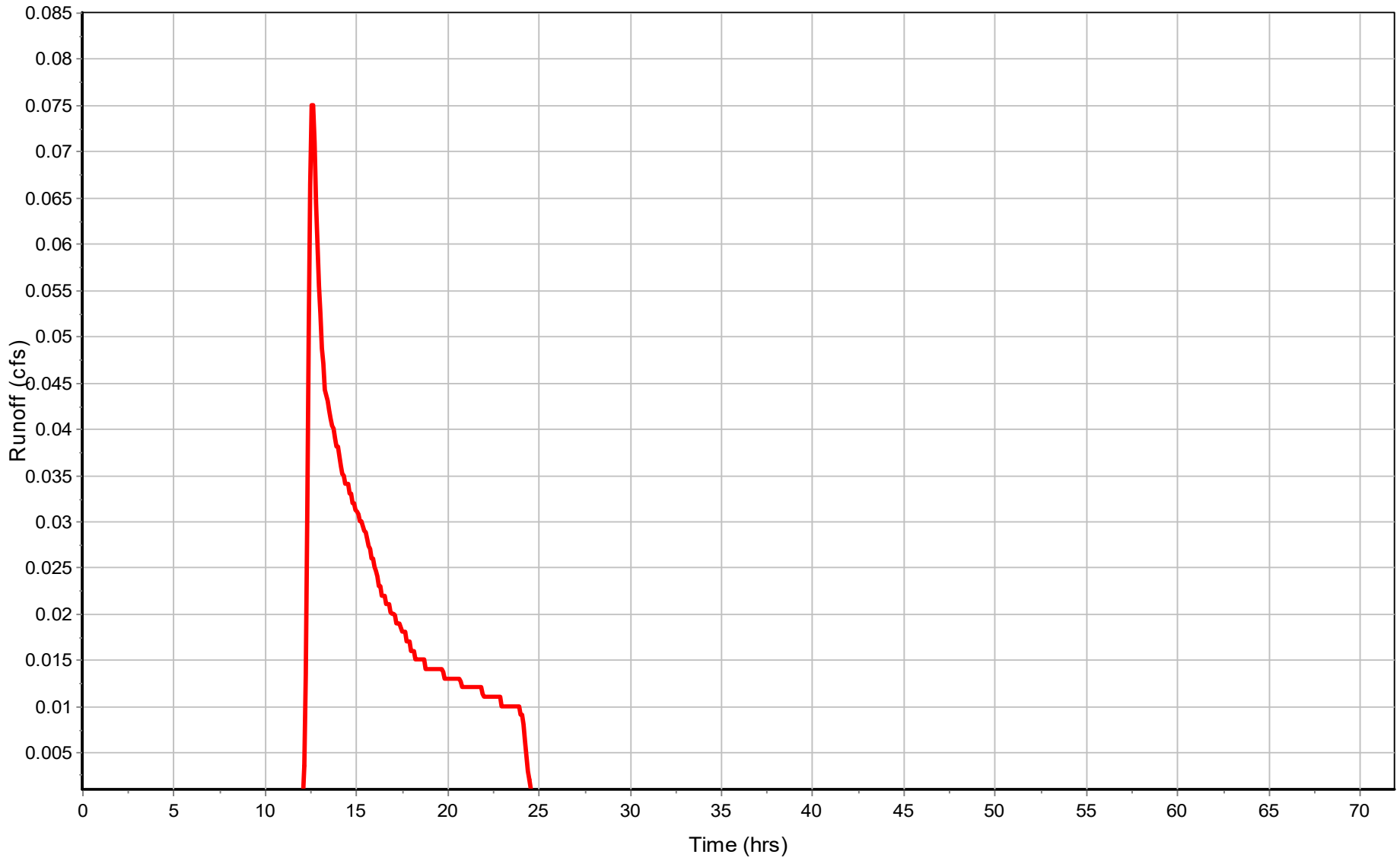
Total Rainfall (in) 4.99
Total Runoff (in) 0.35
Peak Runoff (cfs) 0.08
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:28:49

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

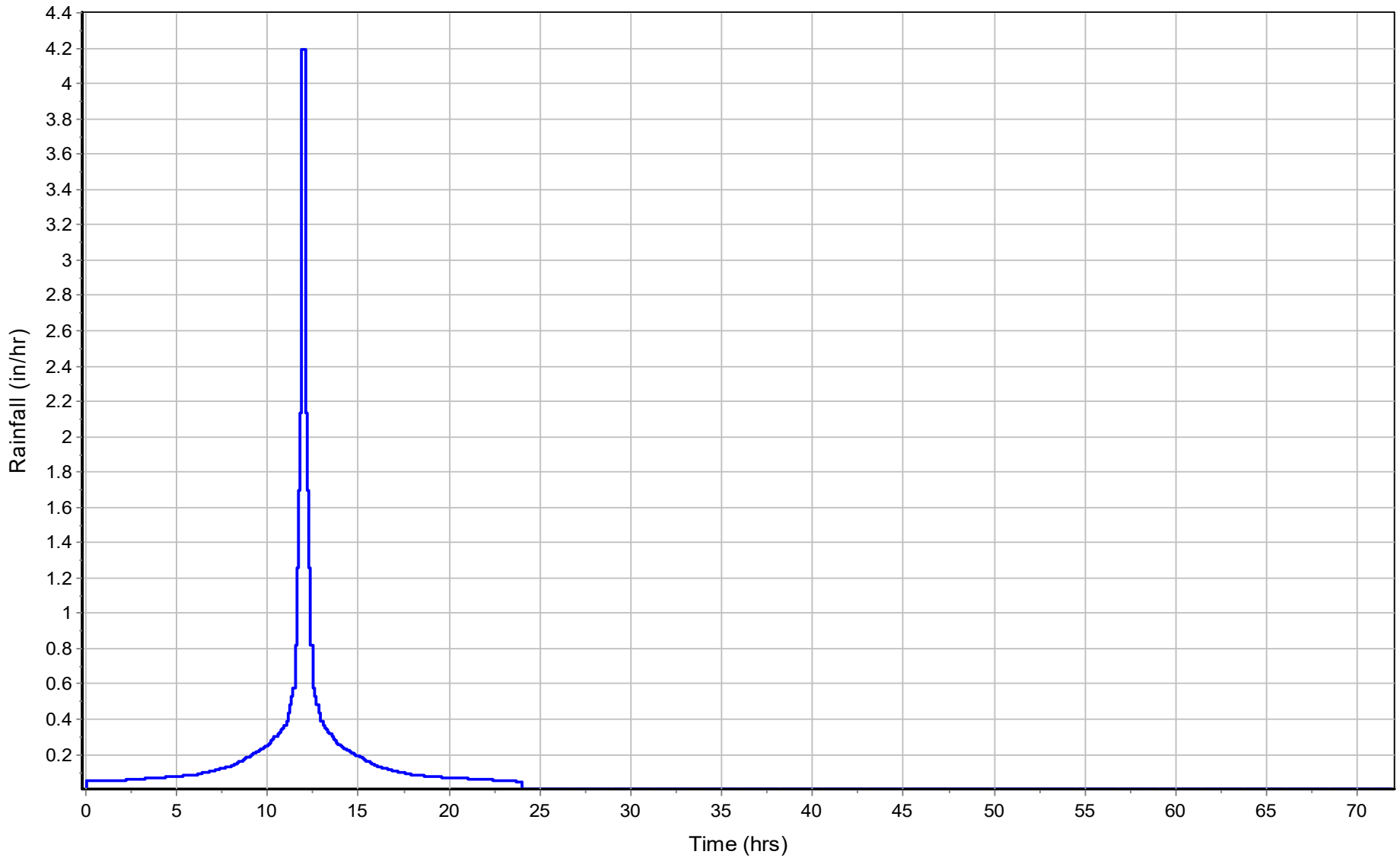
Total TOC (min) 17.94

Subbasin Runoff Results

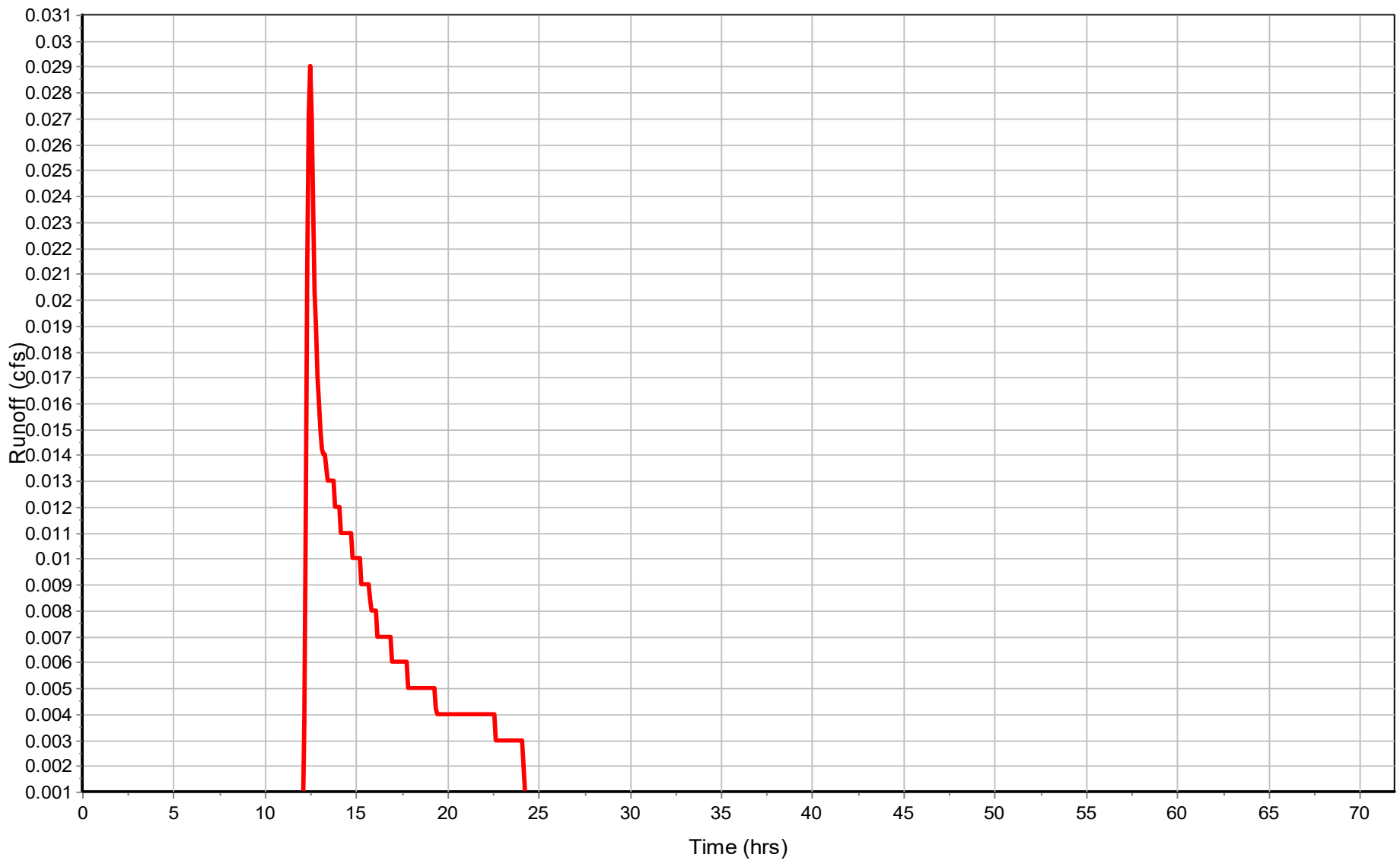
Total Rainfall (in) 4.99
Total Runoff (in) 0.35
Peak Runoff (cfs) 0.03
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:17:56

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

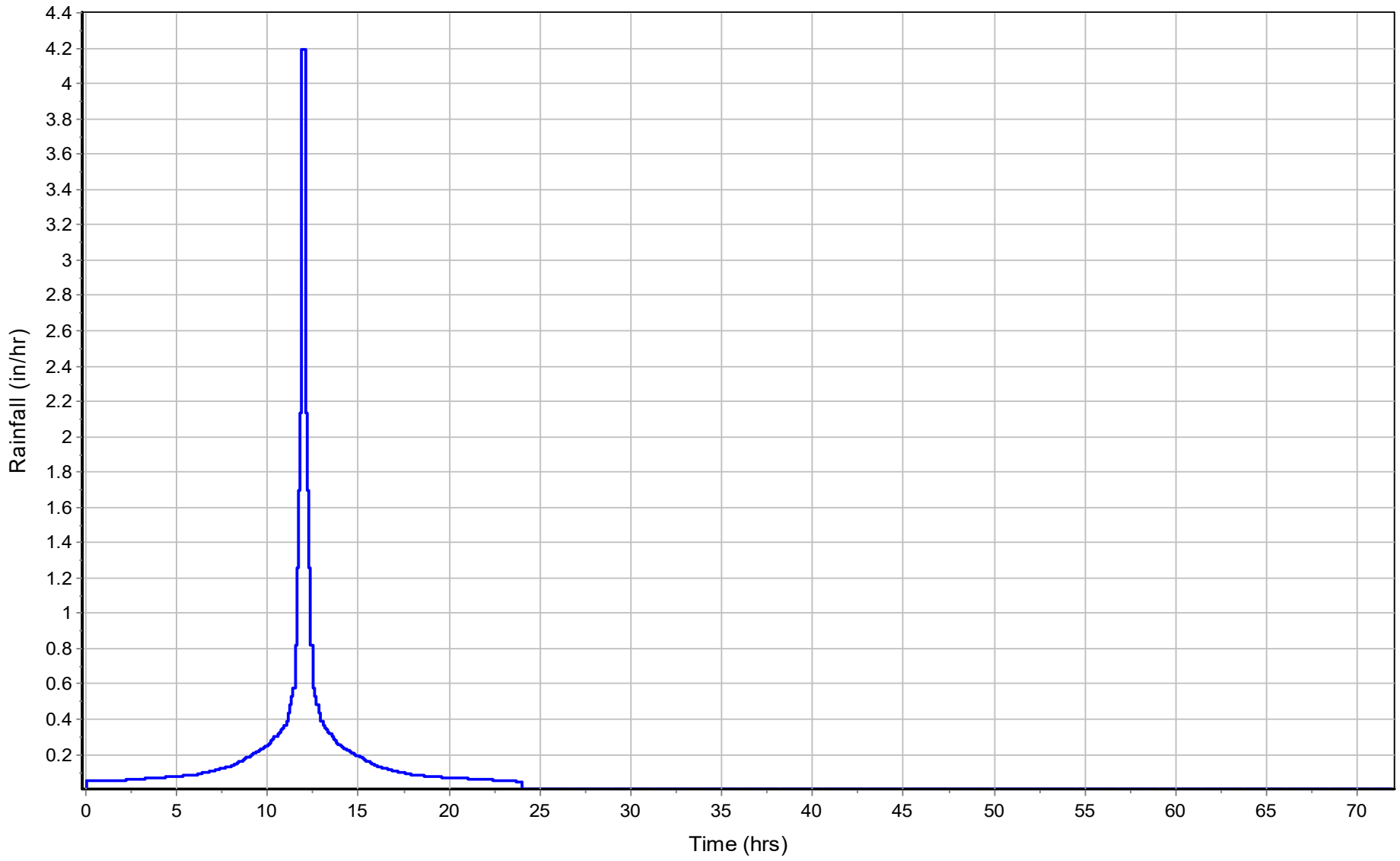
Total TOC (min) 17.48

Subbasin Runoff Results

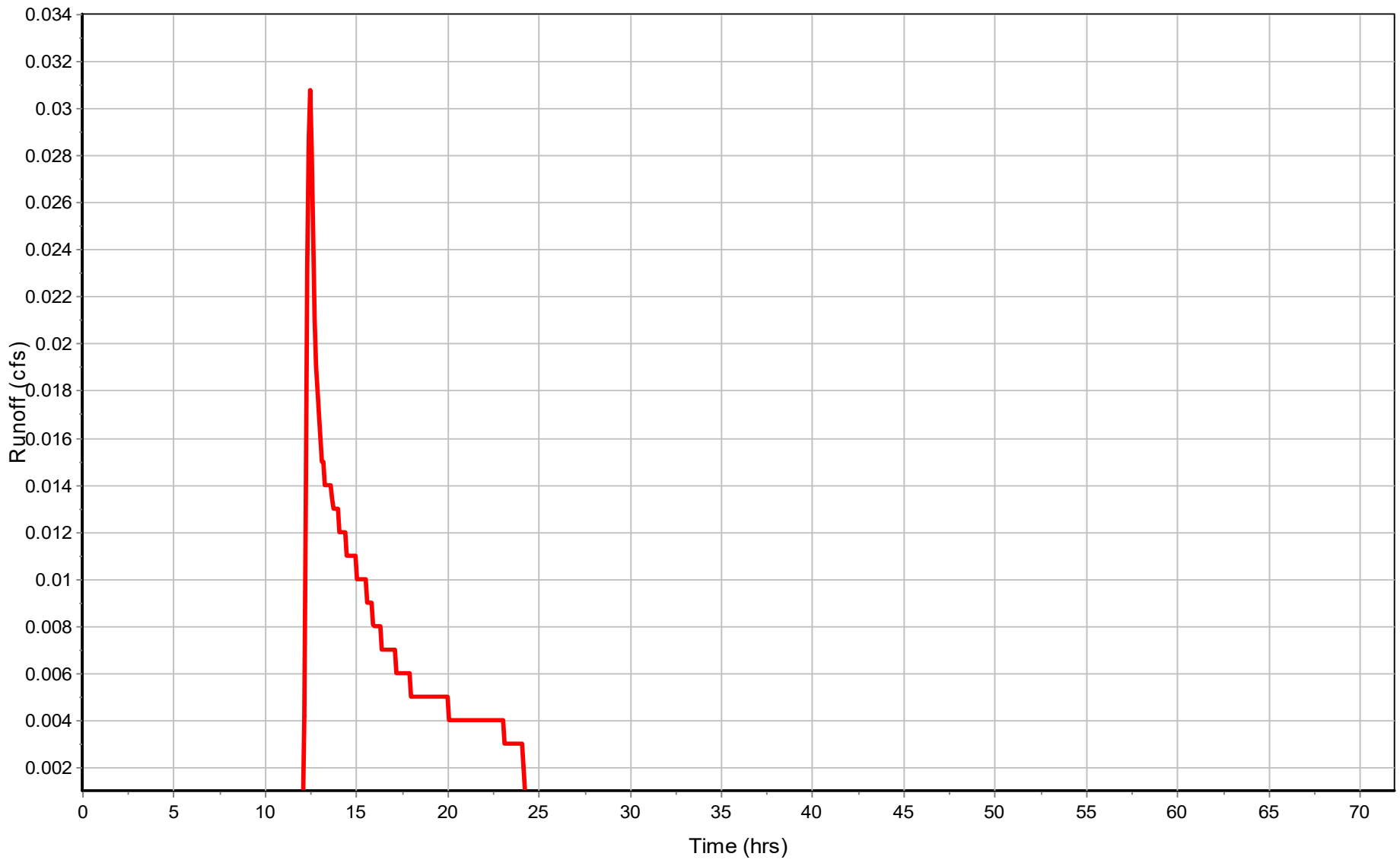
Total Rainfall (in) 4.99
Total Runoff (in) 0.35
Peak Runoff (cfs) 0.03
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:17:29

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

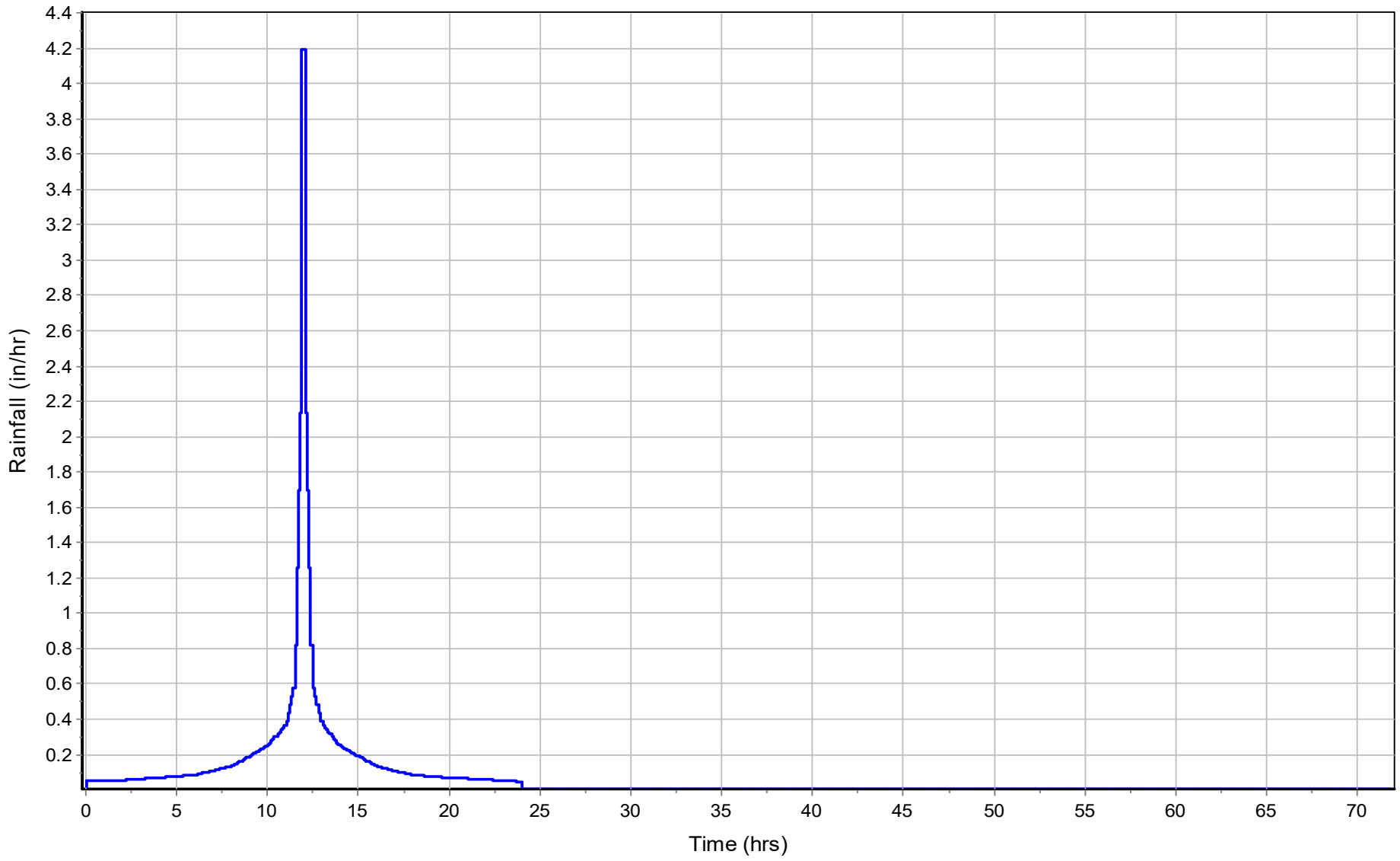
Total TOC (min) 21.50

Subbasin Runoff Results

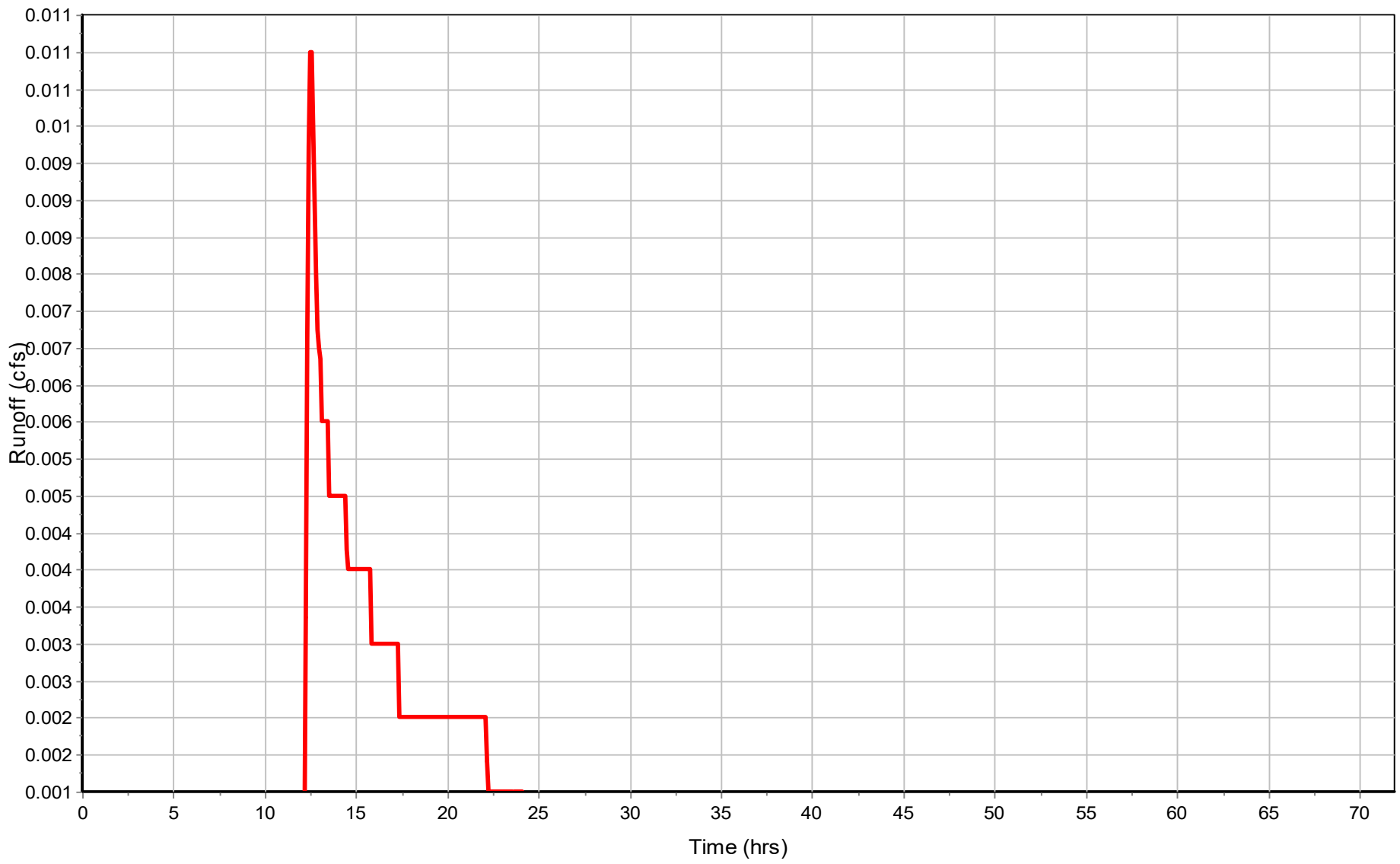
Total Rainfall (in) 4.99
Total Runoff (in) 0.35
Peak Runoff (cfs) 0.01
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:21:30

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

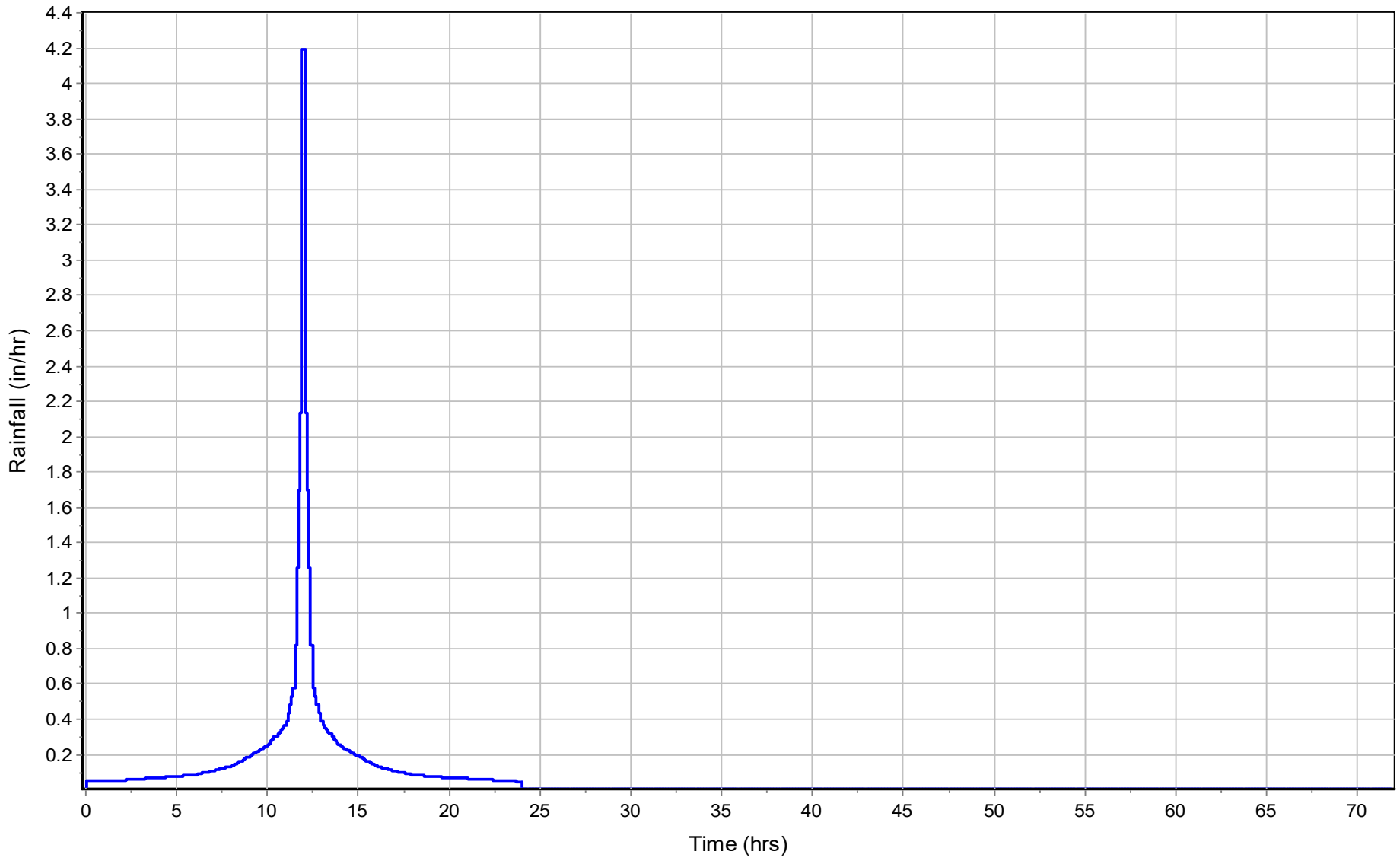
Total TOC (min) 9.01

Subbasin Runoff Results

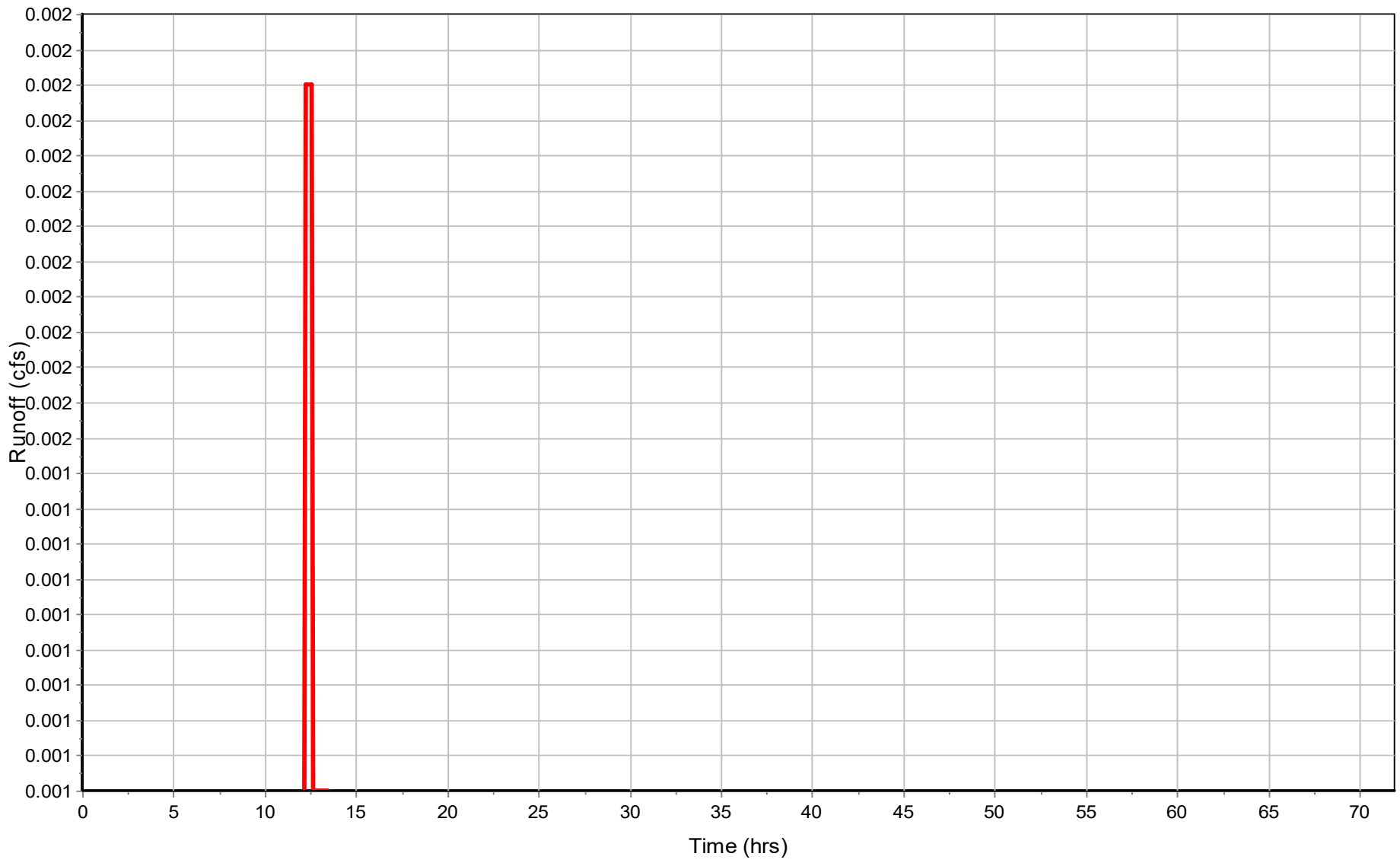
Total Rainfall (in) 4.99
Total Runoff (in) 0.1
Peak Runoff (cfs) 0
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:09:01

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

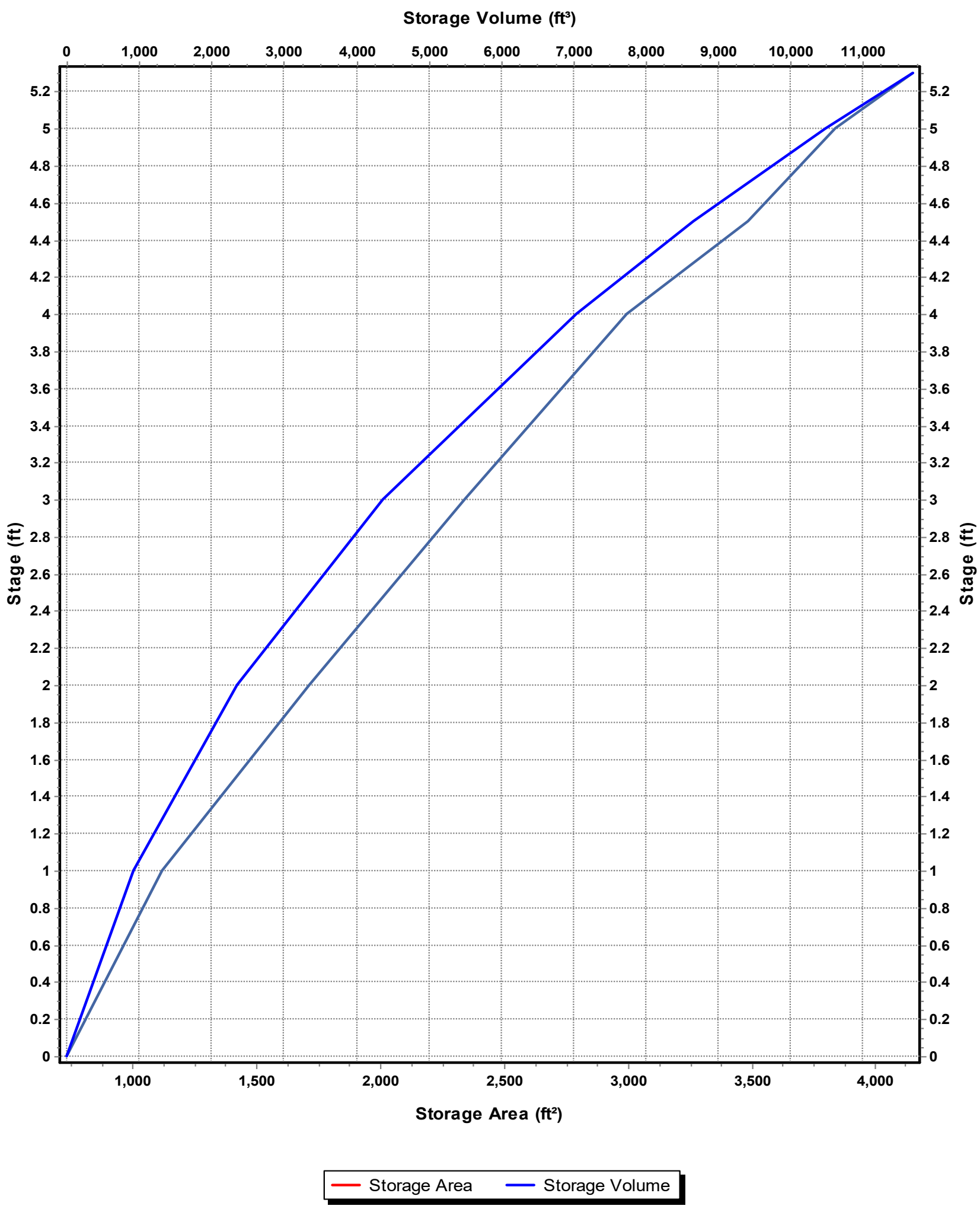
Invert Elevation (ft)	112.40
Max (Rim) Elevation (ft)	117.70
Max (Rim) Offset (ft)	5.30
Initial Water Elevation (ft)	112.40
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

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

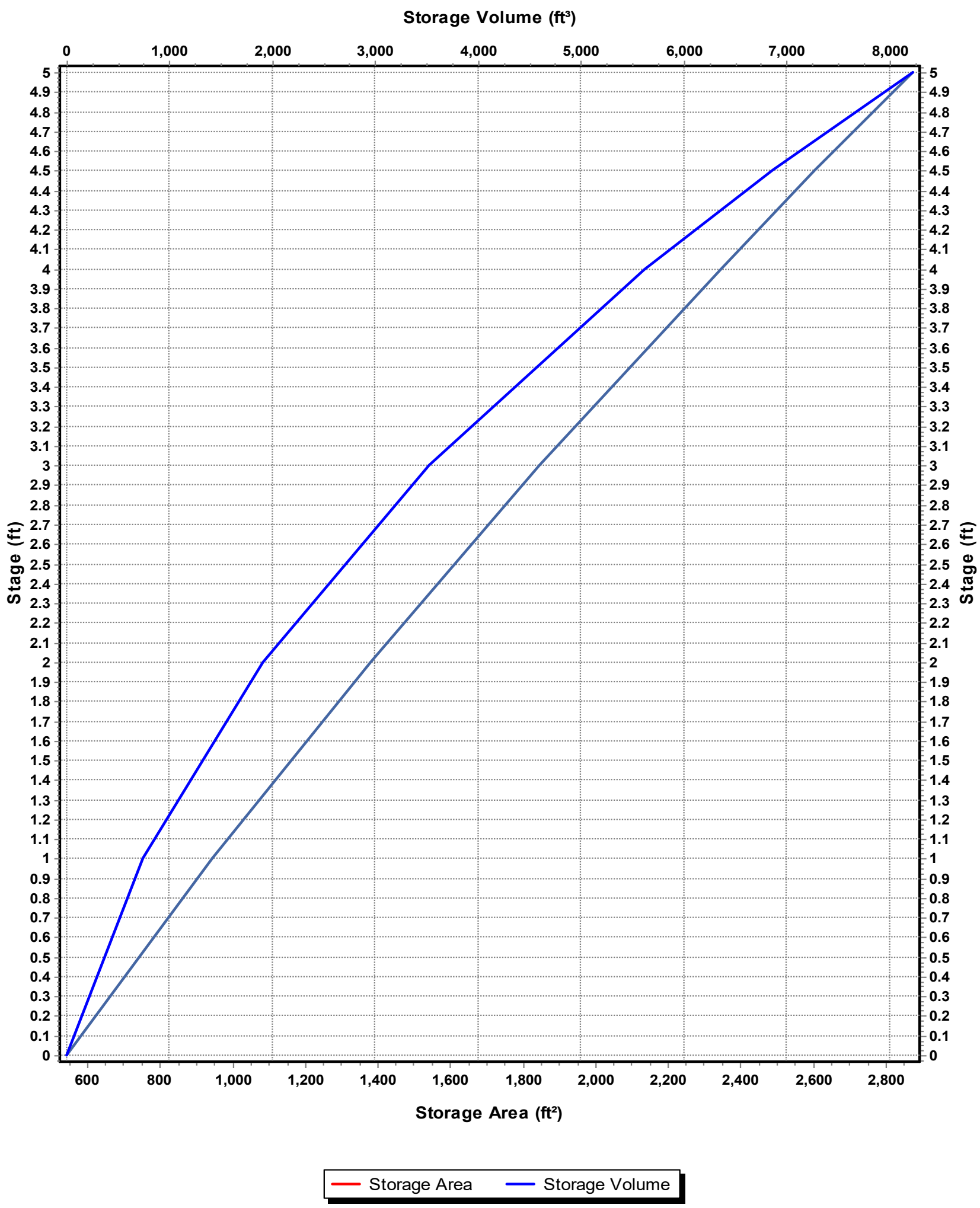
Invert Elevation (ft)	112.90
Max (Rim) Elevation (ft)	117.90
Max (Rim) Offset (ft)	5.00
Initial Water Elevation (ft)	112.90
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

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

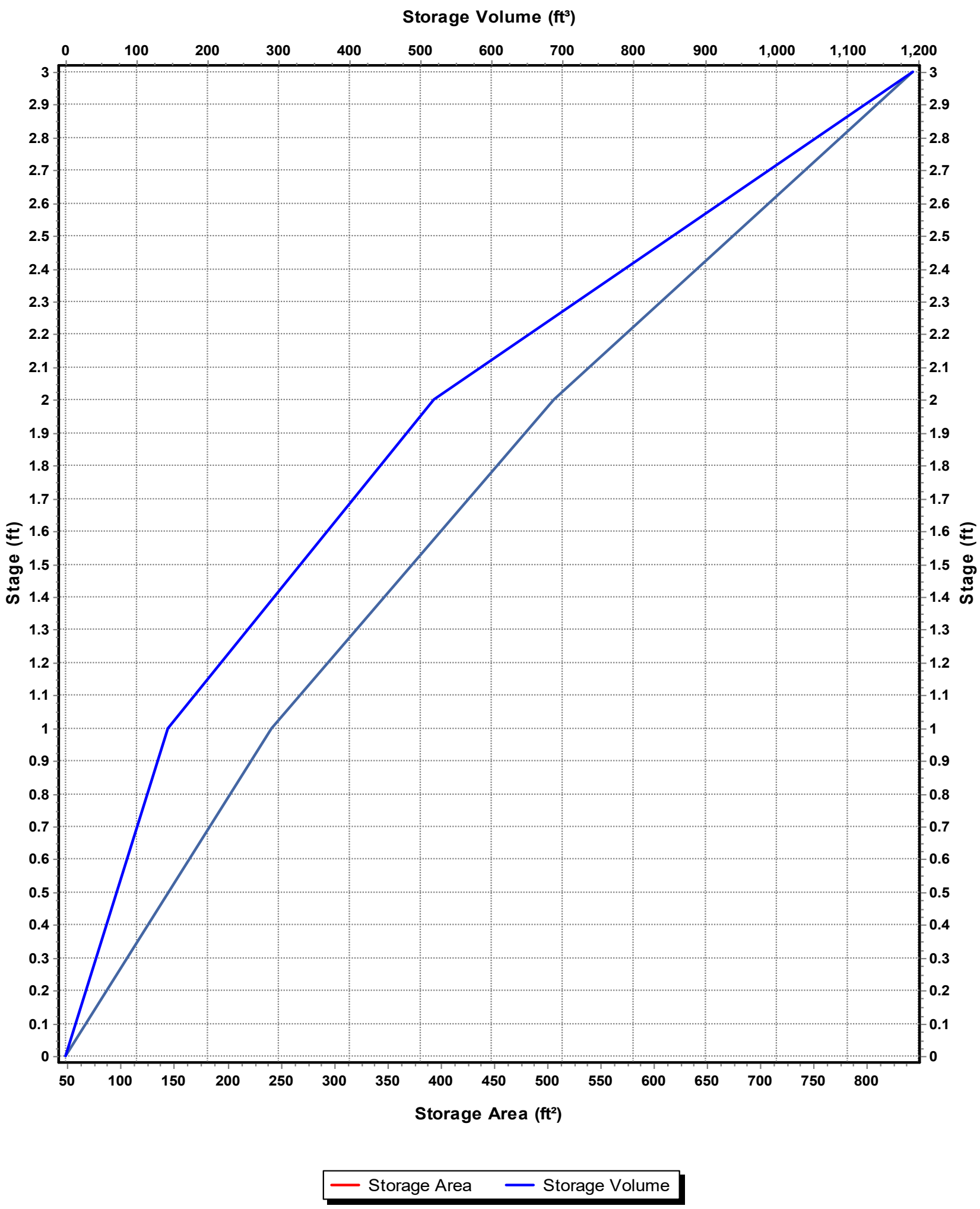
Invert Elevation (ft)	114.40
Max (Rim) Elevation (ft)	117.70
Max (Rim) Offset (ft)	3.30
Initial Water Elevation (ft)	114.40
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

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

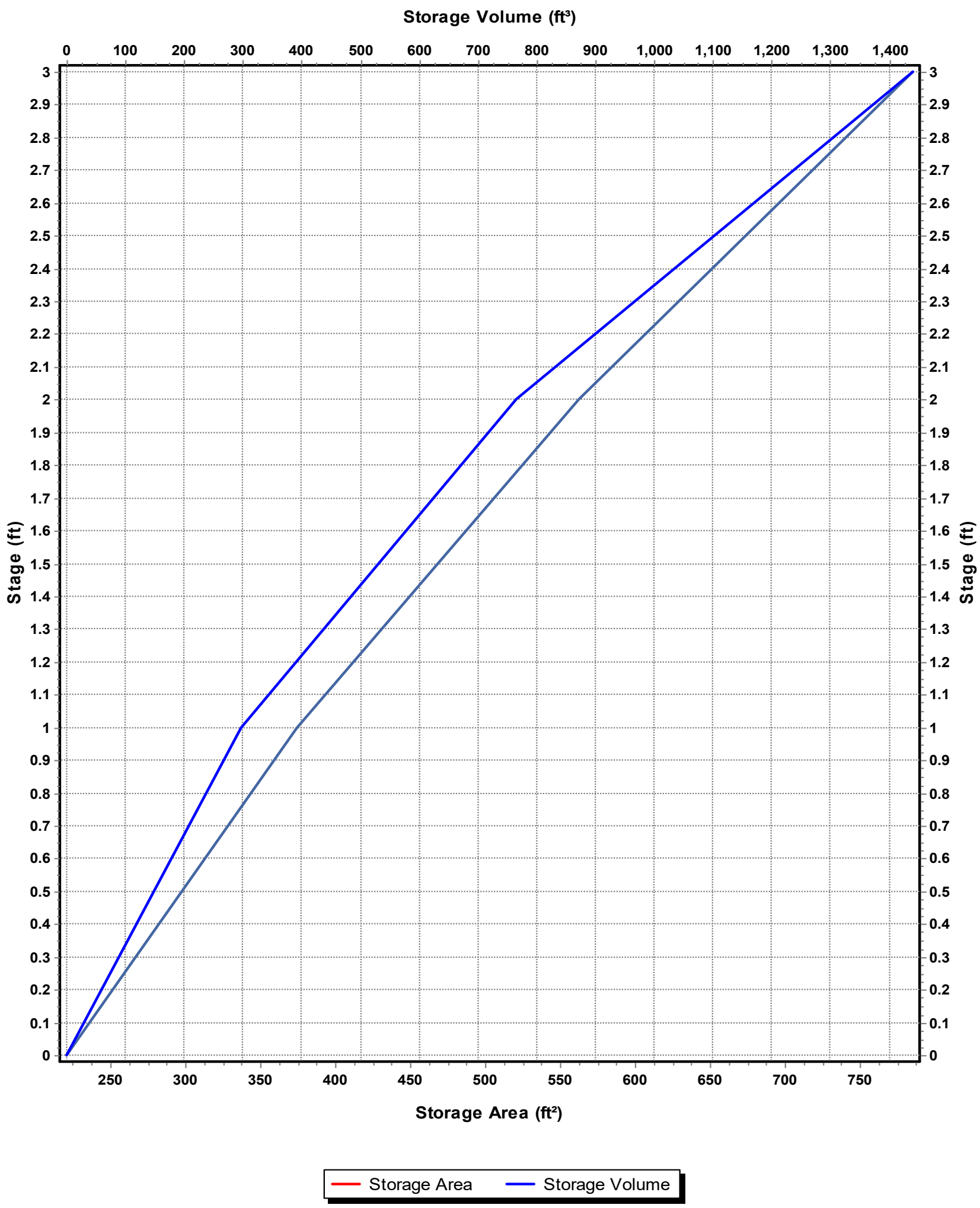
Invert Elevation (ft)	114.90
Max (Rim) Elevation (ft)	117.90
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.90
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

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

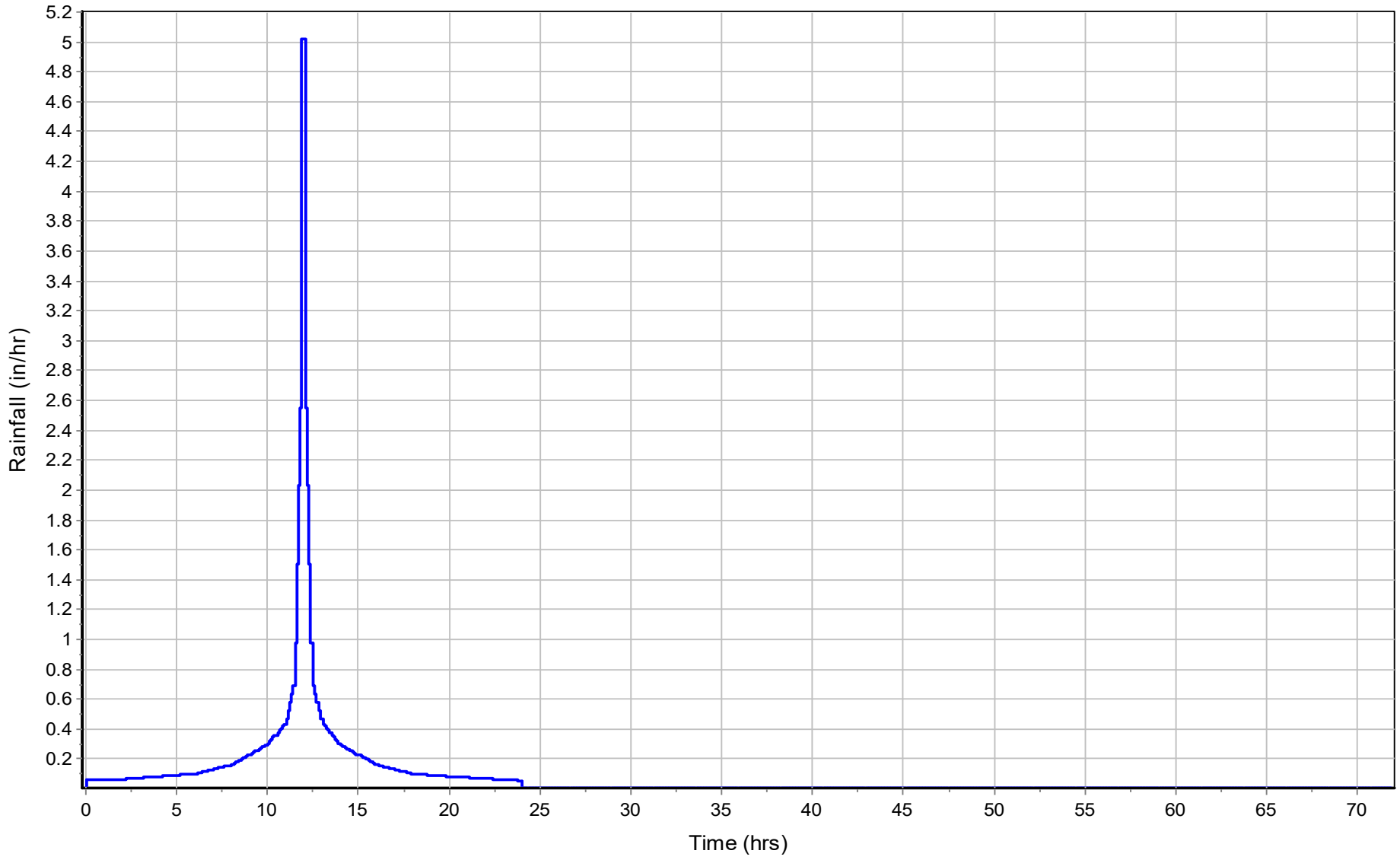
Total TOC (min) 5.38

Subbasin Runoff Results

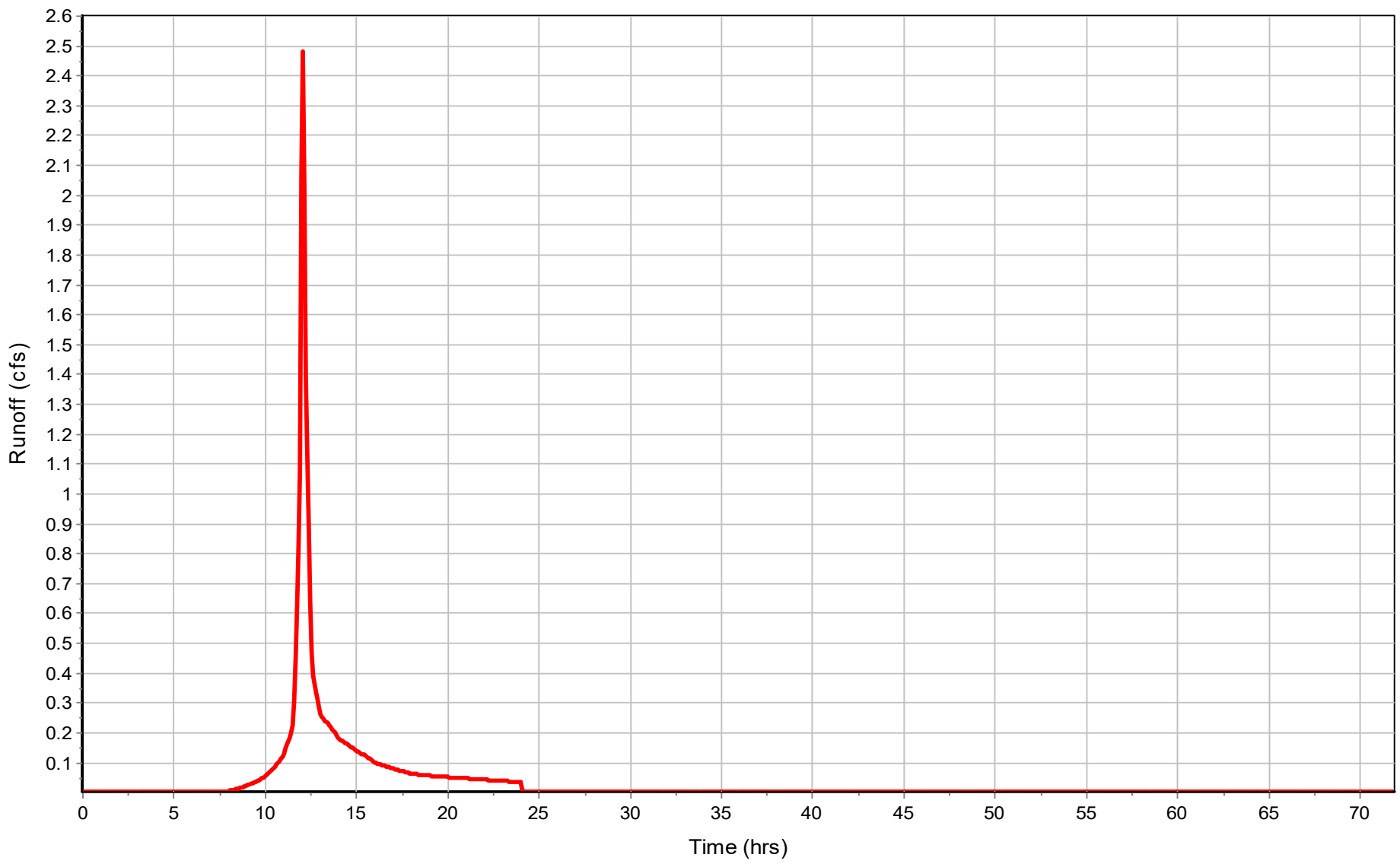
Total Rainfall (in)	5.97
Total Runoff (in)	3.35
Peak Runoff (cfs)	2.54
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:05:23

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

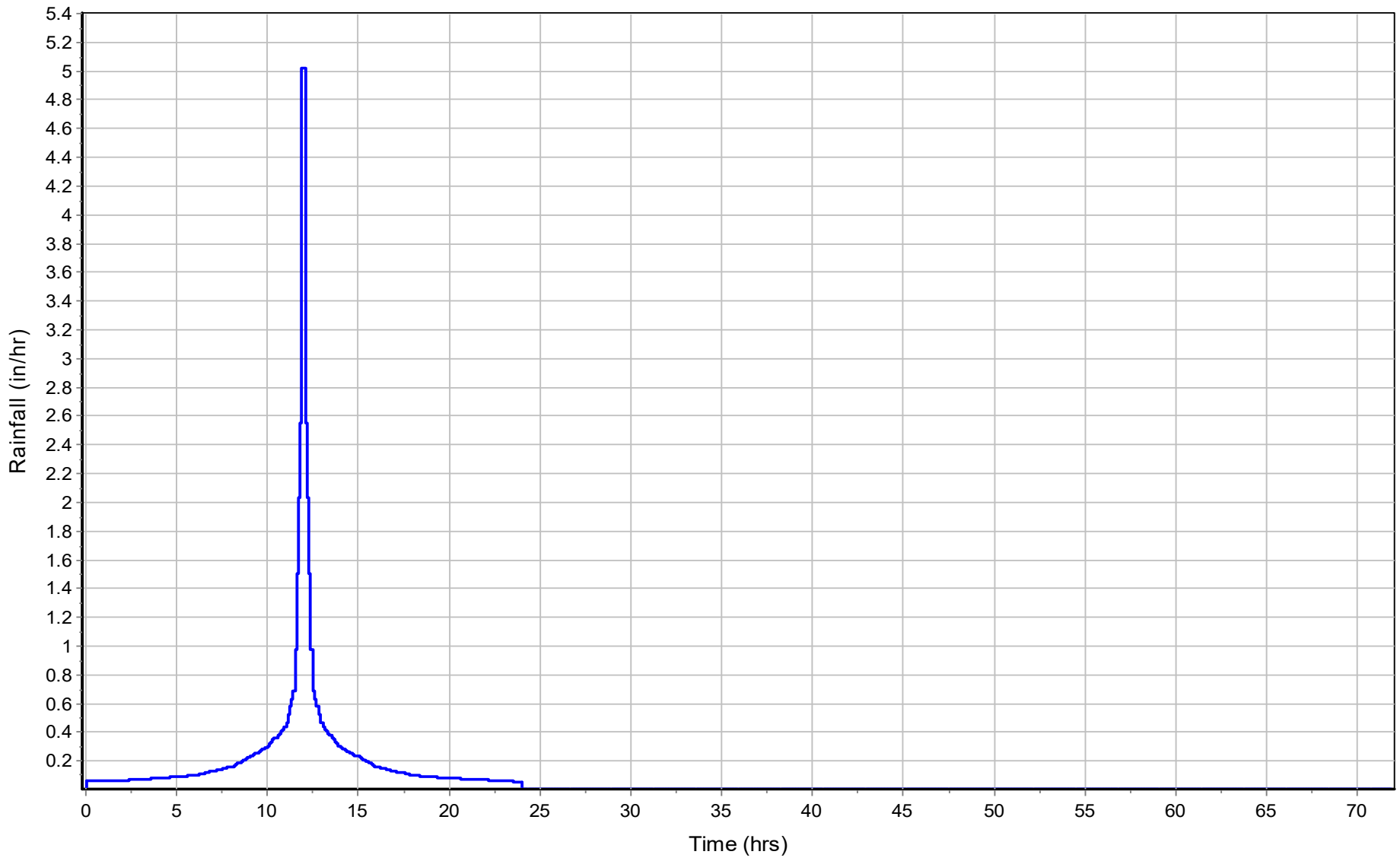
Total TOC (min) 0.79

Subbasin Runoff Results

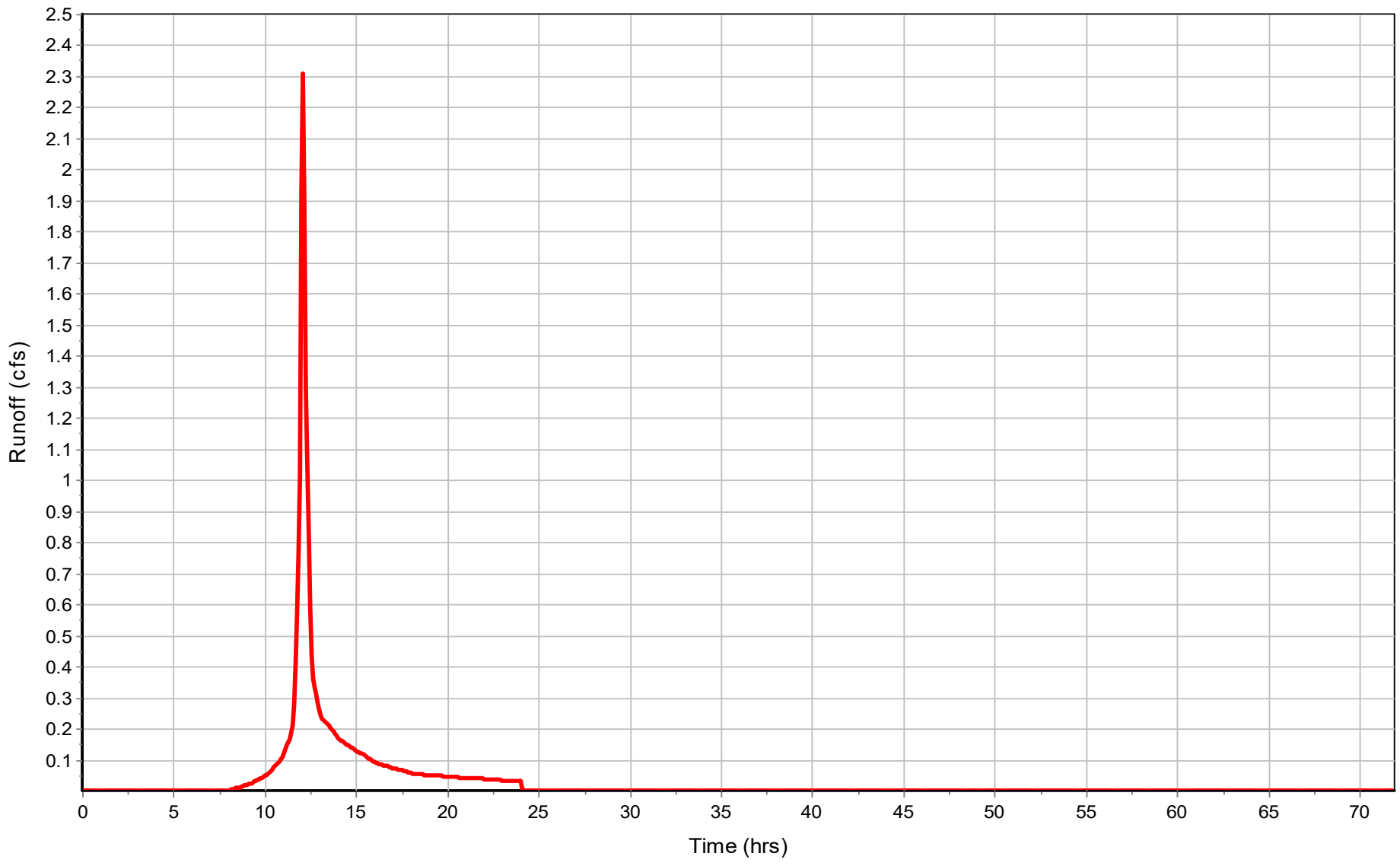
Total Rainfall (in) 5.97
Total Runoff (in) 3.35
Peak Runoff (cfs) 2.36
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:00:47

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

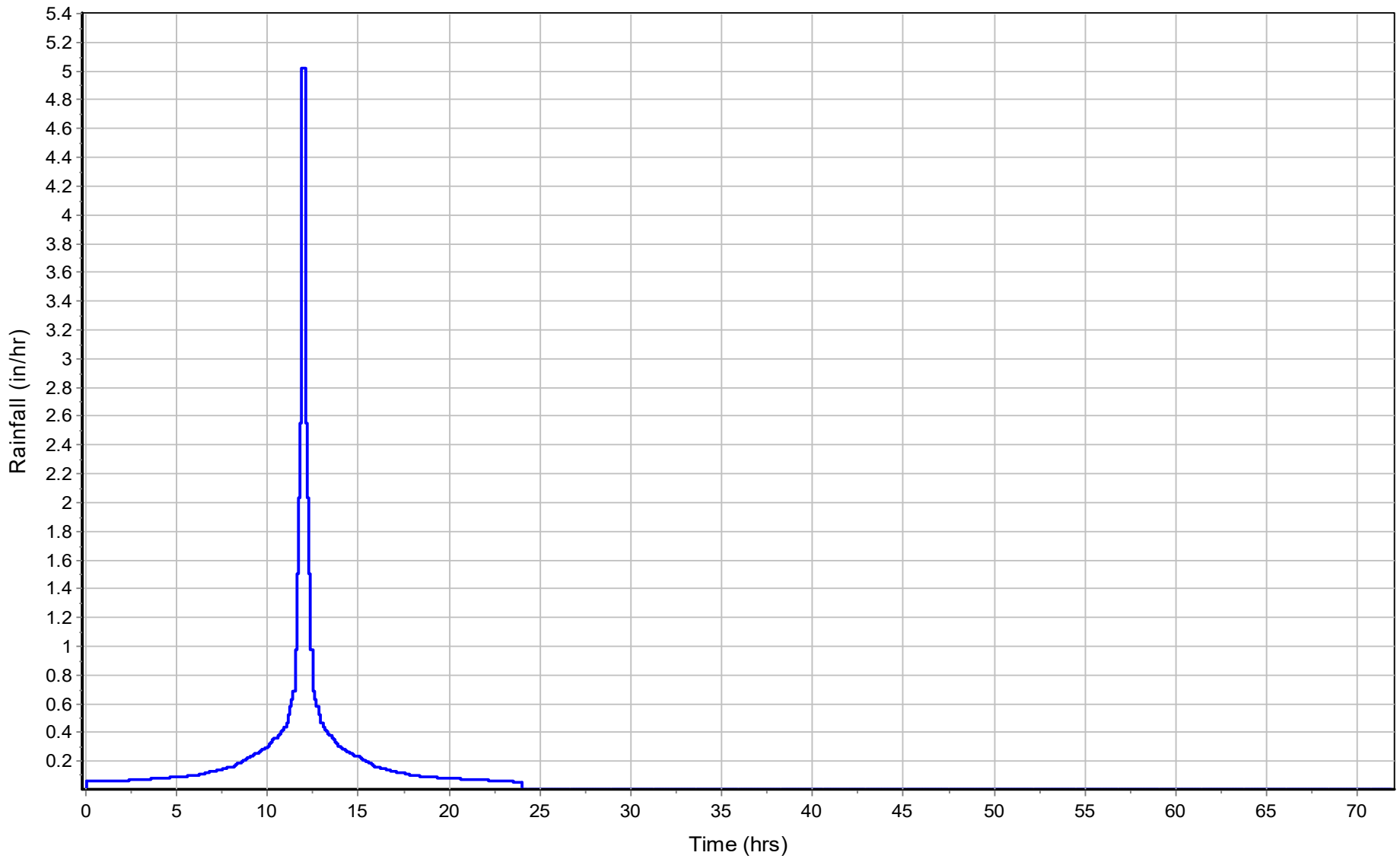
Total TOC (min) 28.81

Subbasin Runoff Results

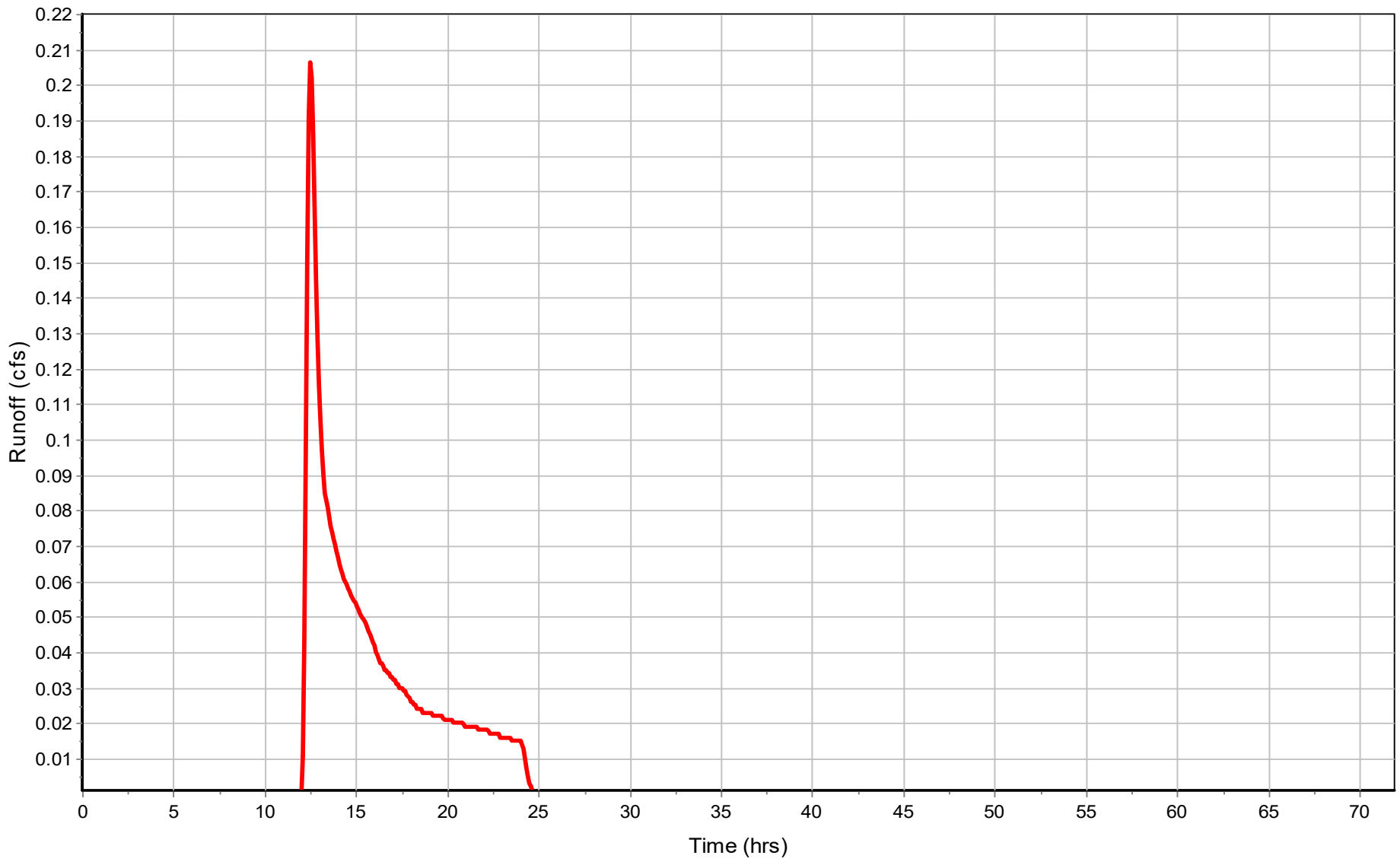
Total Rainfall (in) 5.97
Total Runoff (in) 0.66
Peak Runoff (cfs) 0.21
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:28:49

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

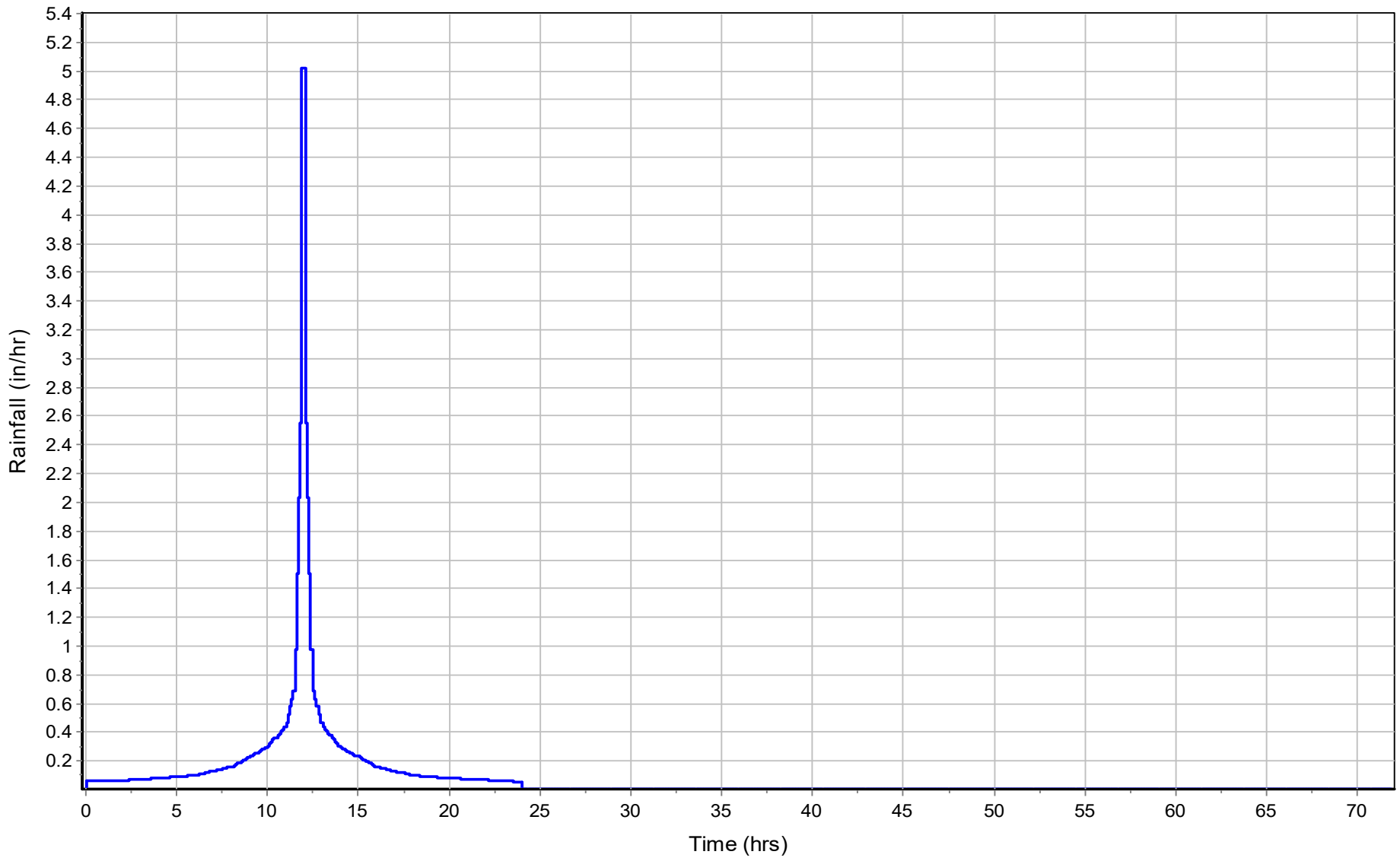
Total TOC (min) 17.94

Subbasin Runoff Results

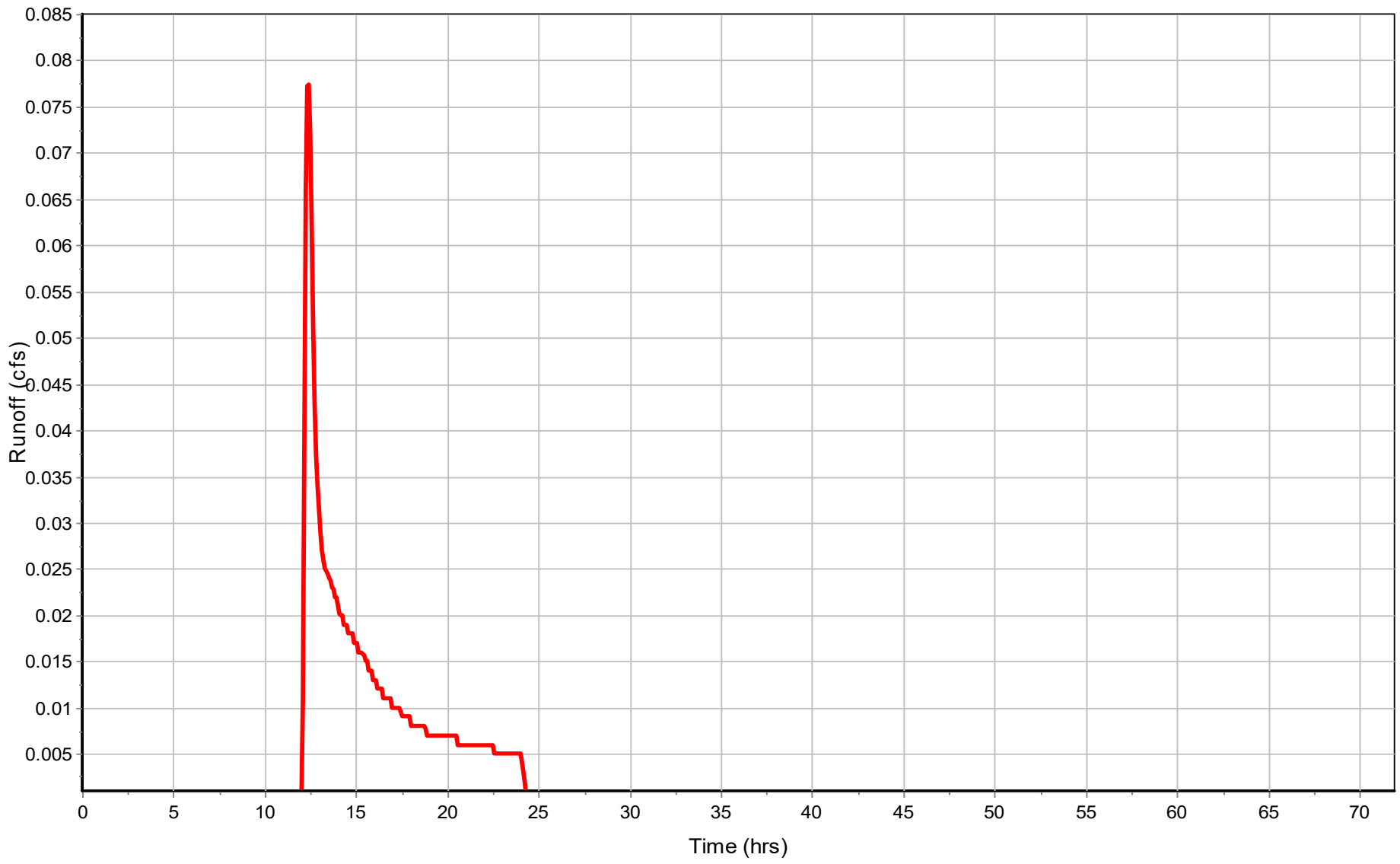
Total Rainfall (in) 5.97
Total Runoff (in) 0.66
Peak Runoff (cfs) 0.08
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:17:56

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

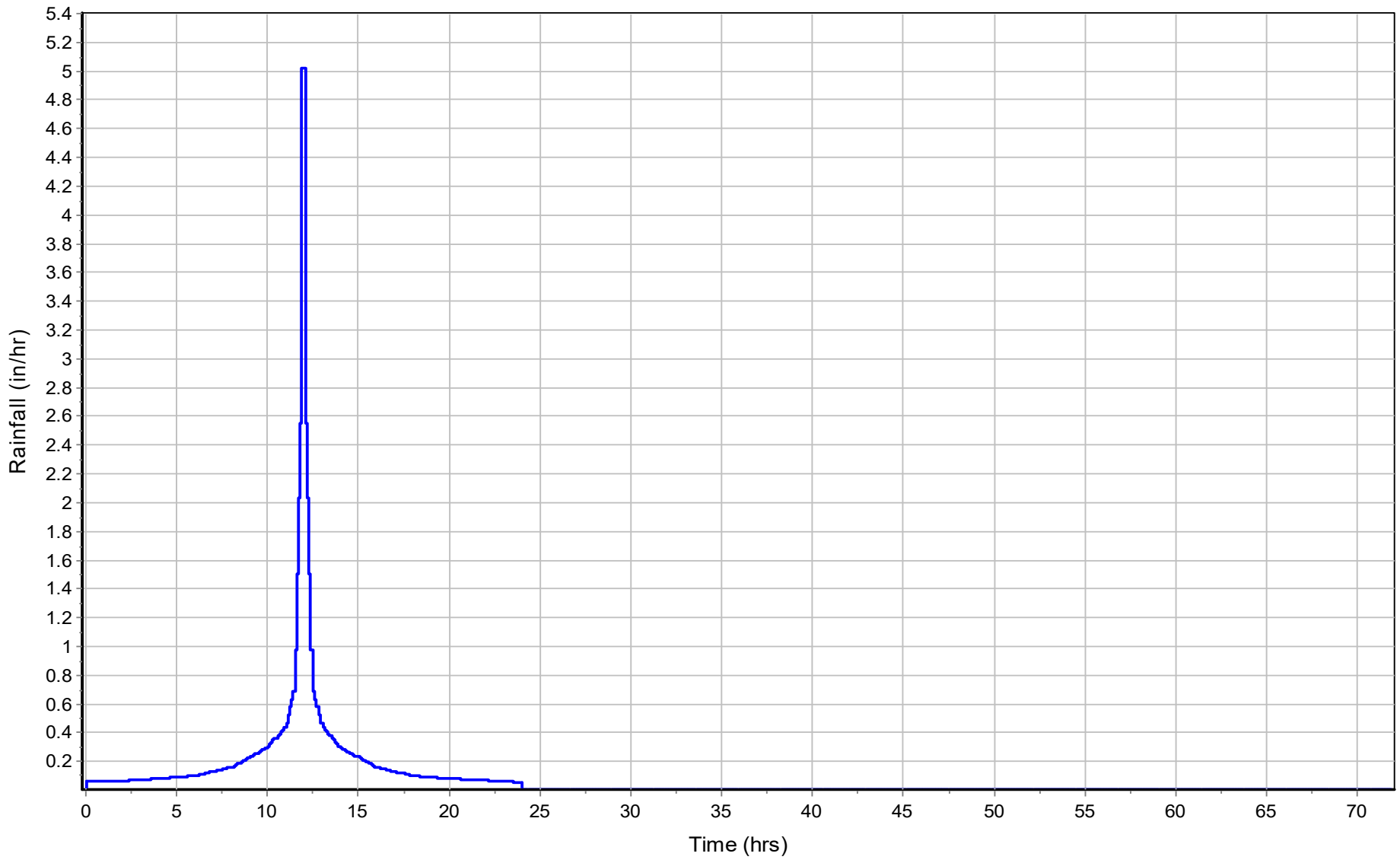
Total TOC (min) 17.48

Subbasin Runoff Results

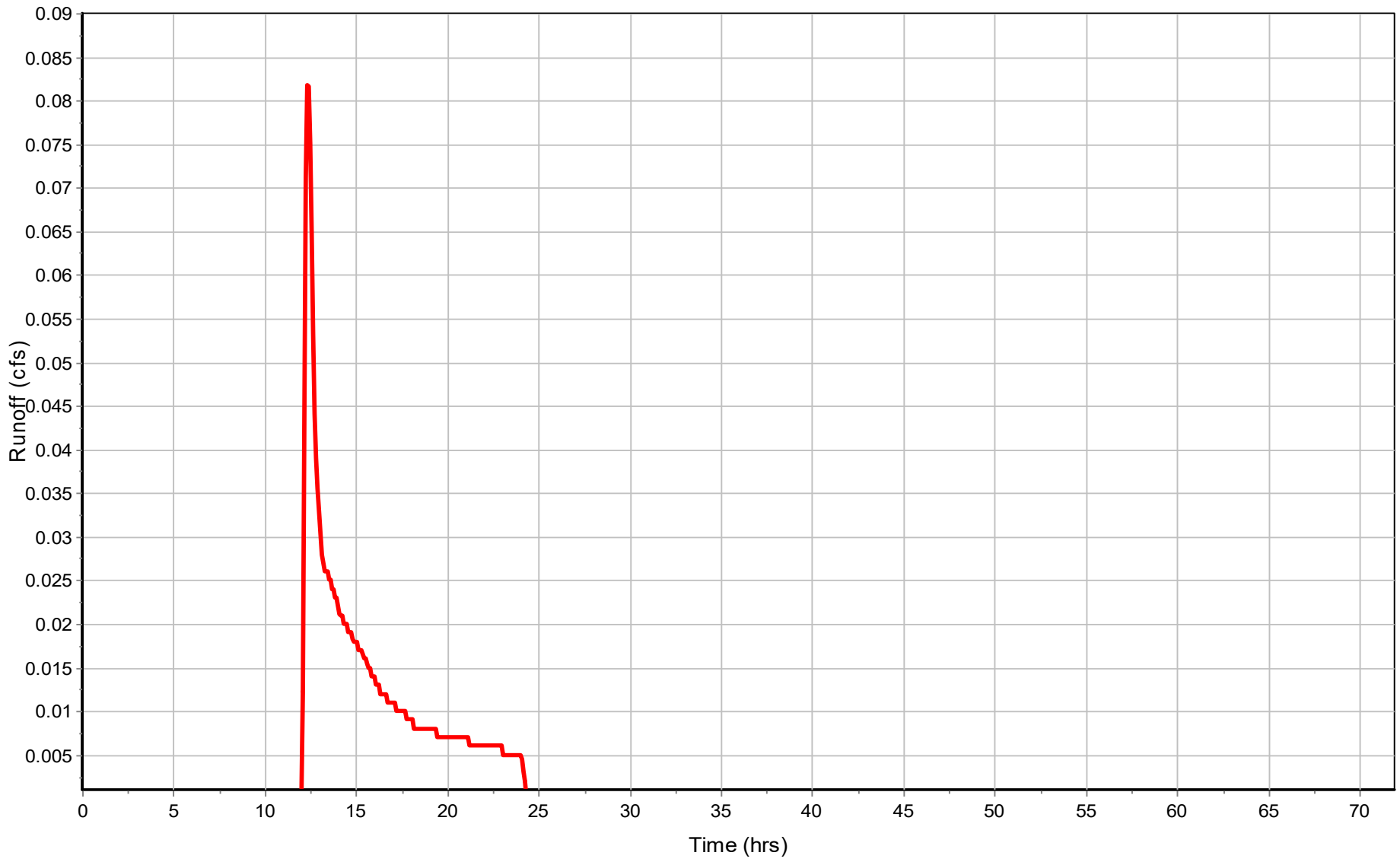
Total Rainfall (in) 5.97
Total Runoff (in) 0.66
Peak Runoff (cfs) 0.08
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:17:29

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

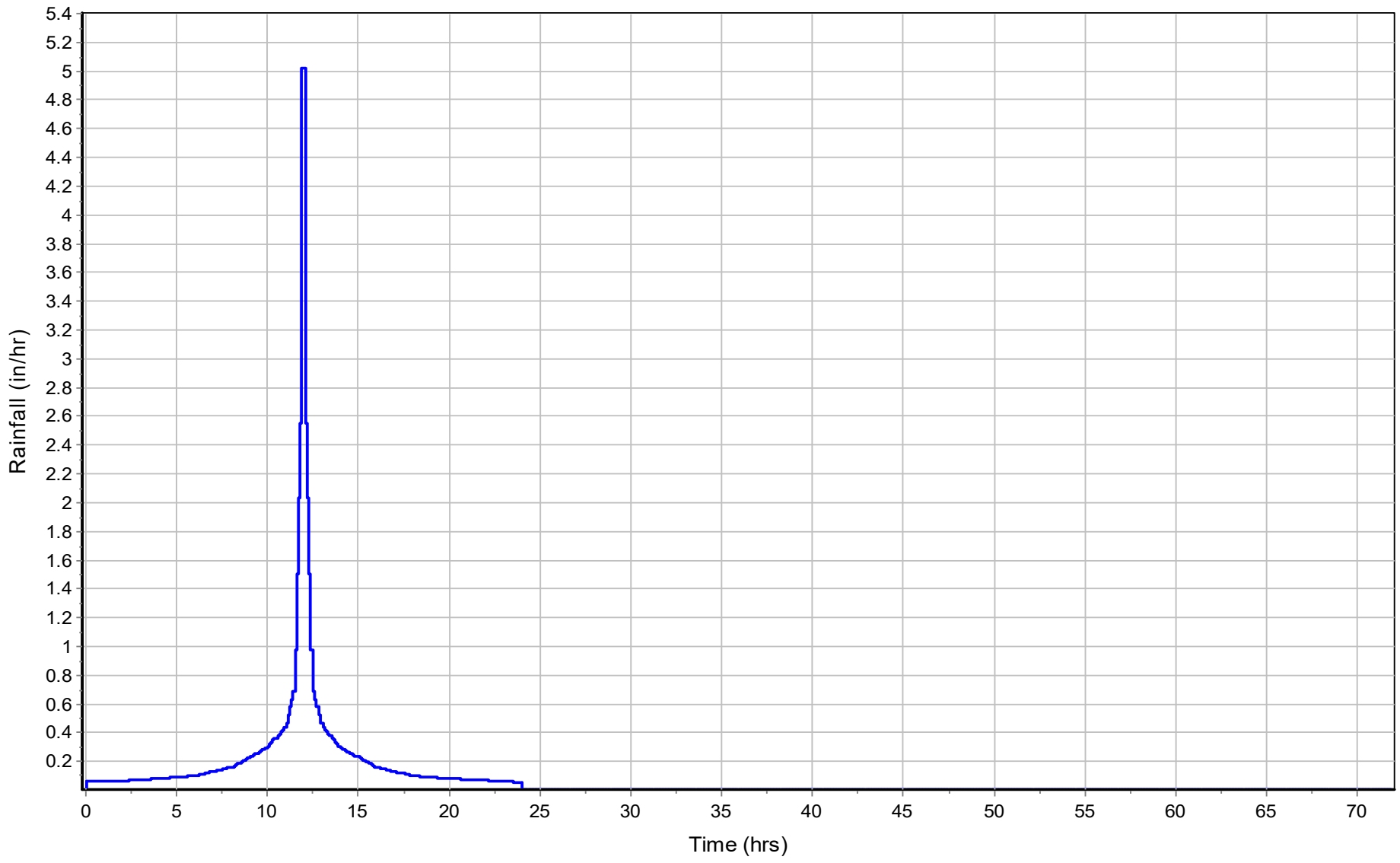
Total TOC (min) 21.50

Subbasin Runoff Results

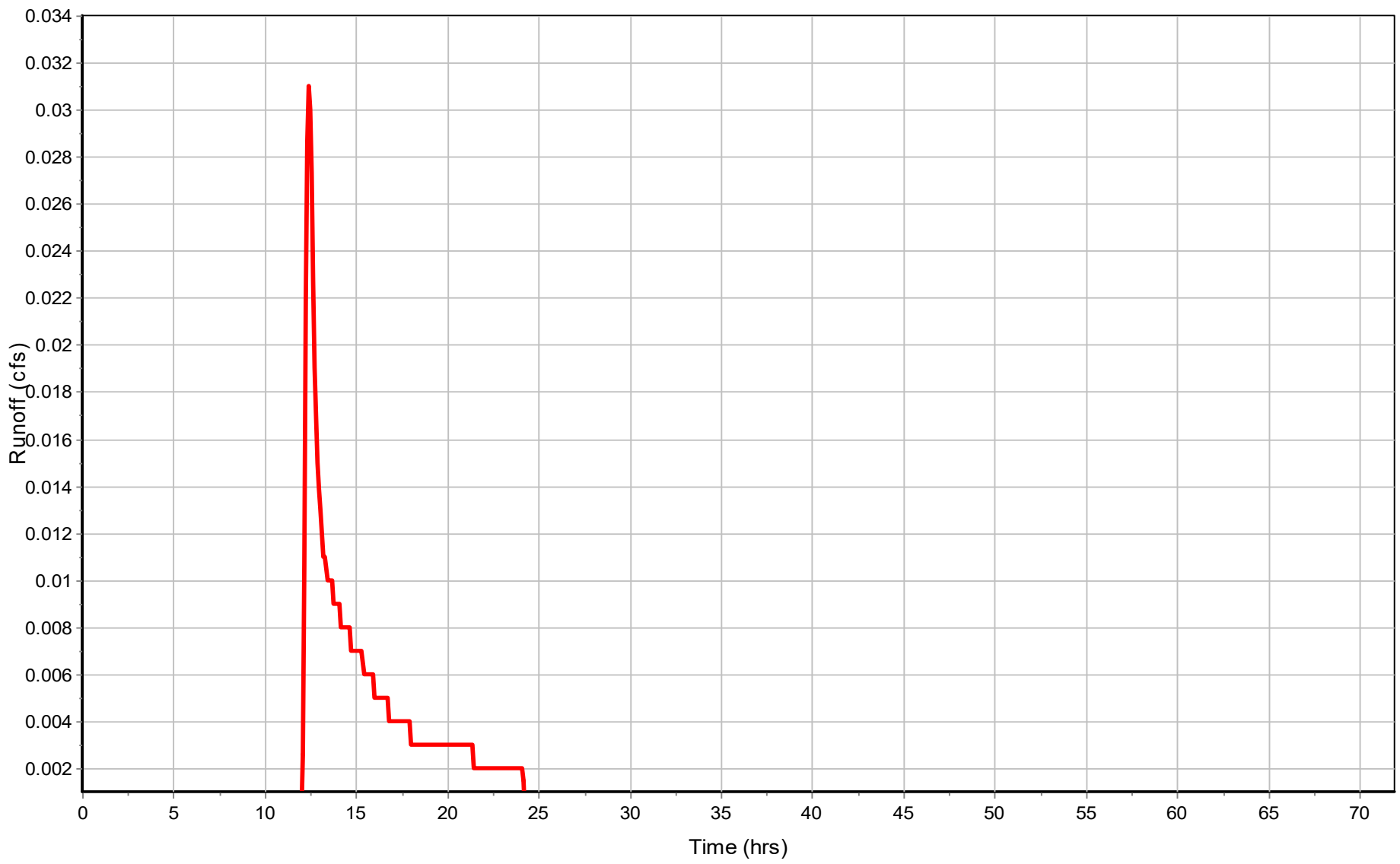
Total Rainfall (in) 5.97
Total Runoff (in) 0.66
Peak Runoff (cfs) 0.03
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:21:30

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

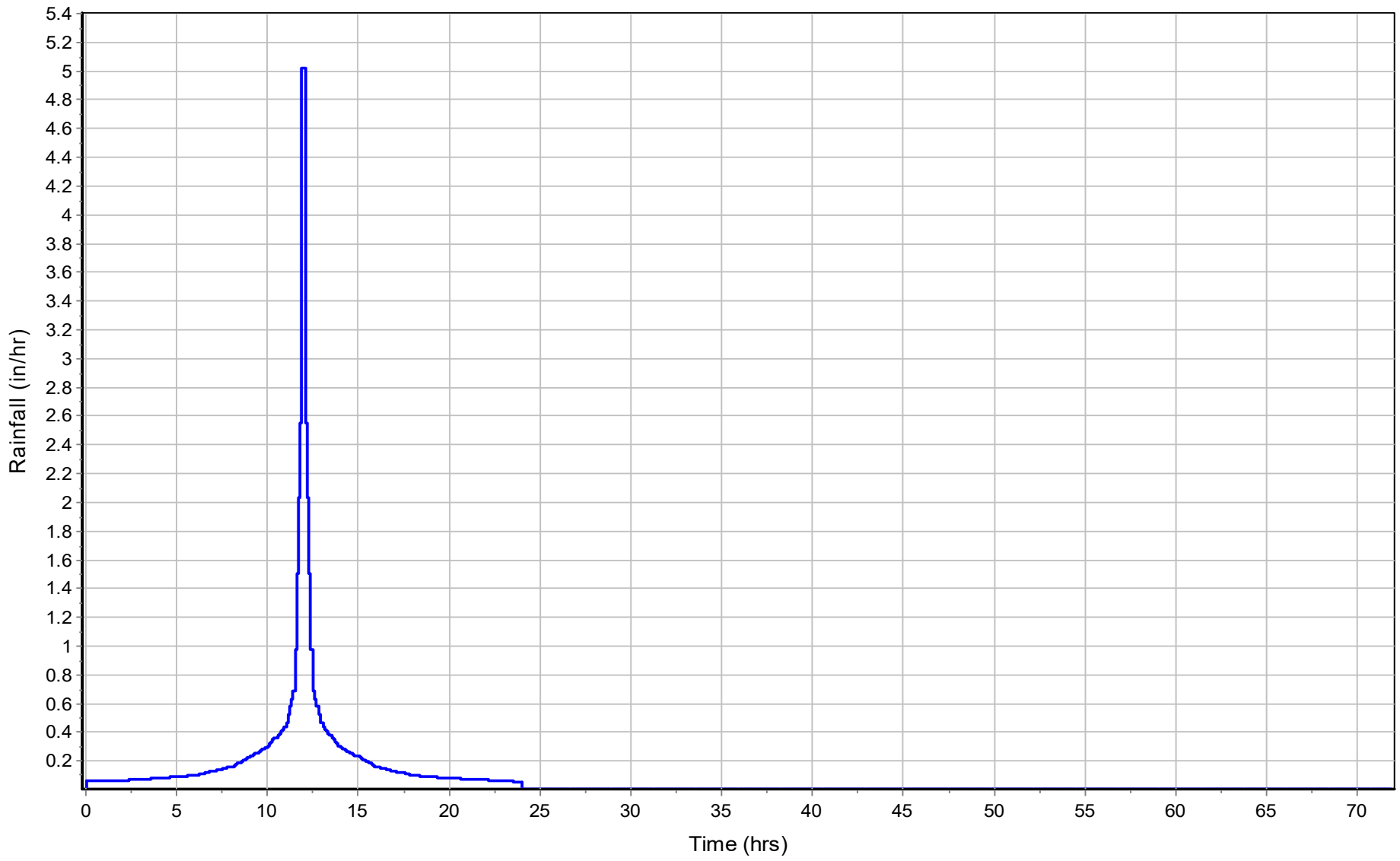
Total TOC (min) 9.01

Subbasin Runoff Results

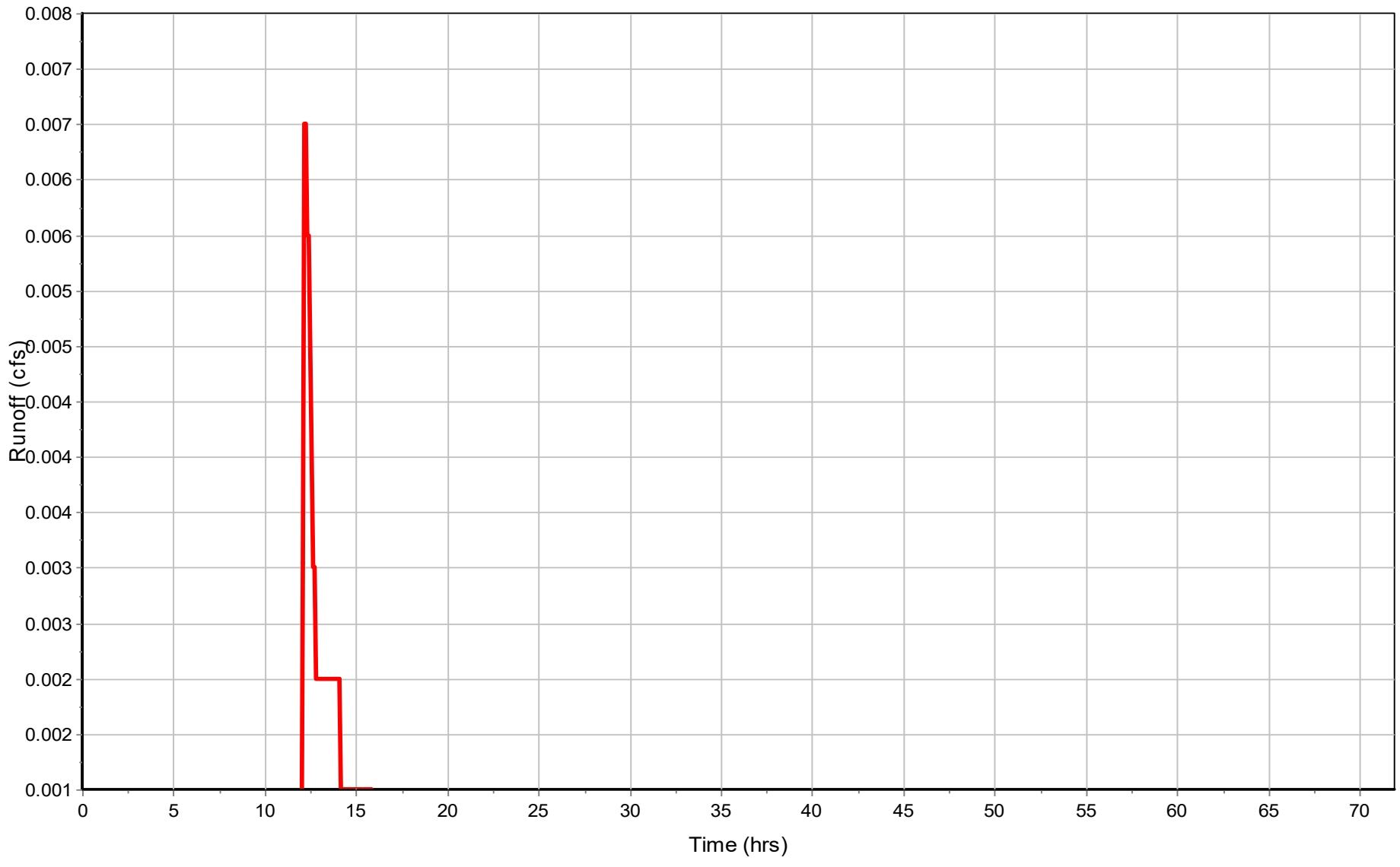
Total Rainfall (in) 5.97
Total Runoff (in) 0.43
Peak Runoff (cfs) 0.01
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:09:01

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

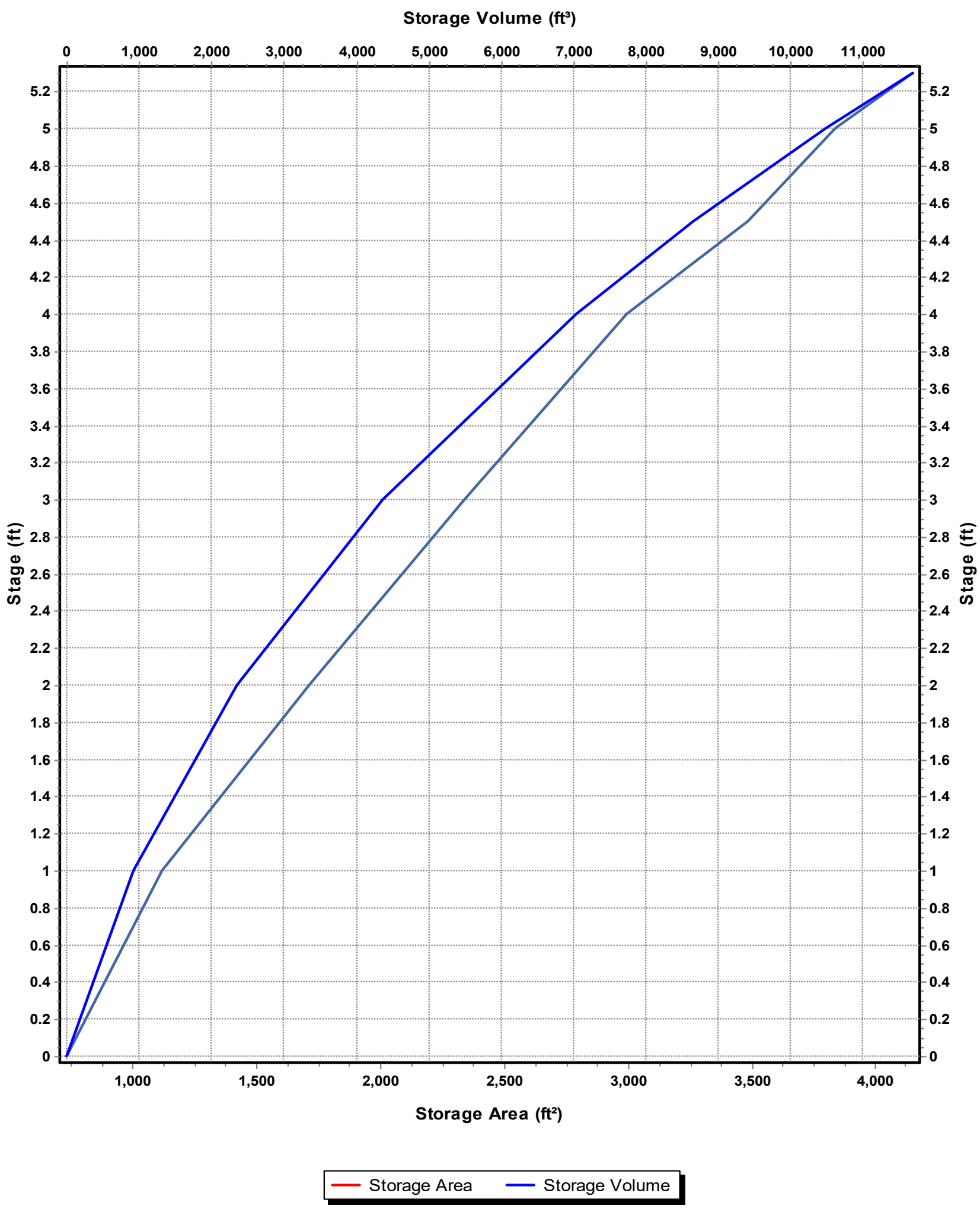
Invert Elevation (ft)	112.40
Max (Rim) Elevation (ft)	117.70
Max (Rim) Offset (ft)	5.30
Initial Water Elevation (ft)	112.40
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

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

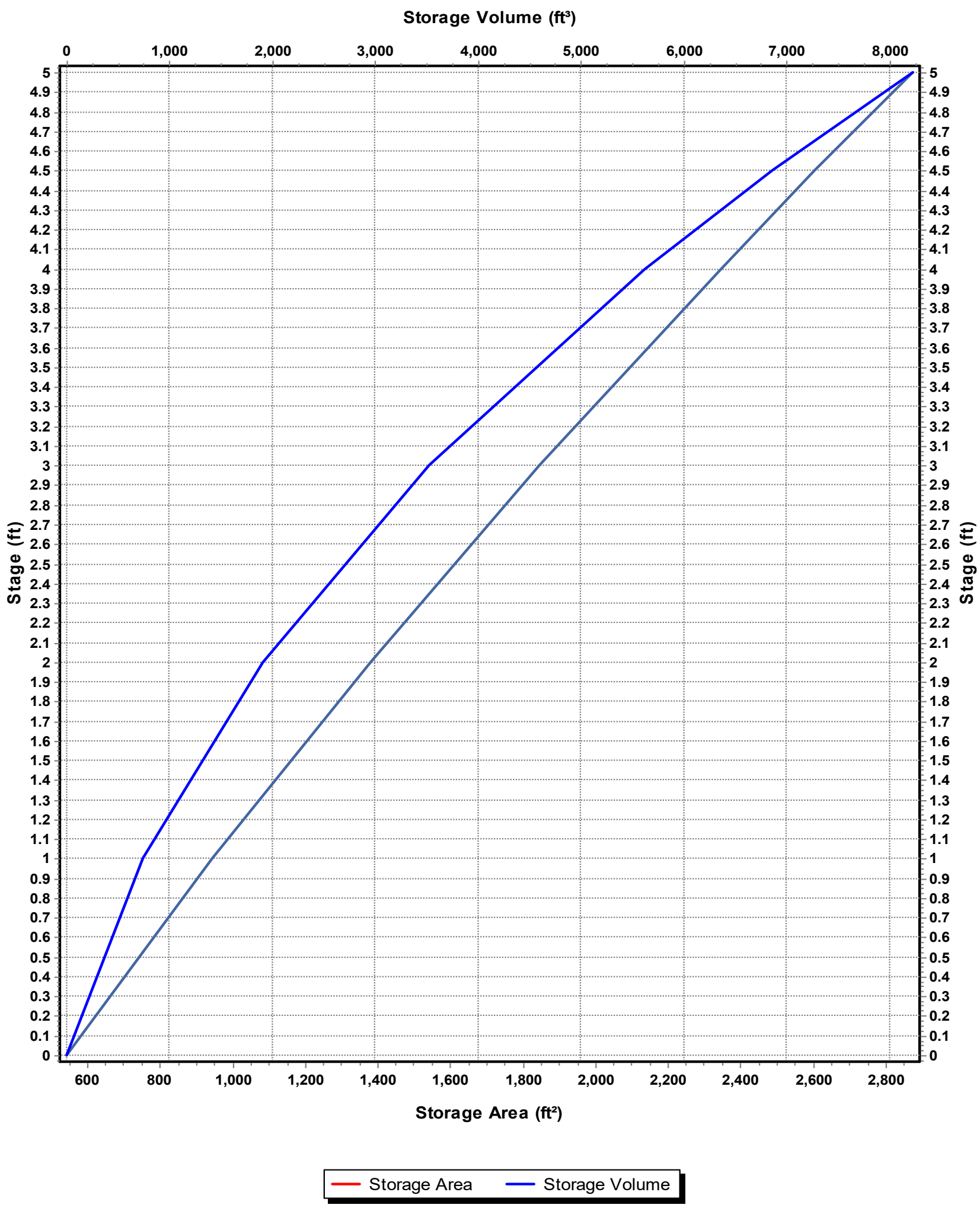
Invert Elevation (ft)	112.90
Max (Rim) Elevation (ft)	117.90
Max (Rim) Offset (ft)	5.00
Initial Water Elevation (ft)	112.90
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

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

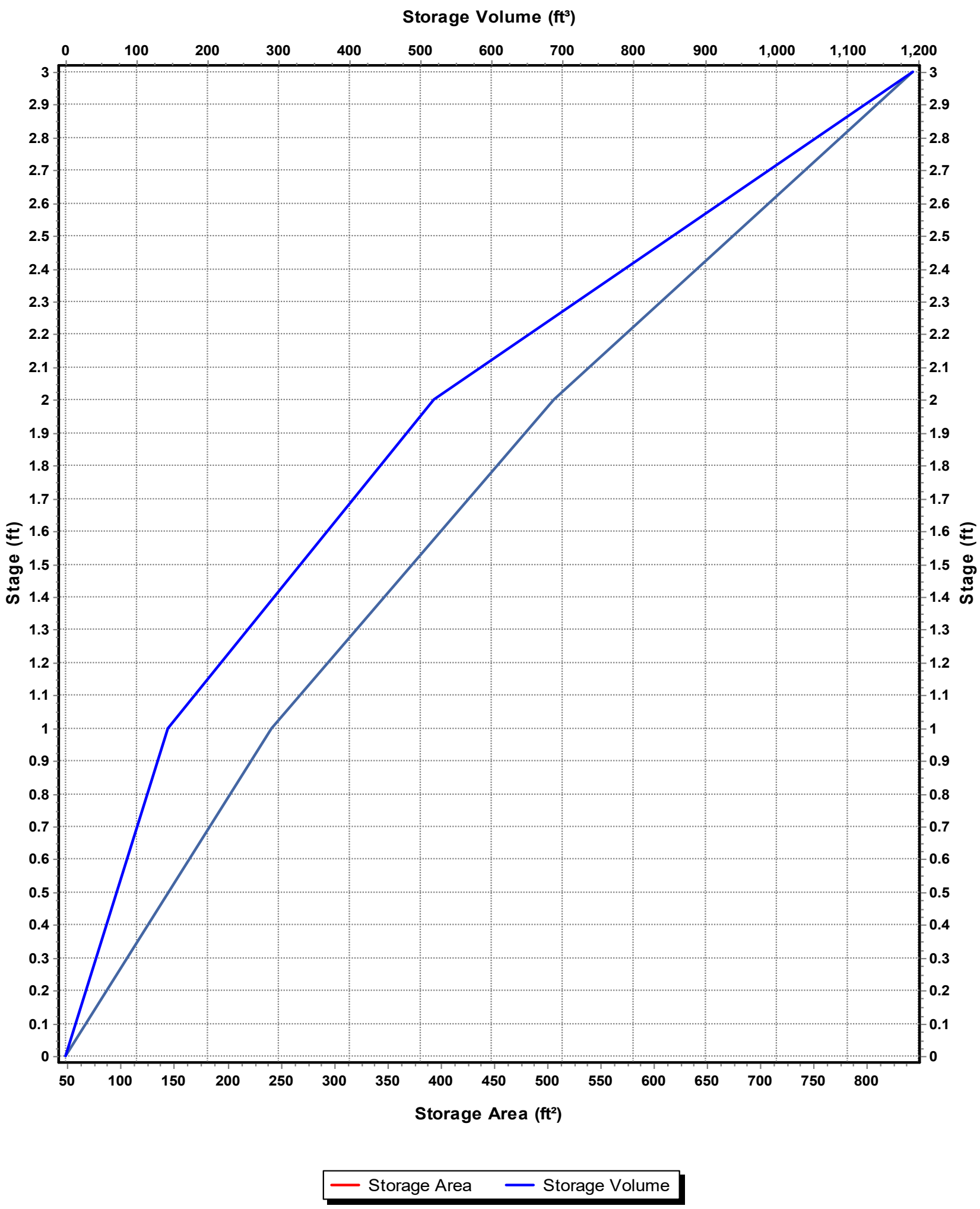
Invert Elevation (ft)	114.40
Max (Rim) Elevation (ft)	117.70
Max (Rim) Offset (ft)	3.30
Initial Water Elevation (ft)	114.40
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

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

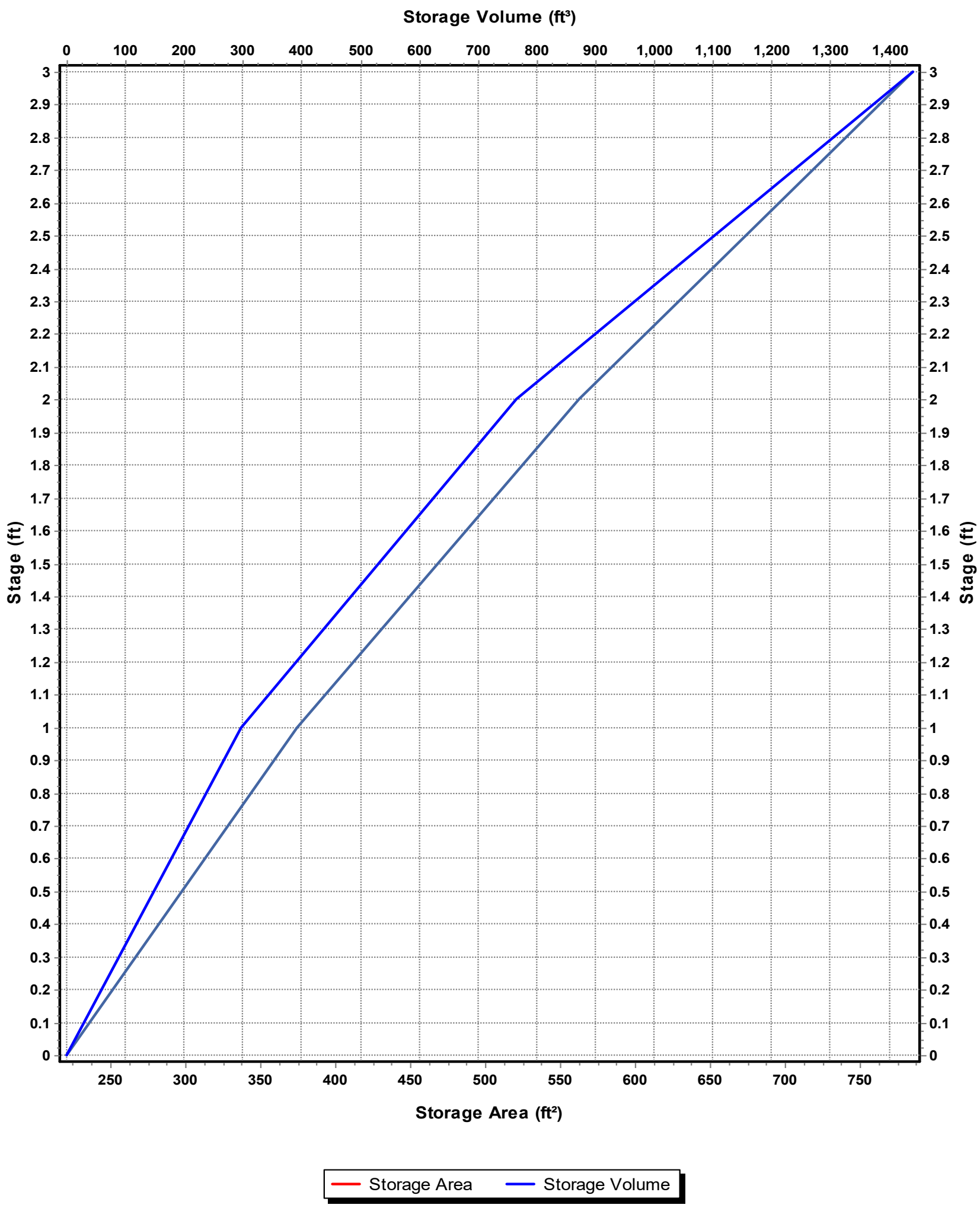
Invert Elevation (ft)	114.90
Max (Rim) Elevation (ft)	117.90
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.90
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

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

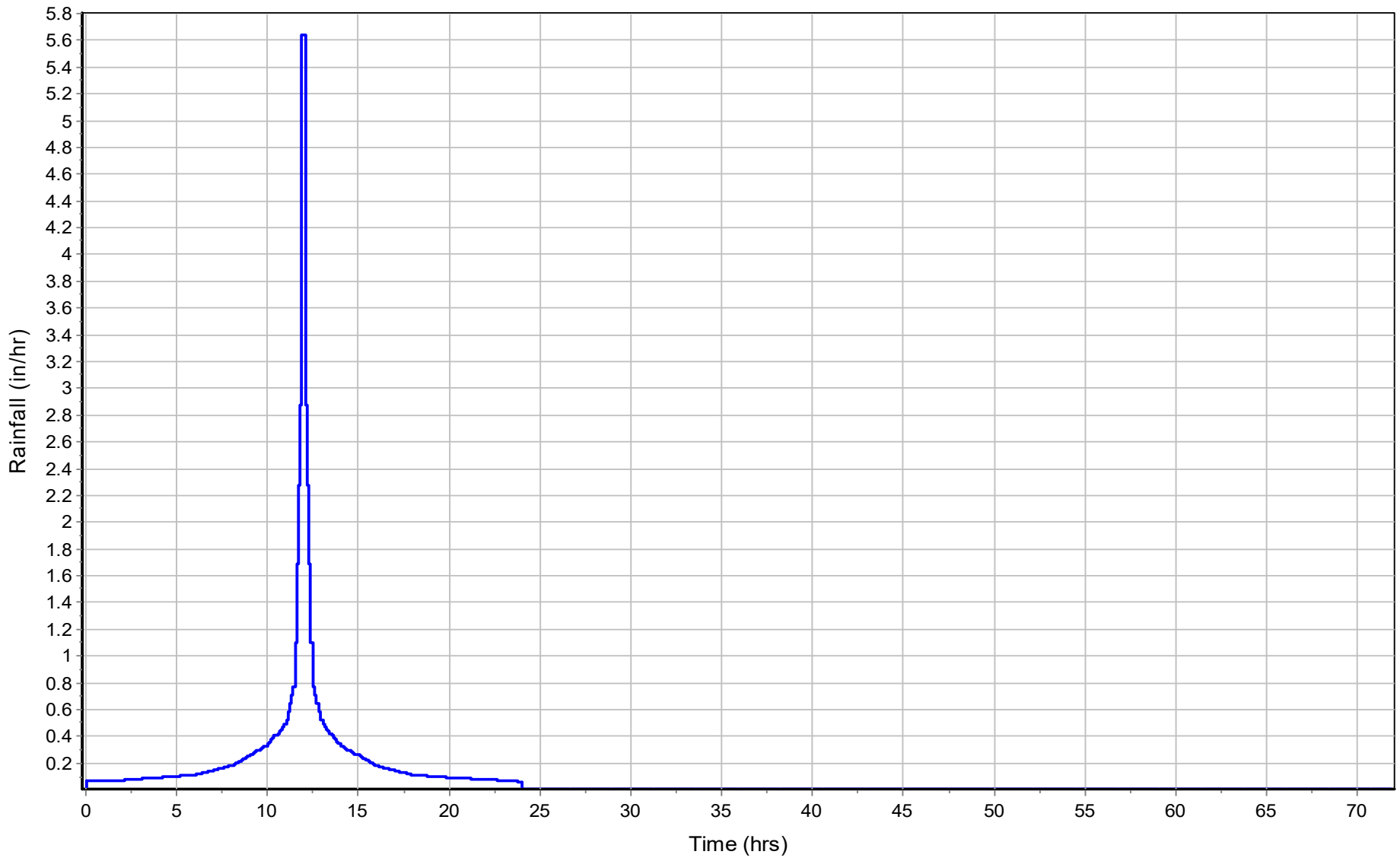
Total TOC (min) 5.38

Subbasin Runoff Results

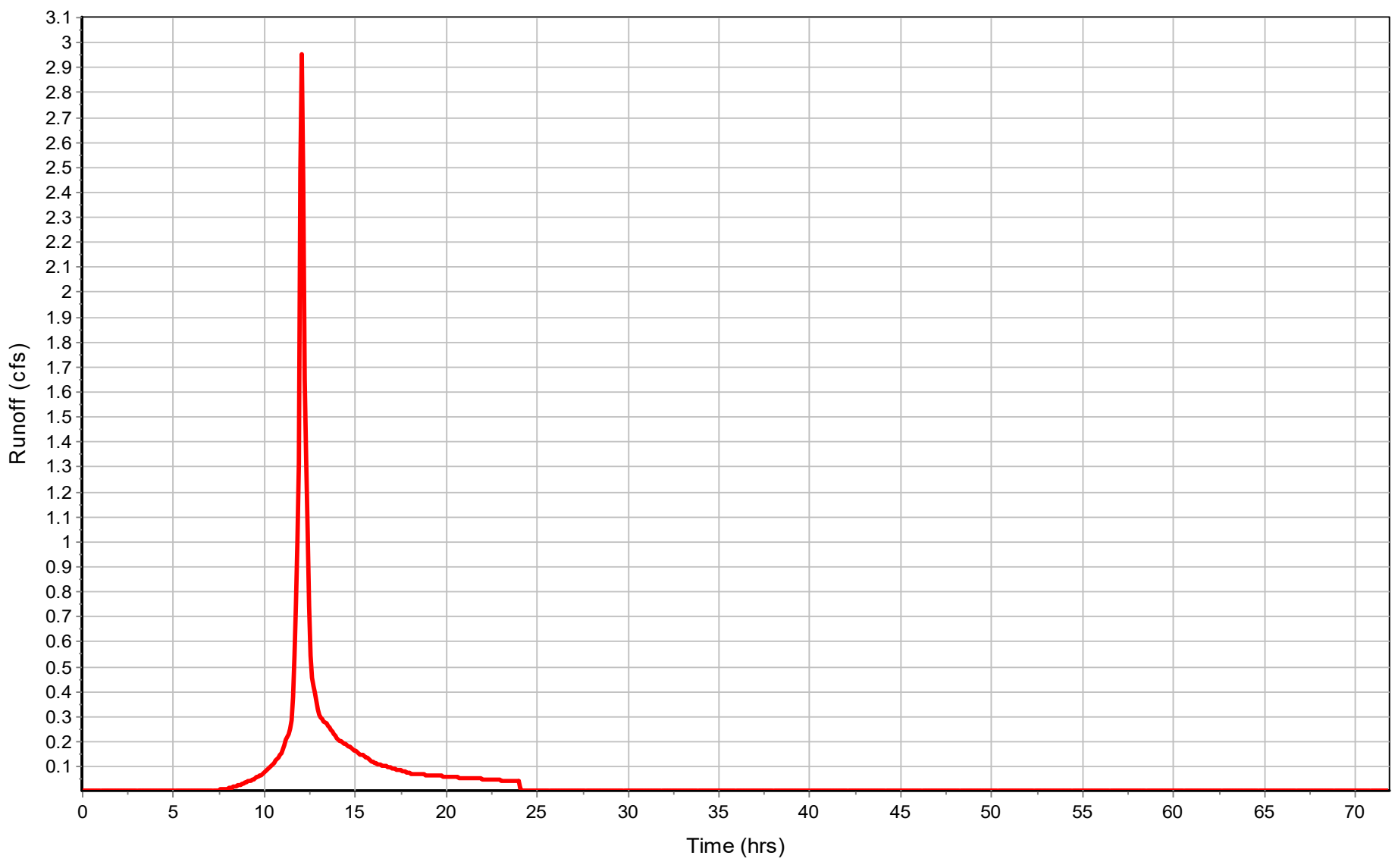
Total Rainfall (in)	6.71
Total Runoff (in)	4
Peak Runoff (cfs)	3.02
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:05:23

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

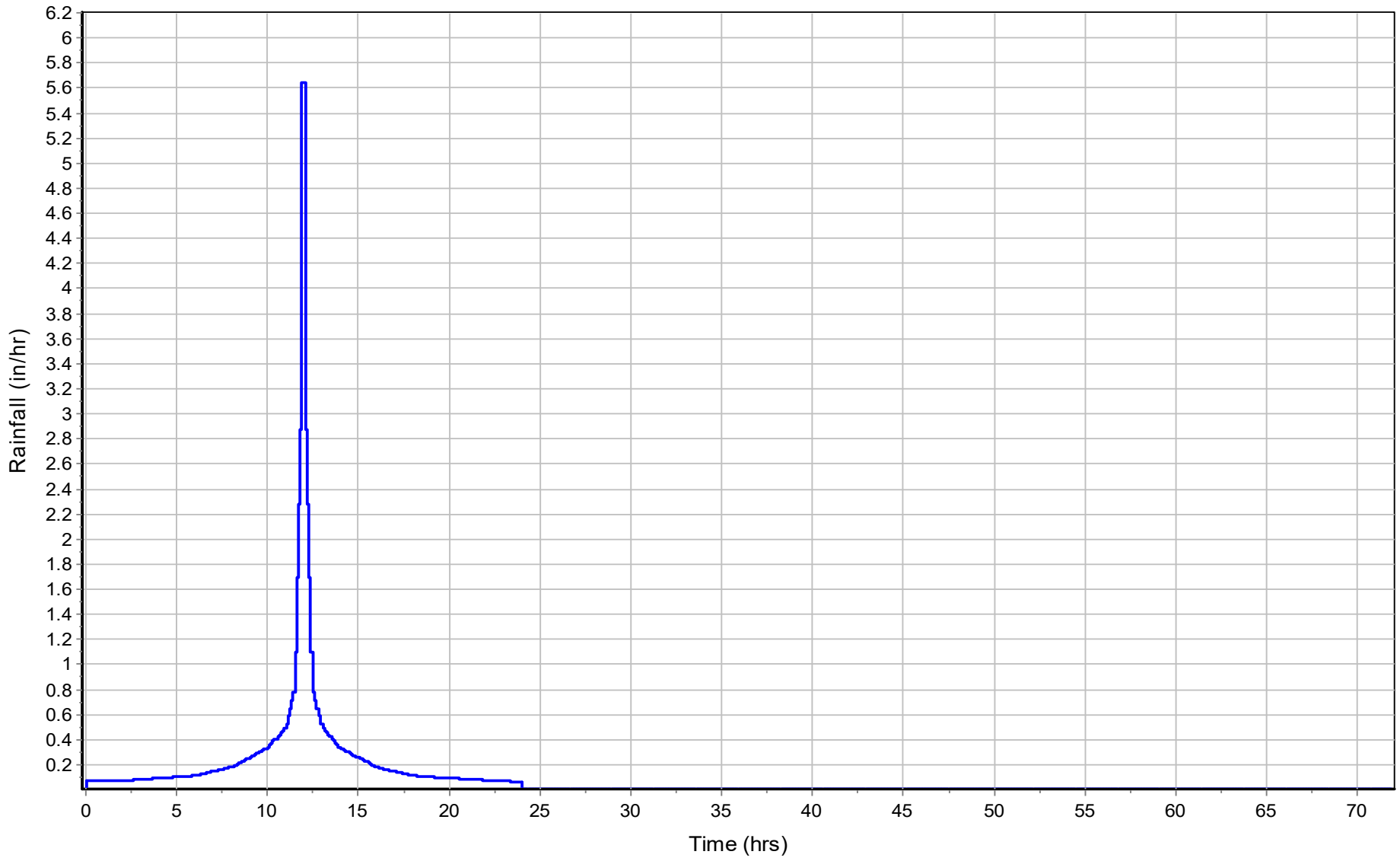
Total TOC (min) 0.79

Subbasin Runoff Results

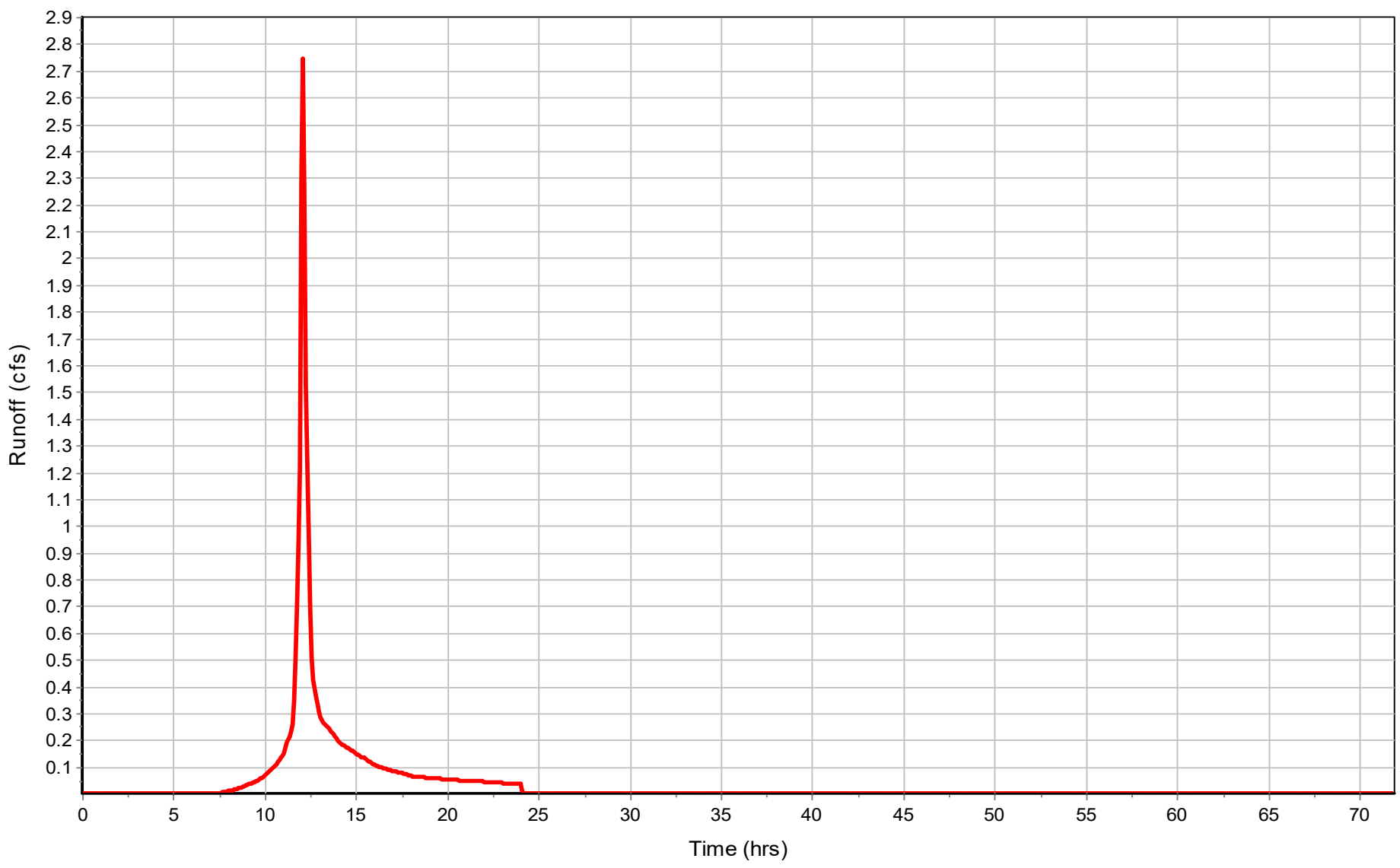
Total Rainfall (in) 6.71
Total Runoff (in) 4
Peak Runoff (cfs) 2.81
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:00:47

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

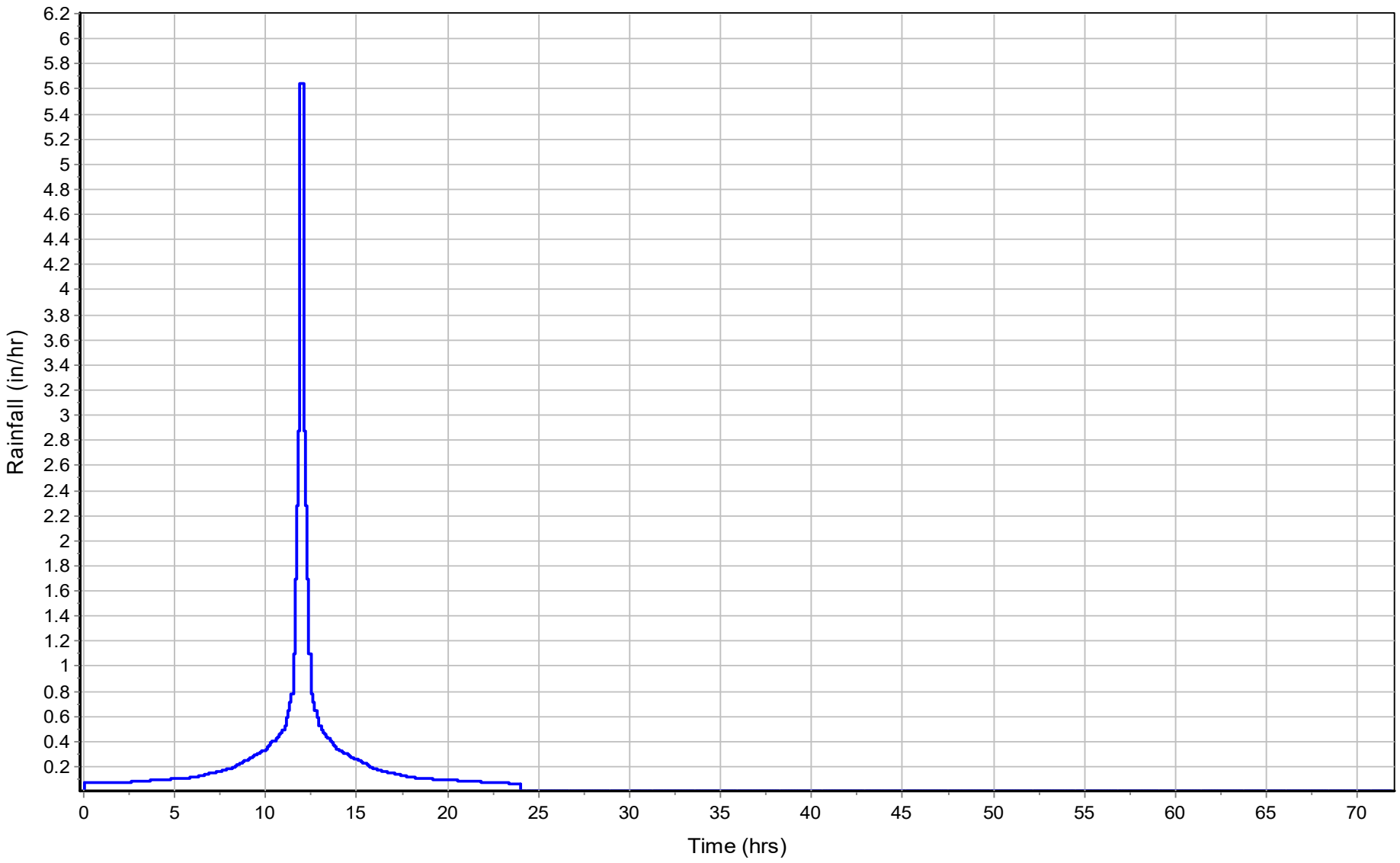
Total TOC (min) 28.81

Subbasin Runoff Results

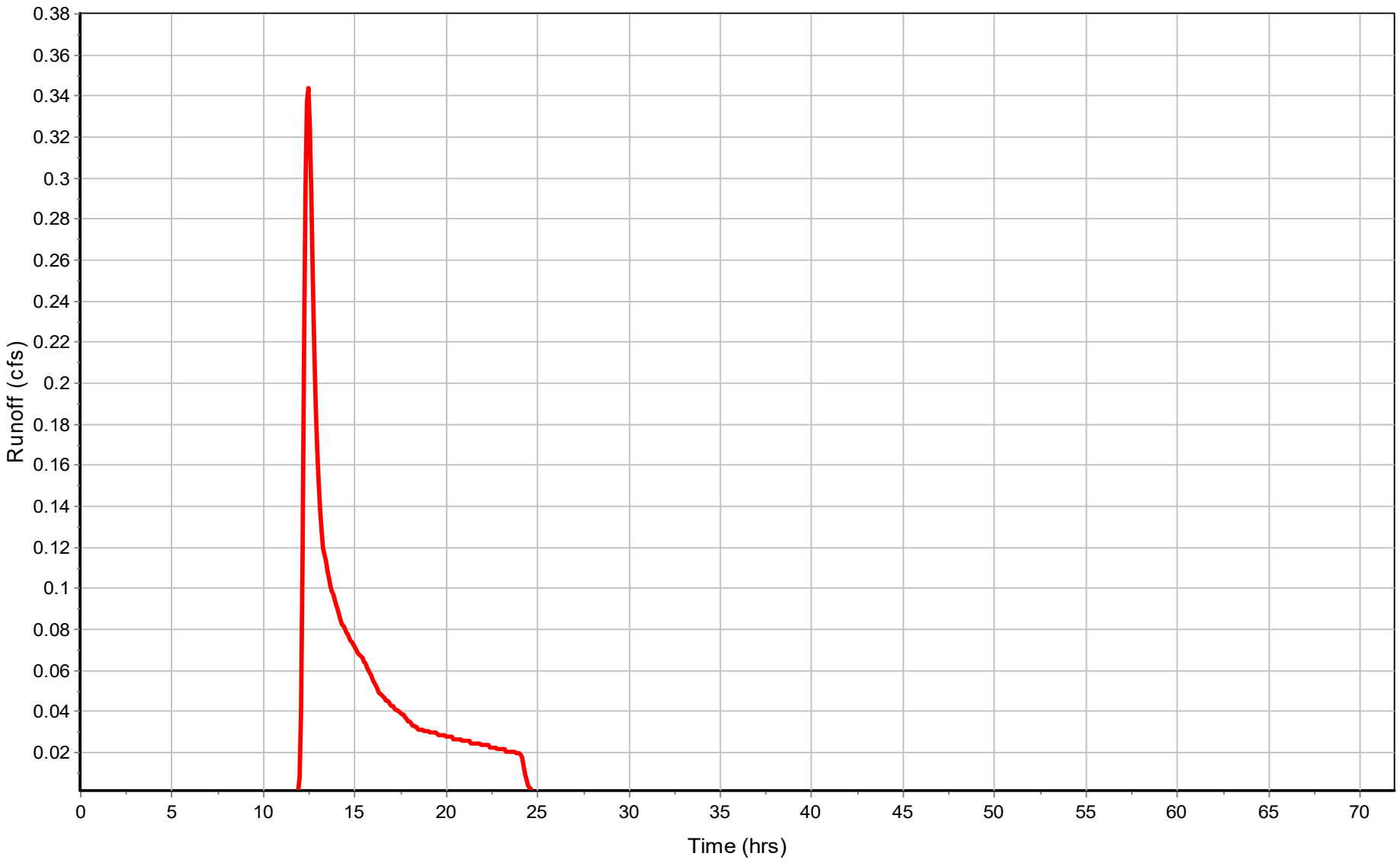
Total Rainfall (in) 6.71
Total Runoff (in) 0.95
Peak Runoff (cfs) 0.34
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:28:49

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

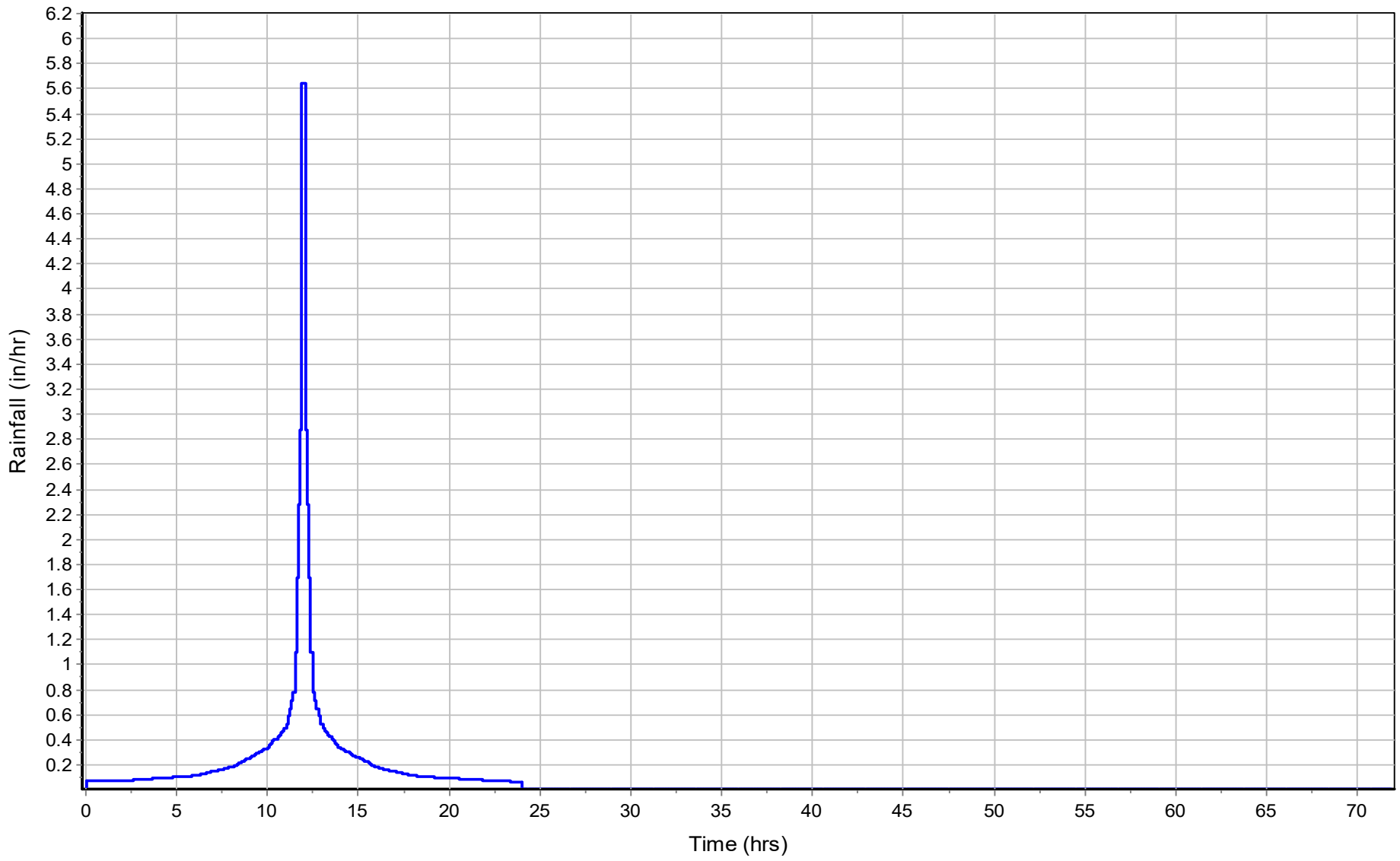
Total TOC (min) 17.94

Subbasin Runoff Results

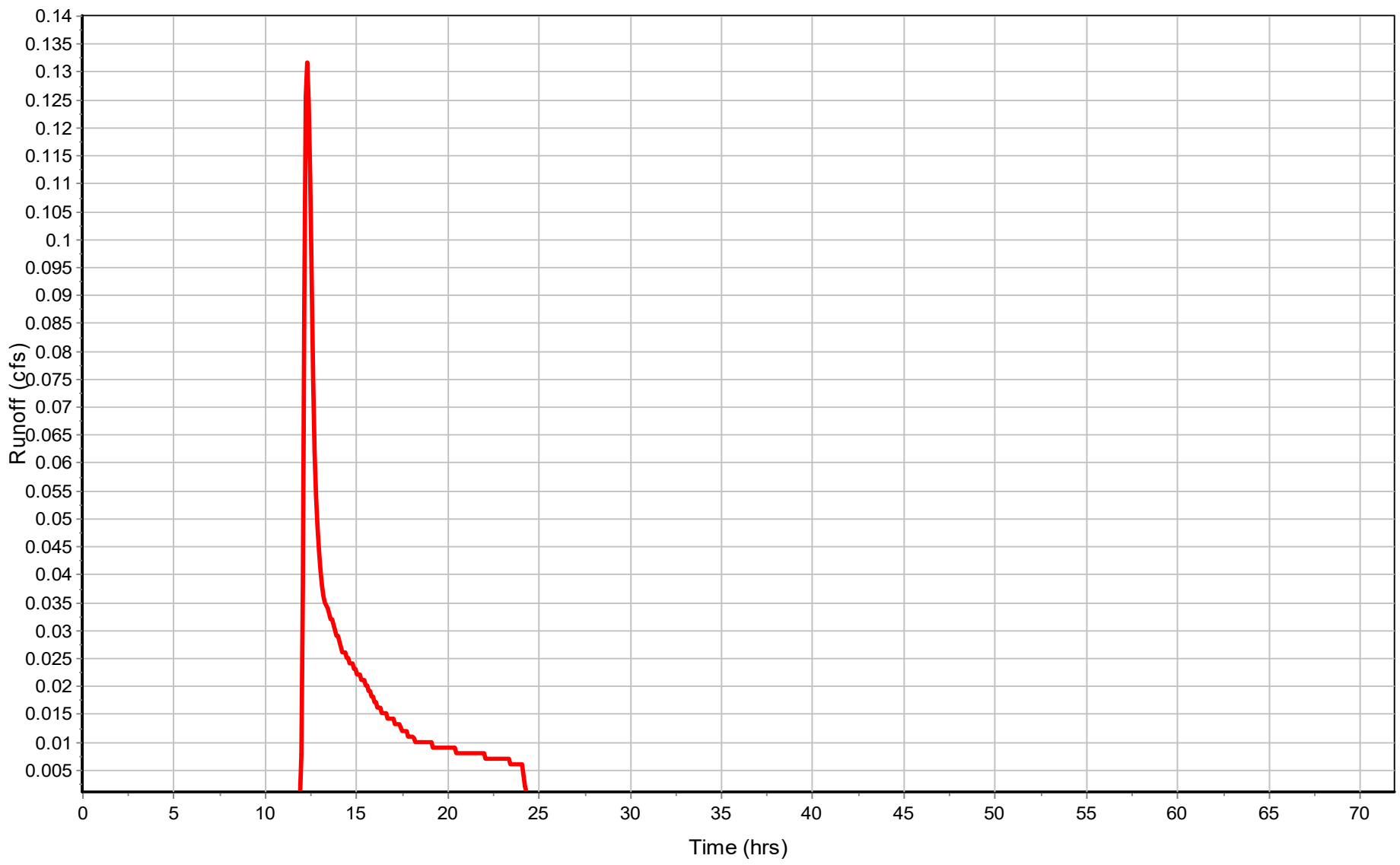
Total Rainfall (in) 6.71
Total Runoff (in) 0.95
Peak Runoff (cfs) 0.13
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:17:56

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

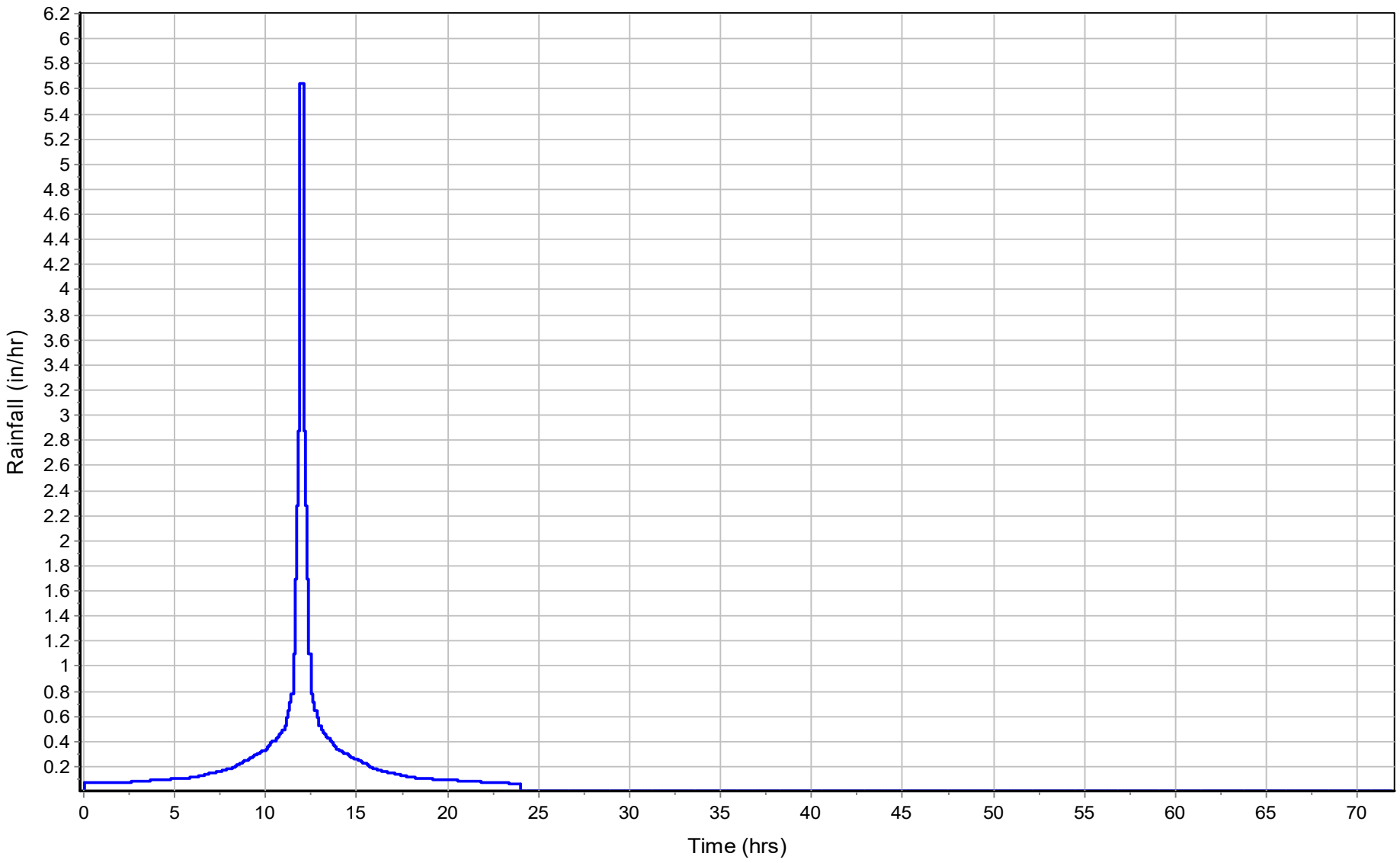
Total TOC (min) 17.48

Subbasin Runoff Results

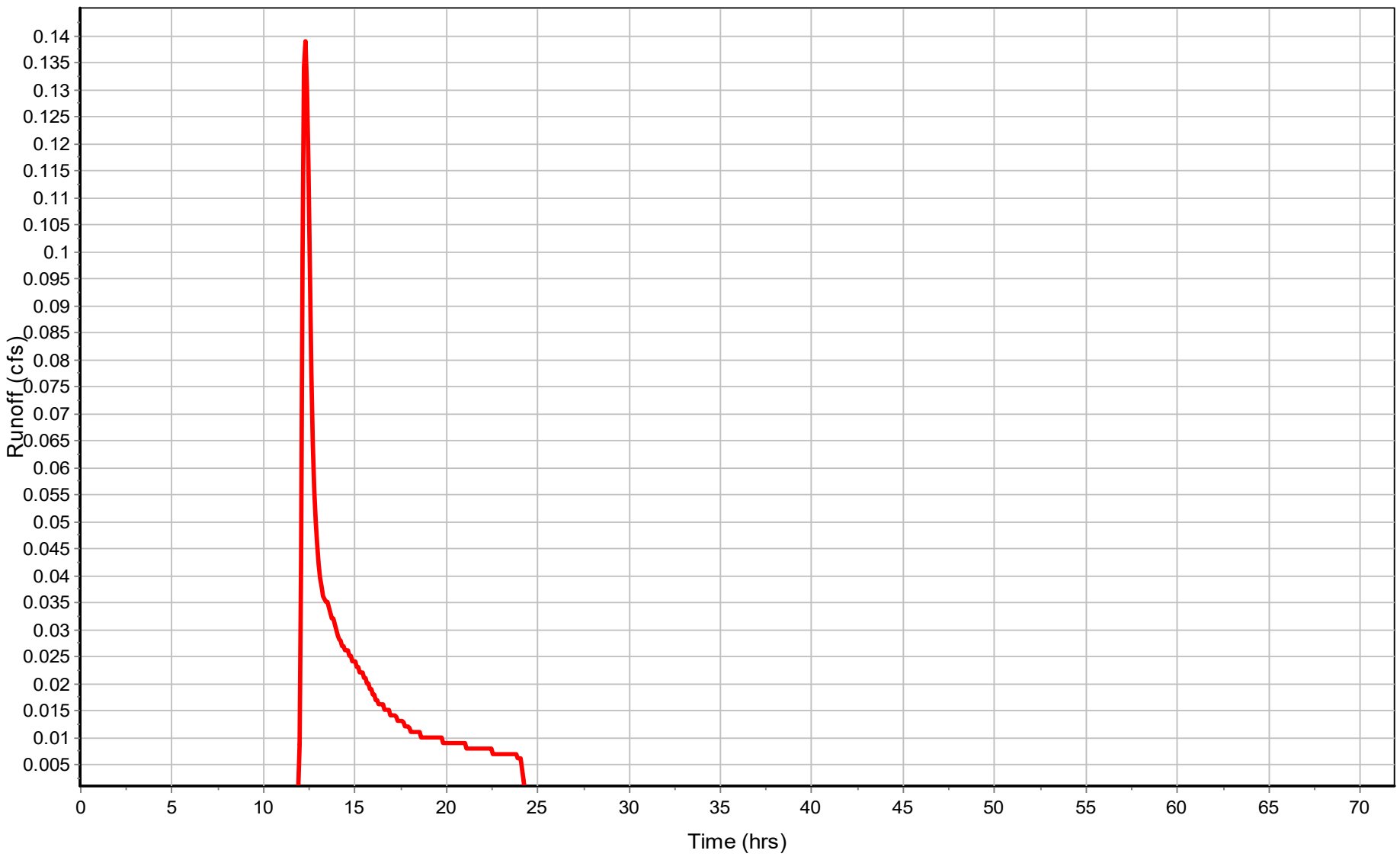
Total Rainfall (in) 6.71
Total Runoff (in) 0.95
Peak Runoff (cfs) 0.14
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:17:29

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

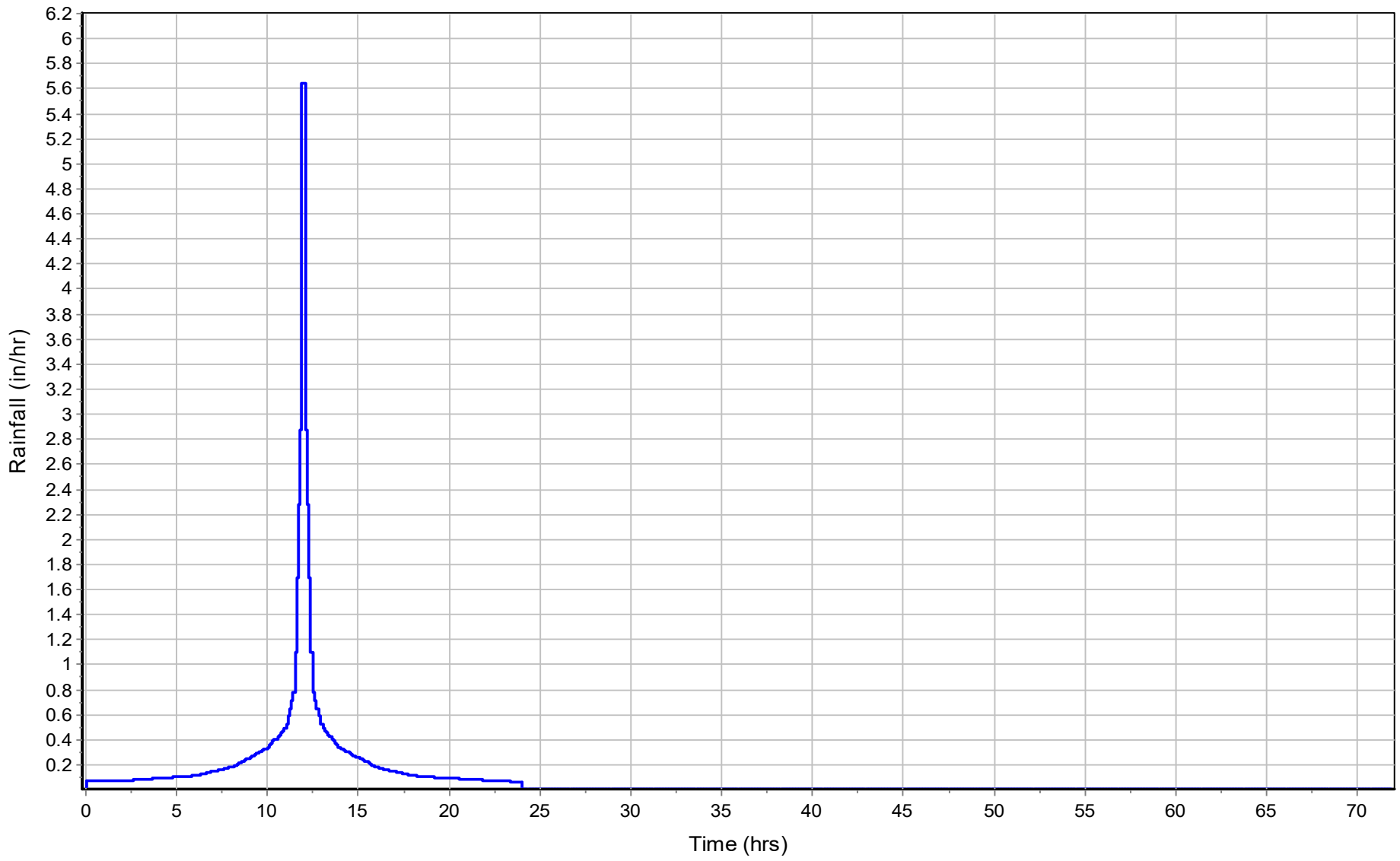
Total TOC (min) 21.50

Subbasin Runoff Results

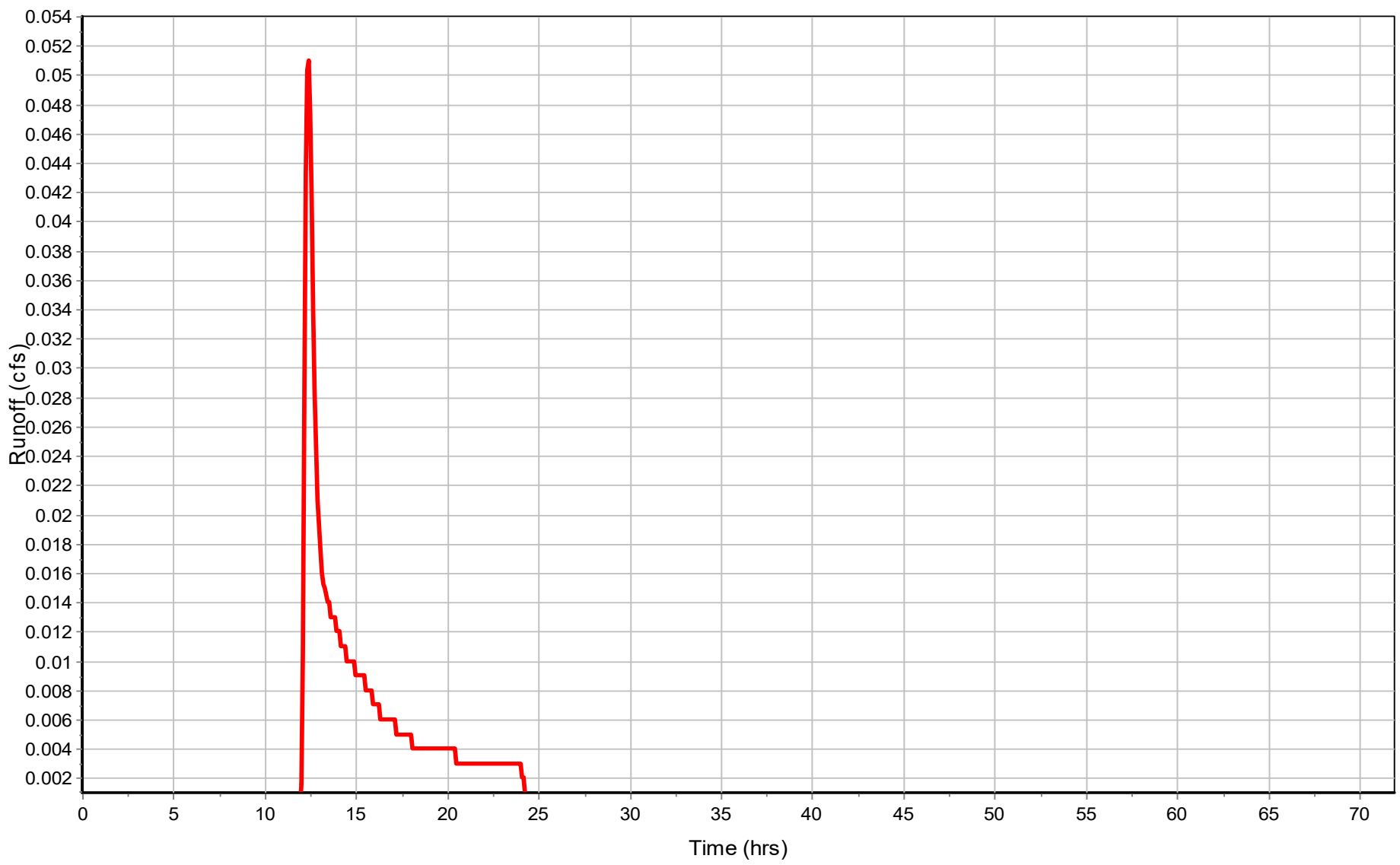
Total Rainfall (in) 6.71
Total Runoff (in) 0.95
Peak Runoff (cfs) 0.05
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:21:30

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

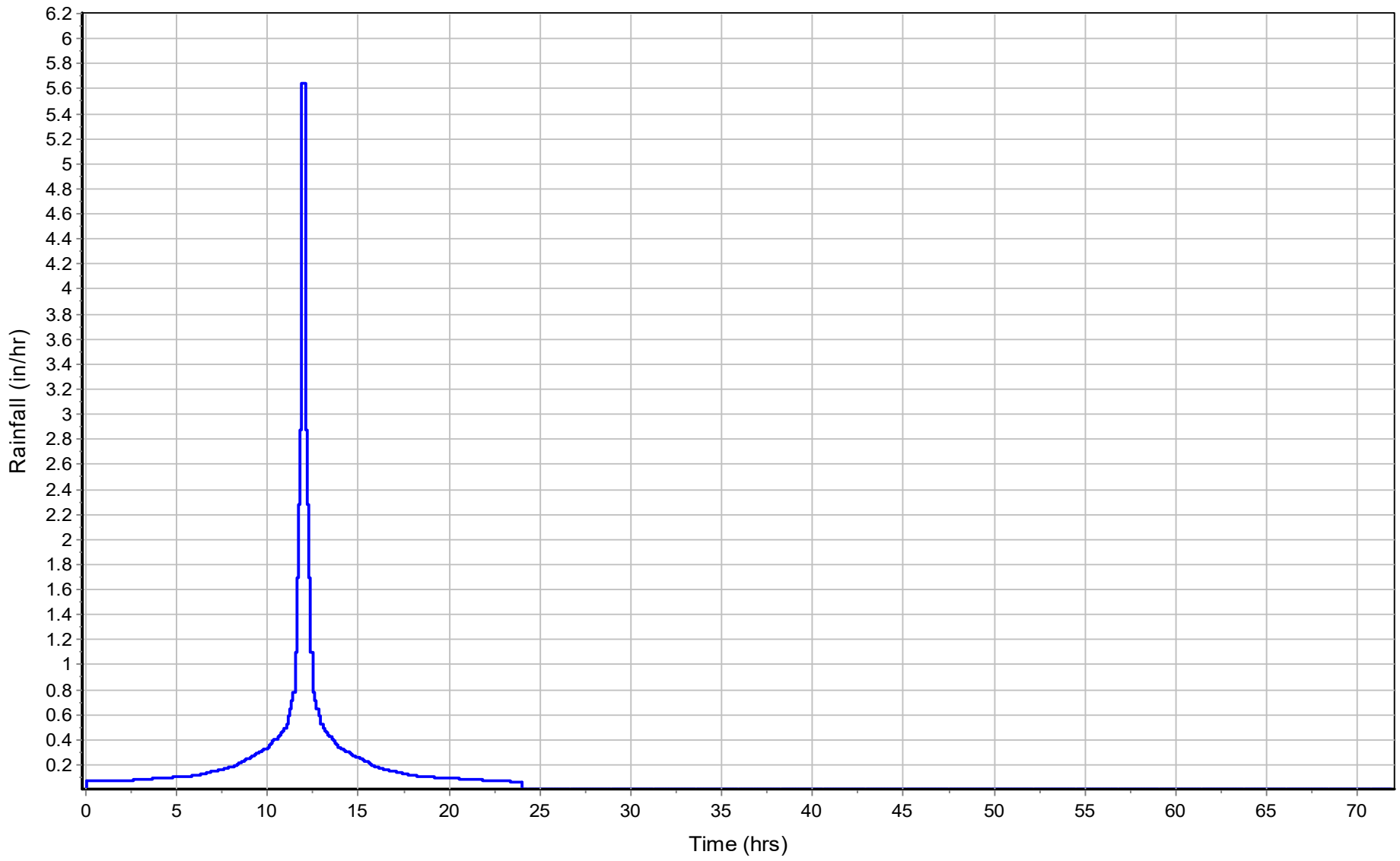
Total TOC (min) 9.01

Subbasin Runoff Results

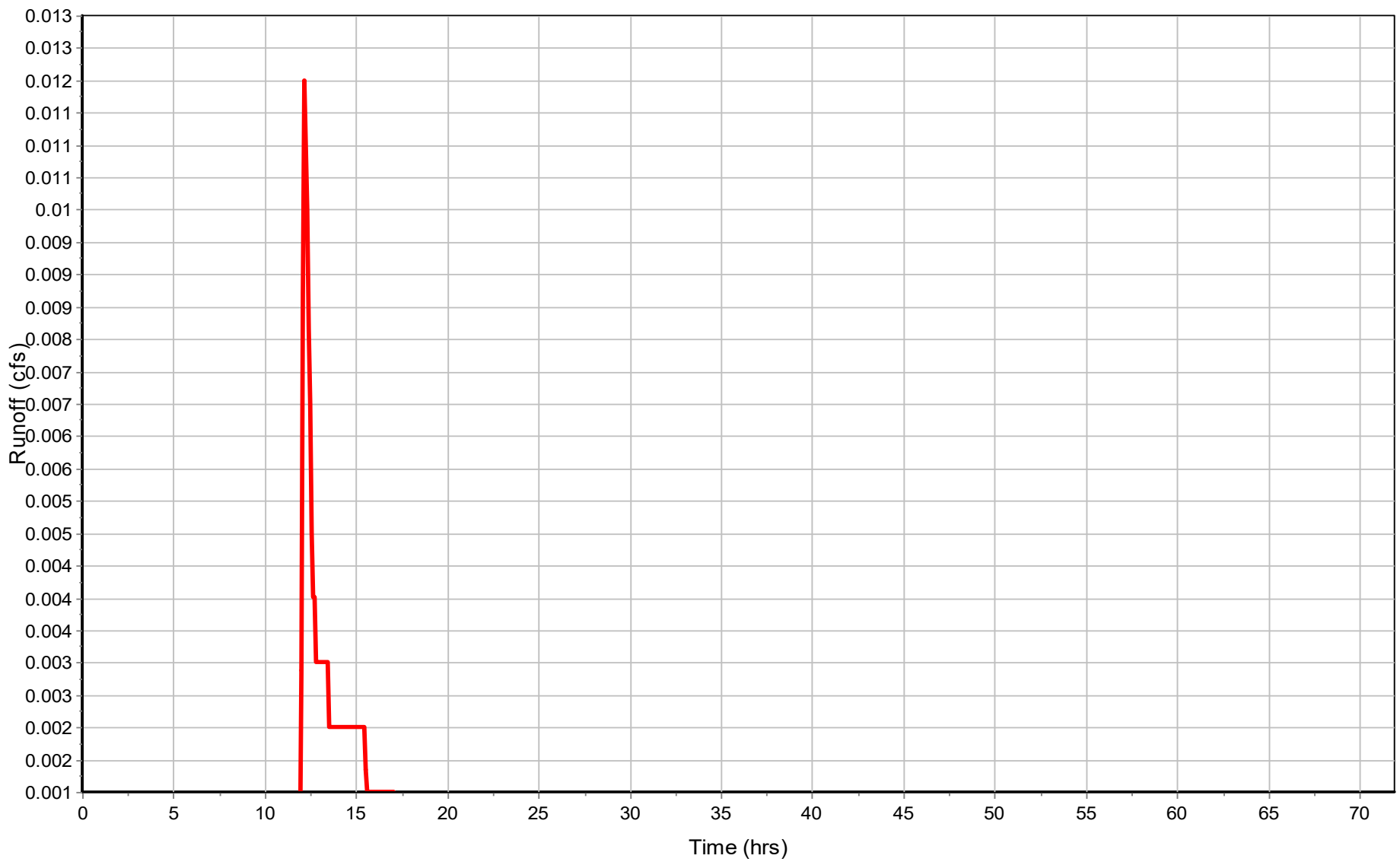
Total Rainfall (in) 6.71
Total Runoff (in) 0.72
Peak Runoff (cfs) 0.01
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:09:01

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

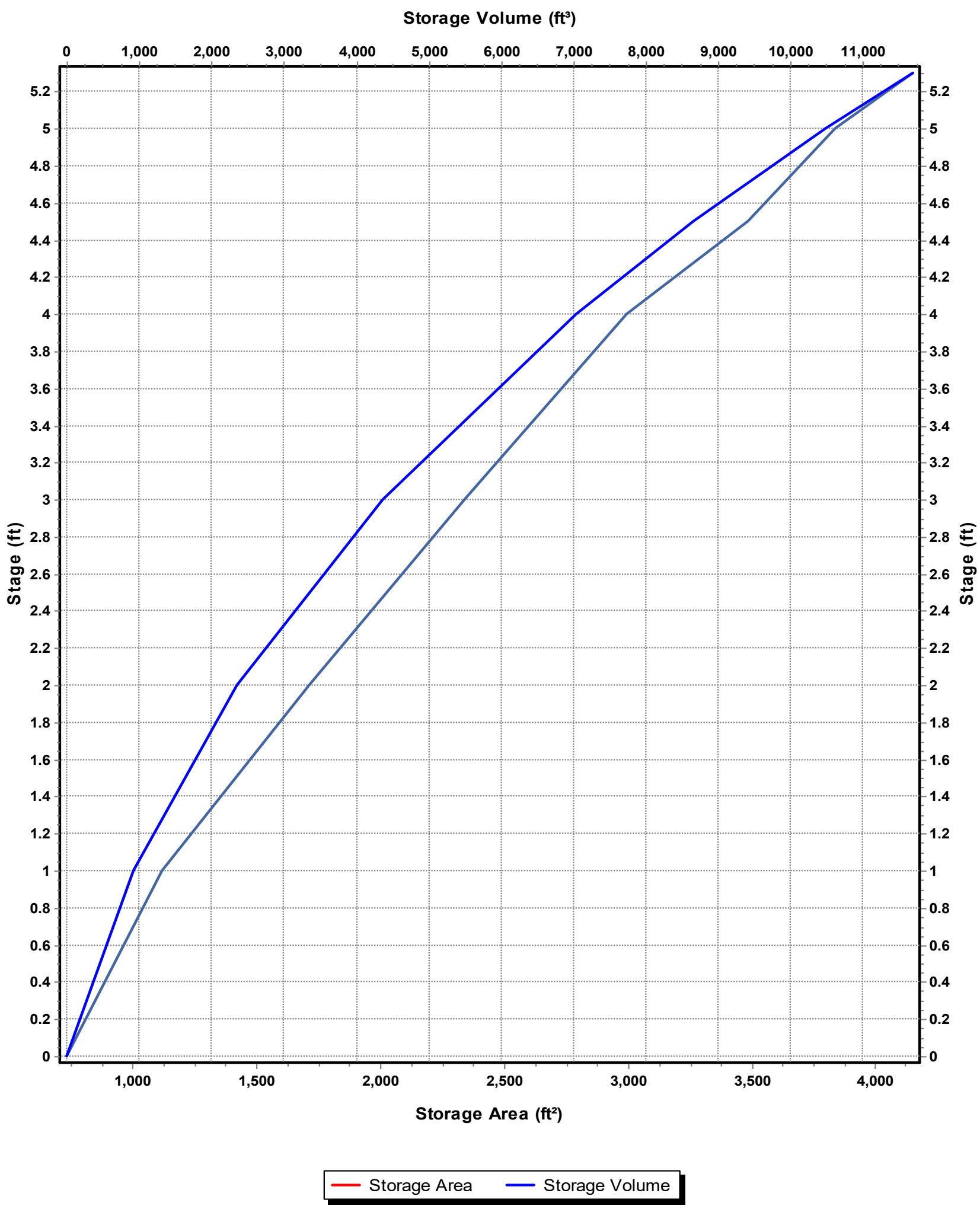
Invert Elevation (ft)	112.40
Max (Rim) Elevation (ft)	117.70
Max (Rim) Offset (ft)	5.30
Initial Water Elevation (ft)	112.40
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

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

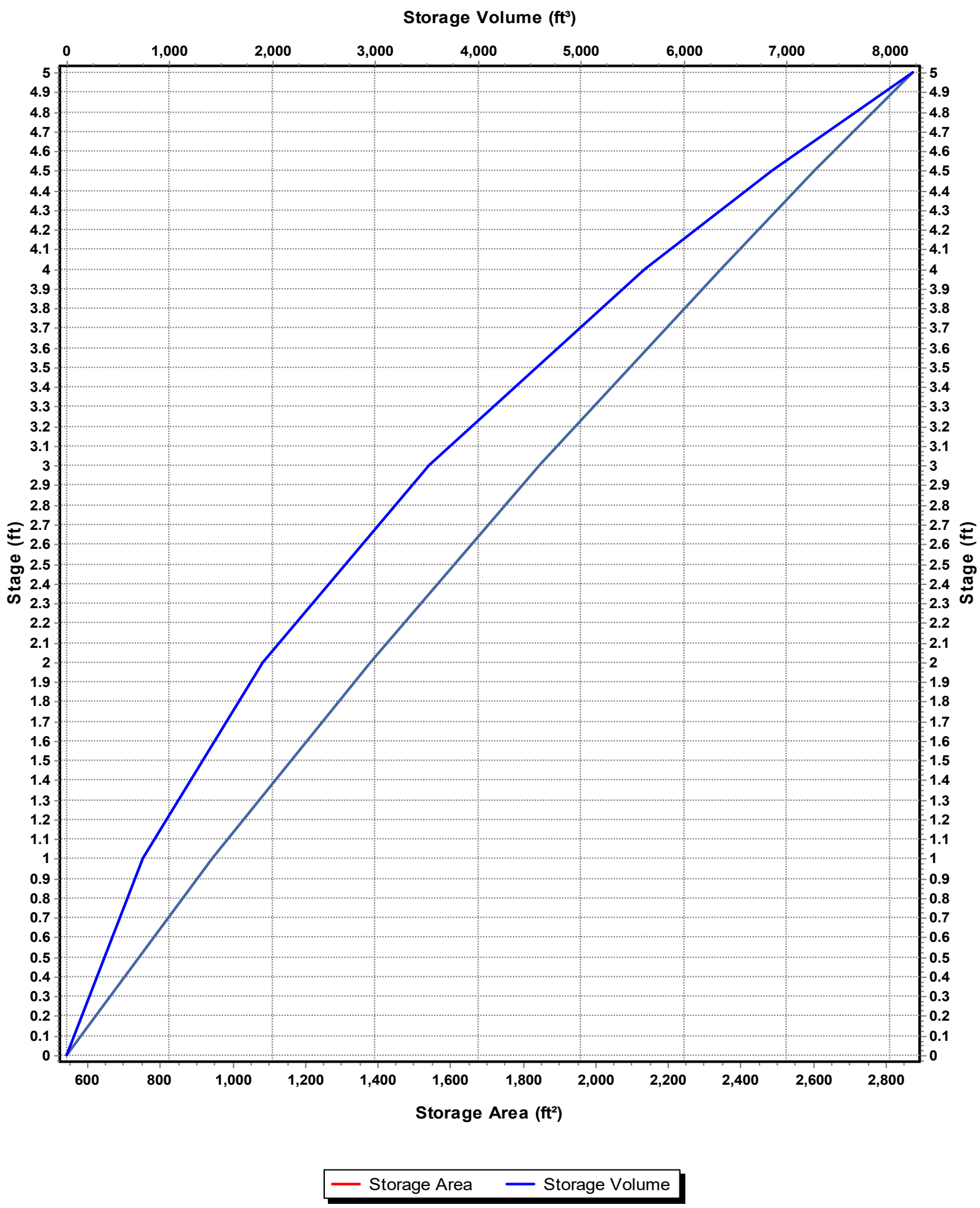
Invert Elevation (ft)	112.90
Max (Rim) Elevation (ft)	117.90
Max (Rim) Offset (ft)	5.00
Initial Water Elevation (ft)	112.90
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

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

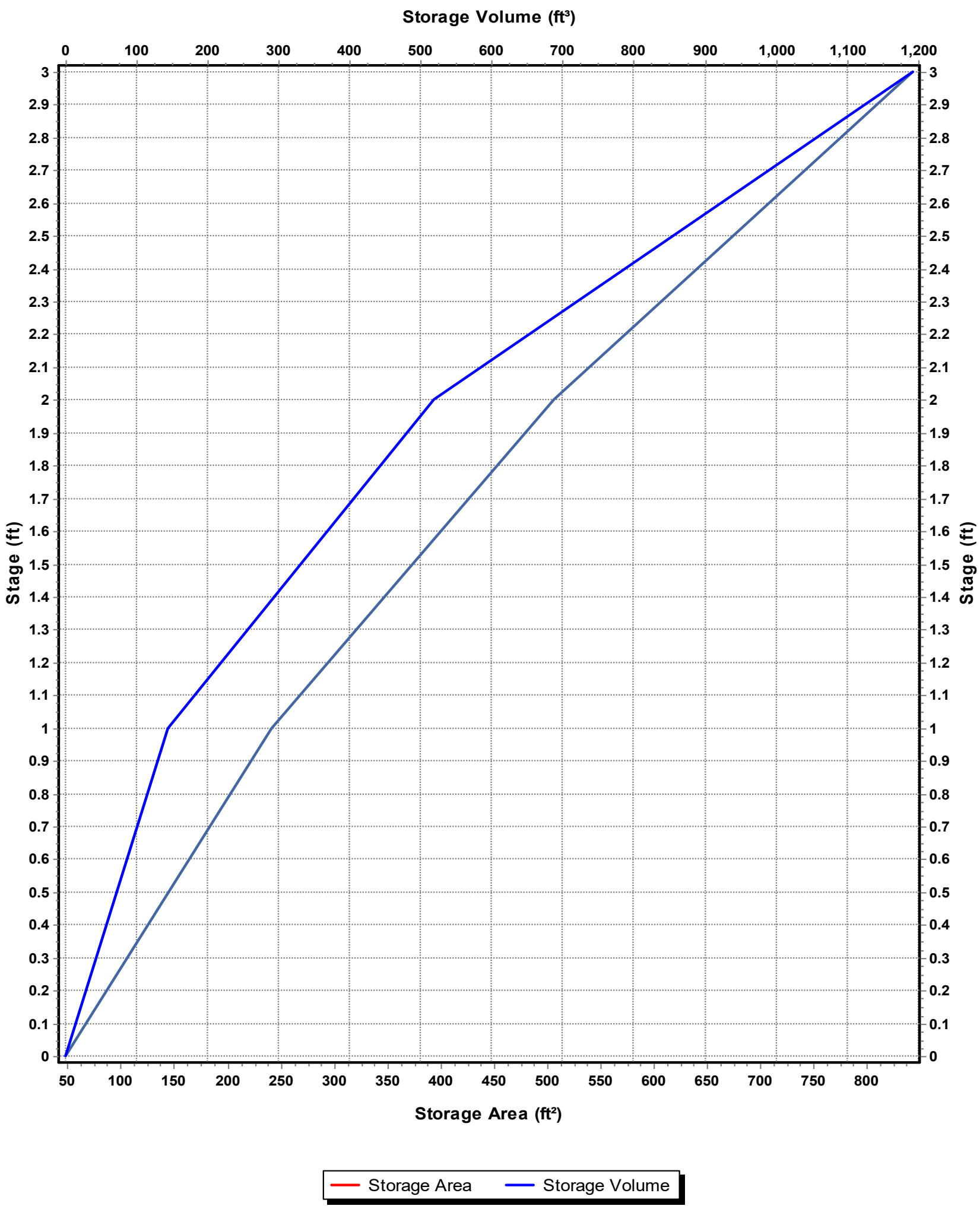
Invert Elevation (ft)	114.40
Max (Rim) Elevation (ft)	117.70
Max (Rim) Offset (ft)	3.30
Initial Water Elevation (ft)	114.40
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

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

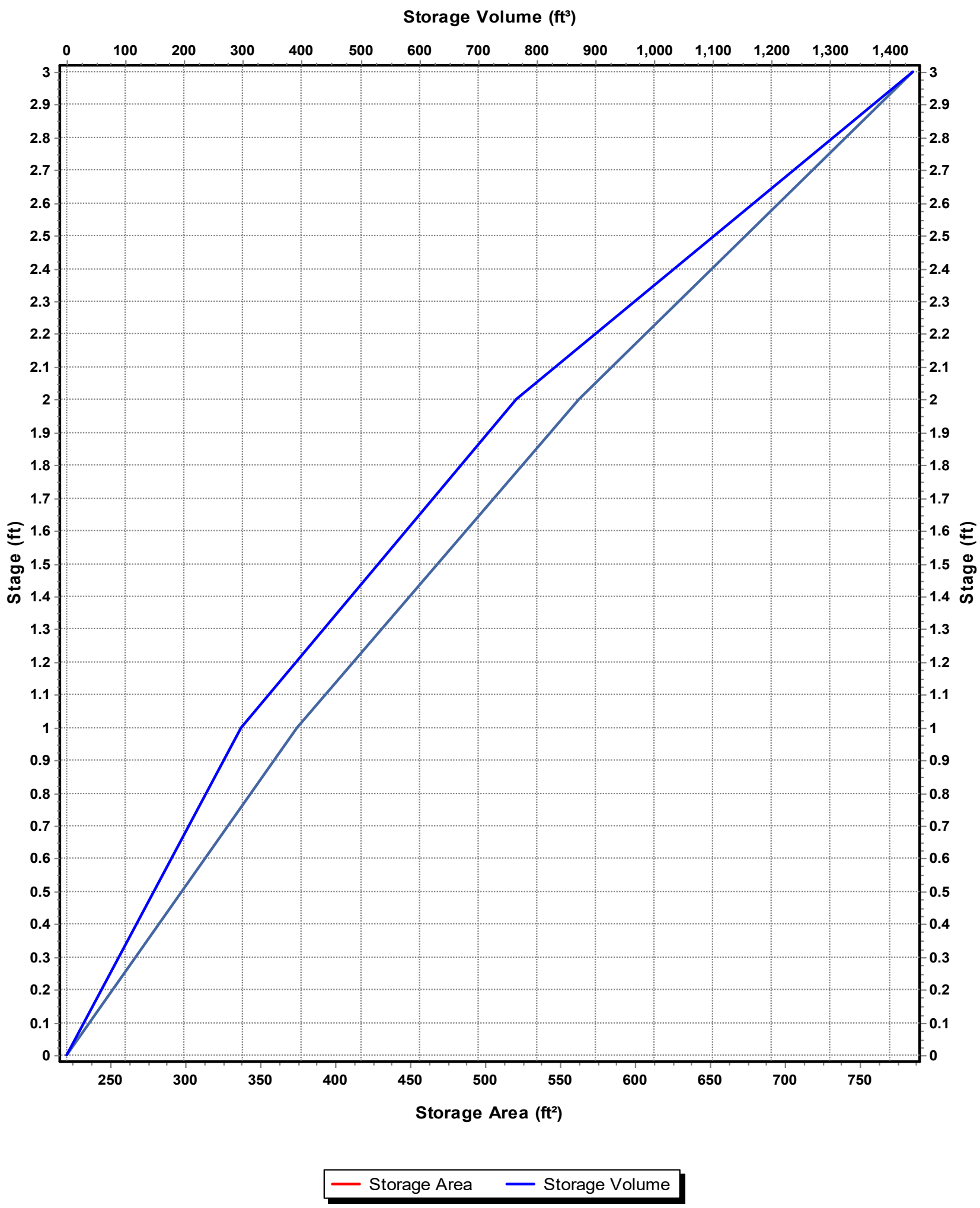
Invert Elevation (ft)	114.90
Max (Rim) Elevation (ft)	117.90
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.90
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

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

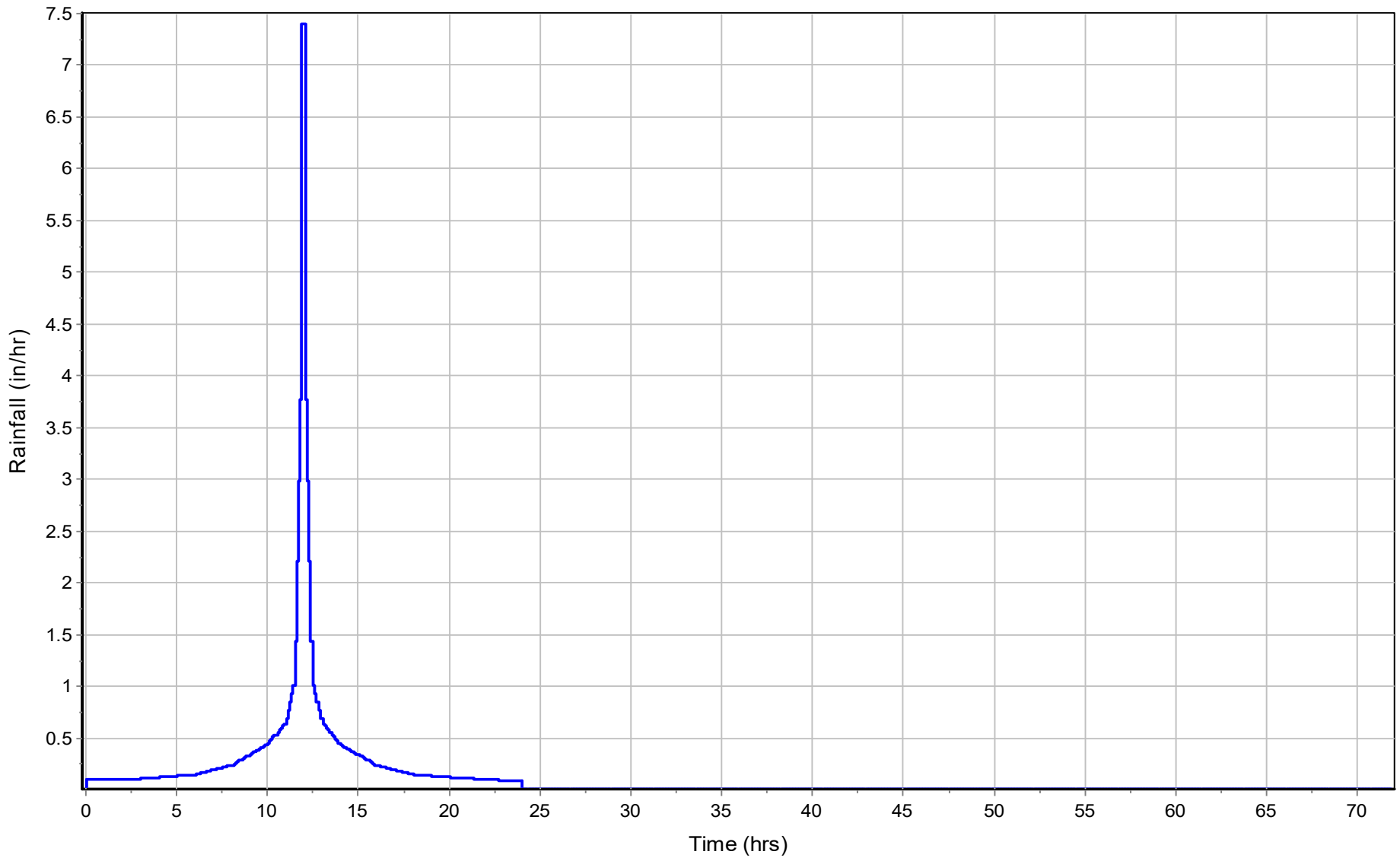
Total TOC (min) 5.38

Subbasin Runoff Results

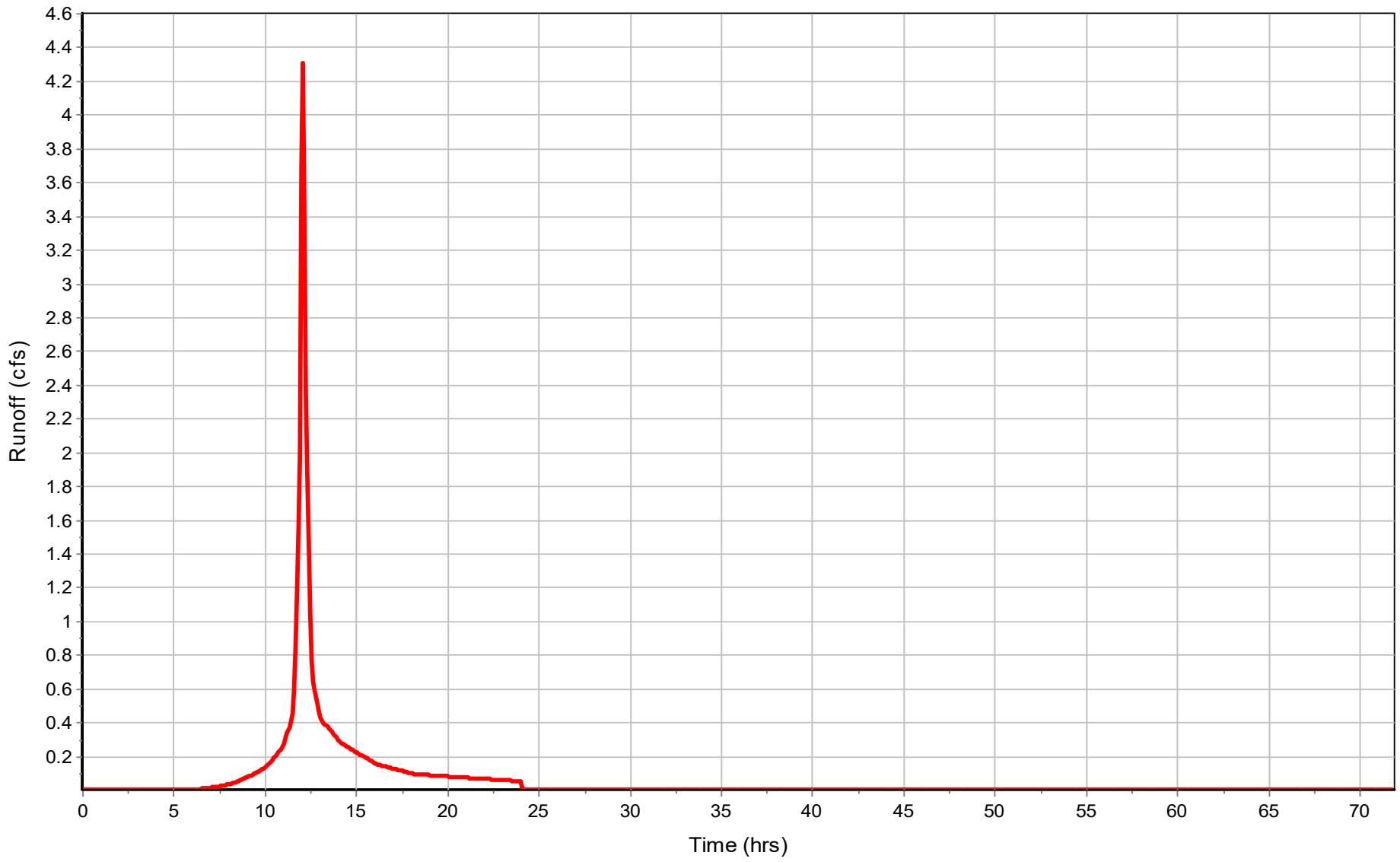
Total Rainfall (in)	8.8
Total Runoff (in)	5.89
Peak Runoff (cfs)	4.37
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:05:23

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

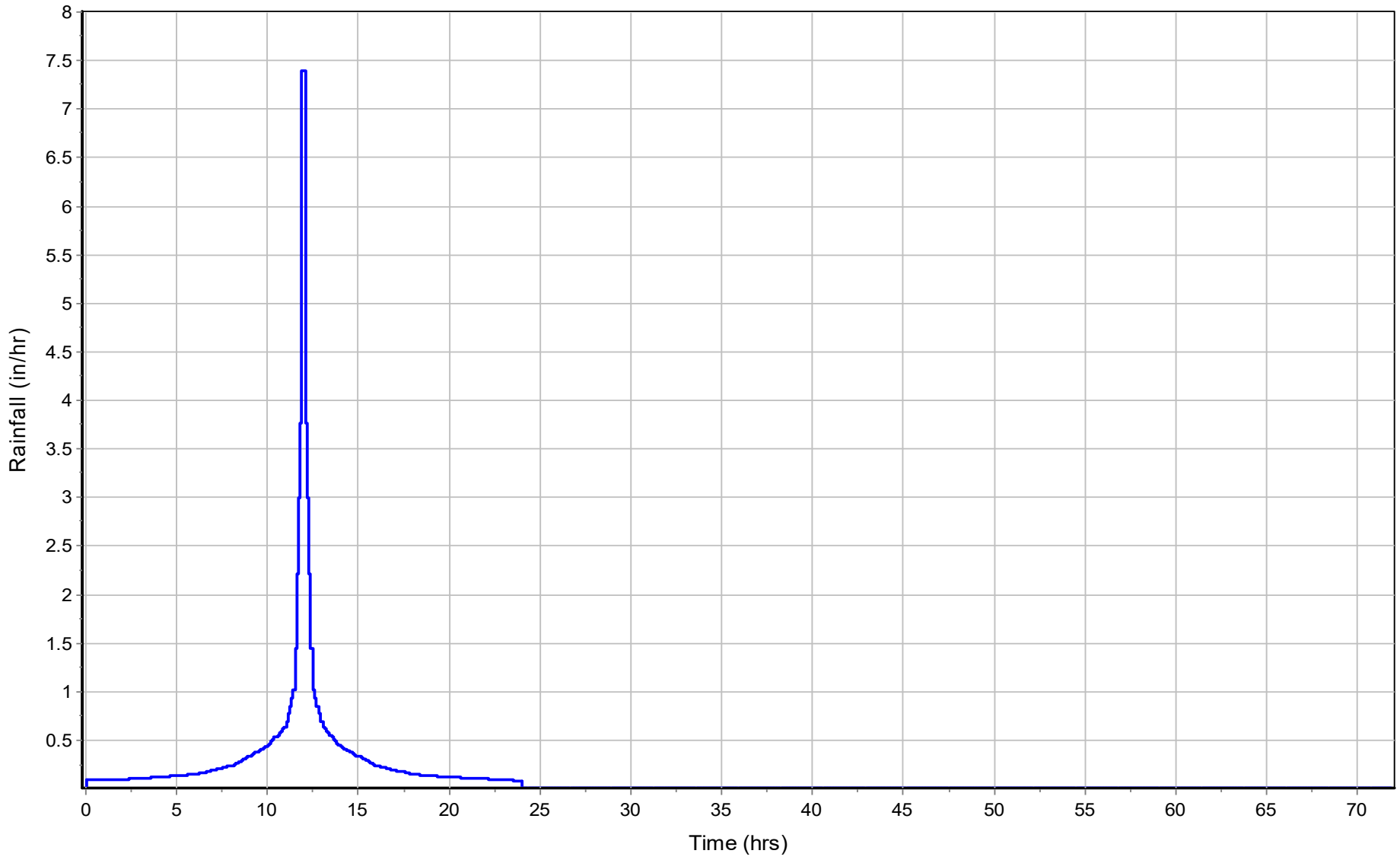
Total TOC (min) 0.79

Subbasin Runoff Results

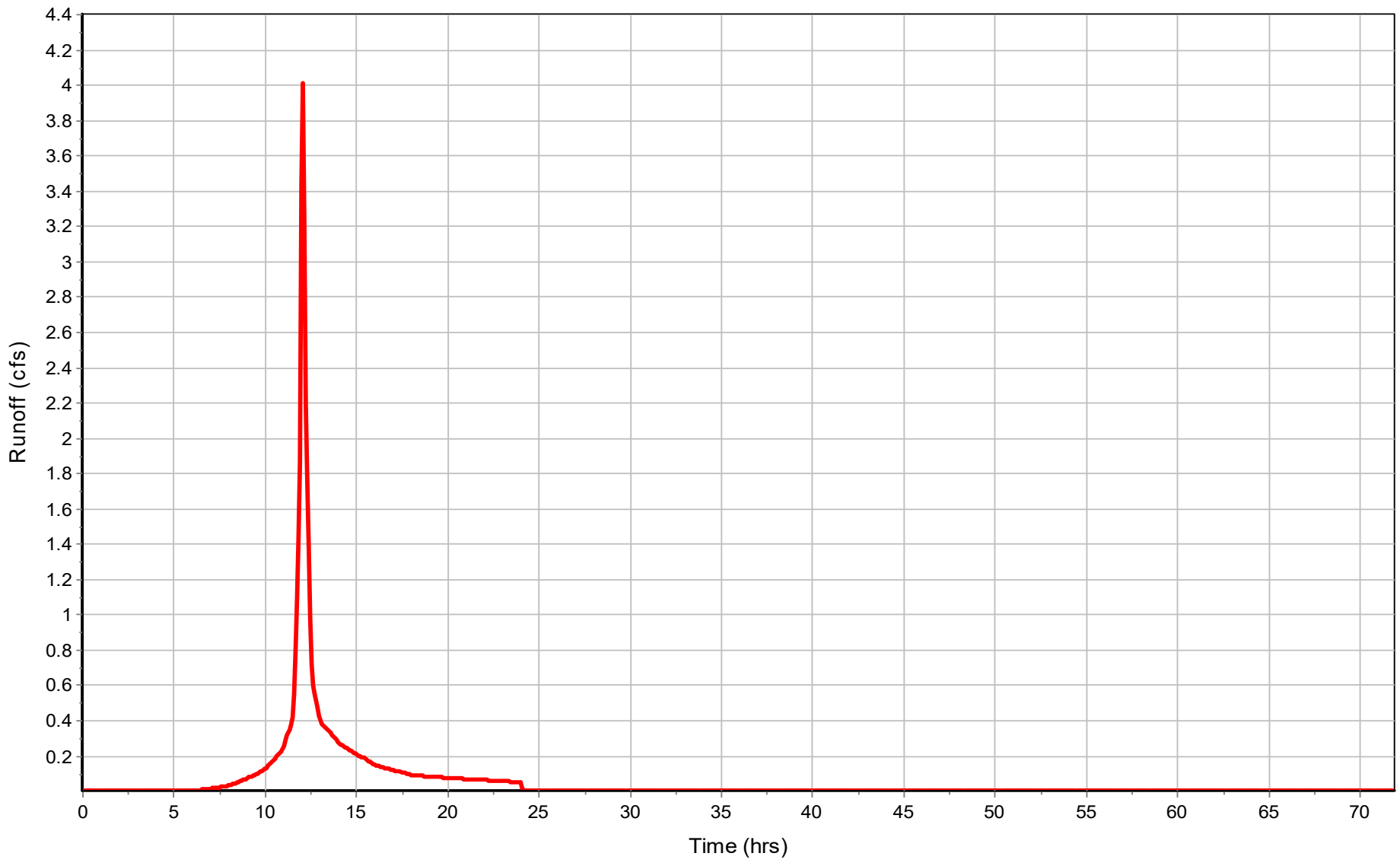
Total Rainfall (in) 8.8
Total Runoff (in) 5.89
Peak Runoff (cfs) 4.07
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:00:47

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

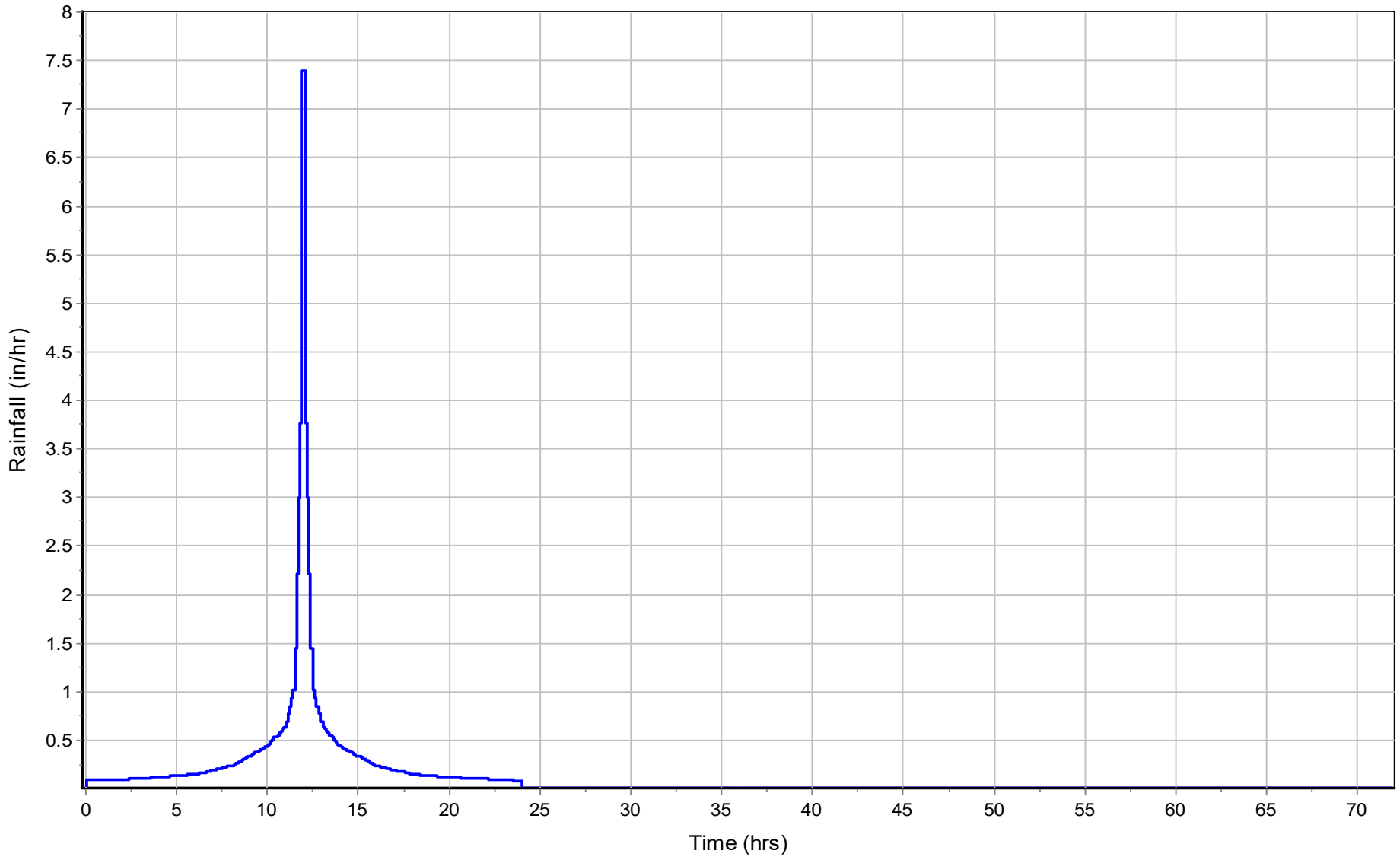
Total TOC (min) 28.81

Subbasin Runoff Results

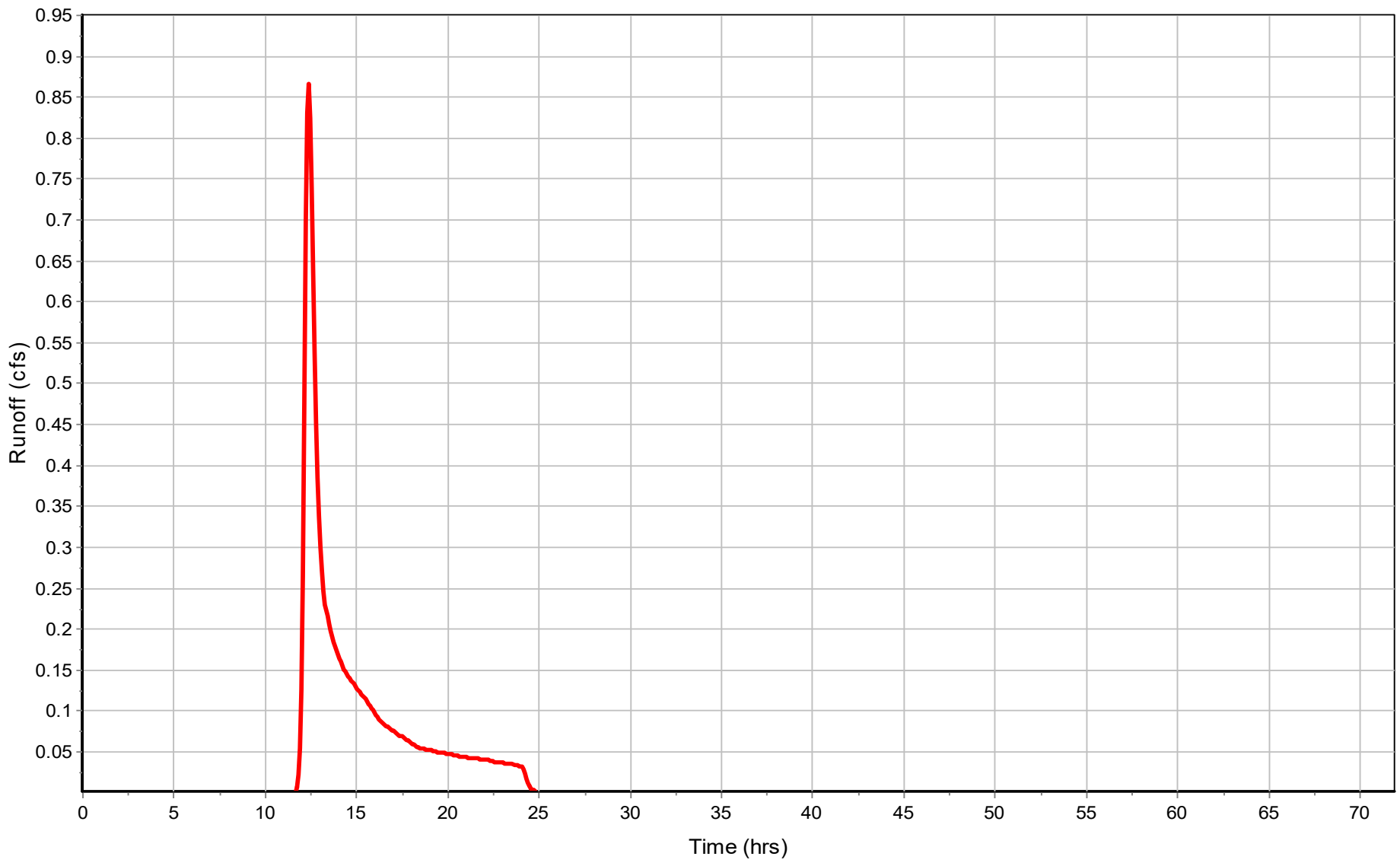
Total Rainfall (in) 8.8
Total Runoff (in) 1.95
Peak Runoff (cfs) 0.87
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:28:49

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

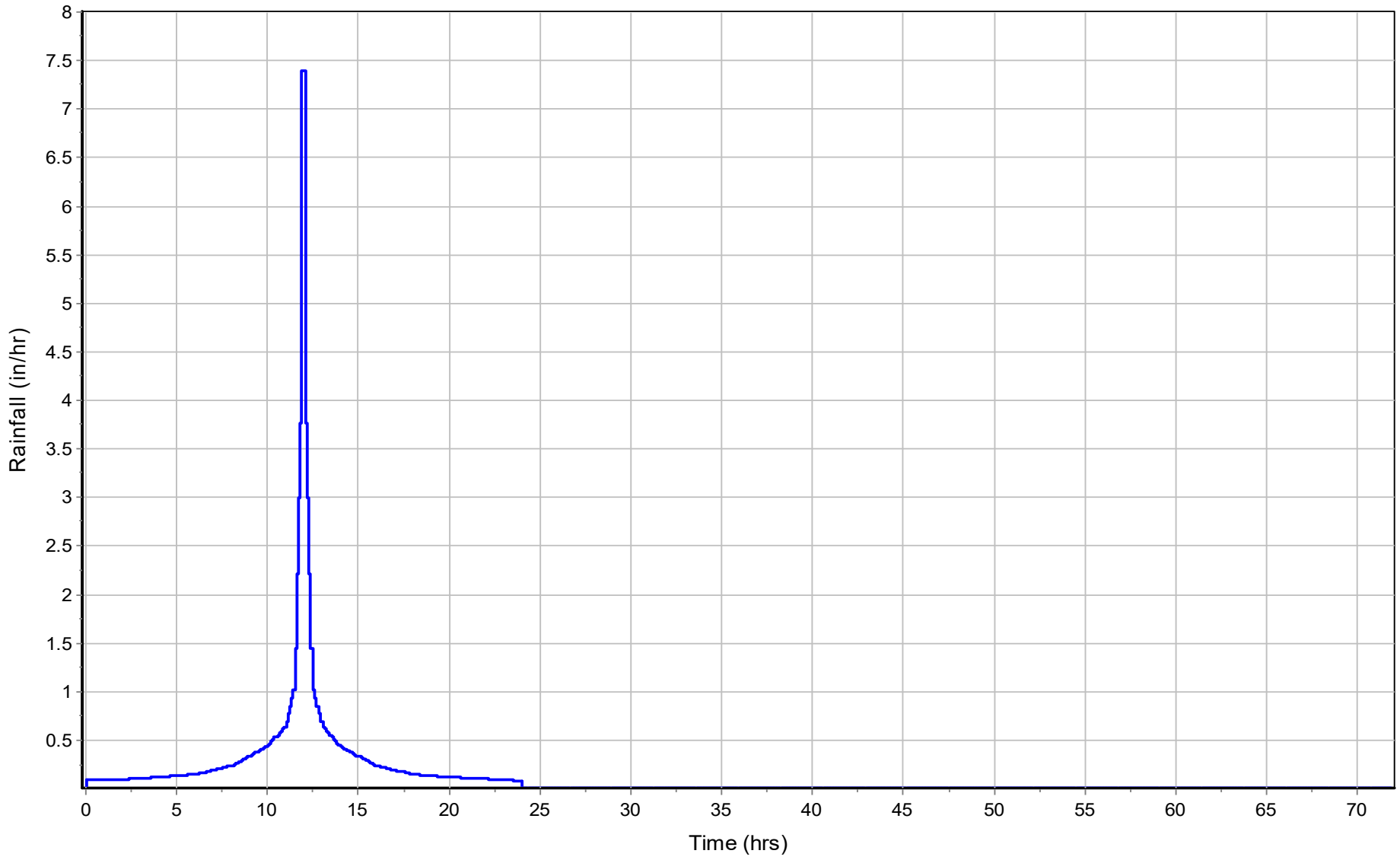
Total TOC (min) 17.94

Subbasin Runoff Results

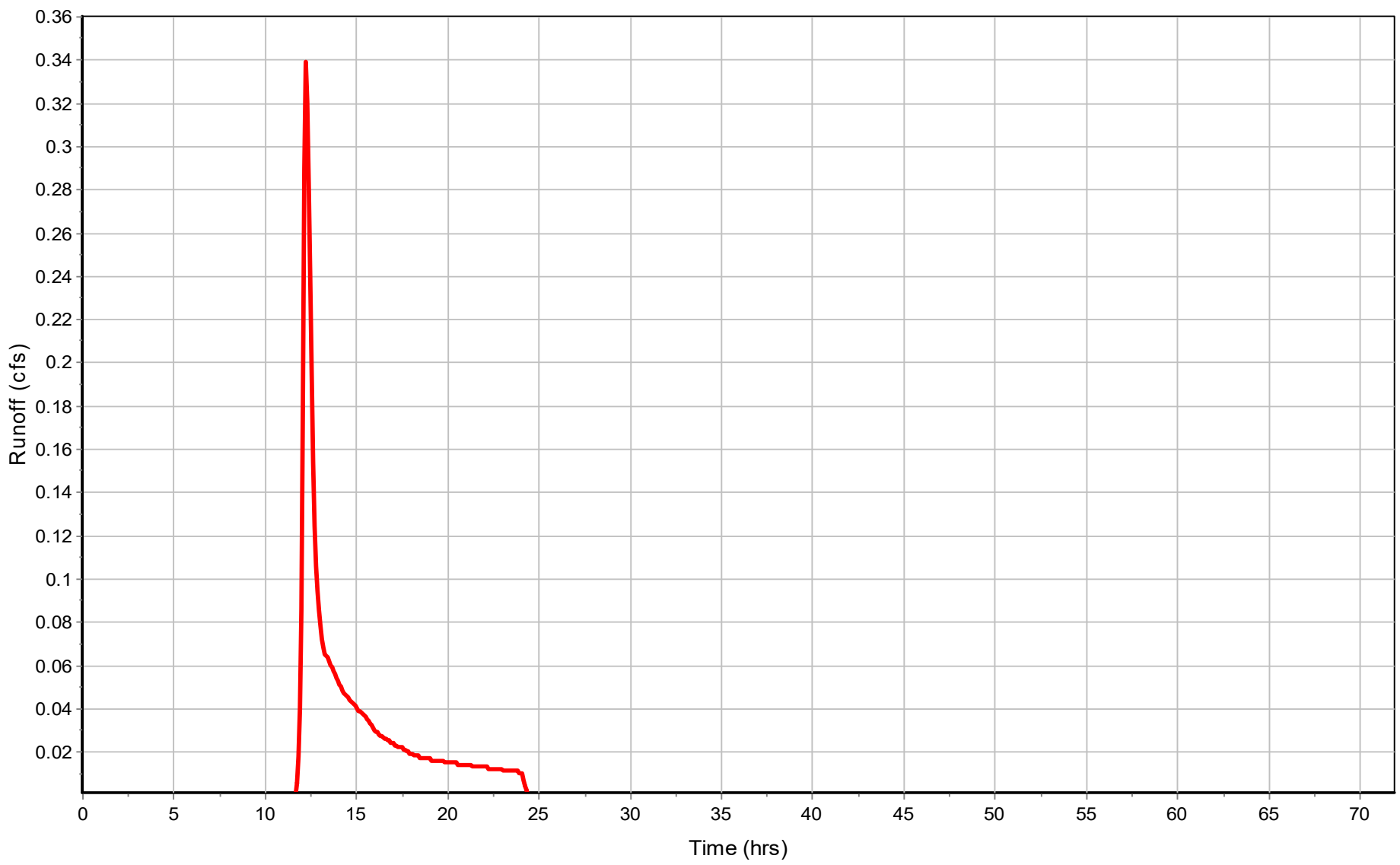
Total Rainfall (in) 8.8
Total Runoff (in) 1.95
Peak Runoff (cfs) 0.34
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:17:56

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

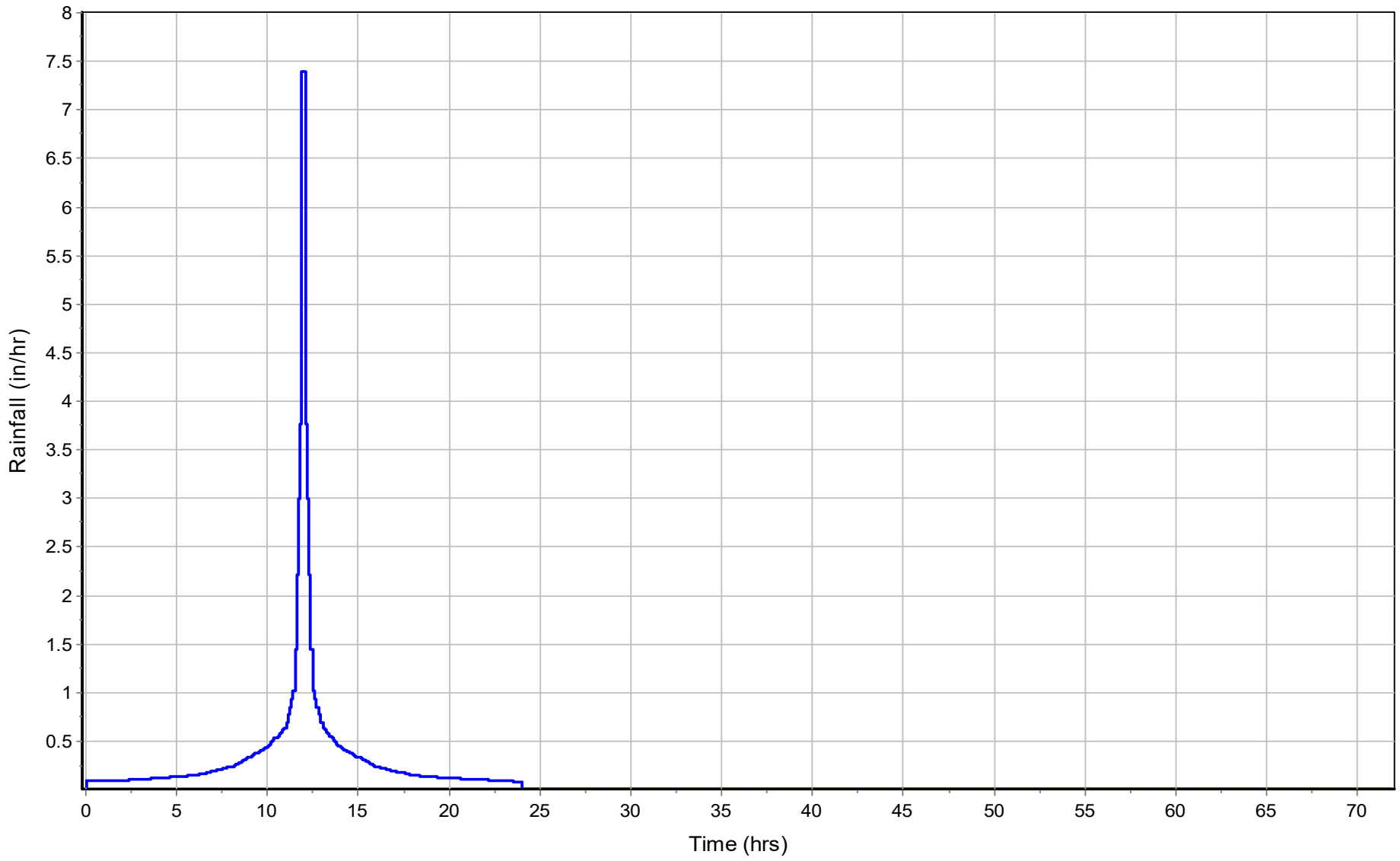
Total TOC (min) 17.48

Subbasin Runoff Results

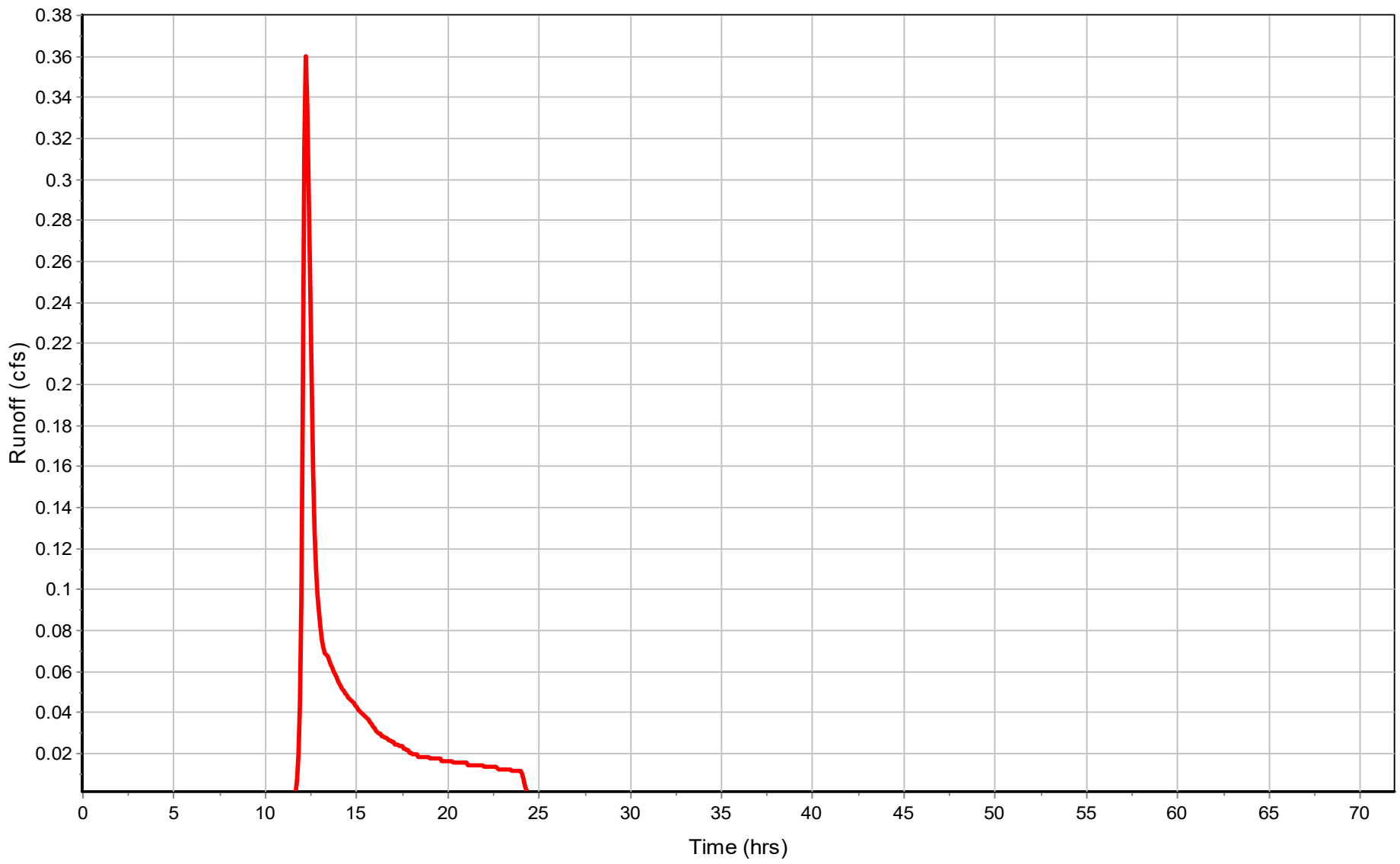
Total Rainfall (in) 8.8
Total Runoff (in) 1.95
Peak Runoff (cfs) 0.36
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:17:29

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

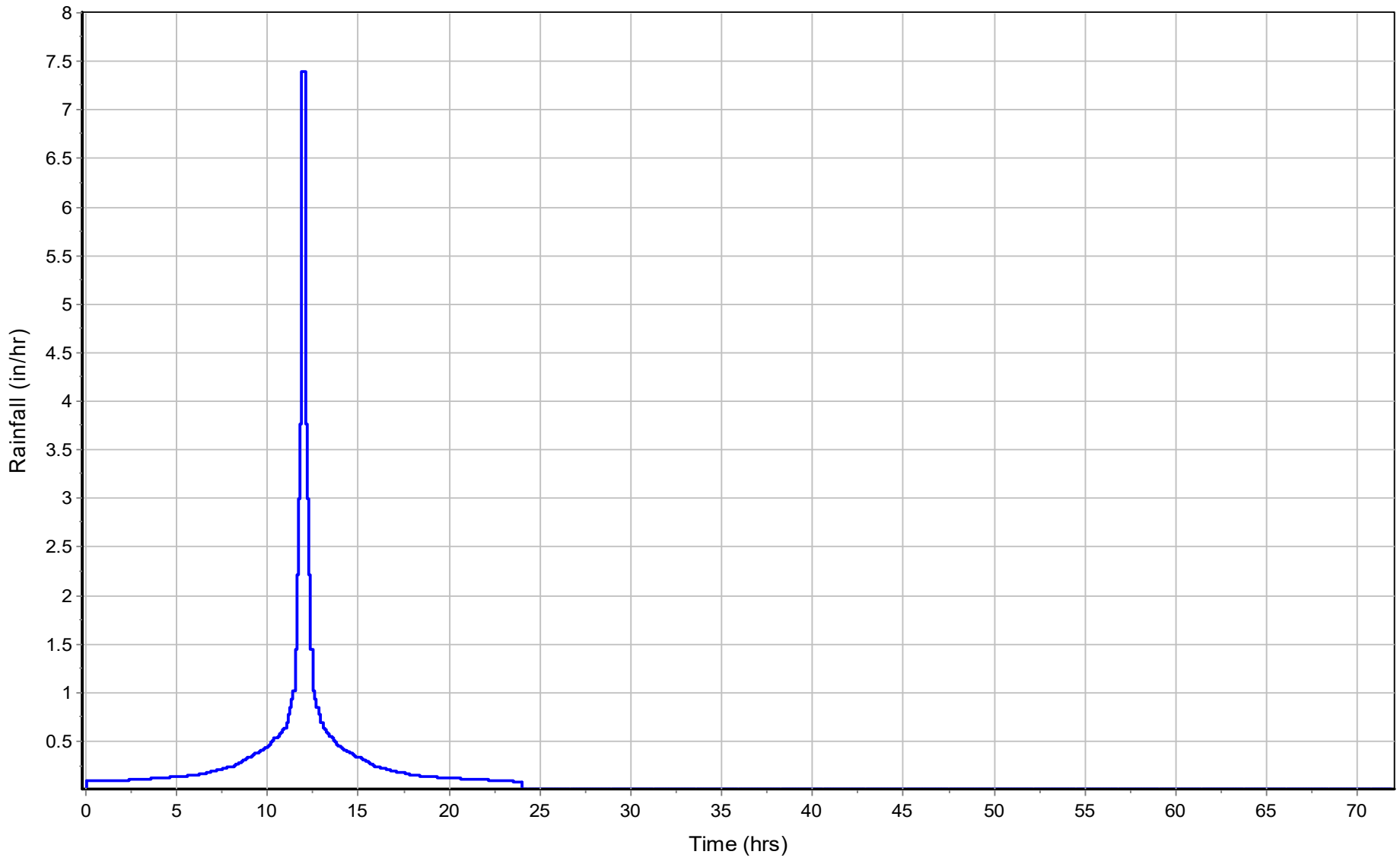
Total TOC (min) 21.50

Subbasin Runoff Results

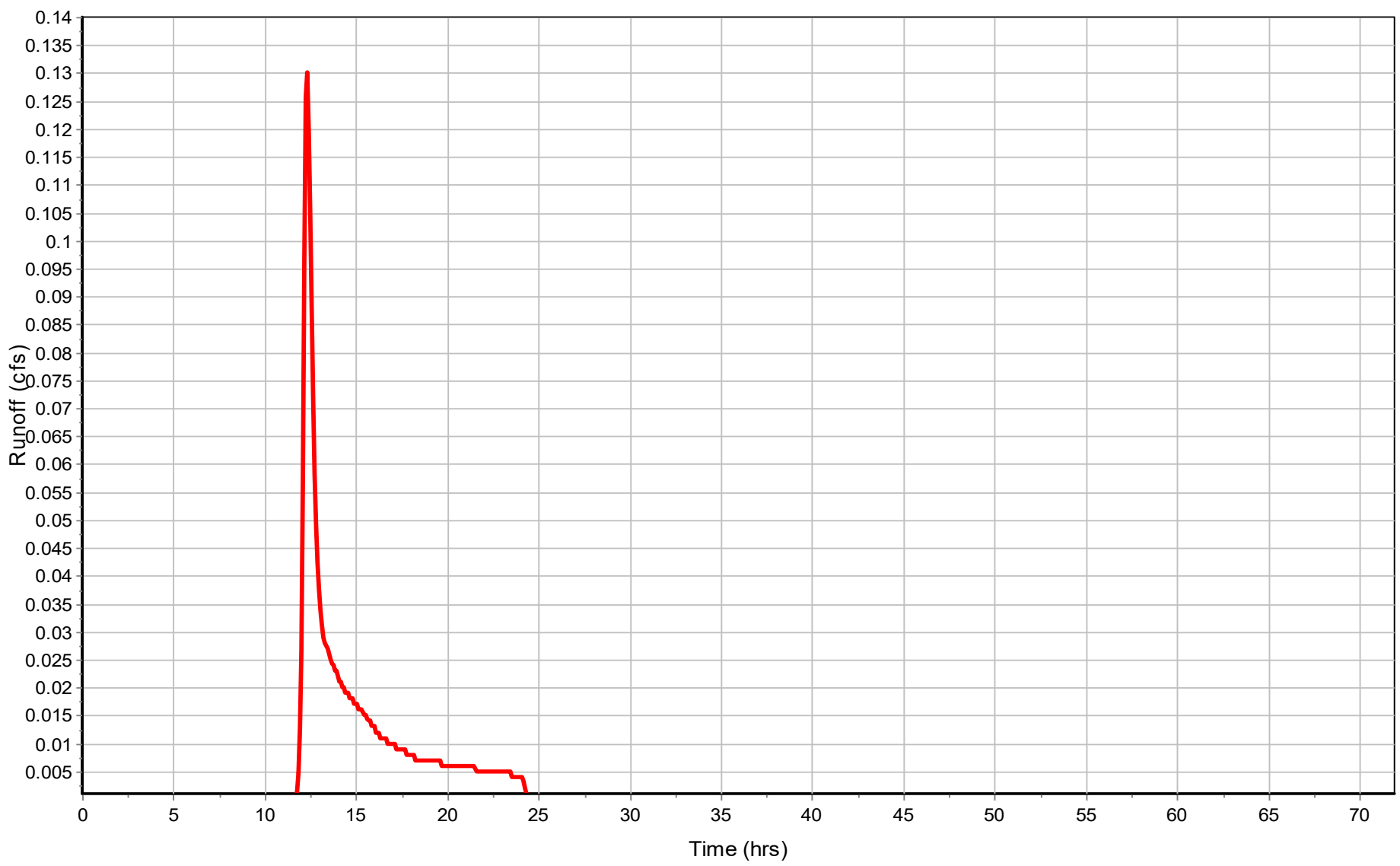
Total Rainfall (in) 8.8
Total Runoff (in) 1.95
Peak Runoff (cfs) 0.13
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:21:30

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

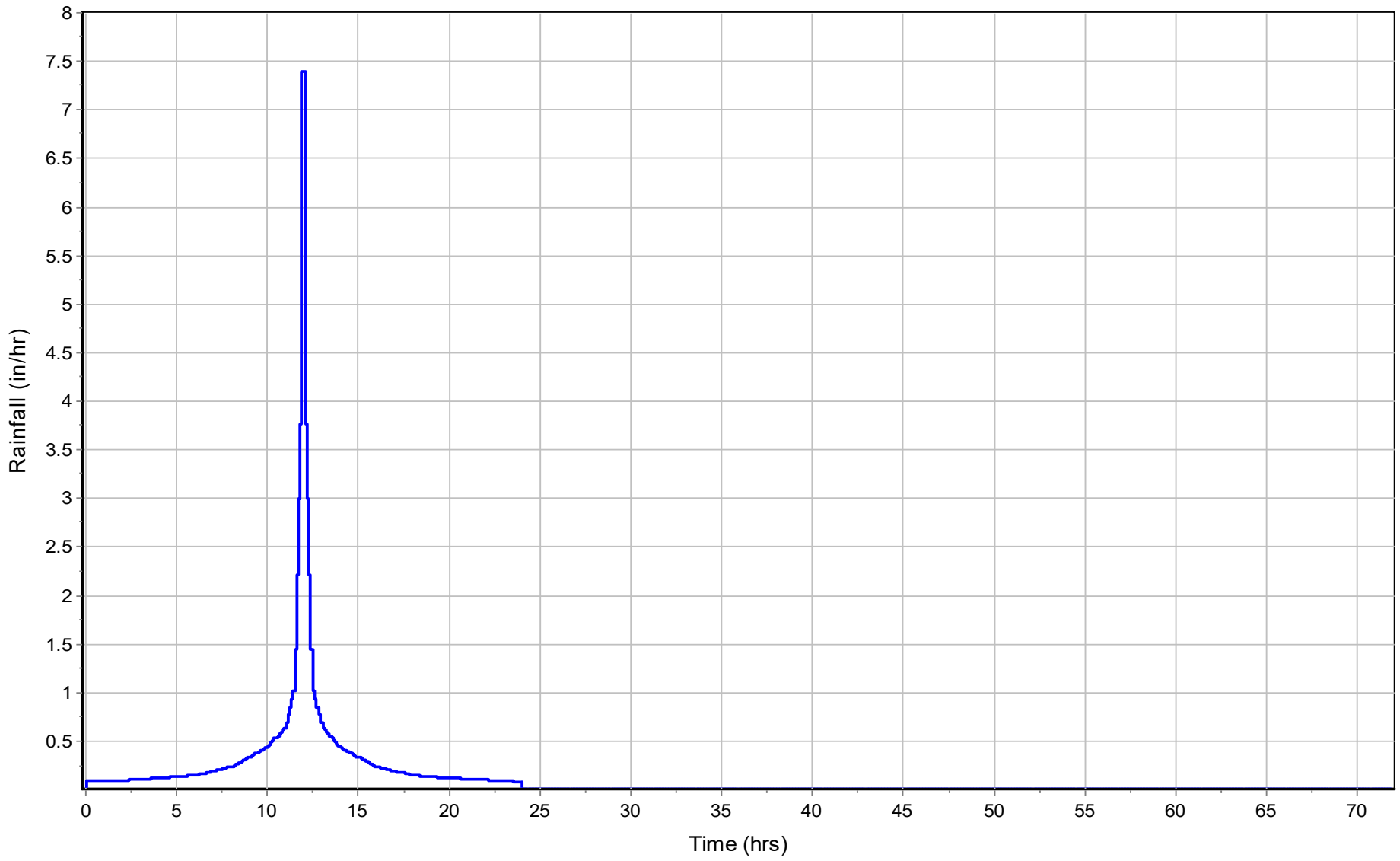
Total TOC (min) 9.01

Subbasin Runoff Results

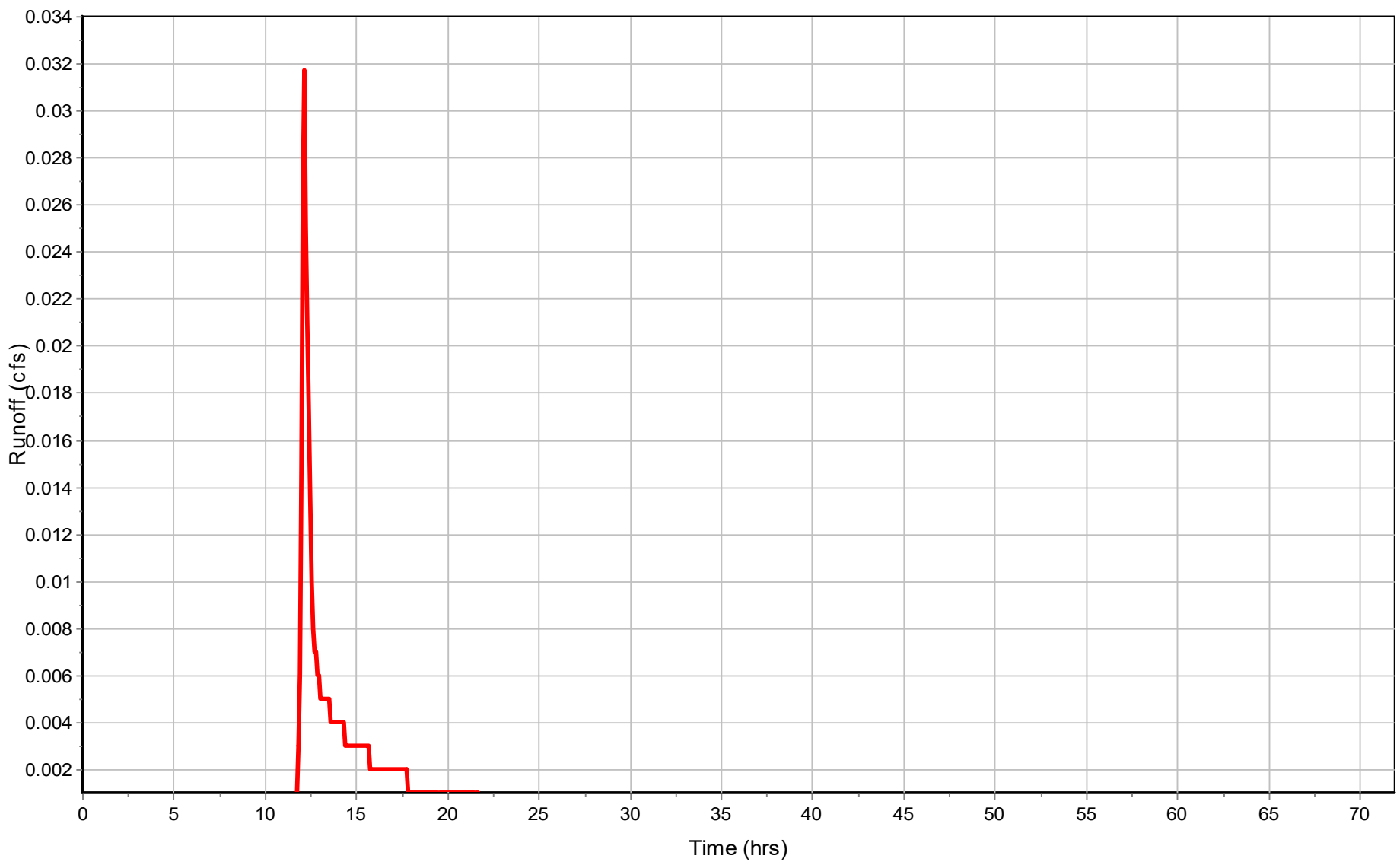
Total Rainfall (in) 8.8
Total Runoff (in) 1.84
Peak Runoff (cfs) 0.03
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:09:01

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

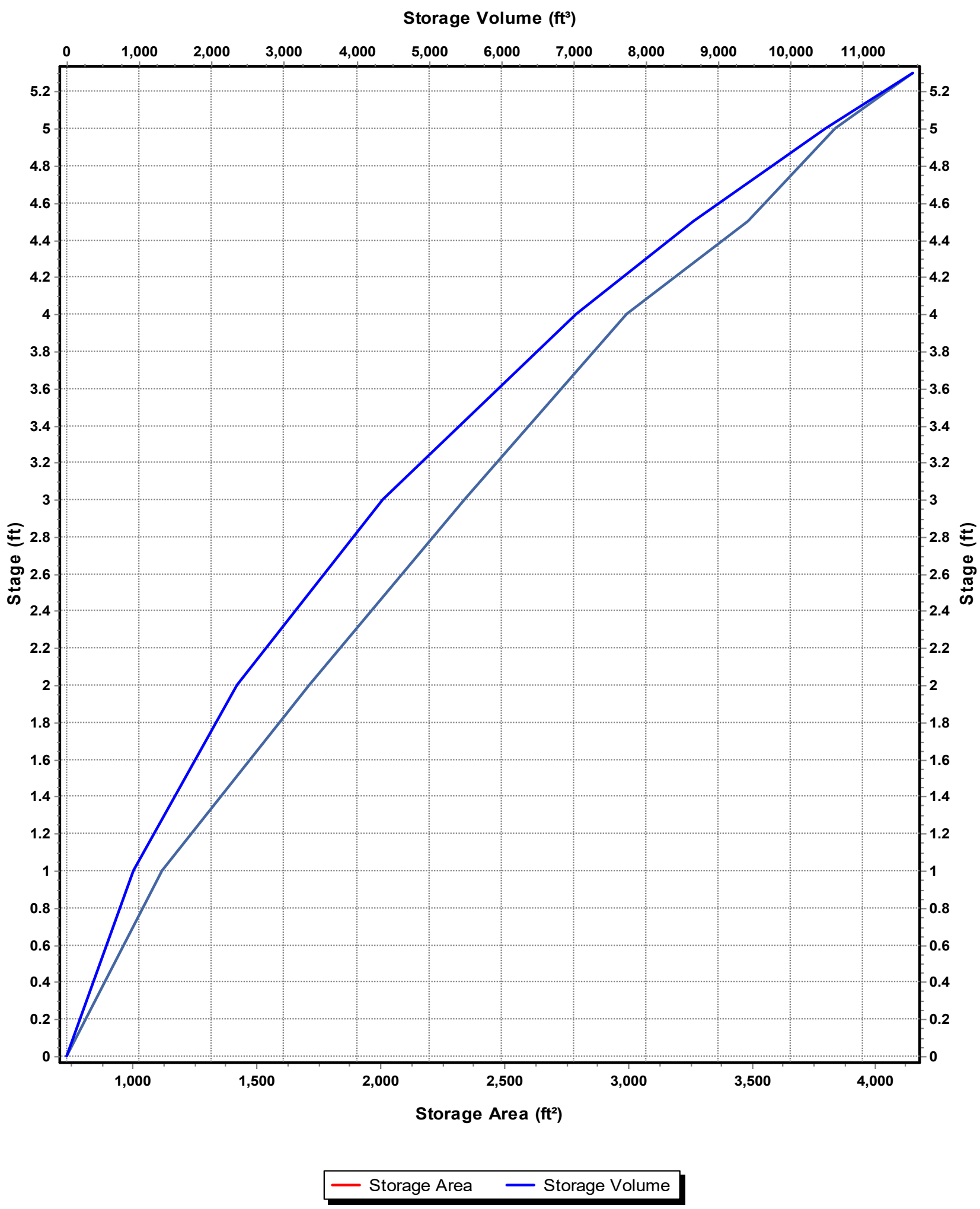
Invert Elevation (ft)	112.40
Max (Rim) Elevation (ft)	117.70
Max (Rim) Offset (ft)	5.30
Initial Water Elevation (ft)	112.40
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

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

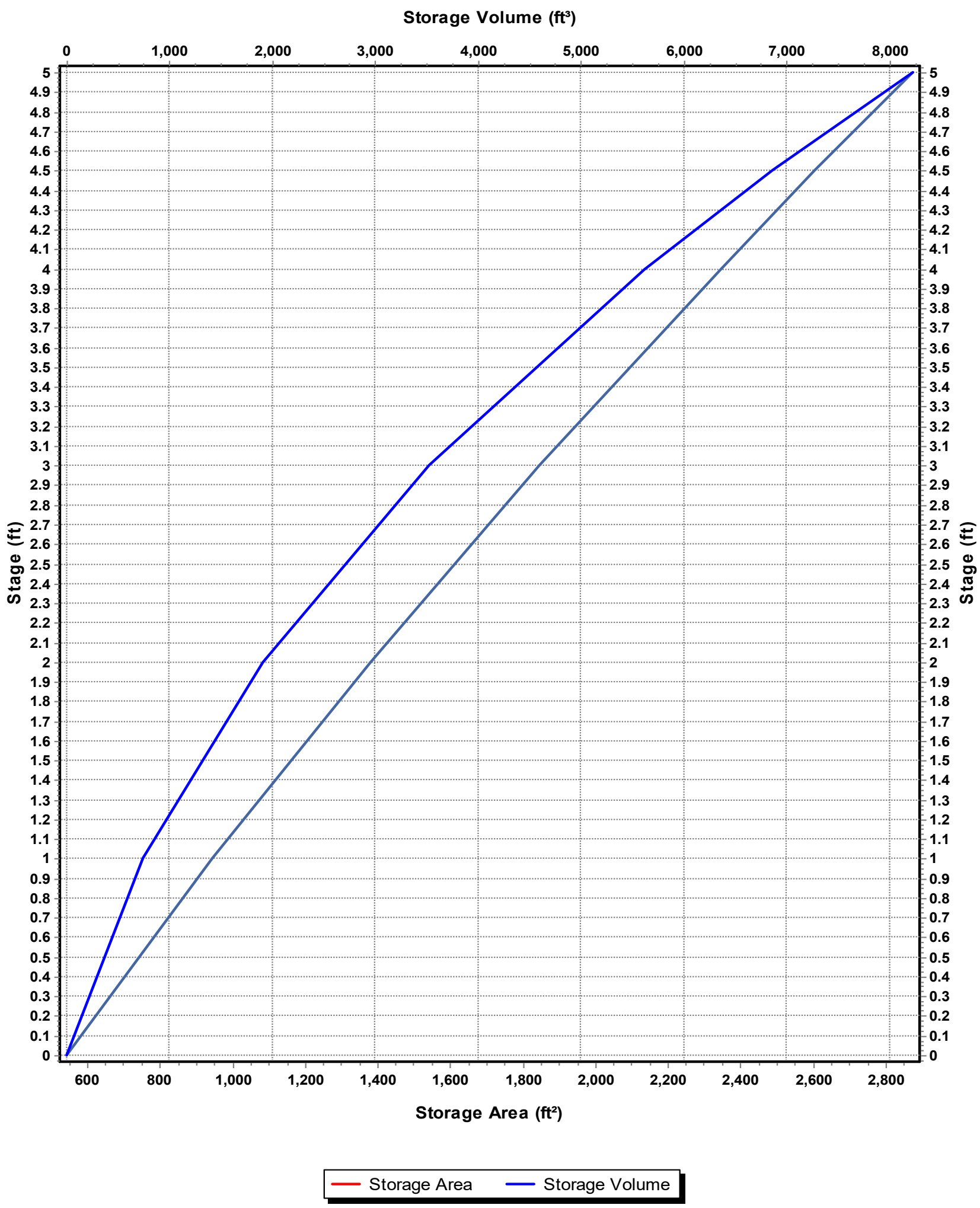
Invert Elevation (ft)	112.90
Max (Rim) Elevation (ft)	117.90
Max (Rim) Offset (ft)	5.00
Initial Water Elevation (ft)	112.90
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

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

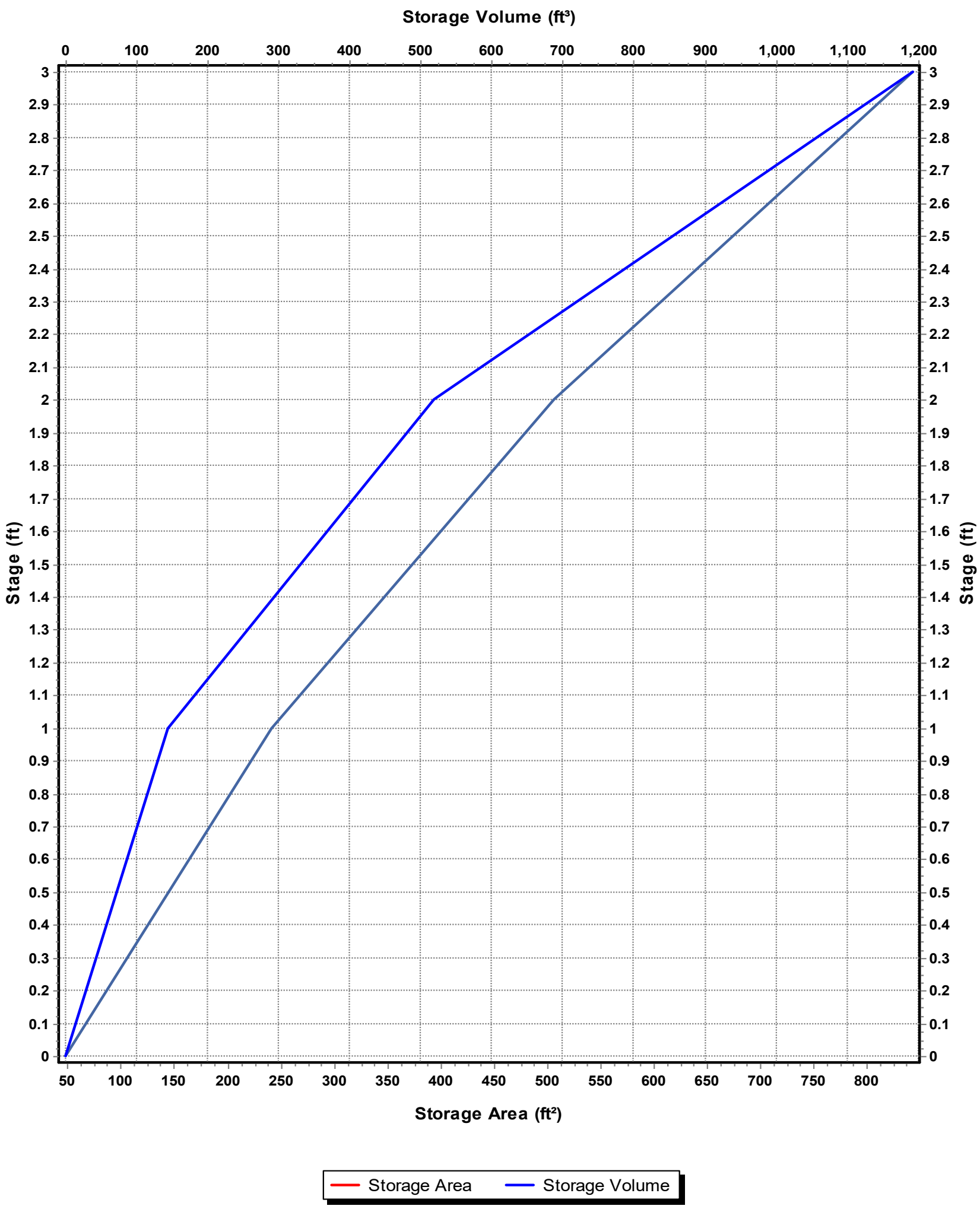
Invert Elevation (ft)	114.40
Max (Rim) Elevation (ft)	117.70
Max (Rim) Offset (ft)	3.30
Initial Water Elevation (ft)	114.40
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

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

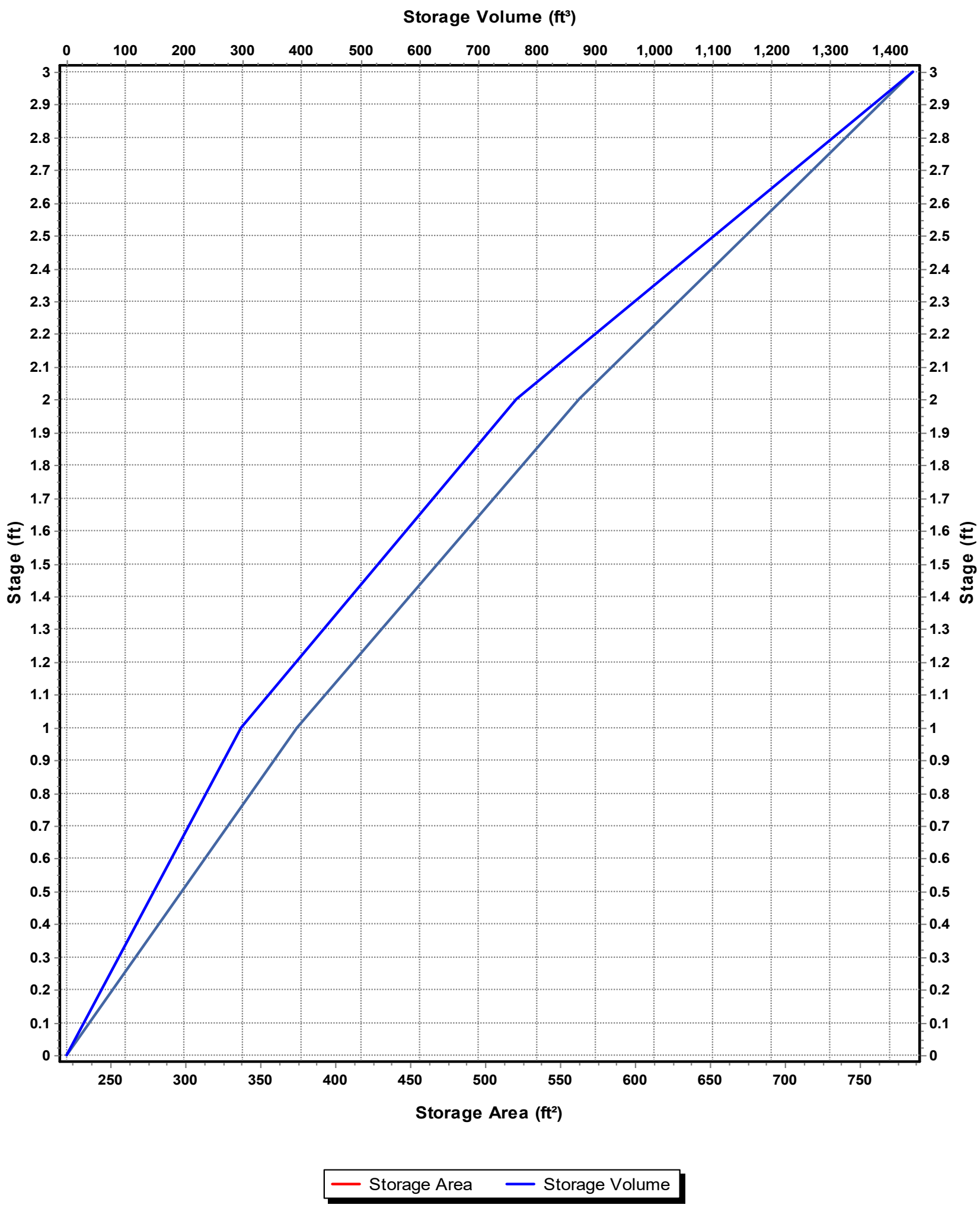
Invert Elevation (ft)	114.90
Max (Rim) Elevation (ft)	117.90
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.90
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

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

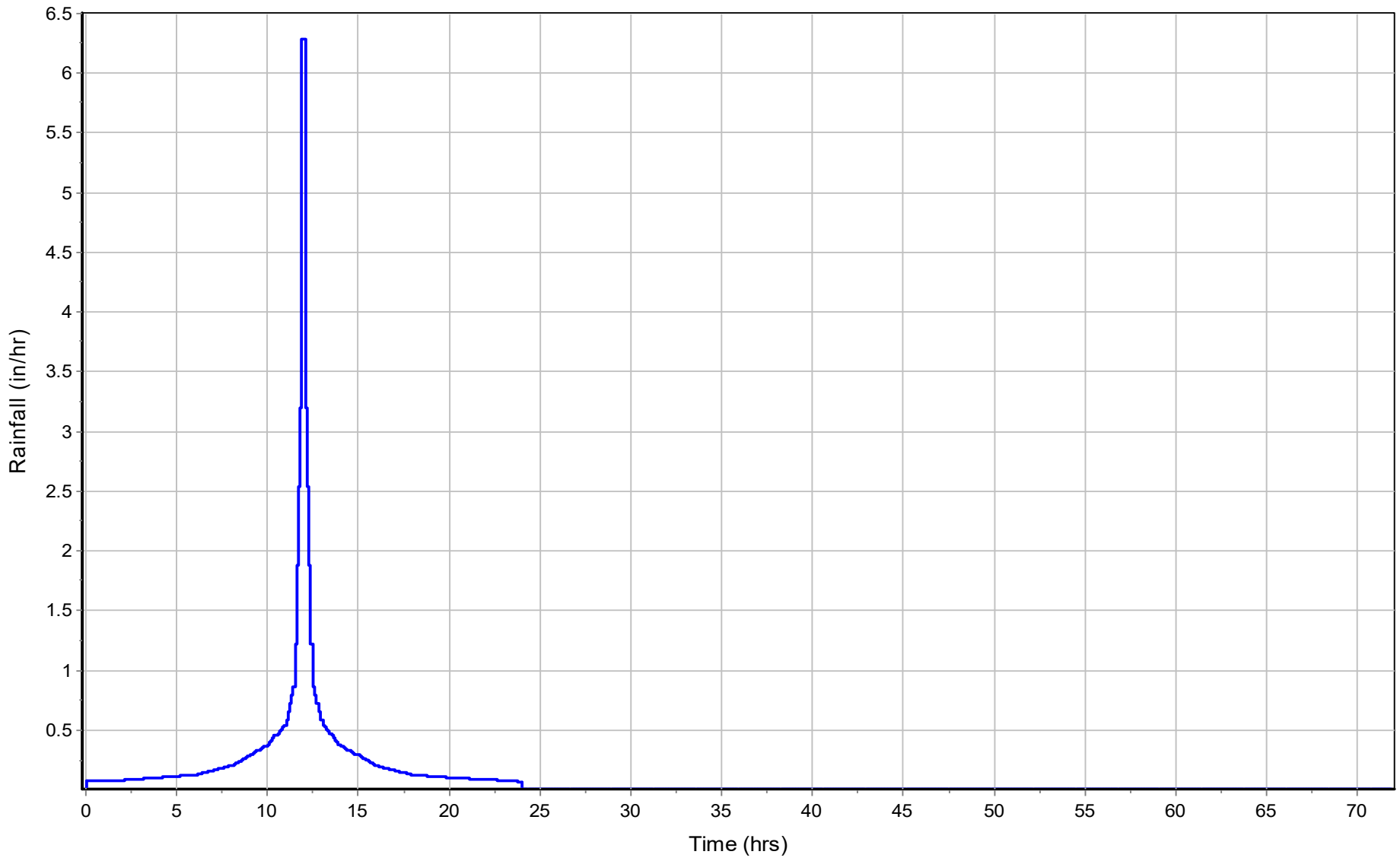
Total TOC (min) 5.38

Subbasin Runoff Results

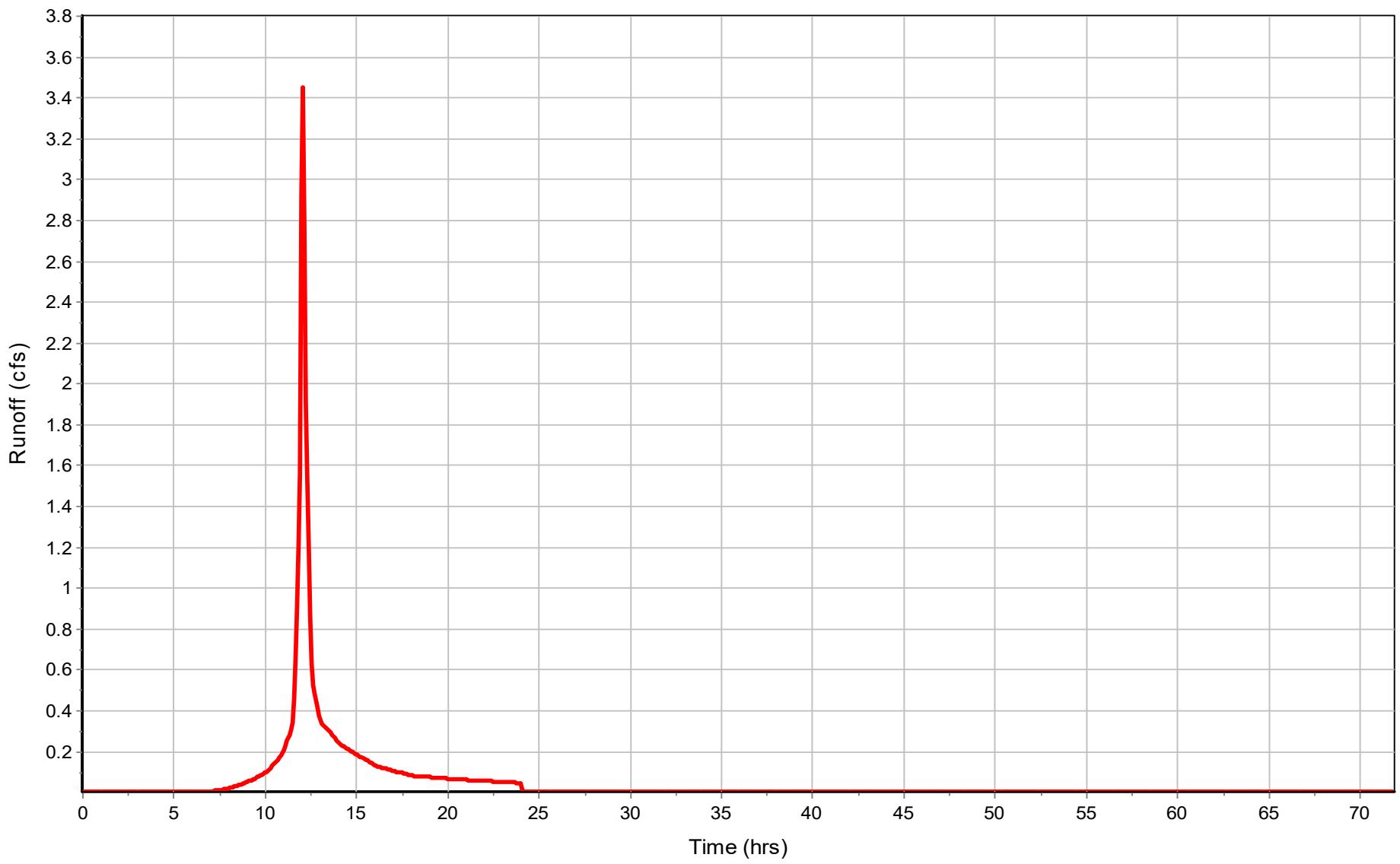
Total Rainfall (in)	7.48
Total Runoff (in)	4.69
Peak Runoff (cfs)	3.51
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:05:23

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

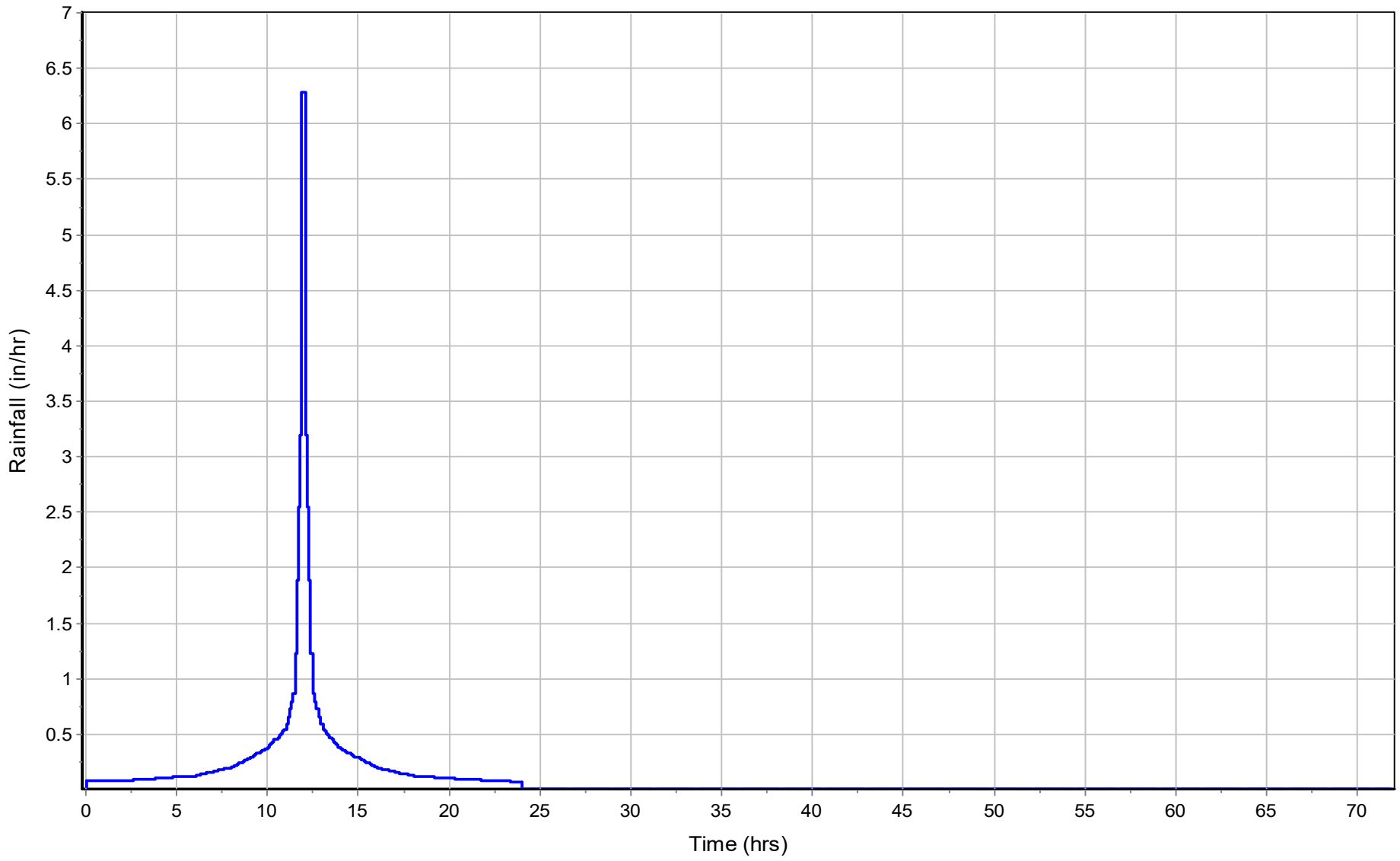
Total TOC (min) 0.79

Subbasin Runoff Results

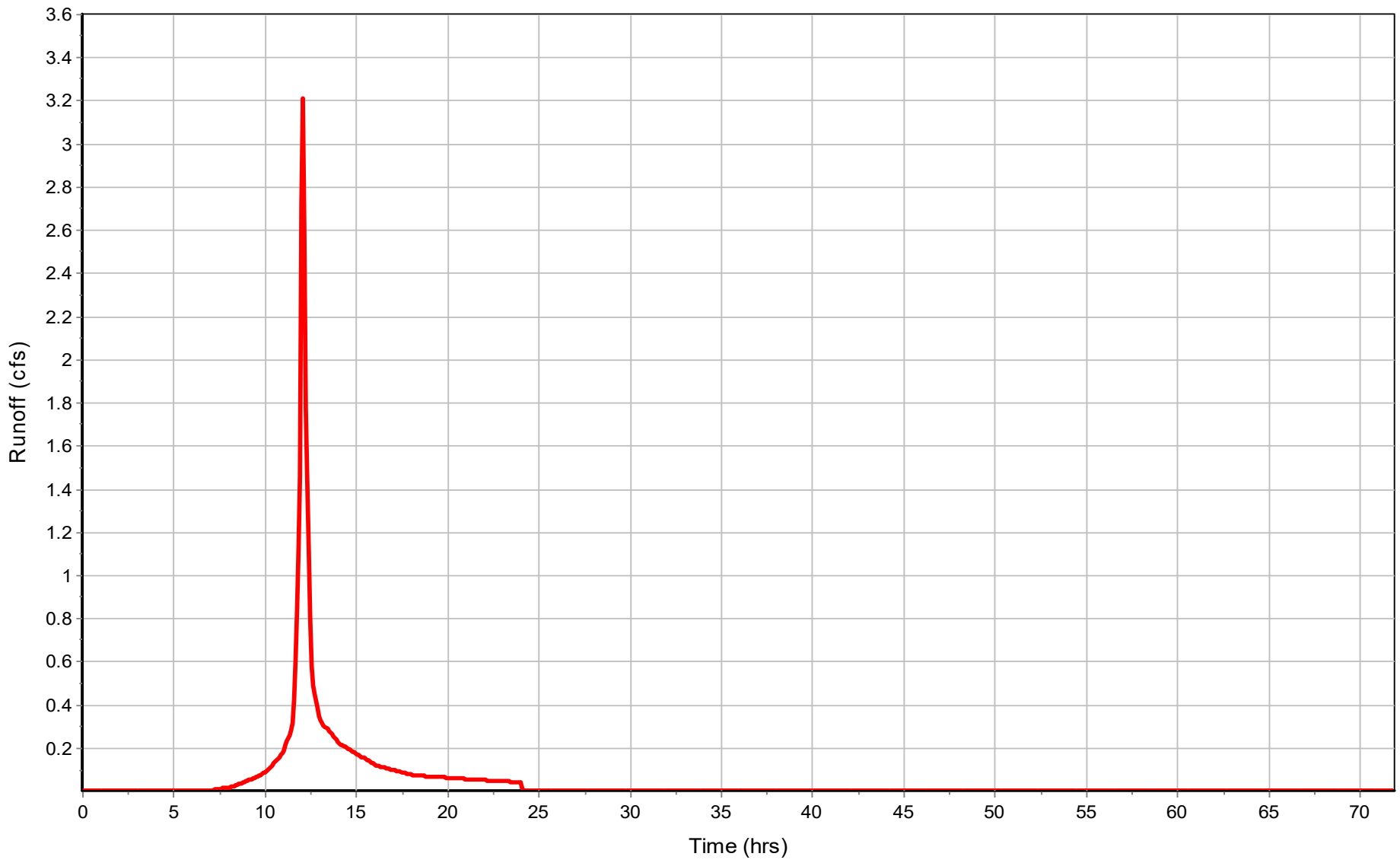
Total Rainfall (in) 7.48
Total Runoff (in) 4.69
Peak Runoff (cfs) 3.27
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:00:47

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

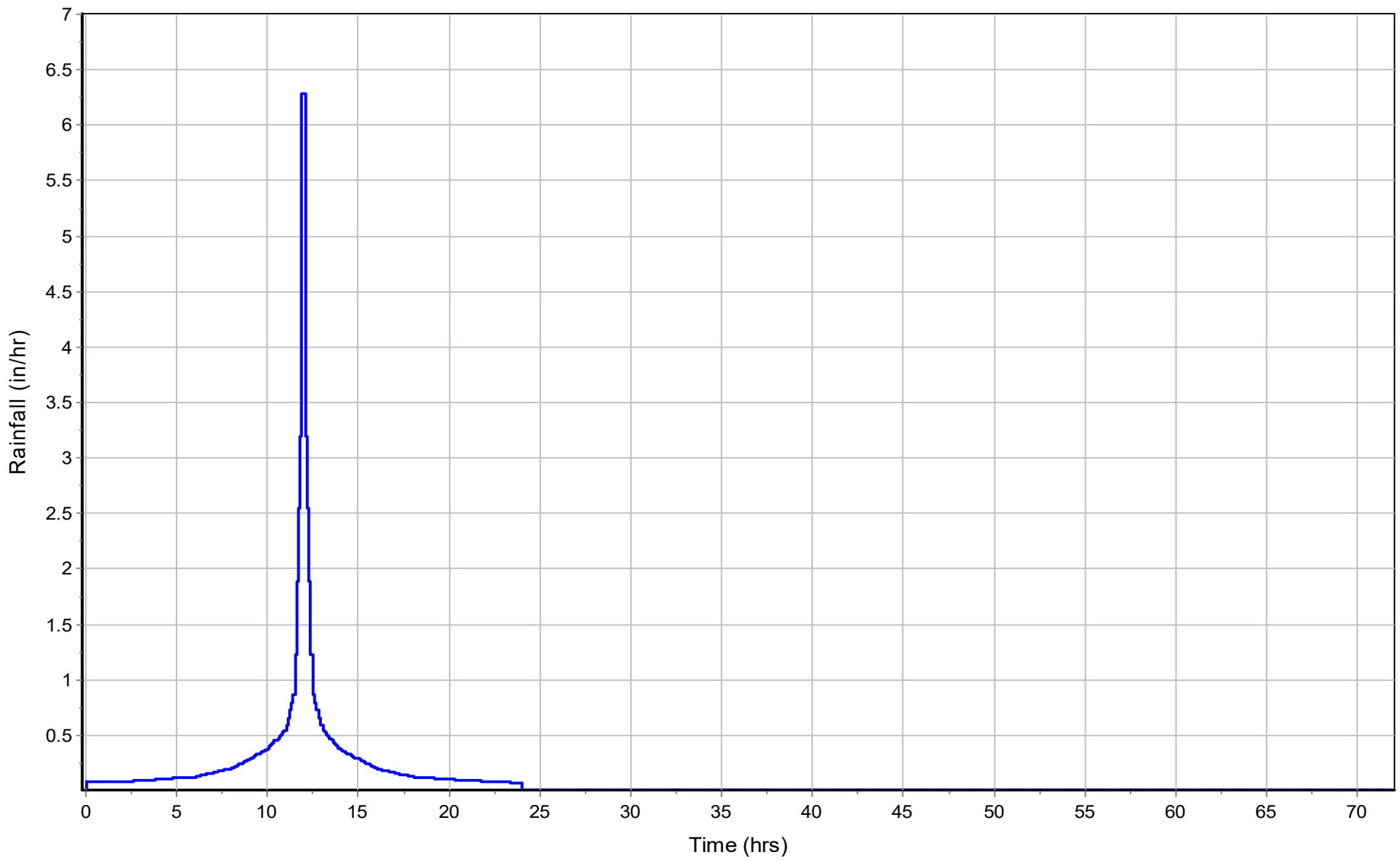
Total TOC (min) 28.81

Subbasin Runoff Results

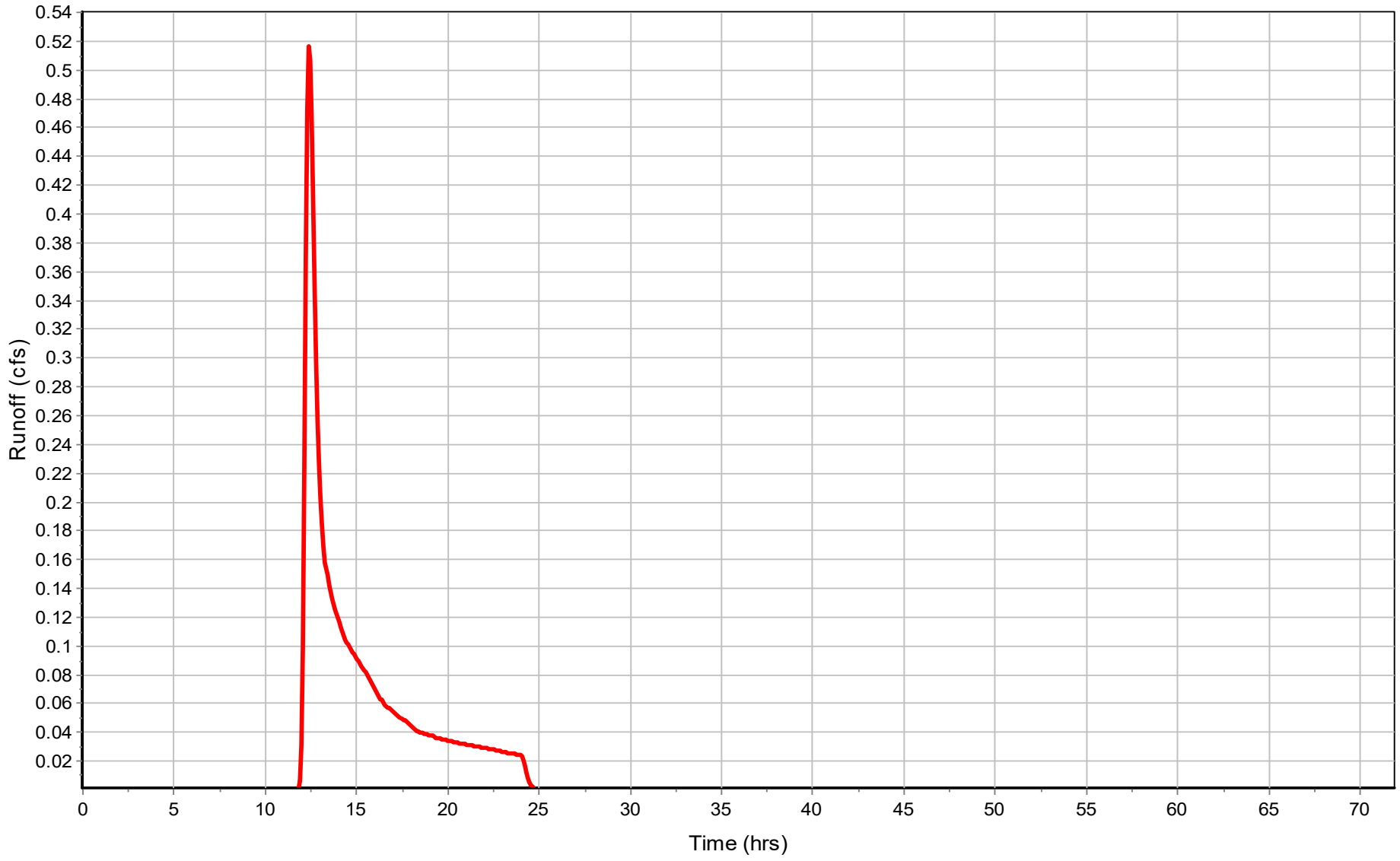
Total Rainfall (in) 7.48
Total Runoff (in) 1.29
Peak Runoff (cfs) 0.52
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:28:49

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

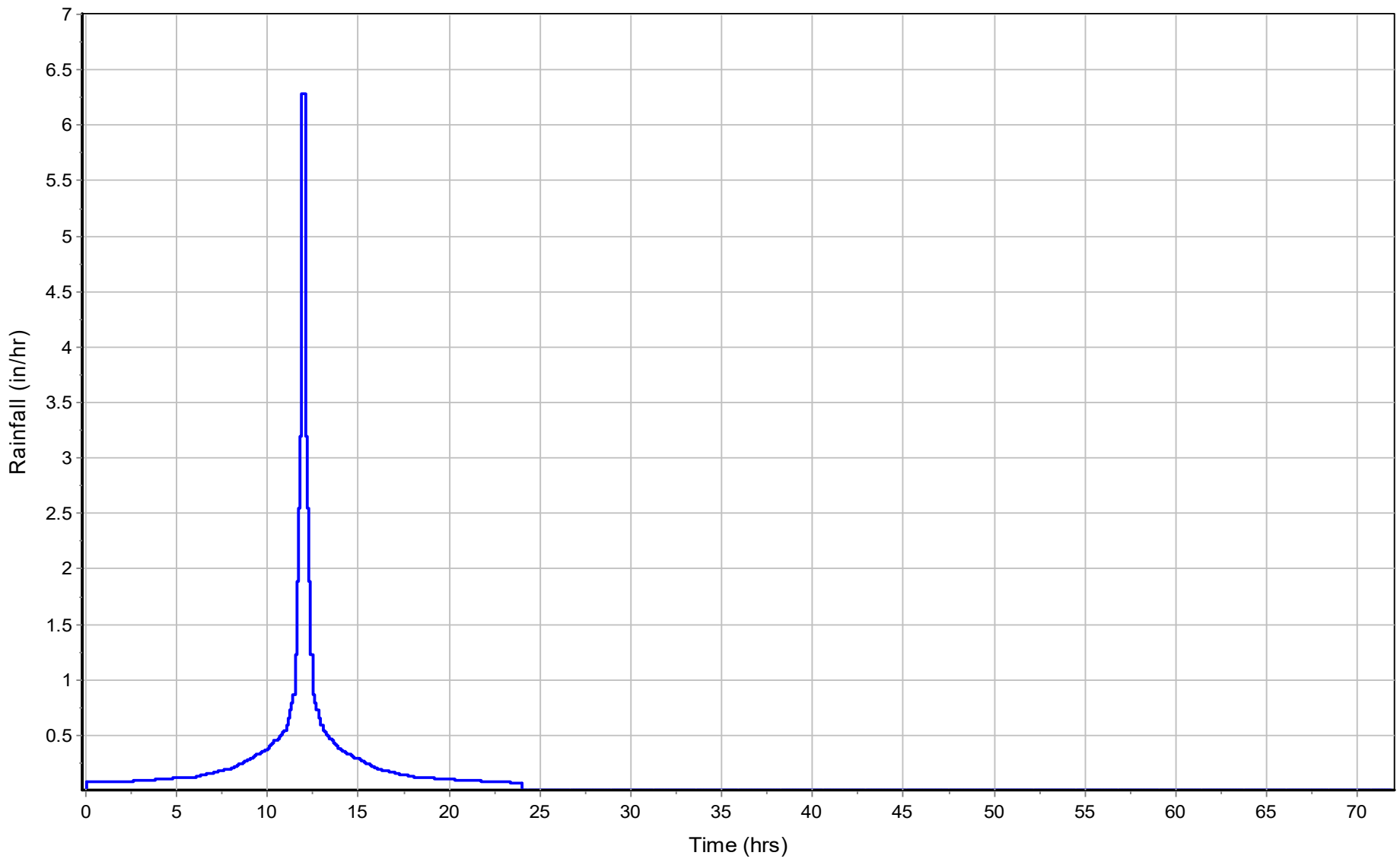
Total TOC (min) 17.94

Subbasin Runoff Results

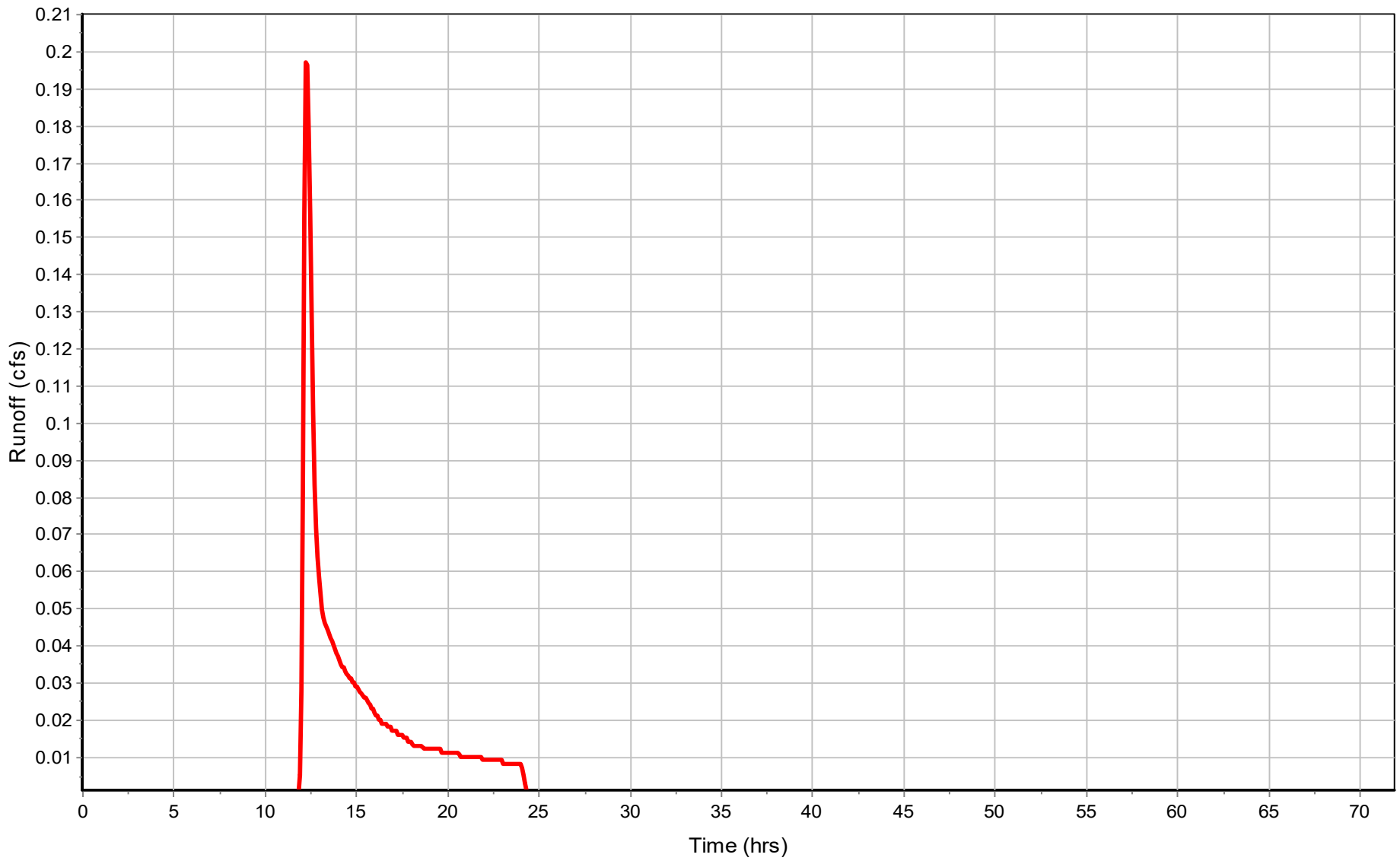
Total Rainfall (in) 7.48
Total Runoff (in) 1.29
Peak Runoff (cfs) 0.2
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:17:56

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

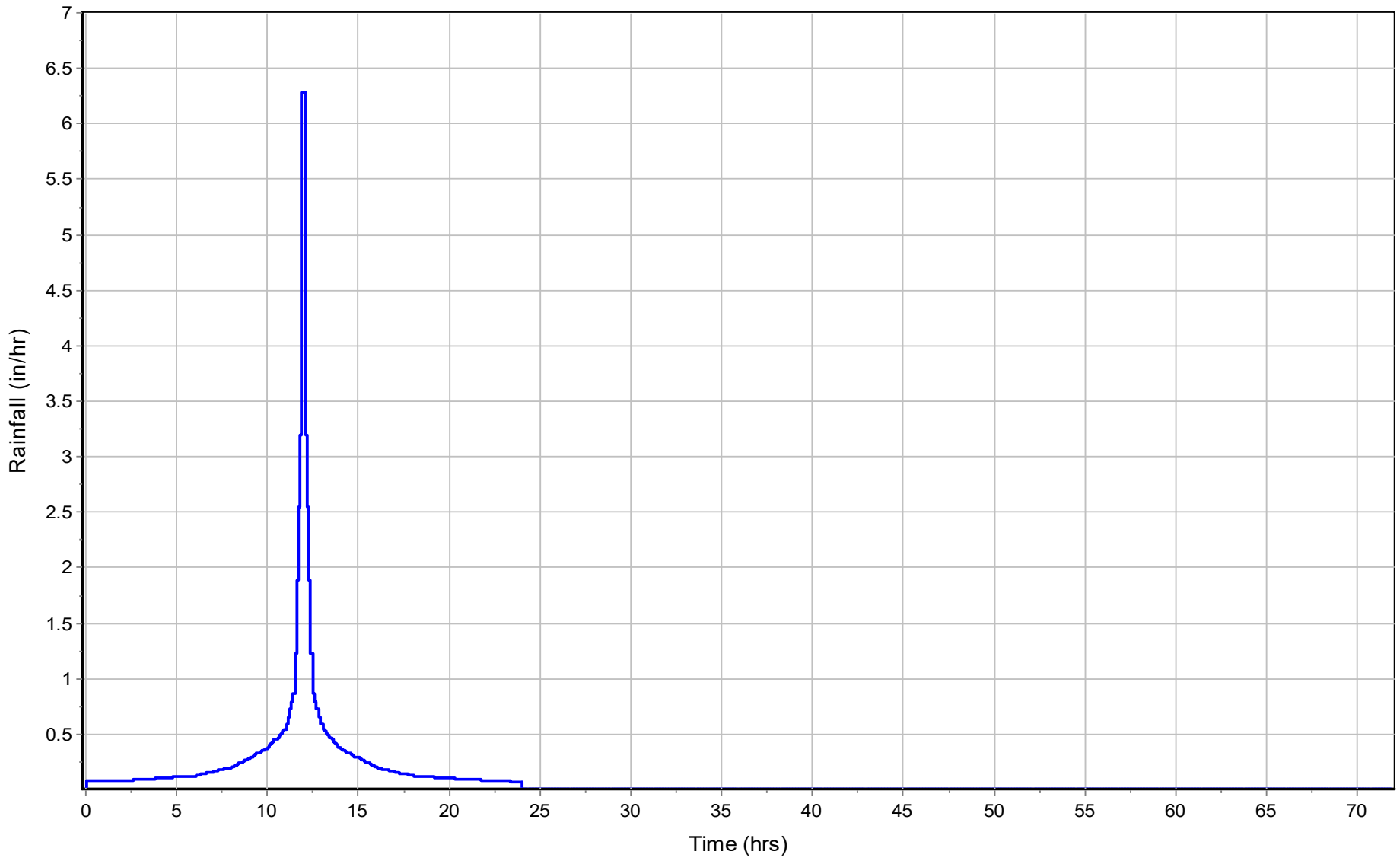
Total TOC (min) 17.48

Subbasin Runoff Results

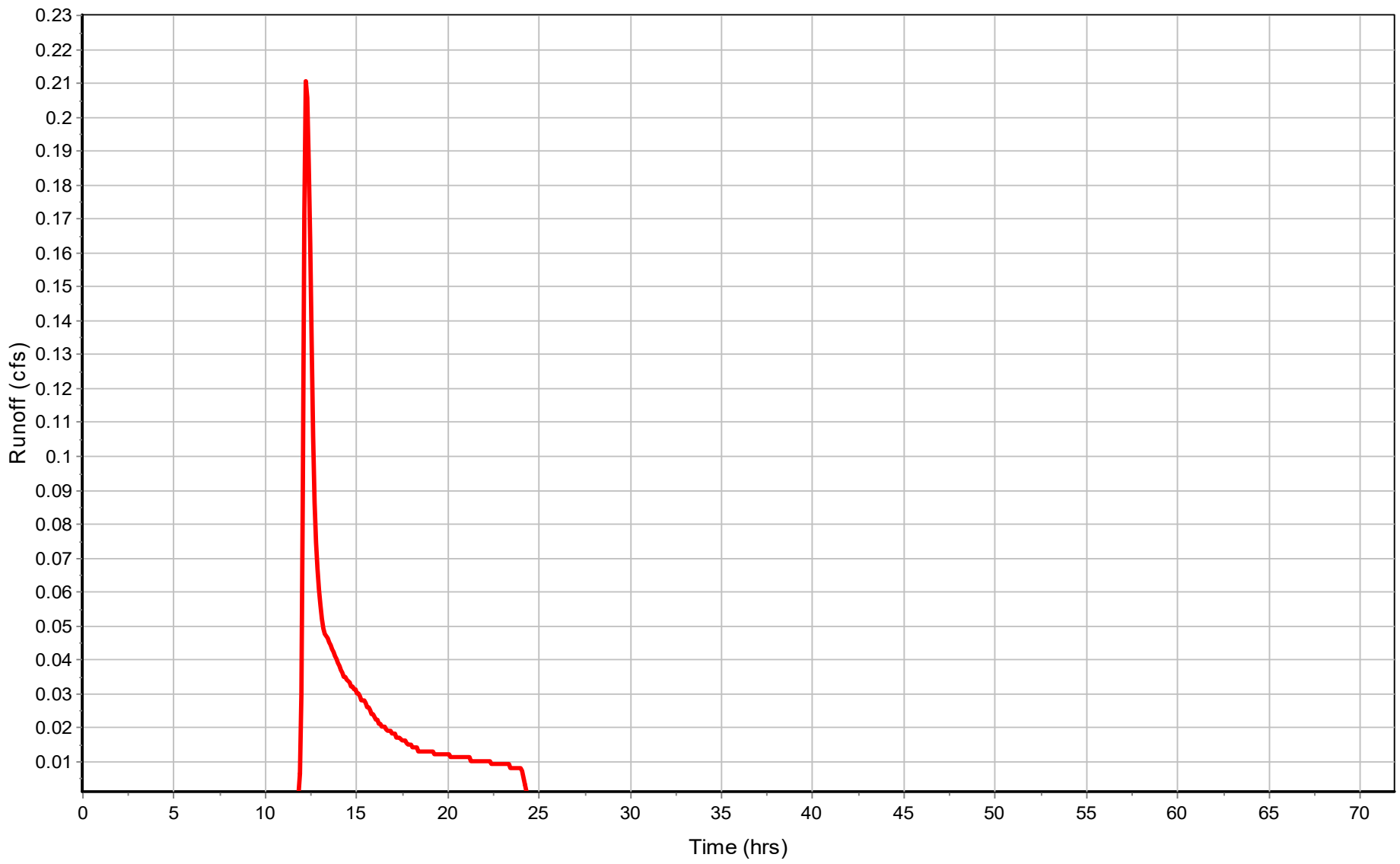
Total Rainfall (in) 7.48
Total Runoff (in) 1.29
Peak Runoff (cfs) 0.21
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:17:29

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

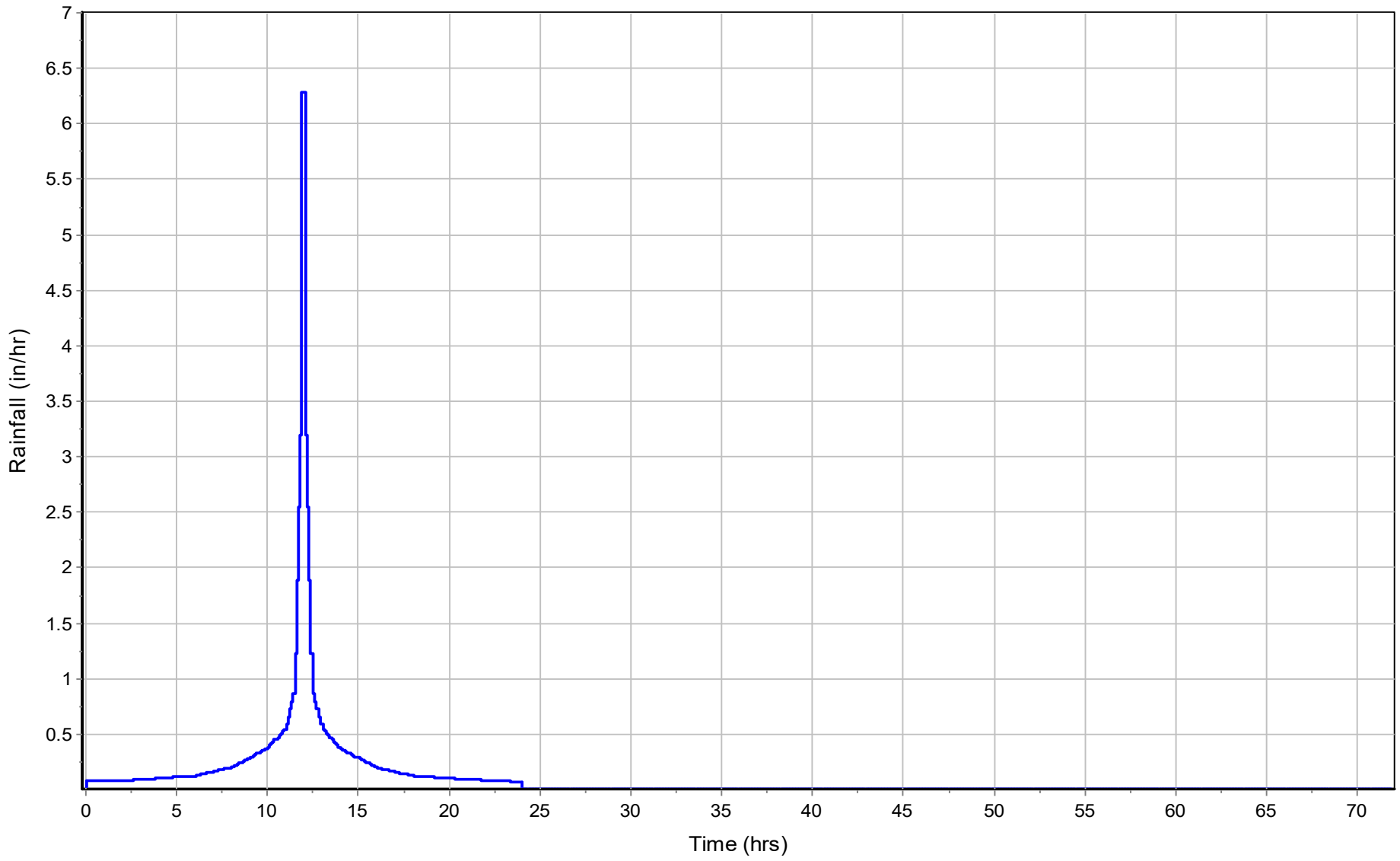
Total TOC (min) 21.50

Subbasin Runoff Results

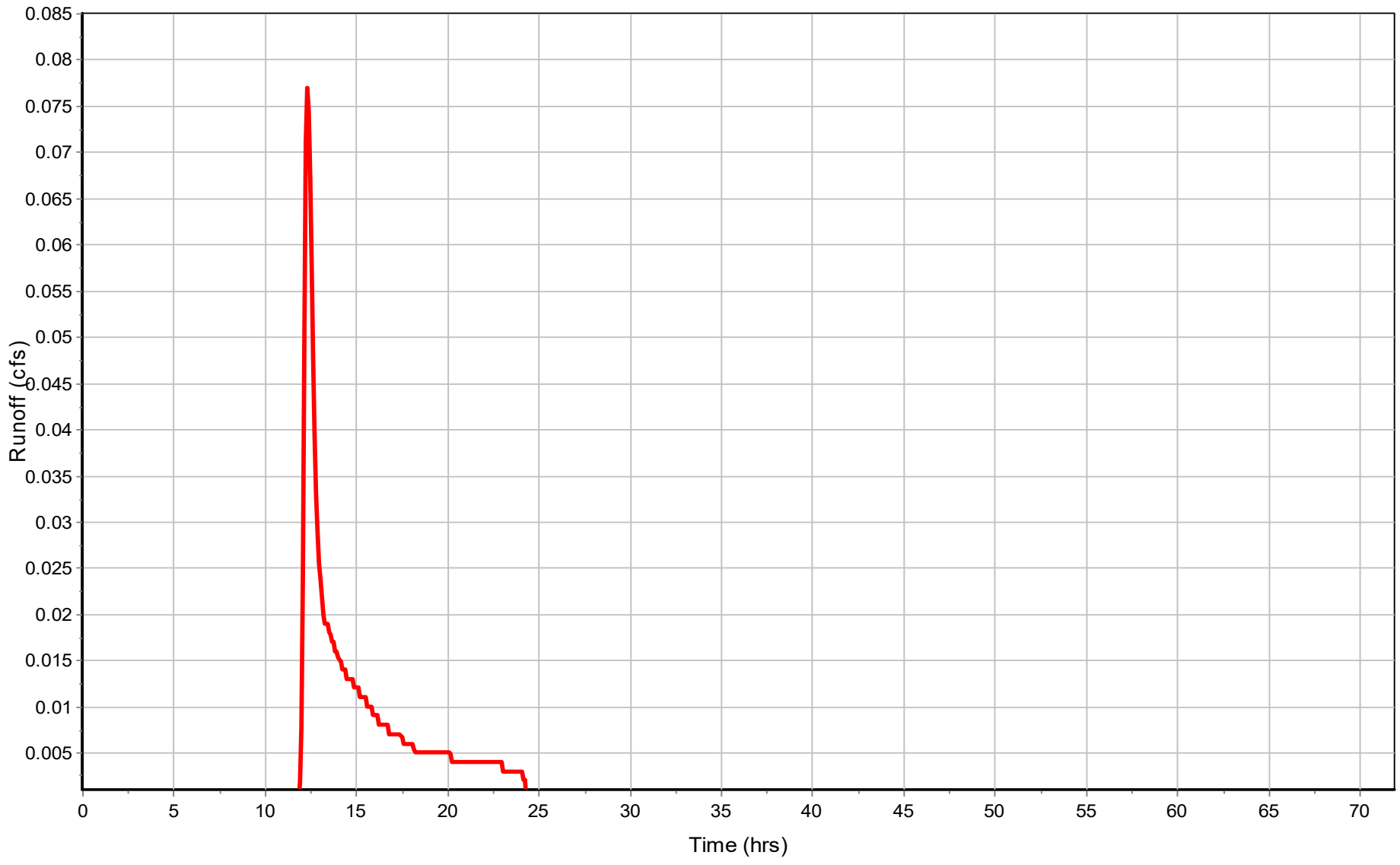
Total Rainfall (in) 7.48
Total Runoff (in) 1.29
Peak Runoff (cfs) 0.08
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:21:30

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

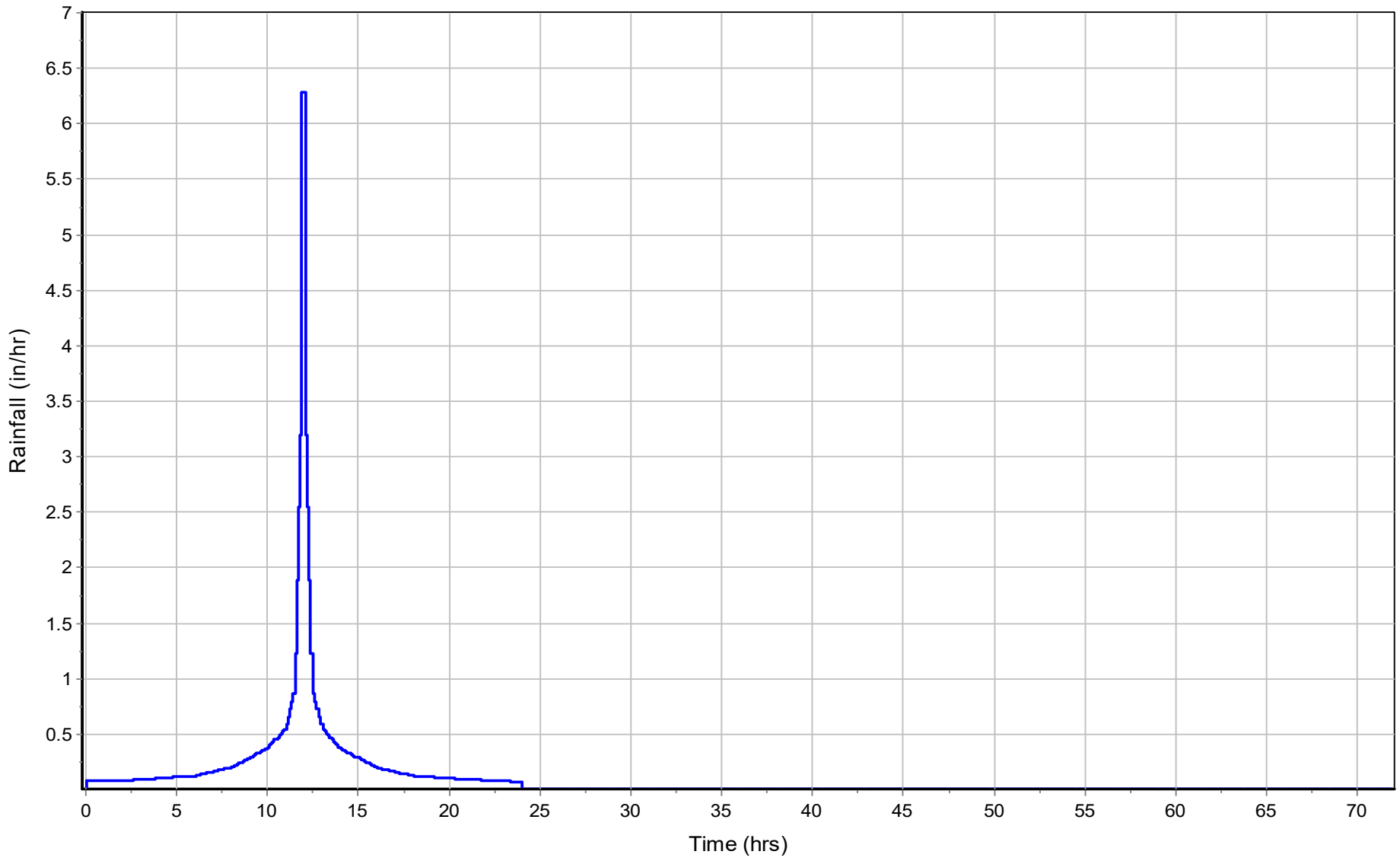
Total TOC (min) 9.01

Subbasin Runoff Results

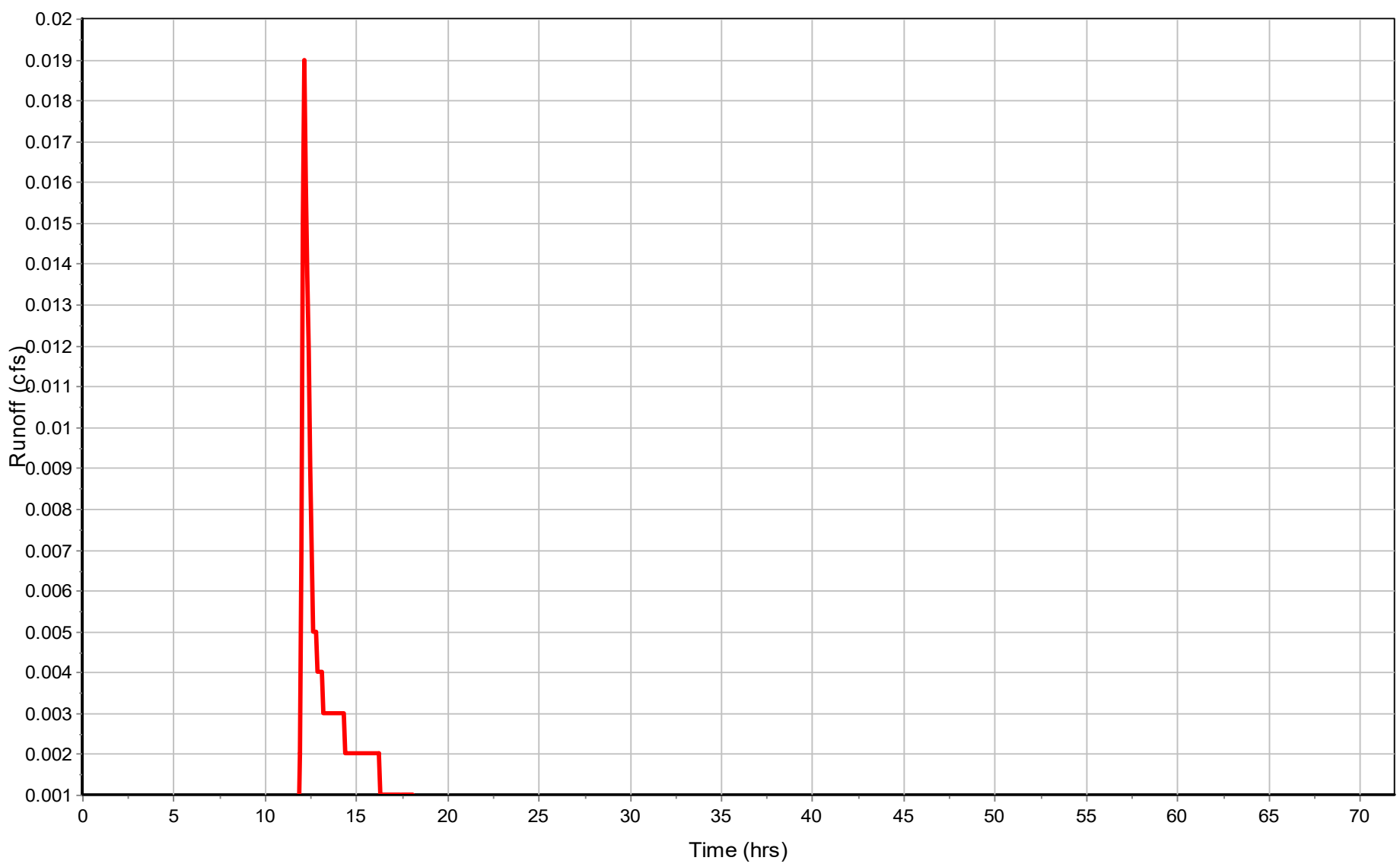
Total Rainfall (in) 7.48
Total Runoff (in) 1.05
Peak Runoff (cfs) 0.02
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:09:01

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

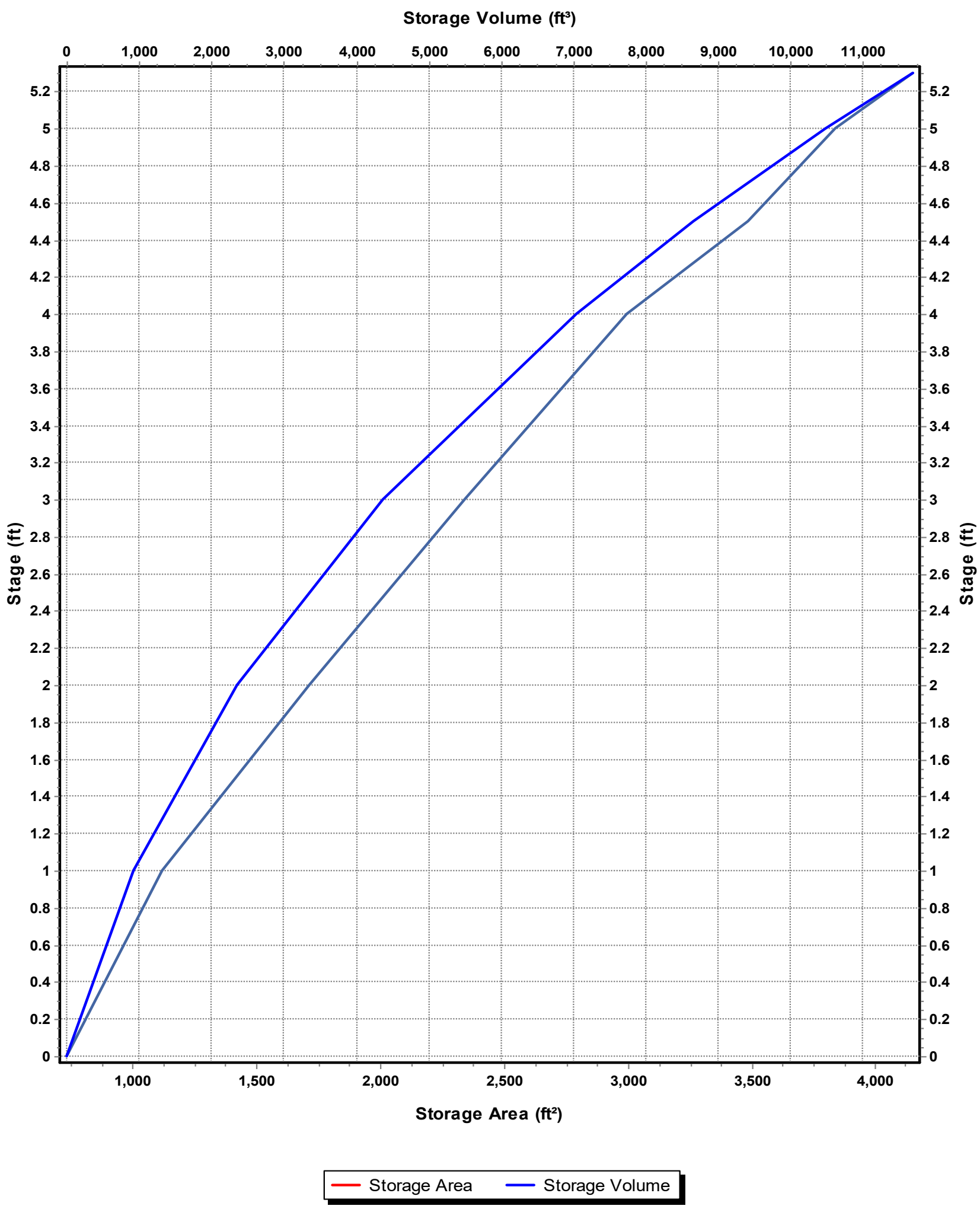
Invert Elevation (ft)	112.40
Max (Rim) Elevation (ft)	117.70
Max (Rim) Offset (ft)	5.30
Initial Water Elevation (ft)	112.40
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

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

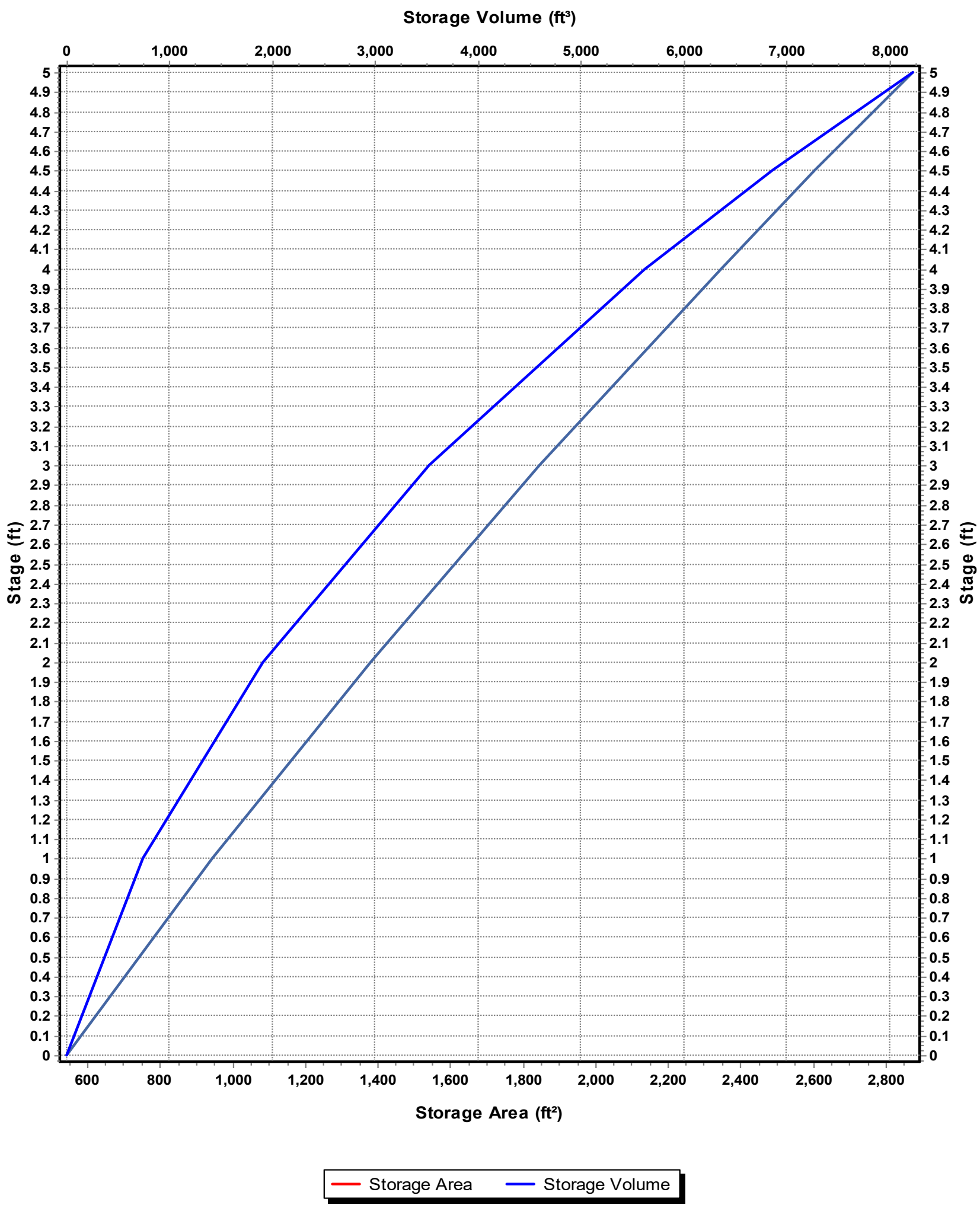
Invert Elevation (ft)	112.90
Max (Rim) Elevation (ft)	117.90
Max (Rim) Offset (ft)	5.00
Initial Water Elevation (ft)	112.90
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

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

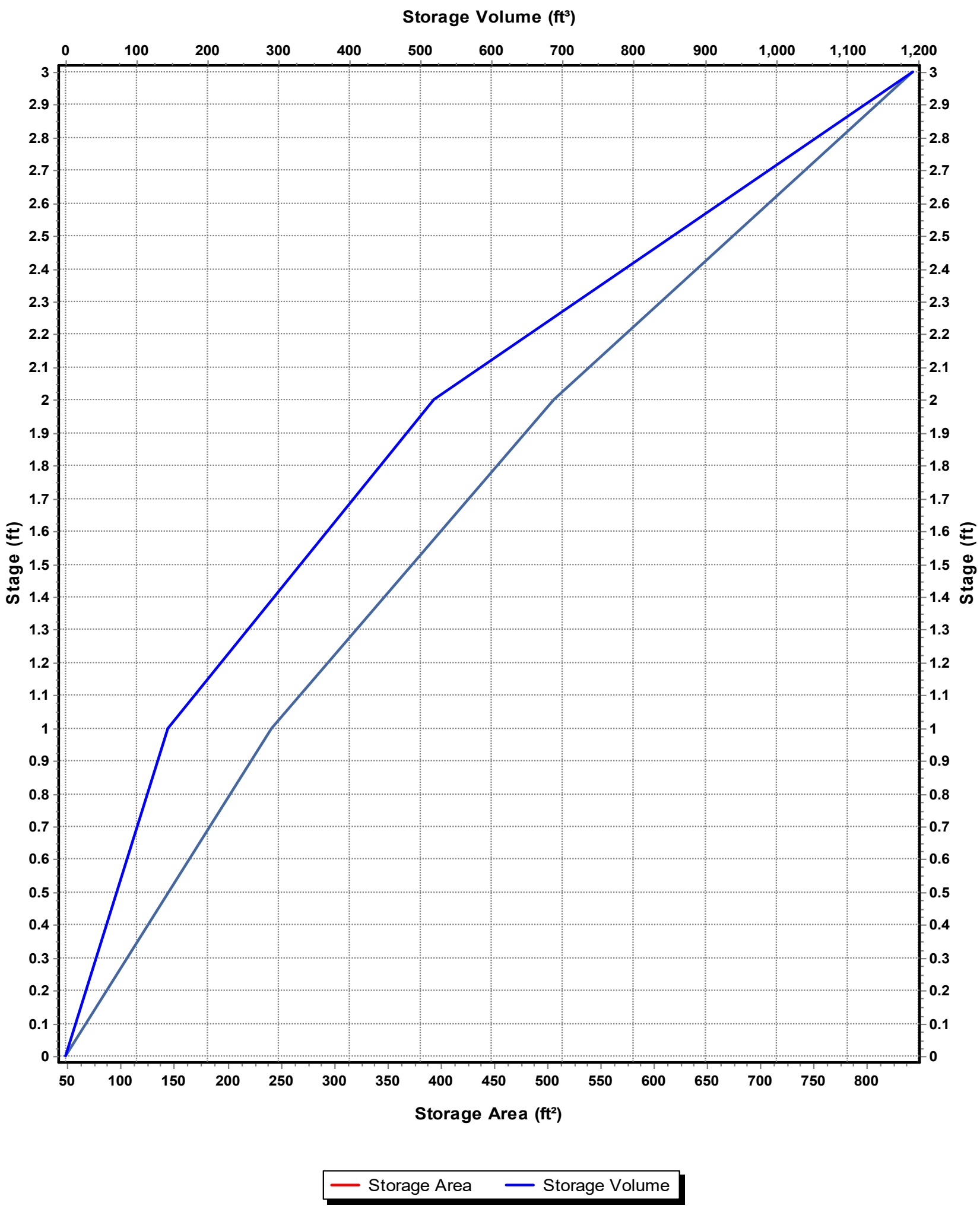
Invert Elevation (ft)	114.40
Max (Rim) Elevation (ft)	117.70
Max (Rim) Offset (ft)	3.30
Initial Water Elevation (ft)	114.40
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

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

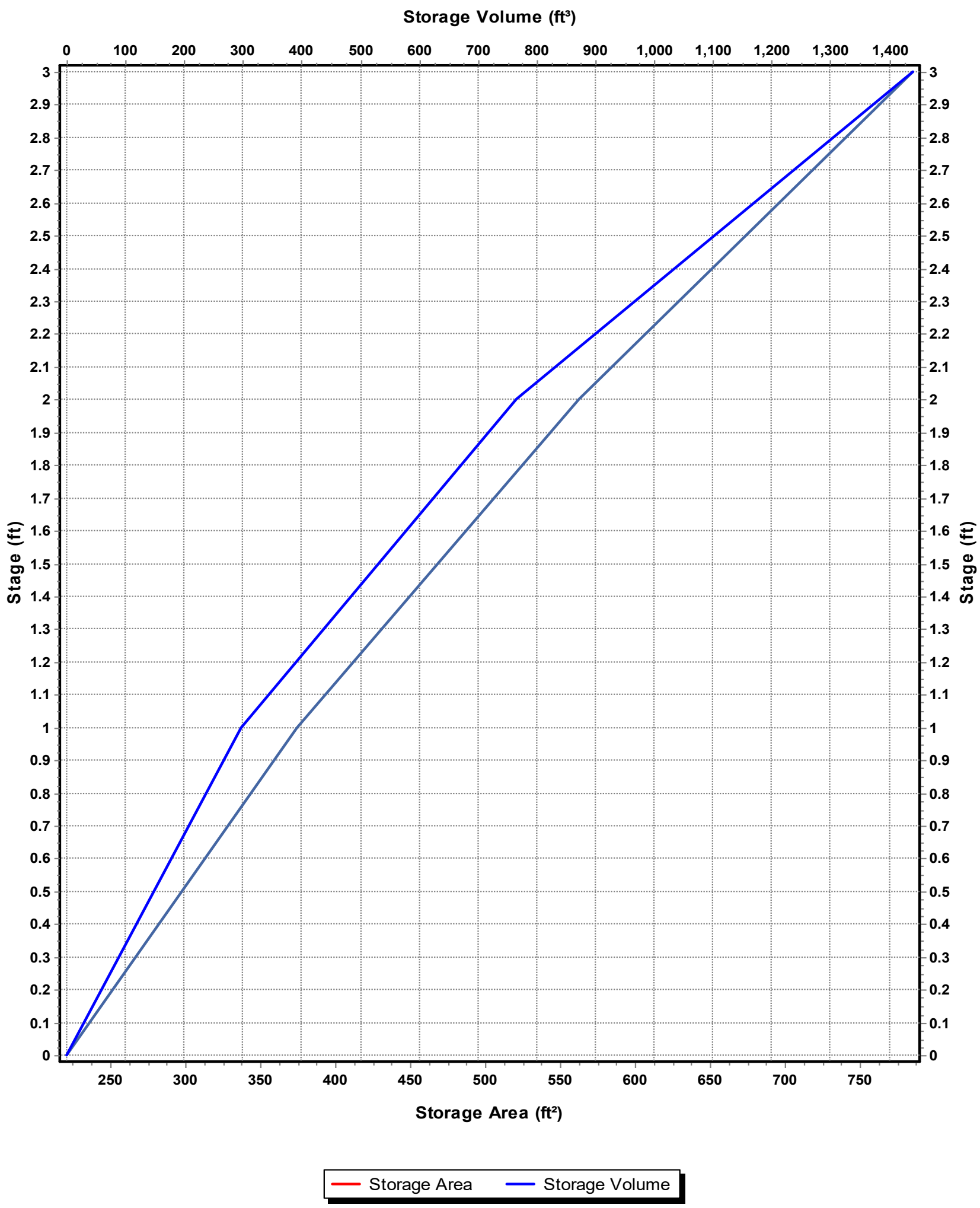
Invert Elevation (ft)	114.90
Max (Rim) Elevation (ft)	117.90
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.90
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

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

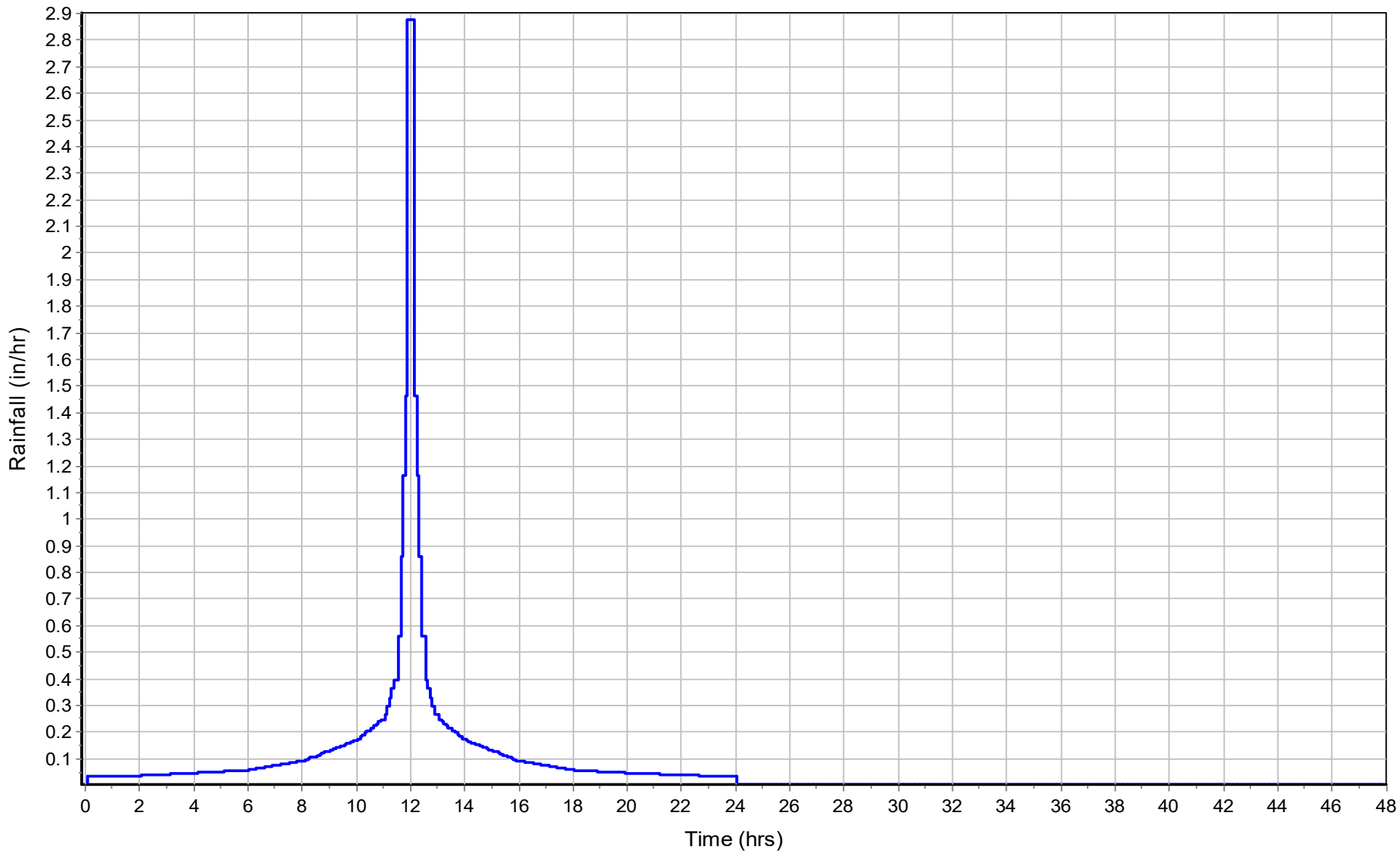
Total TOC (min) 19.27

Subbasin Runoff Results

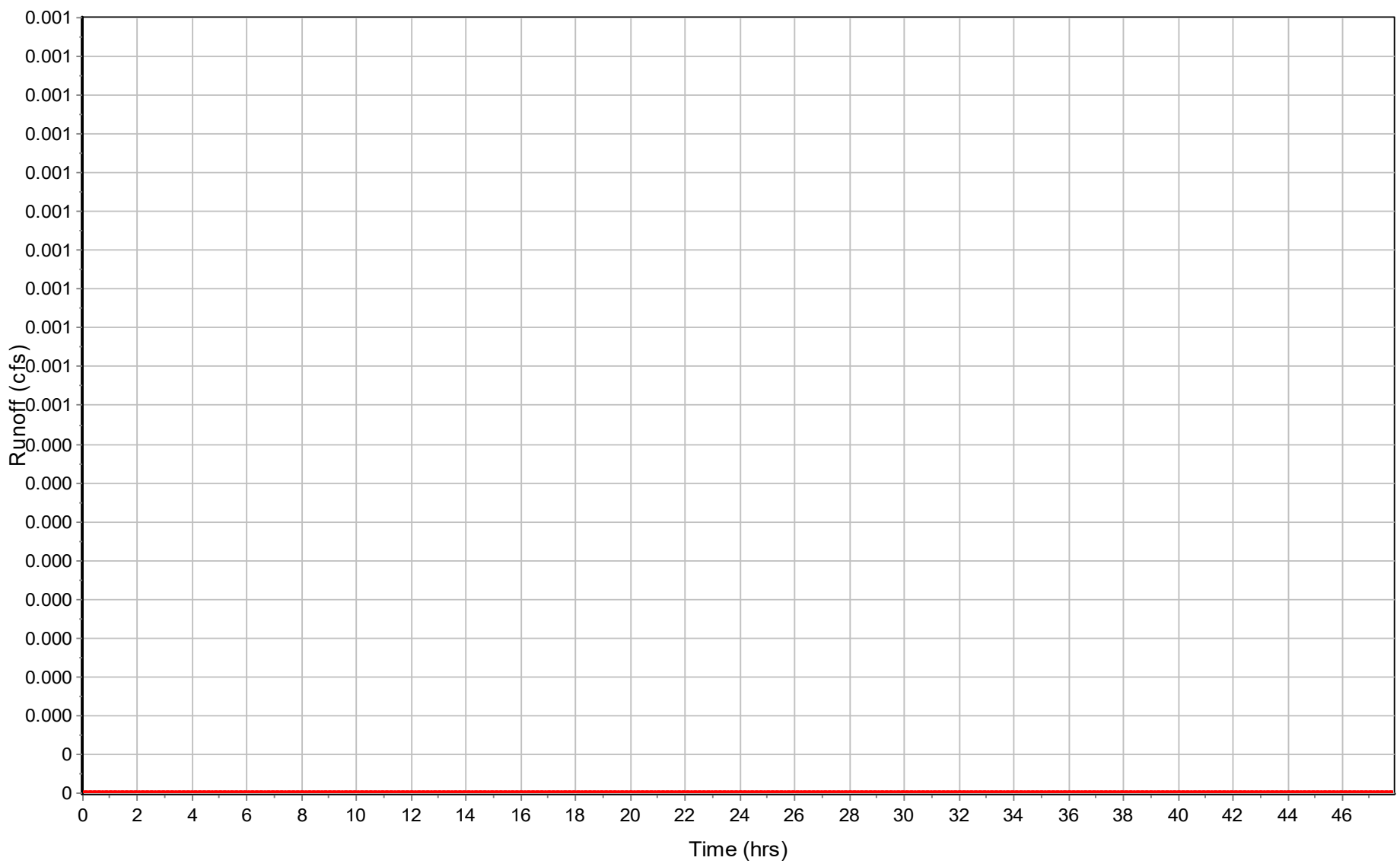
Total Rainfall (in)	3.42
Total Runoff (in)	0
Peak Runoff (cfs)	0
Weighted Curve Number	43
Time of Concentration (days hh:mm:ss)	0 00:19:16

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

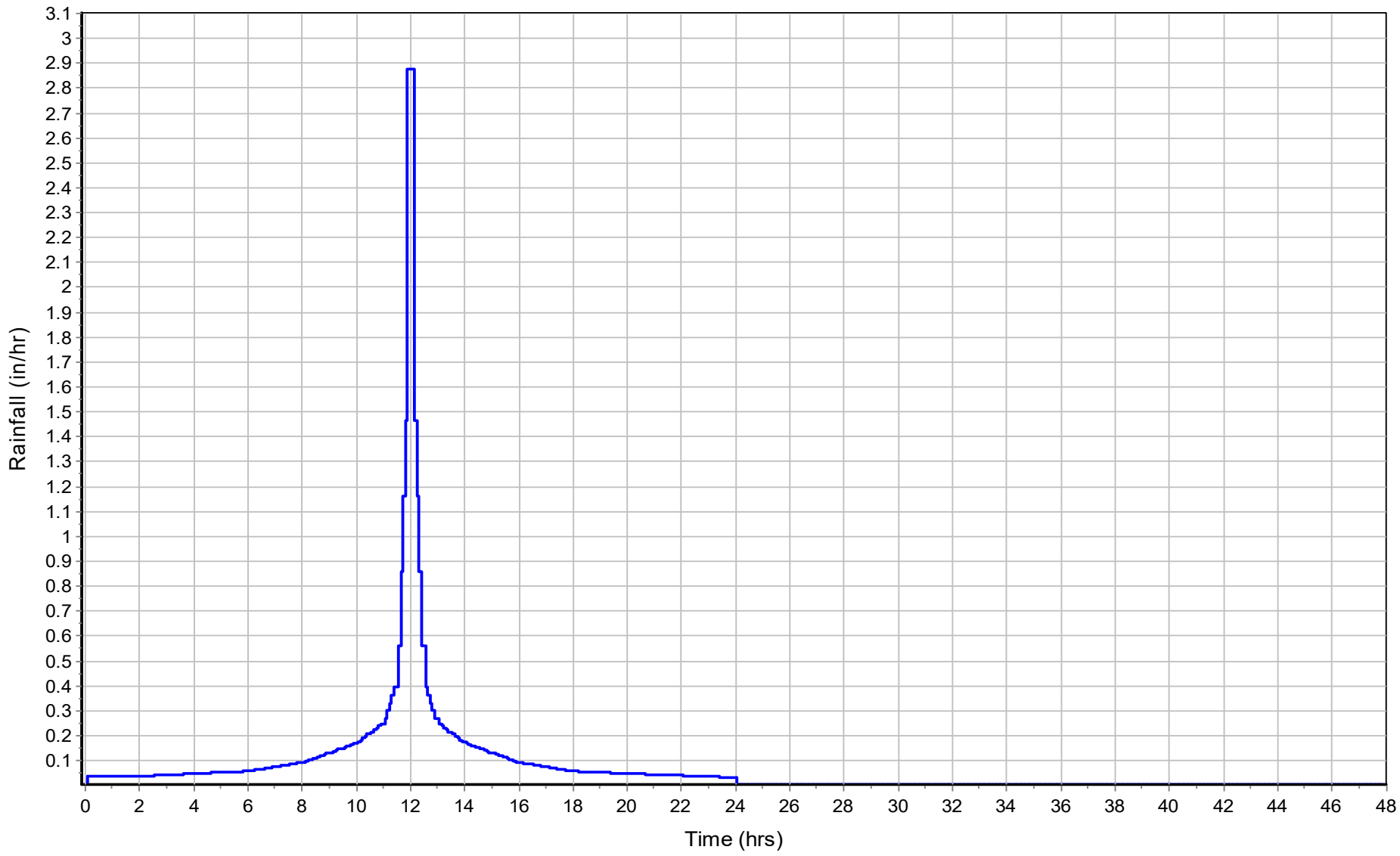
Total TOC (min) 3.27

Subbasin Runoff Results

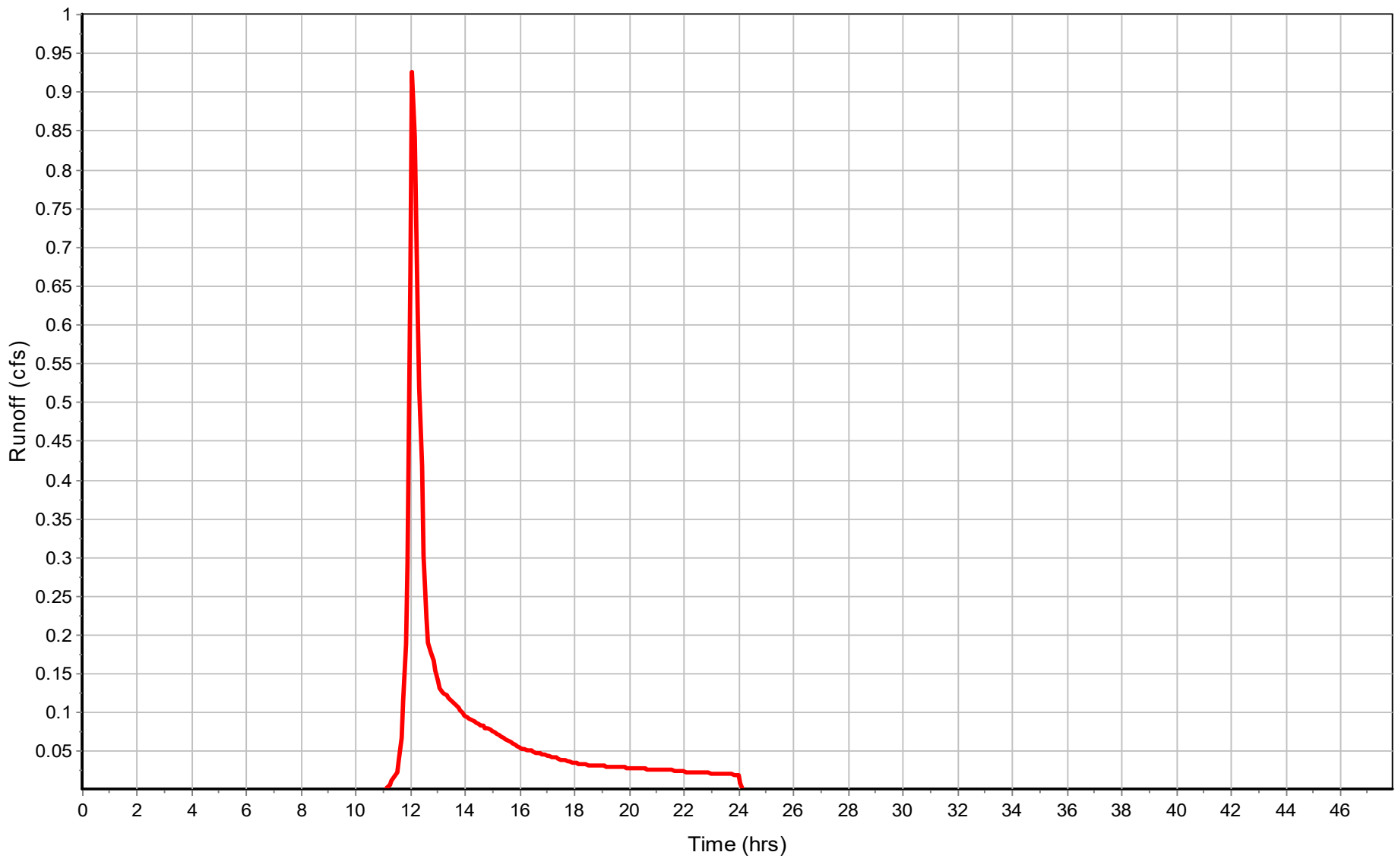
Total Rainfall (in)	3.42
Total Runoff (in)	0.95
Peak Runoff (cfs)	1
Weighted Curve Number	69.85
Time of Concentration (days hh:mm:ss)	0 00:03:16

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

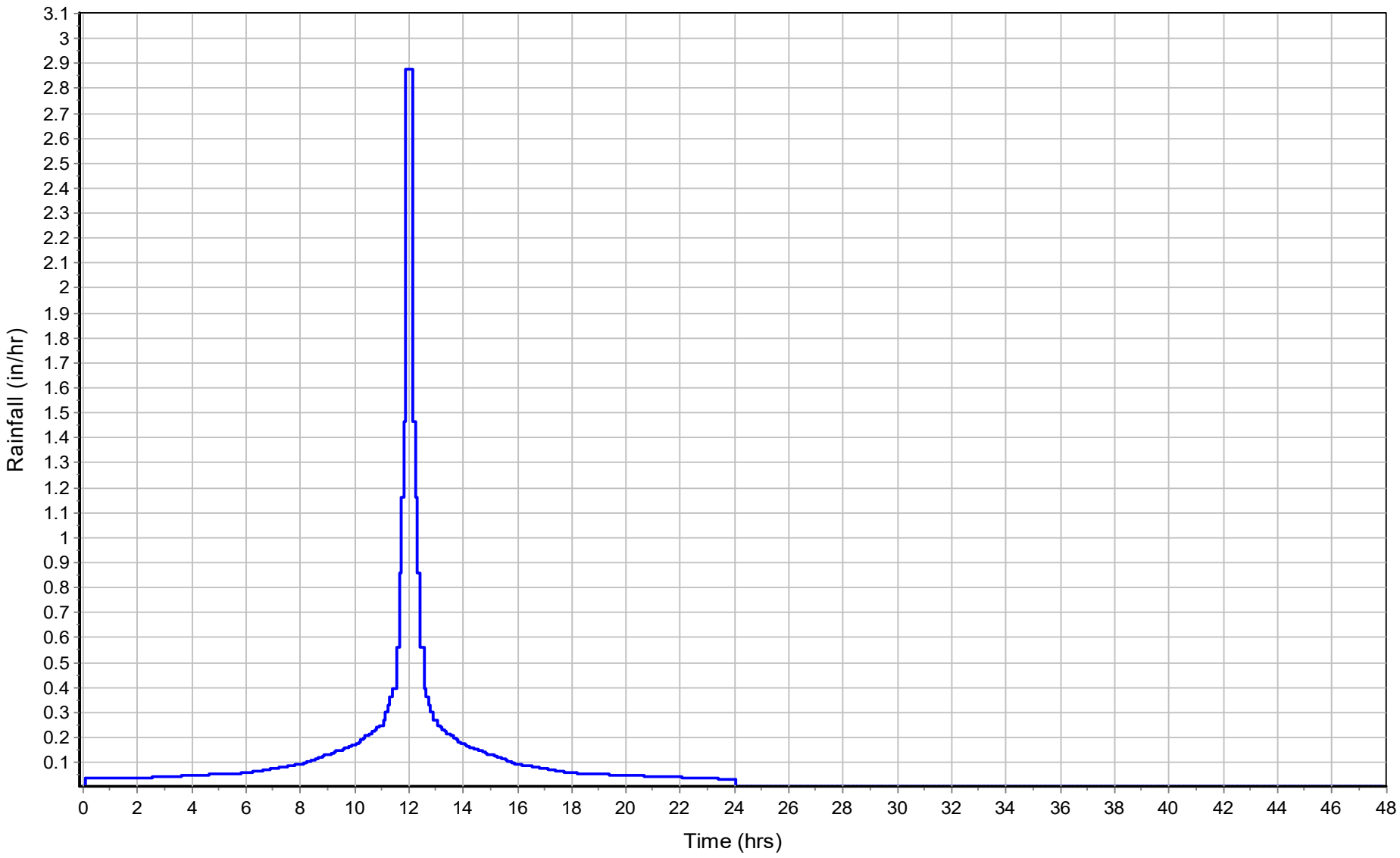
Total TOC (min) 21.10

Subbasin Runoff Results

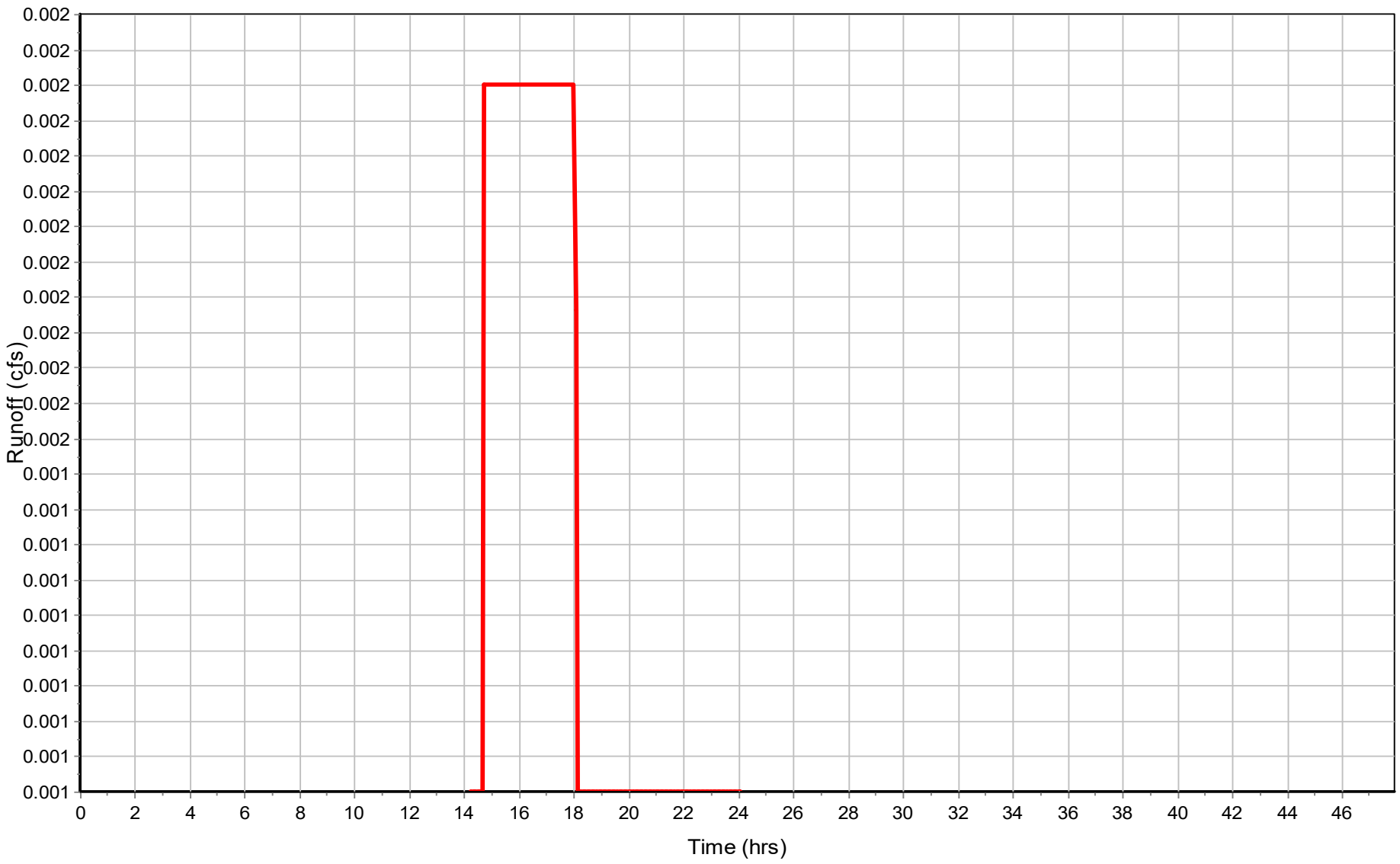
Total Rainfall (in) 3.42
Total Runoff (in) 0.04
Peak Runoff (cfs) 0
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:21:06

Subbasin : Sub-E03.3

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A3

Input Data

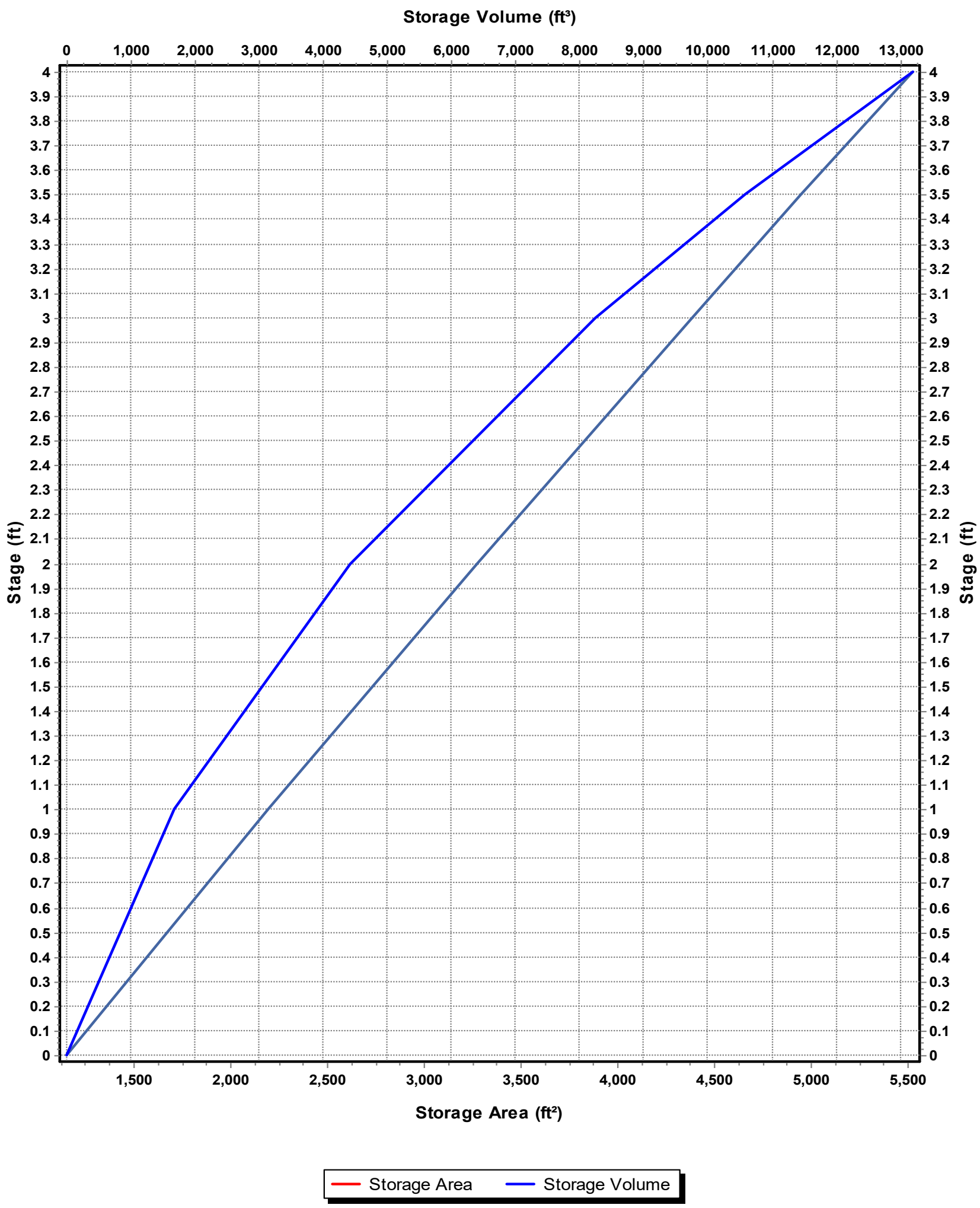
Invert Elevation (ft)	113.50
Max (Rim) Elevation (ft)	117.50
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	113.50
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

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

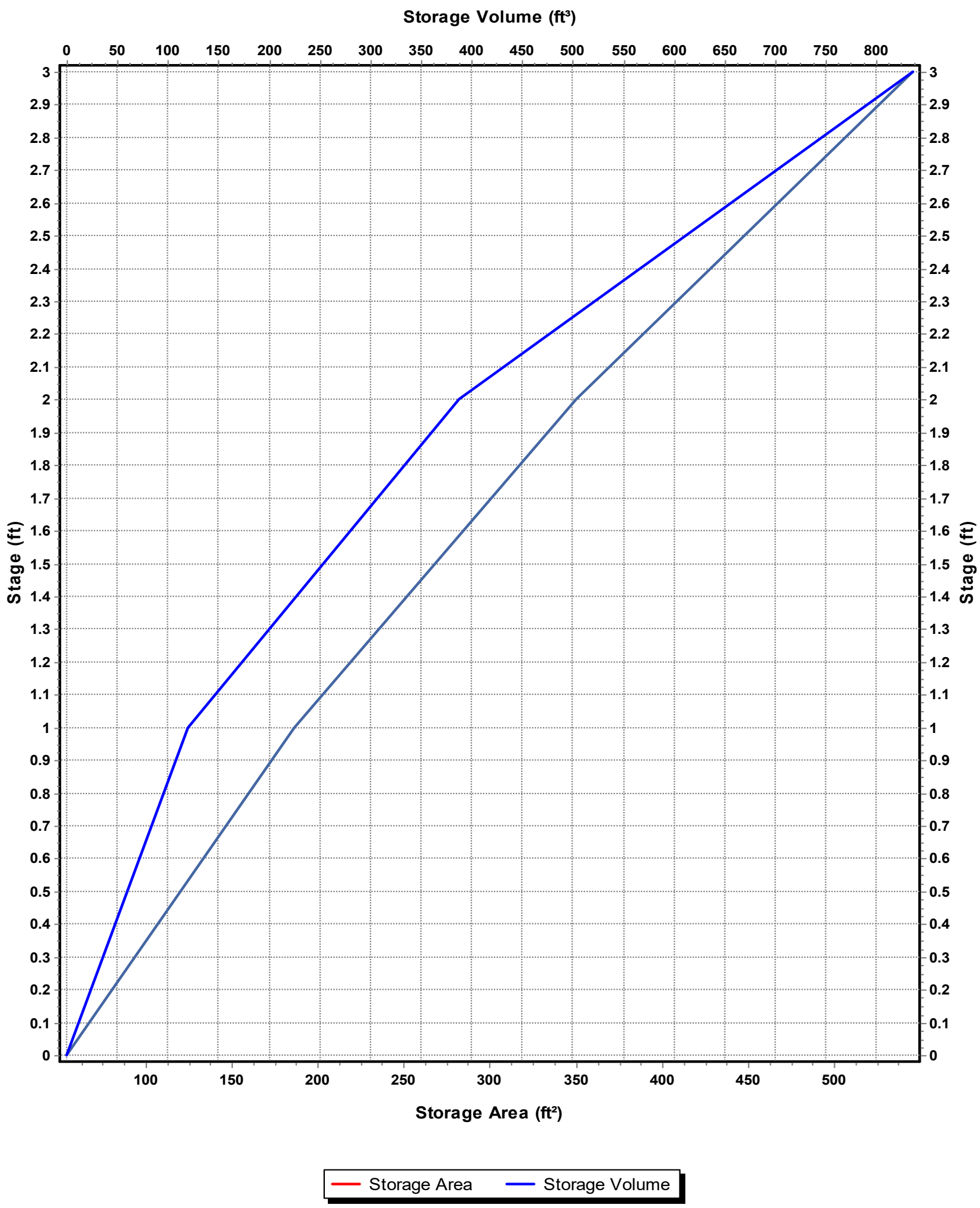
Invert Elevation (ft)	114.50
Max (Rim) Elevation (ft)	117.50
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.50
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

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

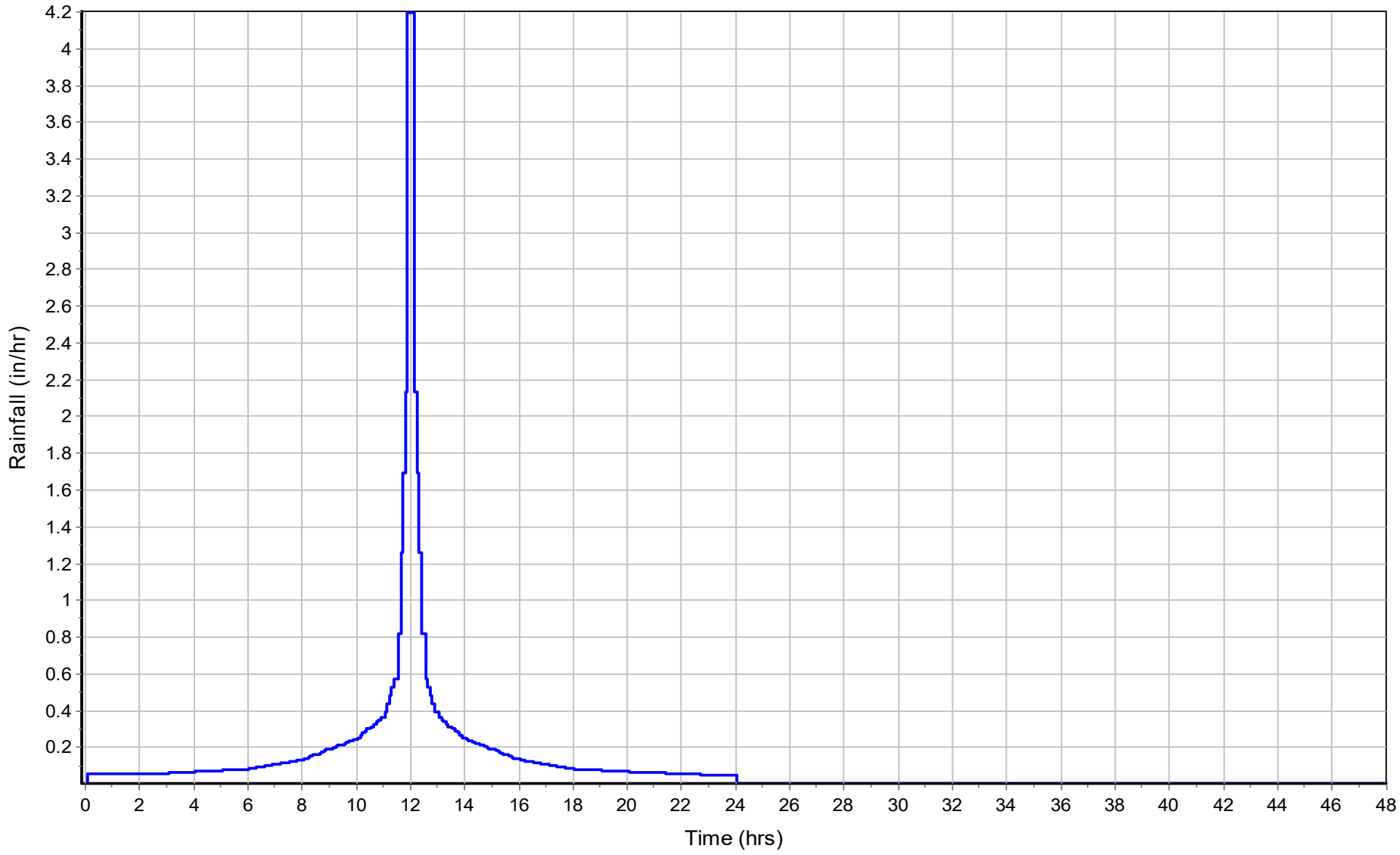
Total TOC (min) 19.27

Subbasin Runoff Results

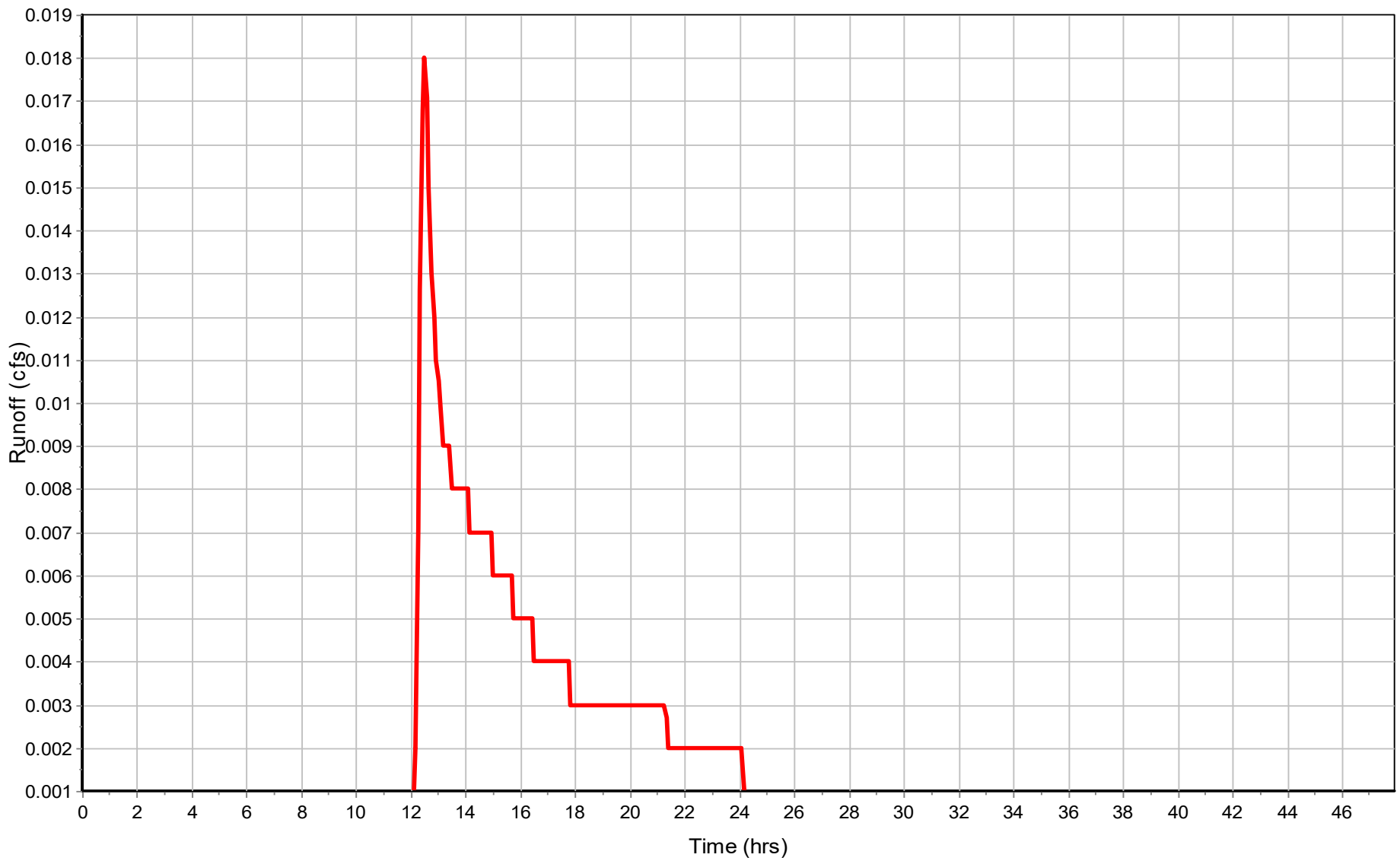
Total Rainfall (in)	4.99
Total Runoff (in)	0.35
Peak Runoff (cfs)	0.02
Weighted Curve Number	43
Time of Concentration (days hh:mm:ss)	0 00:19:16

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

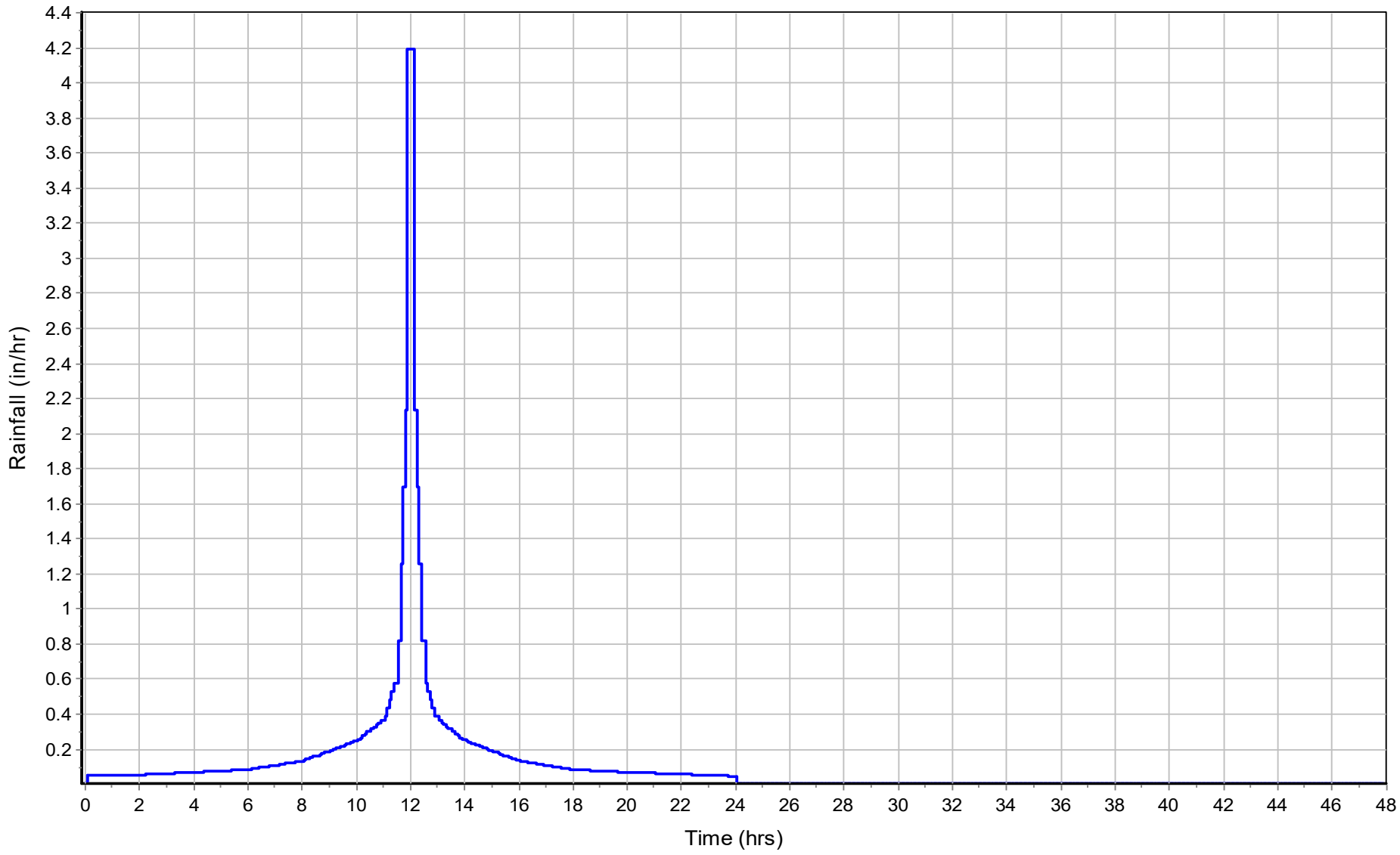
Total TOC (min) 3.27

Subbasin Runoff Results

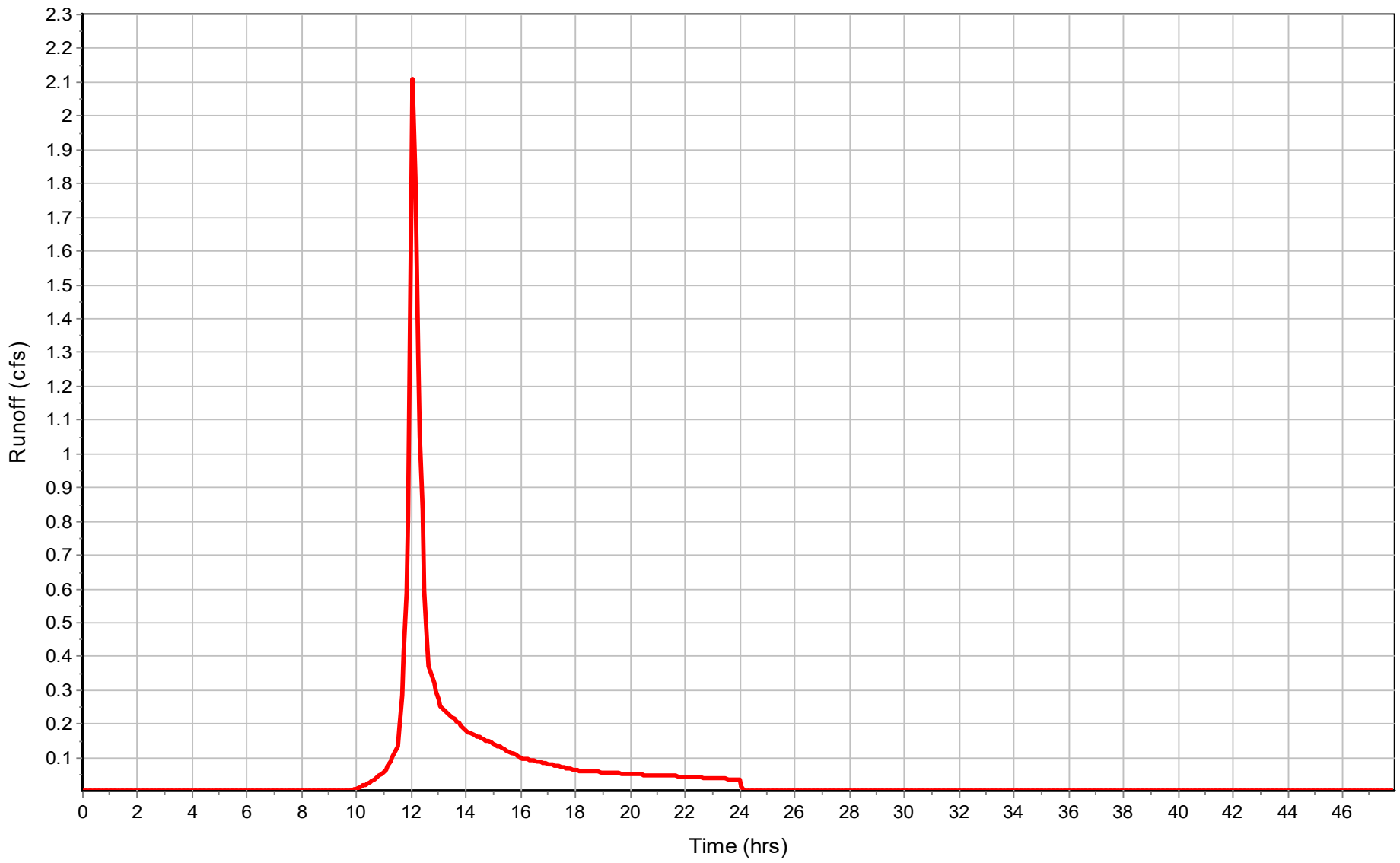
Total Rainfall (in)	4.99
Total Runoff (in)	2.02
Peak Runoff (cfs)	2.2
Weighted Curve Number	69.85
Time of Concentration (days hh:mm:ss)	0 00:03:16

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

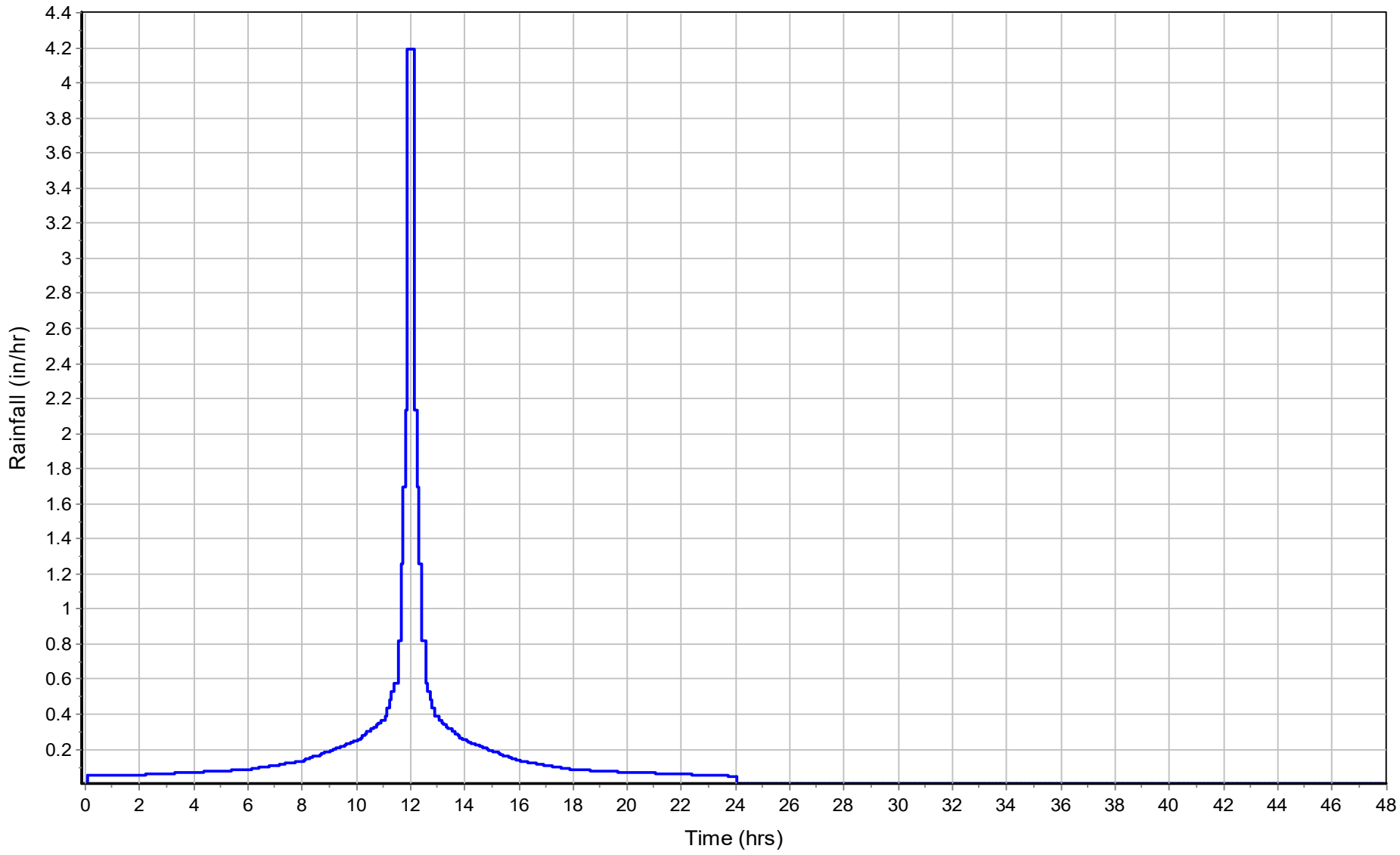
Total TOC (min) 21.10

Subbasin Runoff Results

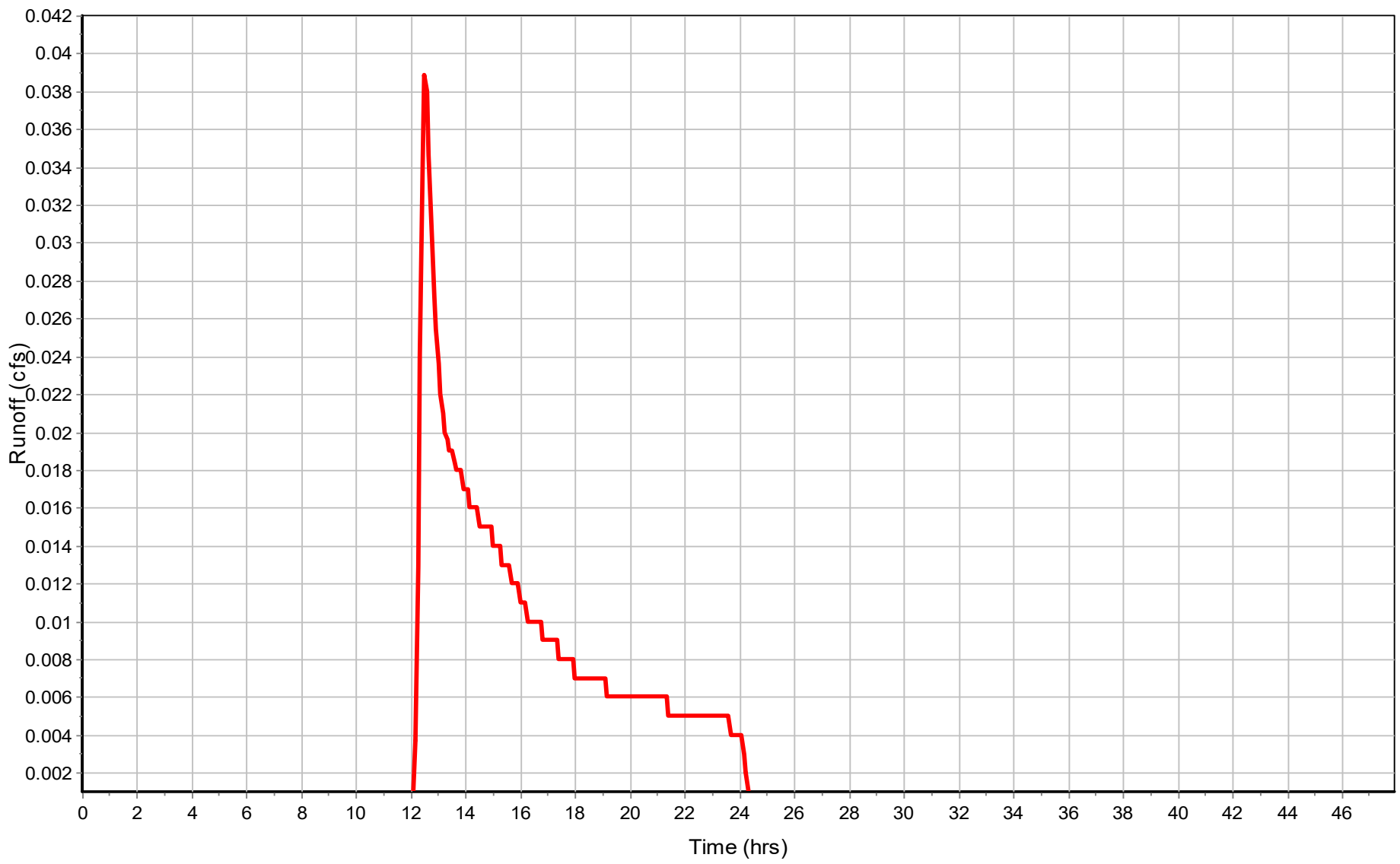
Total Rainfall (in) 4.99
Total Runoff (in) 0.35
Peak Runoff (cfs) 0.04
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:21:06

Subbasin : Sub-E03.3

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A3

Input Data

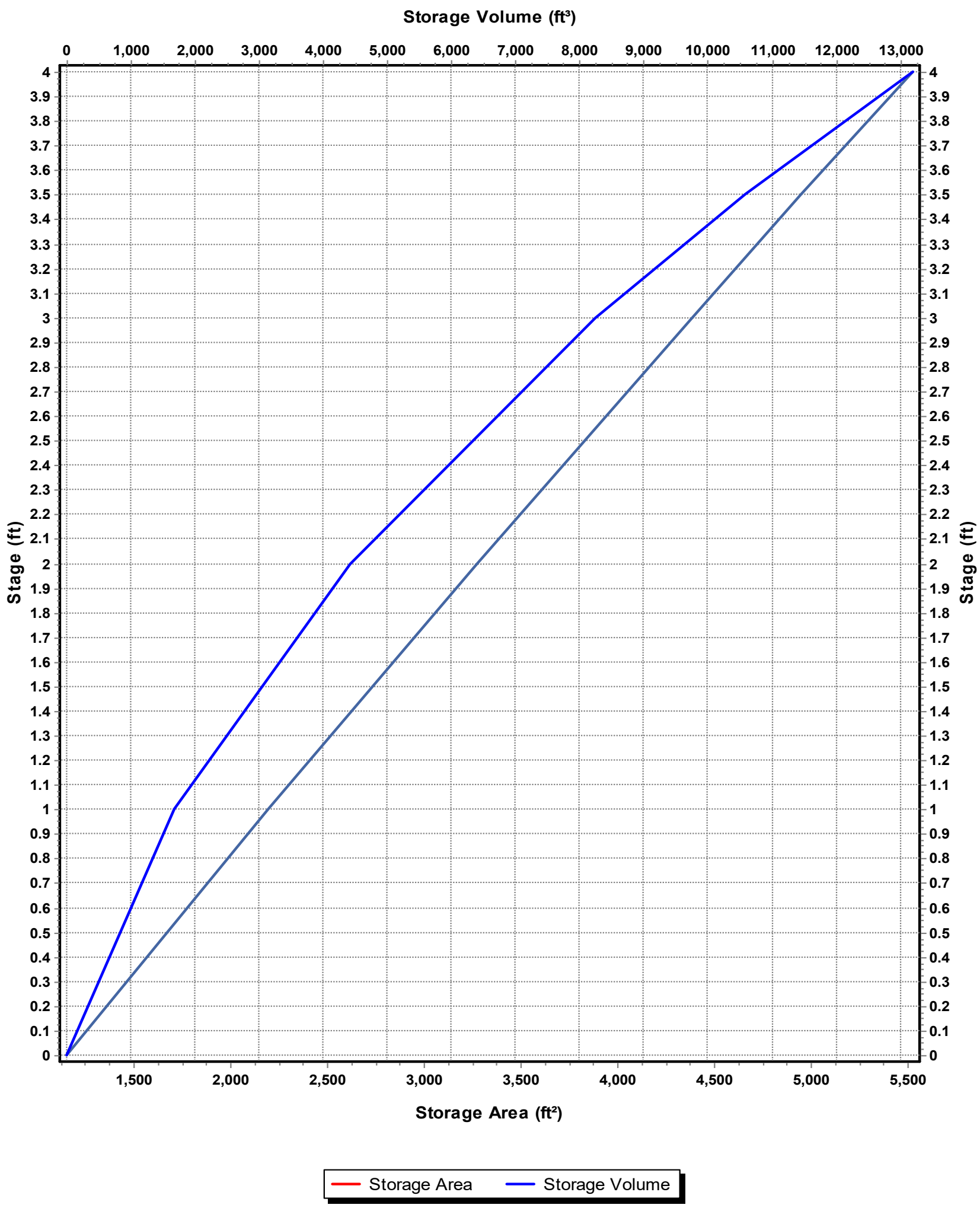
Invert Elevation (ft)	113.50
Max (Rim) Elevation (ft)	117.50
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	113.50
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

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

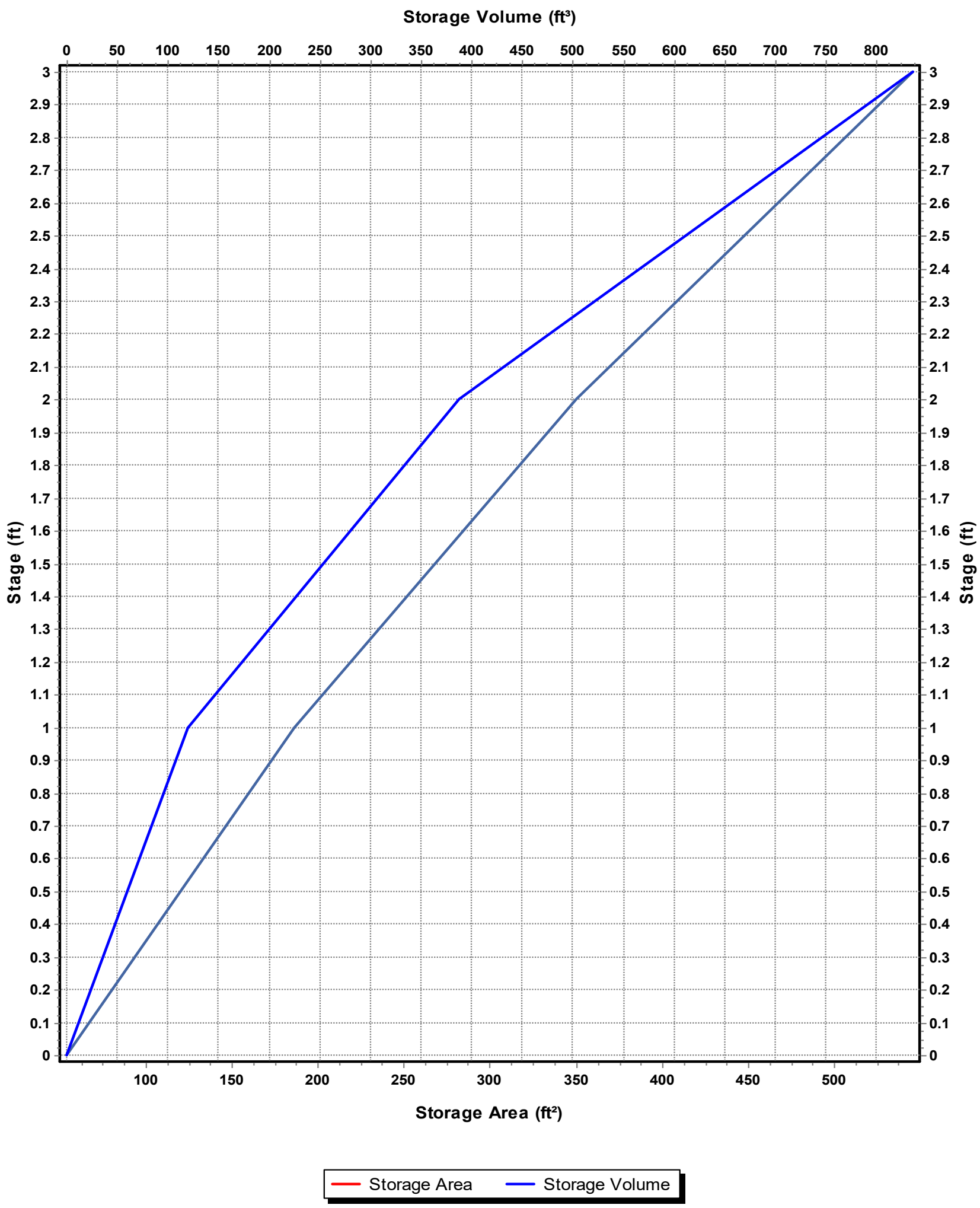
Invert Elevation (ft)	114.50
Max (Rim) Elevation (ft)	117.50
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.50
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

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

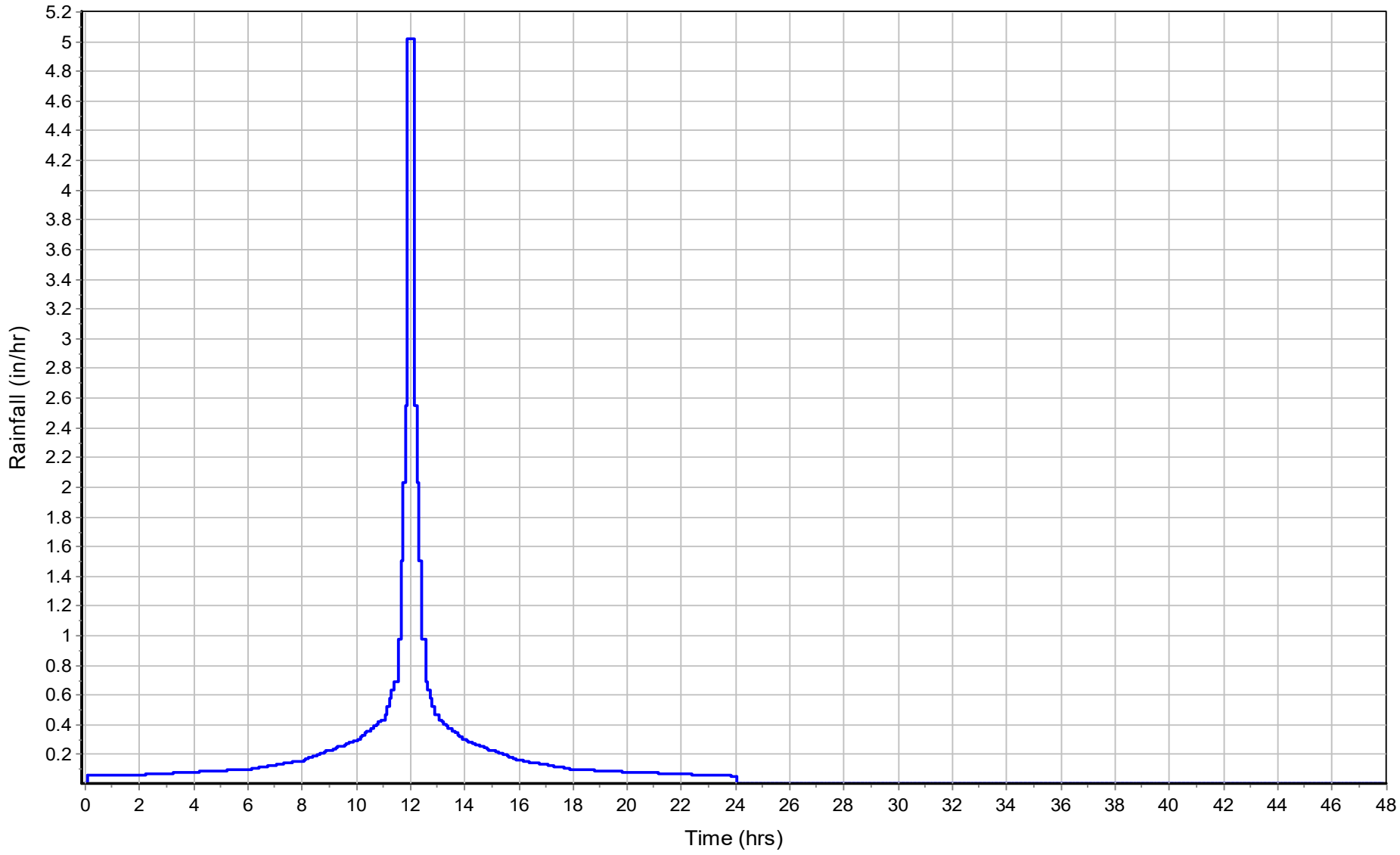
Total TOC (min) 19.27

Subbasin Runoff Results

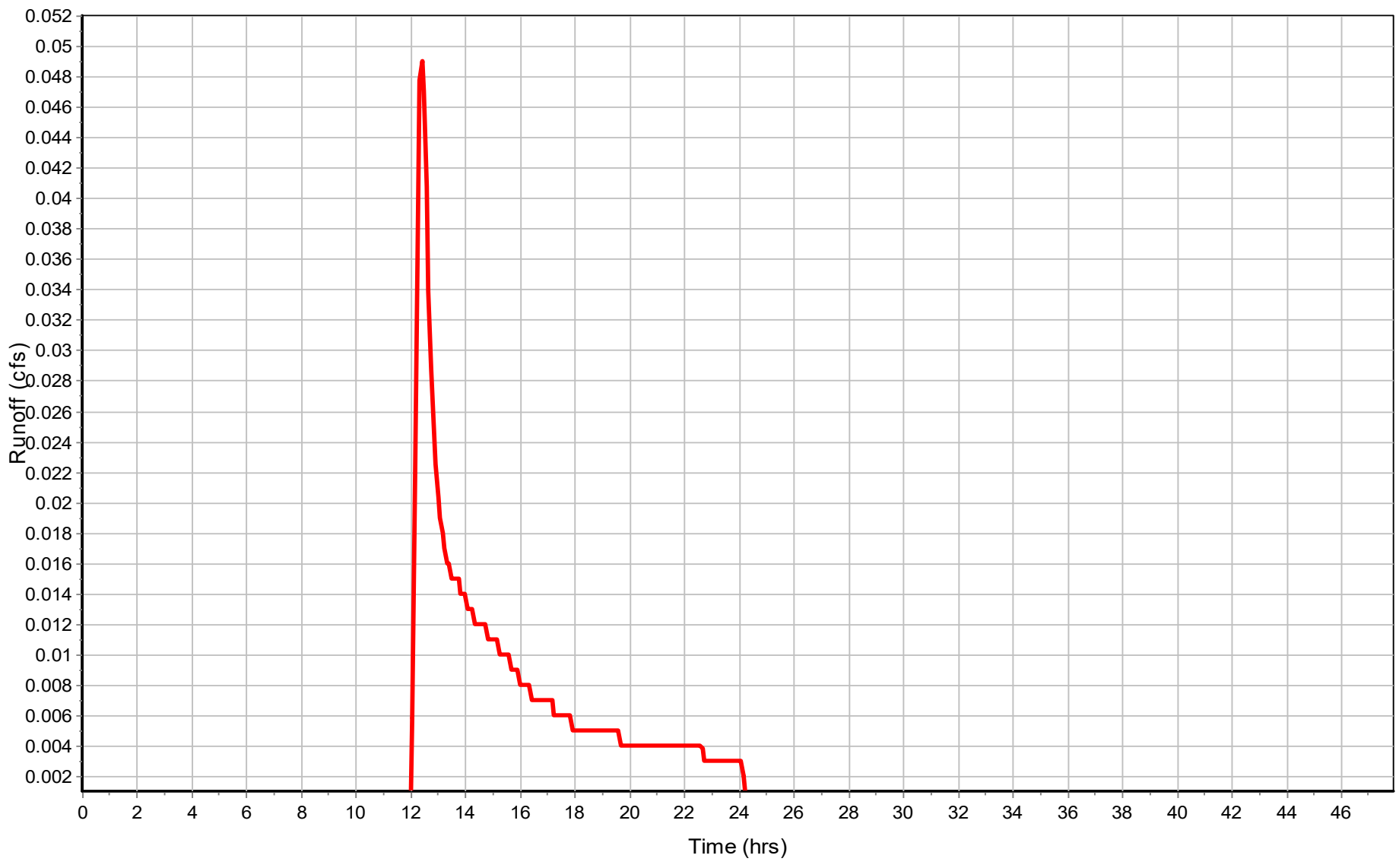
Total Rainfall (in)	5.97
Total Runoff (in)	0.66
Peak Runoff (cfs)	0.05
Weighted Curve Number	43
Time of Concentration (days hh:mm:ss)	0 00:19:16

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

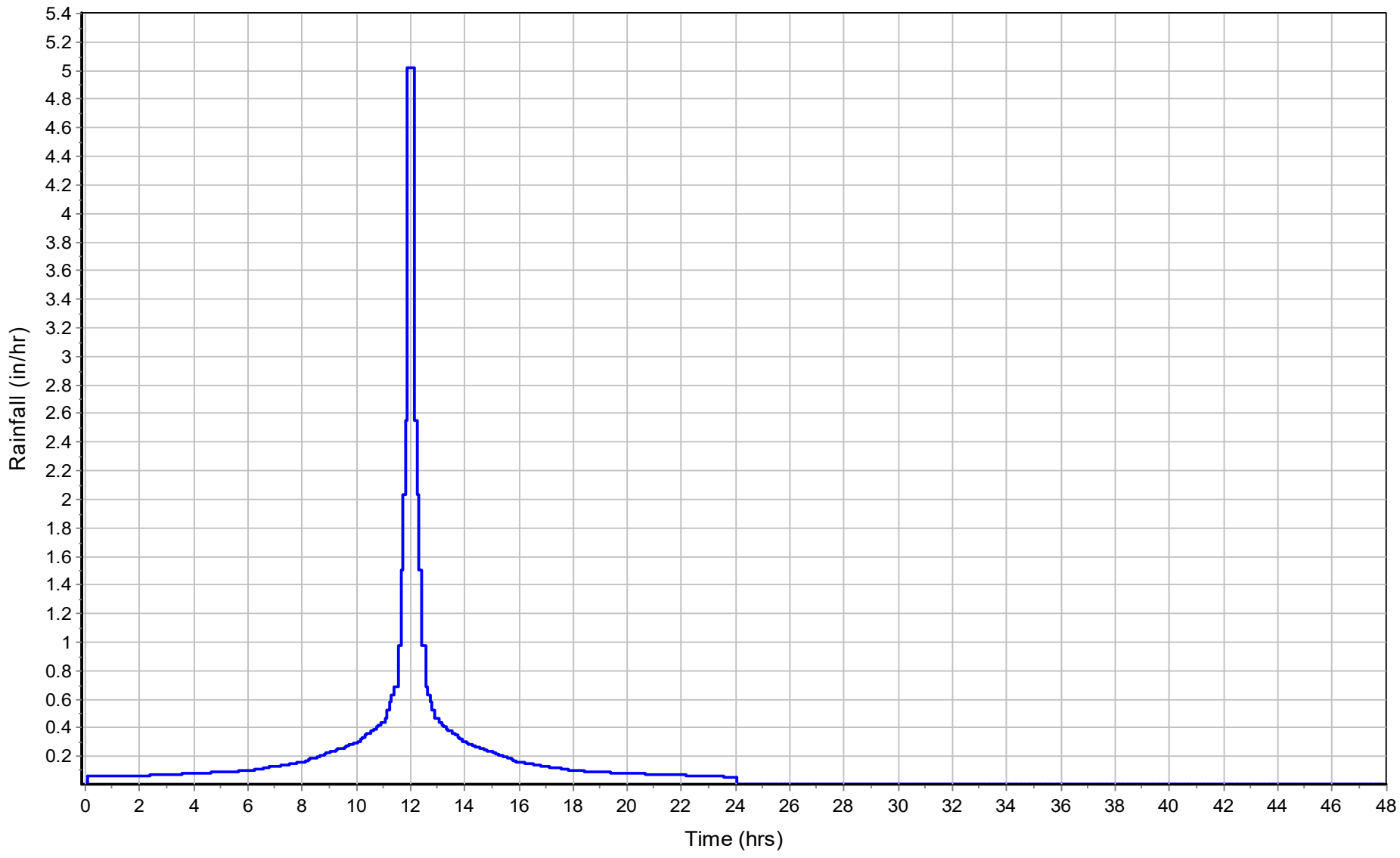
Total TOC (min) 3.27

Subbasin Runoff Results

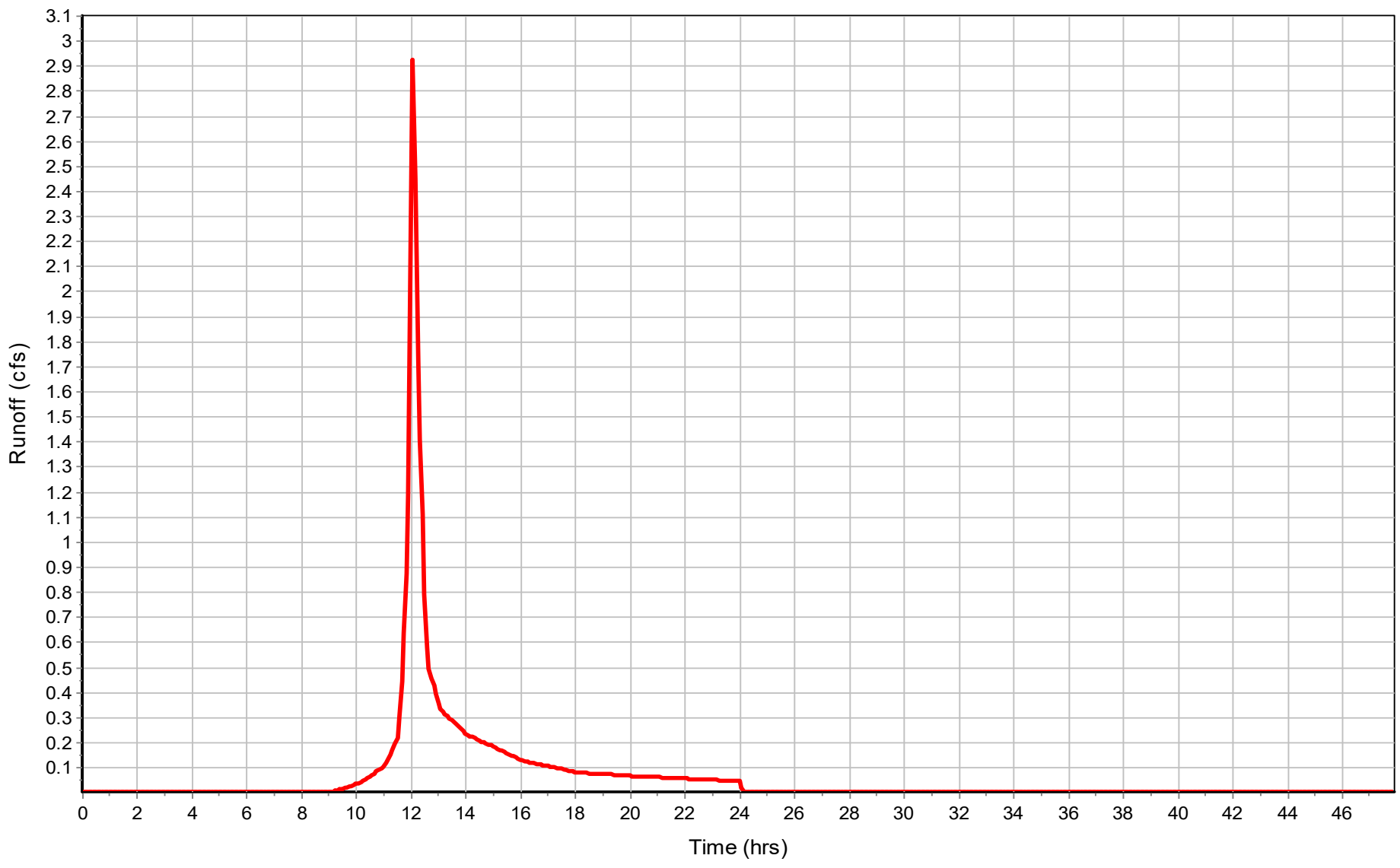
Total Rainfall (in)	5.97
Total Runoff (in)	2.77
Peak Runoff (cfs)	3.03
Weighted Curve Number	69.85
Time of Concentration (days hh:mm:ss)	0 00:03:16

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

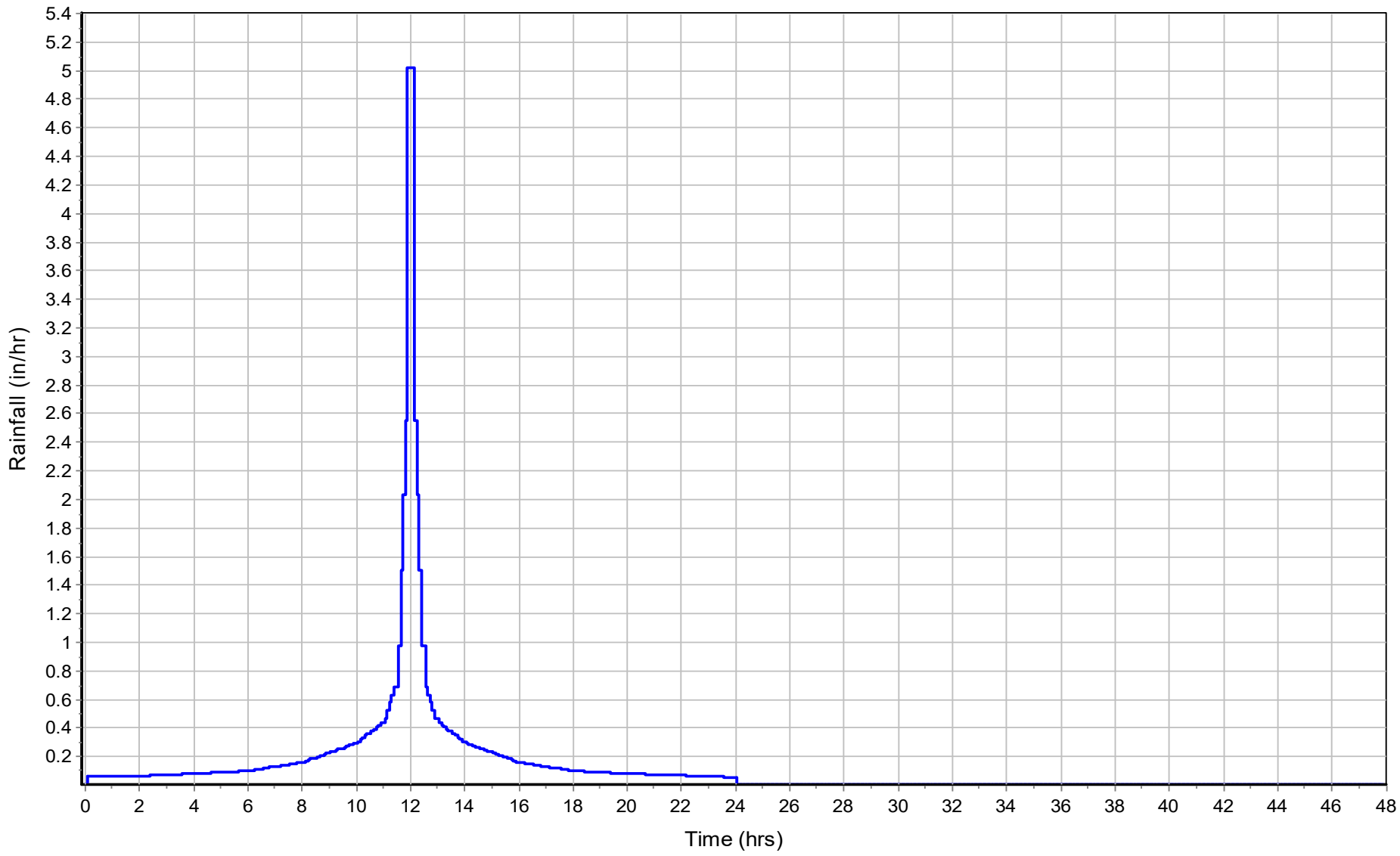
Total TOC (min) 21.10

Subbasin Runoff Results

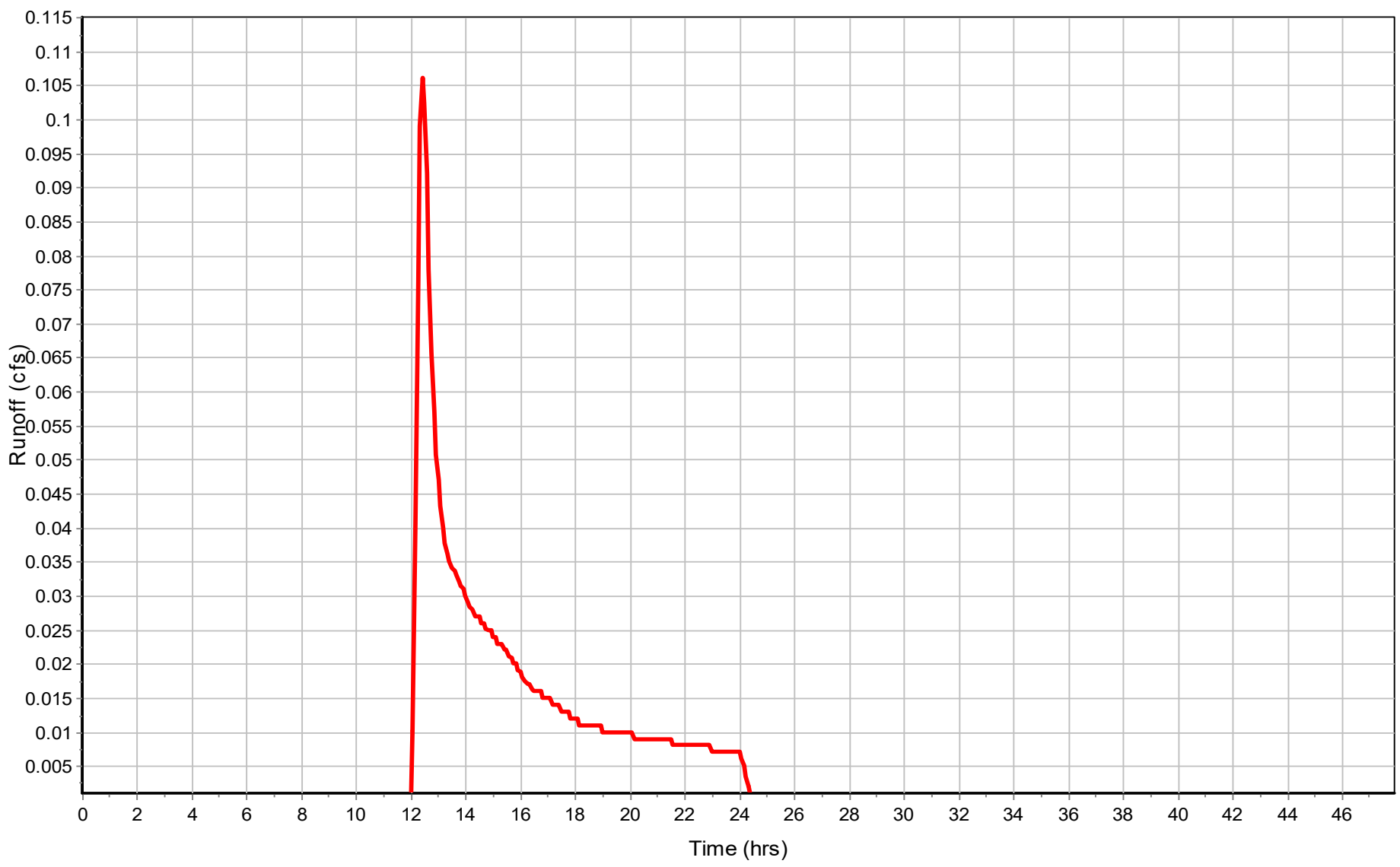
Total Rainfall (in) 5.97
Total Runoff (in) 0.66
Peak Runoff (cfs) 0.11
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:21:06

Subbasin : Sub-E03.3

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A3

Input Data

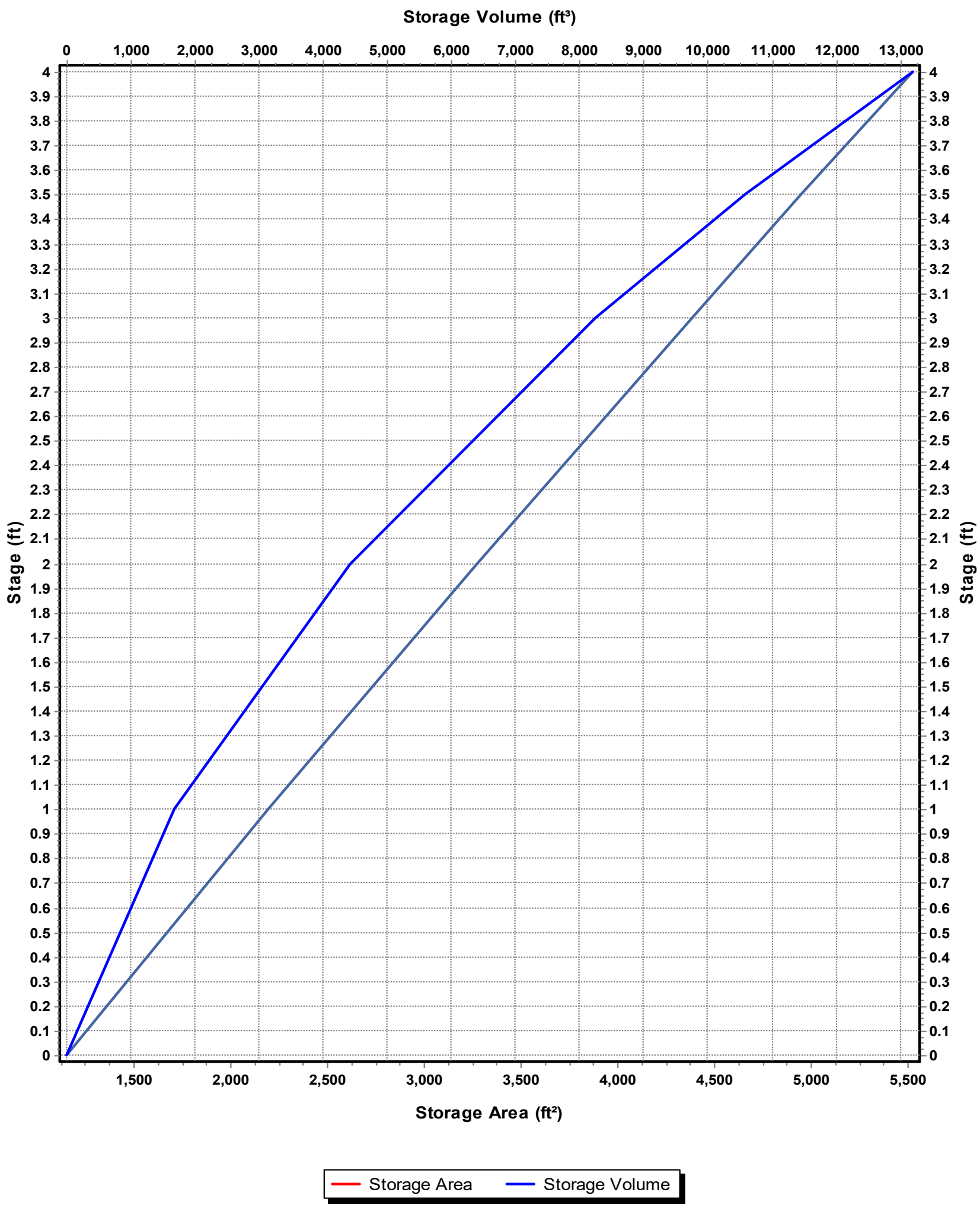
Invert Elevation (ft)	113.50
Max (Rim) Elevation (ft)	117.50
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	113.50
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

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

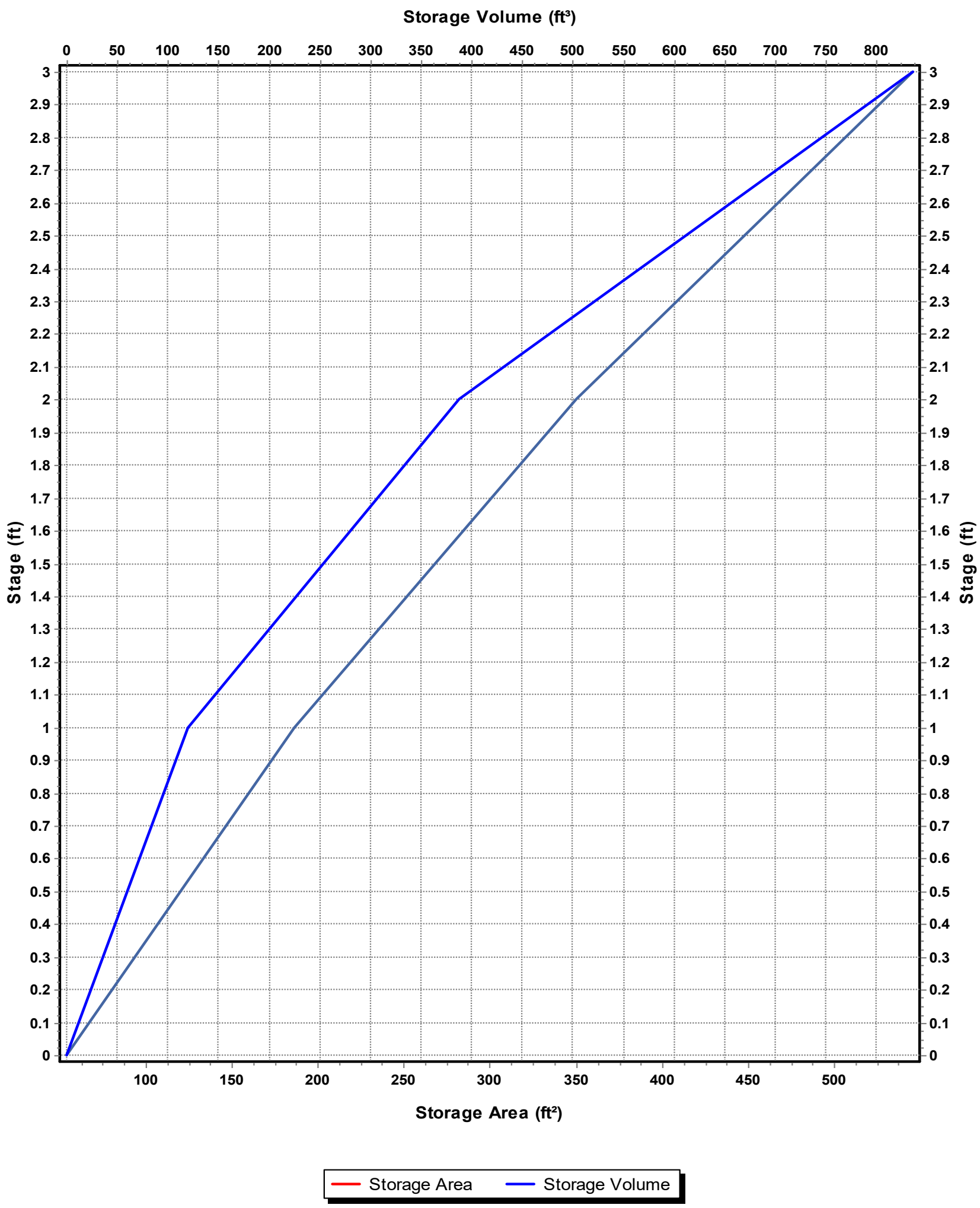
Invert Elevation (ft)	114.50
Max (Rim) Elevation (ft)	117.50
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.50
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

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

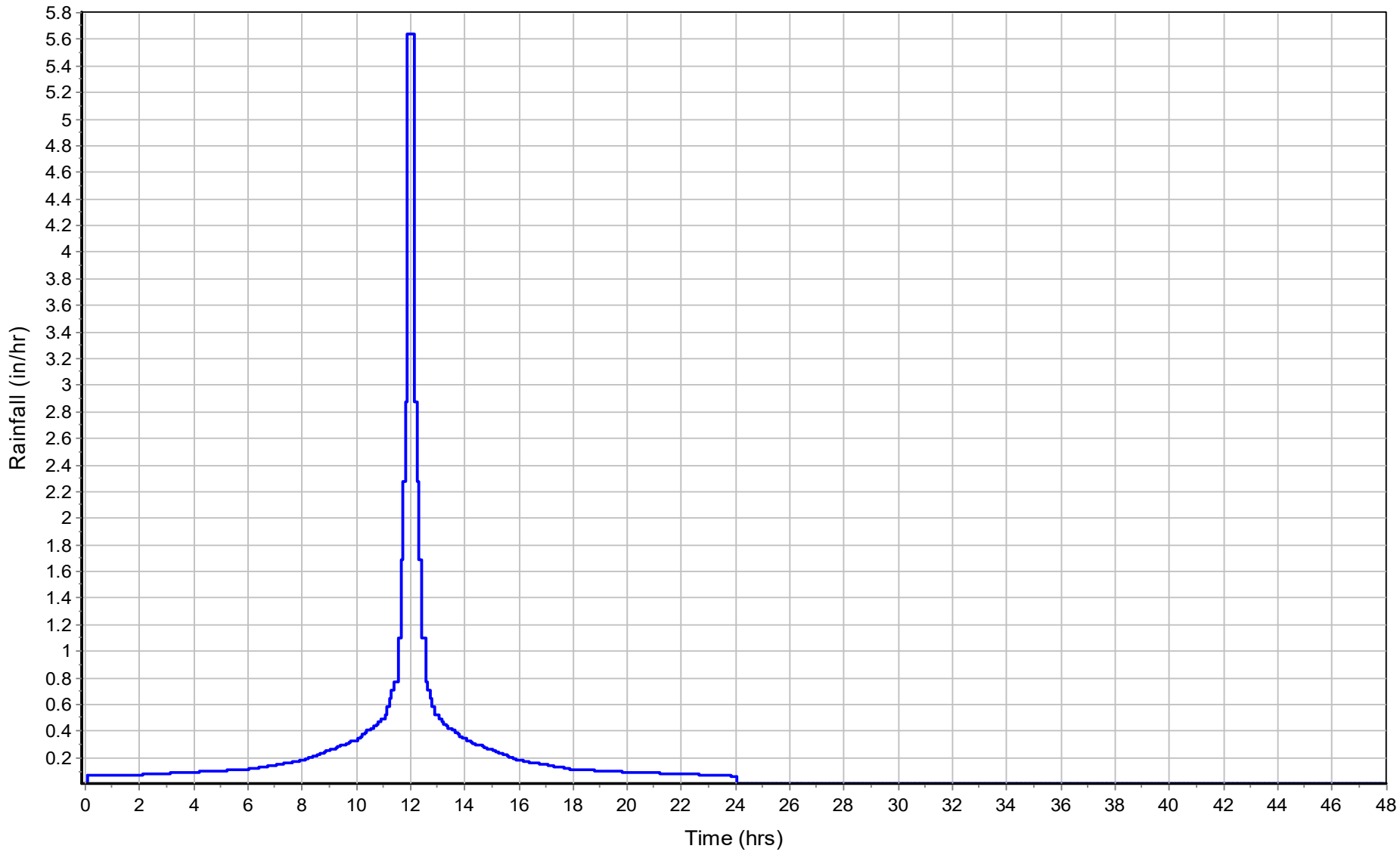
Total TOC (min) 19.27

Subbasin Runoff Results

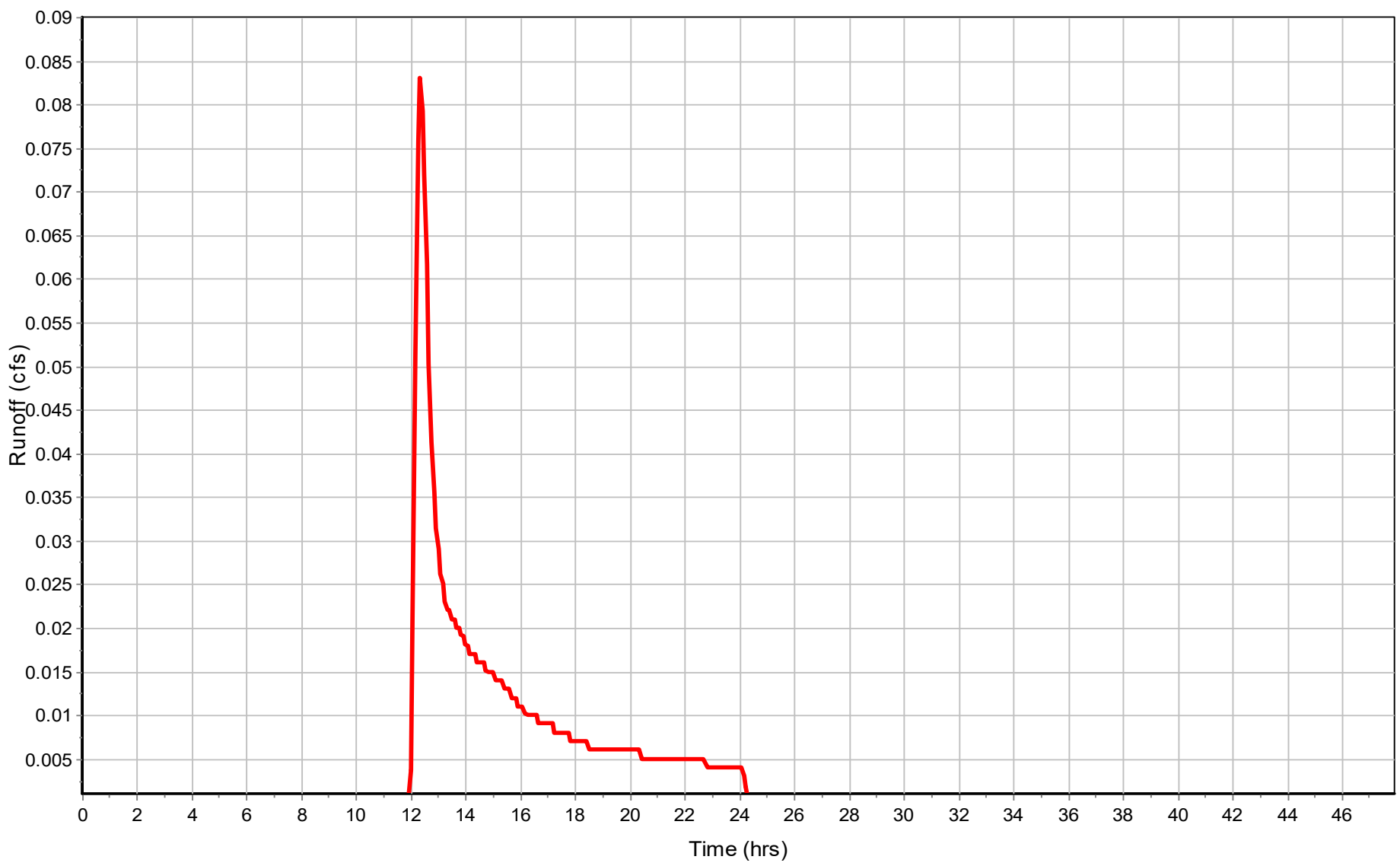
Total Rainfall (in)	6.71
Total Runoff (in)	0.95
Peak Runoff (cfs)	0.08
Weighted Curve Number	43
Time of Concentration (days hh:mm:ss)	0 00:19:16

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

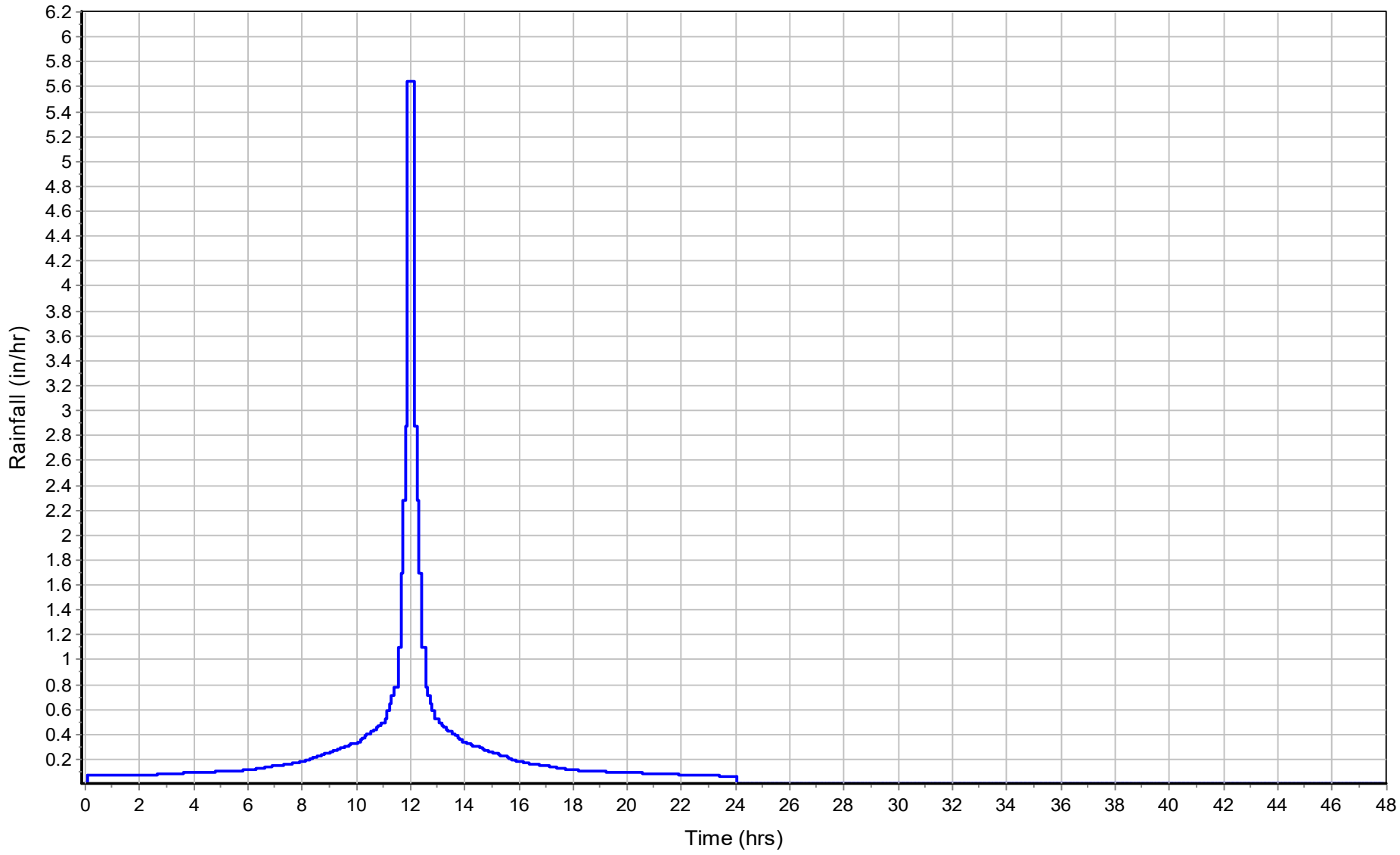
Total TOC (min) 3.27

Subbasin Runoff Results

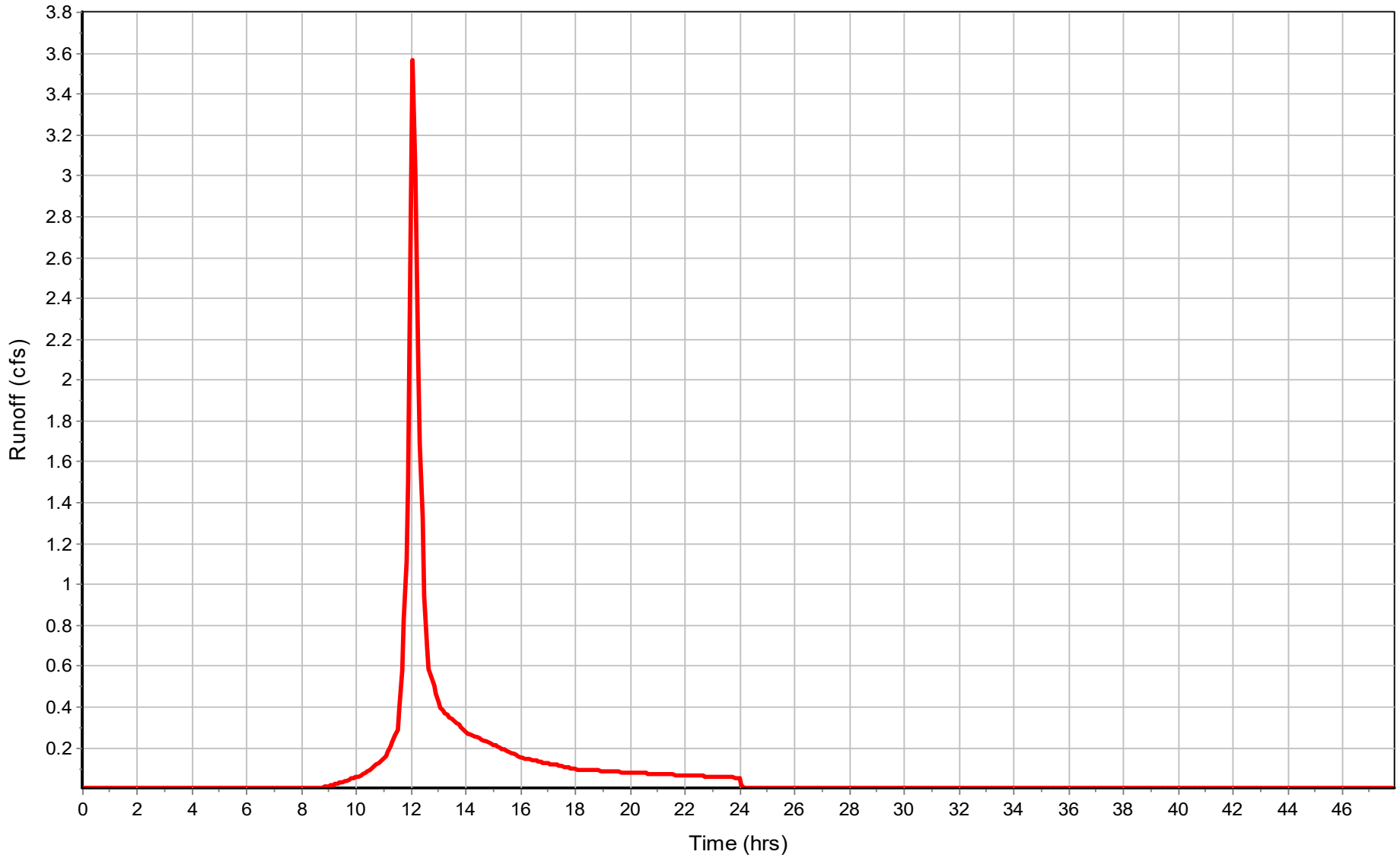
Total Rainfall (in)	6.71
Total Runoff (in)	3.36
Peak Runoff (cfs)	3.68
Weighted Curve Number	69.85
Time of Concentration (days hh:mm:ss)	0 00:03:16

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

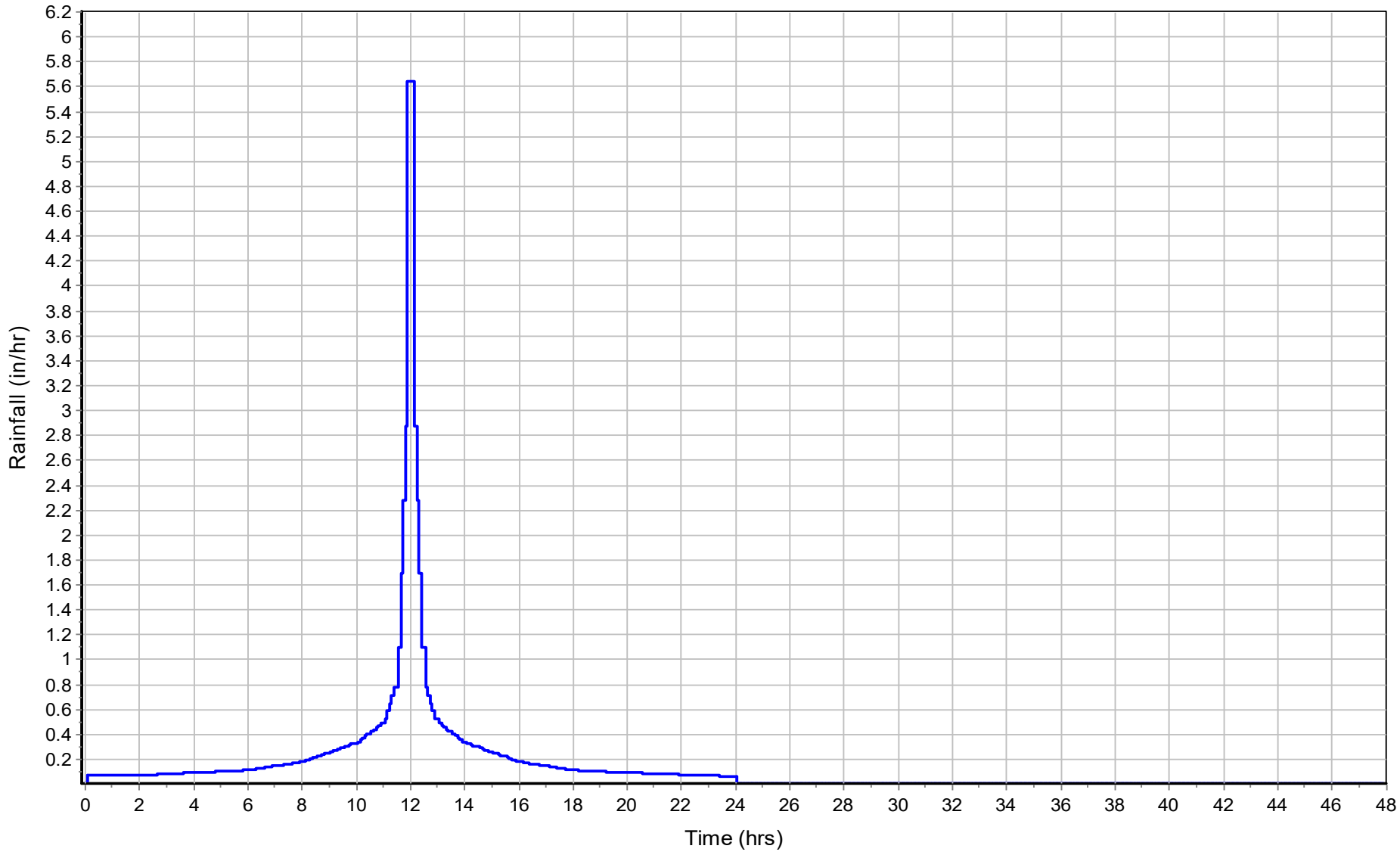
Total TOC (min) 21.10

Subbasin Runoff Results

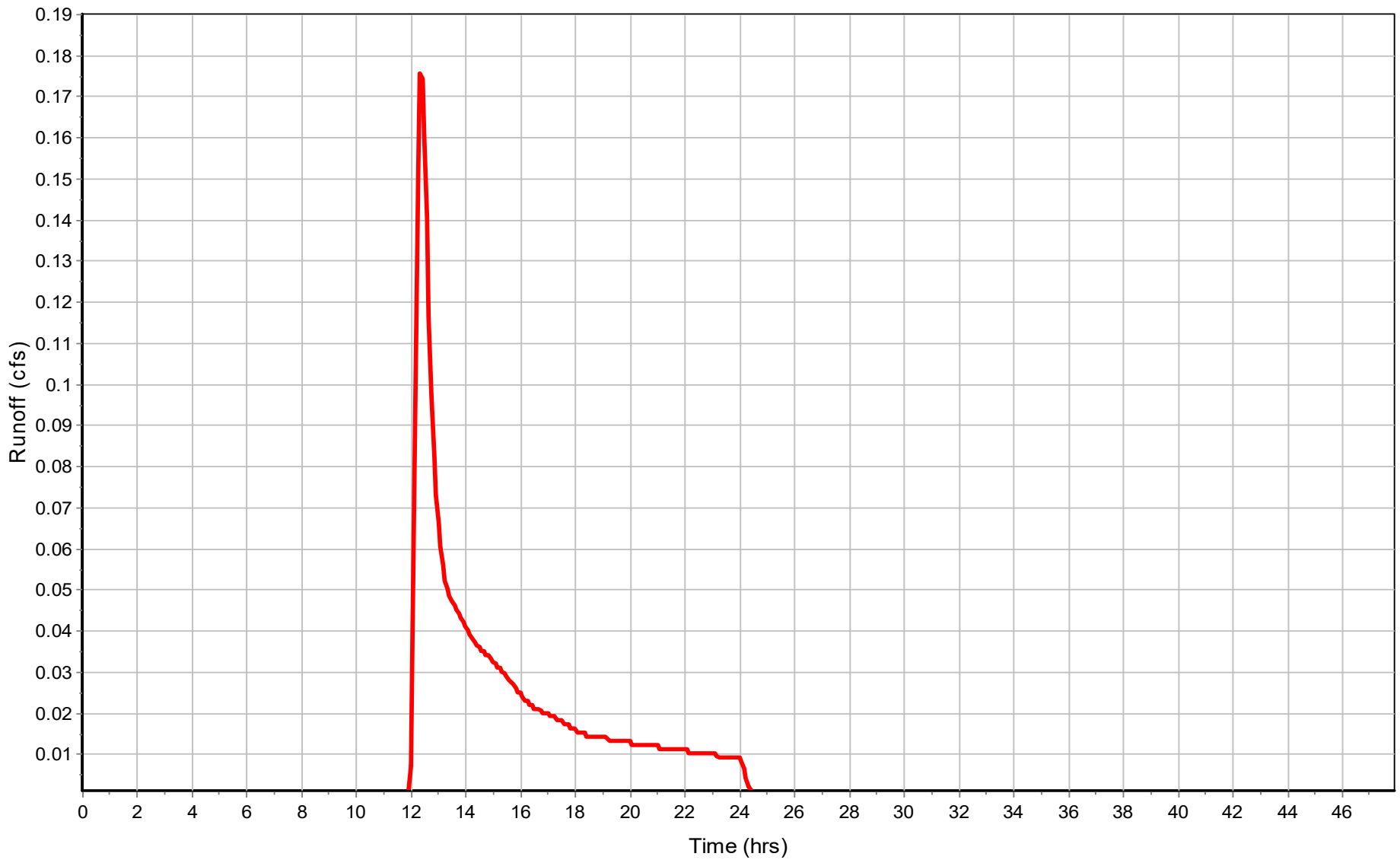
Total Rainfall (in) 6.71
Total Runoff (in) 0.95
Peak Runoff (cfs) 0.18
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:21:06

Subbasin : Sub-E03.3

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A3

Input Data

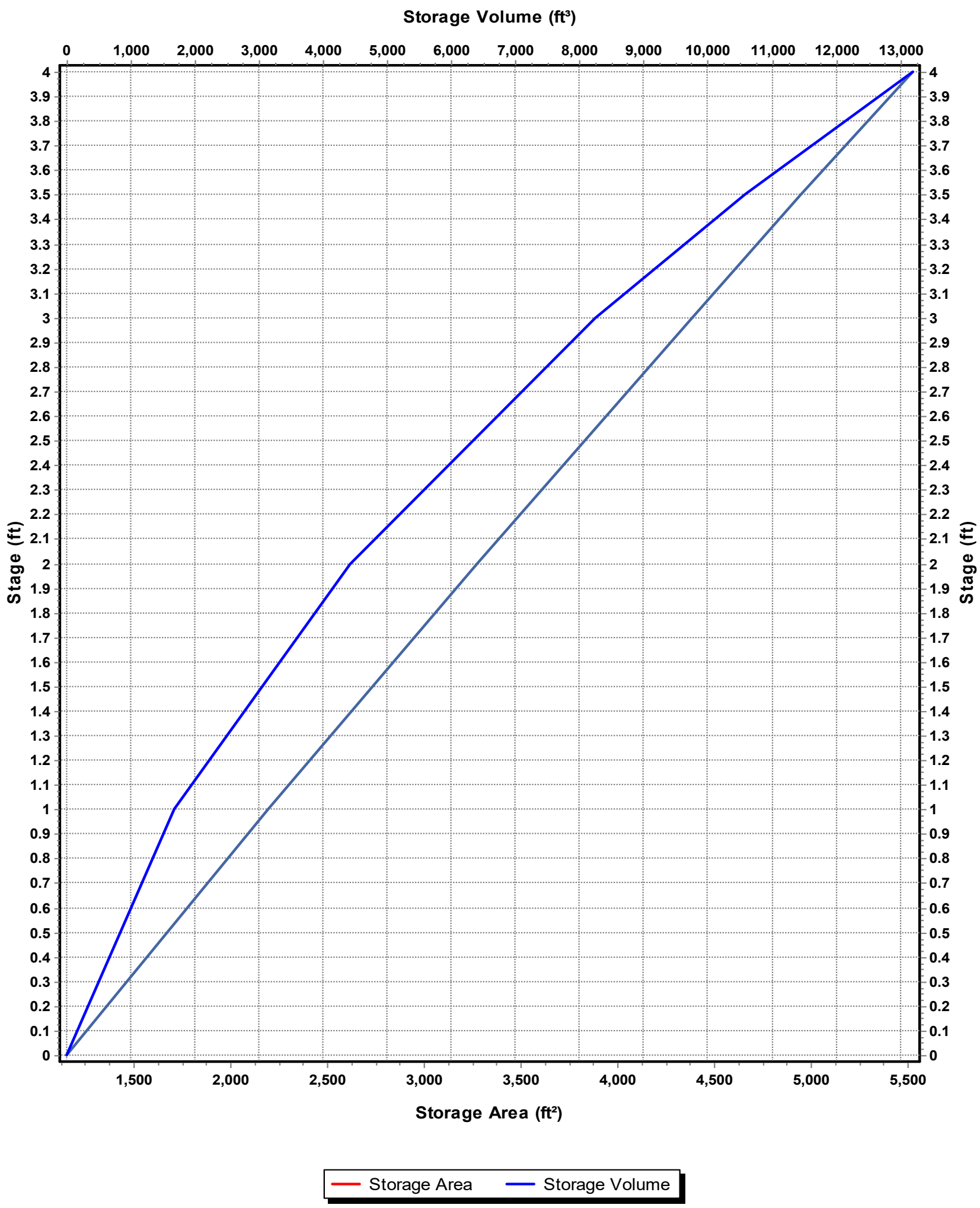
Invert Elevation (ft)	113.50
Max (Rim) Elevation (ft)	117.50
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	113.50
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

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

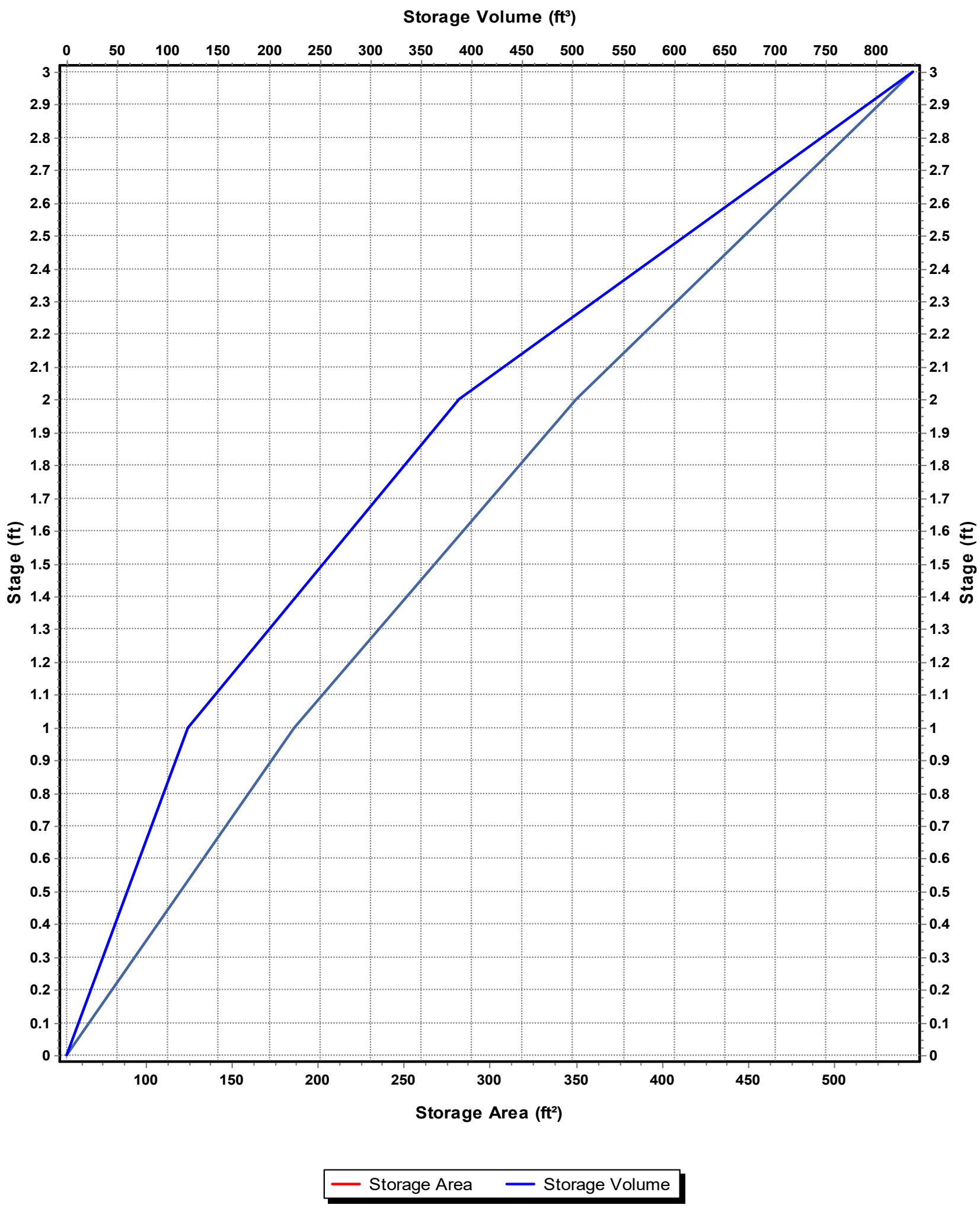
Invert Elevation (ft)	114.50
Max (Rim) Elevation (ft)	117.50
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.50
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

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

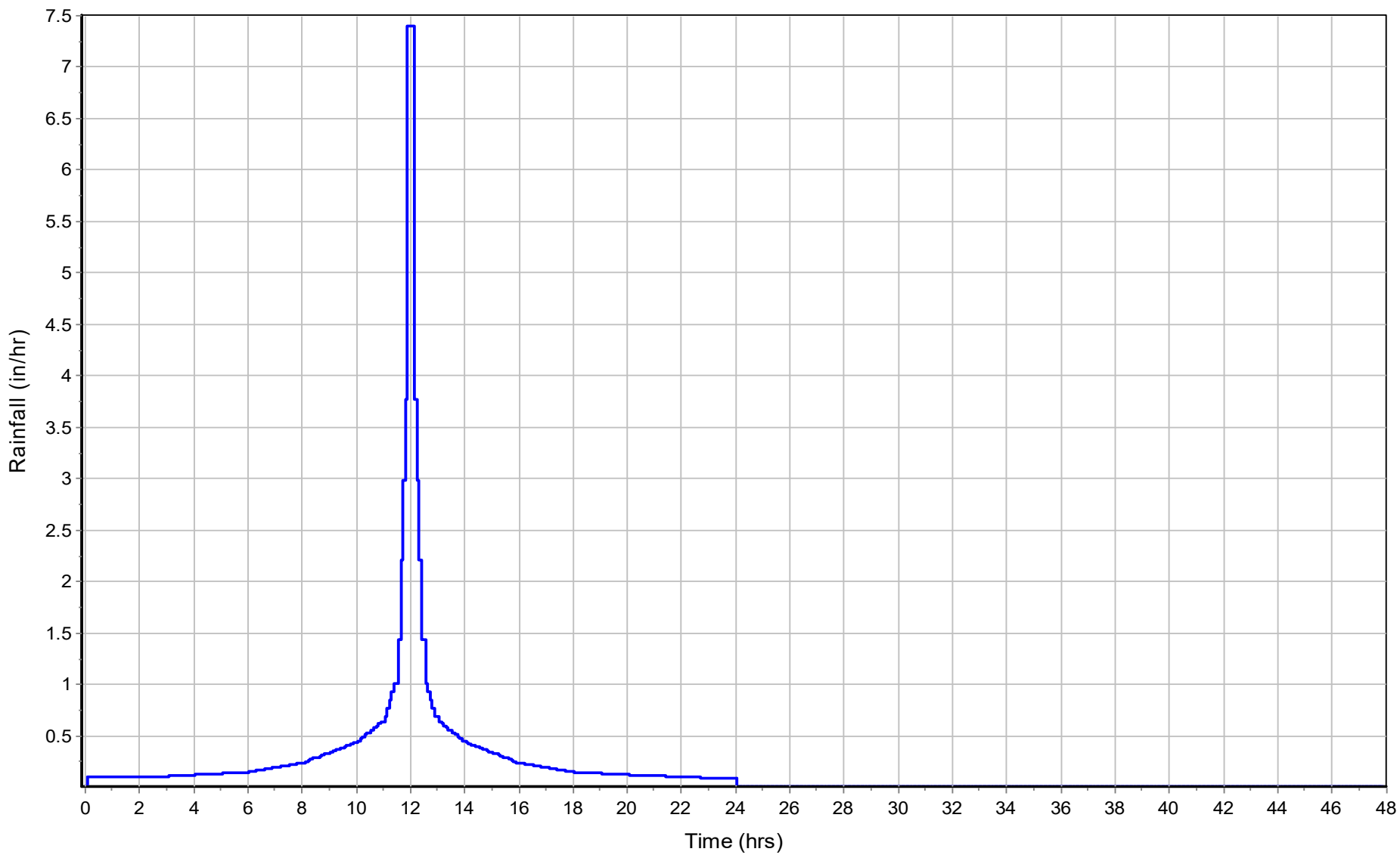
Total TOC (min) 19.27

Subbasin Runoff Results

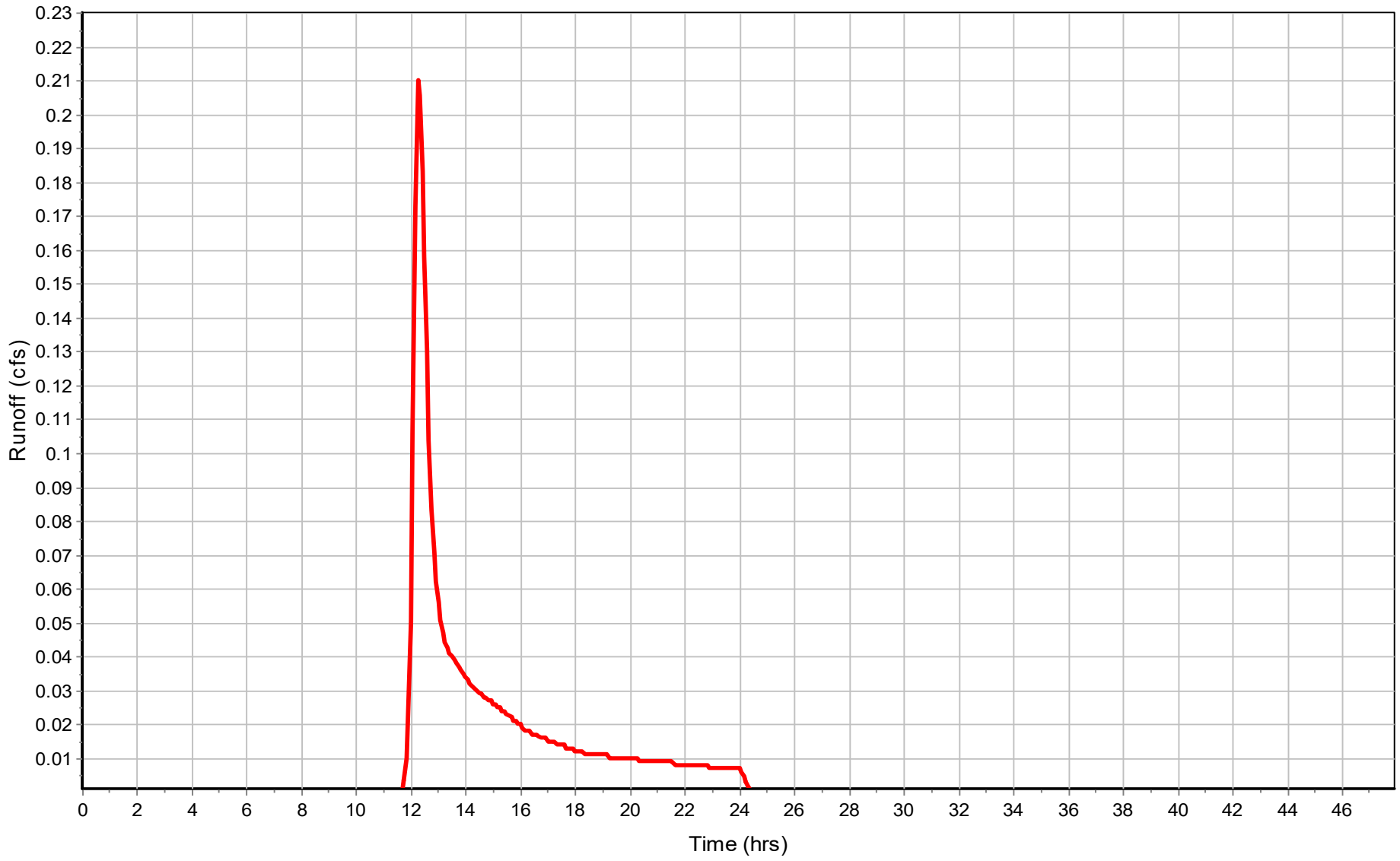
Total Rainfall (in)	8.8
Total Runoff (in)	1.95
Peak Runoff (cfs)	0.21
Weighted Curve Number	43
Time of Concentration (days hh:mm:ss)	0 00:19:16

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

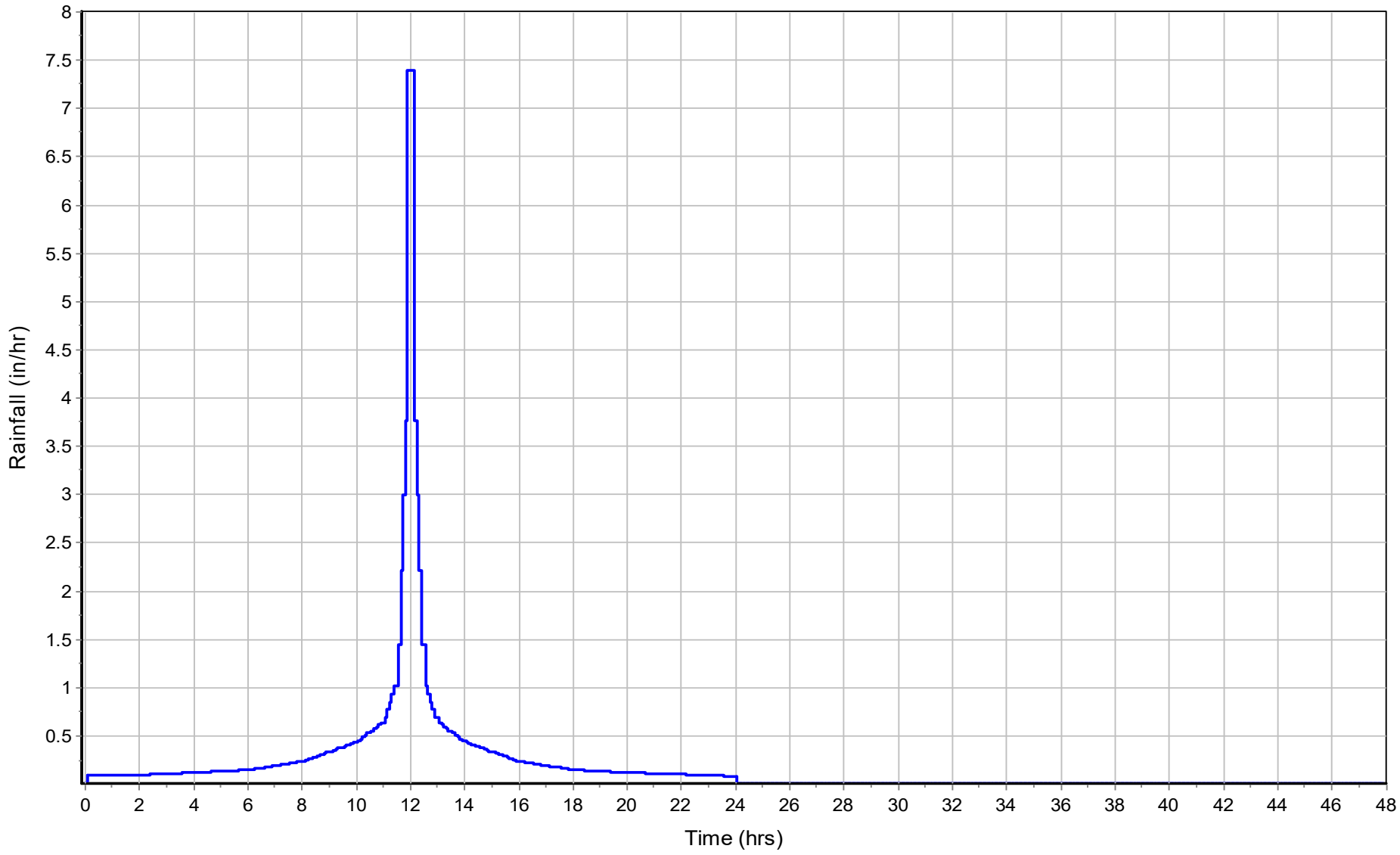
Total TOC (min) 3.27

Subbasin Runoff Results

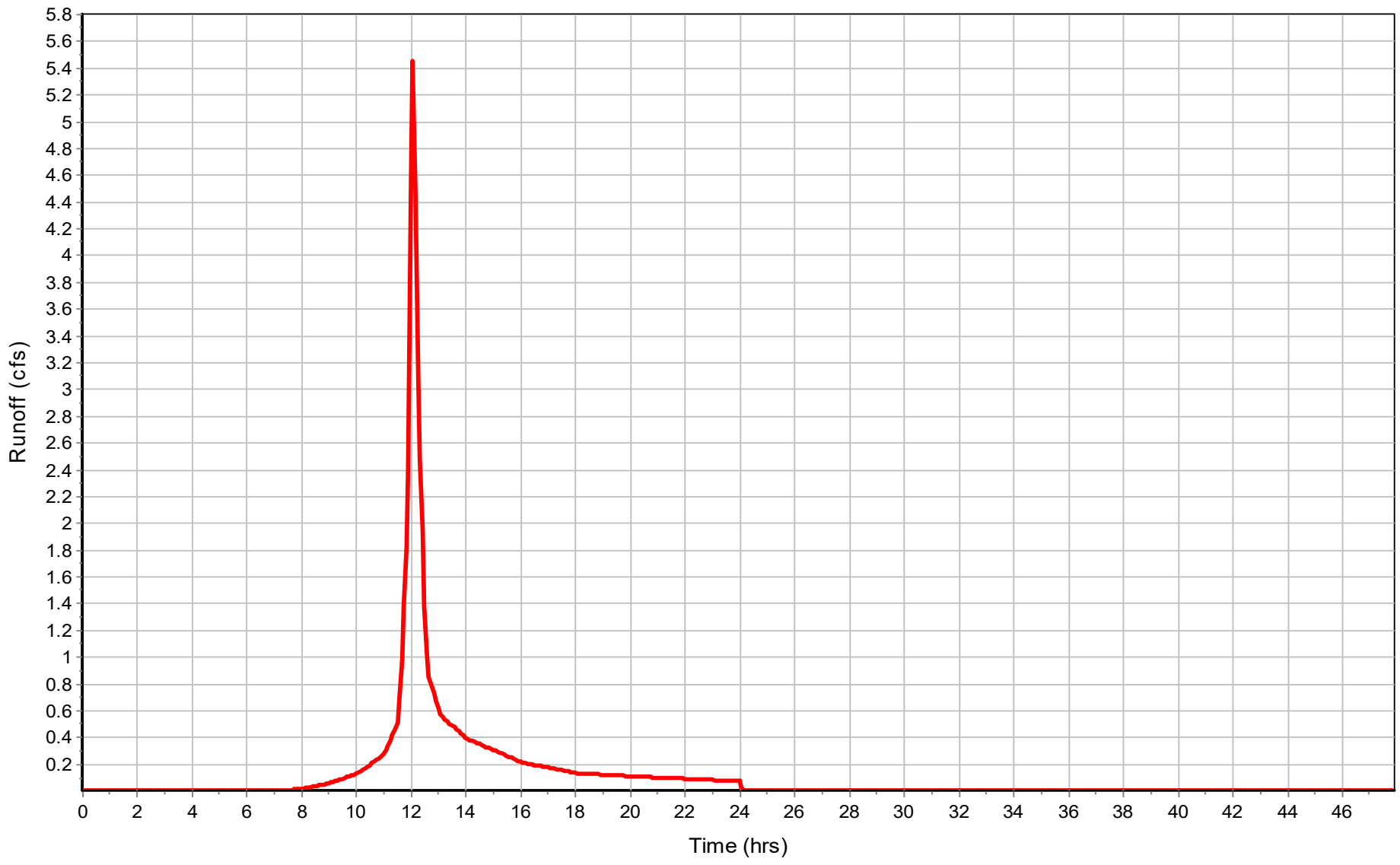
Total Rainfall (in)	8.8
Total Runoff (in)	5.14
Peak Runoff (cfs)	5.57
Weighted Curve Number	69.85
Time of Concentration (days hh:mm:ss)	0 00:03:16

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

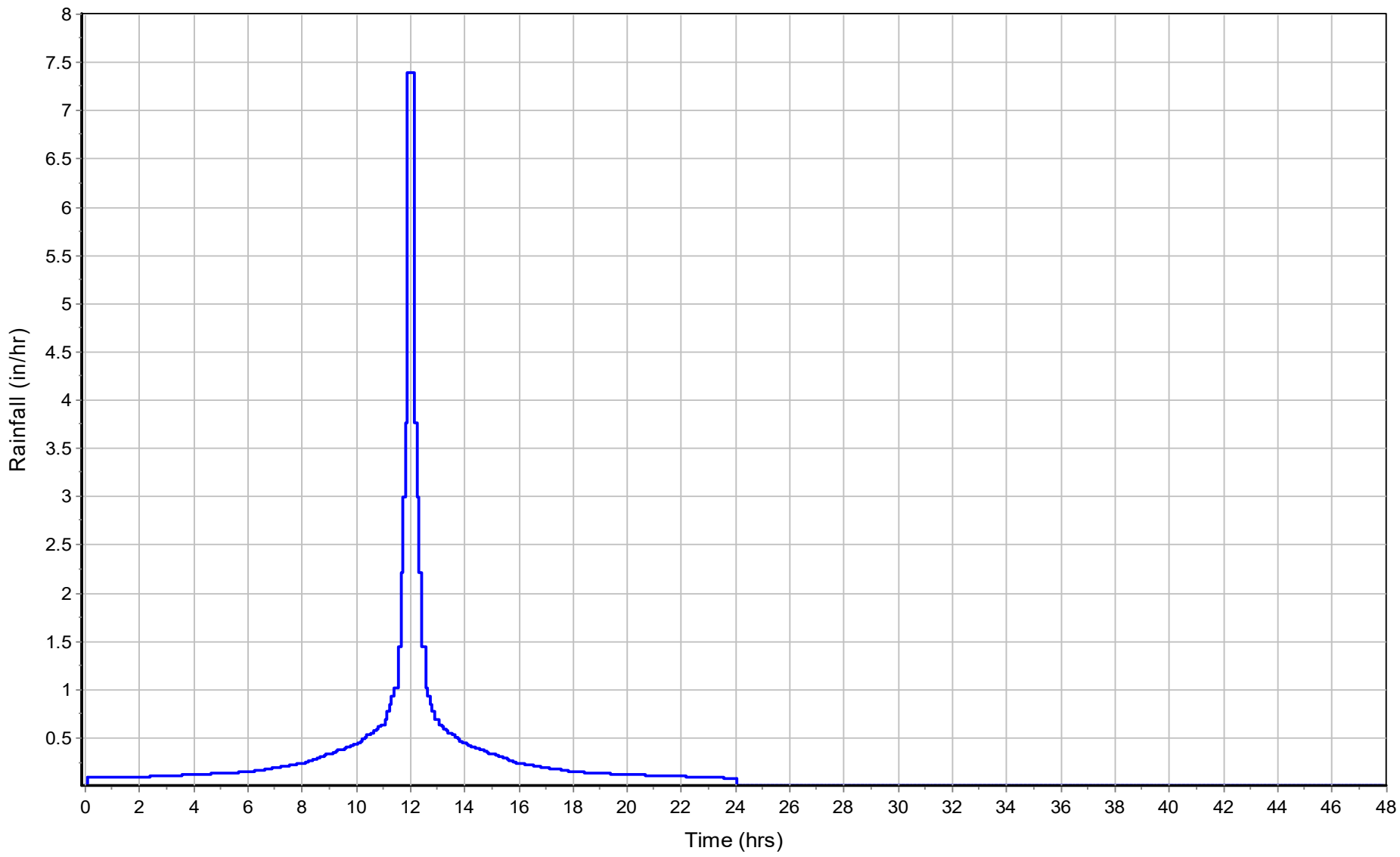
Total TOC (min) 21.10

Subbasin Runoff Results

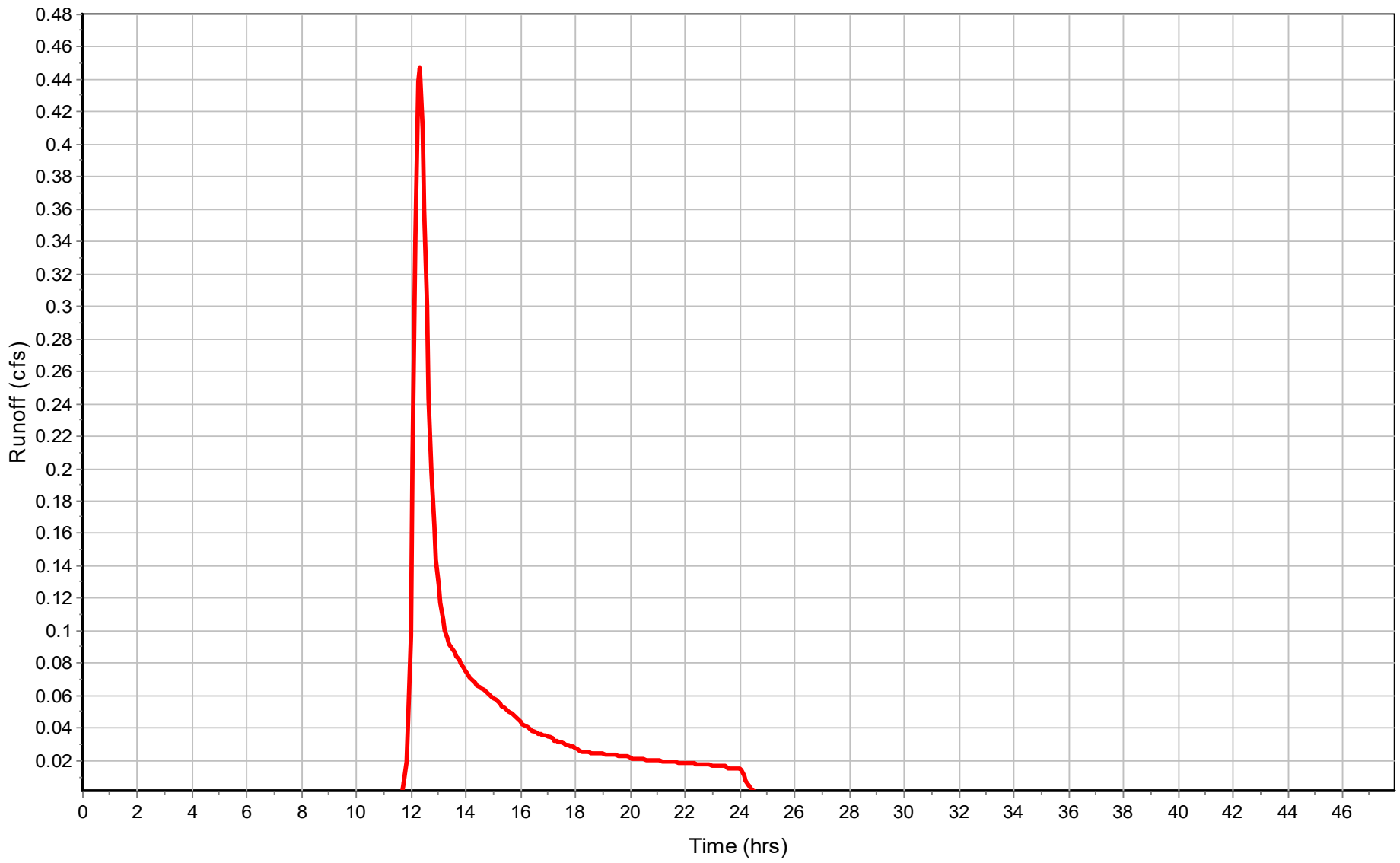
Total Rainfall (in) 8.8
Total Runoff (in) 1.95
Peak Runoff (cfs) 0.45
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:21:06

Subbasin : Sub-E03.3

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A3

Input Data

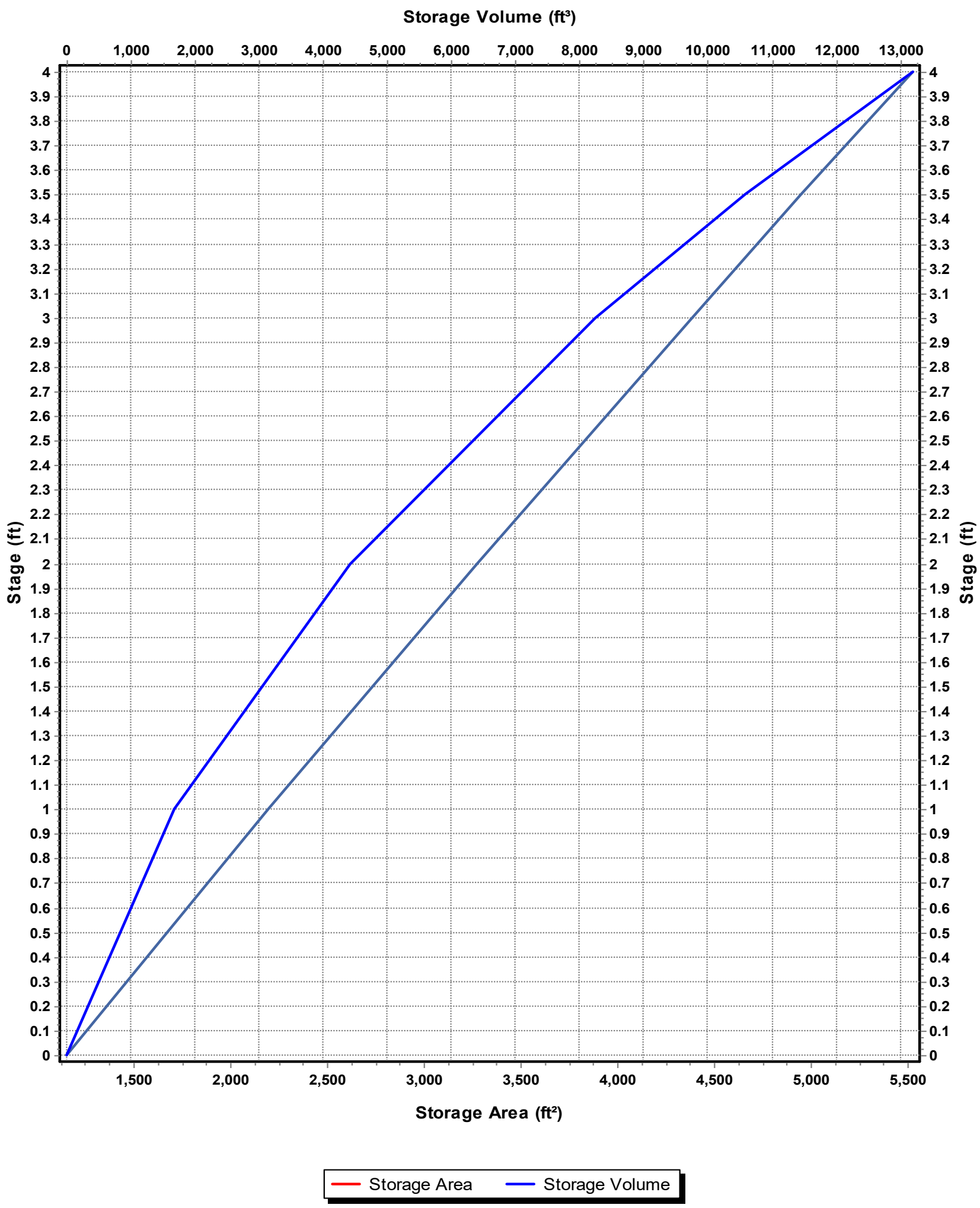
Invert Elevation (ft)	113.50
Max (Rim) Elevation (ft)	117.50
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	113.50
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

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

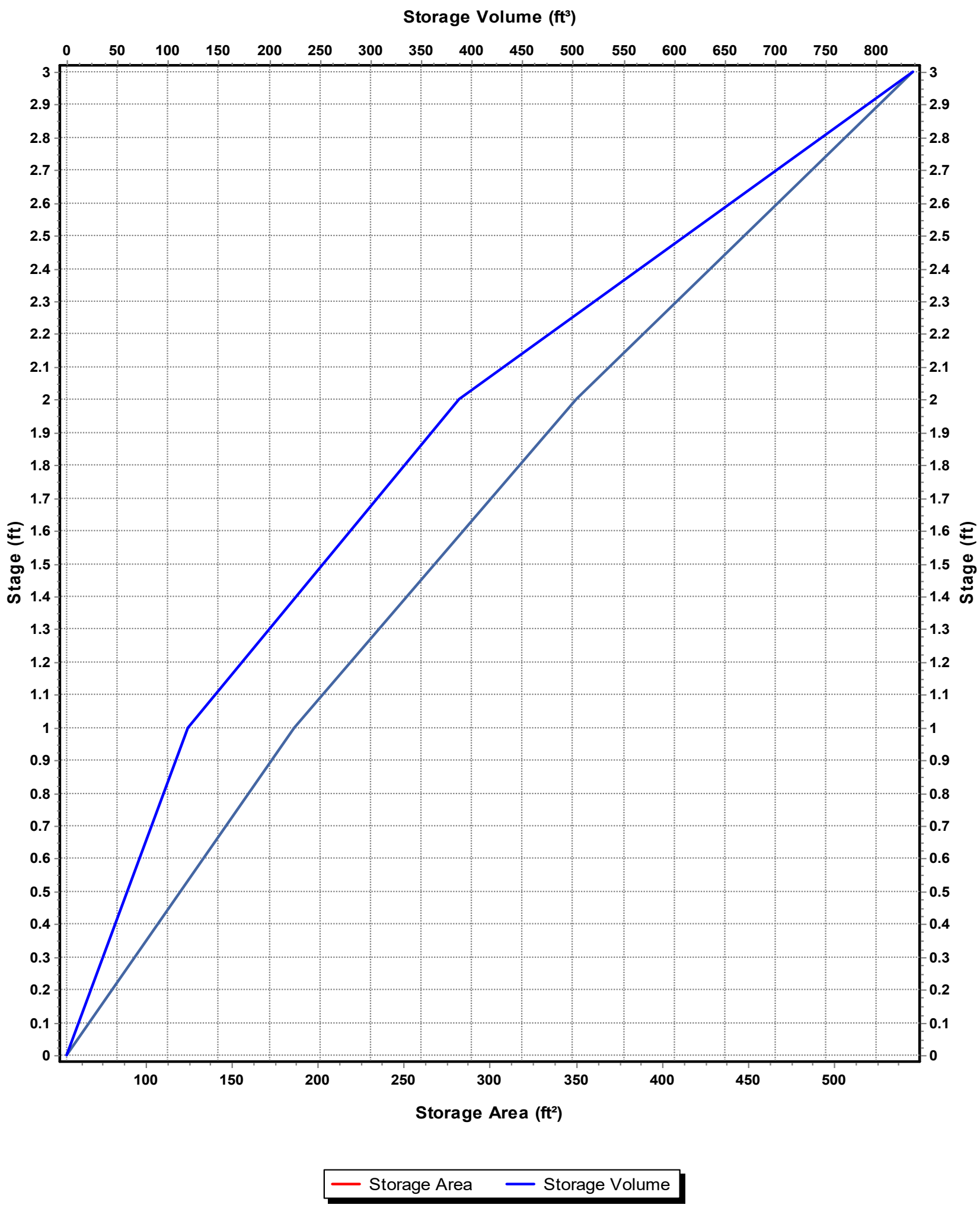
Invert Elevation (ft)	114.50
Max (Rim) Elevation (ft)	117.50
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.50
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

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

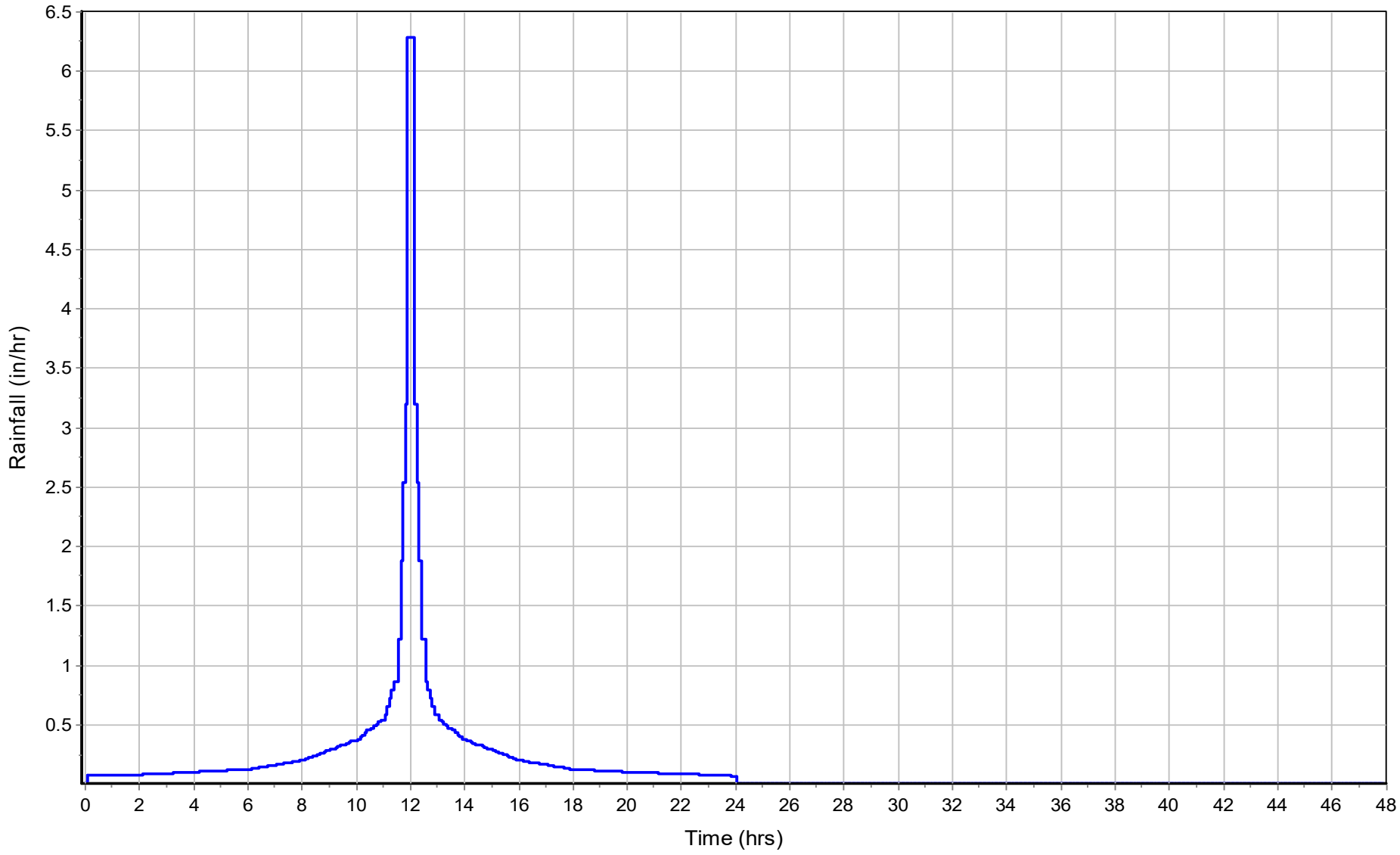
Total TOC (min) 19.27

Subbasin Runoff Results

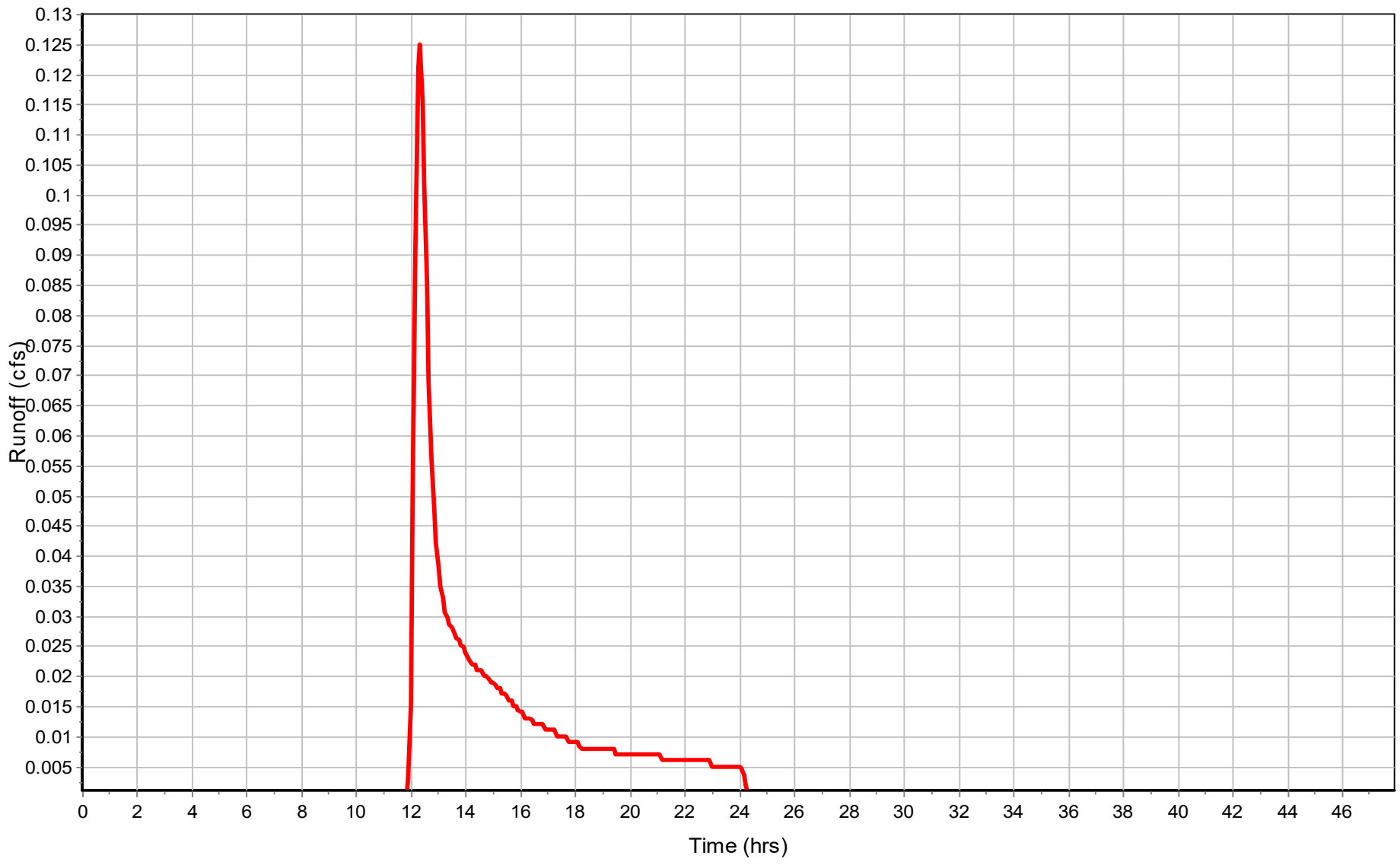
Total Rainfall (in)	7.48
Total Runoff (in)	1.29
Peak Runoff (cfs)	0.13
Weighted Curve Number	43
Time of Concentration (days hh:mm:ss)	0 00:19:16

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

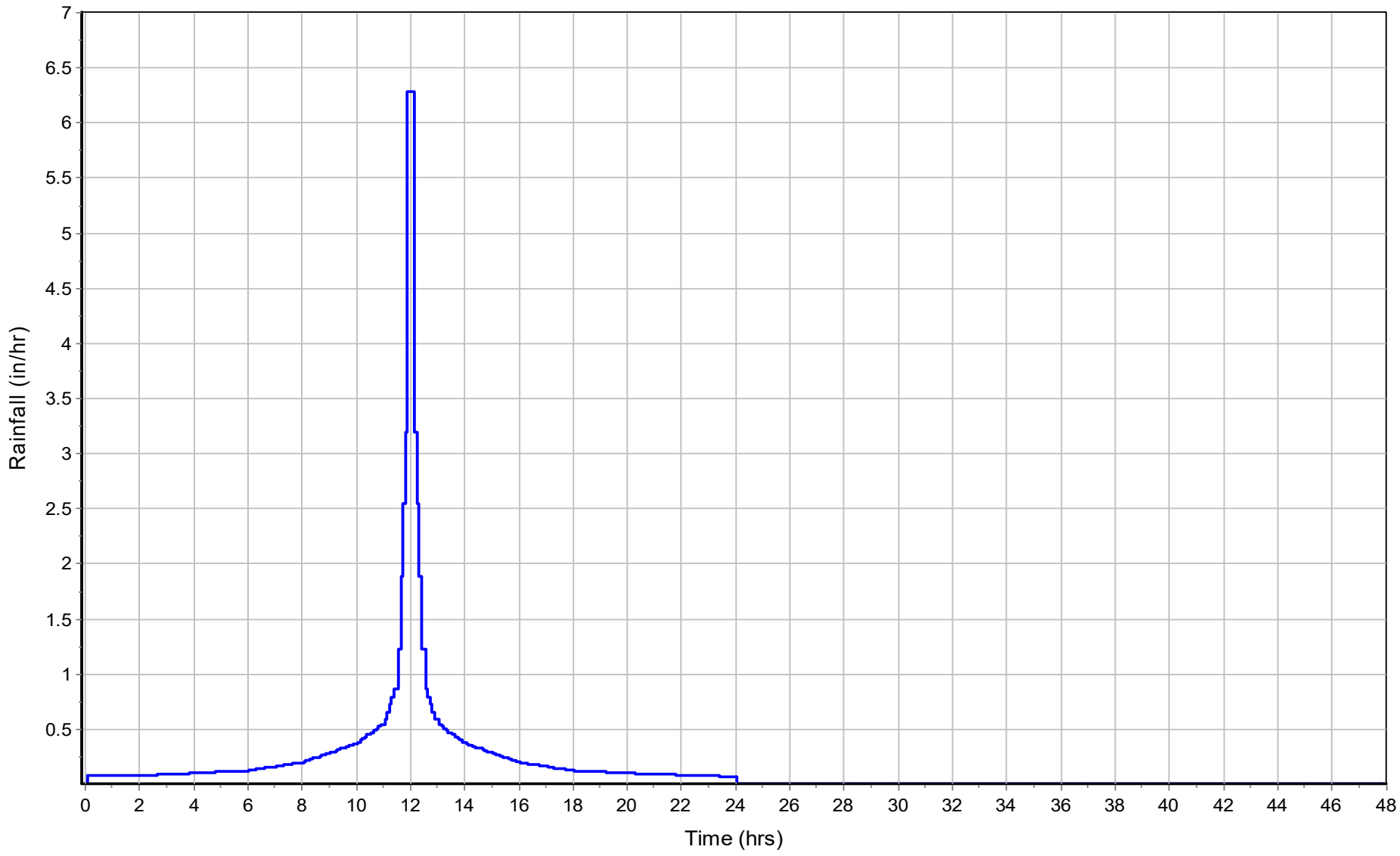
Total TOC (min) 3.27

Subbasin Runoff Results

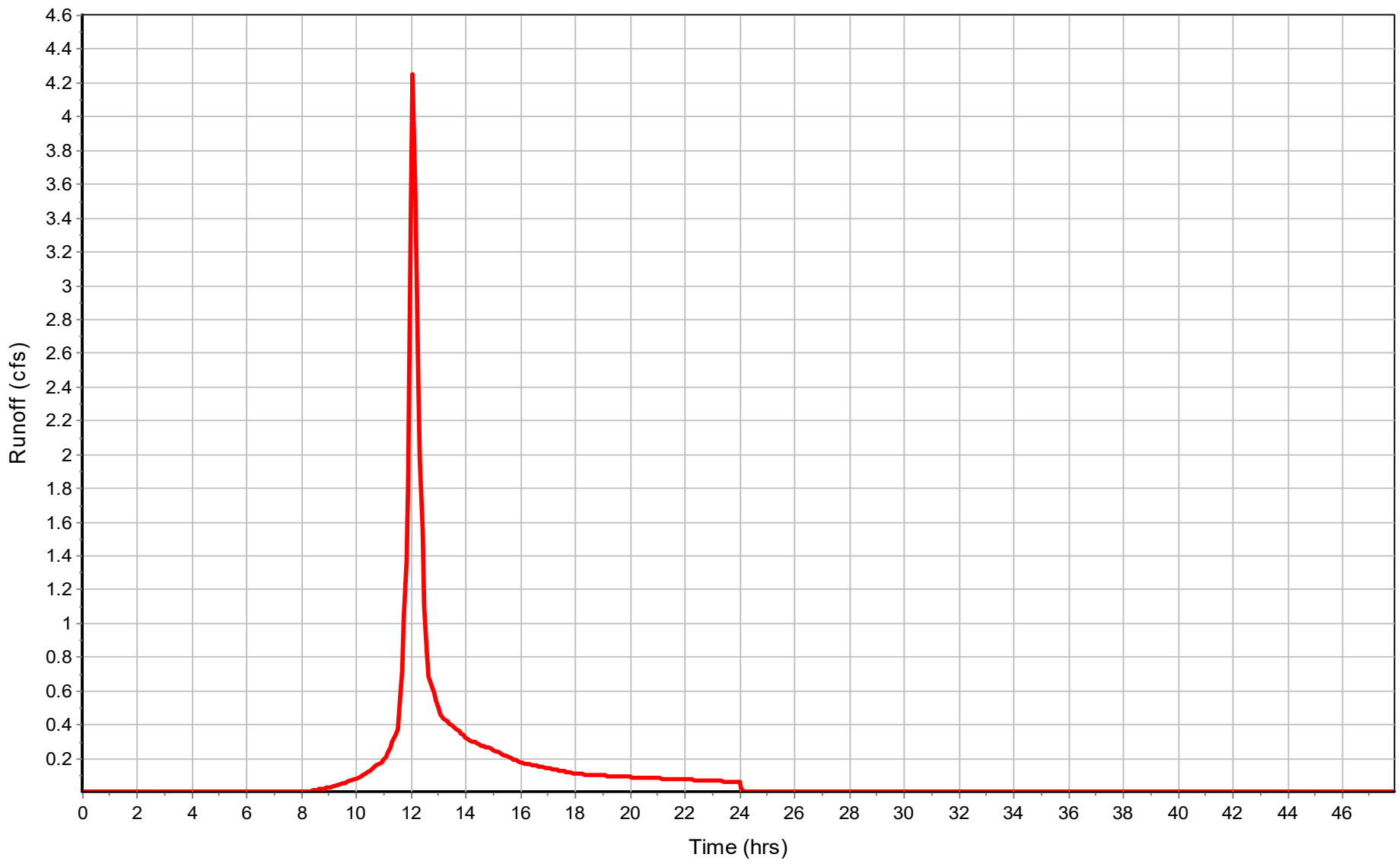
Total Rainfall (in)	7.48
Total Runoff (in)	4
Peak Runoff (cfs)	4.37
Weighted Curve Number	69.85
Time of Concentration (days hh:mm:ss)	0 00:03:16

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

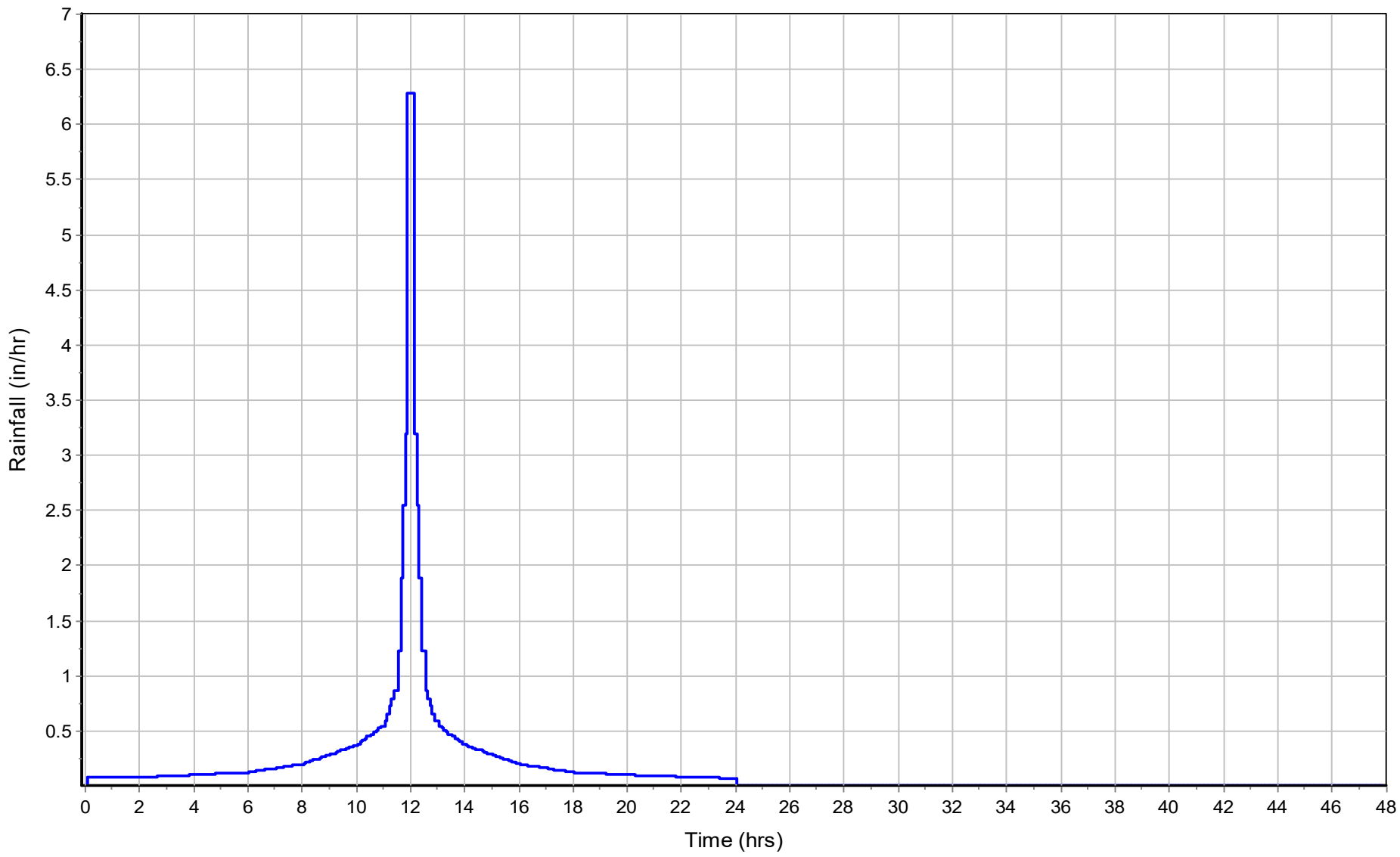
Total TOC (min) 21.10

Subbasin Runoff Results

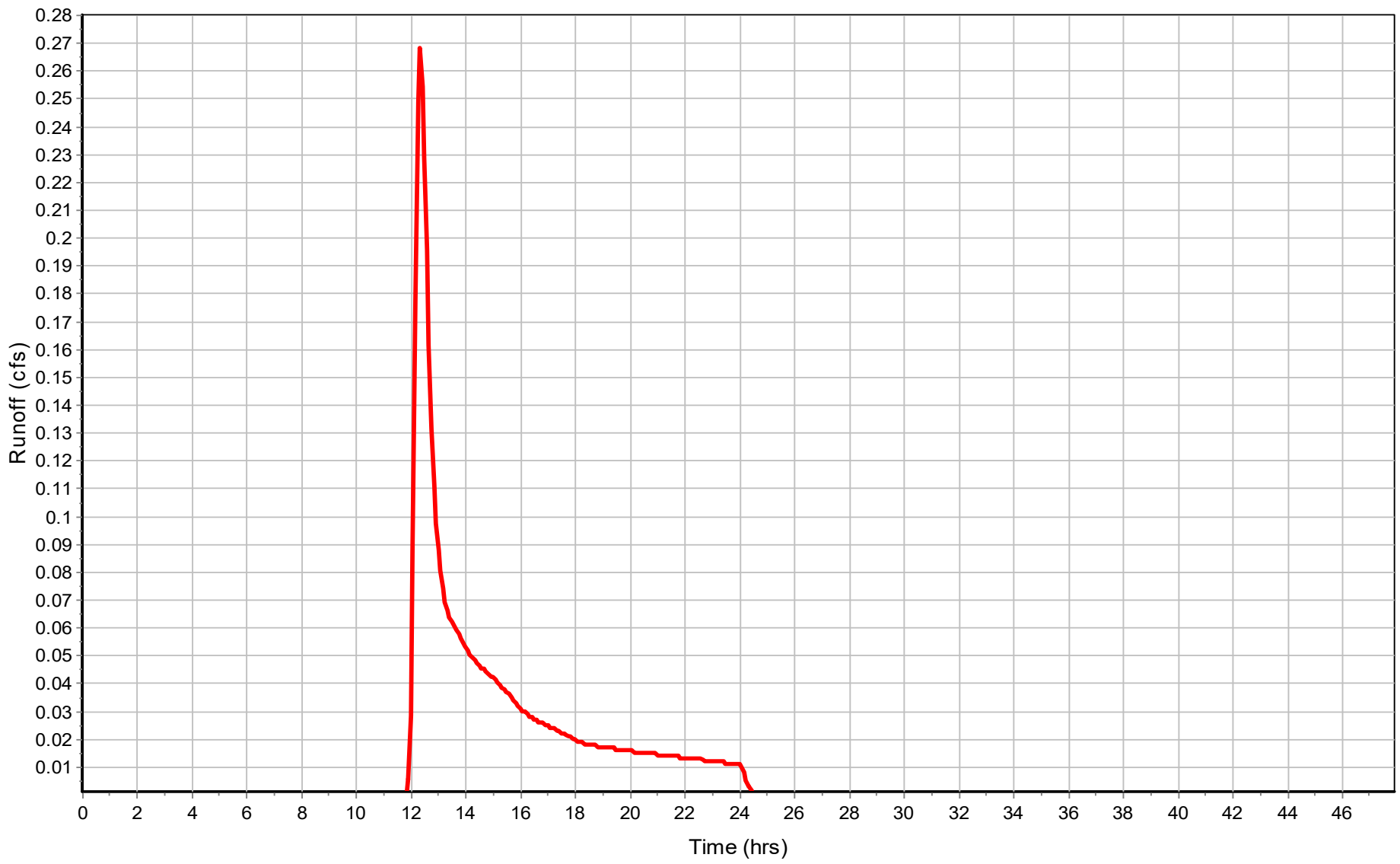
Total Rainfall (in) 7.48
Total Runoff (in) 1.29
Peak Runoff (cfs) 0.27
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:21:06

Subbasin : Sub-E03.3

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A3

Input Data

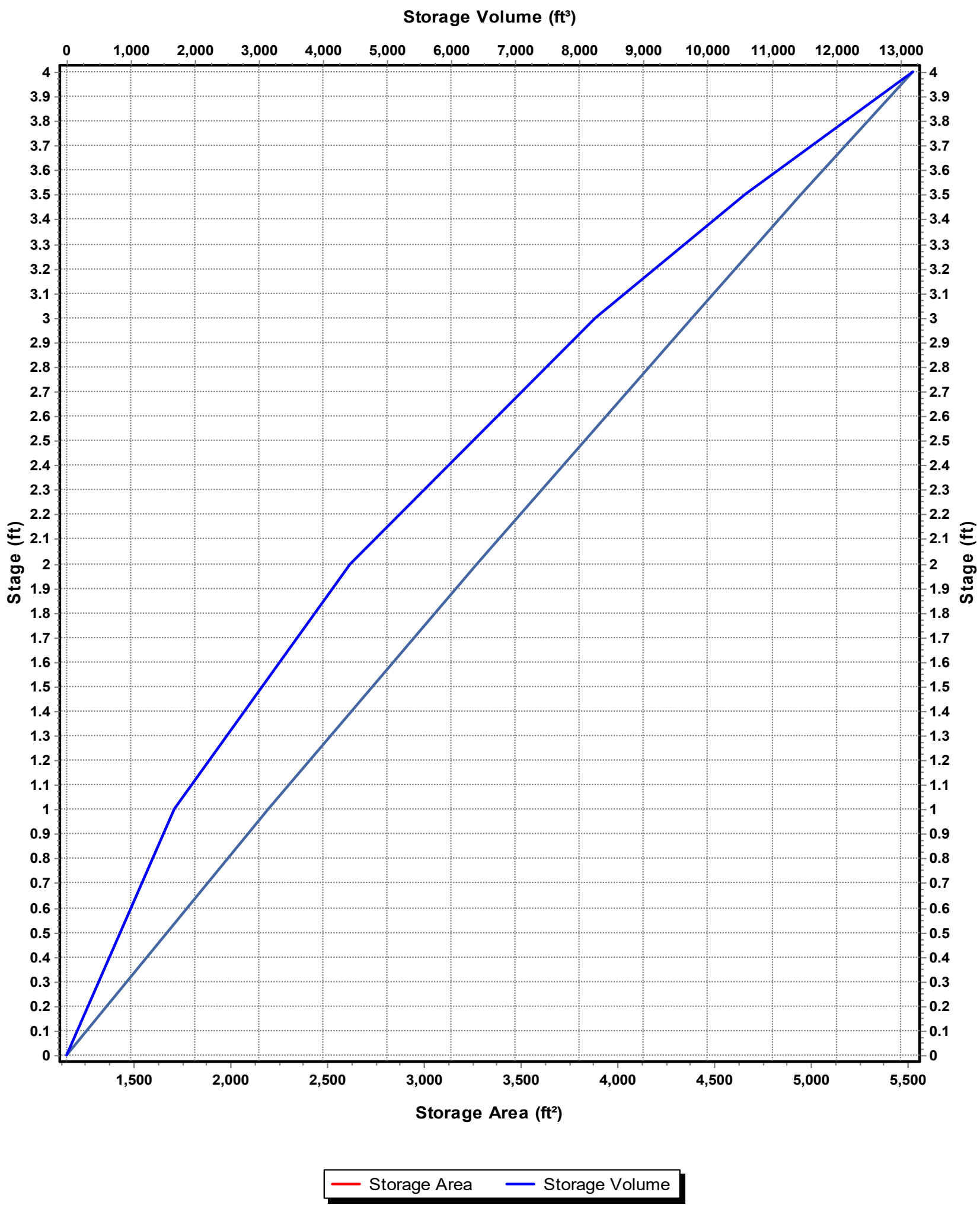
Invert Elevation (ft)	113.50
Max (Rim) Elevation (ft)	117.50
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	113.50
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

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

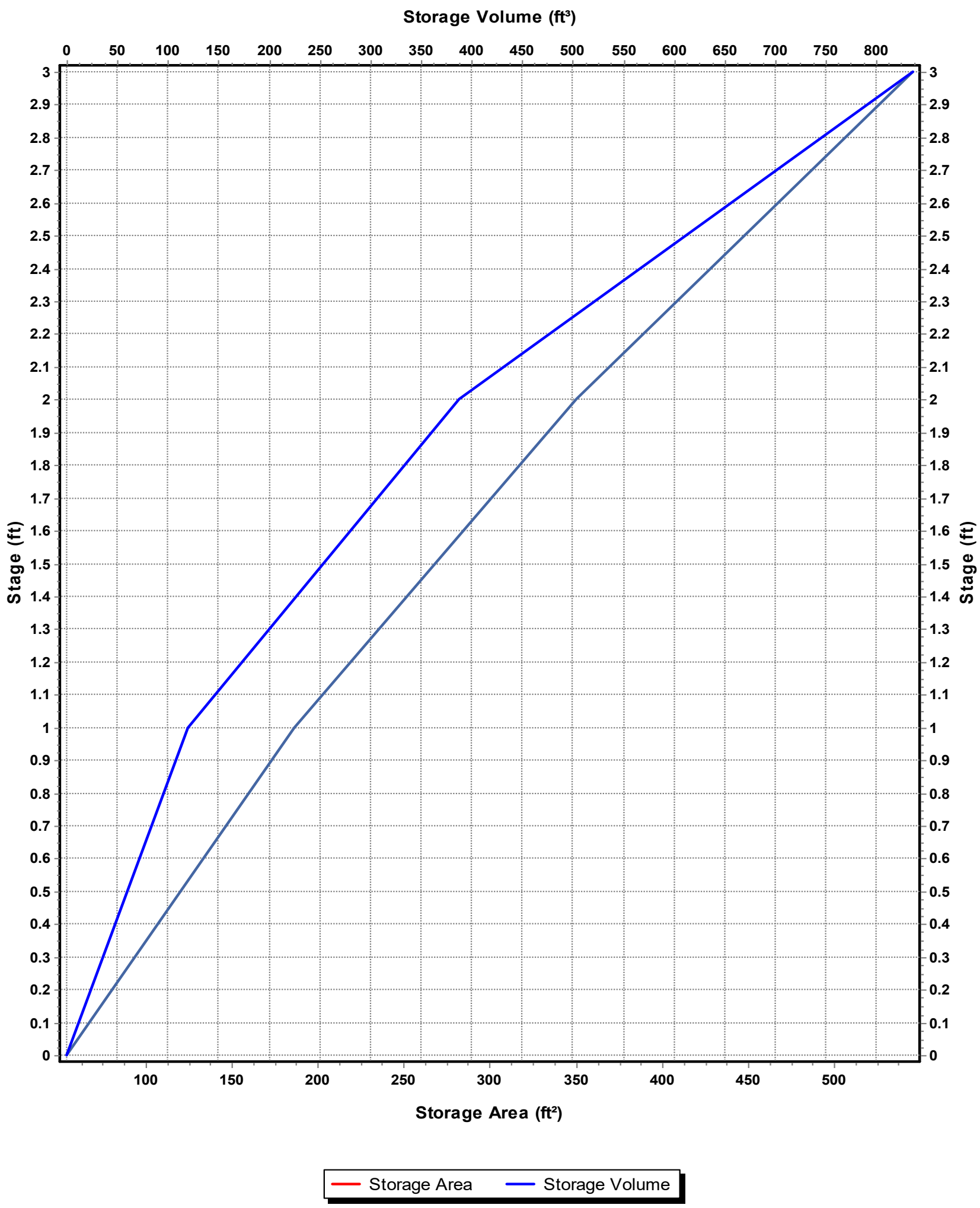
Invert Elevation (ft)	114.50
Max (Rim) Elevation (ft)	117.50
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.50
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

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

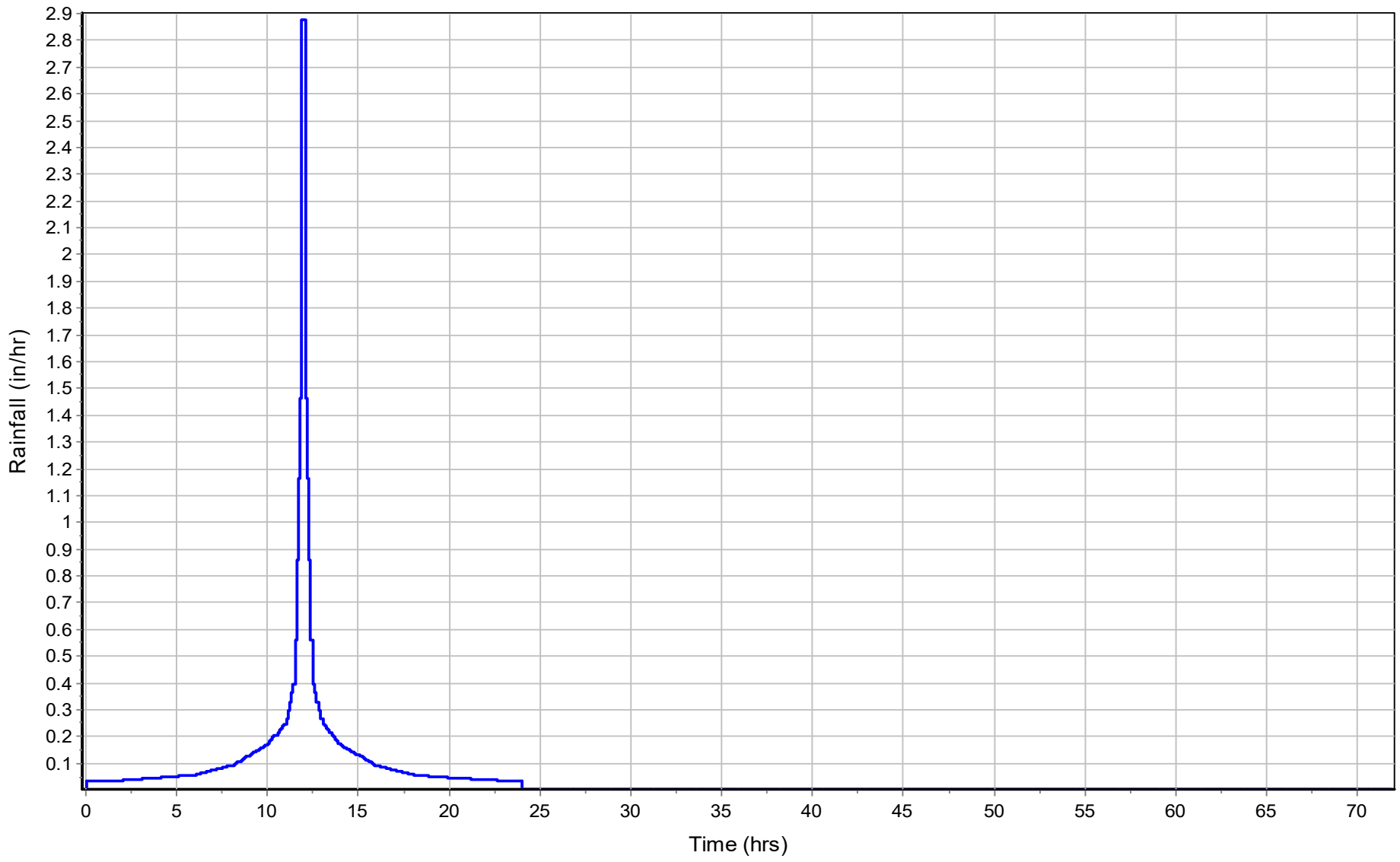
Total TOC (min) 2.57

Subbasin Runoff Results

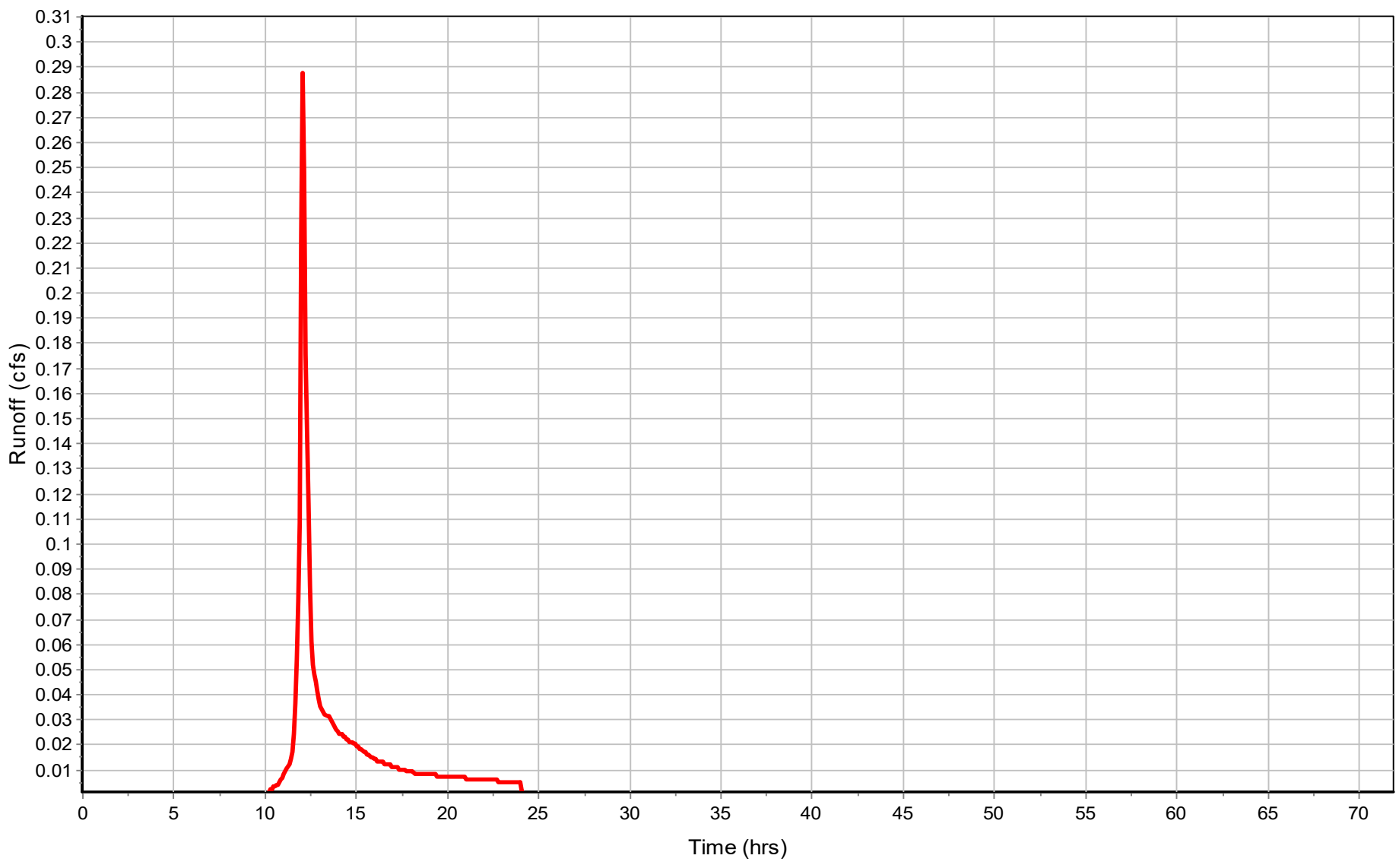
Total Rainfall (in)	3.42
Total Runoff (in)	1.31
Peak Runoff (cfs)	0.3
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:02:34

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

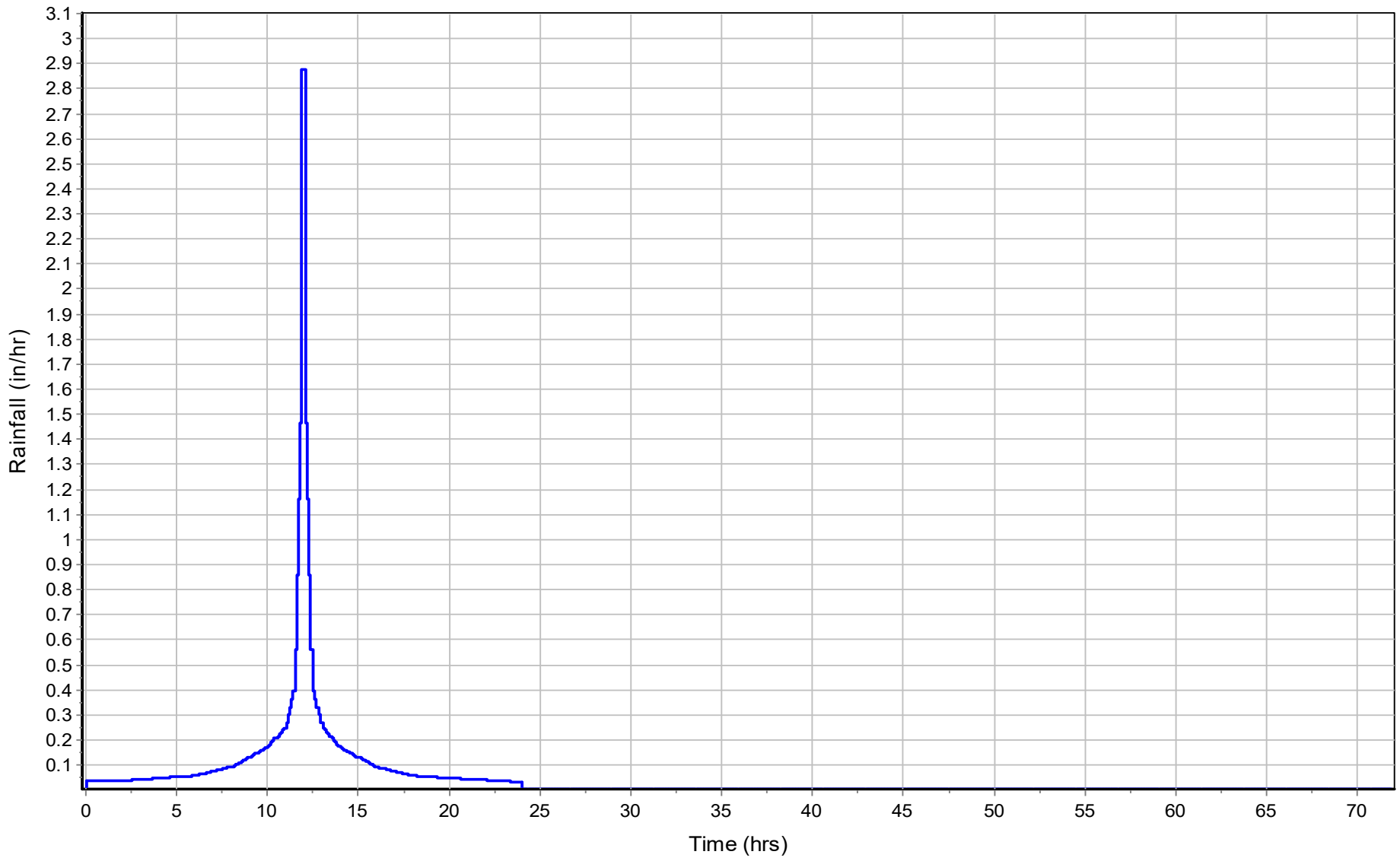
Total TOC (min) 22.21

Subbasin Runoff Results

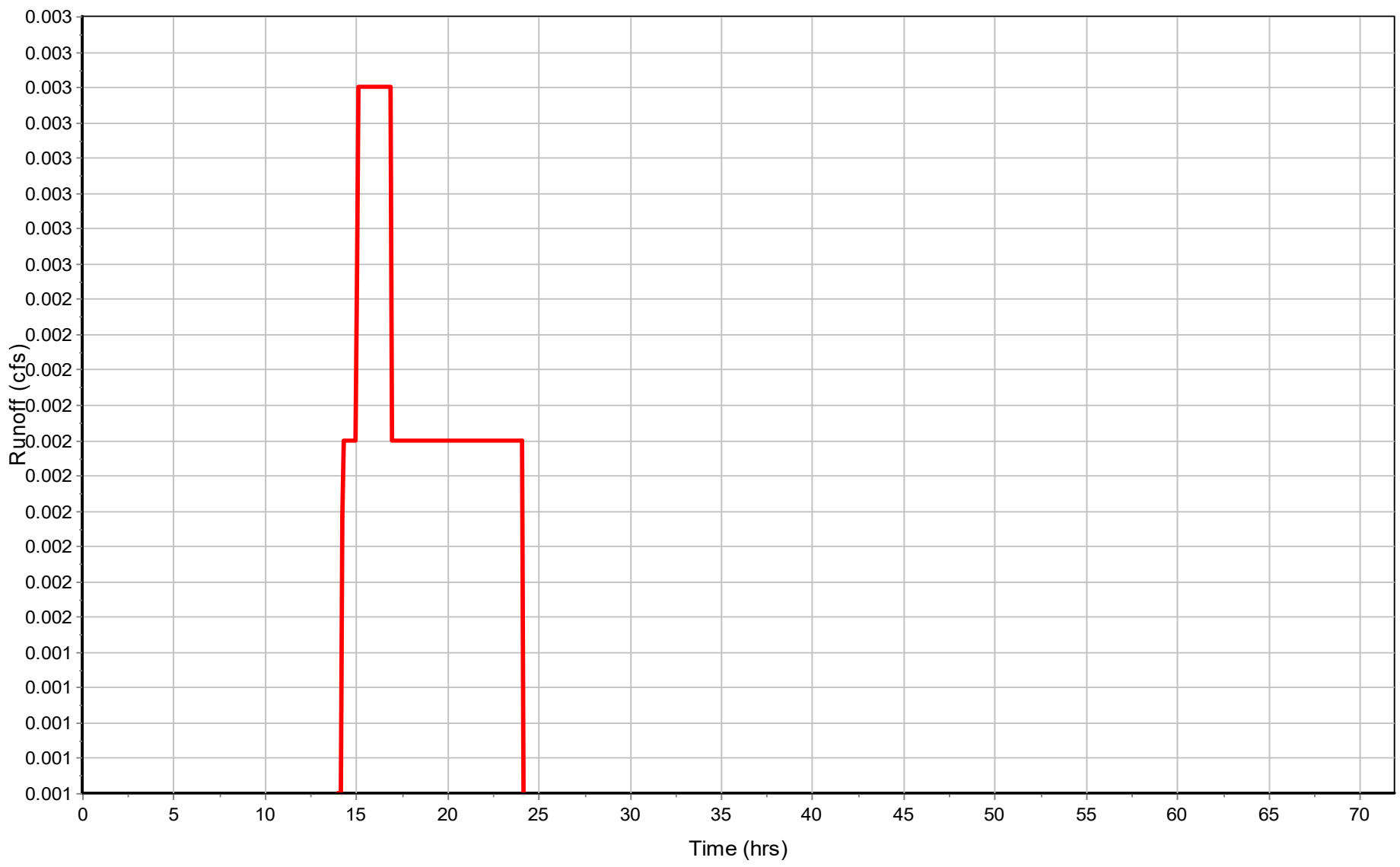
Total Rainfall (in) 3.42
Total Runoff (in) 0.04
Peak Runoff (cfs) 0
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:22:13

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

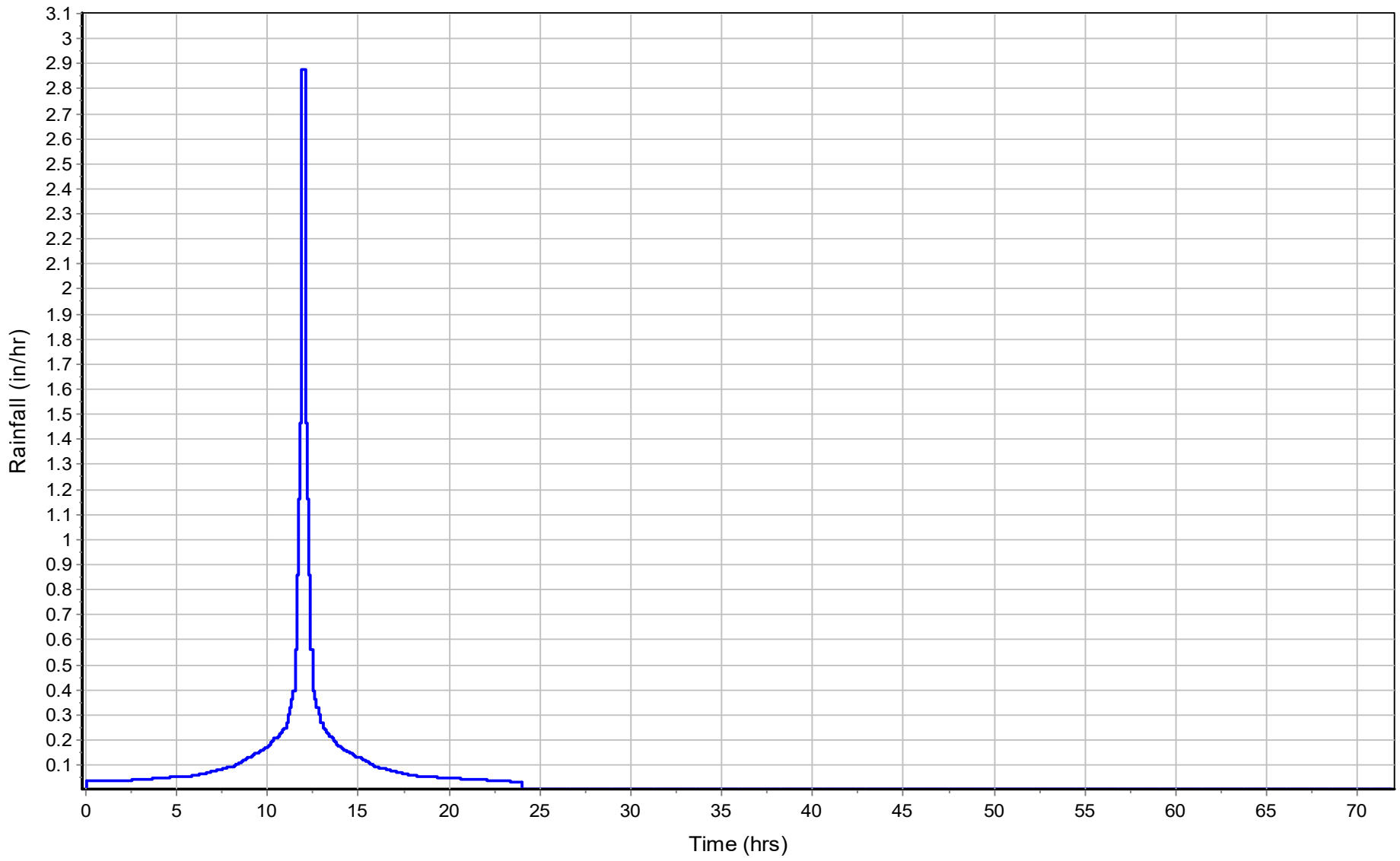
Total TOC (min) 18.29

Subbasin Runoff Results

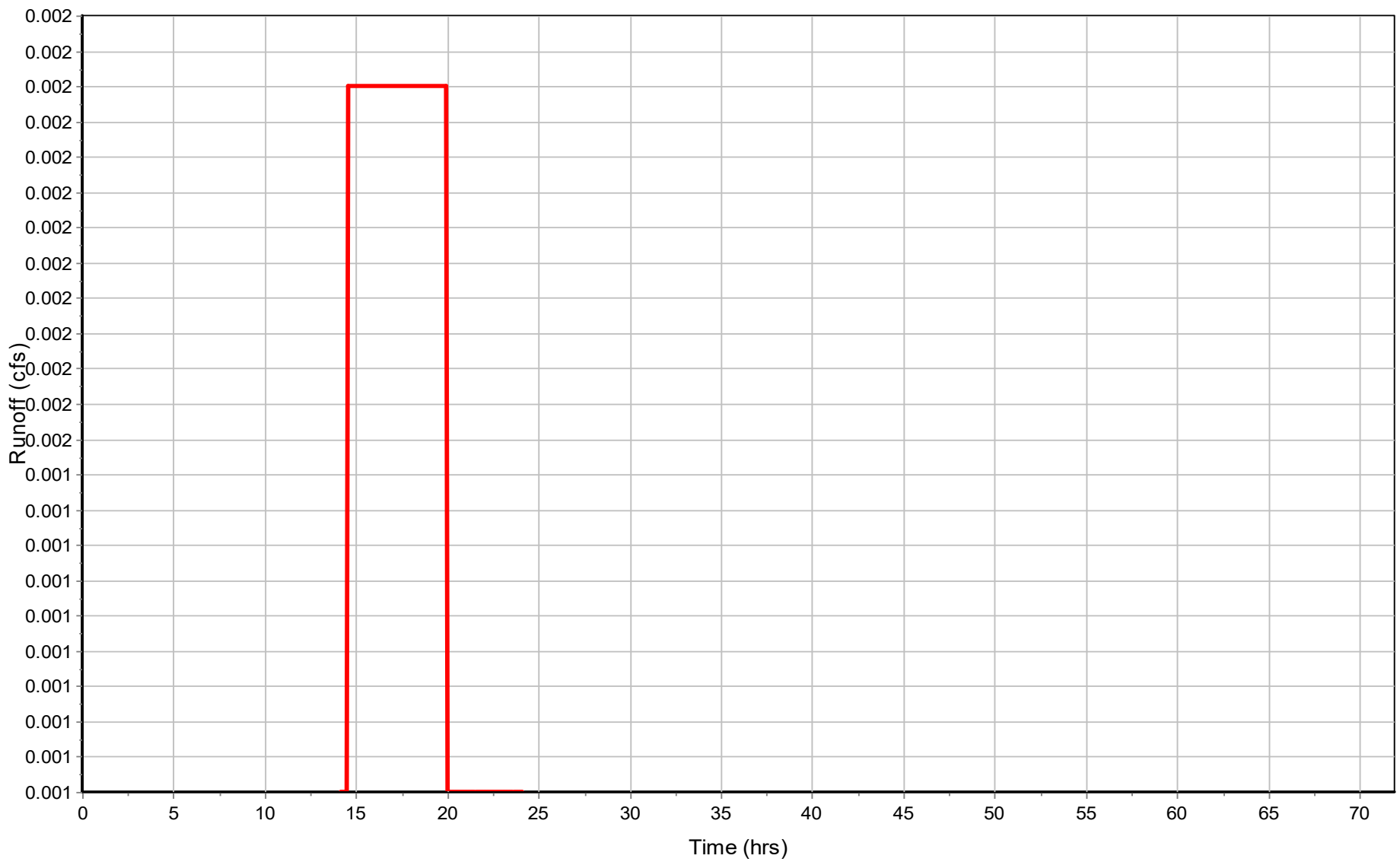
Total Rainfall (in) 3.42
Total Runoff (in) 0.04
Peak Runoff (cfs) 0
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:18:17

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

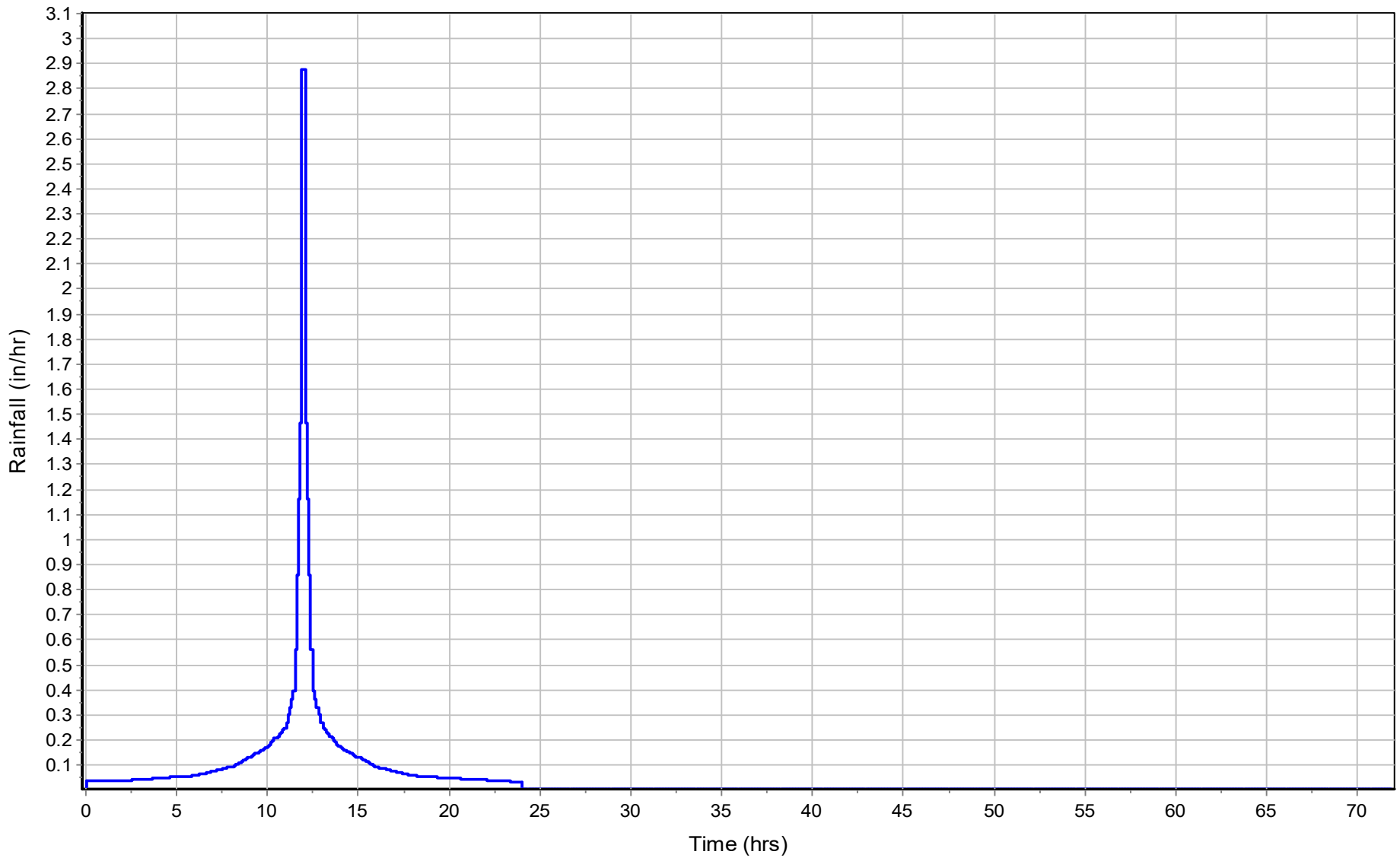
Total TOC (min) 15.09

Subbasin Runoff Results

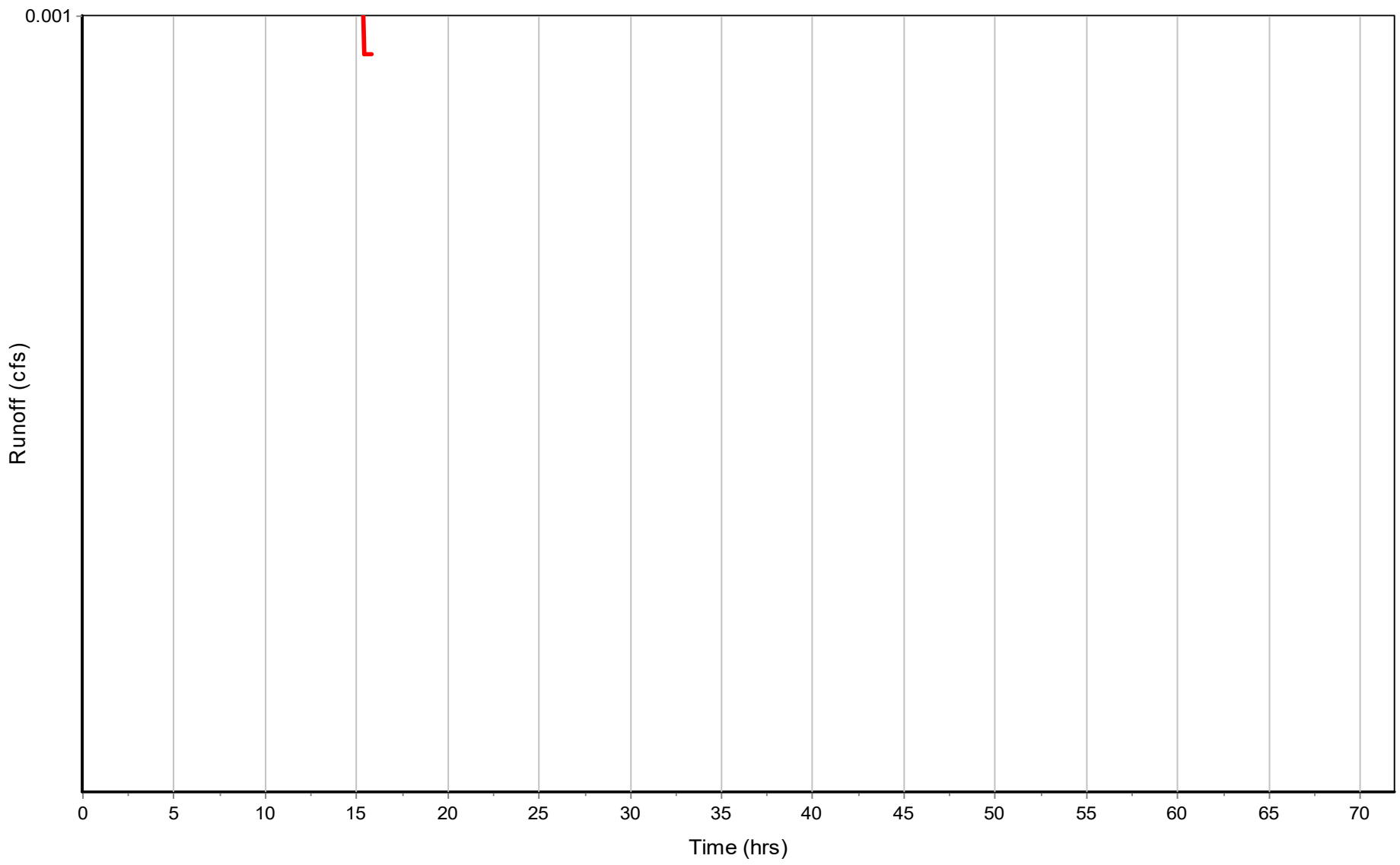
Total Rainfall (in) 3.42
Total Runoff (in) 0
Peak Runoff (cfs) 0
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:15:05

Subbasin : Sub-E04

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A4

Input Data

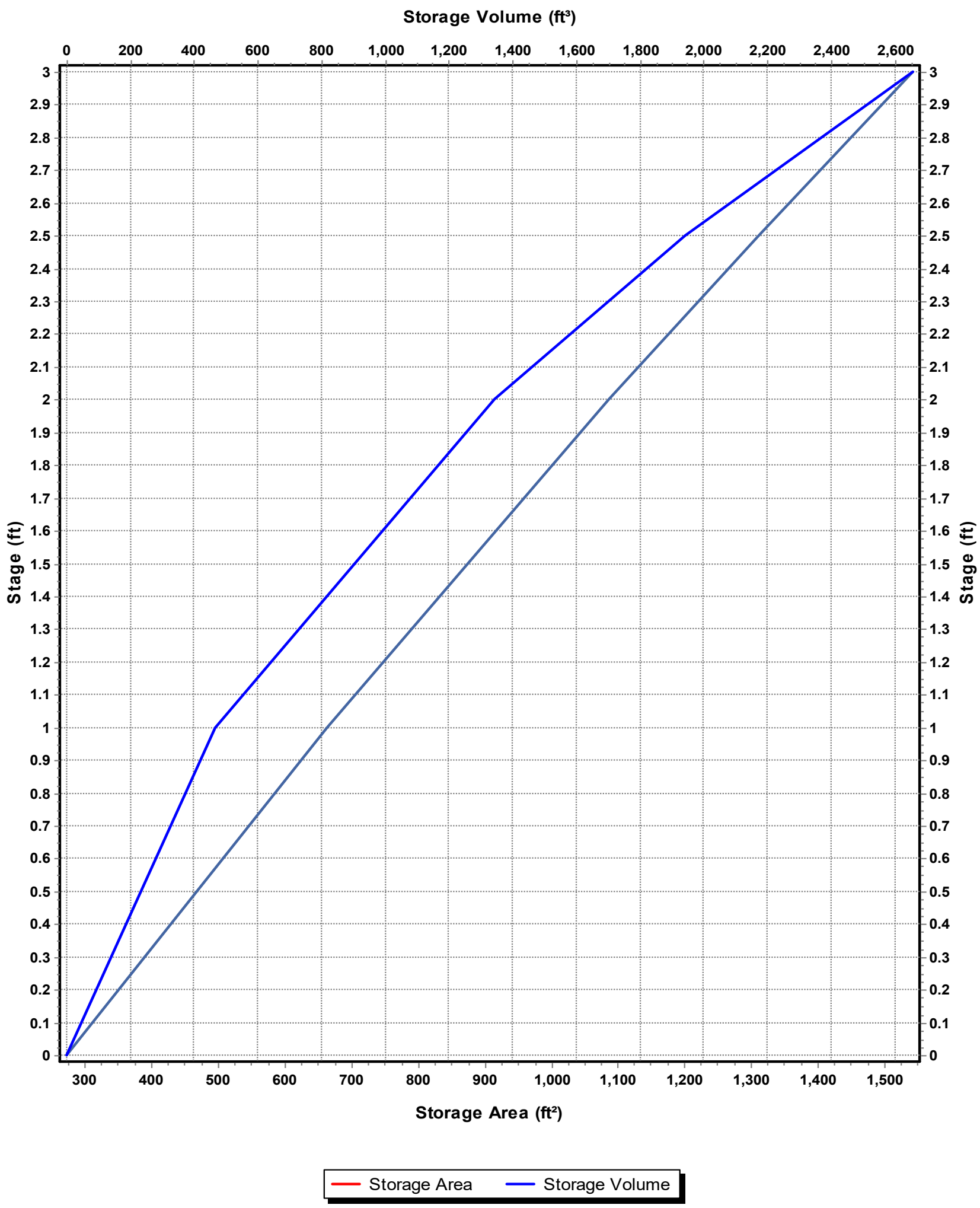
Invert Elevation (ft)	114.00
Max (Rim) Elevation (ft)	117.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.00
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

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

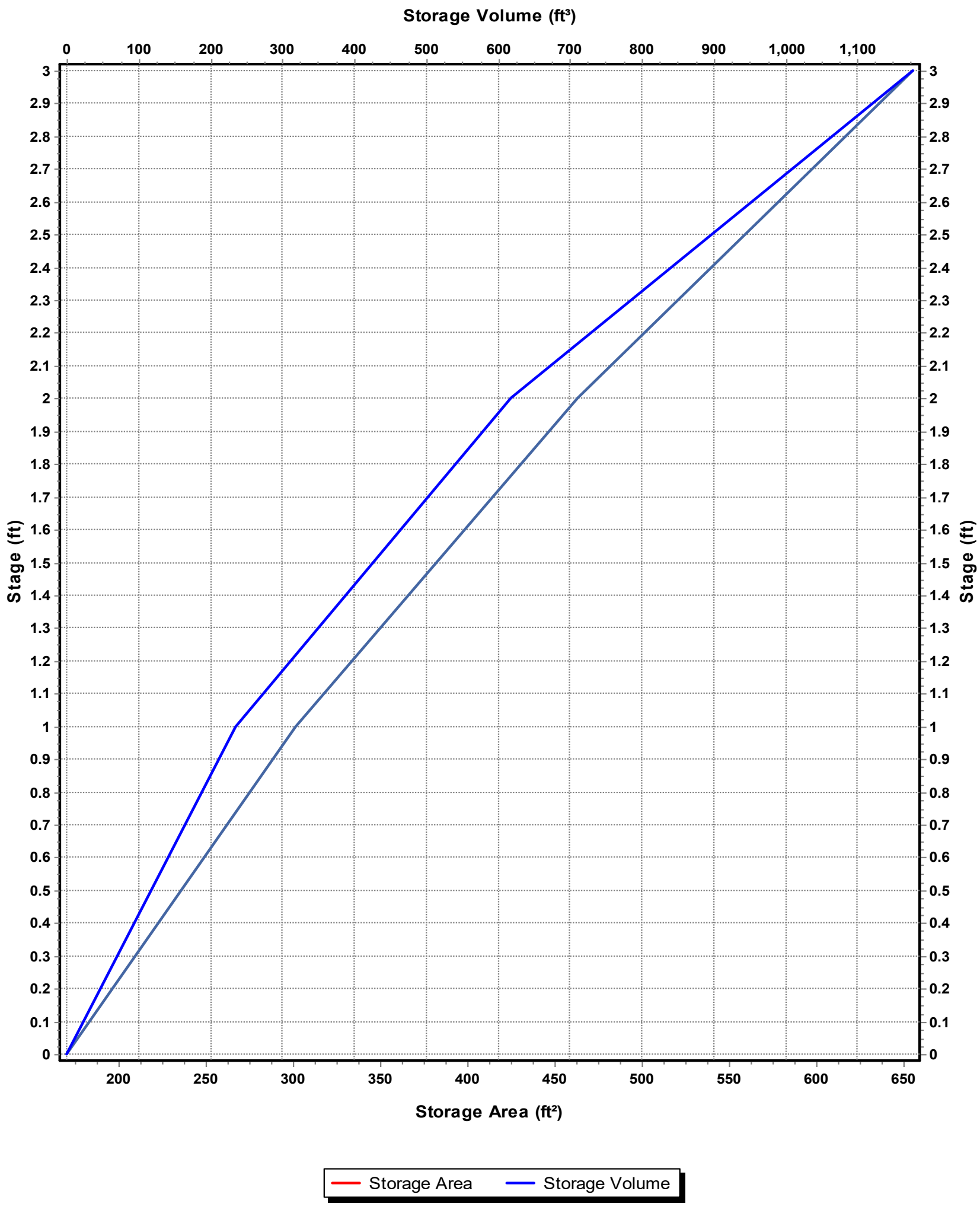
Invert Elevation (ft)	114.00
Max (Rim) Elevation (ft)	117.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.00
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

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

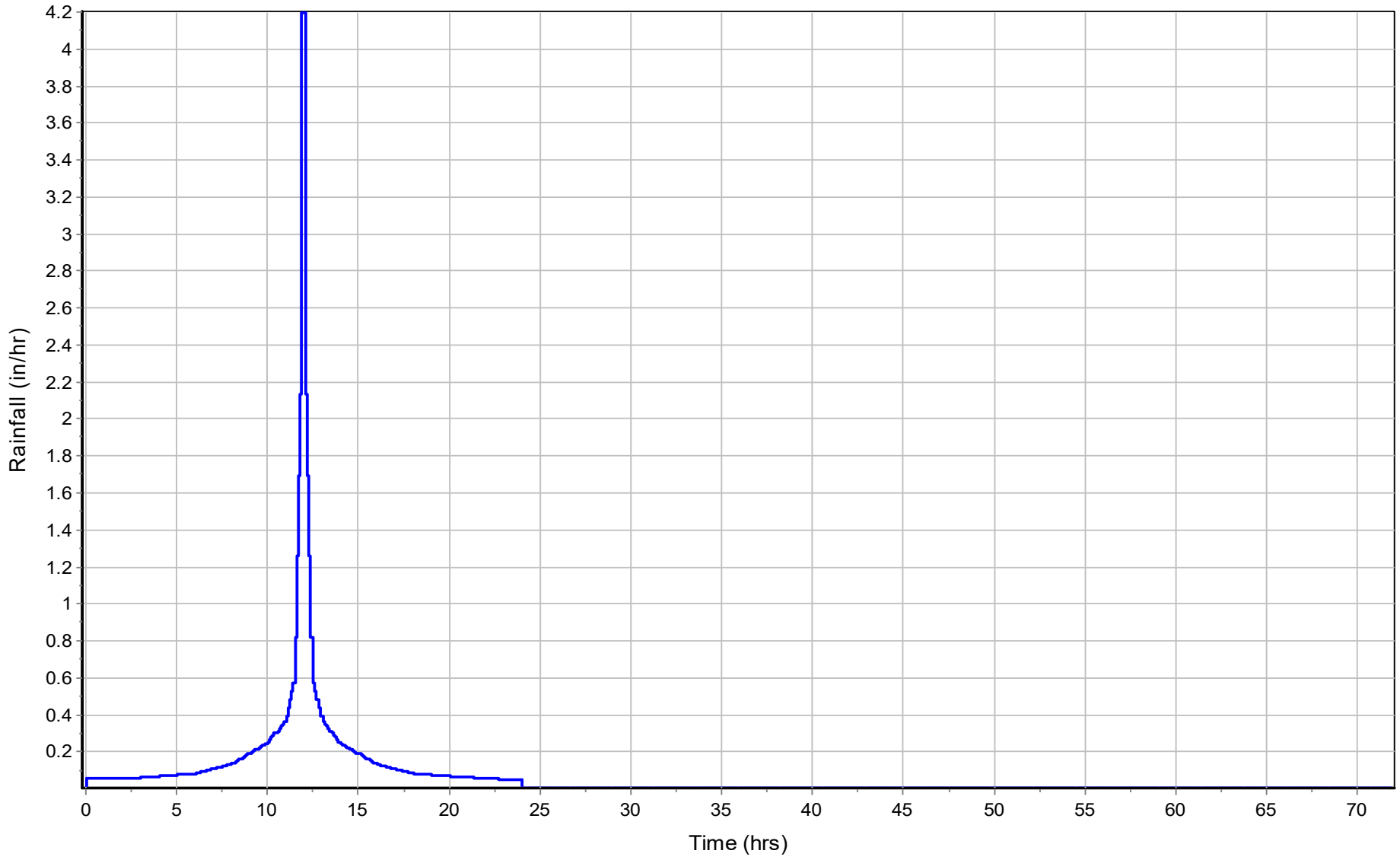
Total TOC (min) 2.57

Subbasin Runoff Results

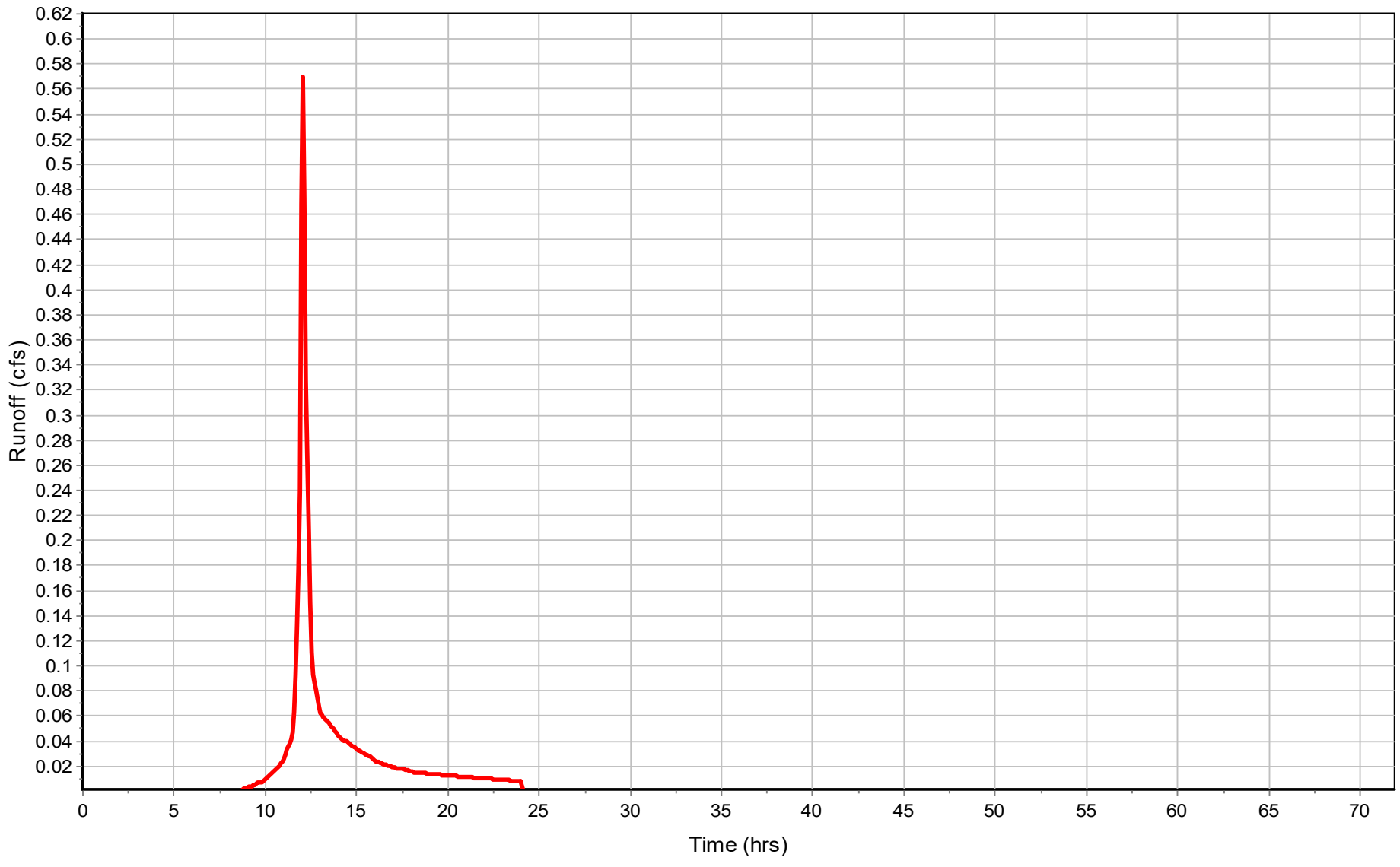
Total Rainfall (in)	4.99
Total Runoff (in)	2.53
Peak Runoff (cfs)	0.59
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:02:34

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

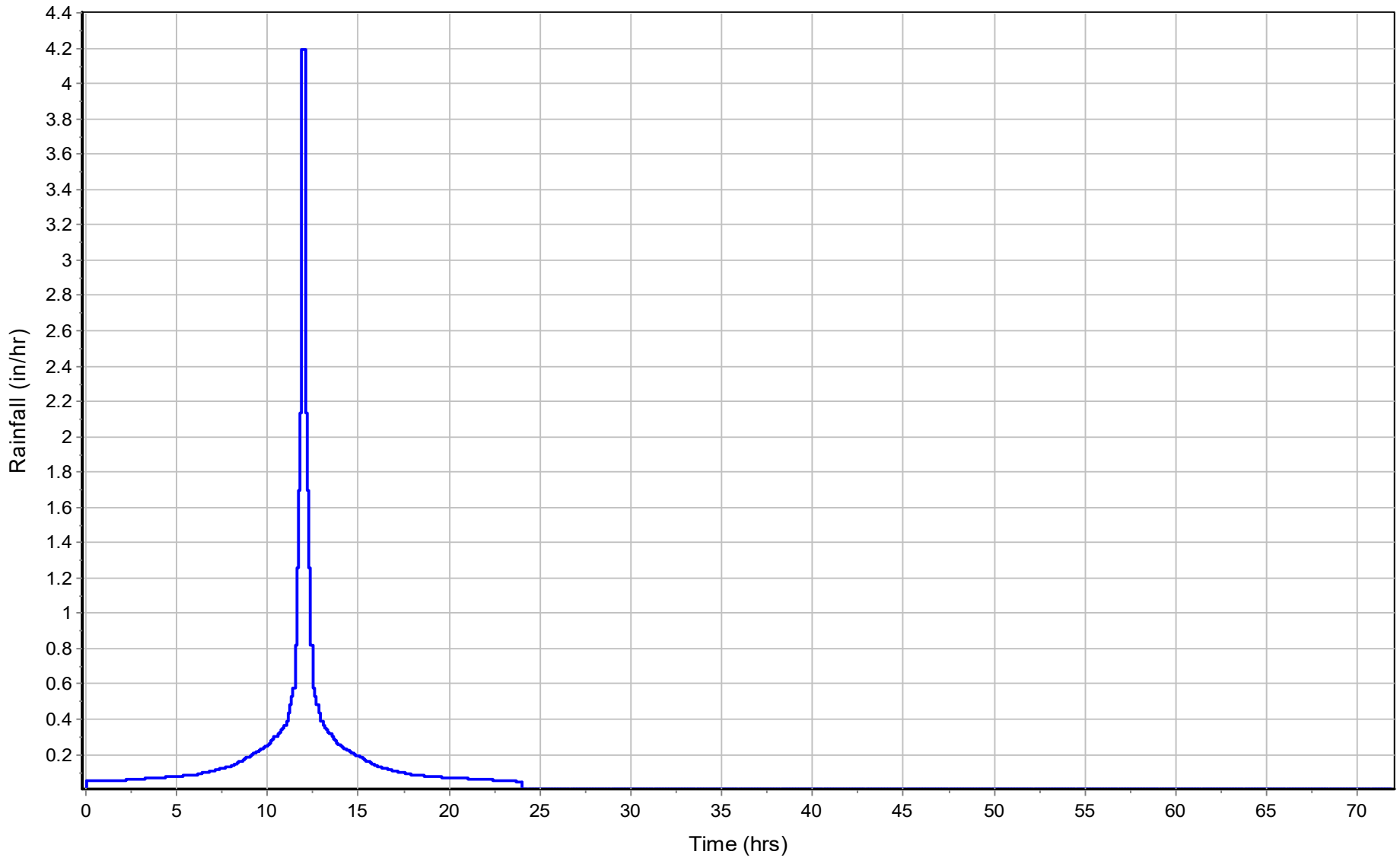
Total TOC (min) 22.21

Subbasin Runoff Results

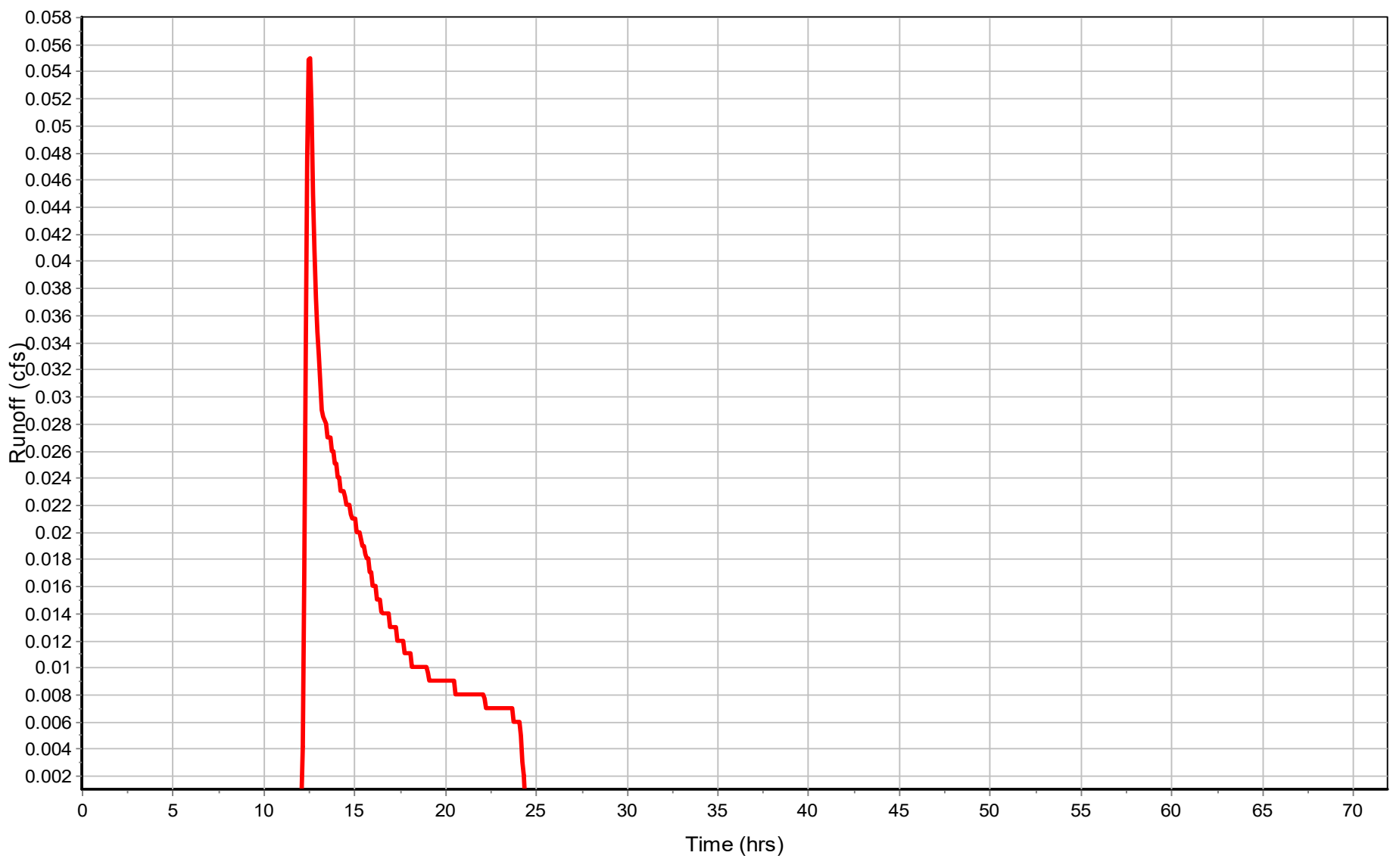
Total Rainfall (in) 4.99
Total Runoff (in) 0.35
Peak Runoff (cfs) 0.06
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:22:13

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

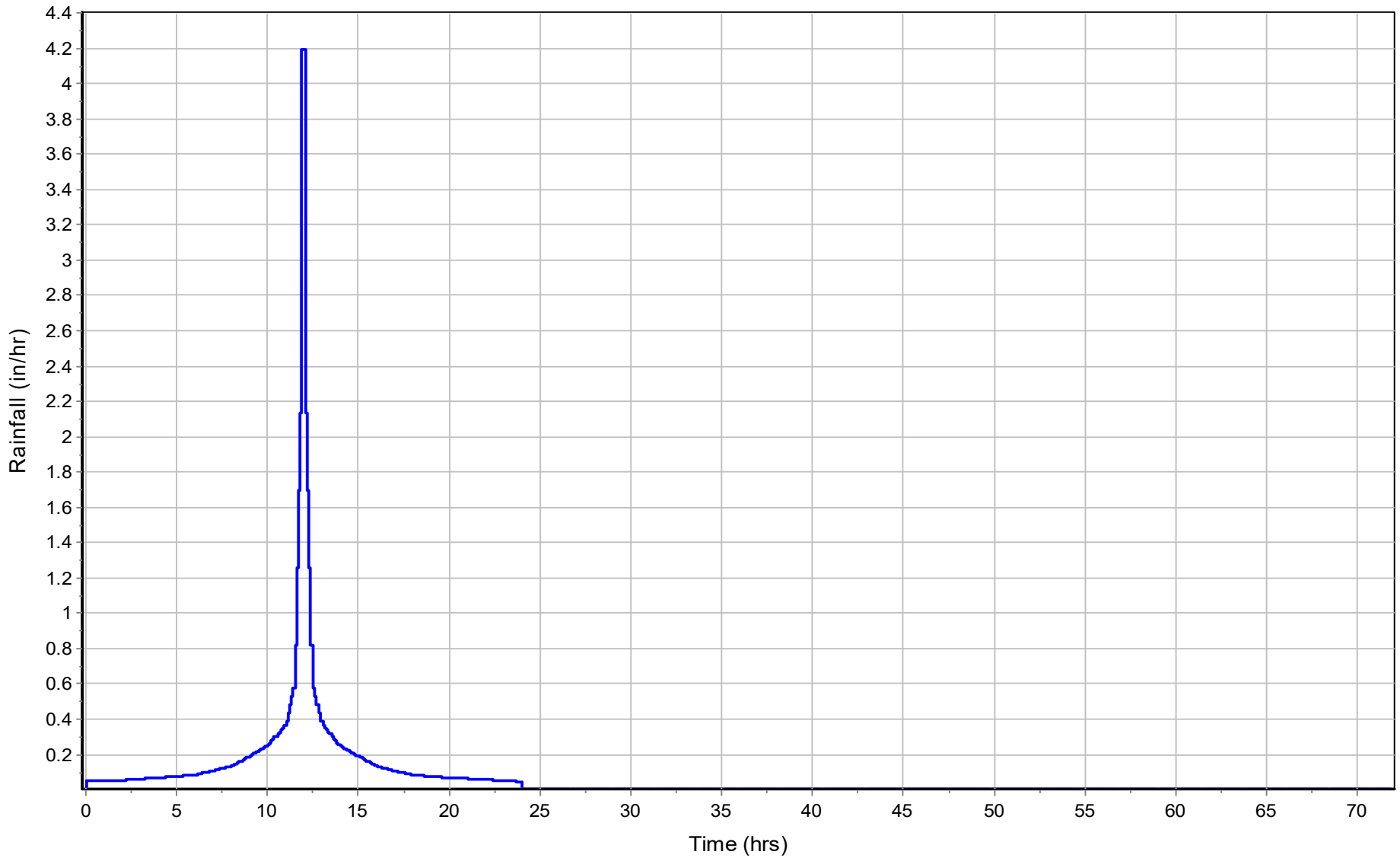
Total TOC (min) 18.29

Subbasin Runoff Results

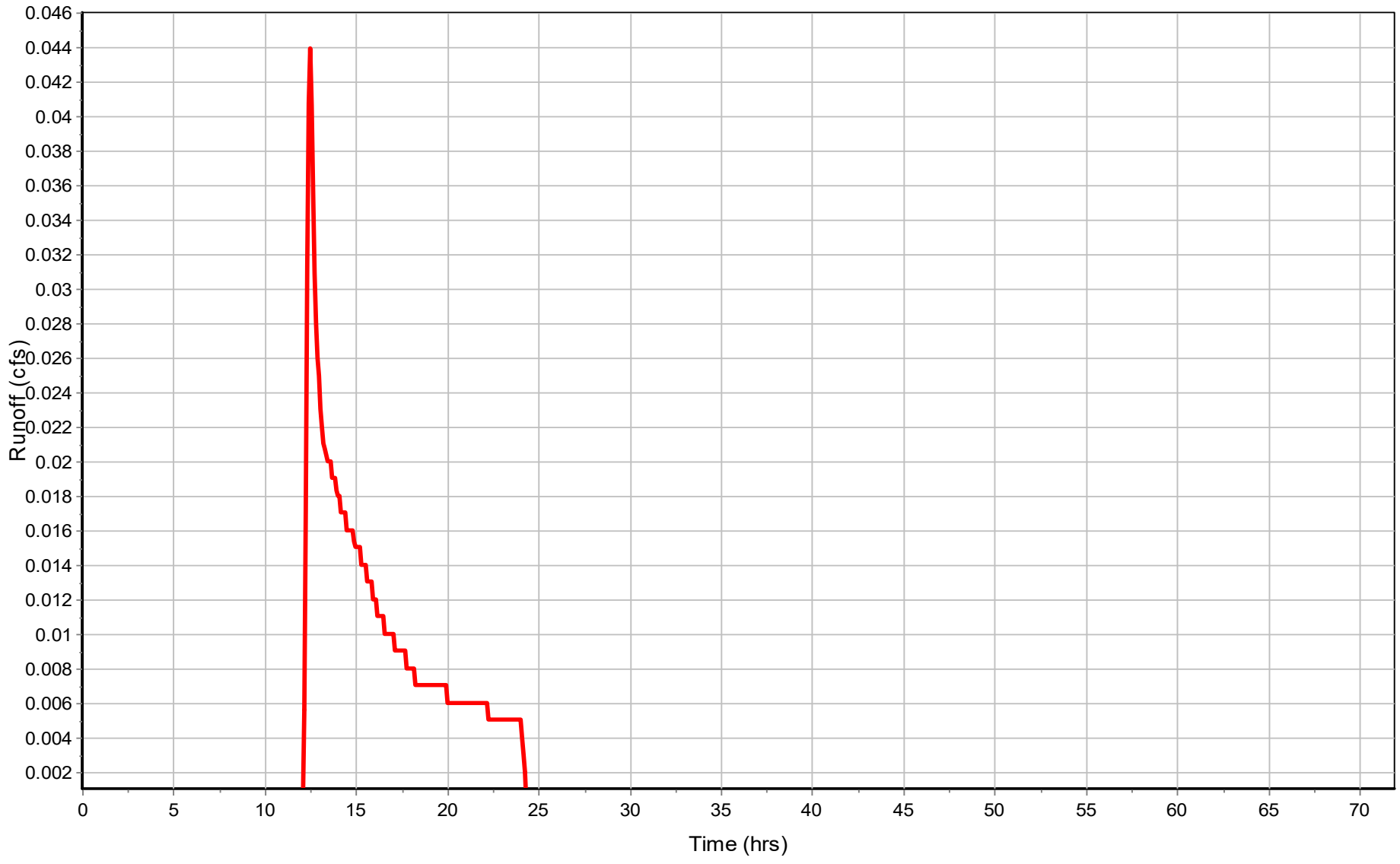
Total Rainfall (in) 4.99
Total Runoff (in) 0.35
Peak Runoff (cfs) 0.04
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:18:17

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

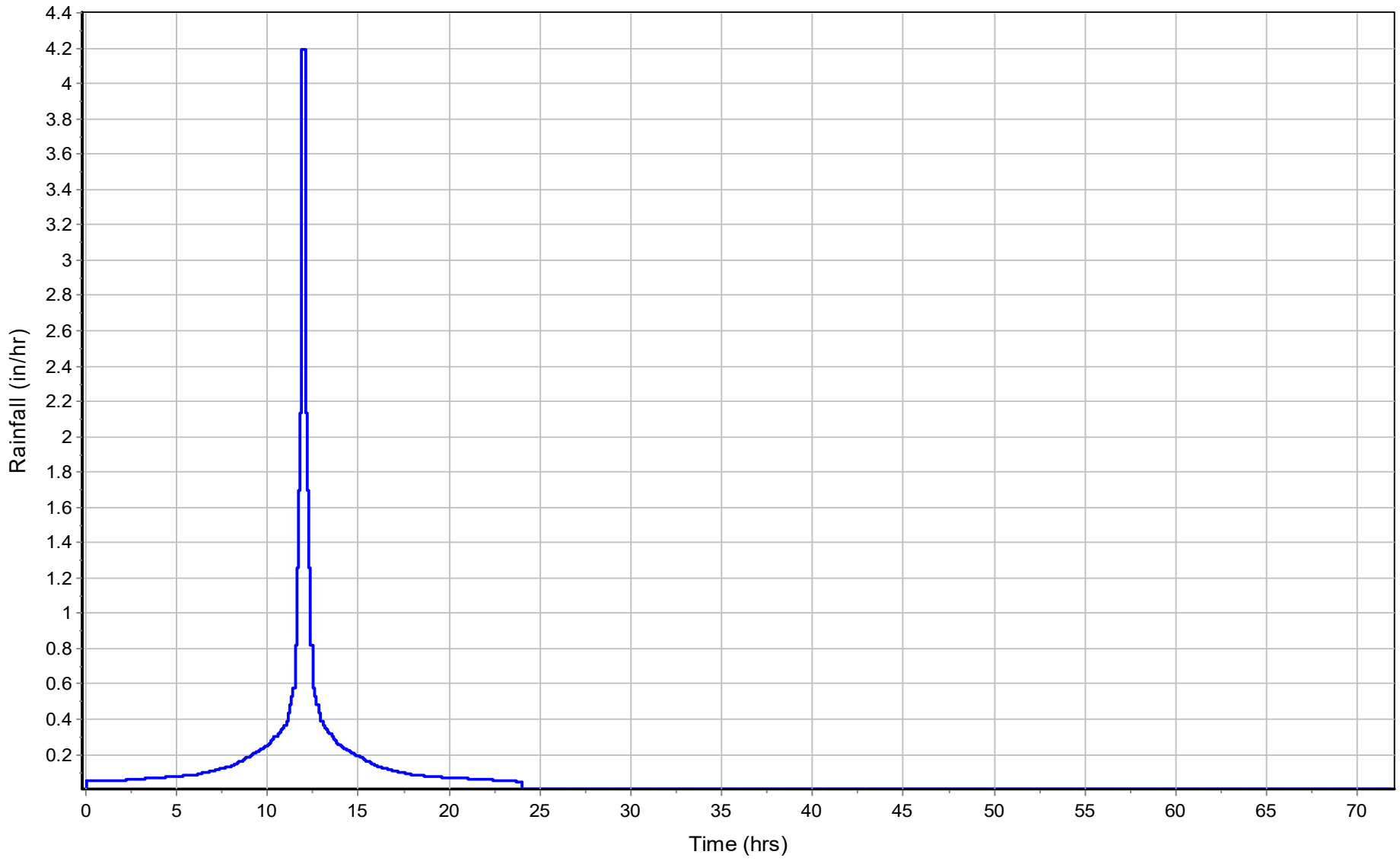
Total TOC (min) 15.09

Subbasin Runoff Results

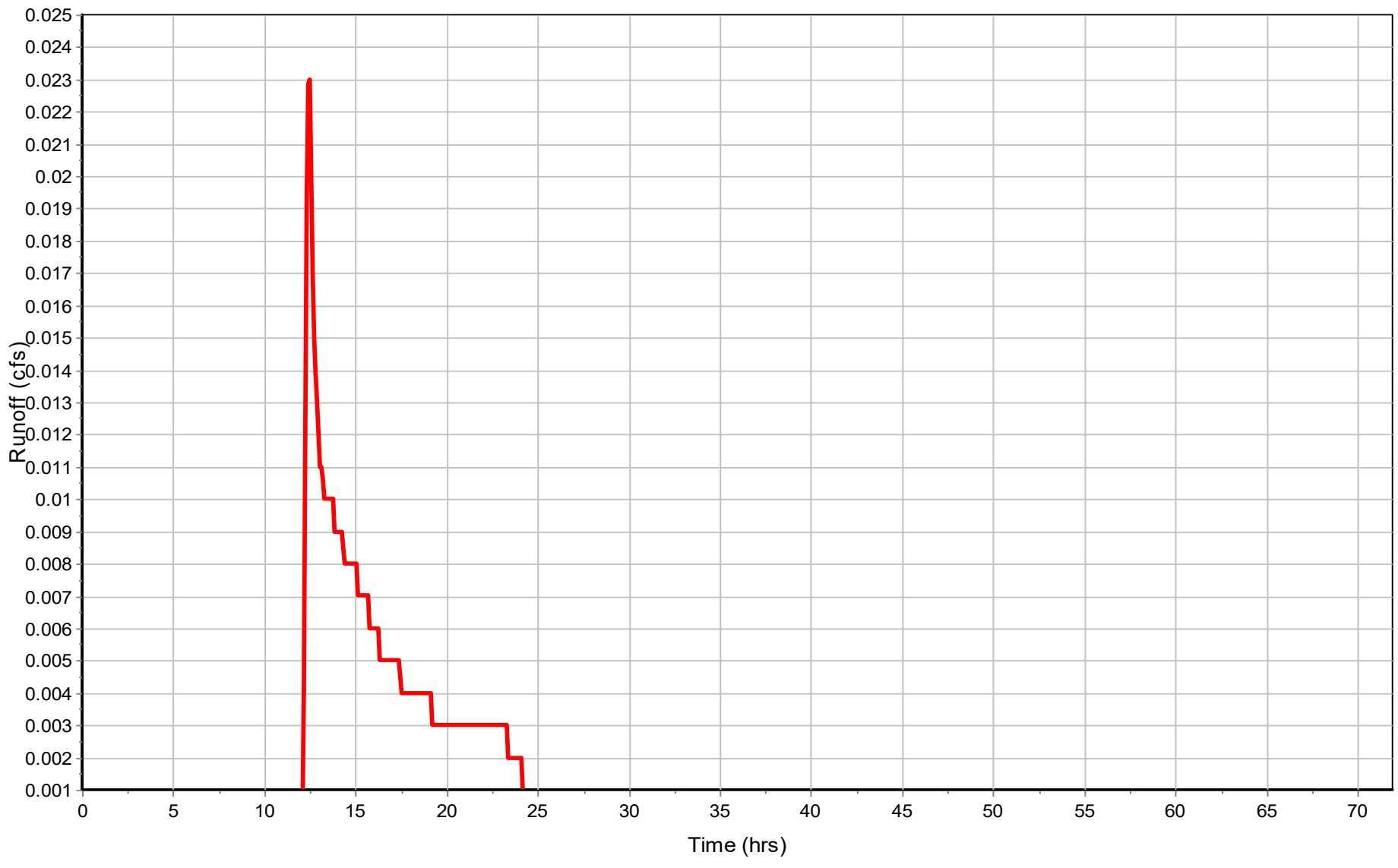
Total Rainfall (in) 4.99
Total Runoff (in) 0.35
Peak Runoff (cfs) 0.02
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:15:05

Subbasin : Sub-E04

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A4

Input Data

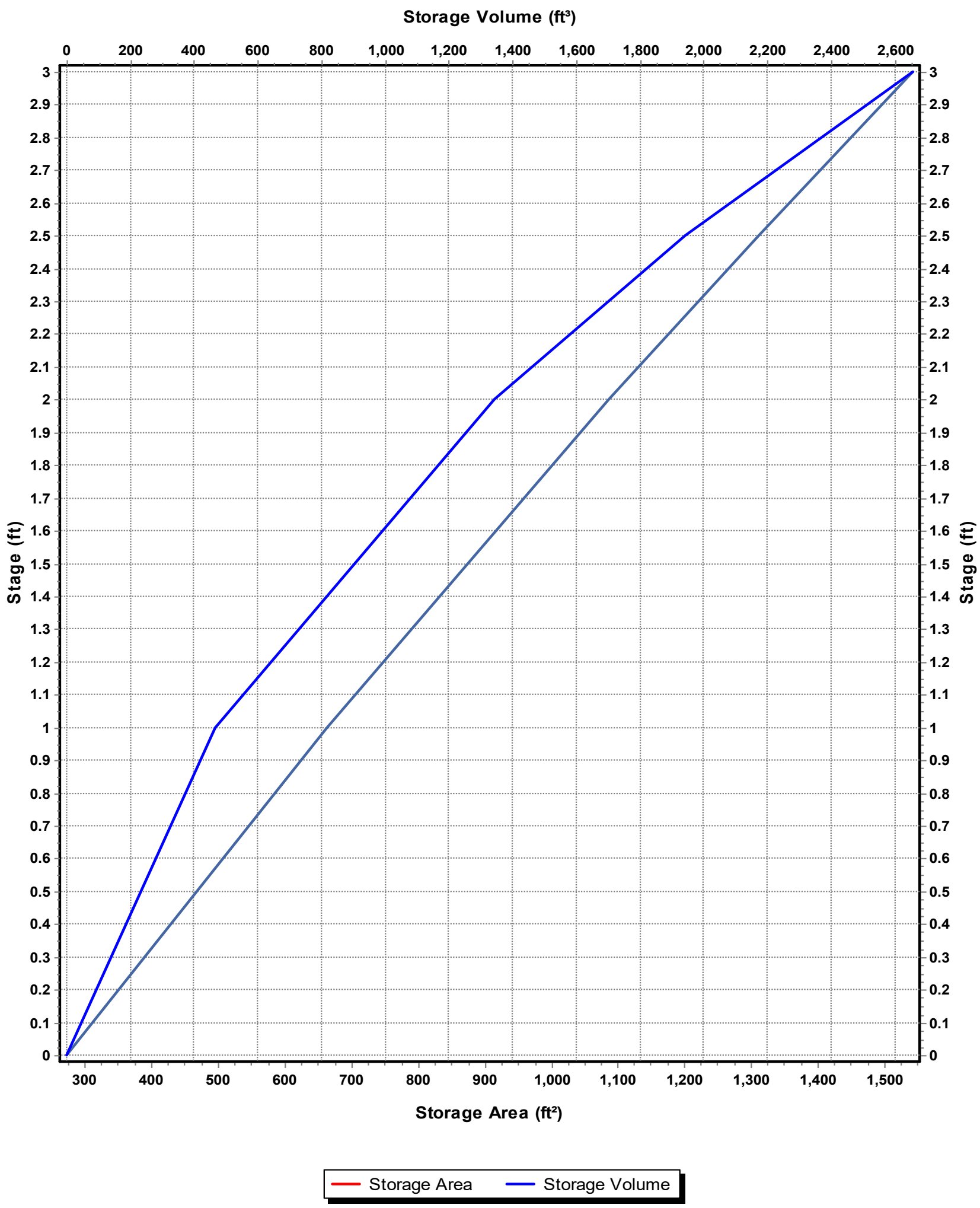
Invert Elevation (ft)	114.00
Max (Rim) Elevation (ft)	117.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.00
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

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

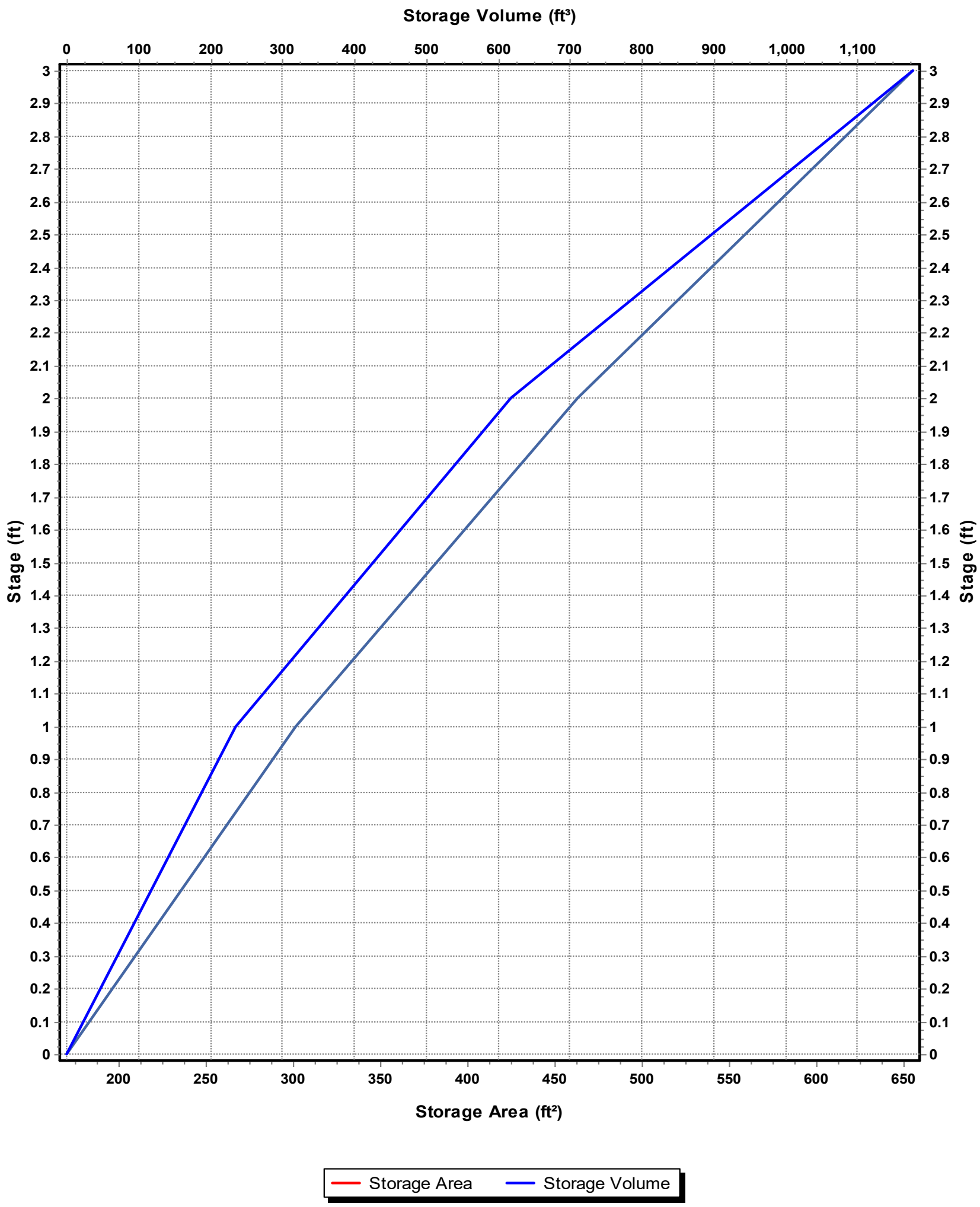
Invert Elevation (ft)	114.00
Max (Rim) Elevation (ft)	117.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.00
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

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

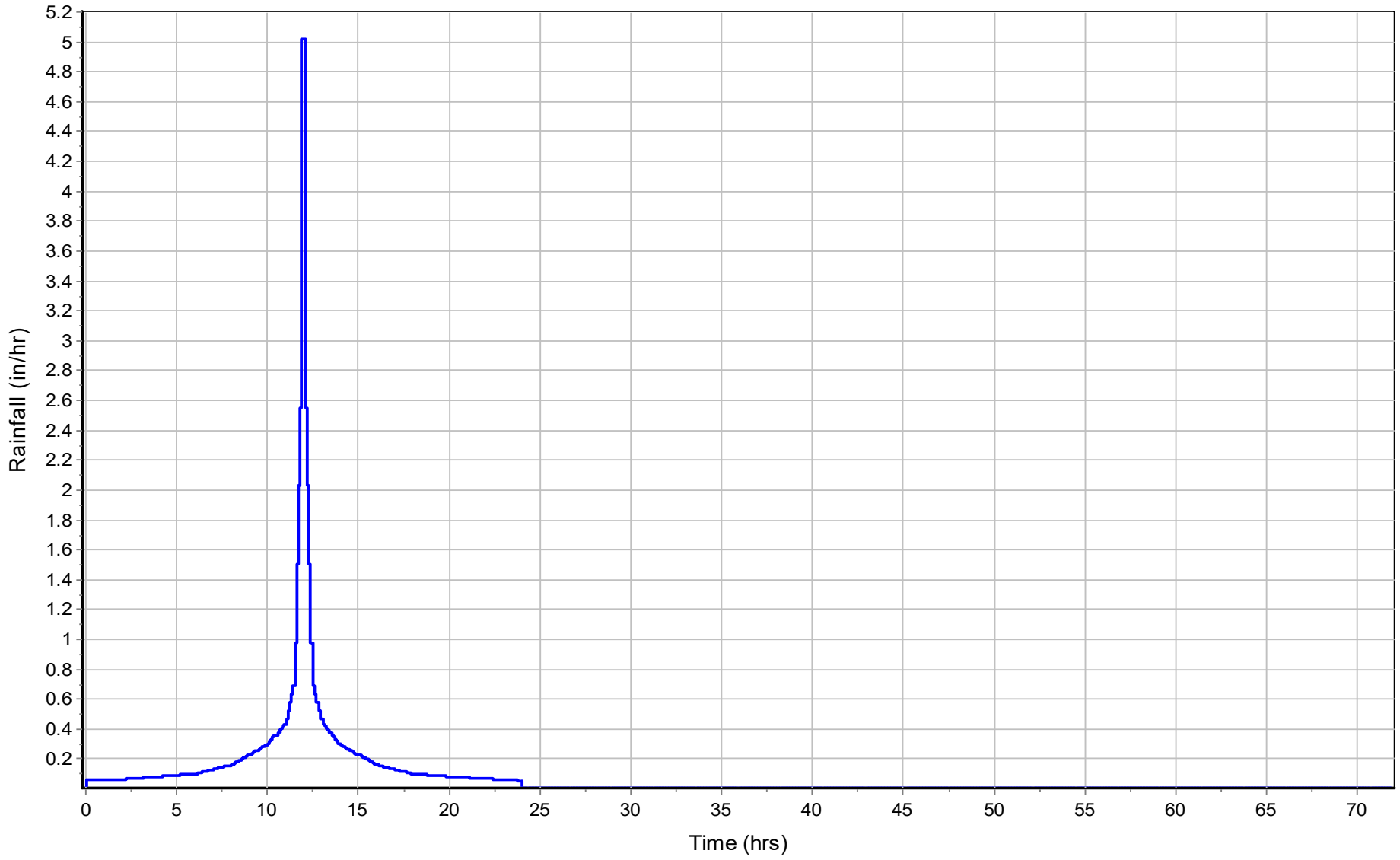
Total TOC (min) 2.57

Subbasin Runoff Results

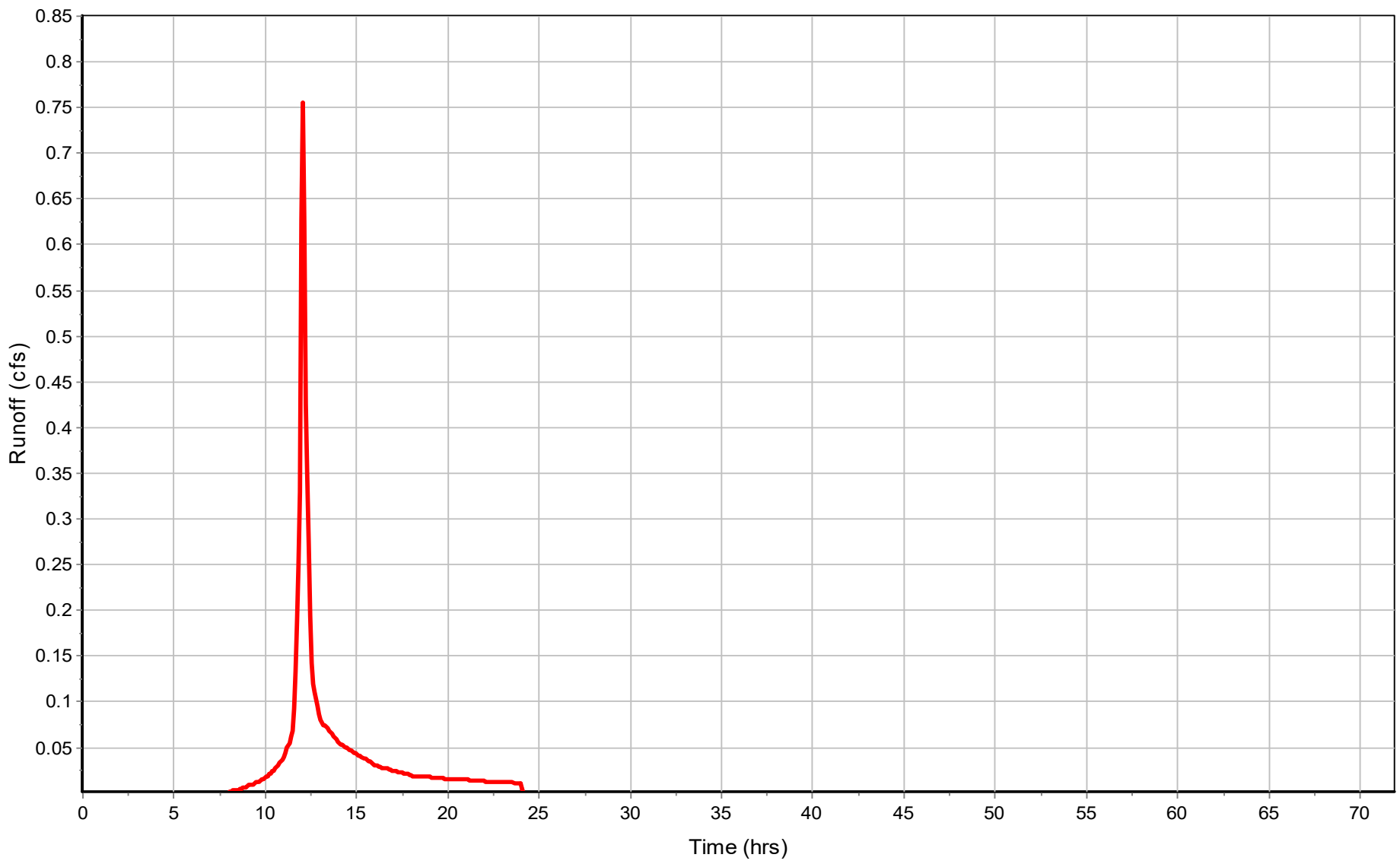
Total Rainfall (in)	5.97
Total Runoff (in)	3.35
Peak Runoff (cfs)	0.77
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:02:34

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

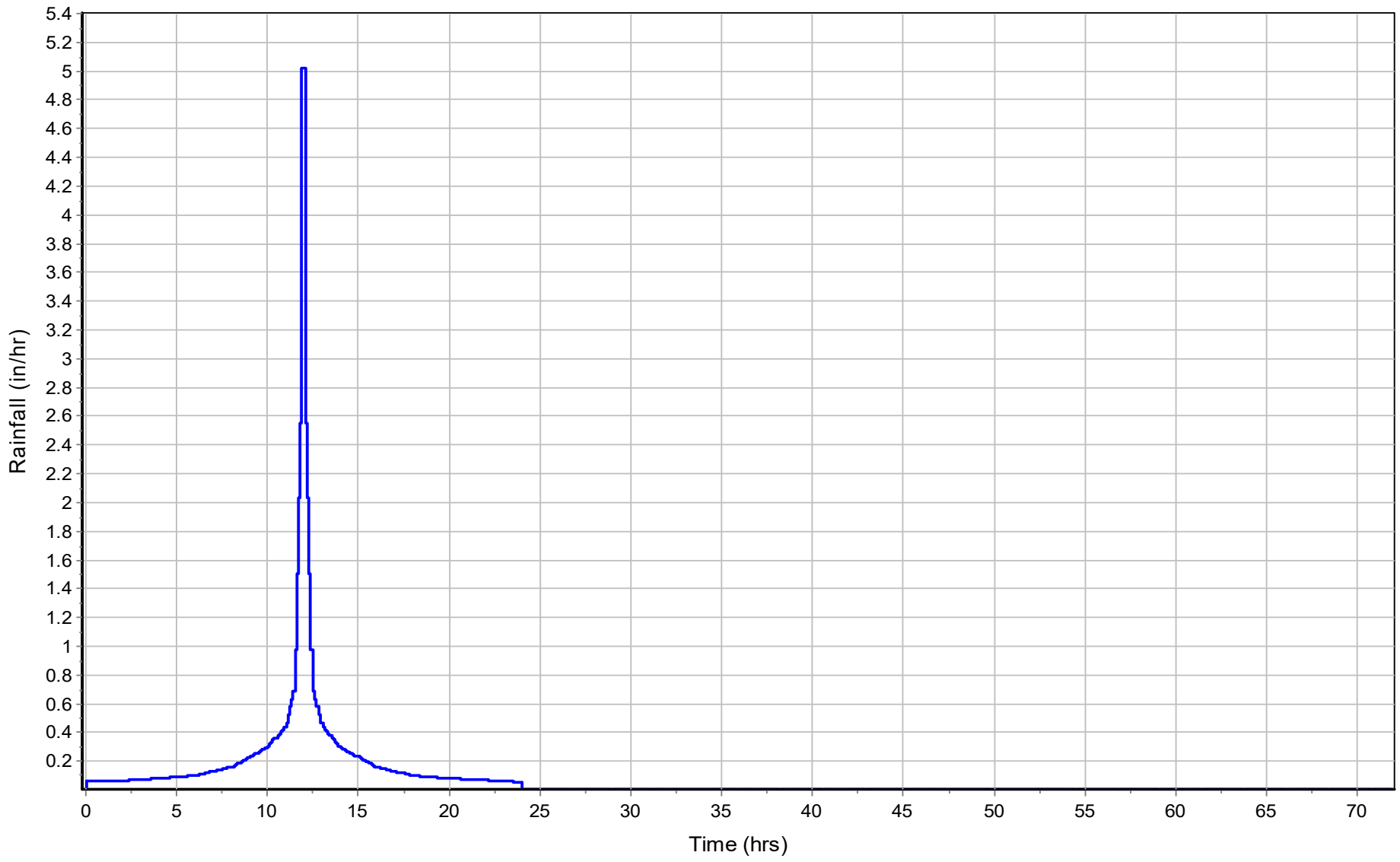
Total TOC (min) 22.21

Subbasin Runoff Results

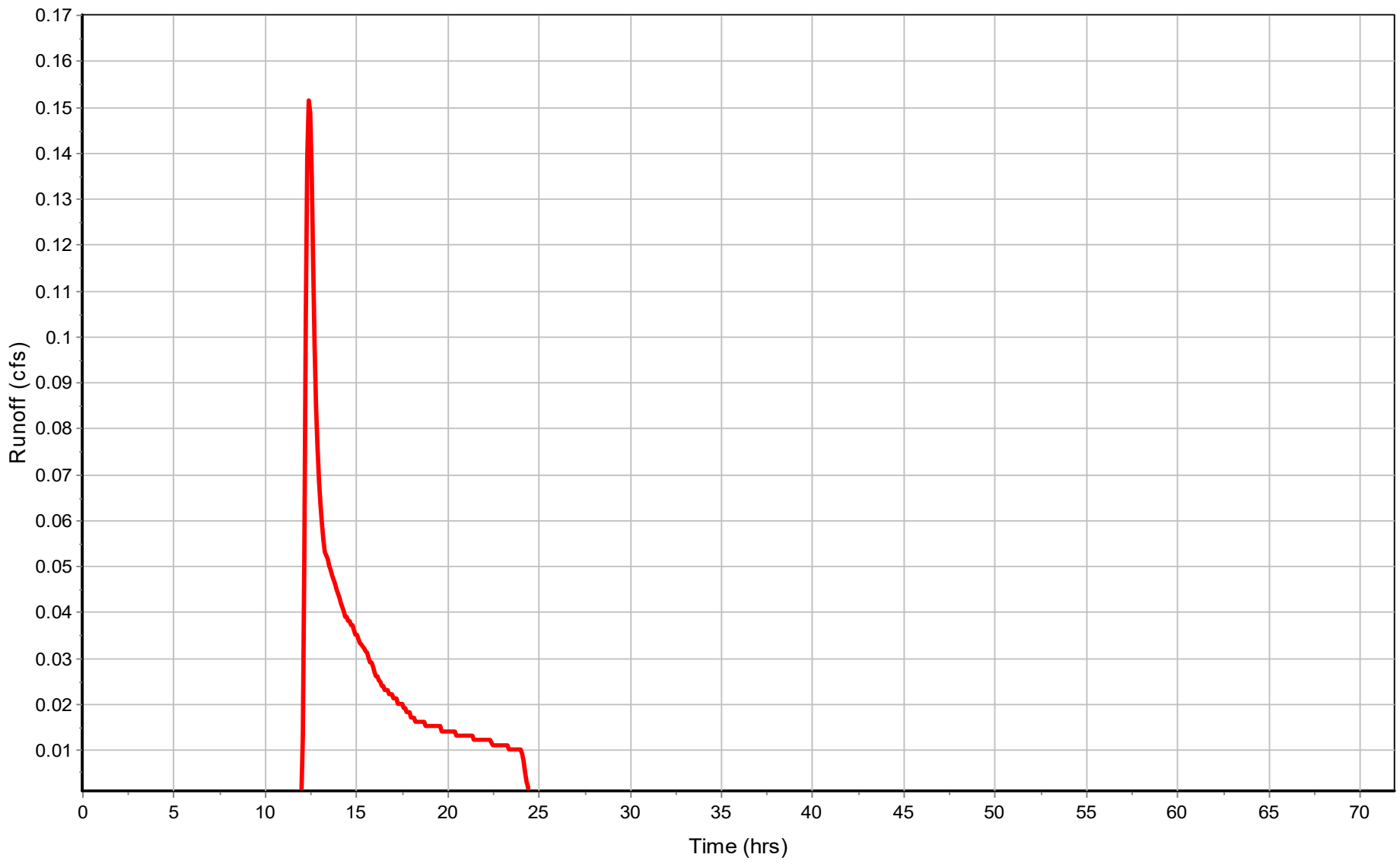
Total Rainfall (in) 5.97
Total Runoff (in) 0.66
Peak Runoff (cfs) 0.15
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:22:13

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

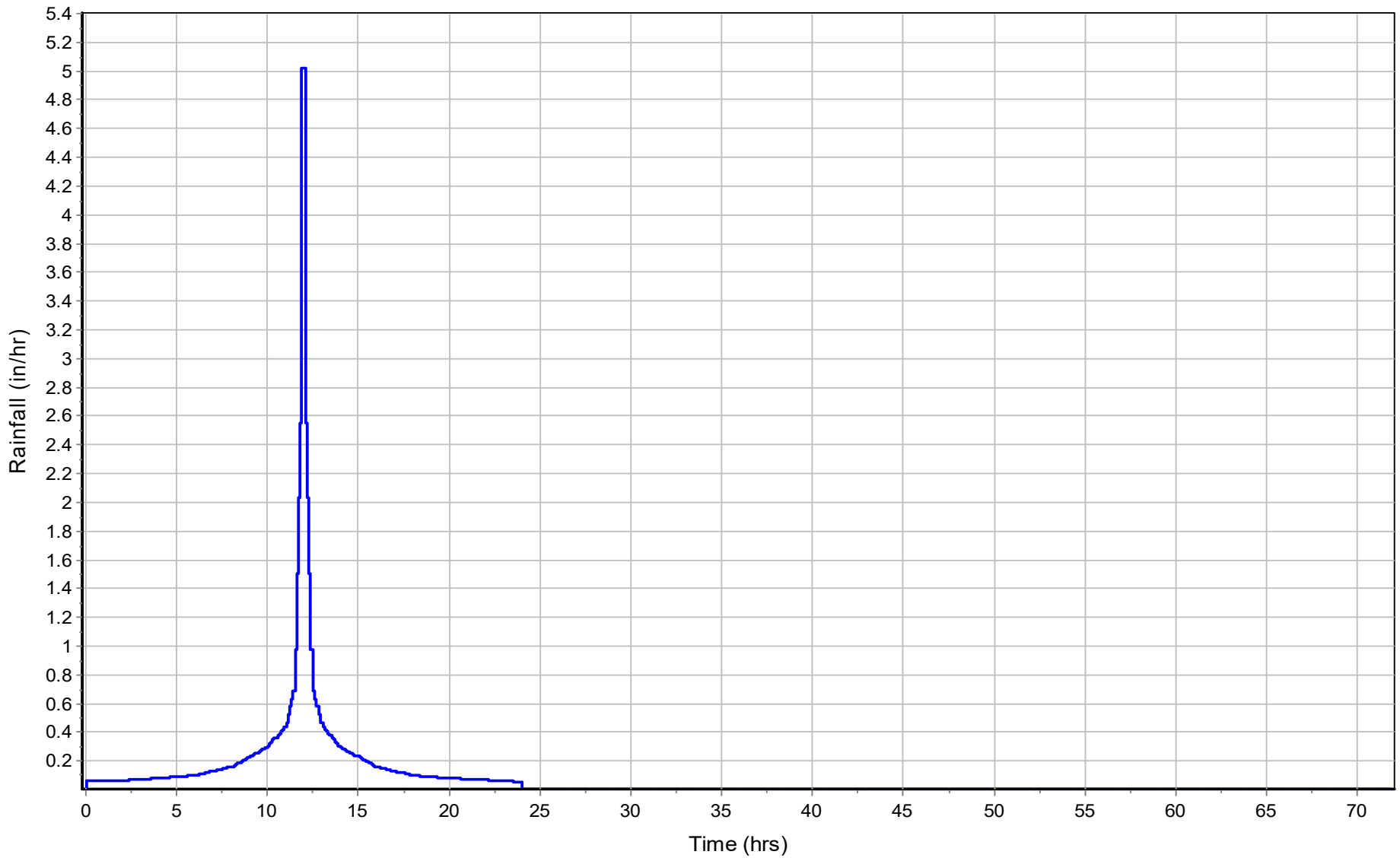
Total TOC (min) 18.29

Subbasin Runoff Results

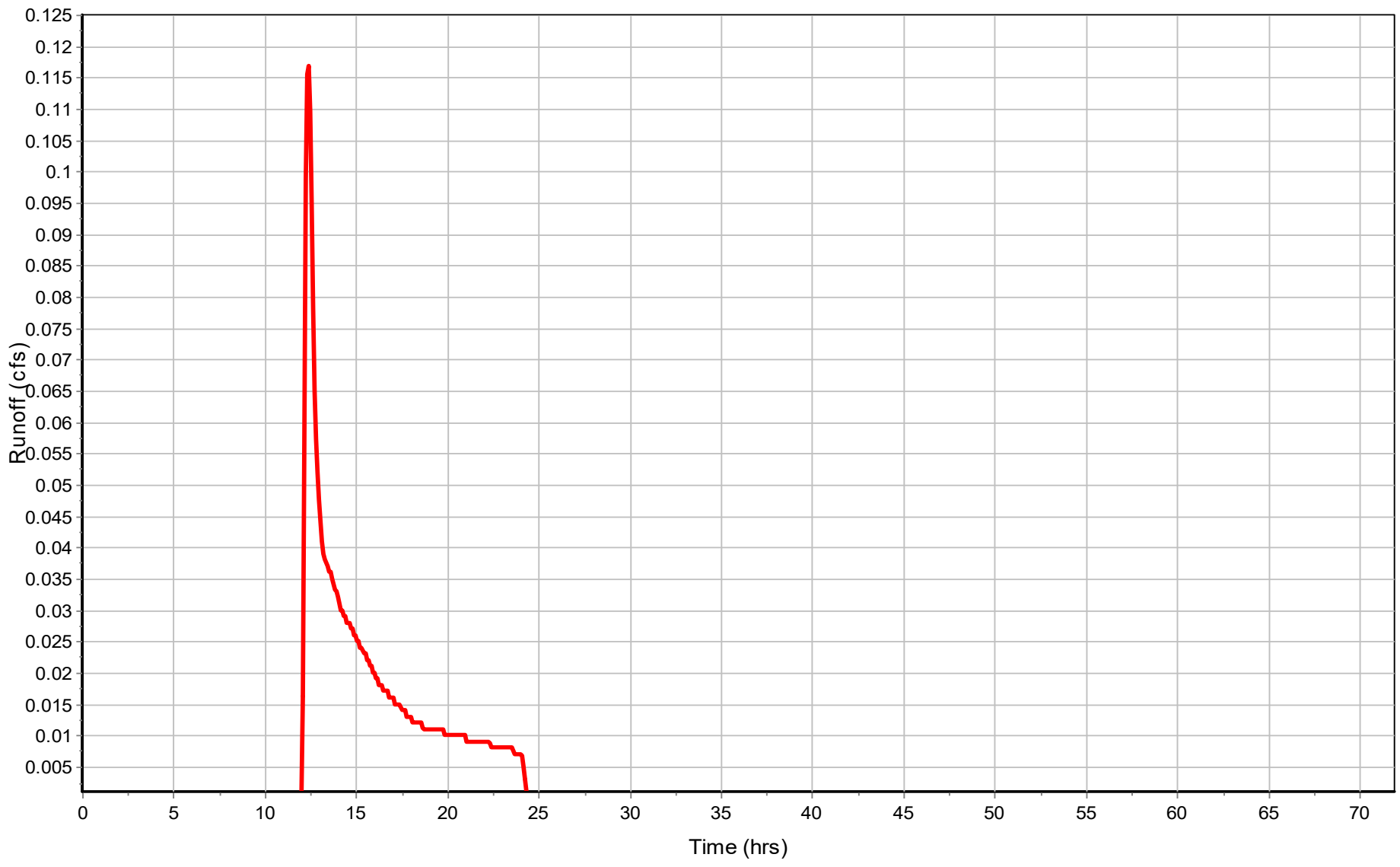
Total Rainfall (in) 5.97
Total Runoff (in) 0.66
Peak Runoff (cfs) 0.12
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:18:17

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

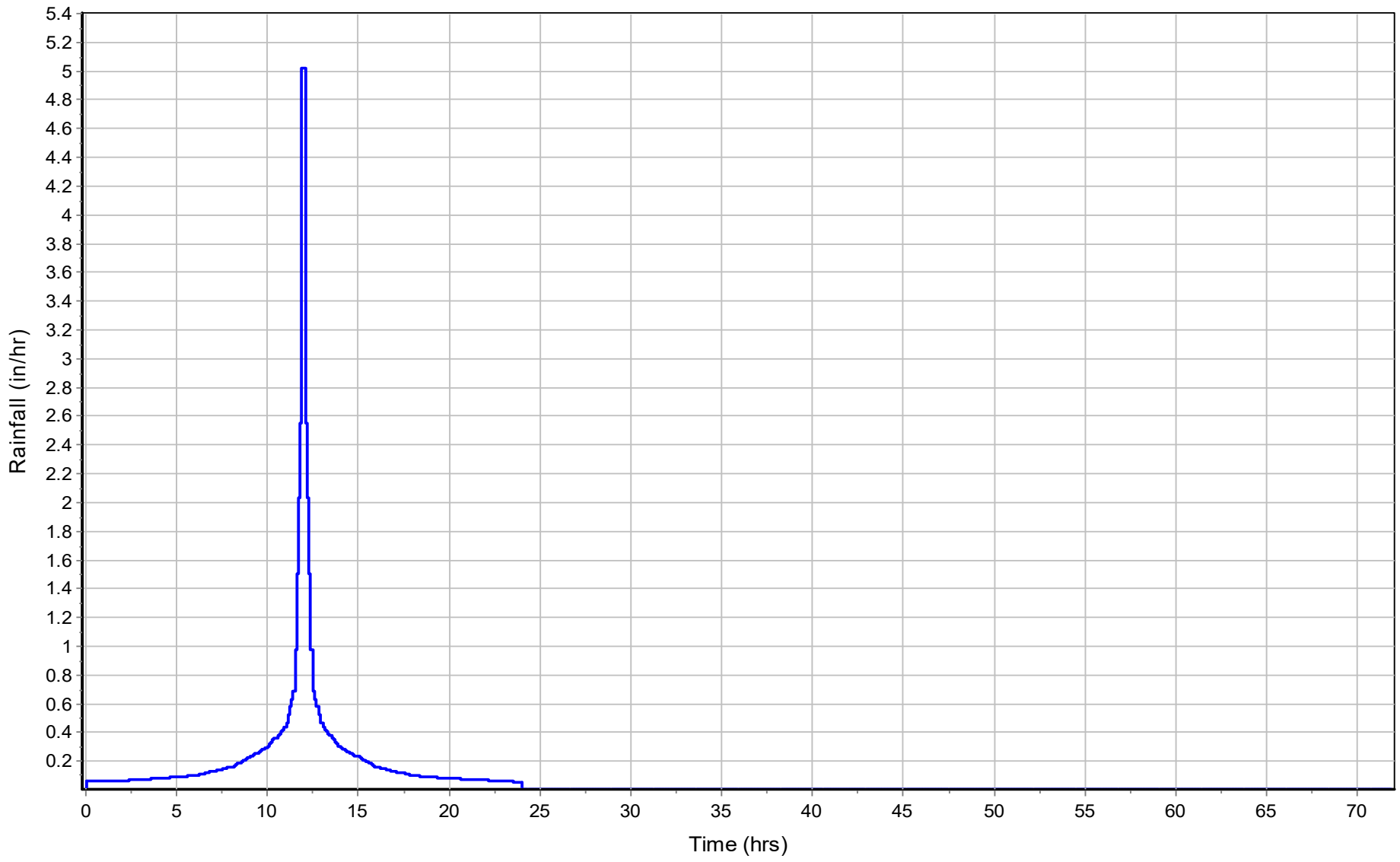
Total TOC (min) 15.09

Subbasin Runoff Results

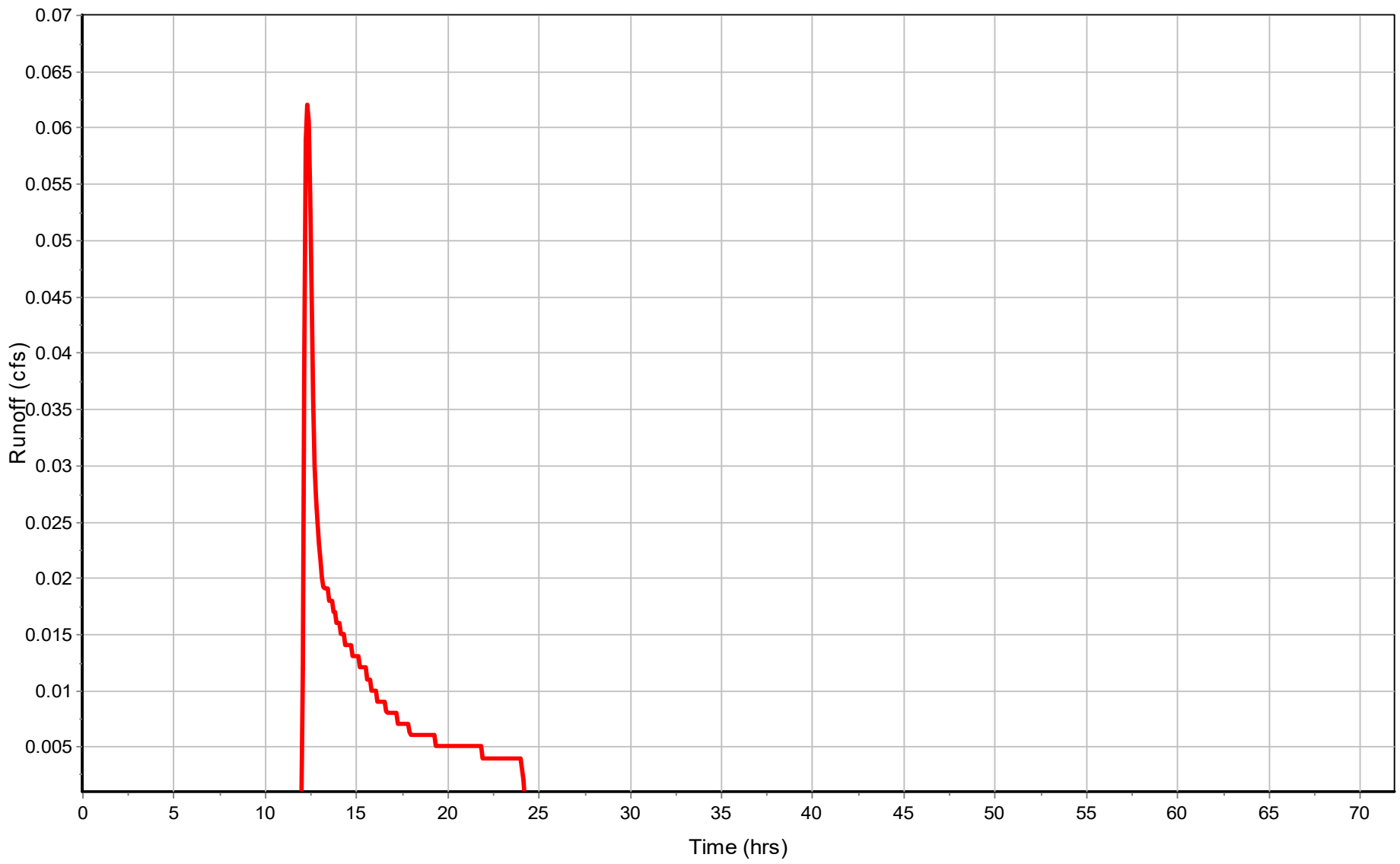
Total Rainfall (in) 5.97
Total Runoff (in) 0.66
Peak Runoff (cfs) 0.06
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:15:05

Subbasin : Sub-E04

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A4

Input Data

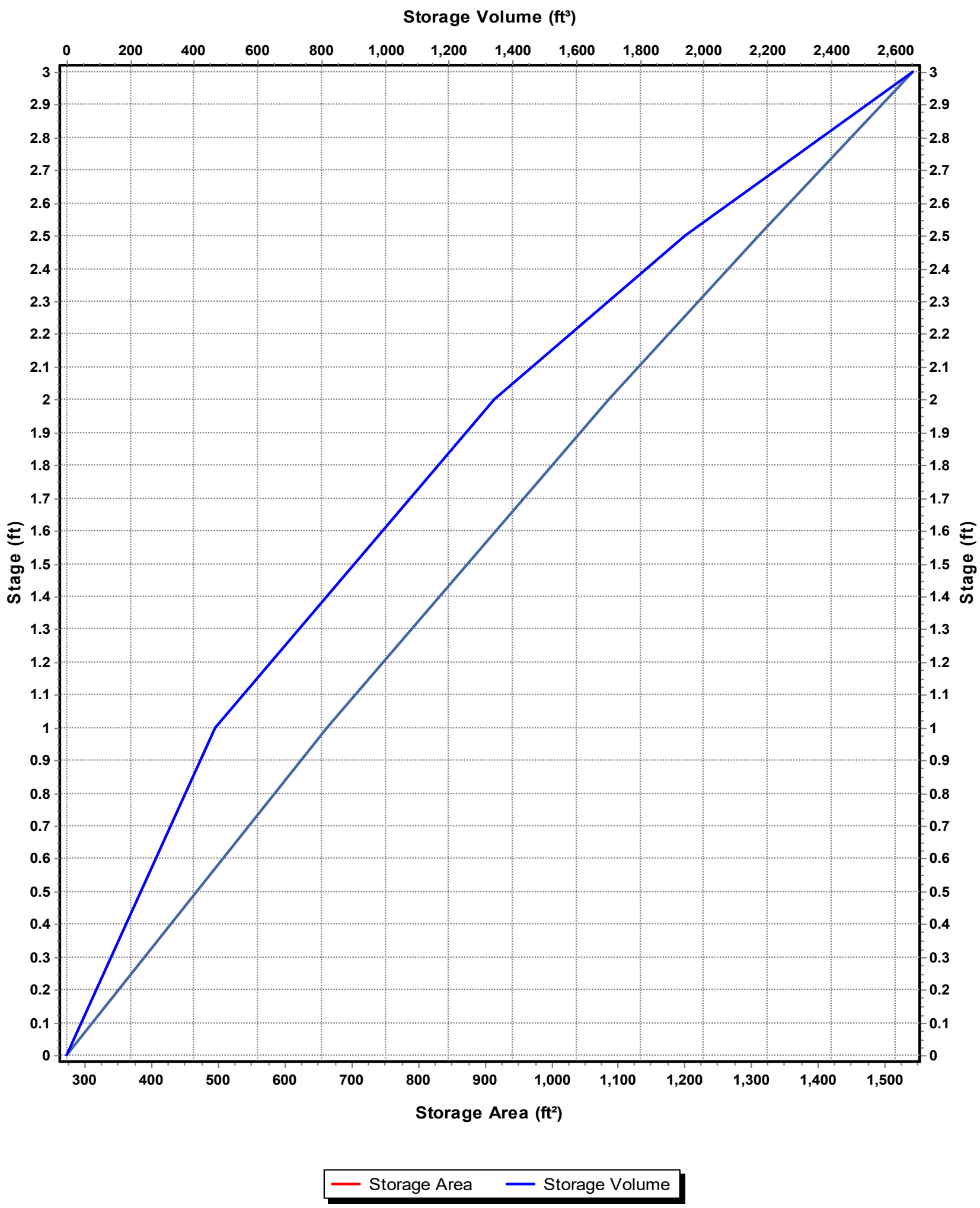
Invert Elevation (ft)	114.00
Max (Rim) Elevation (ft)	117.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.00
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

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

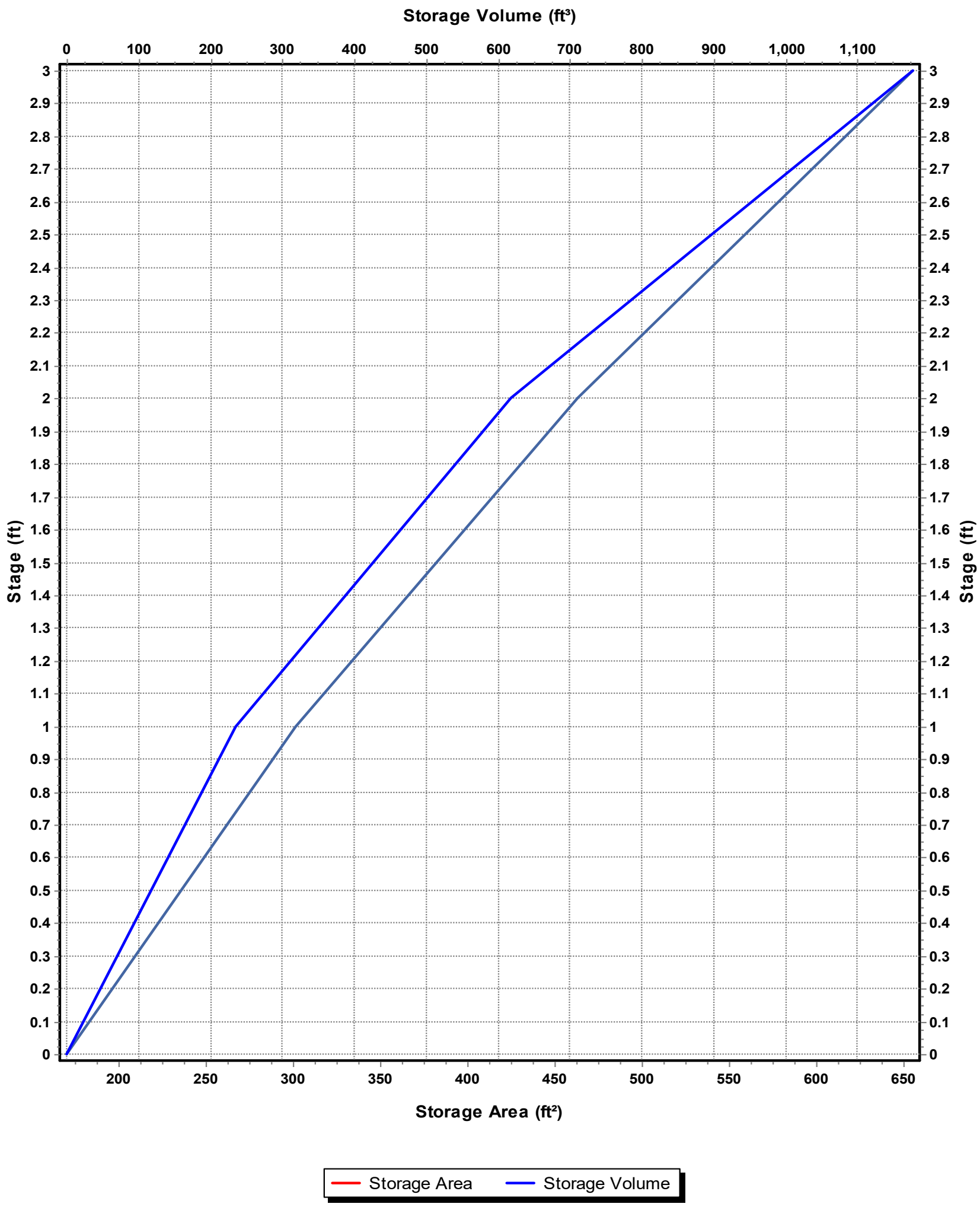
Invert Elevation (ft)	114.00
Max (Rim) Elevation (ft)	117.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.00
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

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

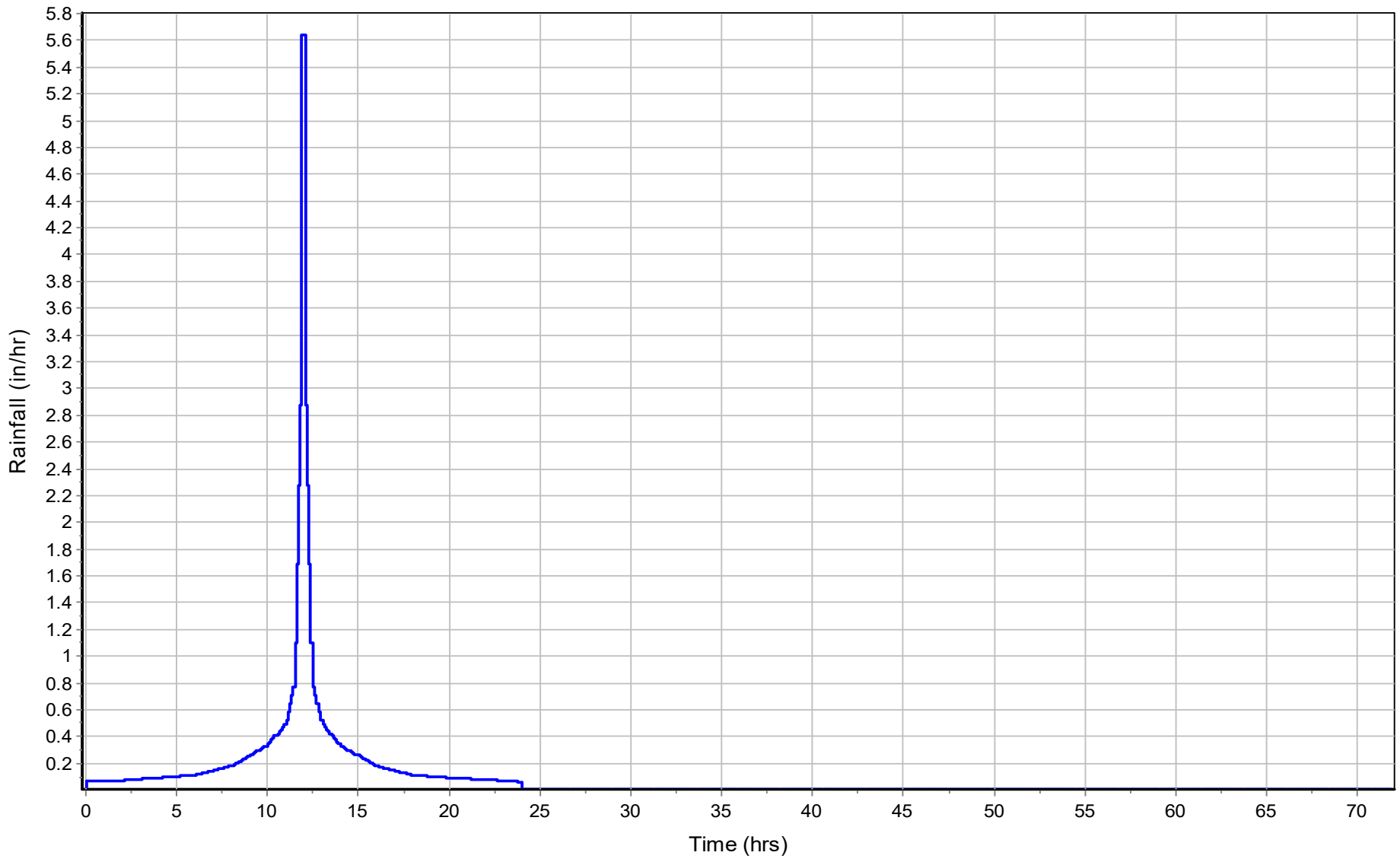
Total TOC (min) 2.57

Subbasin Runoff Results

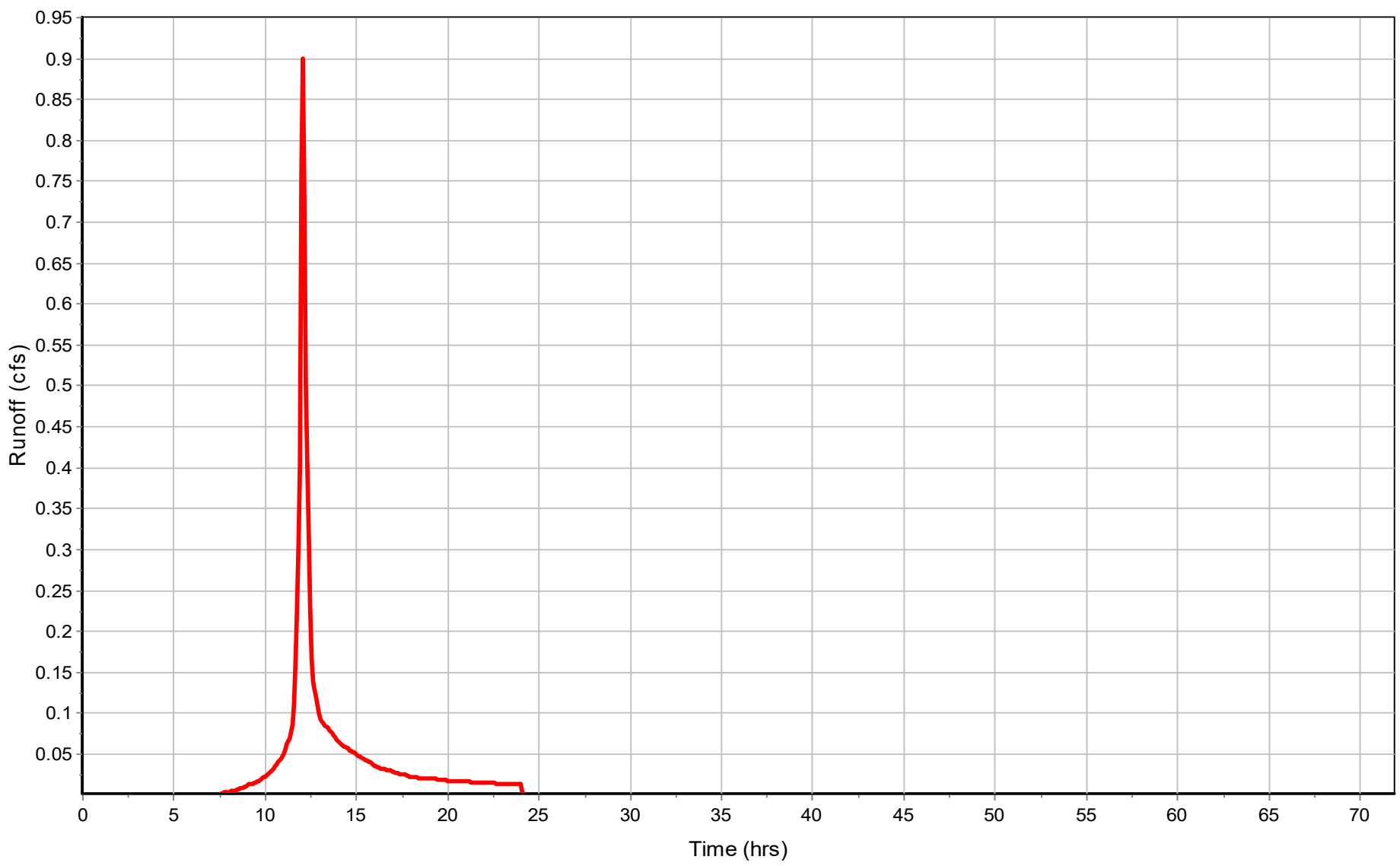
Total Rainfall (in)	6.71
Total Runoff (in)	4
Peak Runoff (cfs)	0.92
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:02:34

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

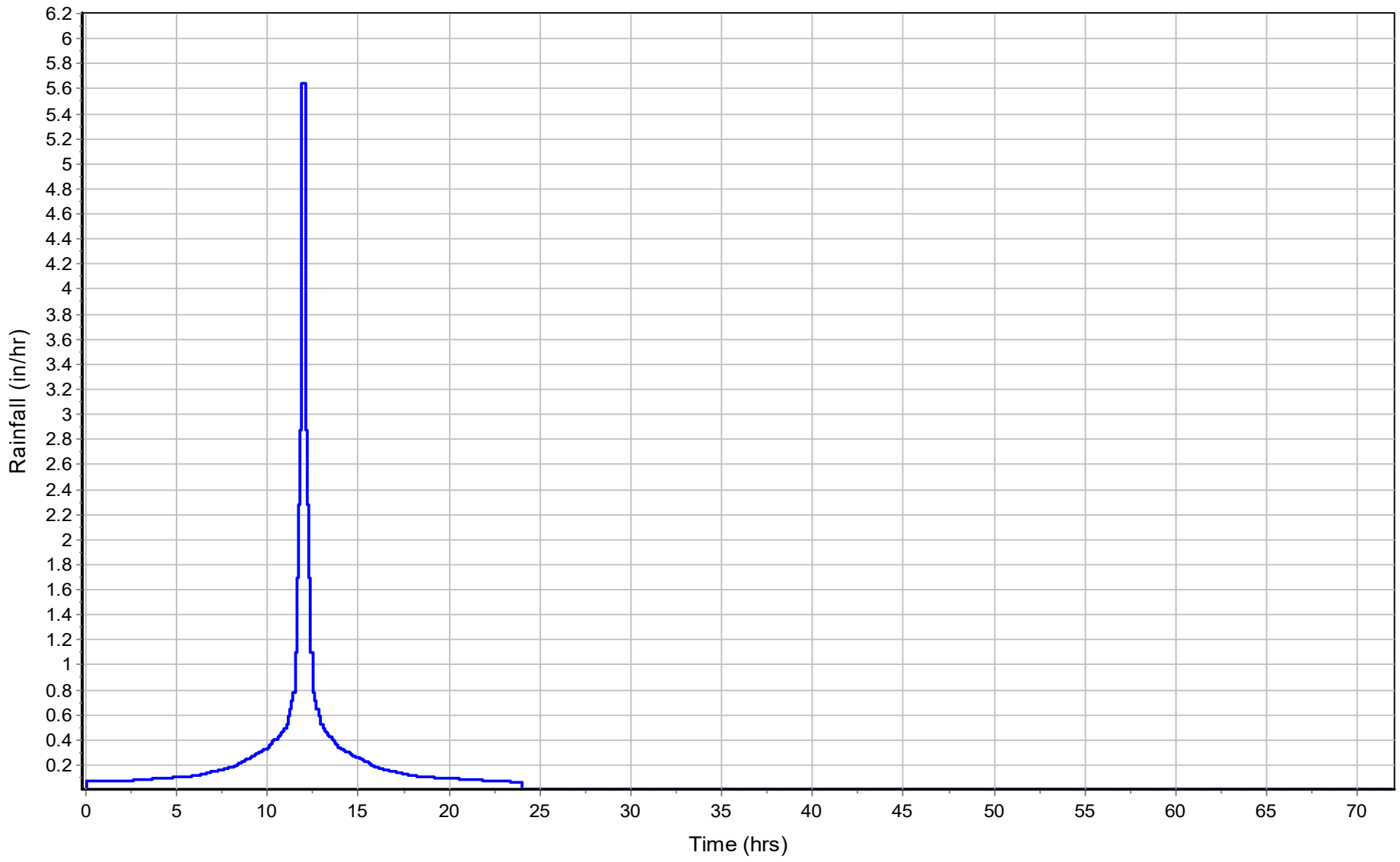
Total TOC (min) 22.21

Subbasin Runoff Results

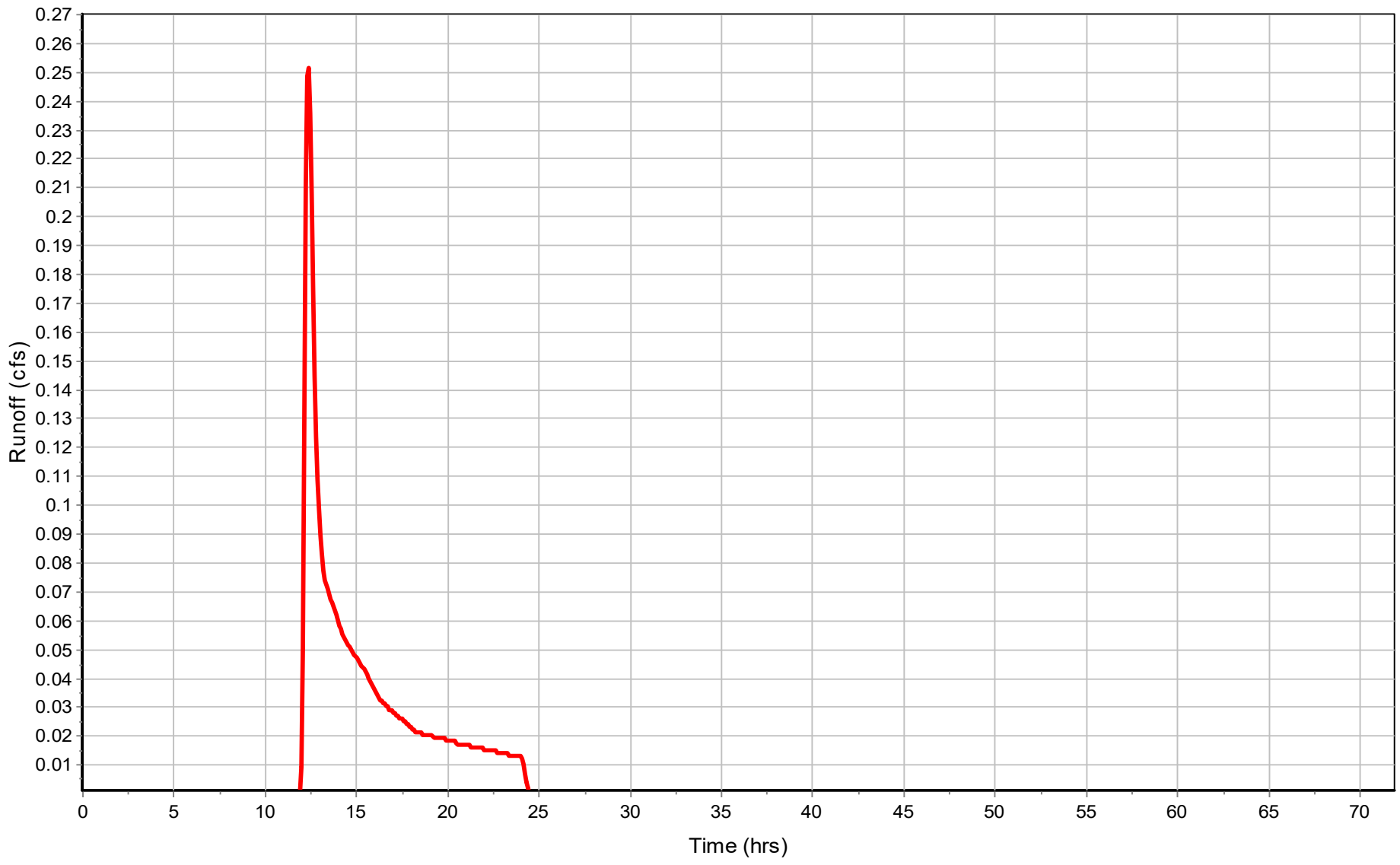
Total Rainfall (in) 6.71
Total Runoff (in) 0.95
Peak Runoff (cfs) 0.25
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:22:13

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

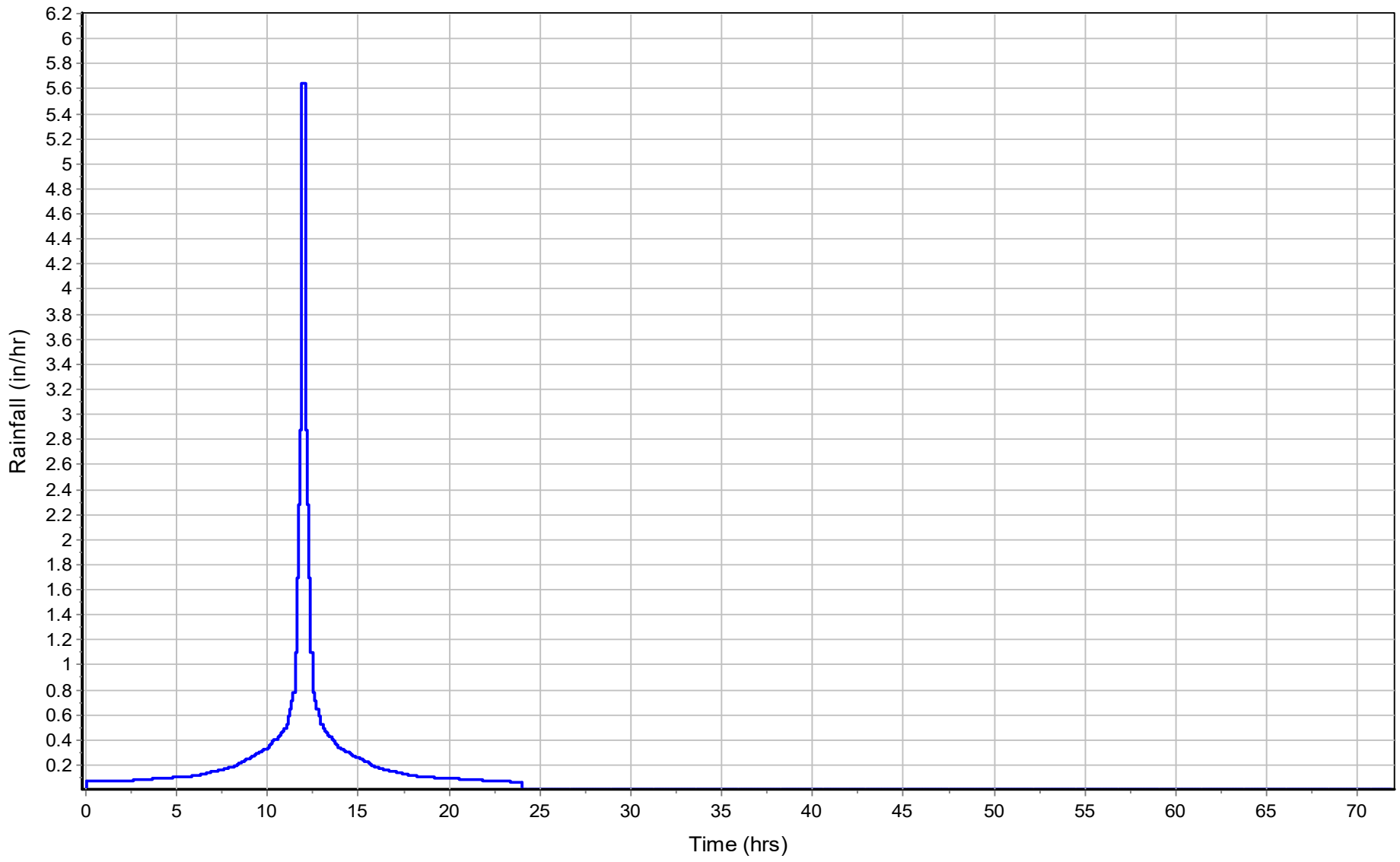
Total TOC (min) 18.29

Subbasin Runoff Results

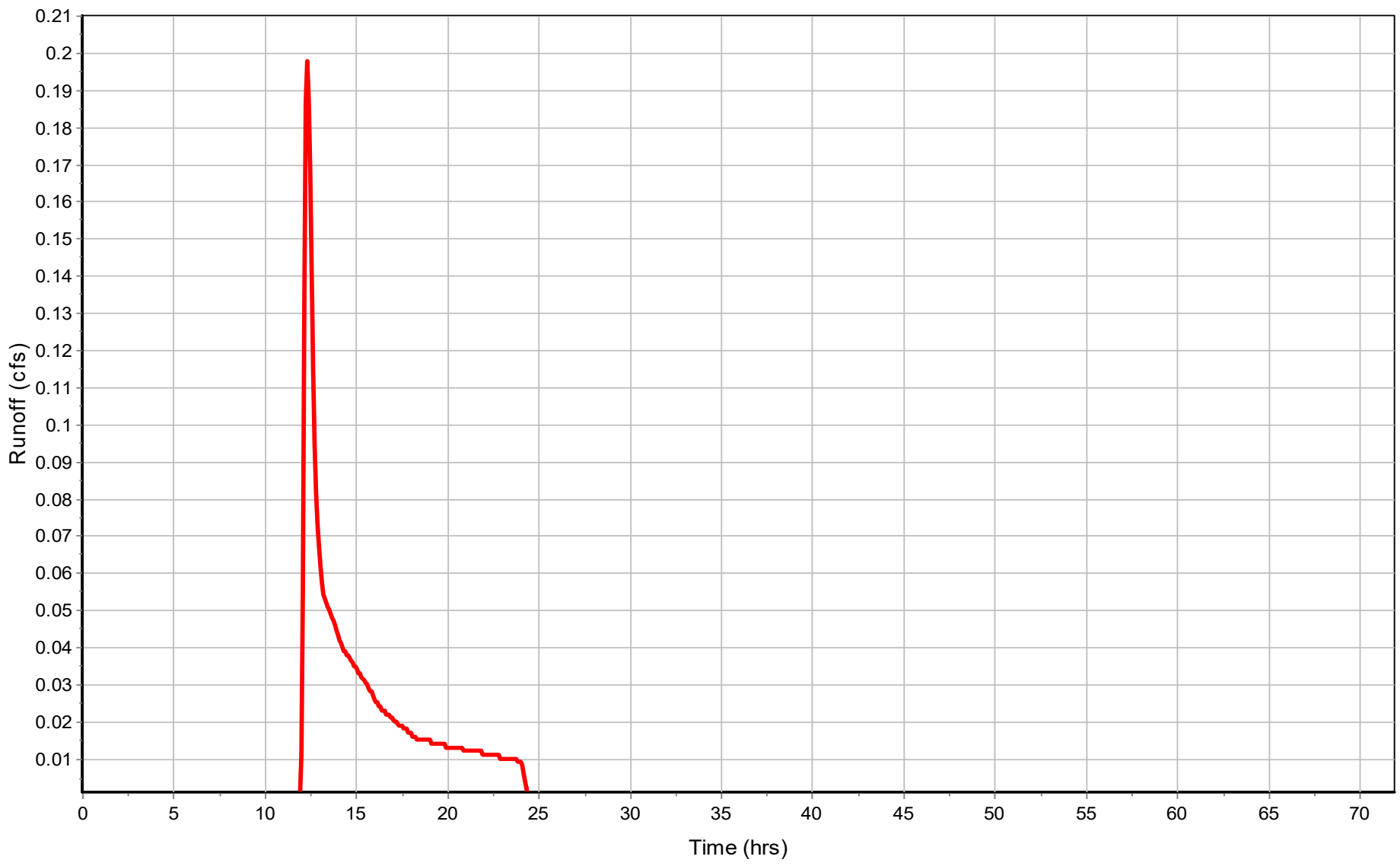
Total Rainfall (in) 6.71
Total Runoff (in) 0.95
Peak Runoff (cfs) 0.2
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:18:17

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

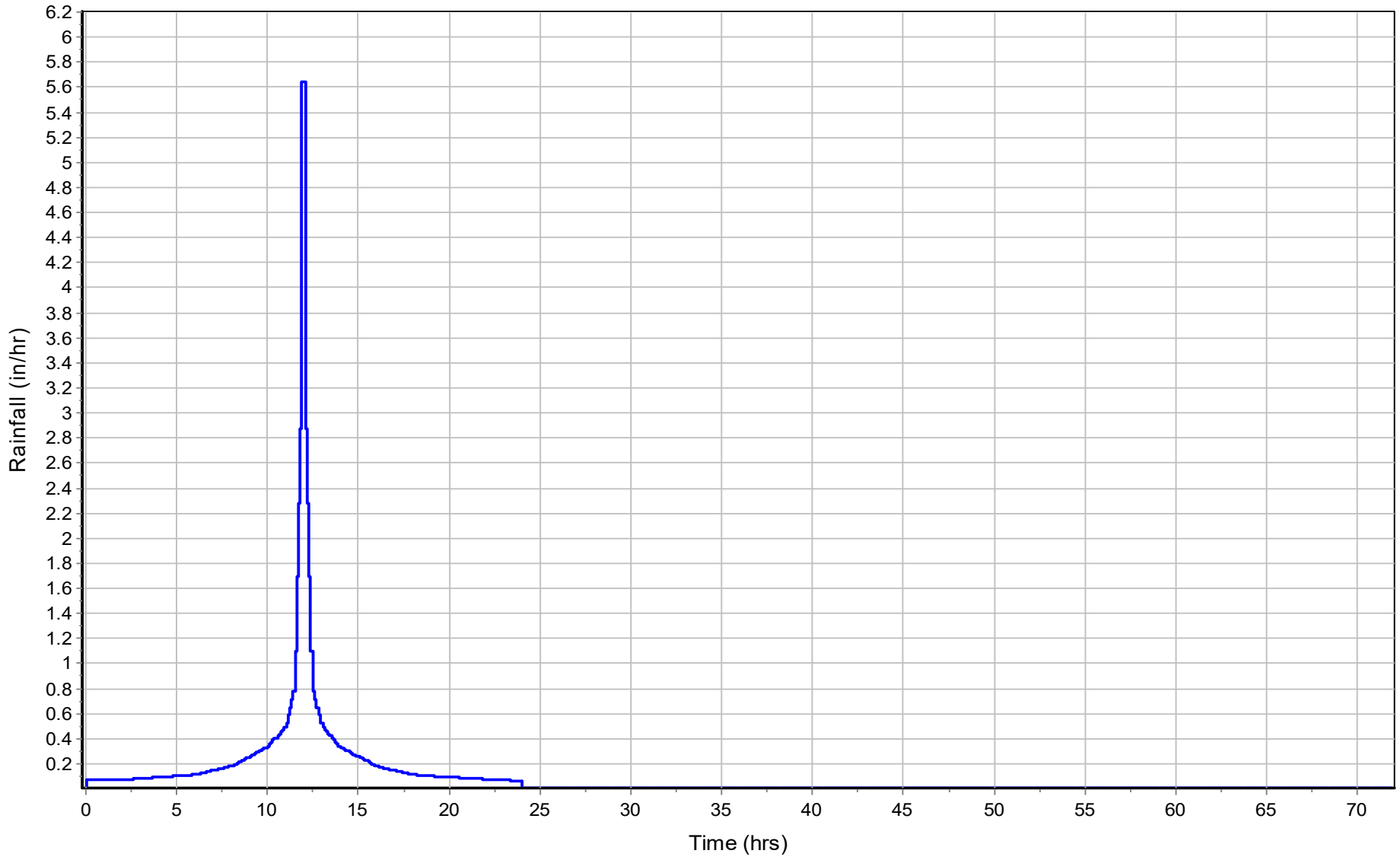
Total TOC (min) 15.09

Subbasin Runoff Results

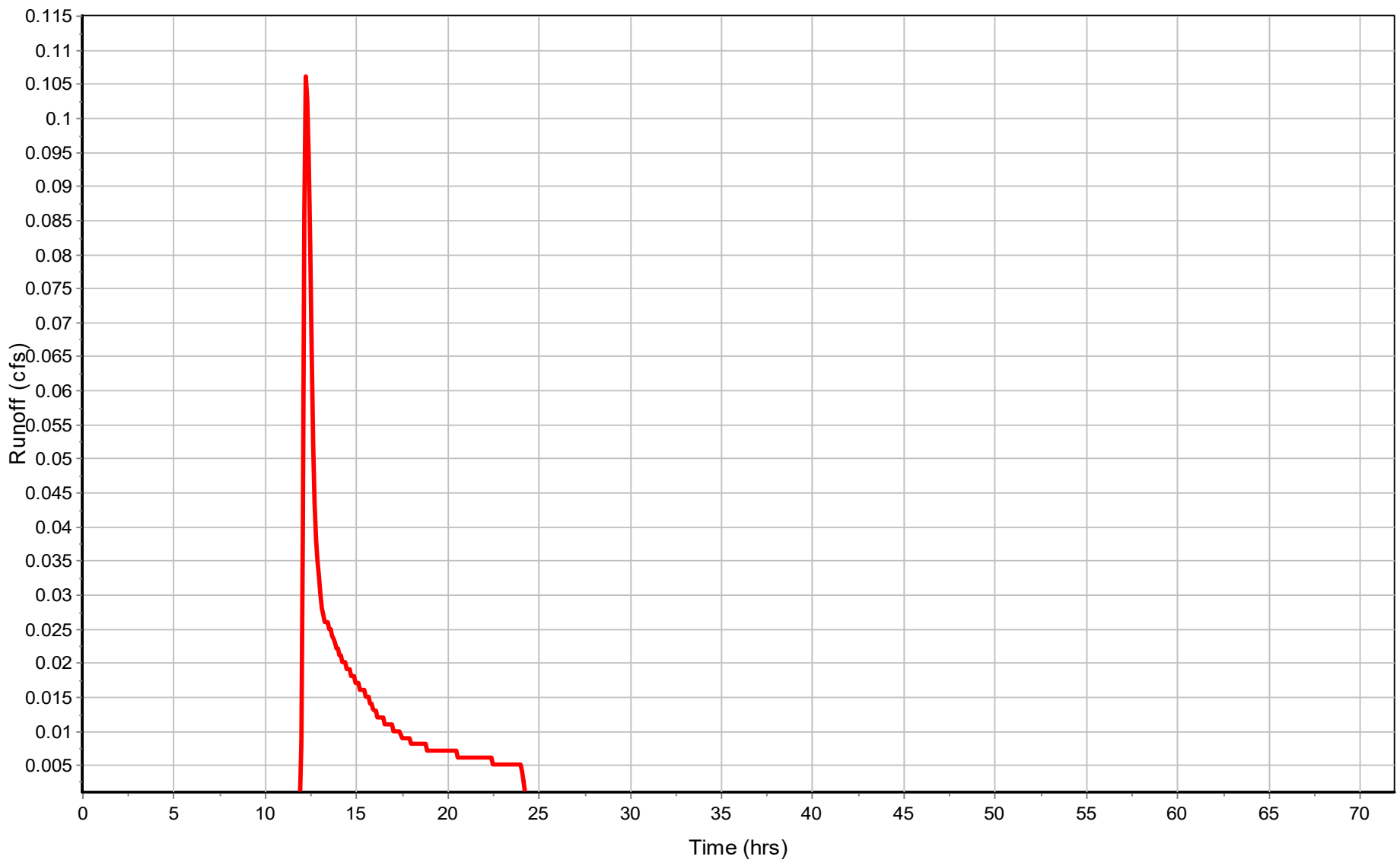
Total Rainfall (in) 6.71
Total Runoff (in) 0.95
Peak Runoff (cfs) 0.11
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:15:05

Subbasin : Sub-E04

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A4

Input Data

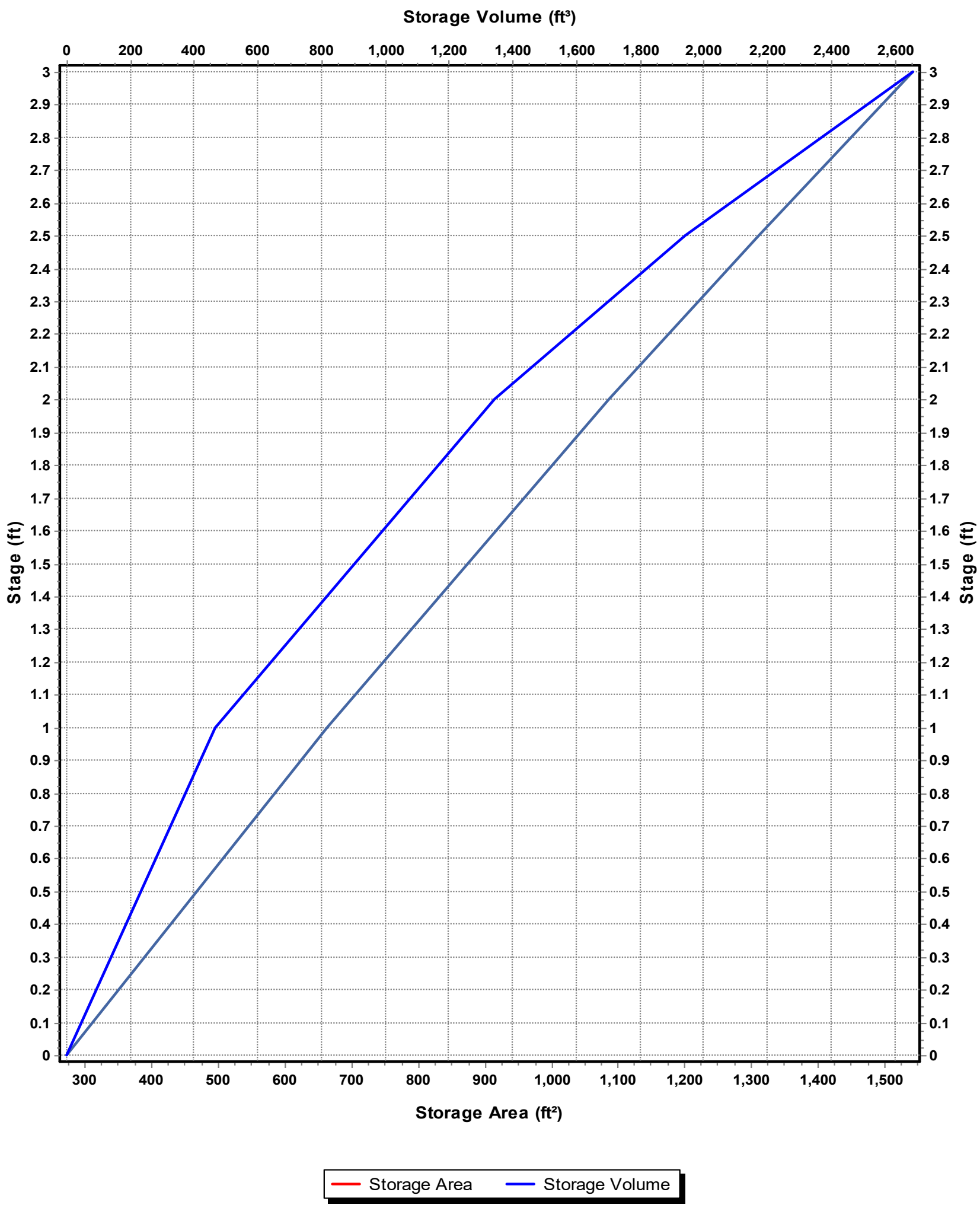
Invert Elevation (ft)	114.00
Max (Rim) Elevation (ft)	117.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.00
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

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

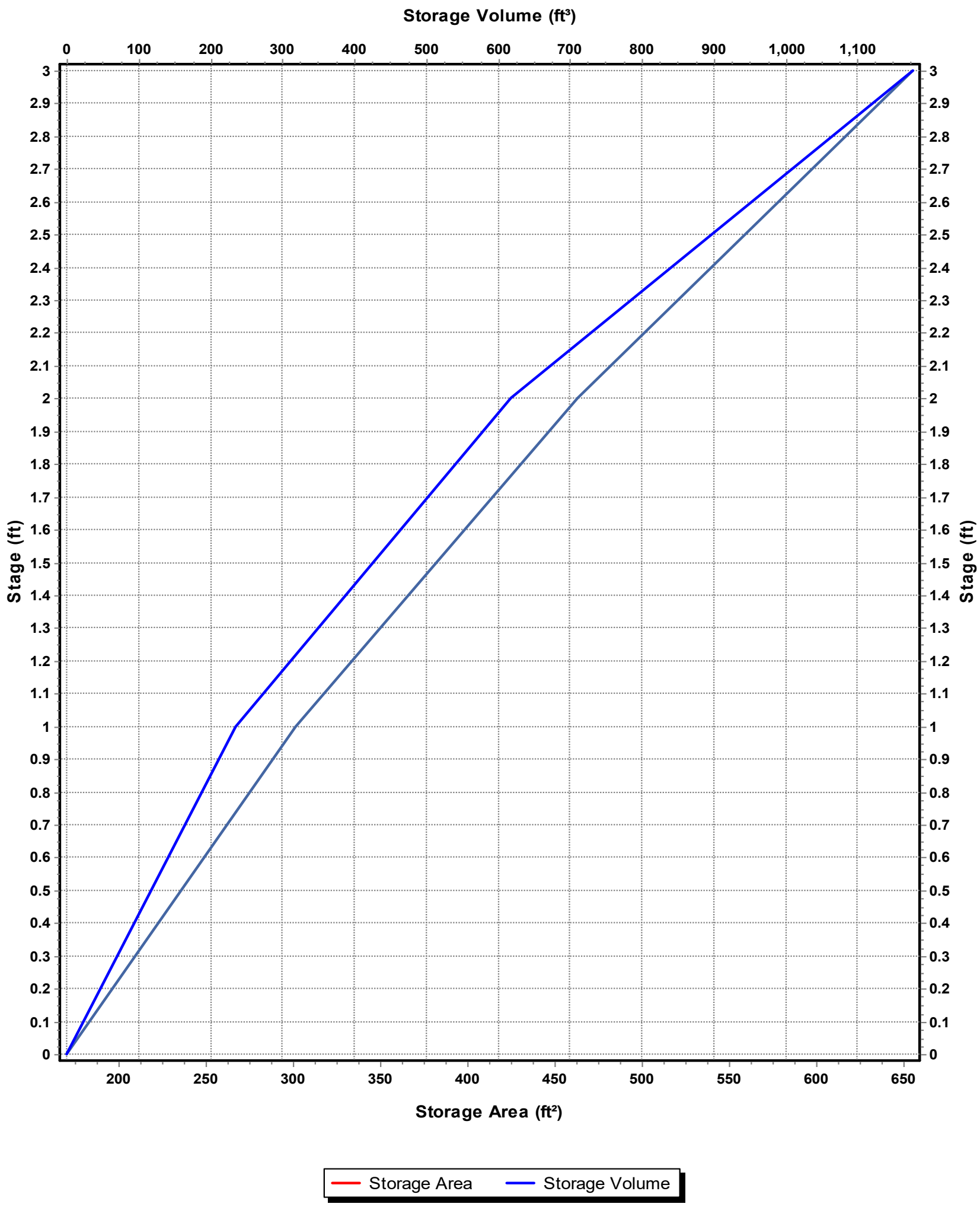
Invert Elevation (ft)	114.00
Max (Rim) Elevation (ft)	117.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.00
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

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

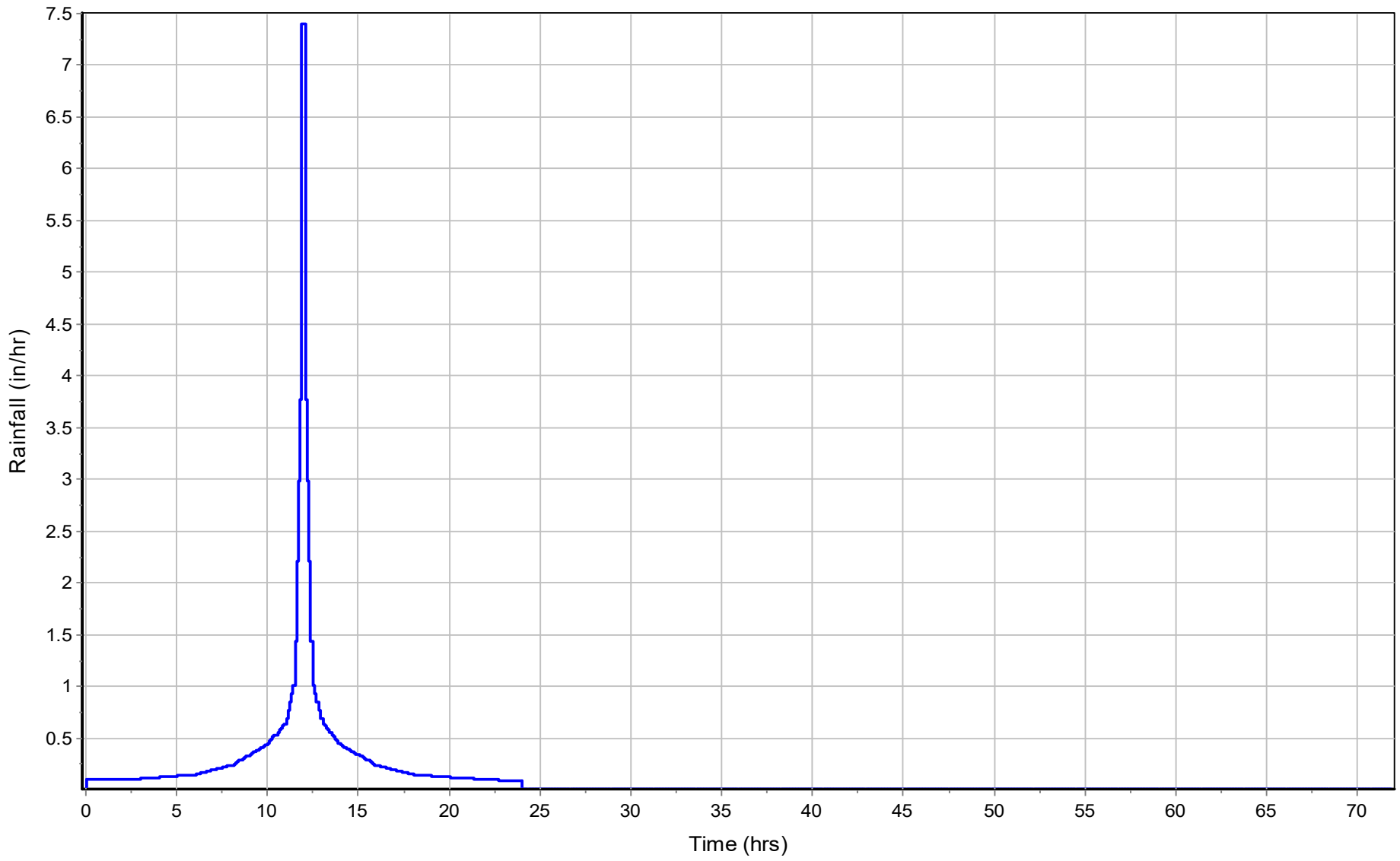
Total TOC (min) 2.57

Subbasin Runoff Results

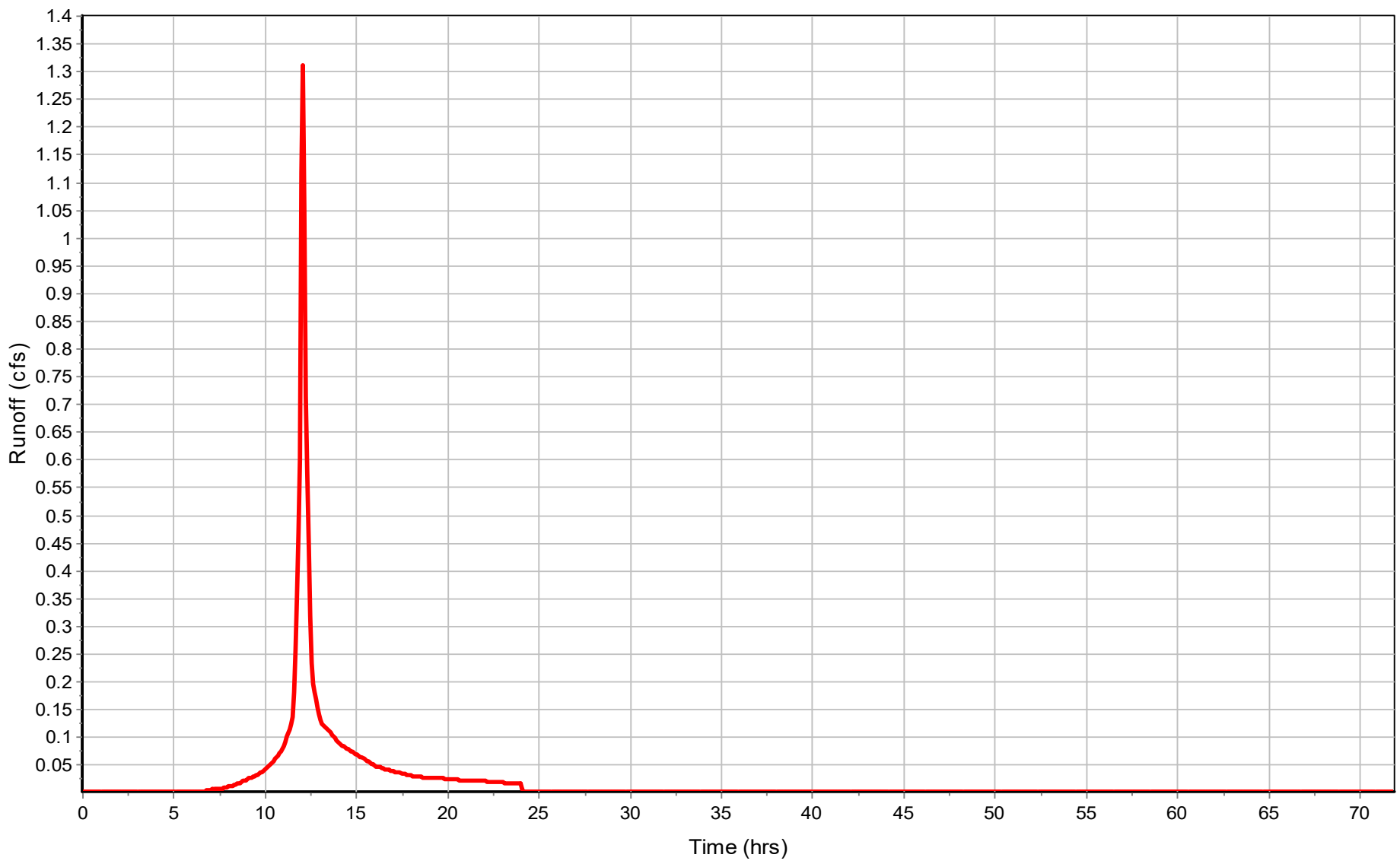
Total Rainfall (in)	8.8
Total Runoff (in)	5.89
Peak Runoff (cfs)	1.33
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:02:34

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

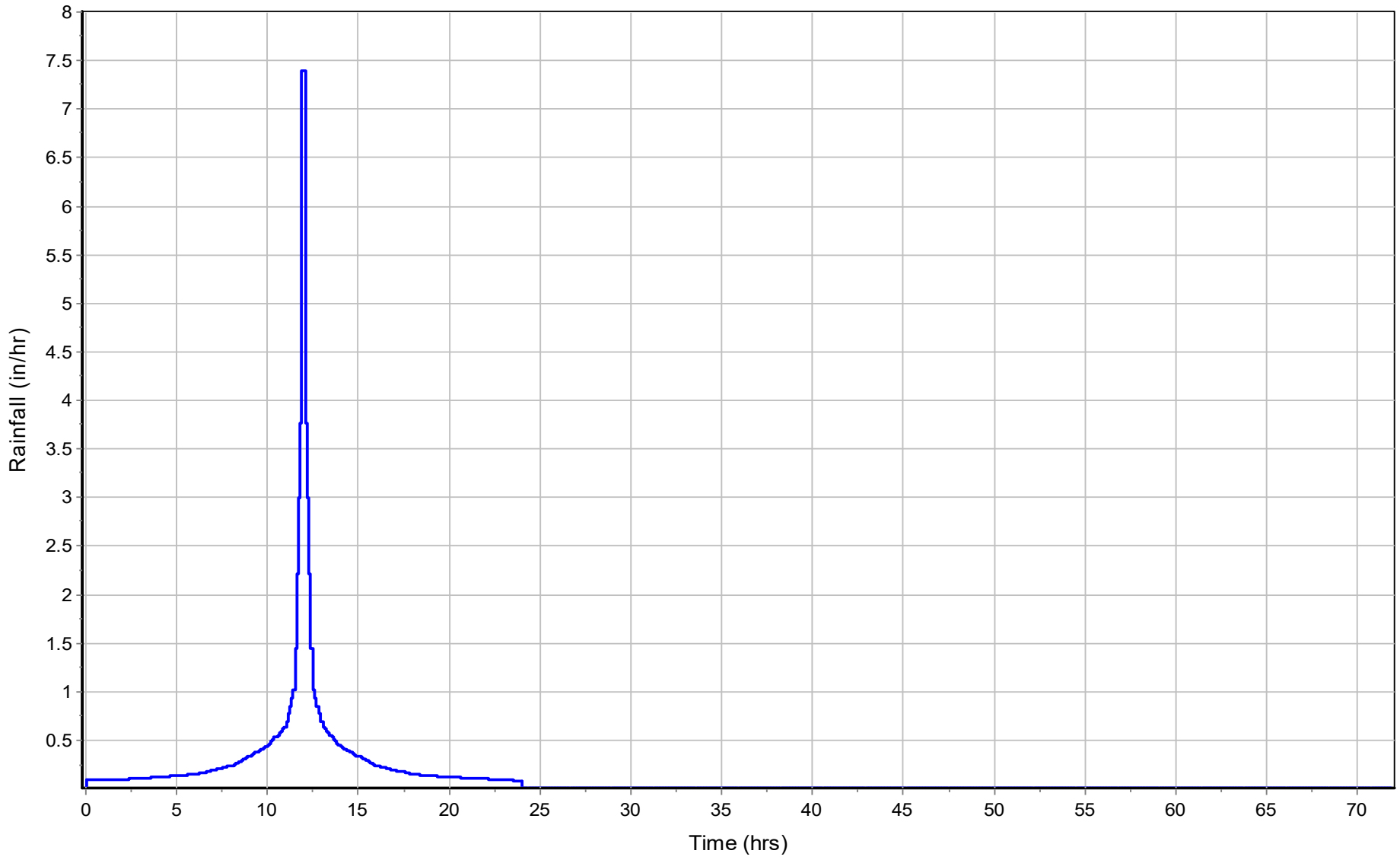
Total TOC (min) 22.21

Subbasin Runoff Results

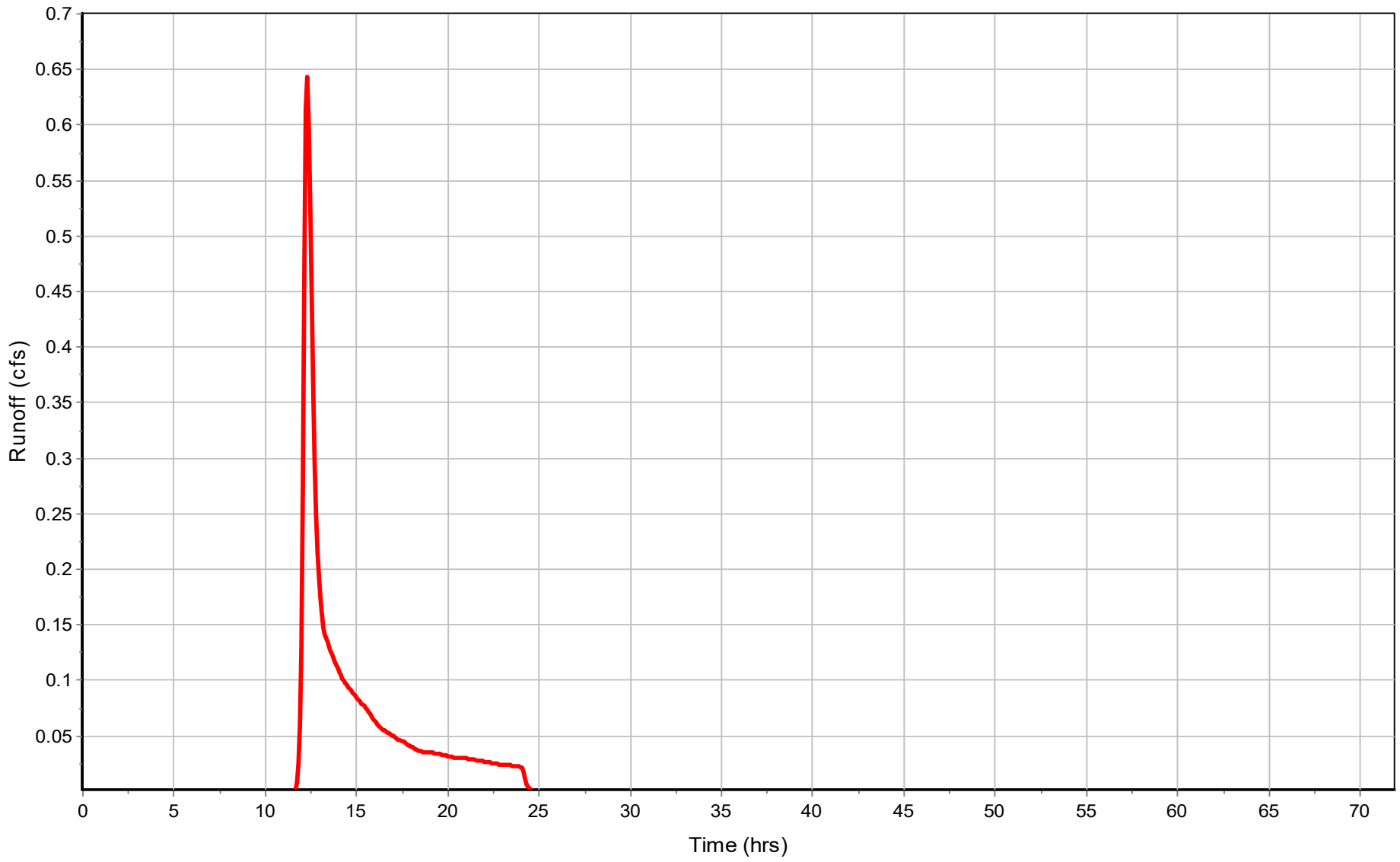
Total Rainfall (in) 8.8
Total Runoff (in) 1.95
Peak Runoff (cfs) 0.65
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:22:13

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

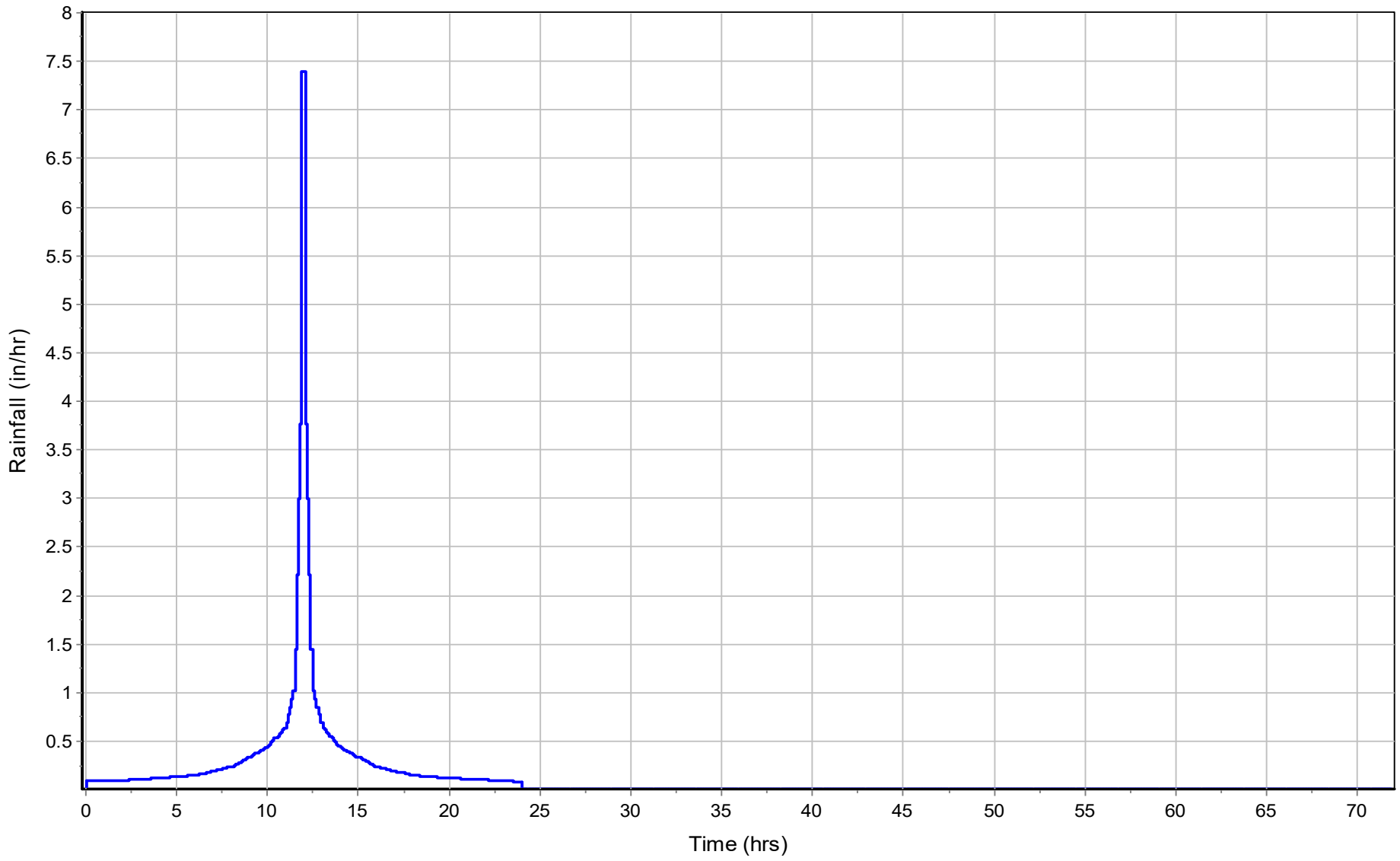
Total TOC (min) 18.29

Subbasin Runoff Results

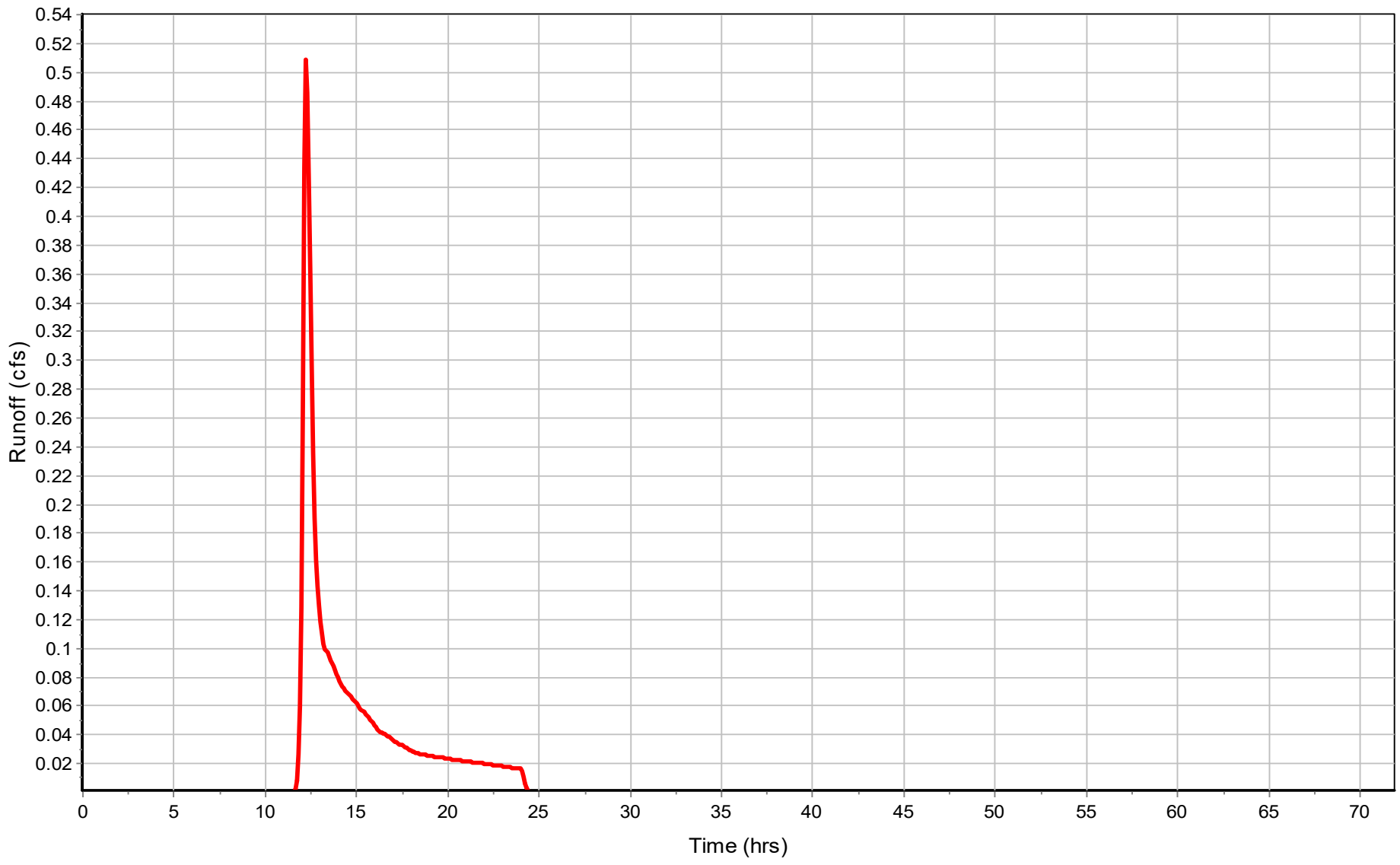
Total Rainfall (in) 8.8
Total Runoff (in) 1.95
Peak Runoff (cfs) 0.51
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:18:17

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

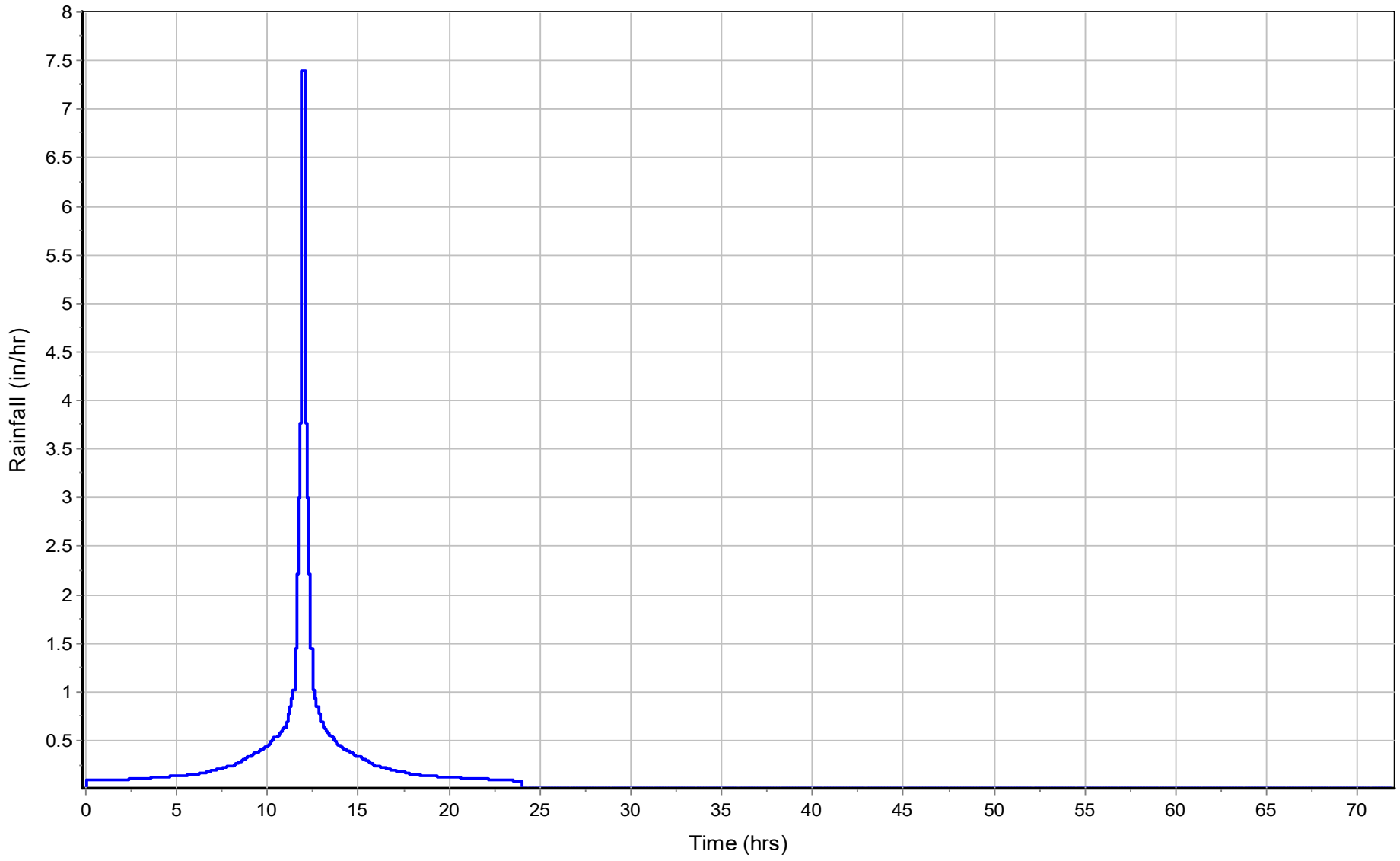
Total TOC (min) 15.09

Subbasin Runoff Results

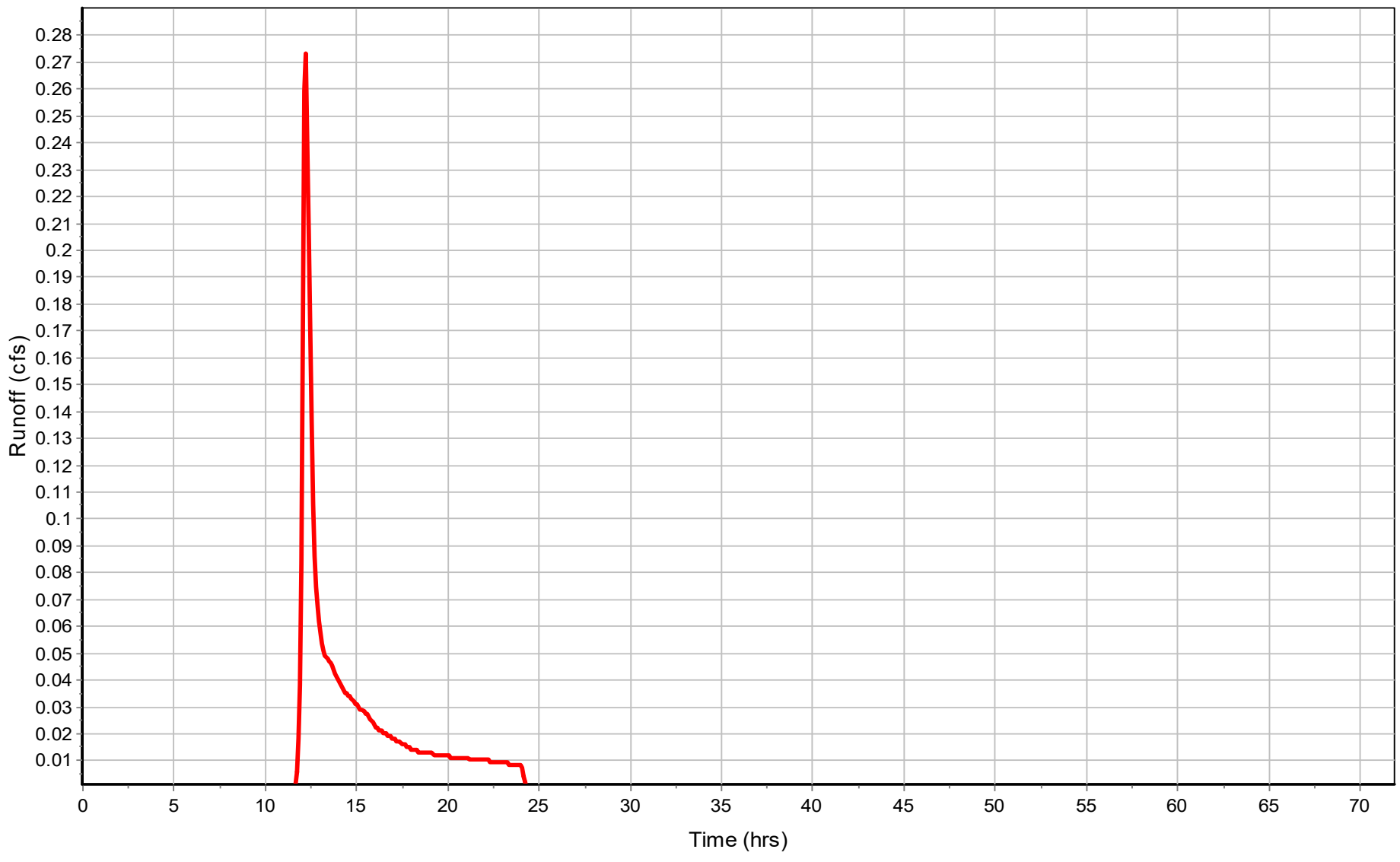
Total Rainfall (in) 8.8
Total Runoff (in) 1.95
Peak Runoff (cfs) 0.28
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:15:05

Subbasin : Sub-E04

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A4

Input Data

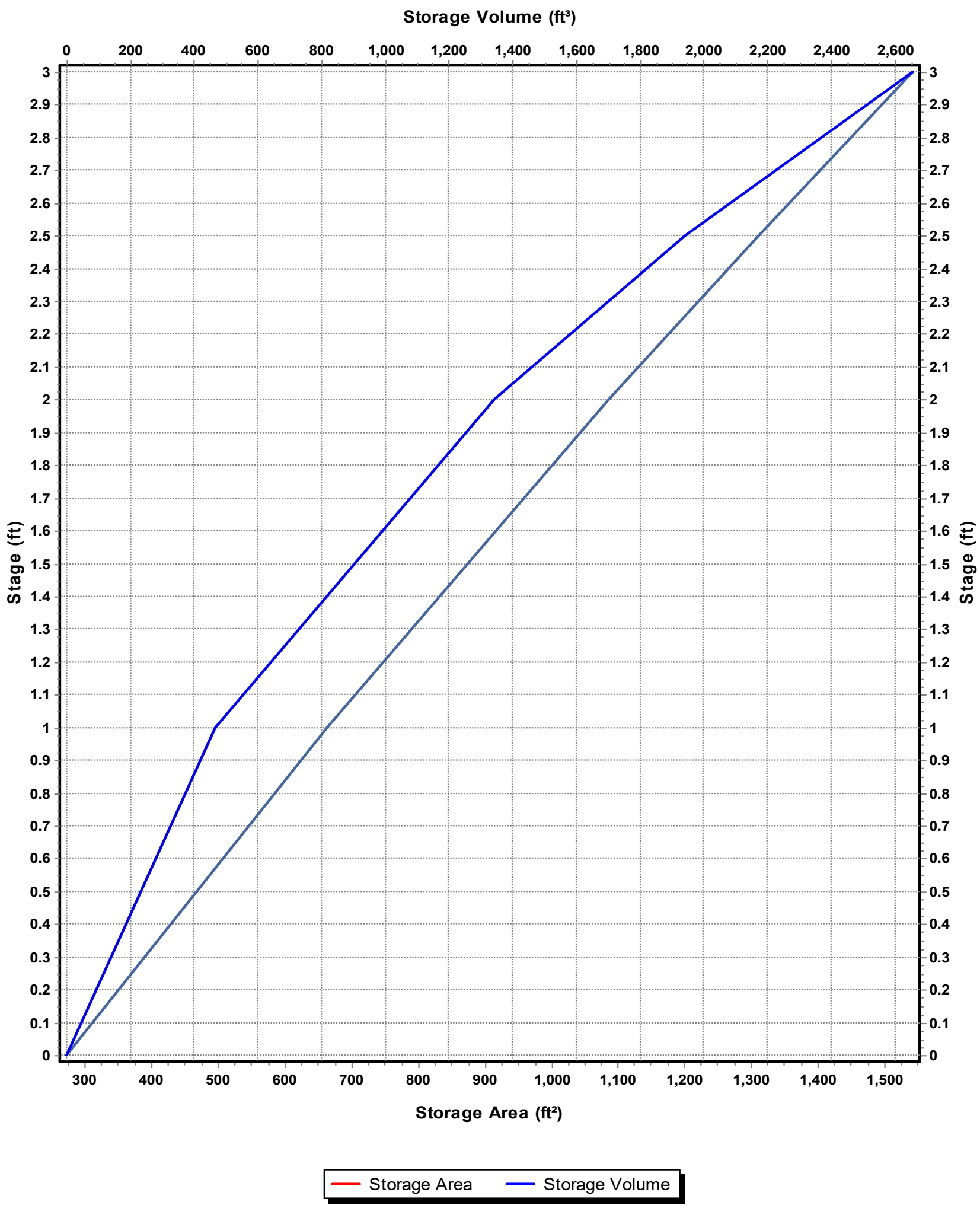
Invert Elevation (ft)	114.00
Max (Rim) Elevation (ft)	117.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.00
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

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

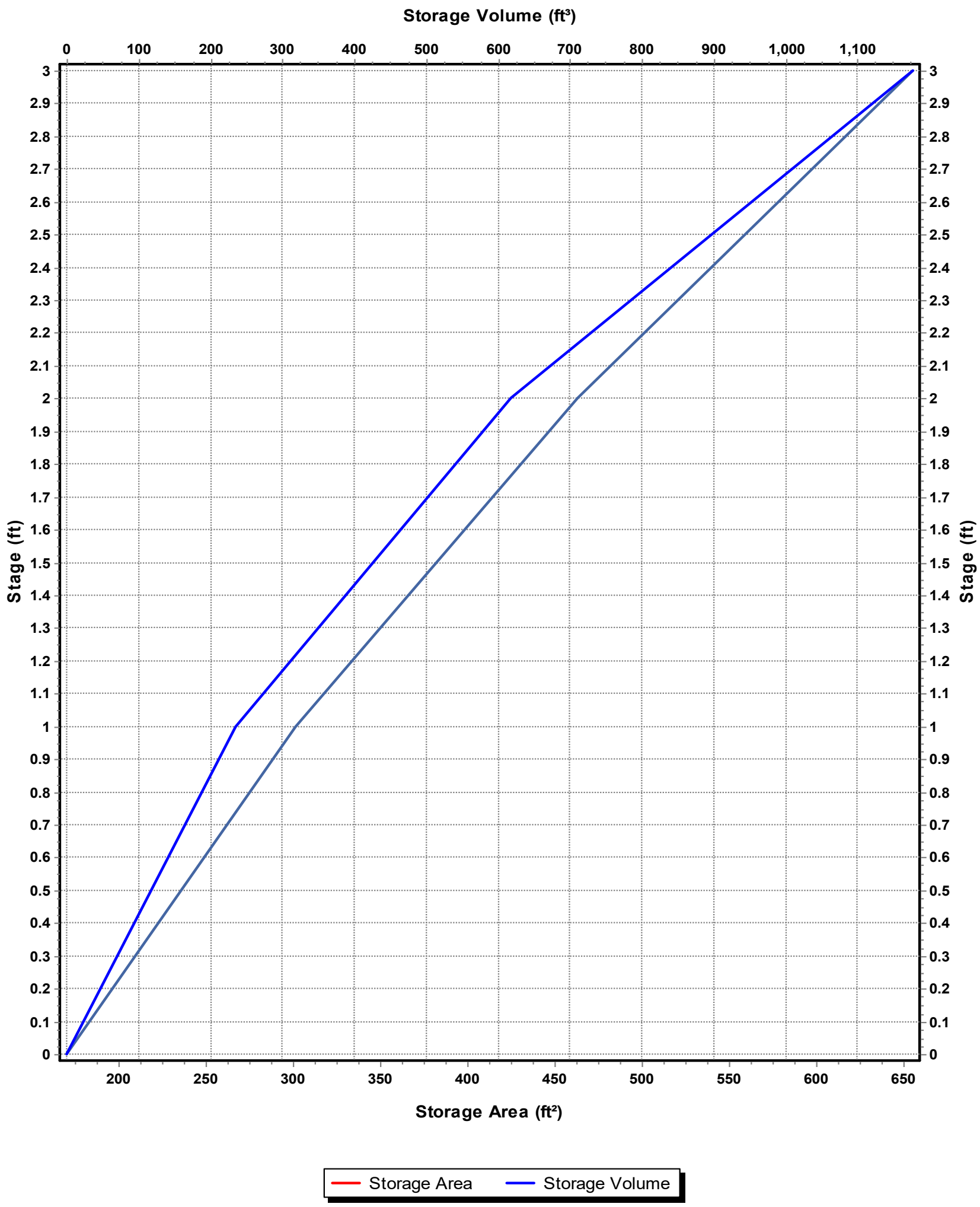
Invert Elevation (ft)	114.00
Max (Rim) Elevation (ft)	117.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.00
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

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

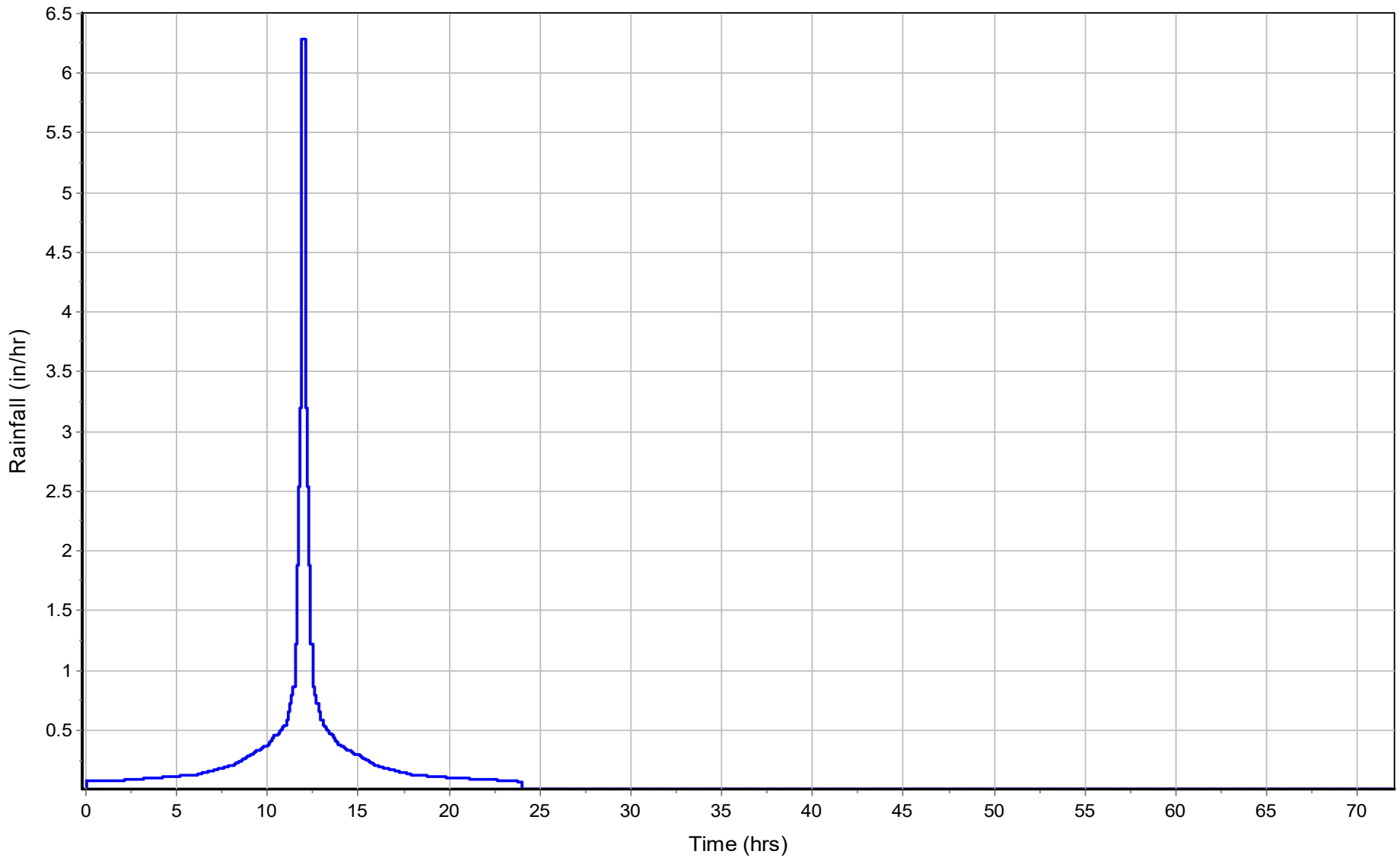
Total TOC (min) 2.57

Subbasin Runoff Results

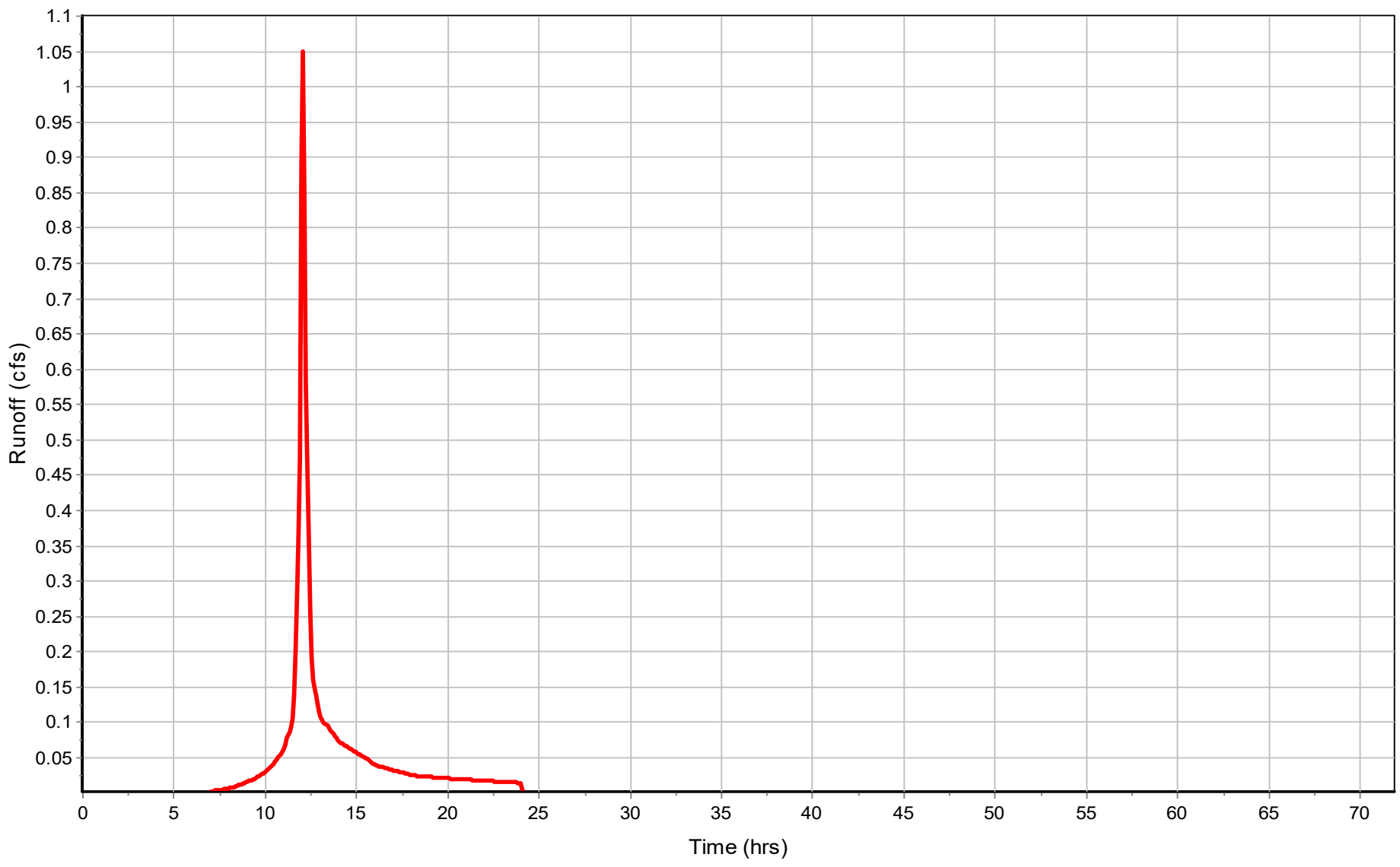
Total Rainfall (in)	7.48
Total Runoff (in)	4.69
Peak Runoff (cfs)	1.07
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:02:34

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

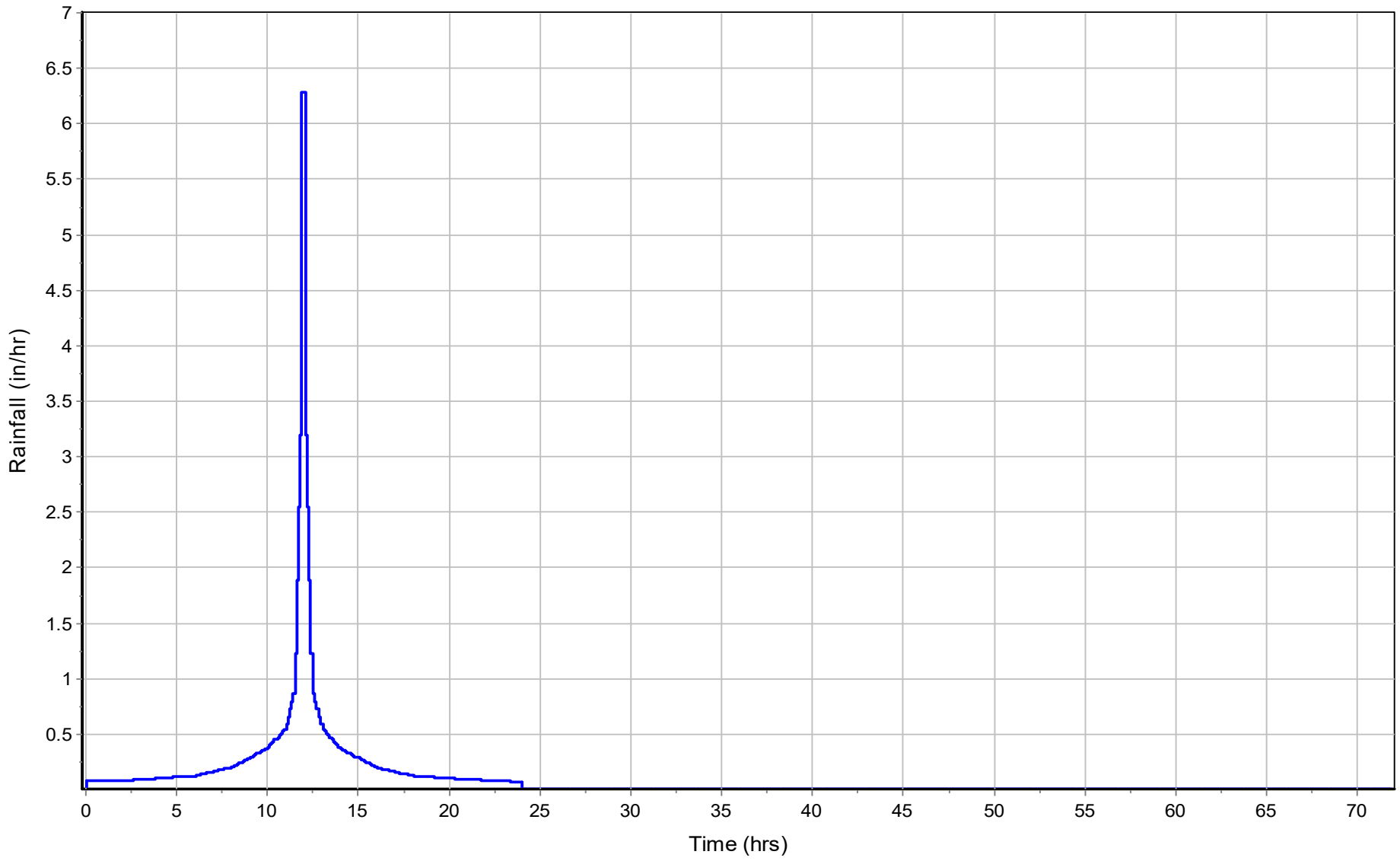
Total TOC (min) 22.21

Subbasin Runoff Results

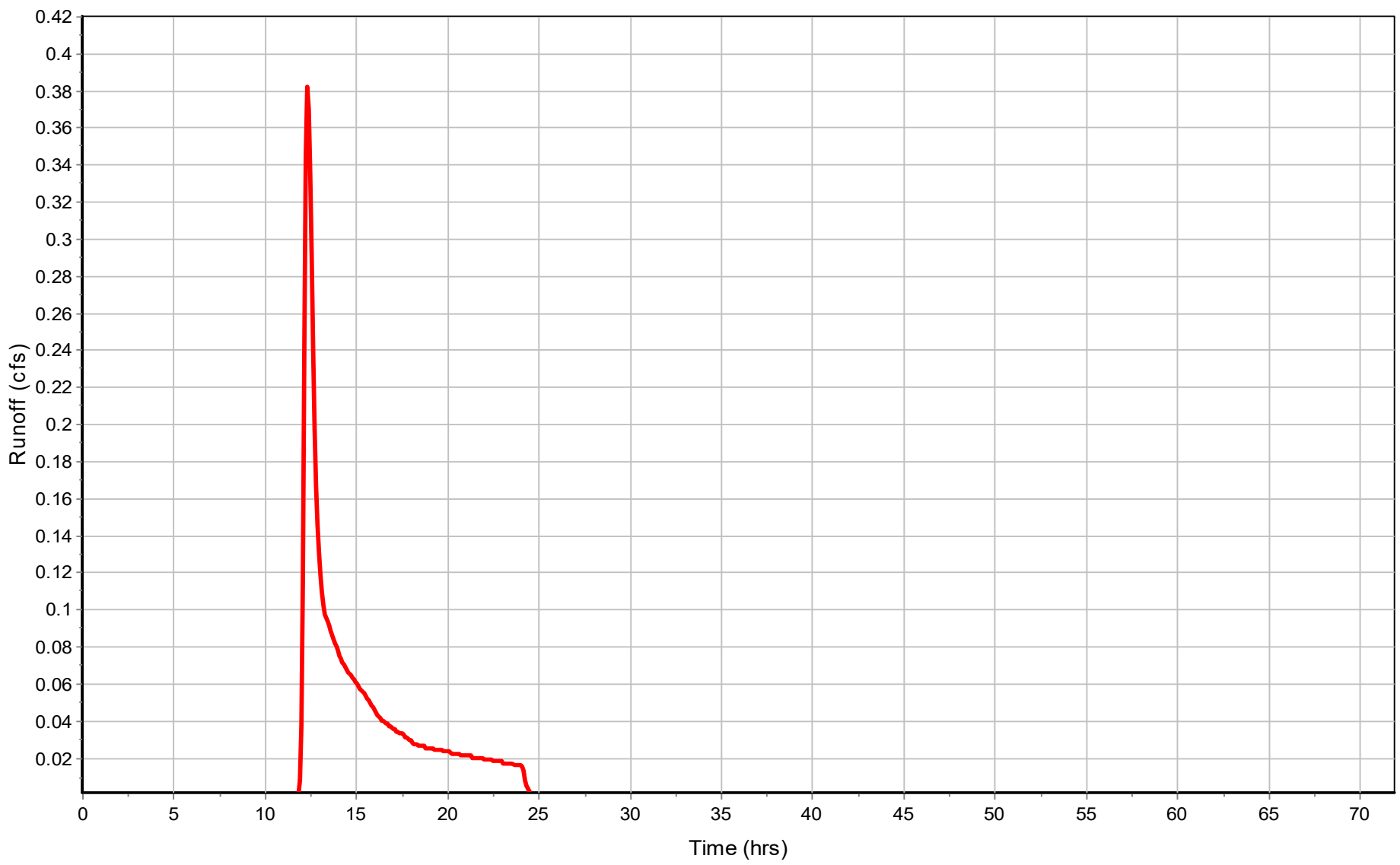
Total Rainfall (in) 7.48
Total Runoff (in) 1.29
Peak Runoff (cfs) 0.38
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:22:13

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

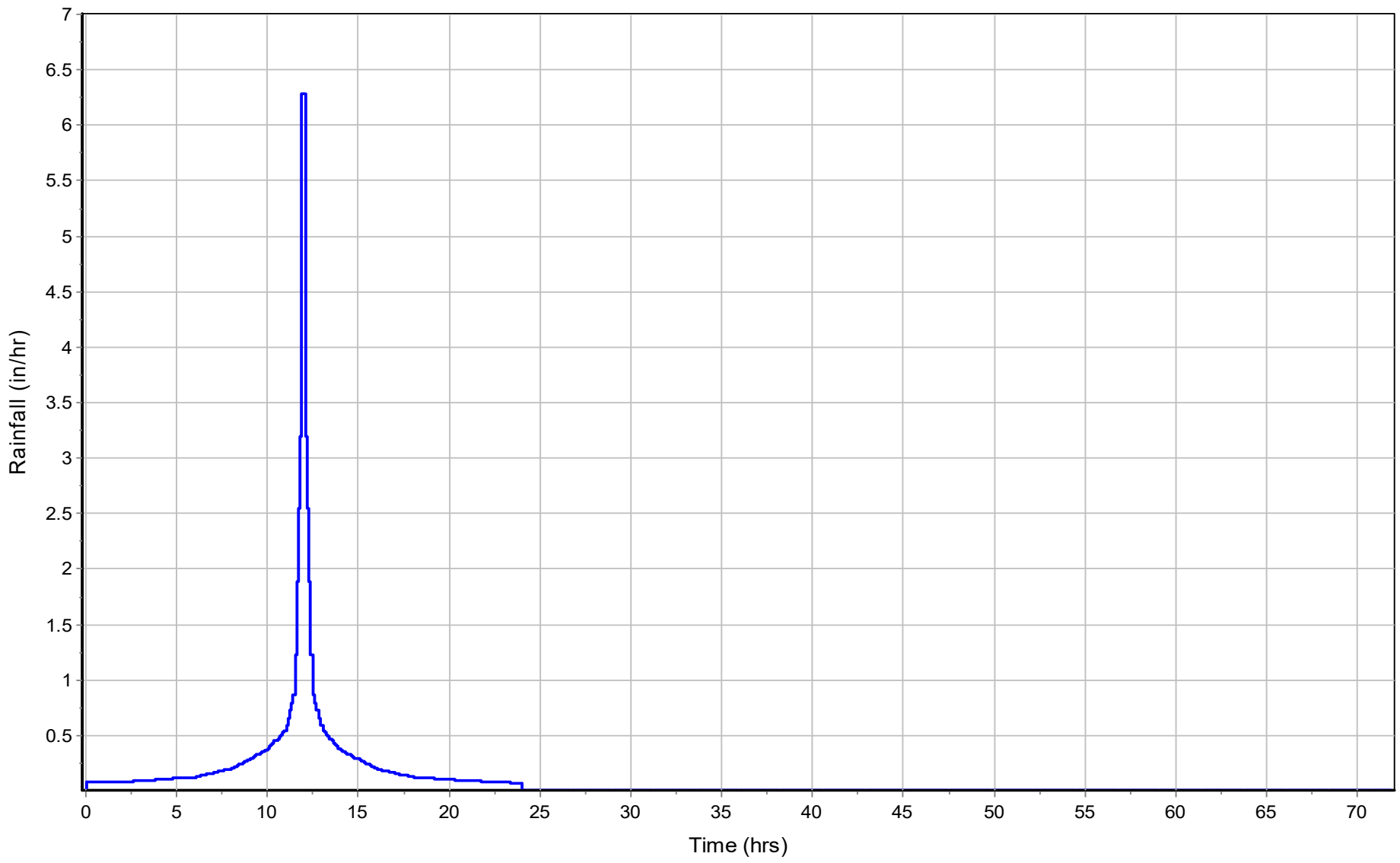
Total TOC (min) 18.29

Subbasin Runoff Results

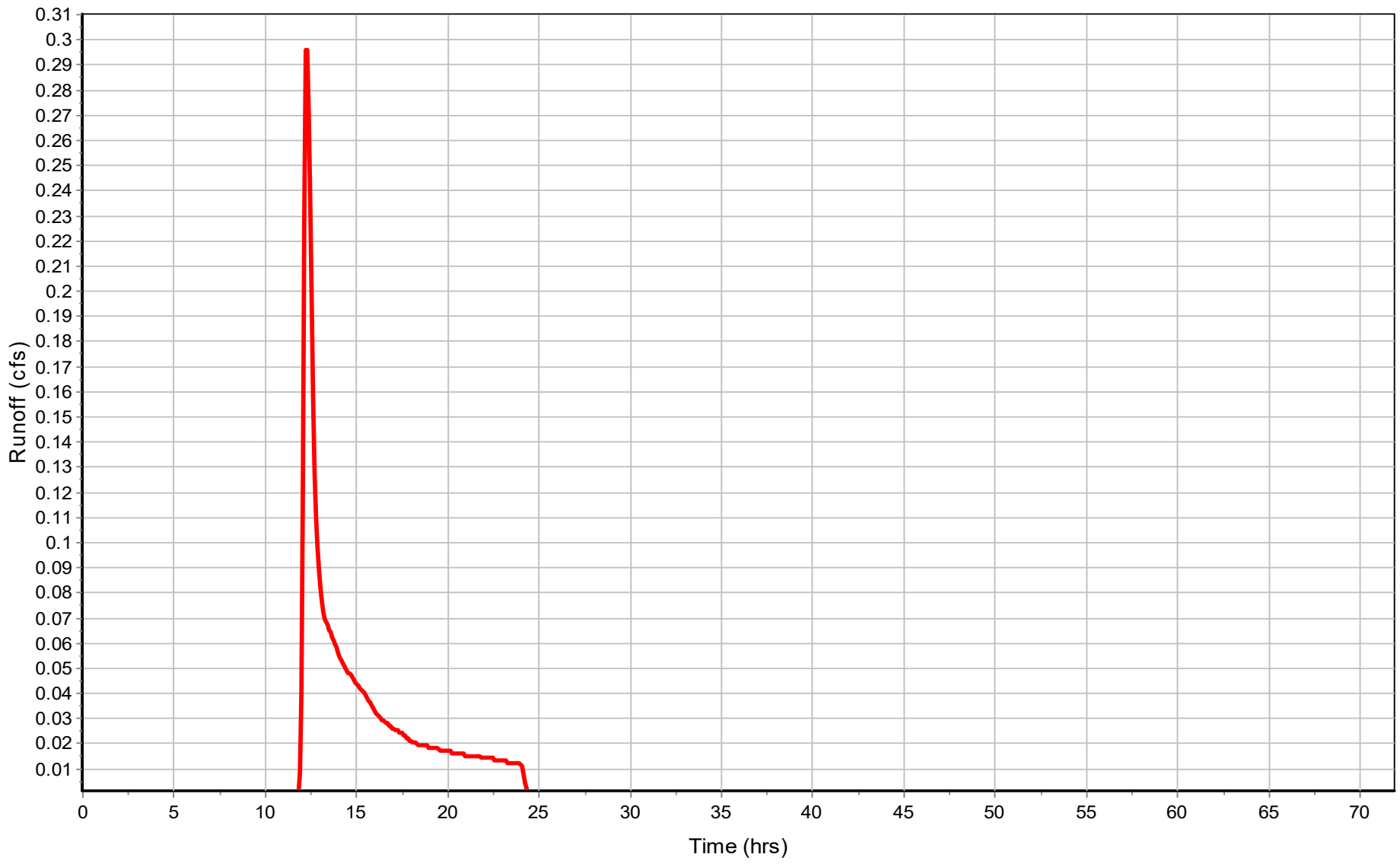
Total Rainfall (in) 7.48
Total Runoff (in) 1.29
Peak Runoff (cfs) 0.3
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:18:17

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

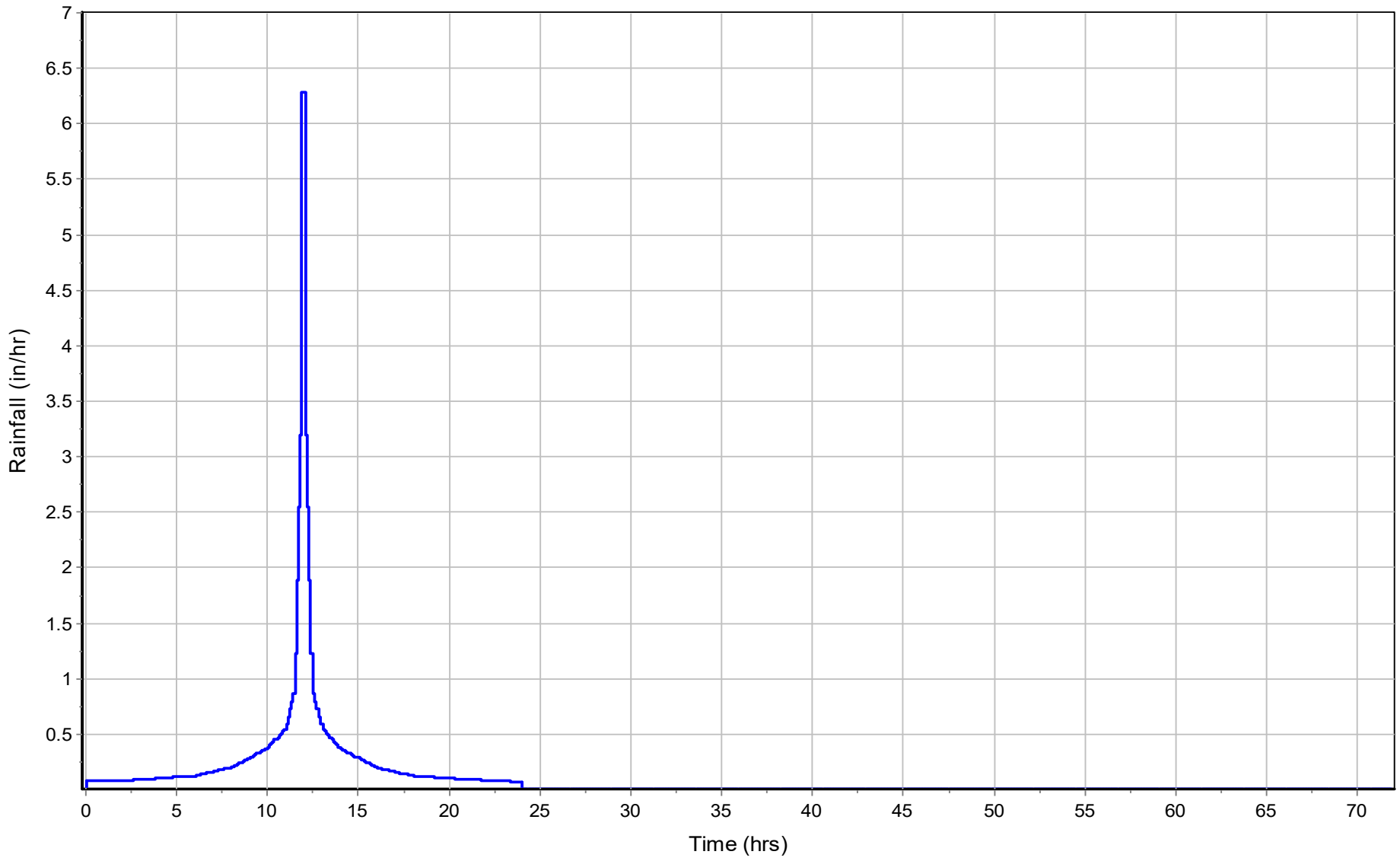
Total TOC (min) 15.09

Subbasin Runoff Results

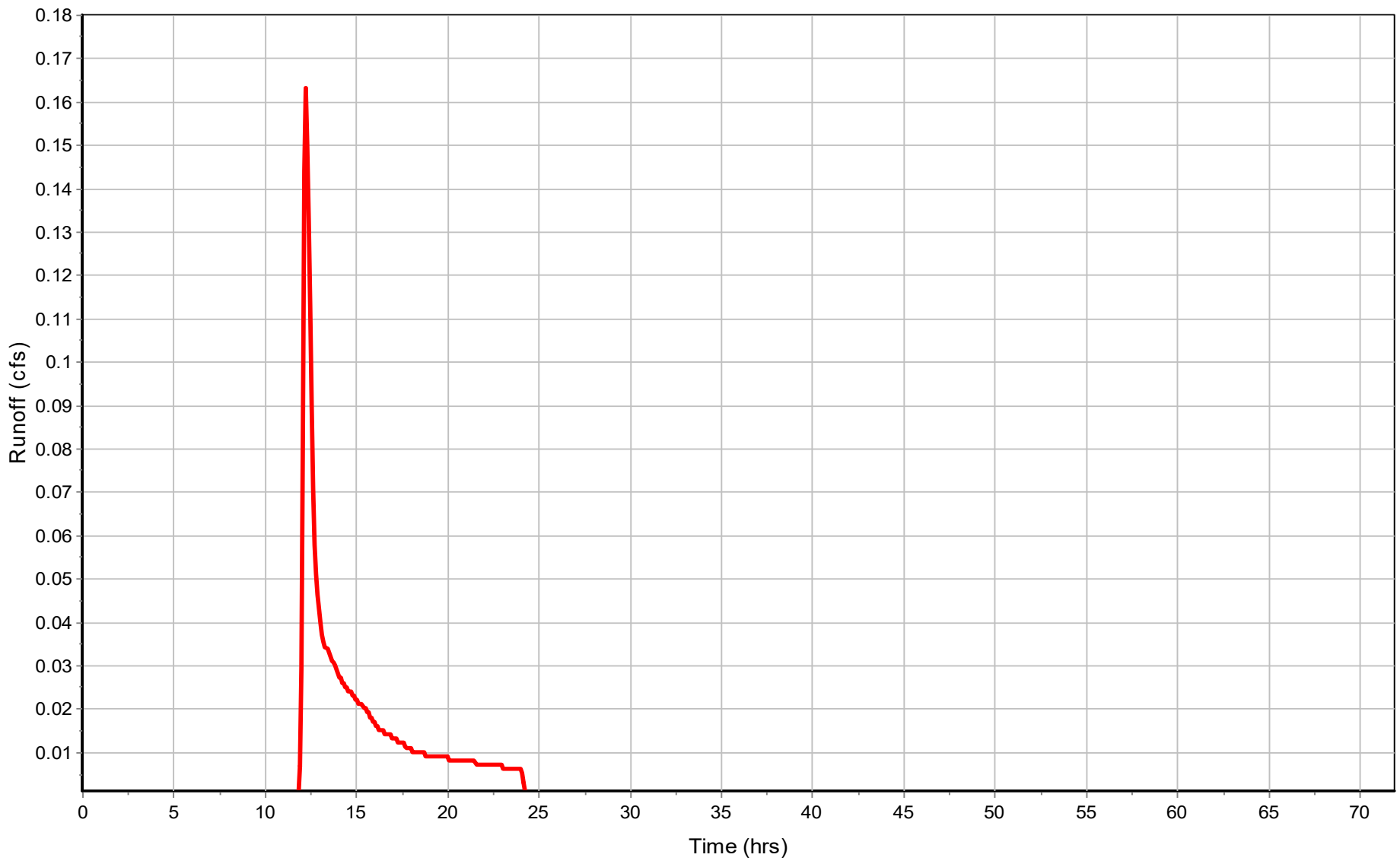
Total Rainfall (in) 7.48
Total Runoff (in) 1.29
Peak Runoff (cfs) 0.16
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:15:05

Subbasin : Sub-E04

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A4

Input Data

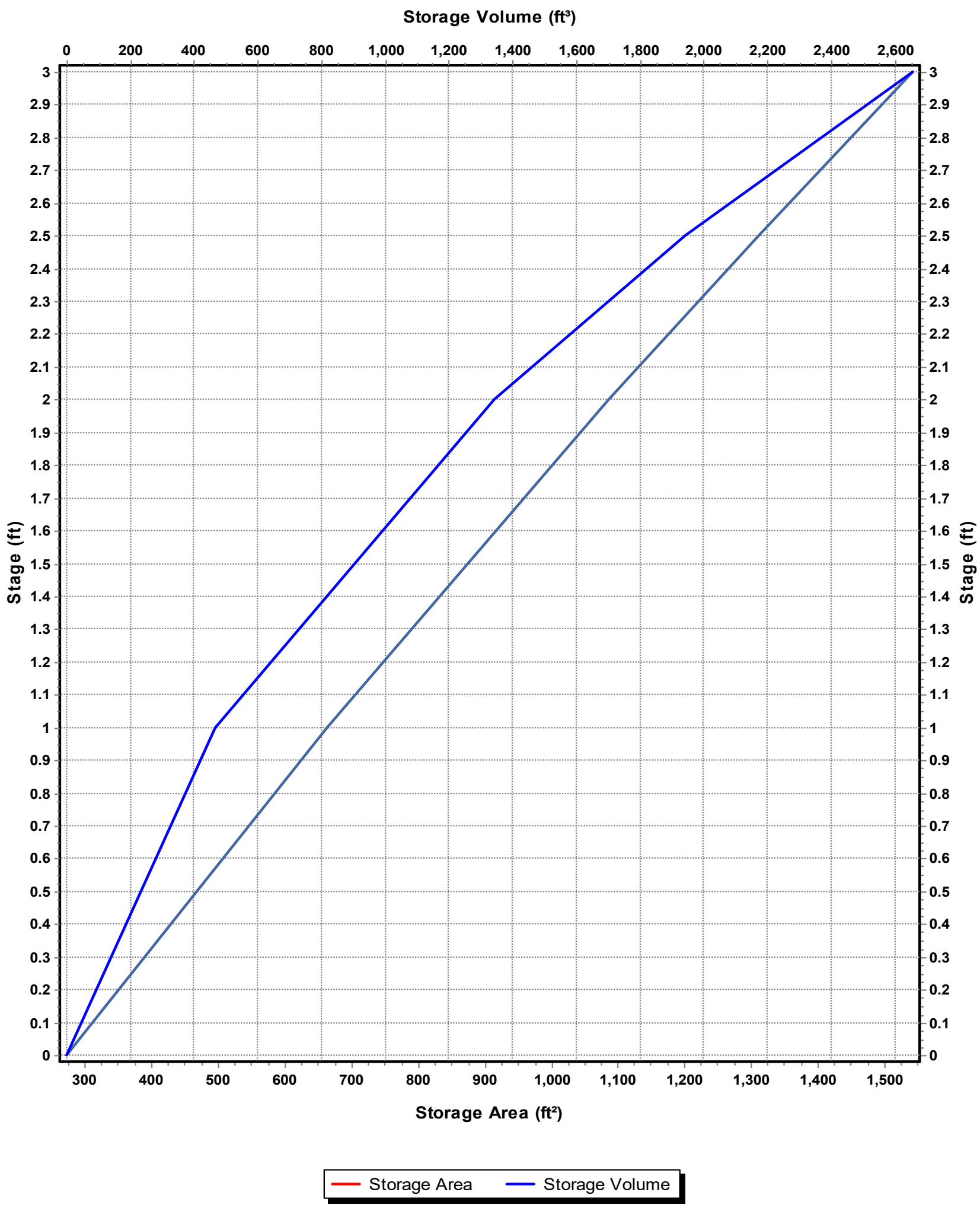
Invert Elevation (ft)	114.00
Max (Rim) Elevation (ft)	117.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.00
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

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

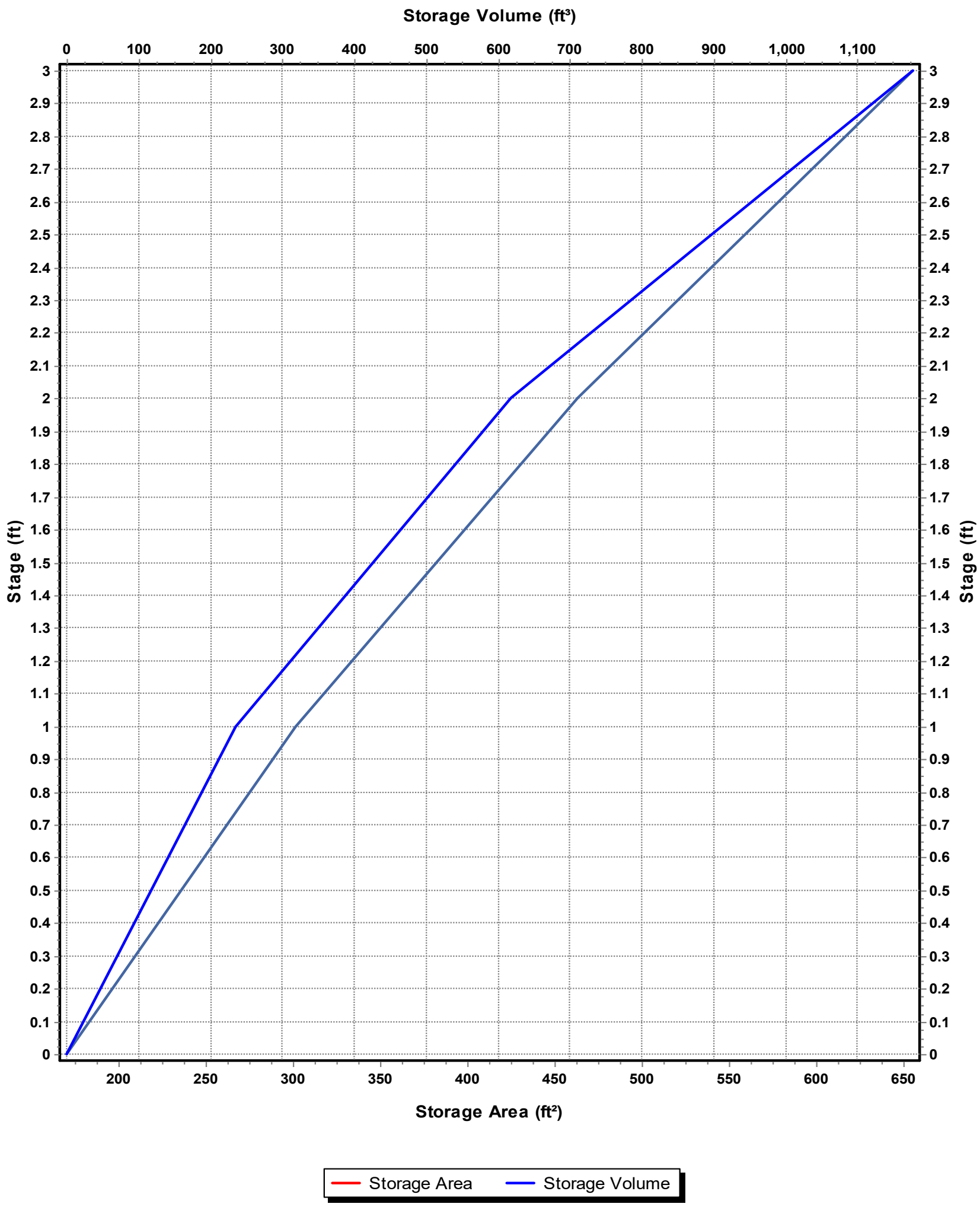
Invert Elevation (ft)	114.00
Max (Rim) Elevation (ft)	117.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.00
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

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

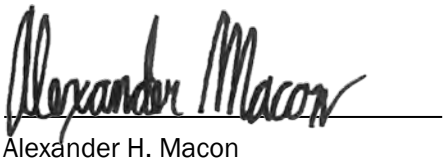
Prepared for:

Enbridge, Inc.
915 North Eldridge Parkway, Suite 1100
Houston, Texas 77079

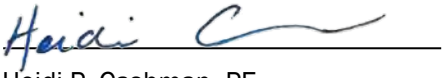
Attention: Cindy Dilber

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.

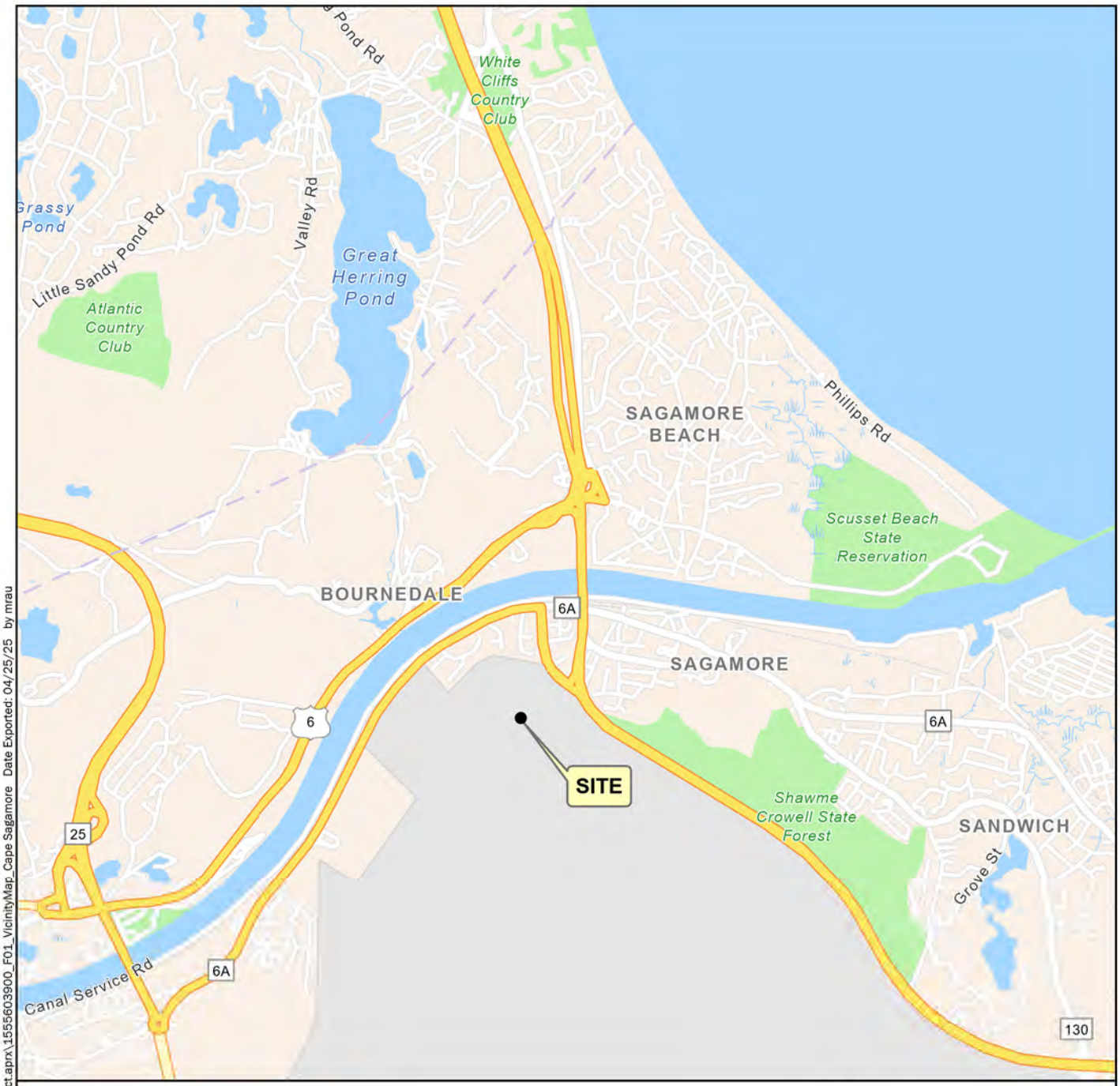
International Code Council, 2021, “International Building Code.”

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.

Date:4/24/25 Path:P:\15\15556039\GINT\15556039900.GPJ DBLibrary/Library:GEOUSA_DF_STD_US.GLB/GEI8_GEOTECH_STANDARD_%F_NO_GW_4BC

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

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

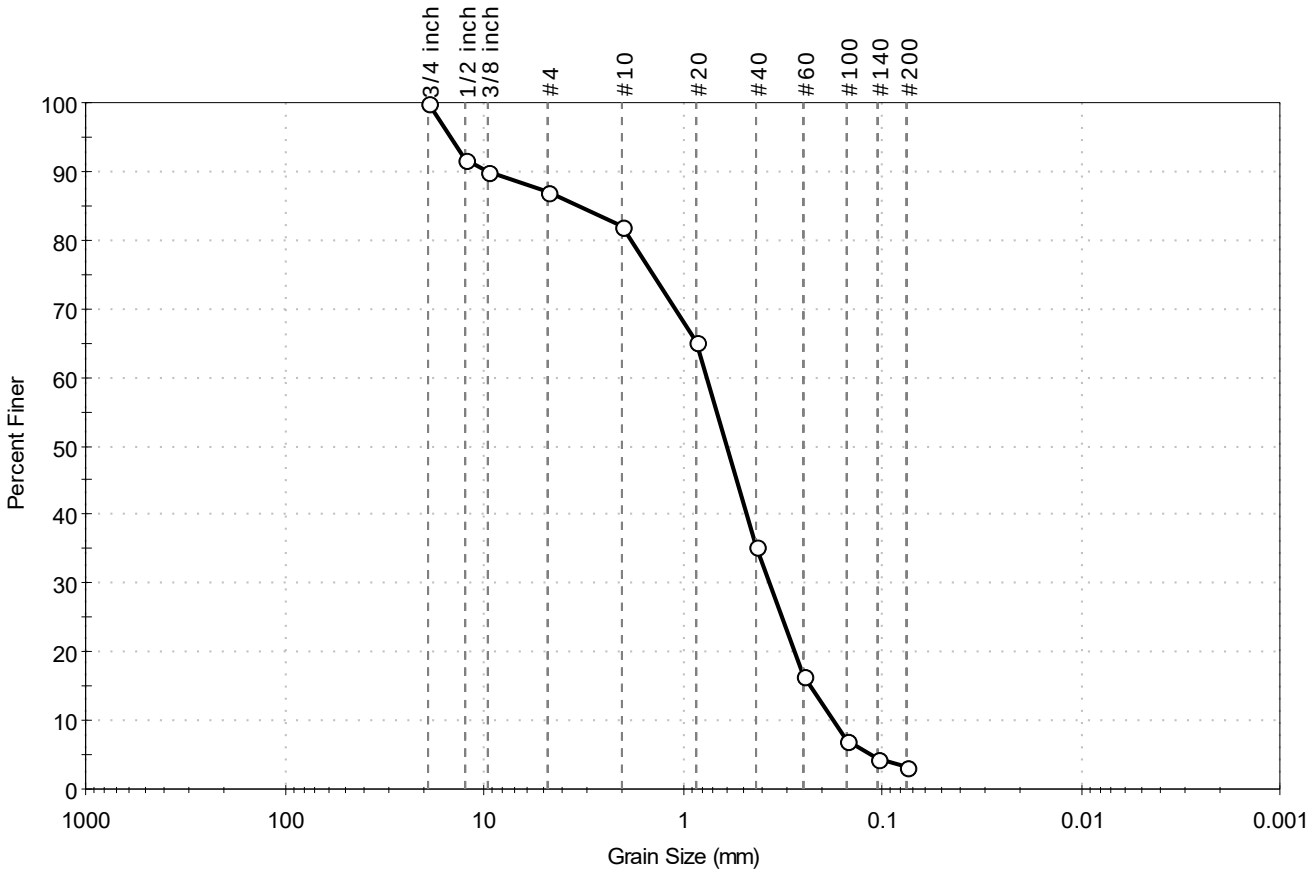
Client:	GeoEngineers, Inc.				
Project:	Cape Cod - En bridge				
Location:	MA			Project No:	GTX-320749
Boring ID:	MR-02	Sample Type:	Jar	Tested By:	ajl
Sample ID:	S-5	Test Date:	03/27/25	Checked By:	ank
Depth :	8-10	Test Id:	808039		
Test Comment:	---				
Visual Description:	Moist, yellowish brown sand				
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

COMMONWEALTH OF MASSACHUSETTS
PAUL BAKER
CIVIL
No. 58957
PROFESSIONAL ENGINEER
07/08/26

ENBRIDGE®

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

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: EROSION AND SEDIMENT CONTROL COVER SHEET
TITLE	INITIALS	DATE	LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

YEAR: 2026 | W.O.: | SCALE: NTS | DWG.: 00845-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\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

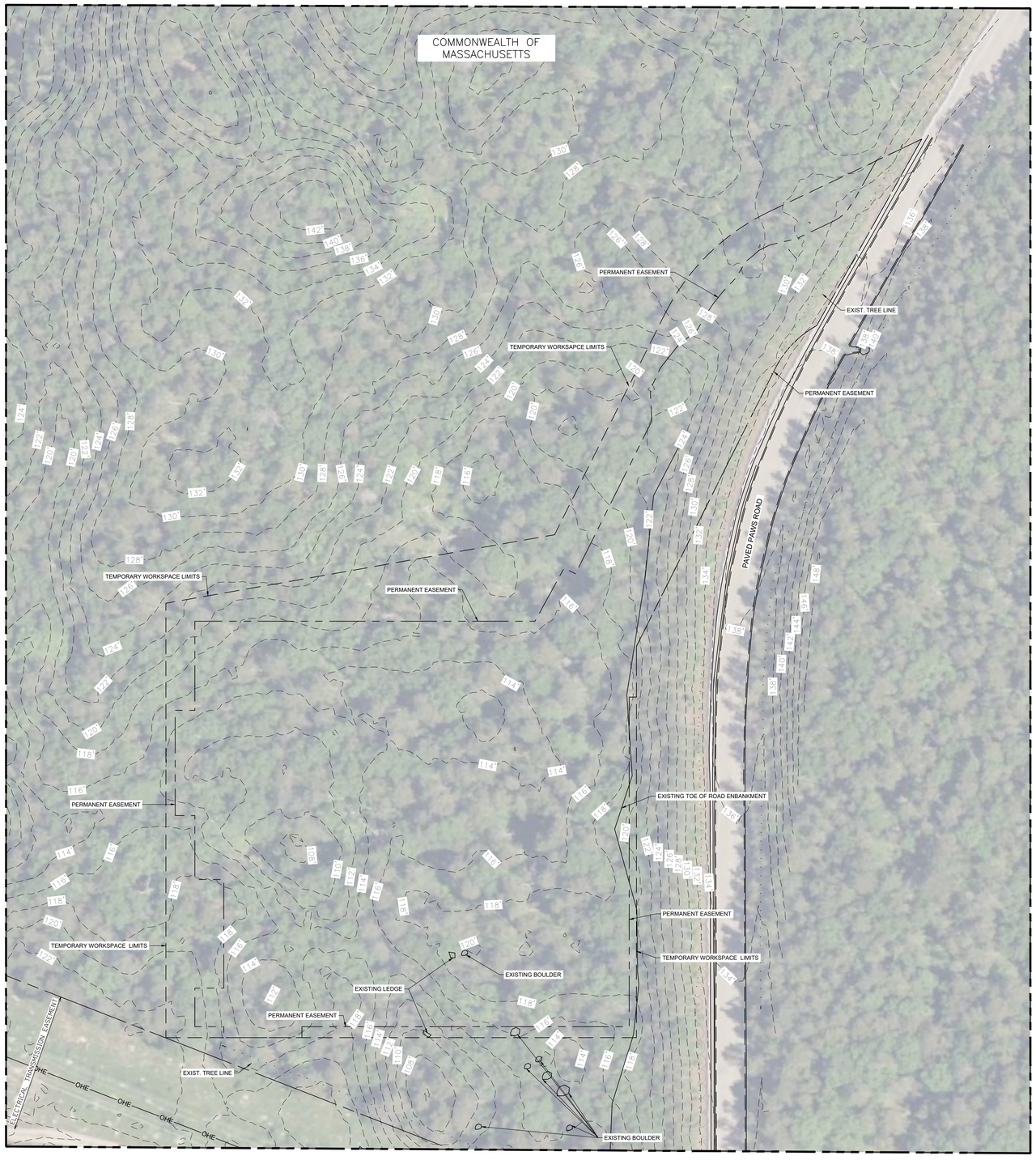
TITLE	INITIALS	DATE
DRAWN BY:	VN	05/15/26
DESIGN CHECKER:	DT	06/24/26
DESIGN ENGINEER:	PB	06/24/26
PROJECT MANAGER:	AC	06/24/26

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

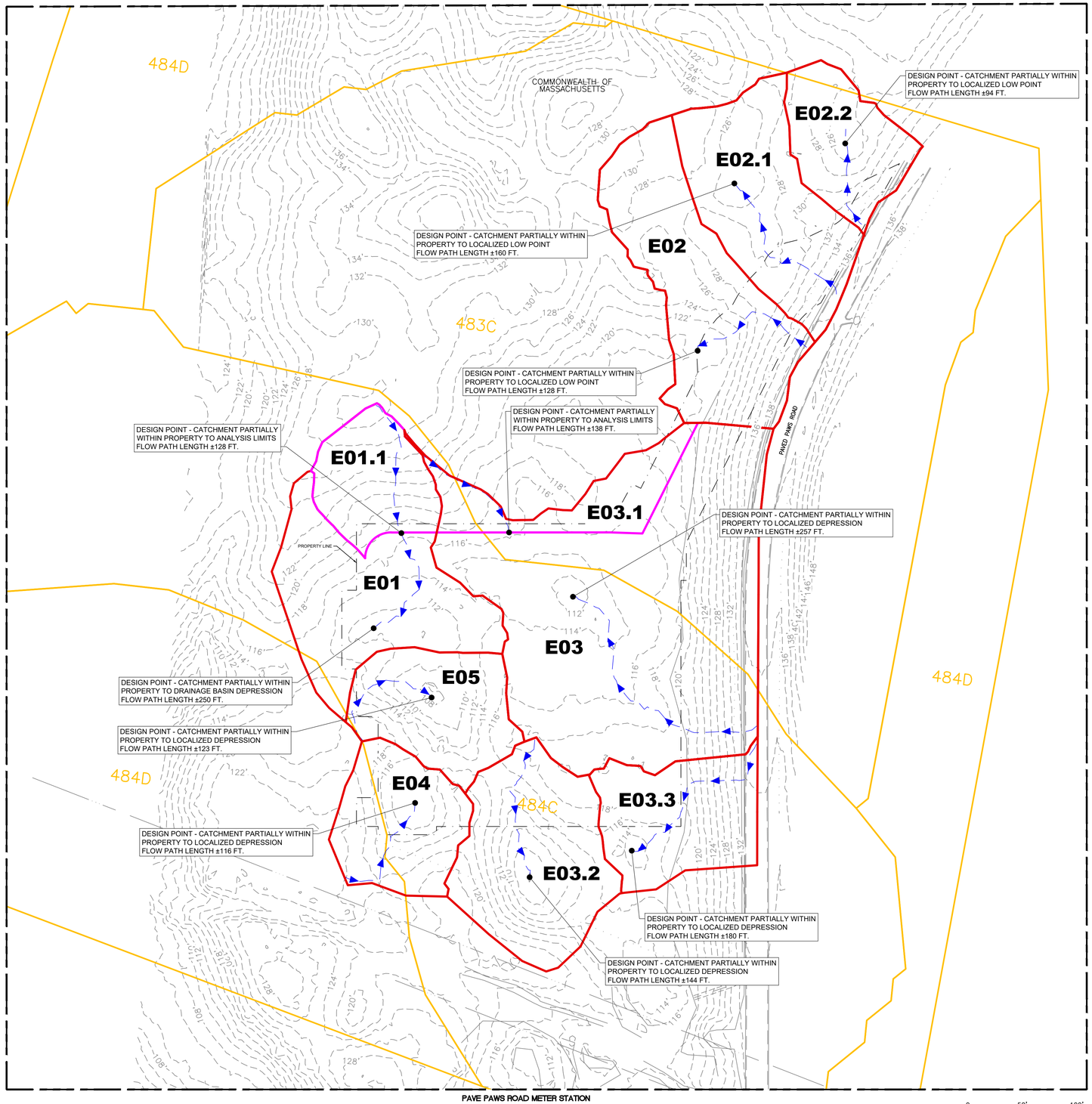
DRAWN BY:	JA	05/15/26	CAPE COD CANAL PIPELINE RELOCATION PROJECT
DESIGN CHECKER:	DT	06/24/26	PAVE PAWS ROAD METER STATION
DESIGN ENGINEER:	PB	06/24/26	M&R 00845
PROJECT MANAGER:	AC	06/24/26	TITLE: EXISTING CONDITIONS PLAN
TITLE	INITIALS	DATE	LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

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

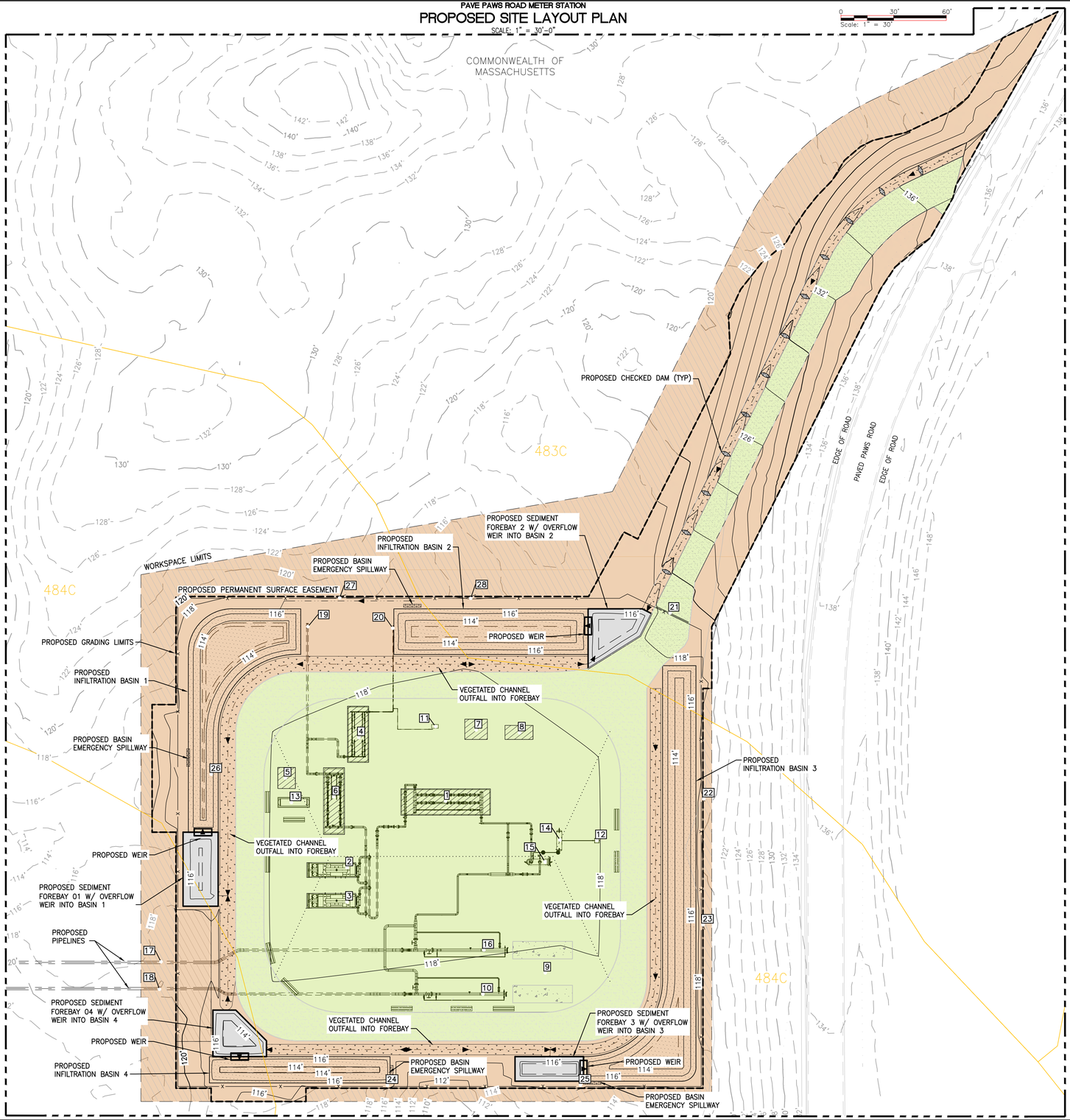
ENBRIDGE
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

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

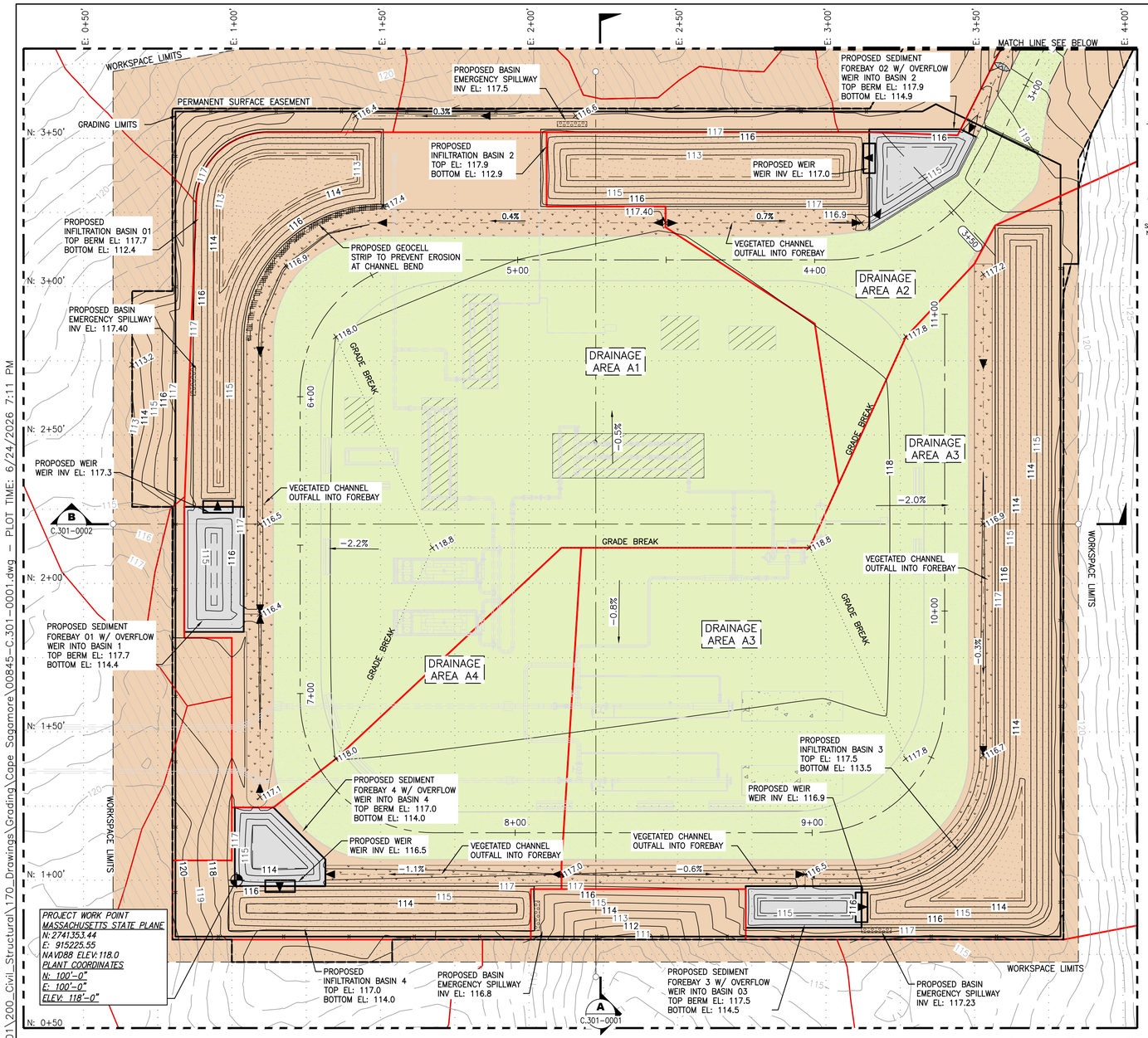
DRAWN BY:	JA	05/15/26
DESIGN CHECKER:	DT	06/24/26
DESIGN ENGINEER:	PB	06/24/26
PROJECT MANAGER:	AC	06/24/26

CAPE COD CANAL PIPELINE RELOCATION PROJECT
PAVE PAWS ROAD METER STATION
M&R 00845
TITLE: PROPOSED SITE LAYOUT PLAN
LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

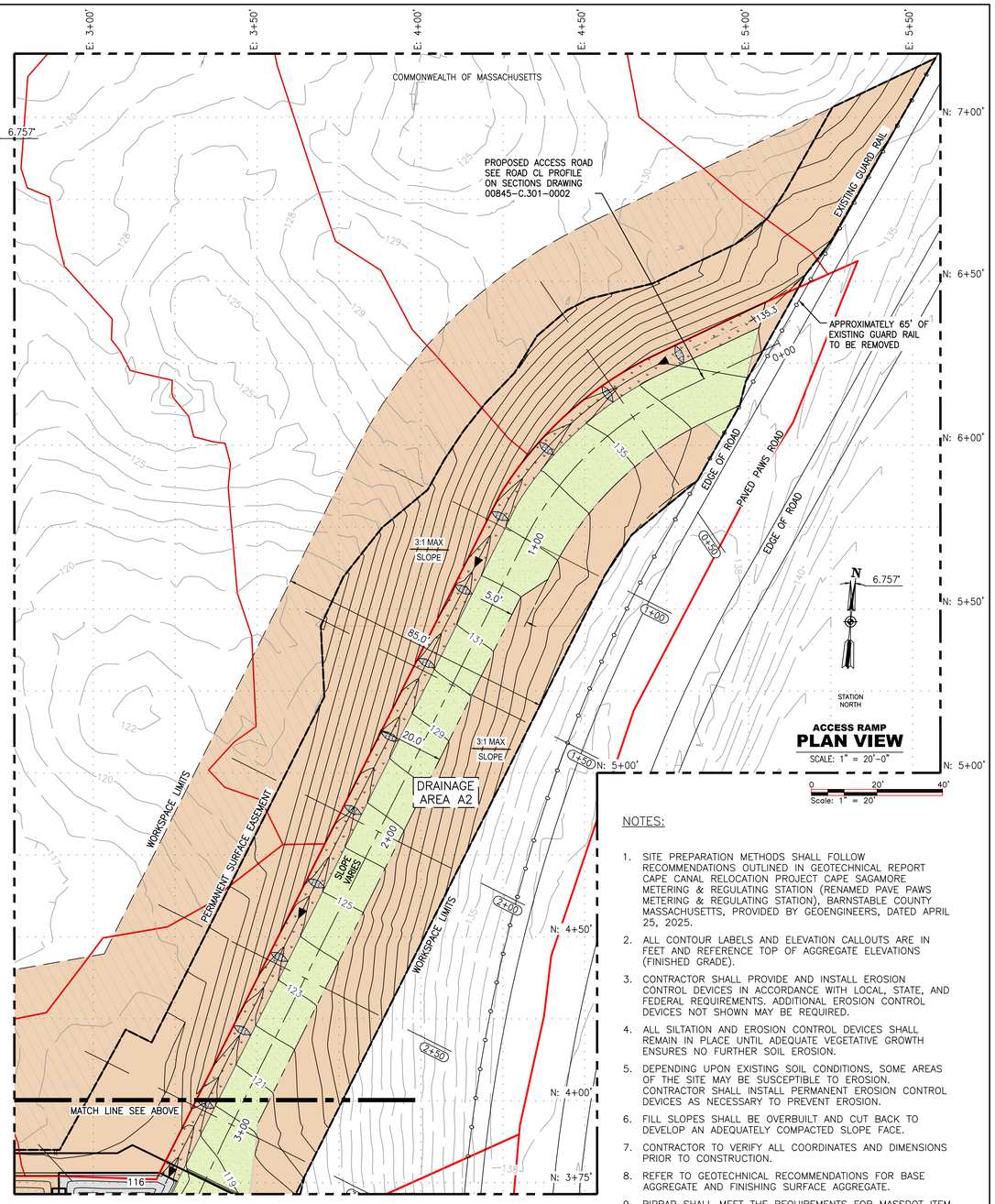
ENBRIDGE
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

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

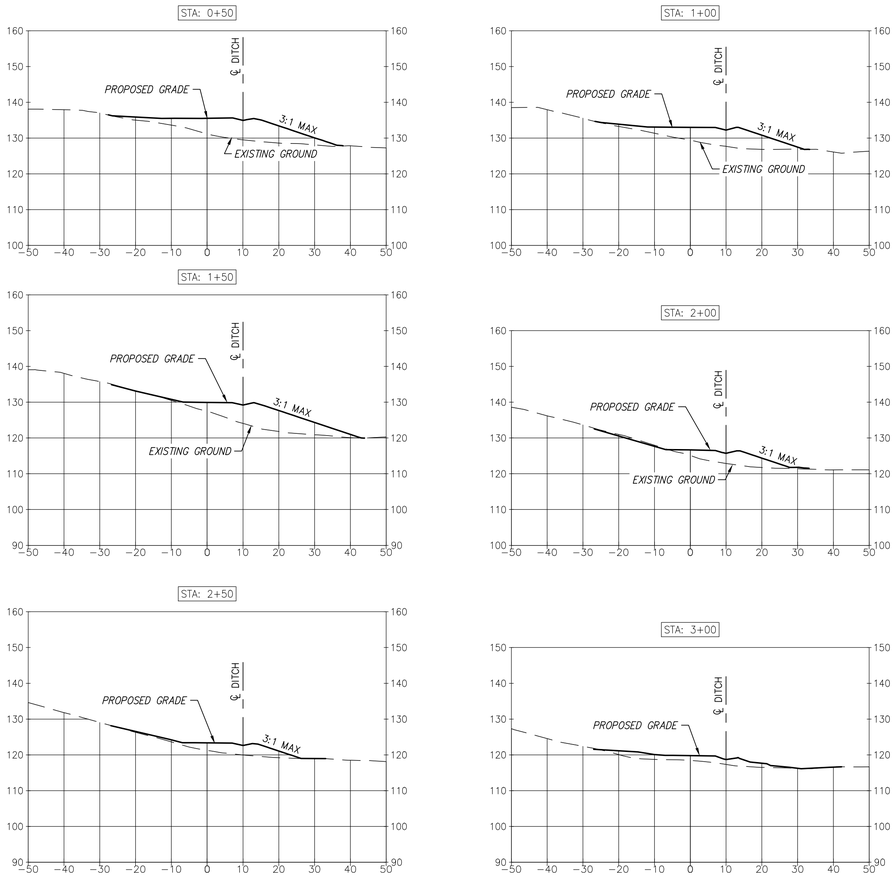
audubon Engineering
3505 W. SAM HOUSTON PKWY. N., SUITE 100
HOUSTON, TX 77043
PHONE: (281) 669-0590

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

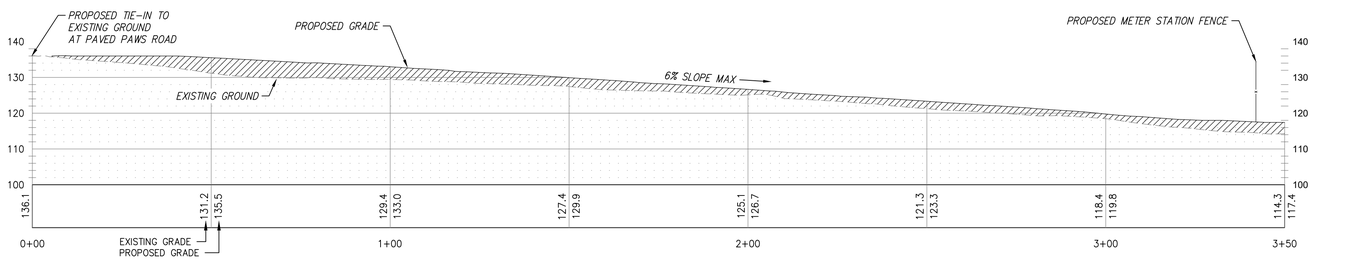
S:\AE\Projects\Enbridge\Mass\026356-001\200_Civil_Structural\170_Drawings\Grading\Cape Sagamore\00845-C.301-0001.dwg – PLOT TIME: 6/24/2026 7:11 PM



REFER TO GRADING PLAN 00845-C.301-0001

ACCESS ROAD RAMP CROSS SECTIONS

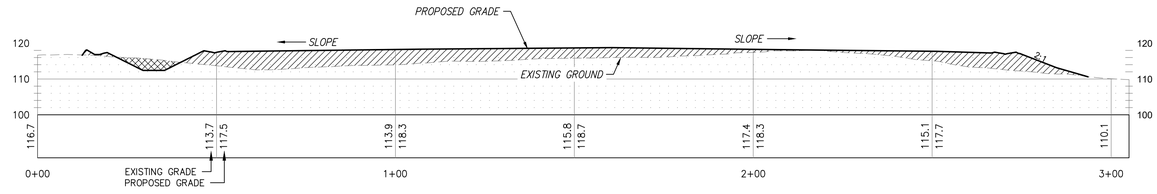
HORZ. & VERT. SCALE: 1" = 20'-0"



REFER TO GRADING PLAN 00845-C.301-0001

ACCESS ROAD RAMP C/L PROFILE

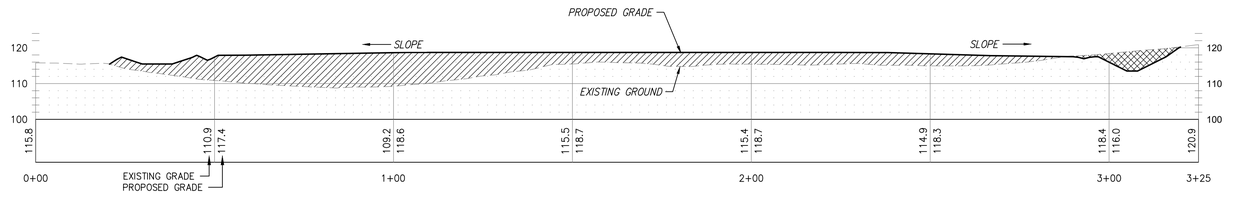
SCALE: 1" = 20'-0"



REFER TO GRADING PLAN 00845-C.301-0001

SECTION A

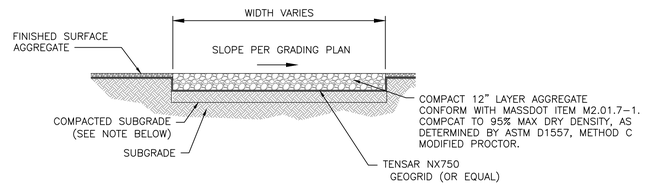
SCALE: 1" = 20'-0"



REFER TO GRADING PLAN 00845-C.301-0001

SECTION B

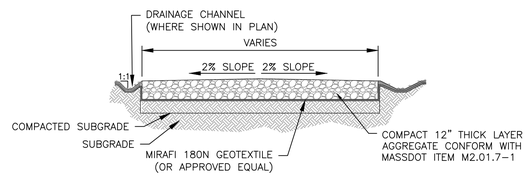
SCALE: 1" = 20'-0"



DETAIL B – TYPICAL AGGREGATE DRIVE AISLE

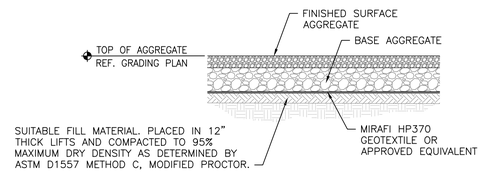
SCALE: NOT TO SCALE

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

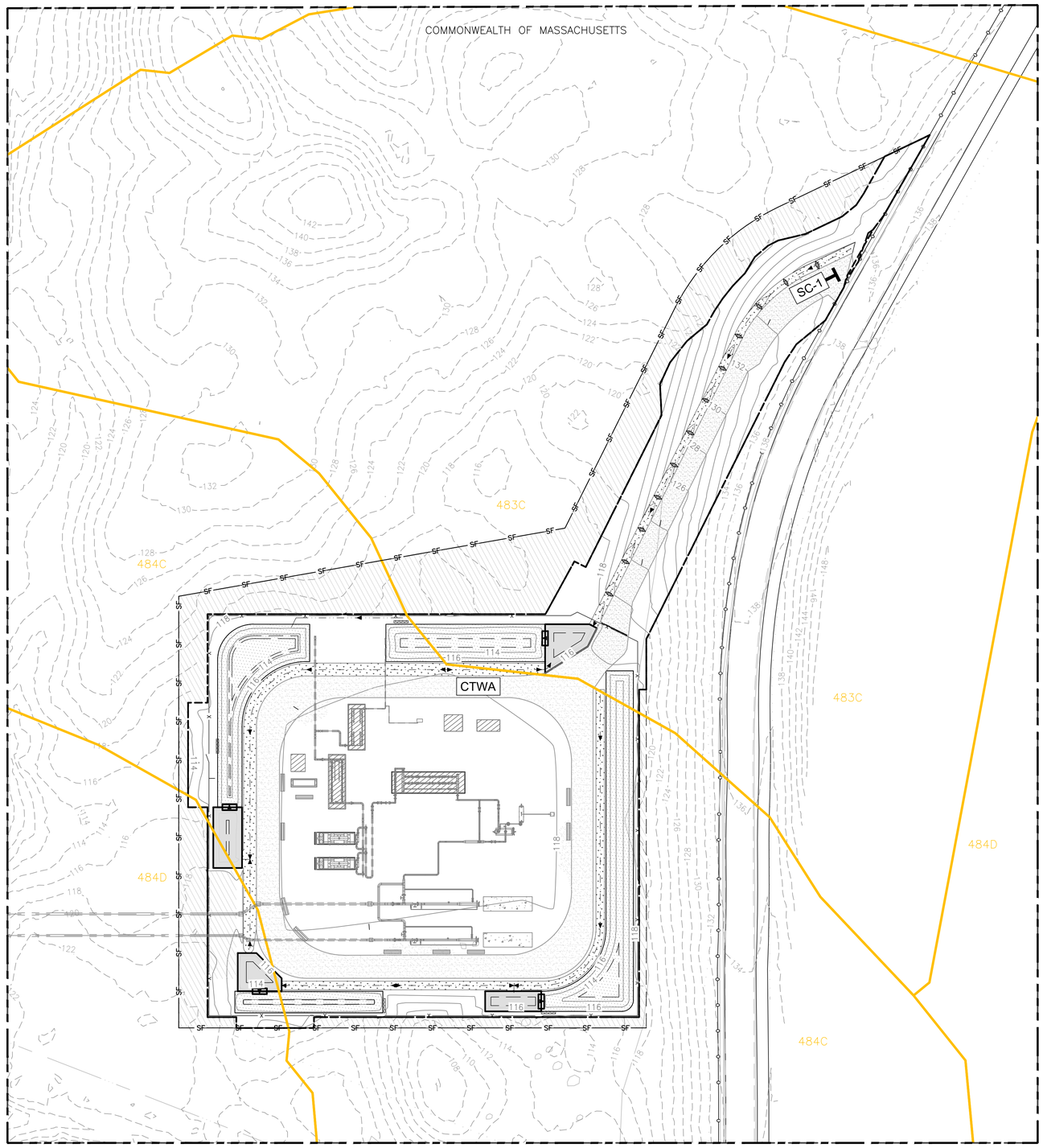
CAPE COD CANAL PIPELINE RELOCATION PROJECT
PAVE PAWS ROAD METER STATION
M&R 0845
TITLE: GRADING CROSS SECTIONS

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

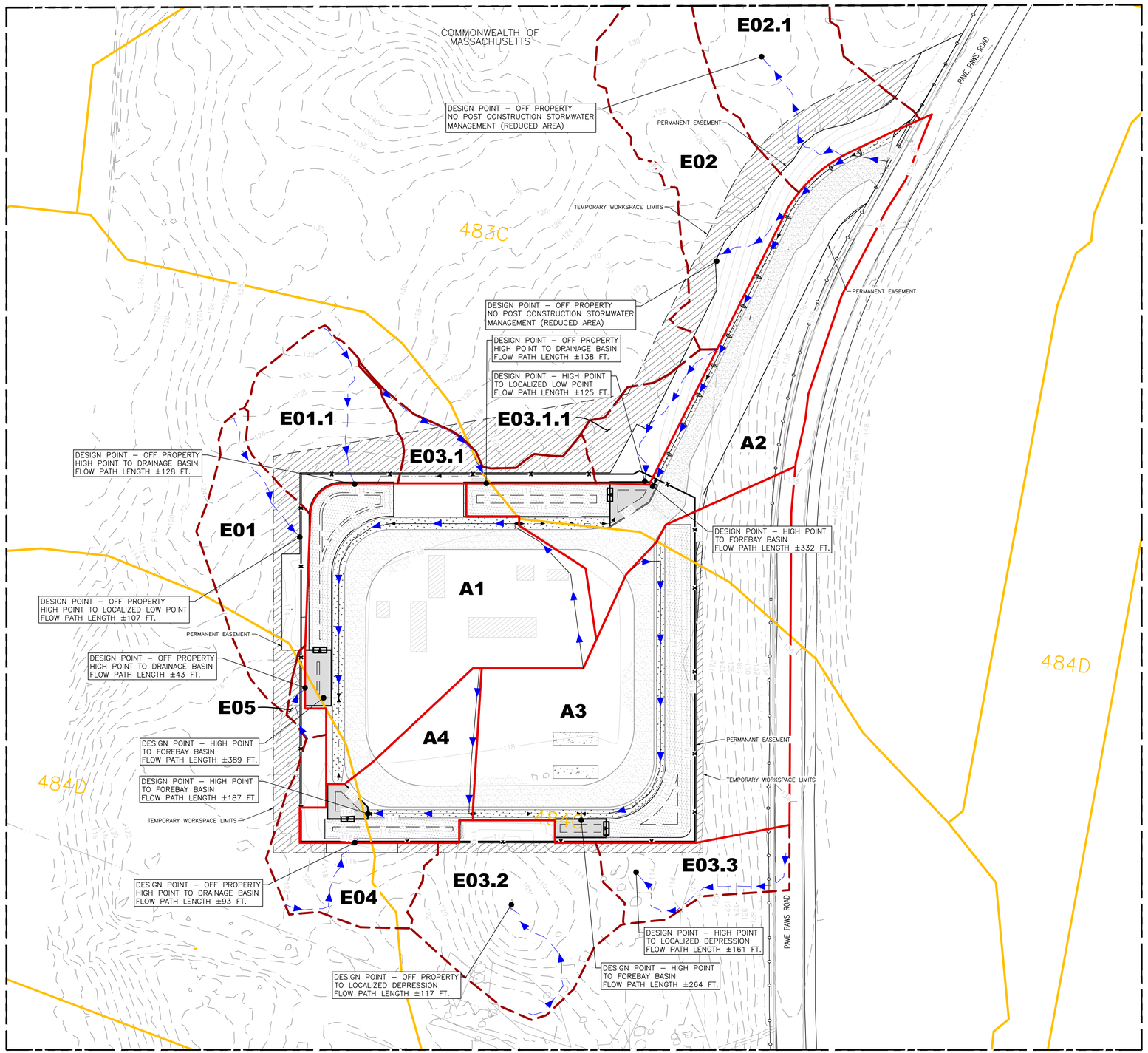
CAPE COD CANAL PIPELINE RELOCATION PROJECT
PAVE PAWS ROAD METER STATION
M&R 00845
CONSTRUCTION EROSION AND SEDIMENT CONTROL PLAN

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

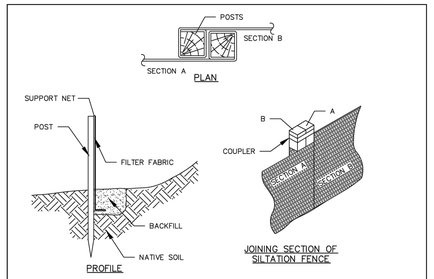
E&S CONSTRUCTION SEQUENCE AND MAINTENANCE

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:

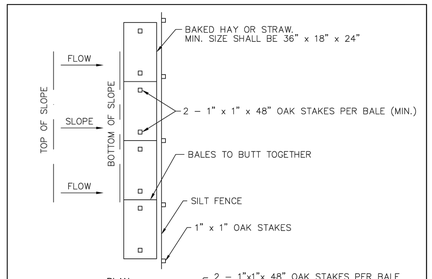
- INSPECT ALL EROSION AND SEDIMENTATION CONTROL MEASURES PERIODICALLY AND AFTER EACH RAINFALL EVENT. INSPECTION RECORDS SHALL BE MAINTAINED ONSITE BY THE CONTRACTOR.
- REPAIR OR REPLACE DAMAGED OR DETERIORATED EROSION CONTROL MEASURES IMMEDIATELY UPON IDENTIFICATION.
- REMOVE ACCUMULATED SEDIMENT FROM 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.



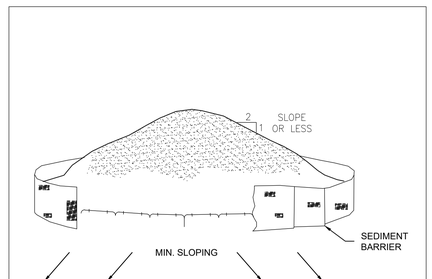
CONSTRUCTION NOTES

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



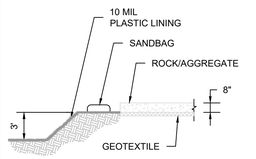
HAYBALES AND SILT FENCE

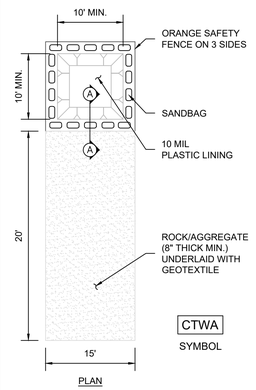


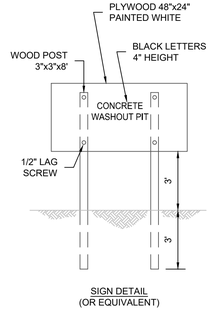
INSTALLATION NOTES:

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



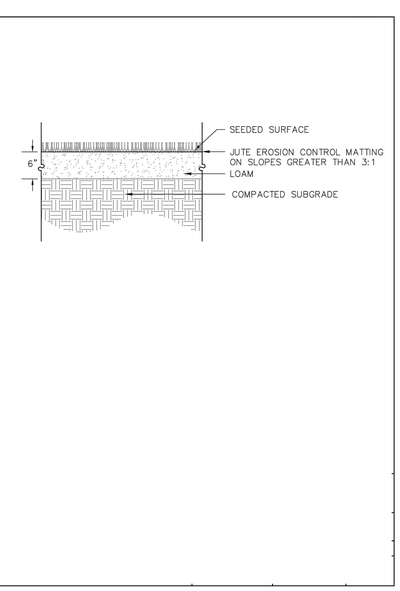




GENERAL NOTES:

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

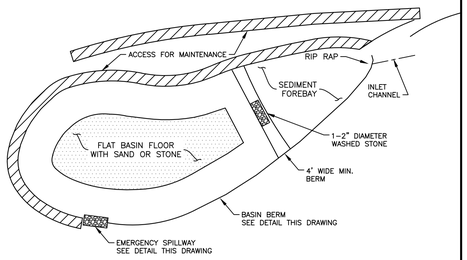
ENBRIDGE

LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

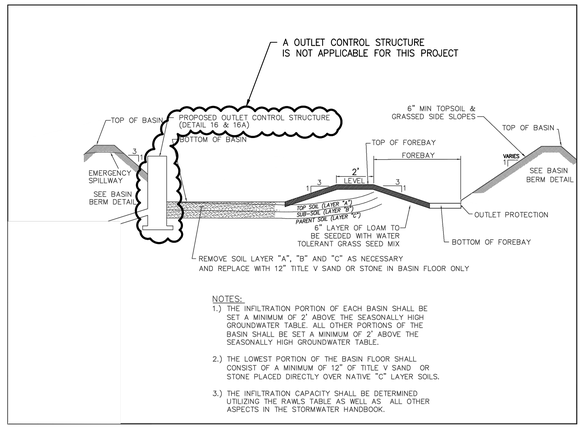
YEAR: 2026 | W.O.: | SCALE: N.T.S. | DWG.: 00845-C.320-0006 | REV.: C

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

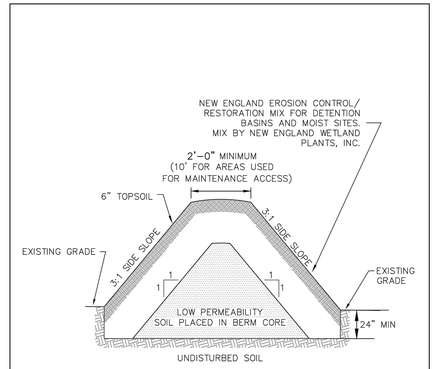


NOTES:
1.) THE INFILTRATION PORTION OF EACH BASIN SHALL BE SET A MINIMUM OF 2' ABOVE THE SEASONALLY HIGH GROUNDWATER TABLE. ALL OTHER PORTIONS OF THE BASIN SHALL BE SET A MINIMUM OF 2' ABOVE THE SEASONALLY HIGH GROUNDWATER TABLE.

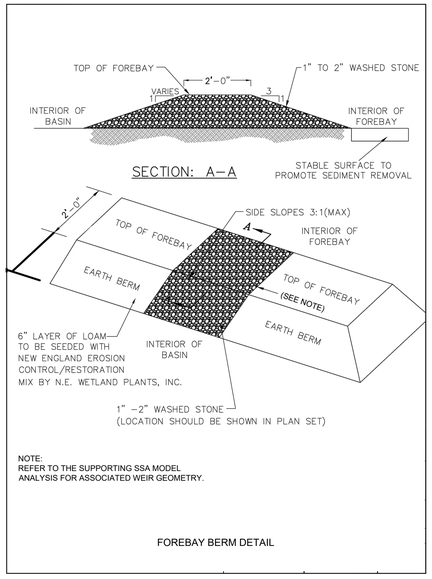
2.) THE LOWEST PORTION OF THE BASIN FLOOR SHALL CONSIST OF A MINIMUM OF 12" OF TITLE V SAND OR STONE PLACED DIRECTLY OVER NATIVE "C" LAYER SOILS.

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

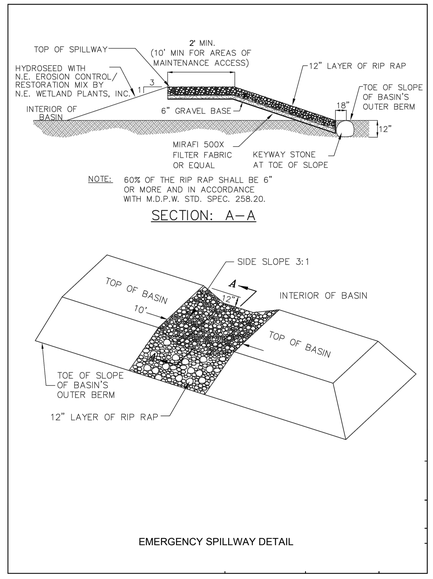


BASIN BERM DETAIL

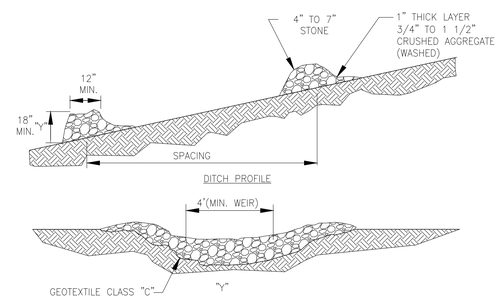


NOTE:
REFER TO THE SUPPORTING SSA MODEL ANALYSIS FOR ASSOCIATED WEIR GEOMETRY.

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.

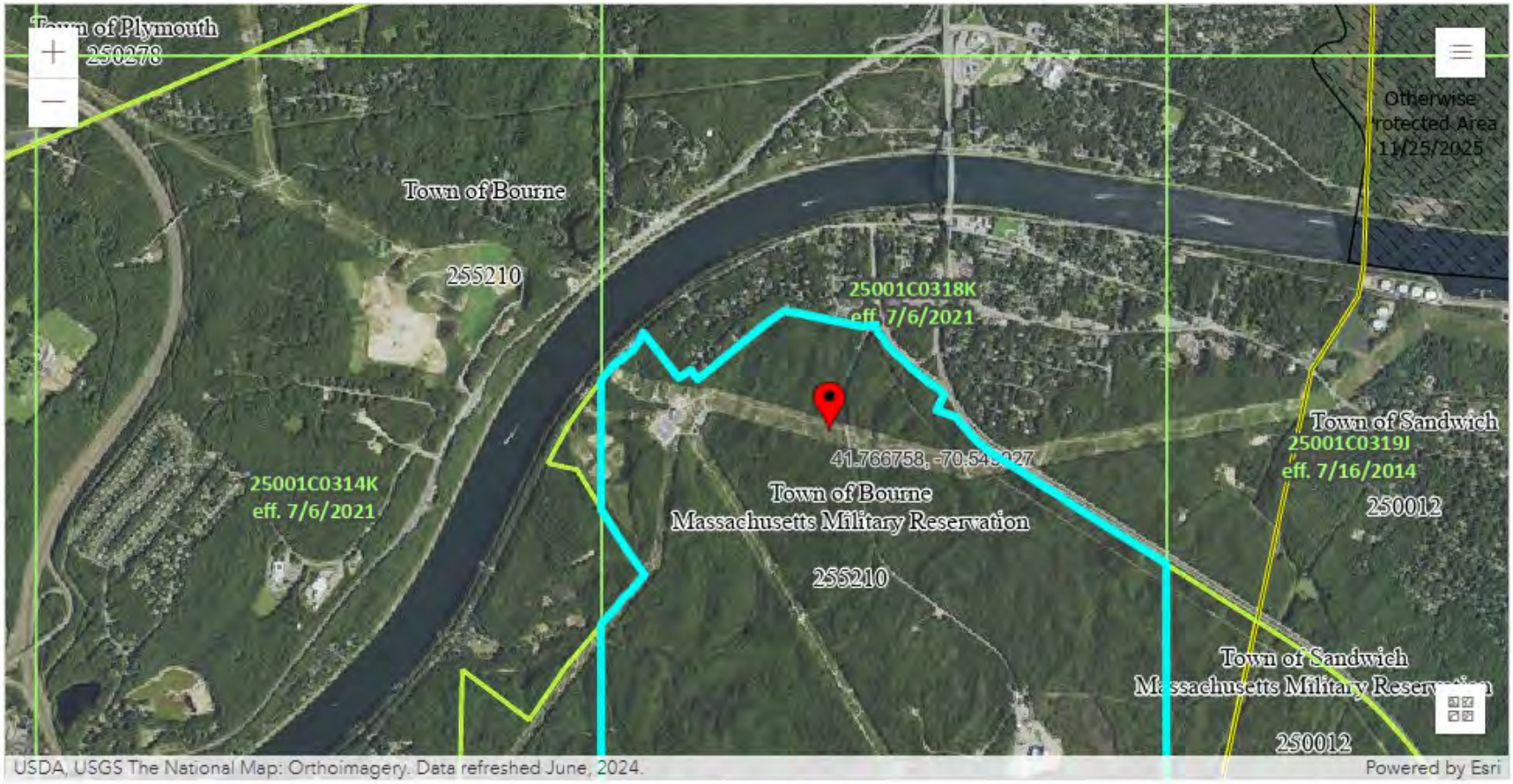
ENBRIDGE
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

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

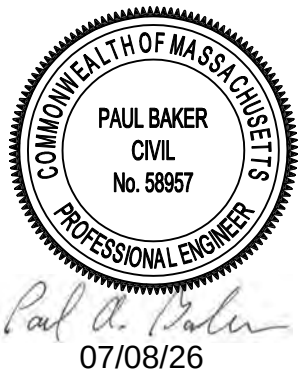
JULY 8, 2026

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

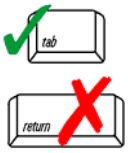
1 Checklist for Stormwater Report

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.

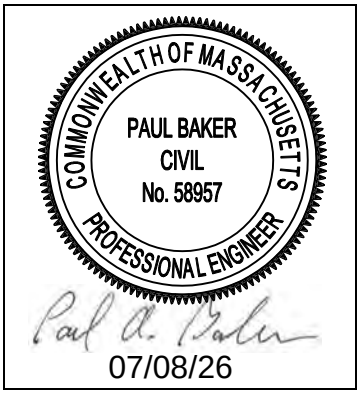
Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the 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

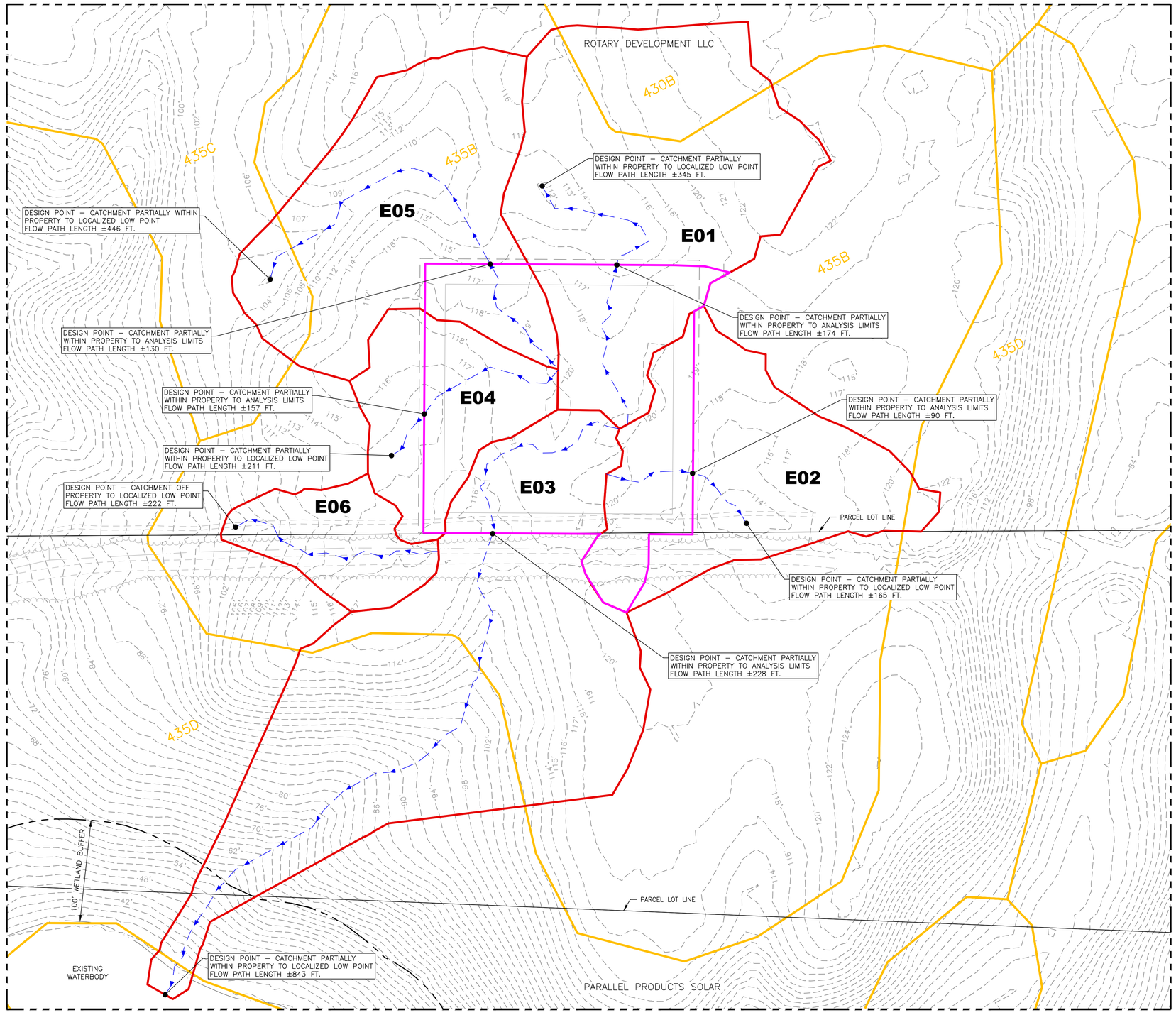
CAPE COD CANAL PIPELINE RELOCATION PROJECT
BOURNE ROTARY METER STATION
M&R 00846
TITLE: EXISTING CONDITIONS PLAN

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

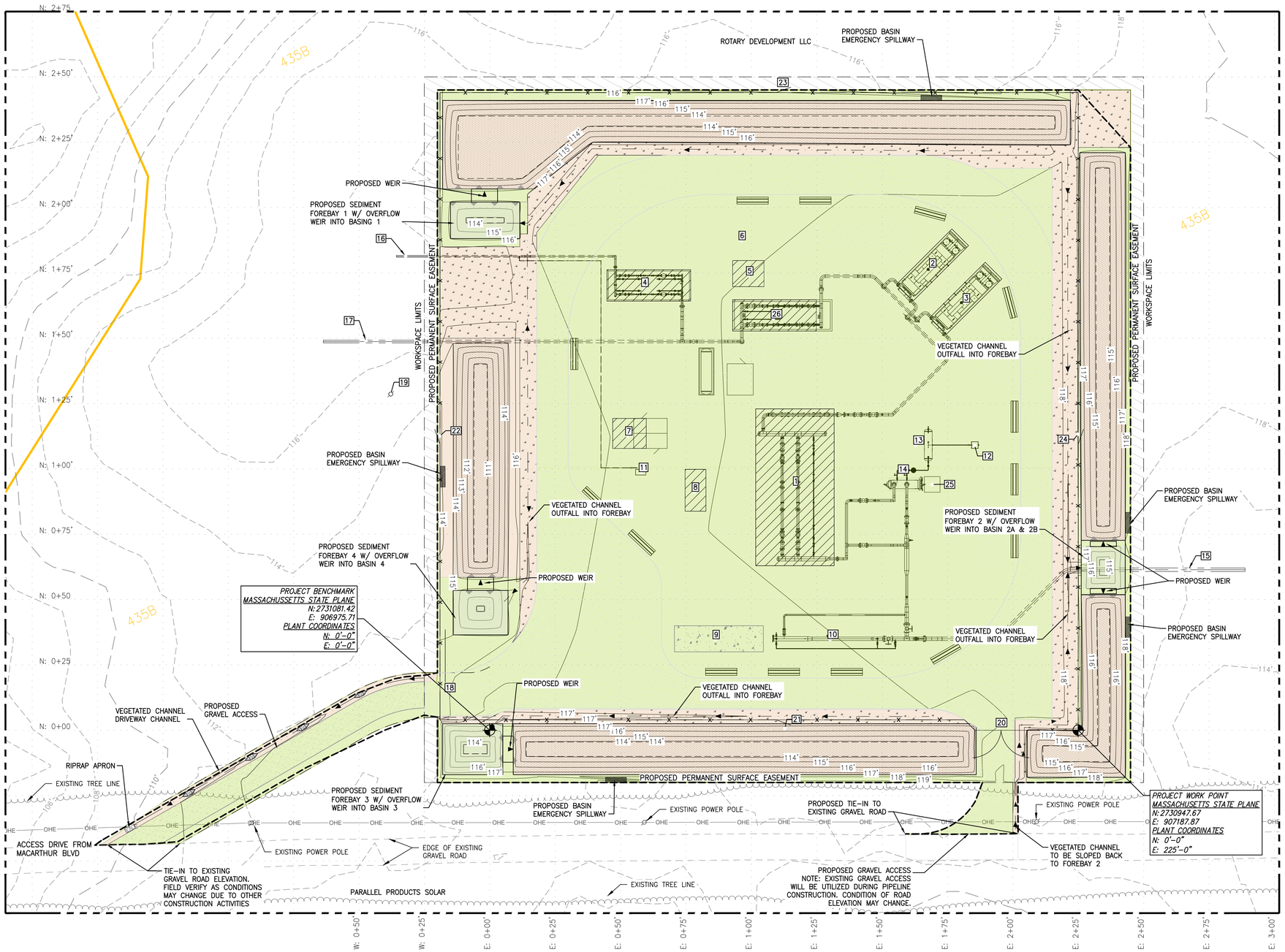
LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

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

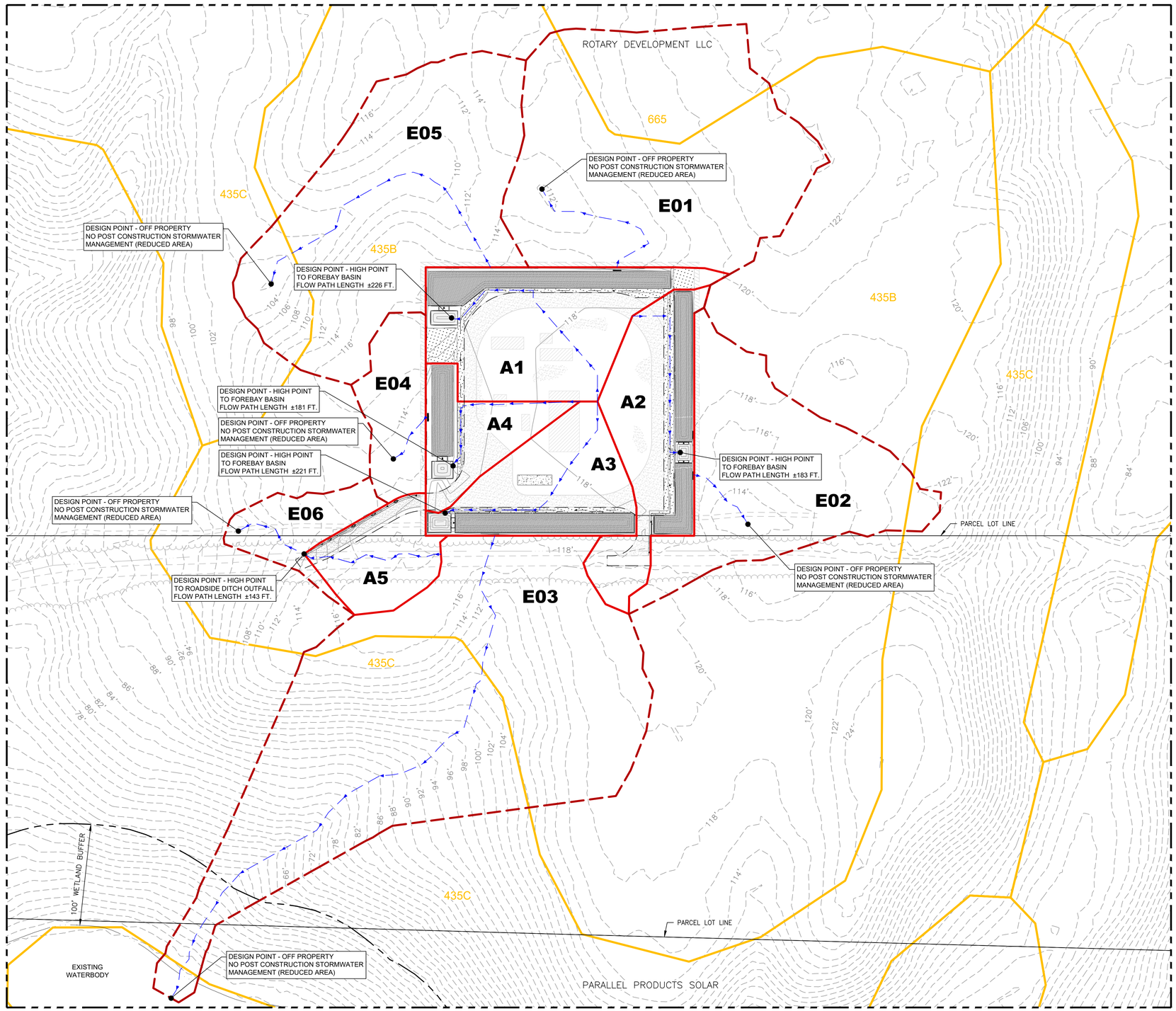
CAPE COD CANAL PIPELINE RELOCATION PROJECT
BOURNE ROTARY METER STATION
M&R 00846
TITLE: PROPOSED SITE LAYOUT PLAN

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

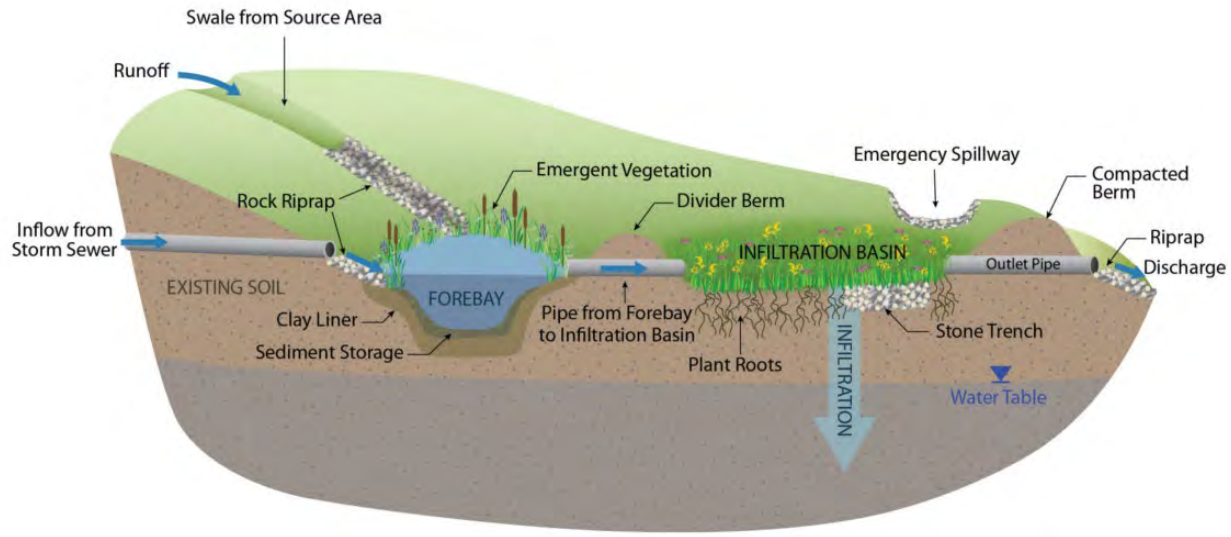


Illustration by Geosyntec Consultants, Inc.

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)

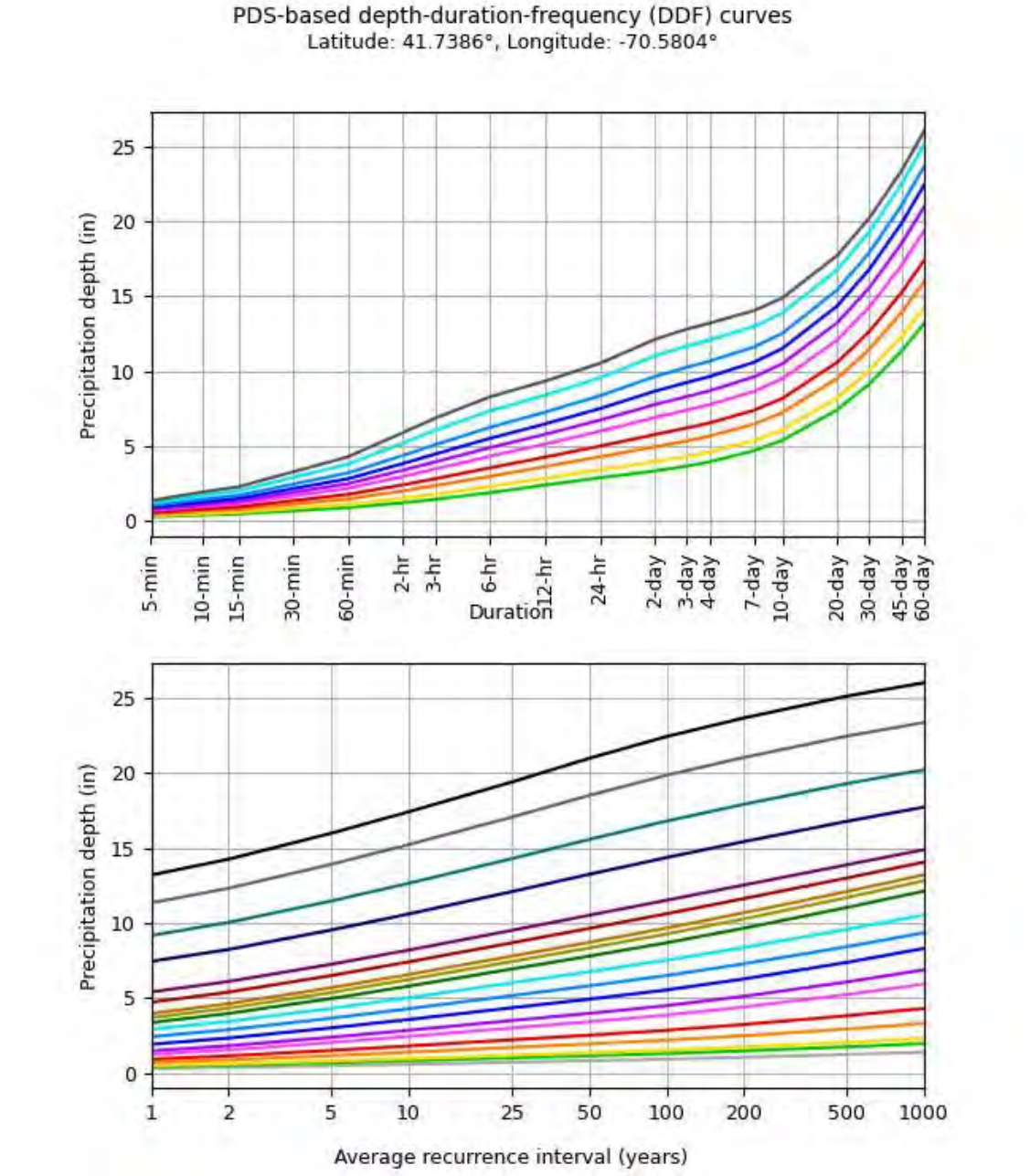
[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

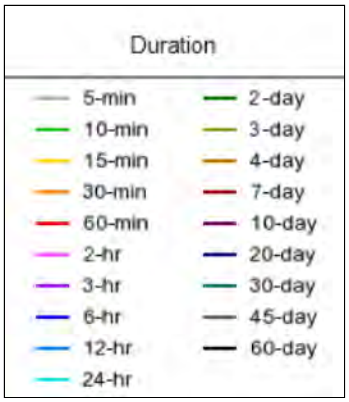
Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper 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





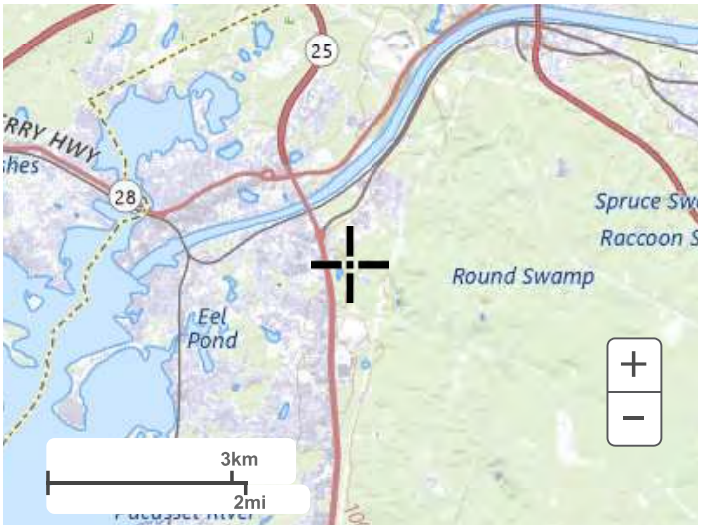
NOAA Atlas 14, Volume 10, Version 3

Created (GMT): Tue Apr 21 16:29:24 2026

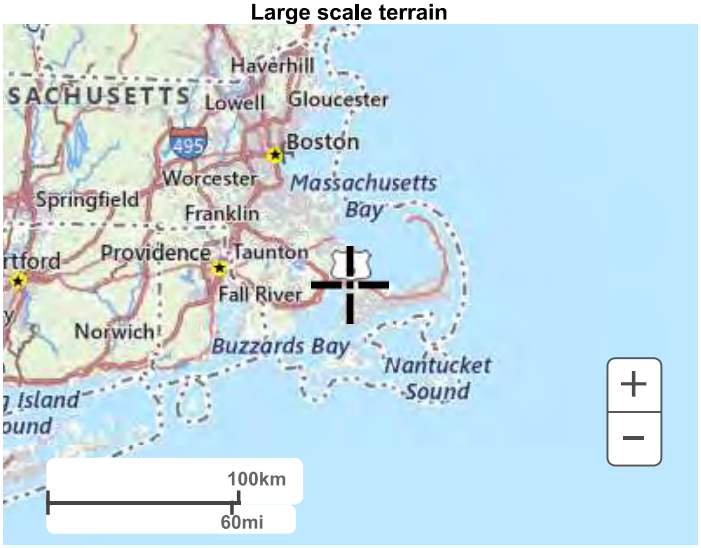
Back to Top

Maps & aerials

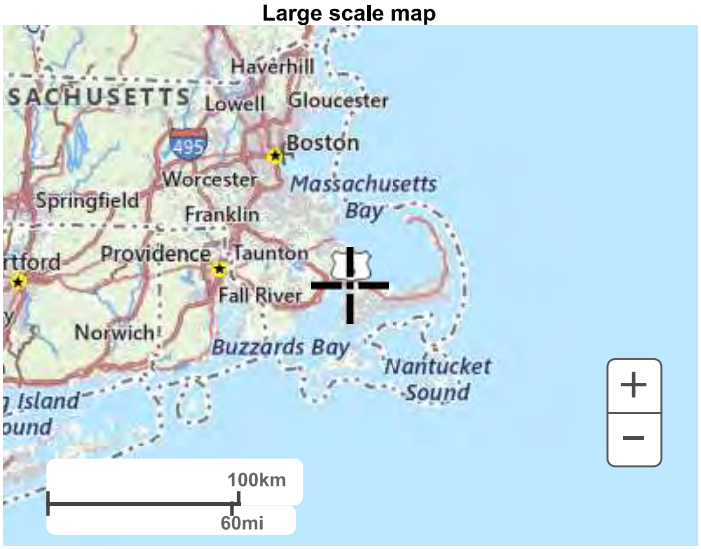
Small scale terrain



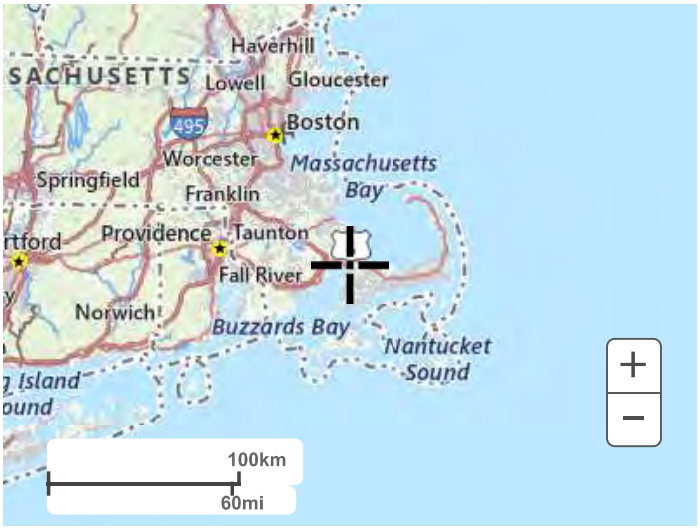
Large scale terrain



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

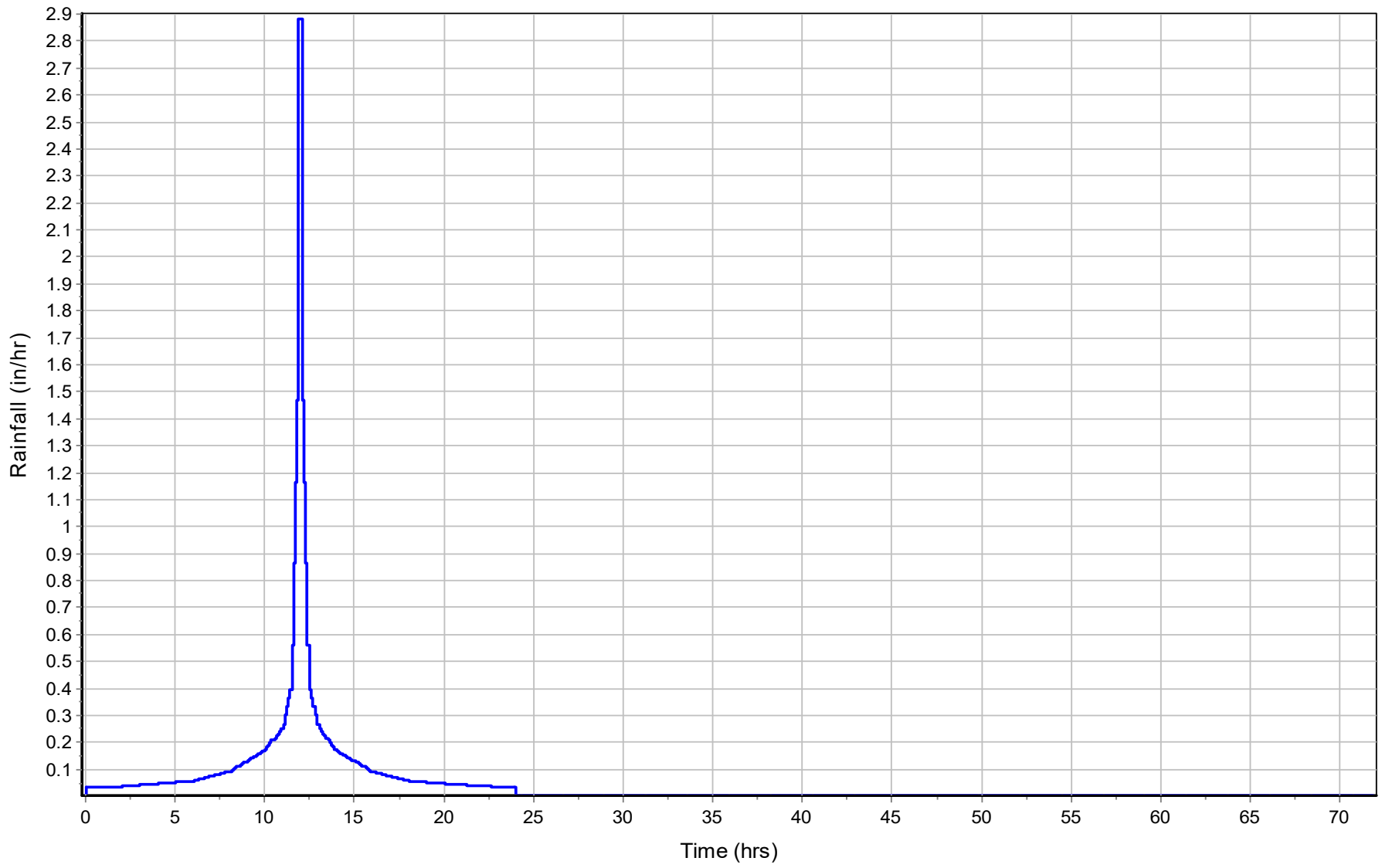
Total TOC (min) 3.15

Subbasin Runoff Results

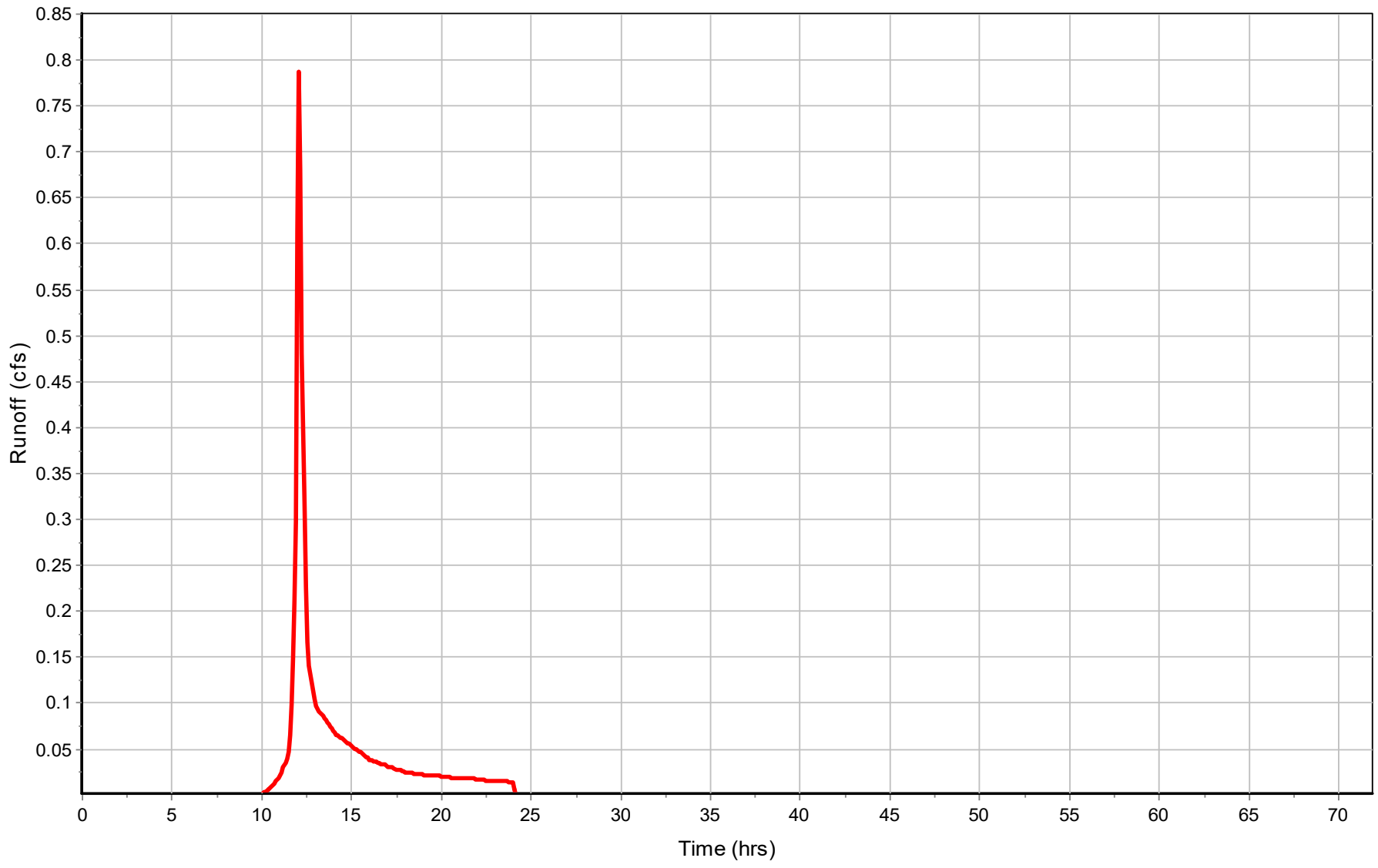
Total Rainfall (in)	3.43
Total Runoff (in)	1.32
Peak Runoff (cfs)	0.82
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:03:09

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

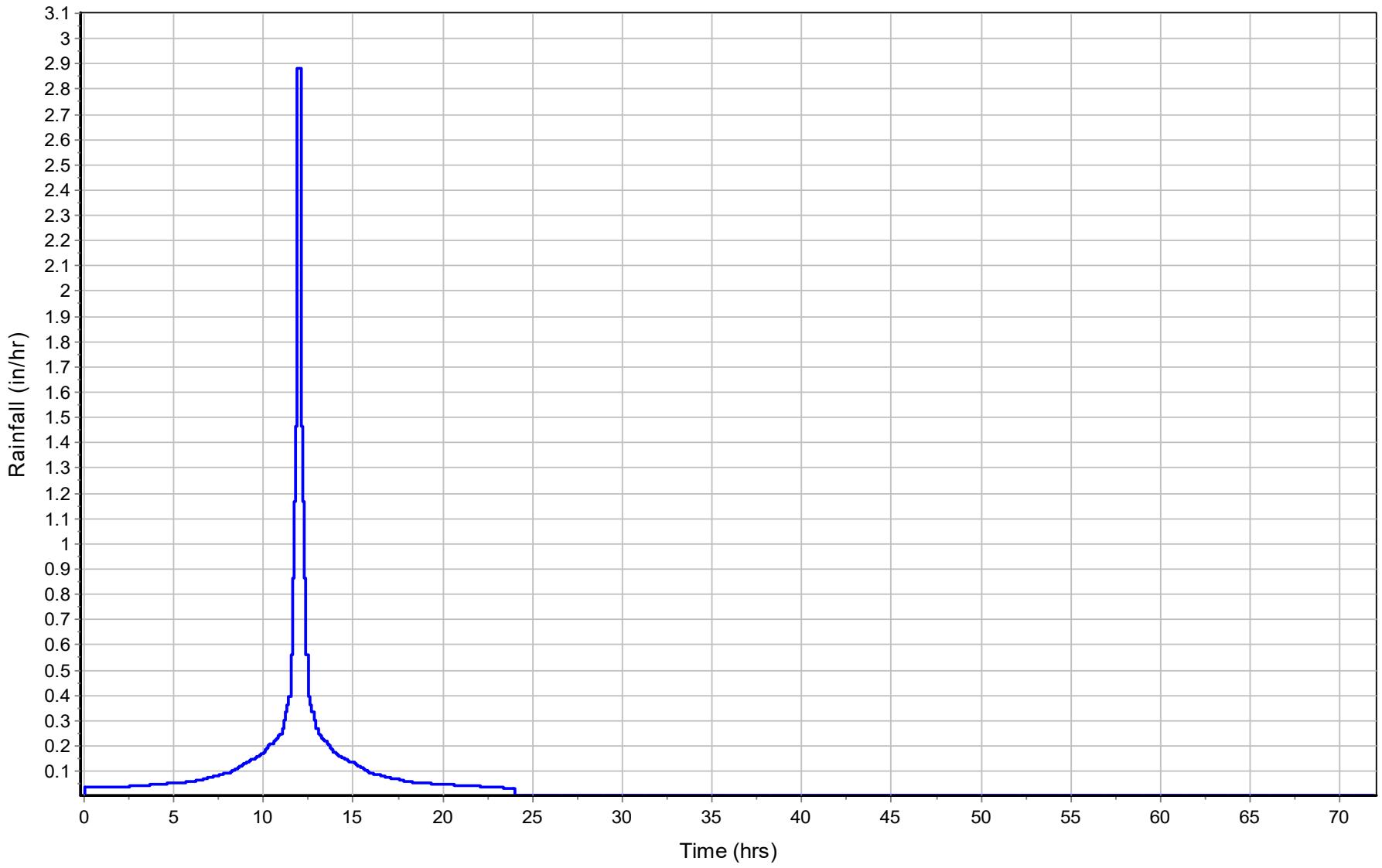
Total TOC (min) 39.09

Subbasin Runoff Results

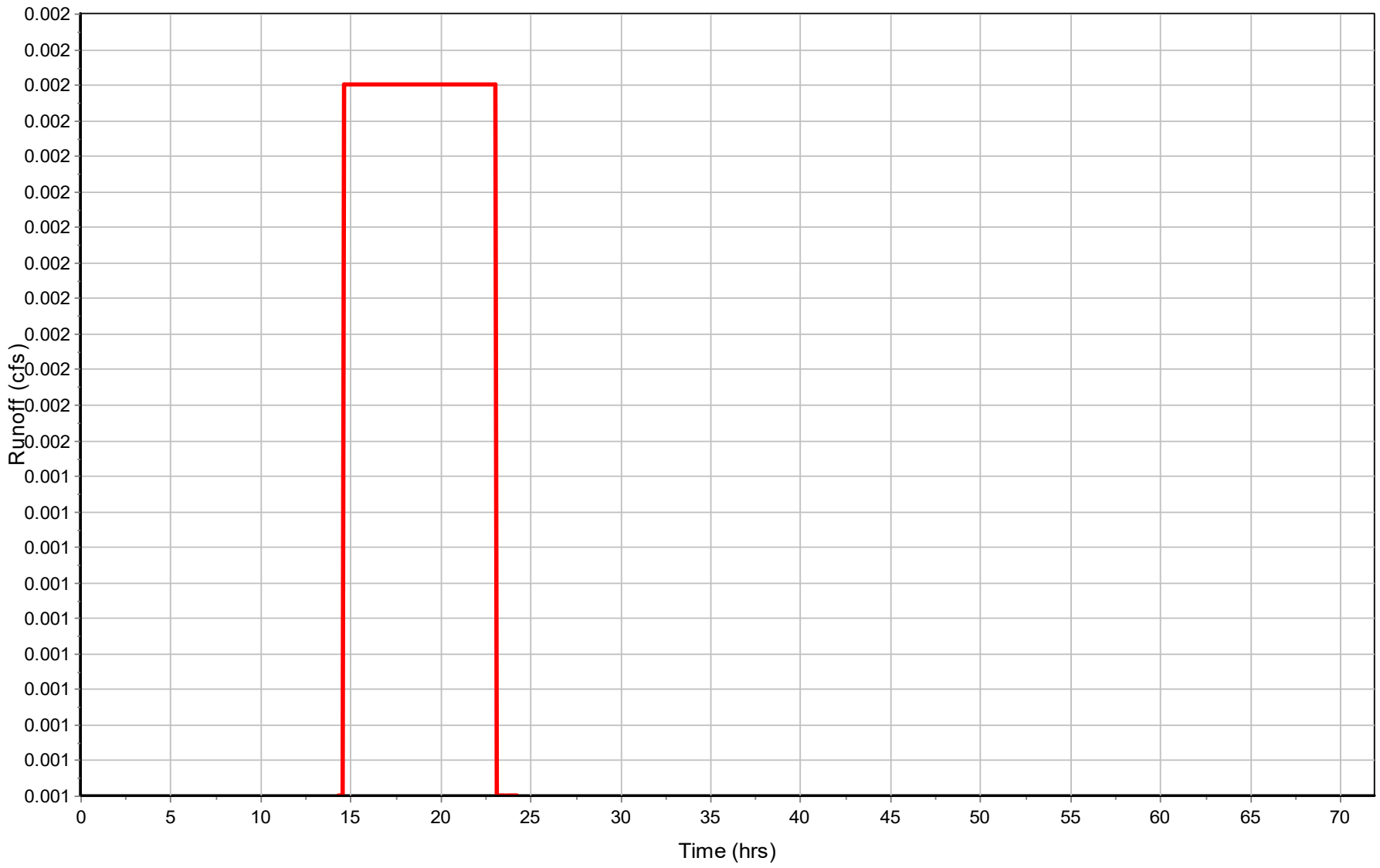
Total Rainfall (in) 3.43
Total Runoff (in) 0.04
Peak Runoff (cfs) 0
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:39:05

Subbasin : Sub-E01

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A1

Input Data

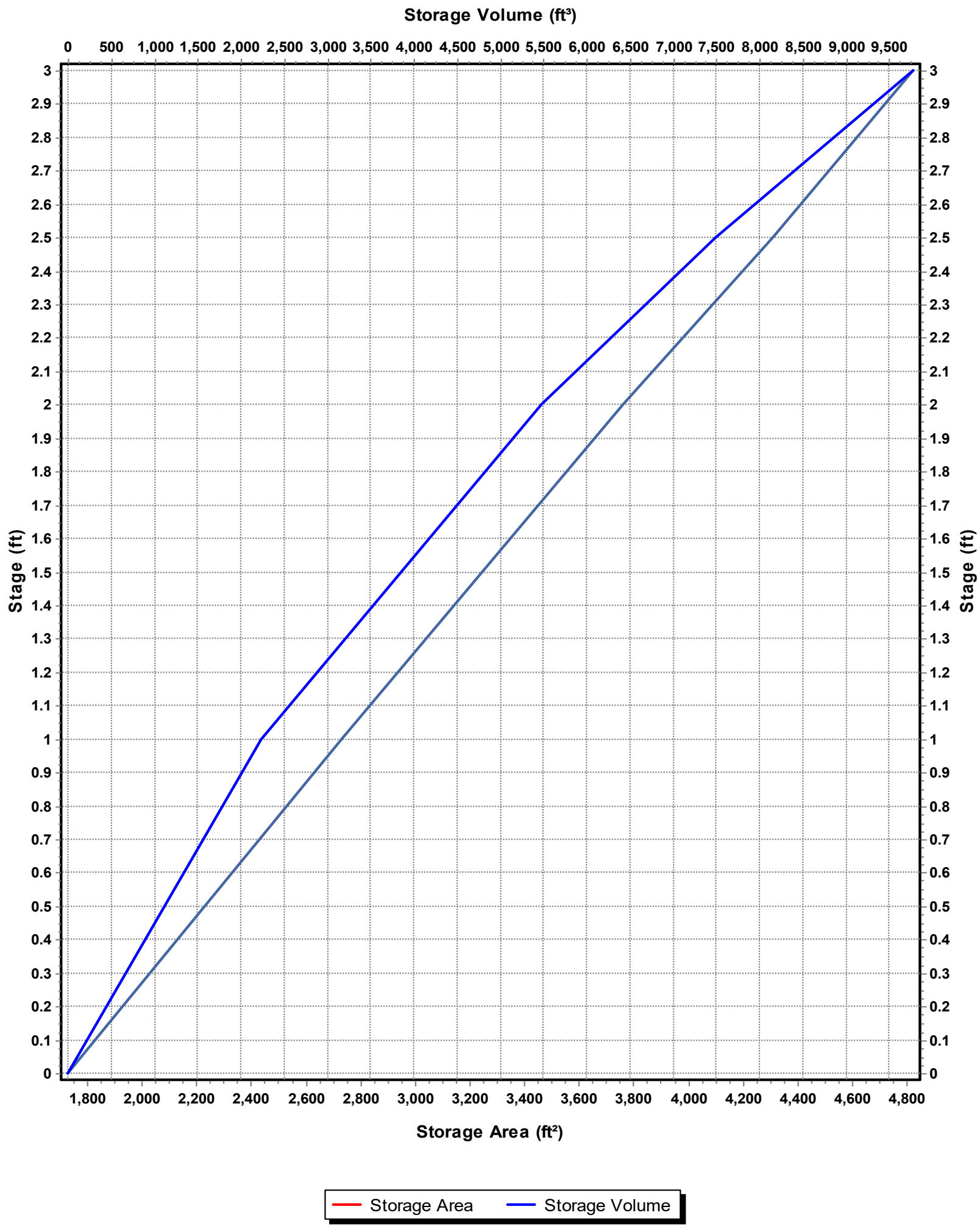
Invert Elevation (ft)	114.00
Max (Rim) Elevation (ft)	117.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

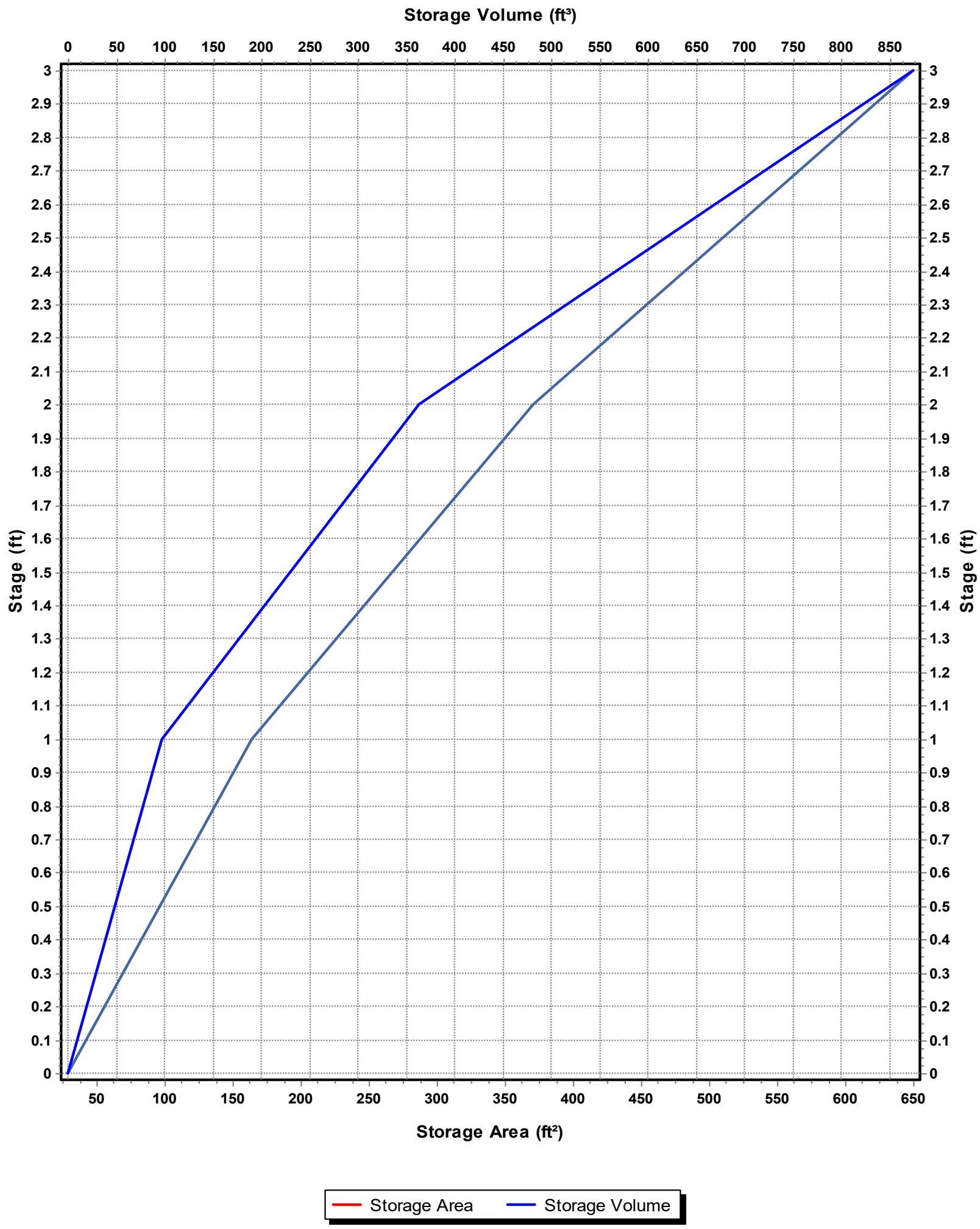
Invert Elevation (ft)	114.00
Max (Rim) Elevation (ft)	117.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

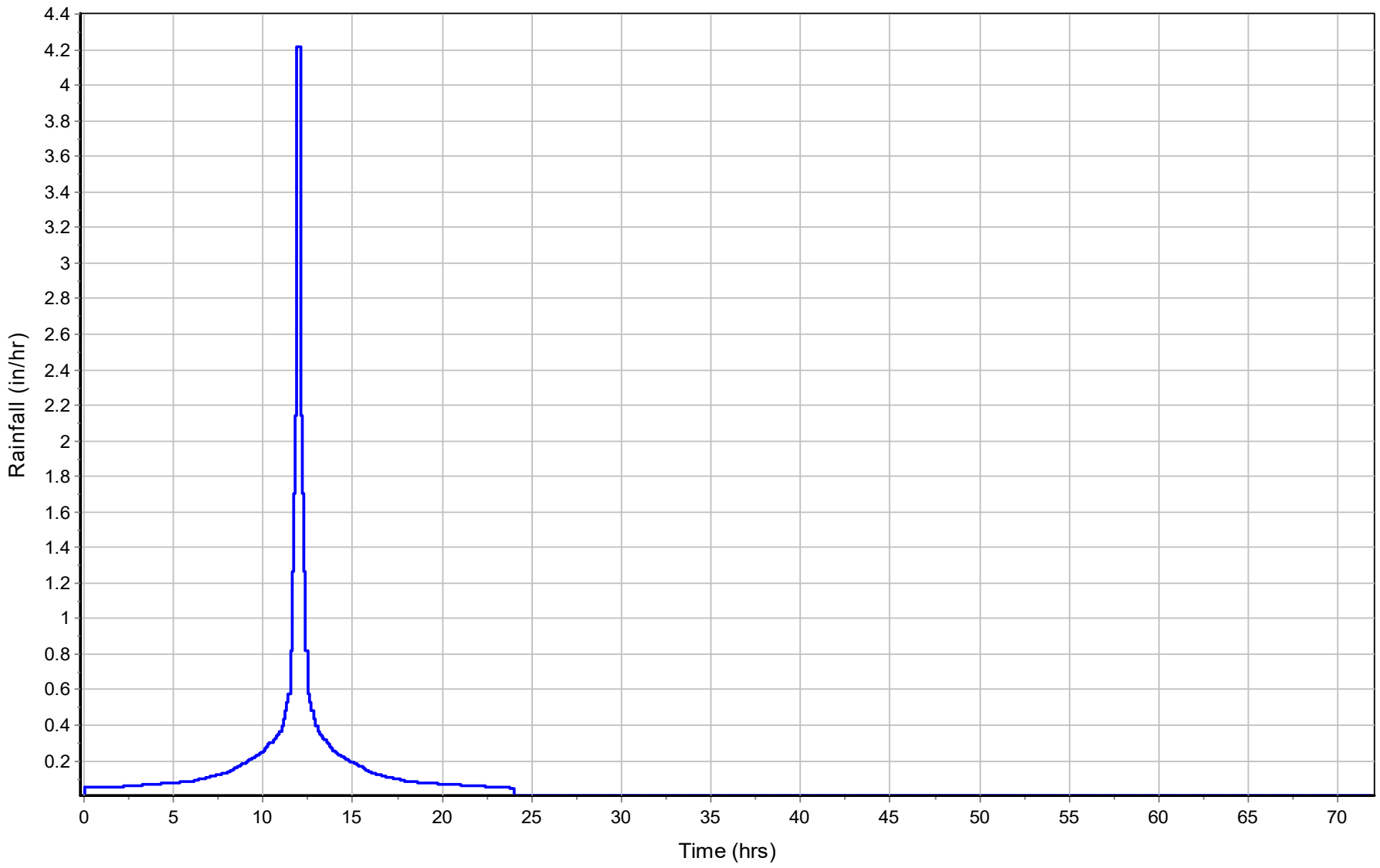
Total TOC (min) 3.15

Subbasin Runoff Results

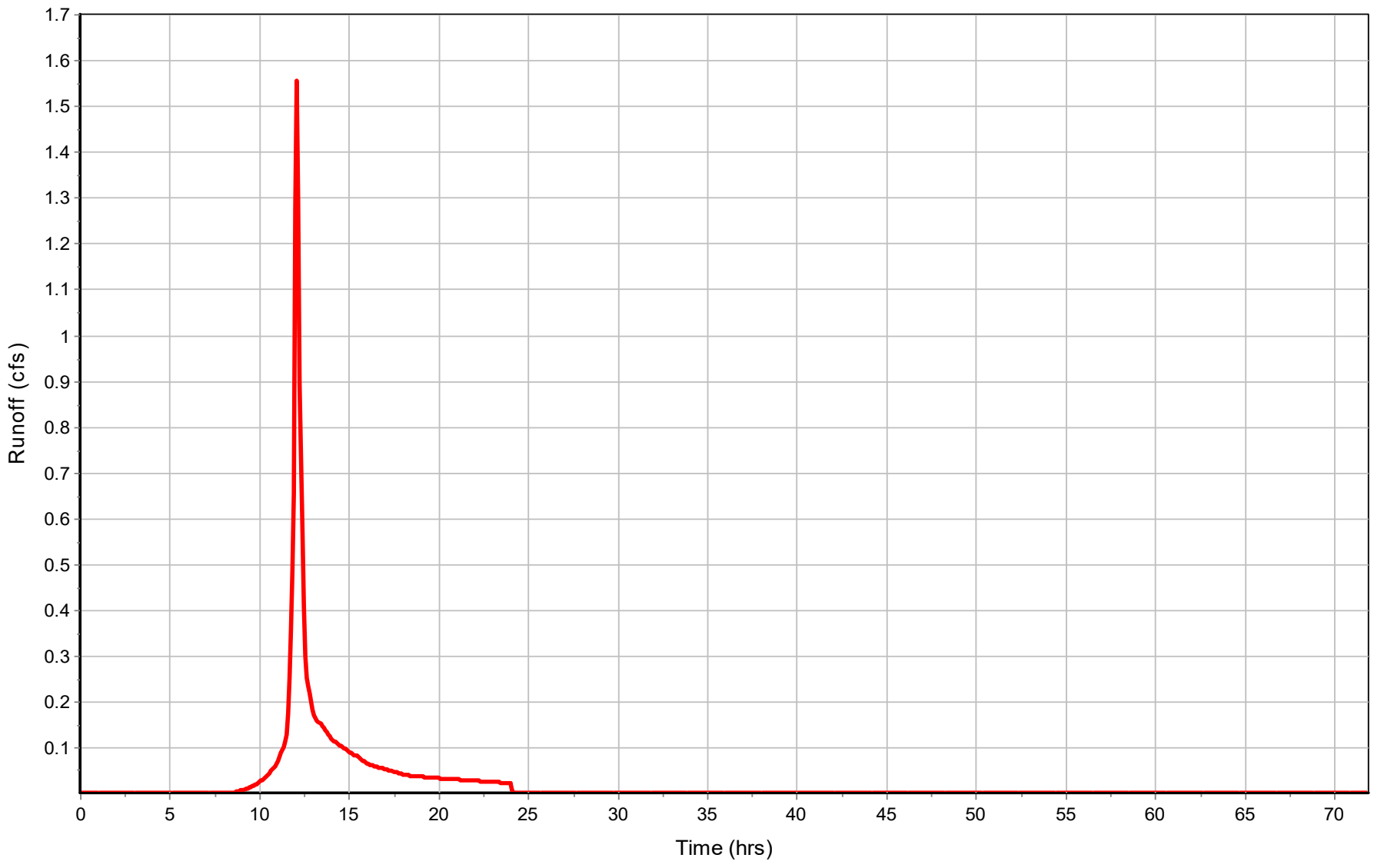
Total Rainfall (in)	5.01
Total Runoff (in)	2.54
Peak Runoff (cfs)	1.6
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:03:09

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

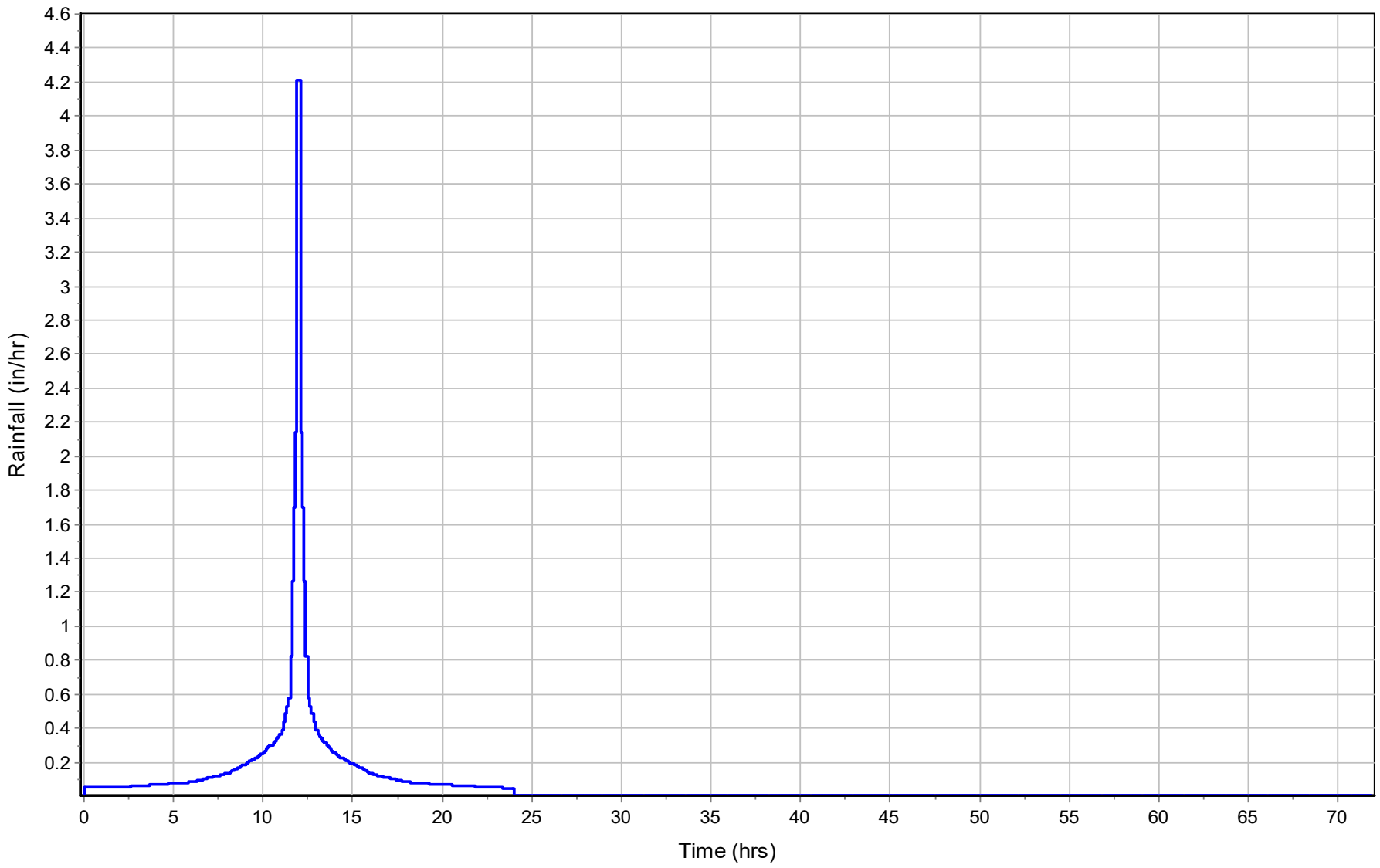
Total TOC (min) 39.09

Subbasin Runoff Results

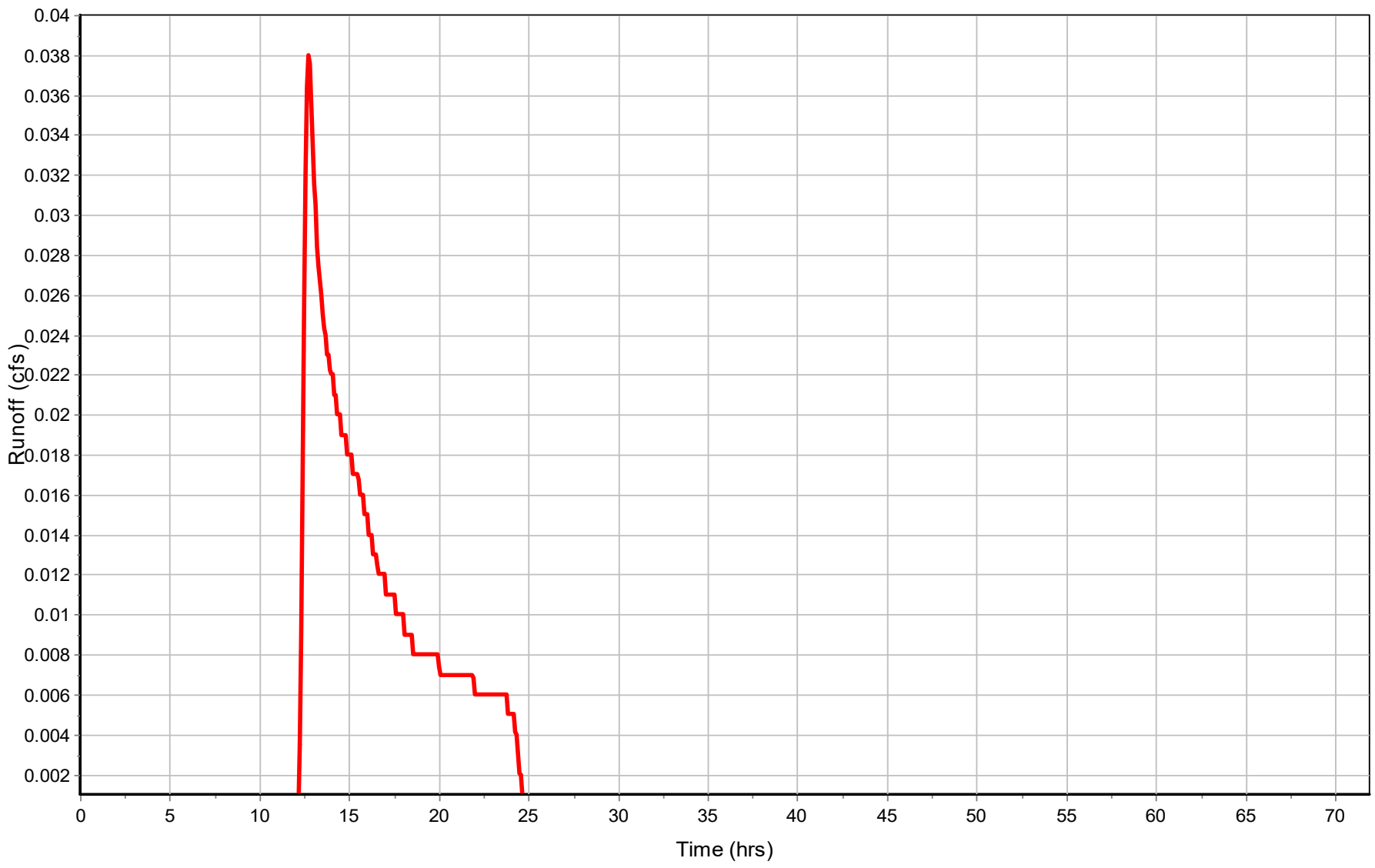
Total Rainfall (in) 5.01
Total Runoff (in) 0.36
Peak Runoff (cfs) 0.04
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:39:05

Subbasin : Sub-E01

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A1

Input Data

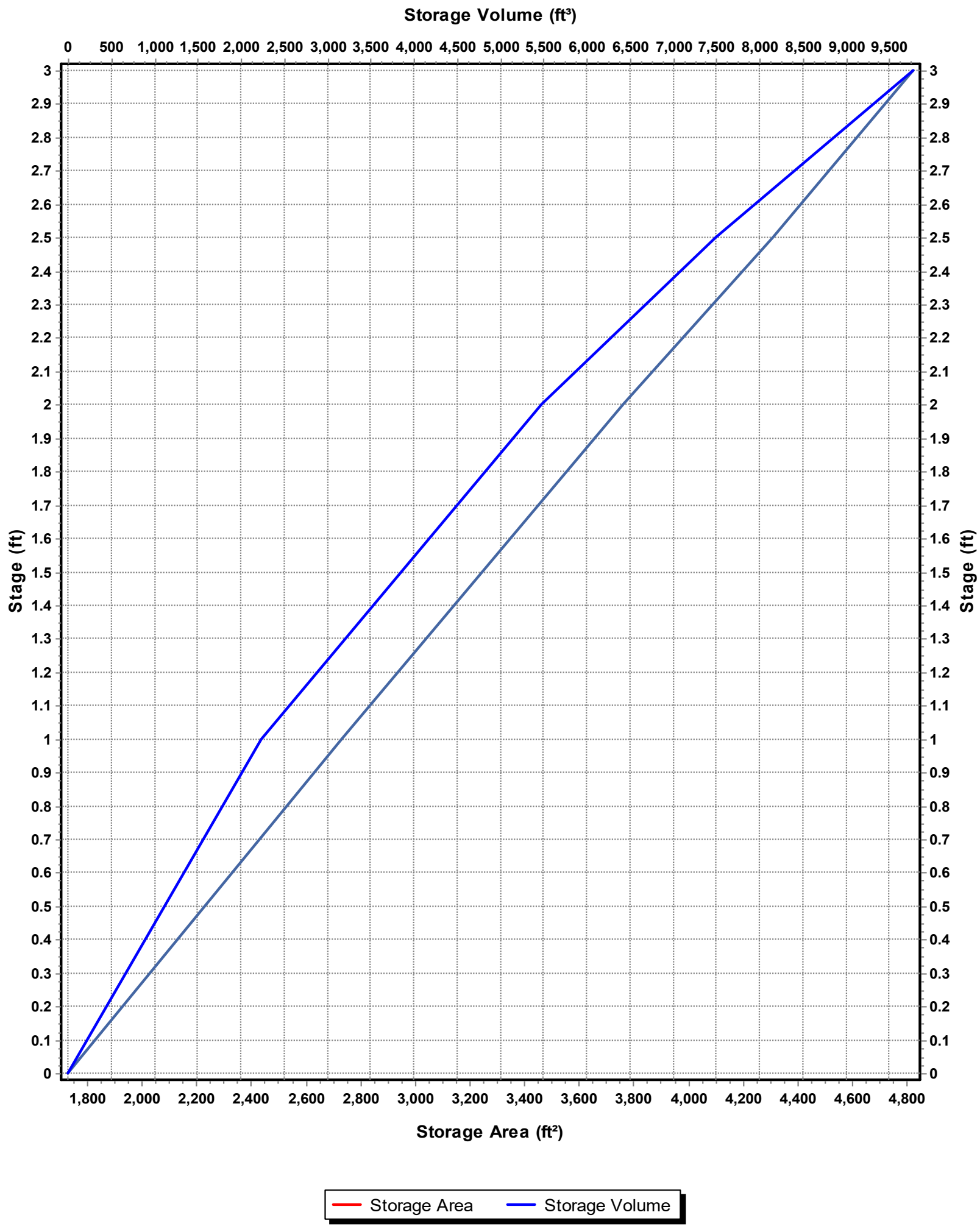
Invert Elevation (ft)	114.00
Max (Rim) Elevation (ft)	117.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

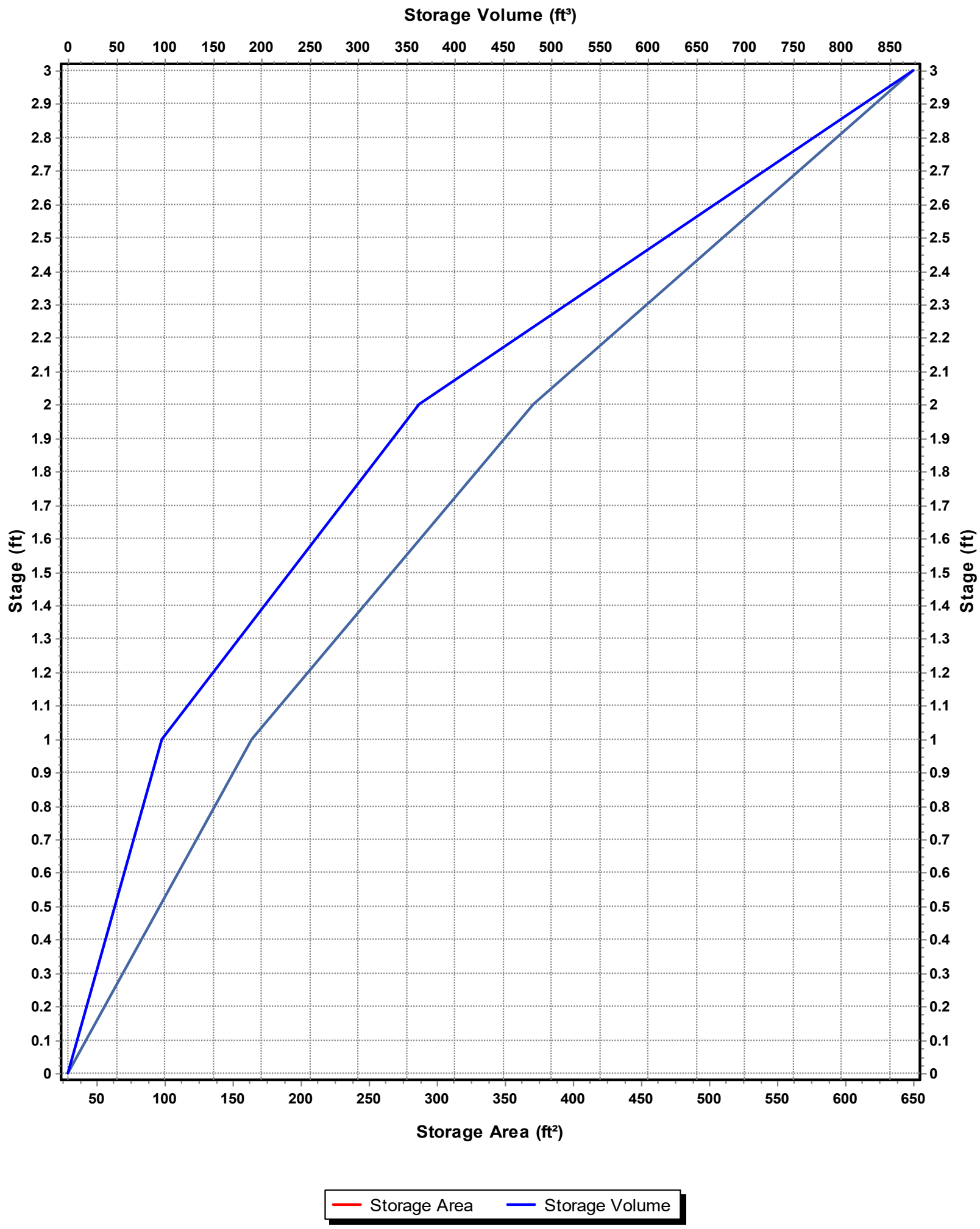
Invert Elevation (ft)	114.00
Max (Rim) Elevation (ft)	117.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

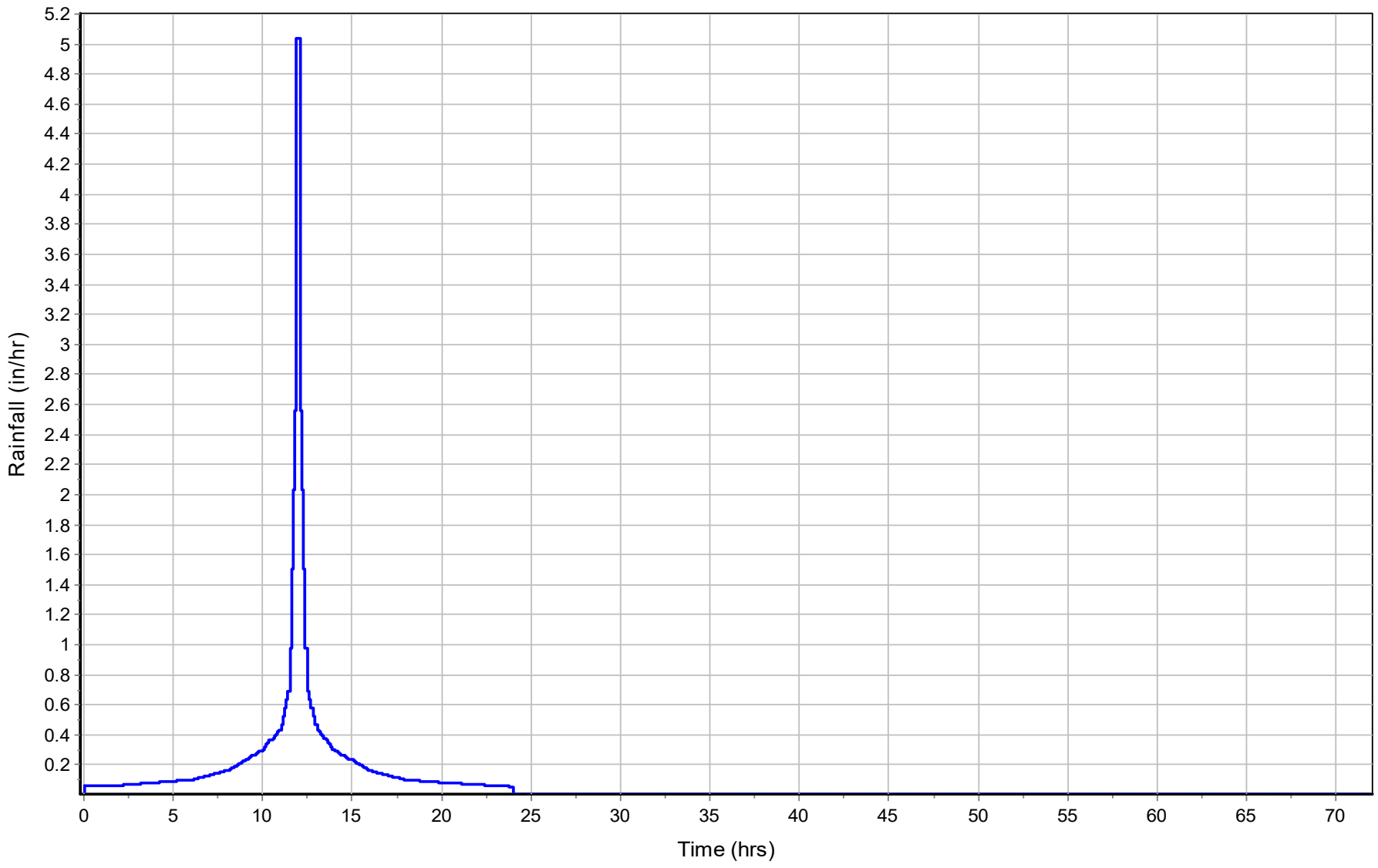
Total TOC (min) 3.15

Subbasin Runoff Results

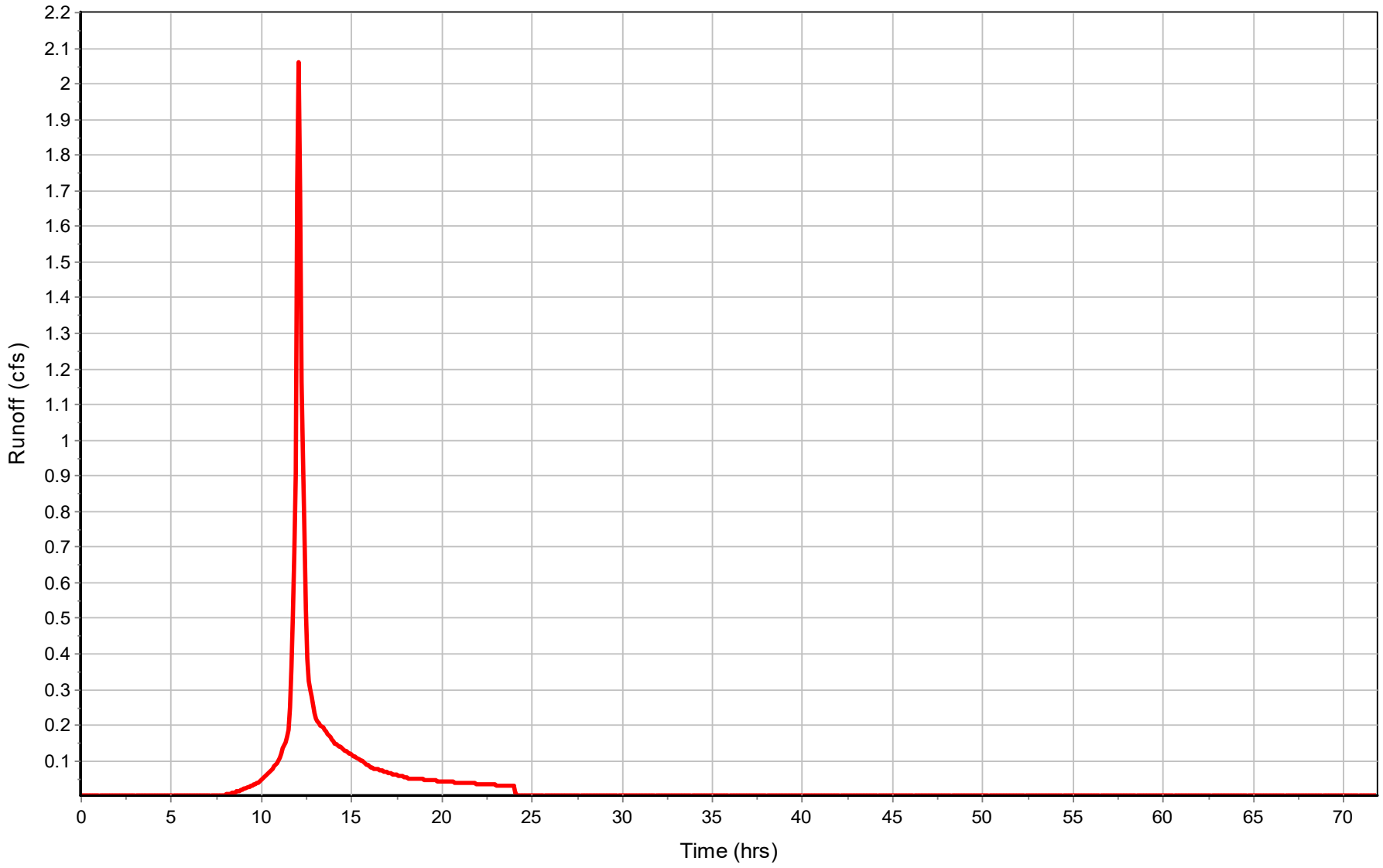
Total Rainfall (in)	5.99
Total Runoff (in)	3.37
Peak Runoff (cfs)	2.11
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:03:09

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

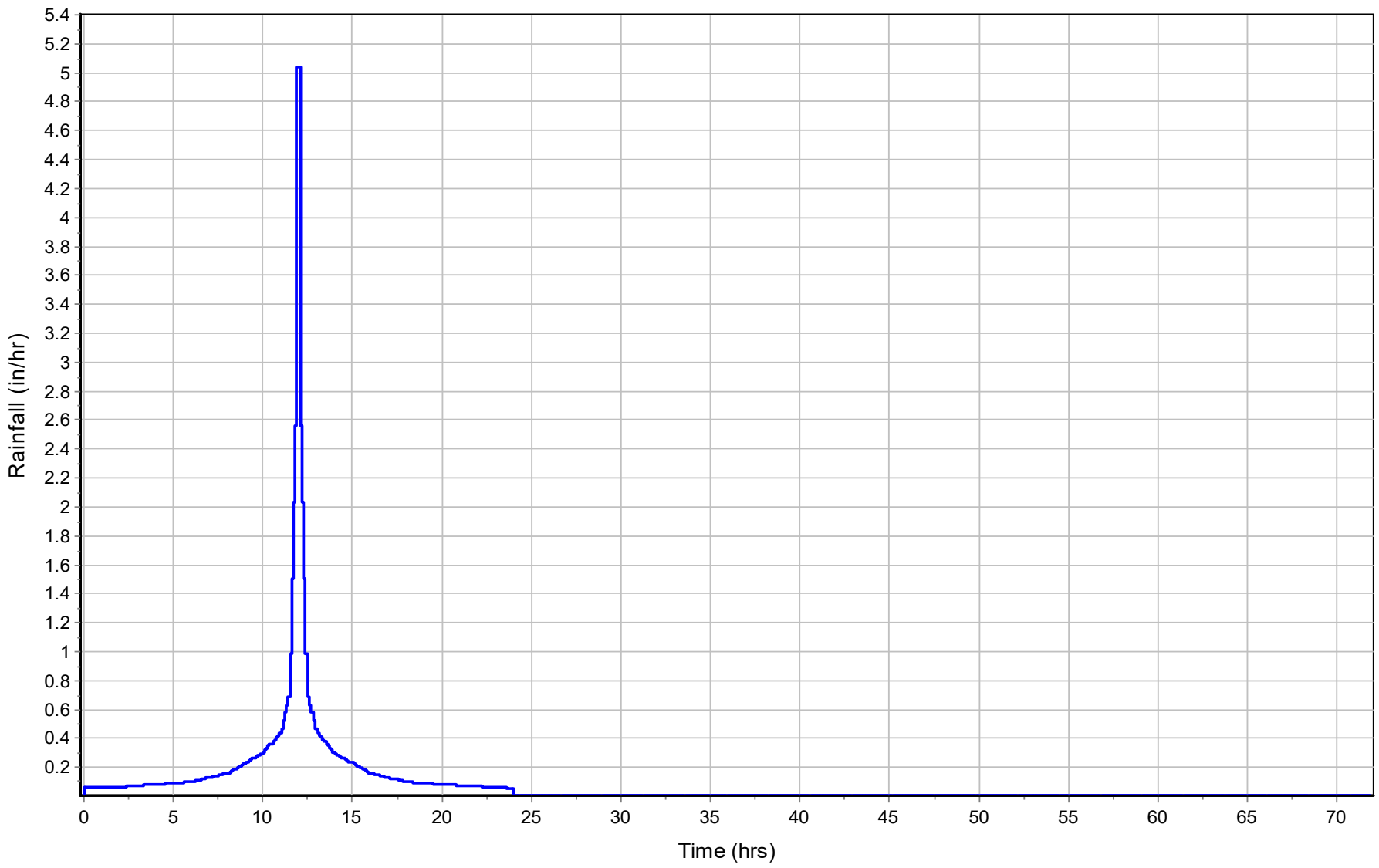
Total TOC (min) 39.09

Subbasin Runoff Results

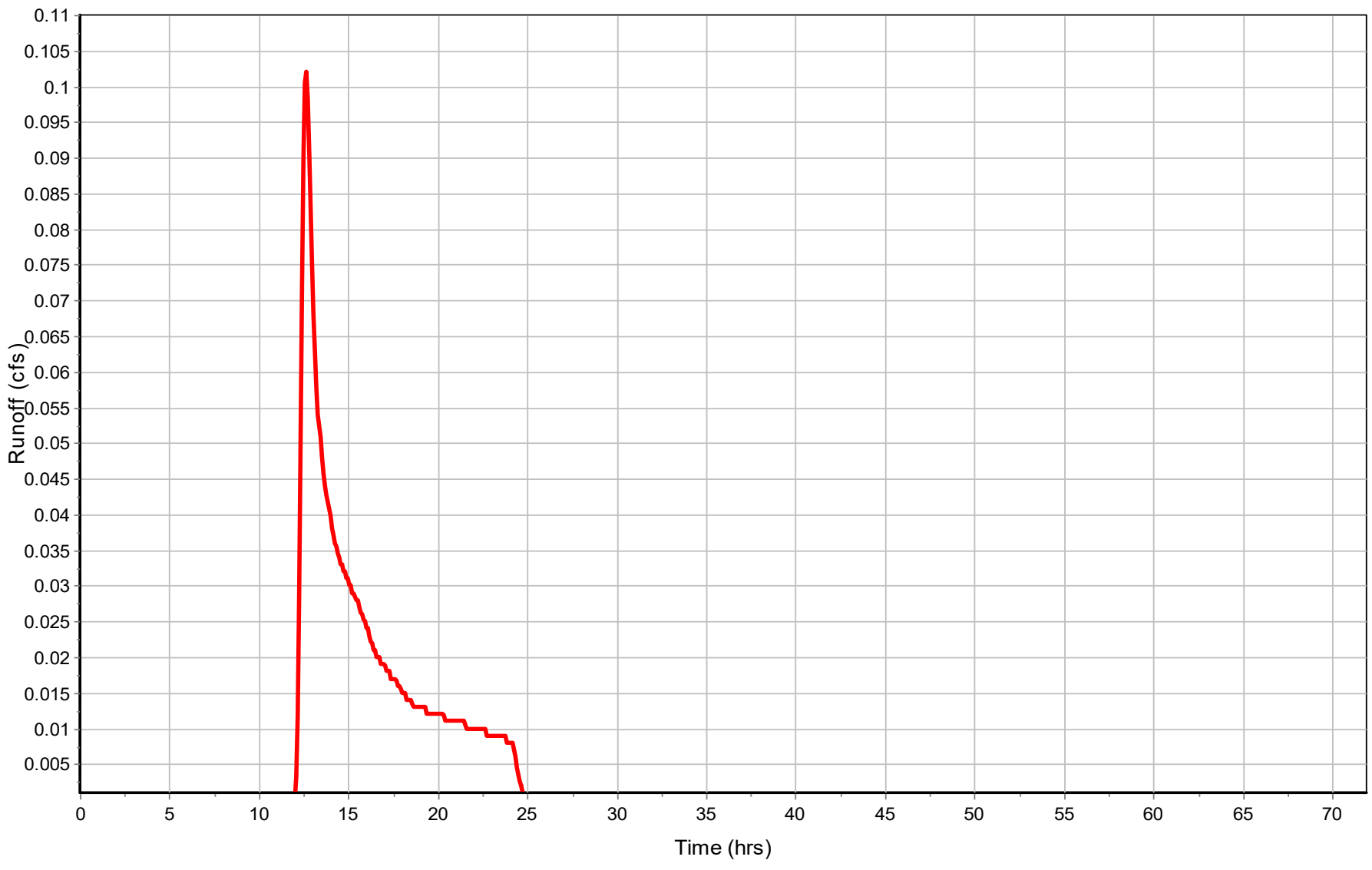
Total Rainfall (in) 5.99
Total Runoff (in) 0.67
Peak Runoff (cfs) 0.1
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:39:05

Subbasin : Sub-E01

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A1

Input Data

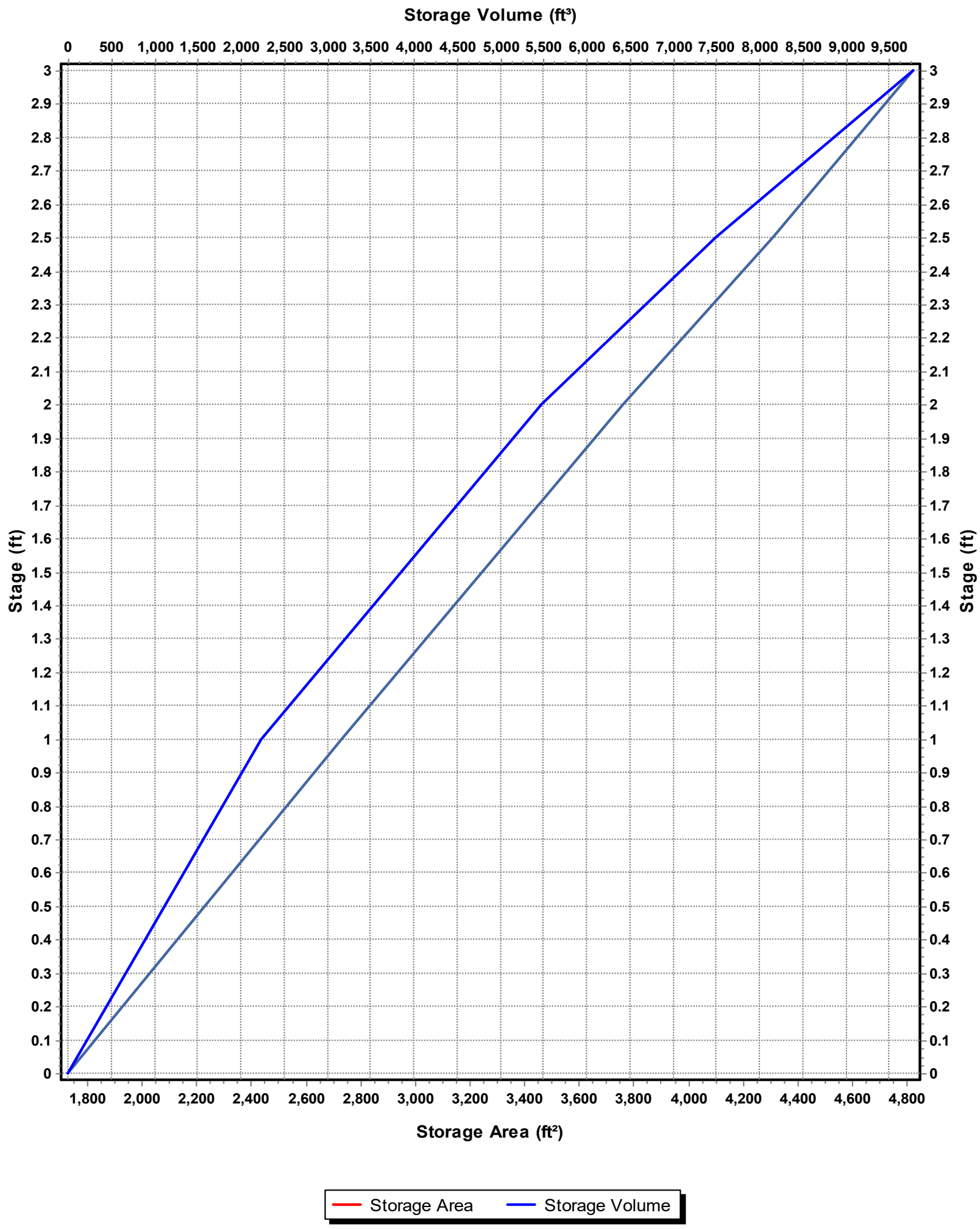
Invert Elevation (ft)	114.00
Max (Rim) Elevation (ft)	117.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

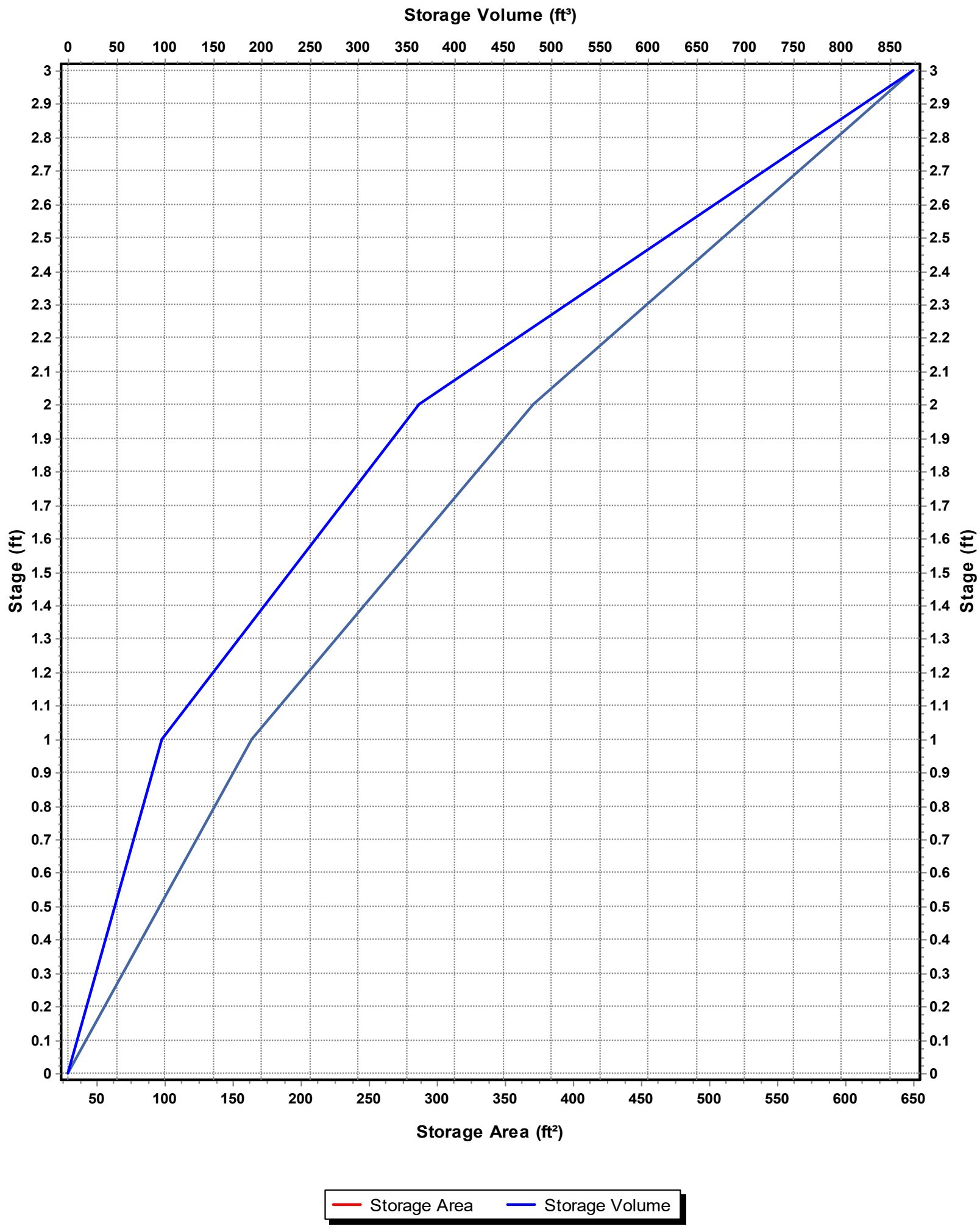
Invert Elevation (ft)	114.00
Max (Rim) Elevation (ft)	117.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

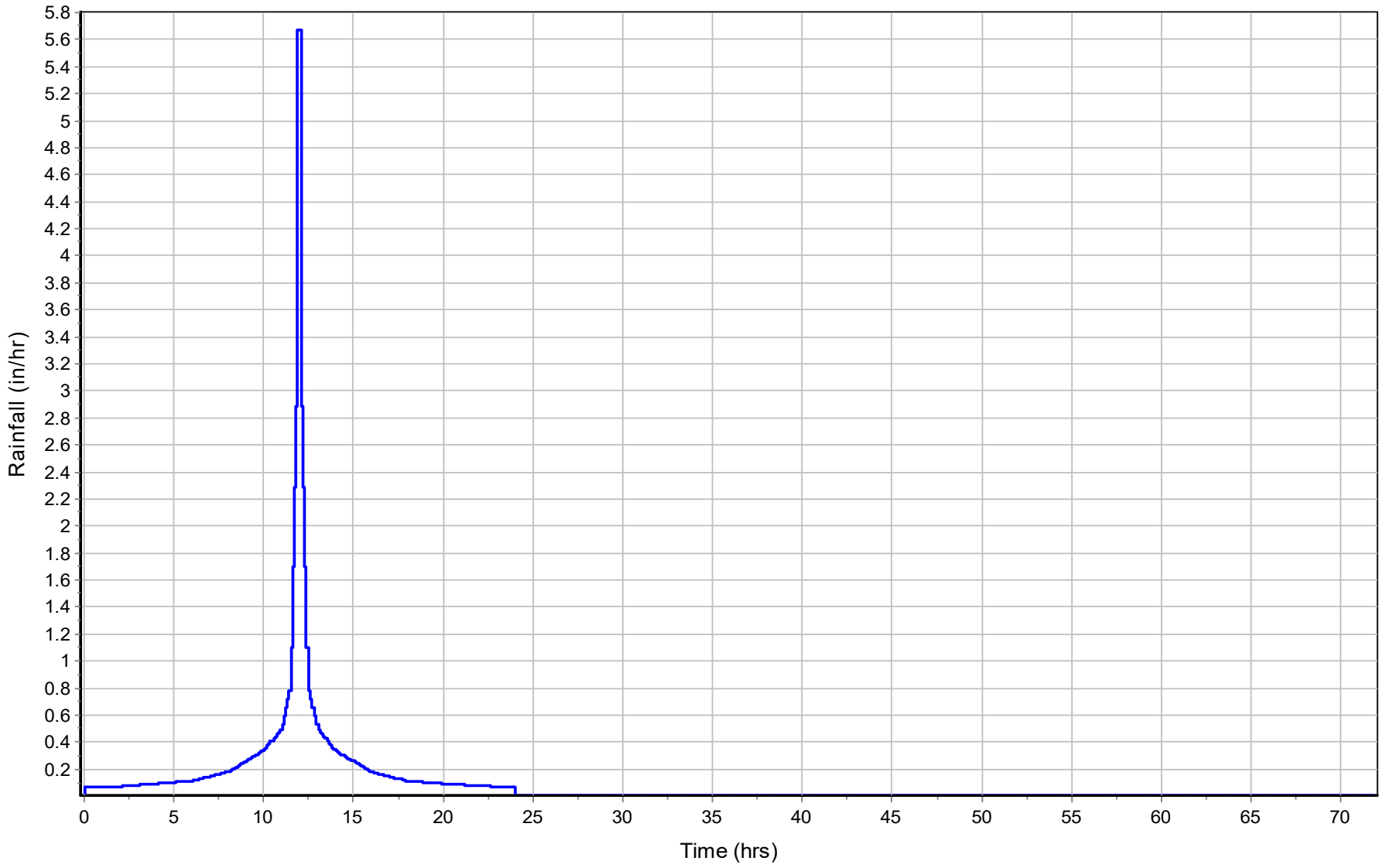
Total TOC (min) 3.15

Subbasin Runoff Results

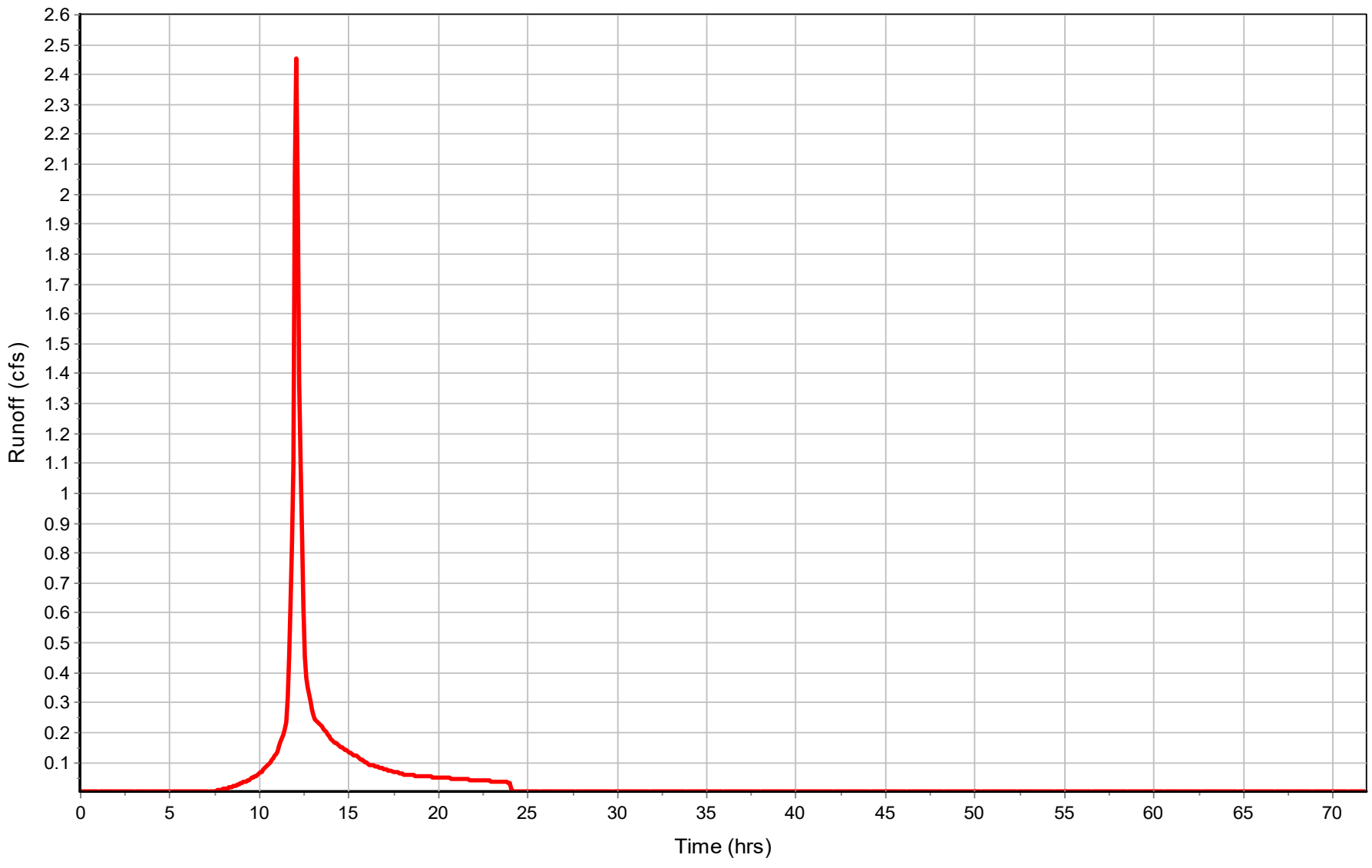
Total Rainfall (in)	6.74
Total Runoff (in)	4.03
Peak Runoff (cfs)	2.51
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:03:09

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

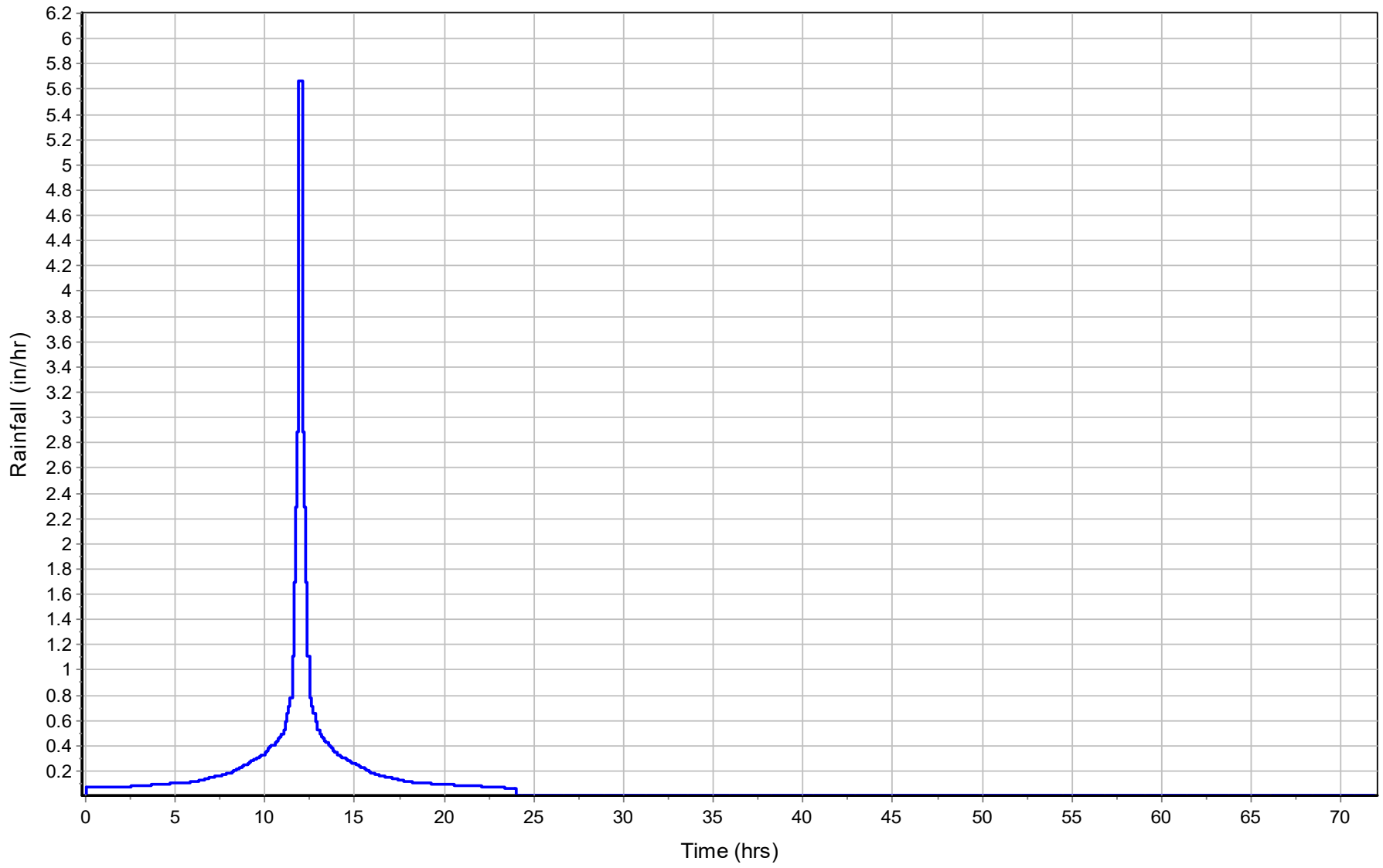
Total TOC (min) 39.09

Subbasin Runoff Results

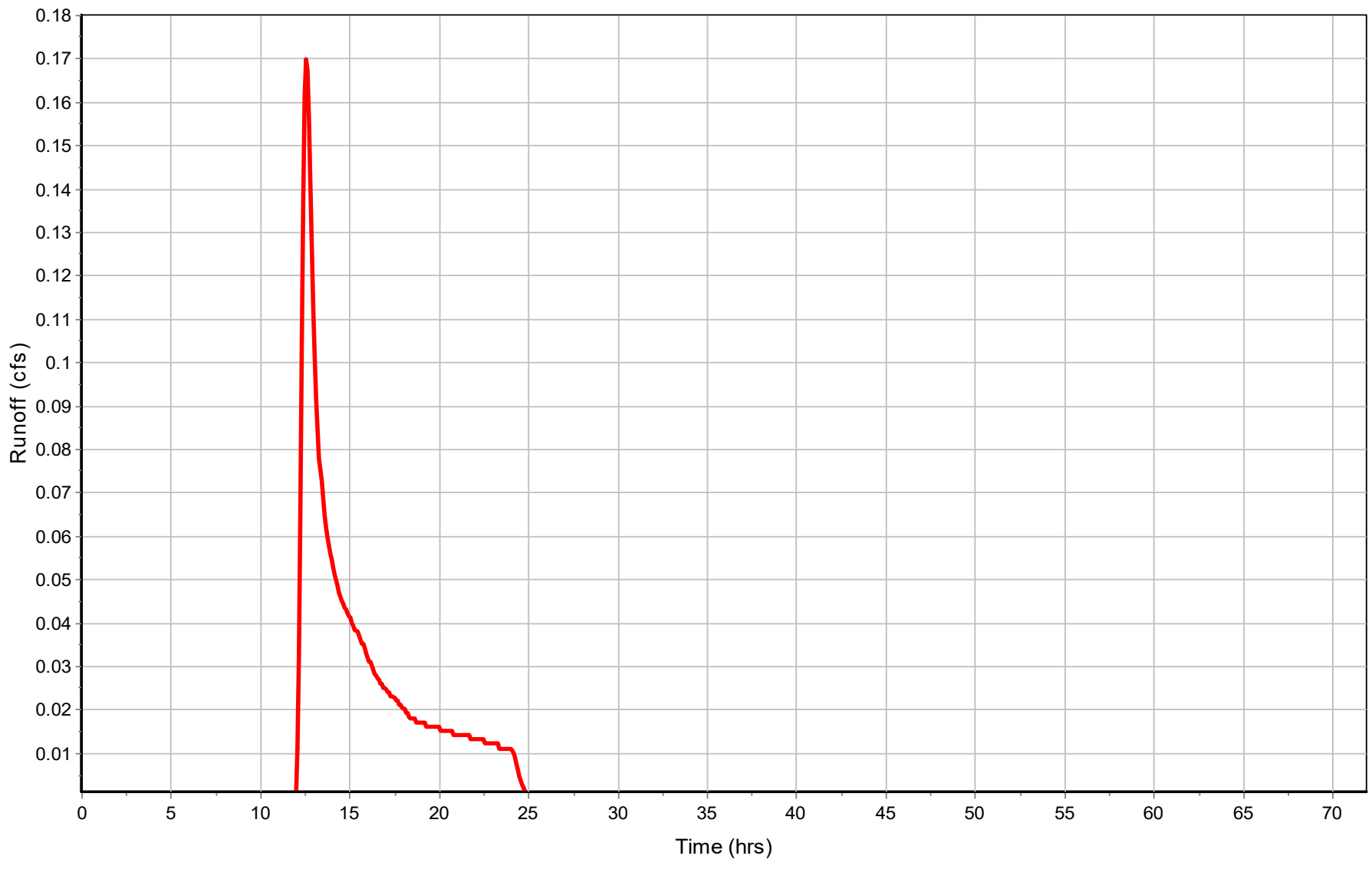
Total Rainfall (in) 6.74
Total Runoff (in) 0.96
Peak Runoff (cfs) 0.17
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:39:05

Subbasin : Sub-E01

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A1

Input Data

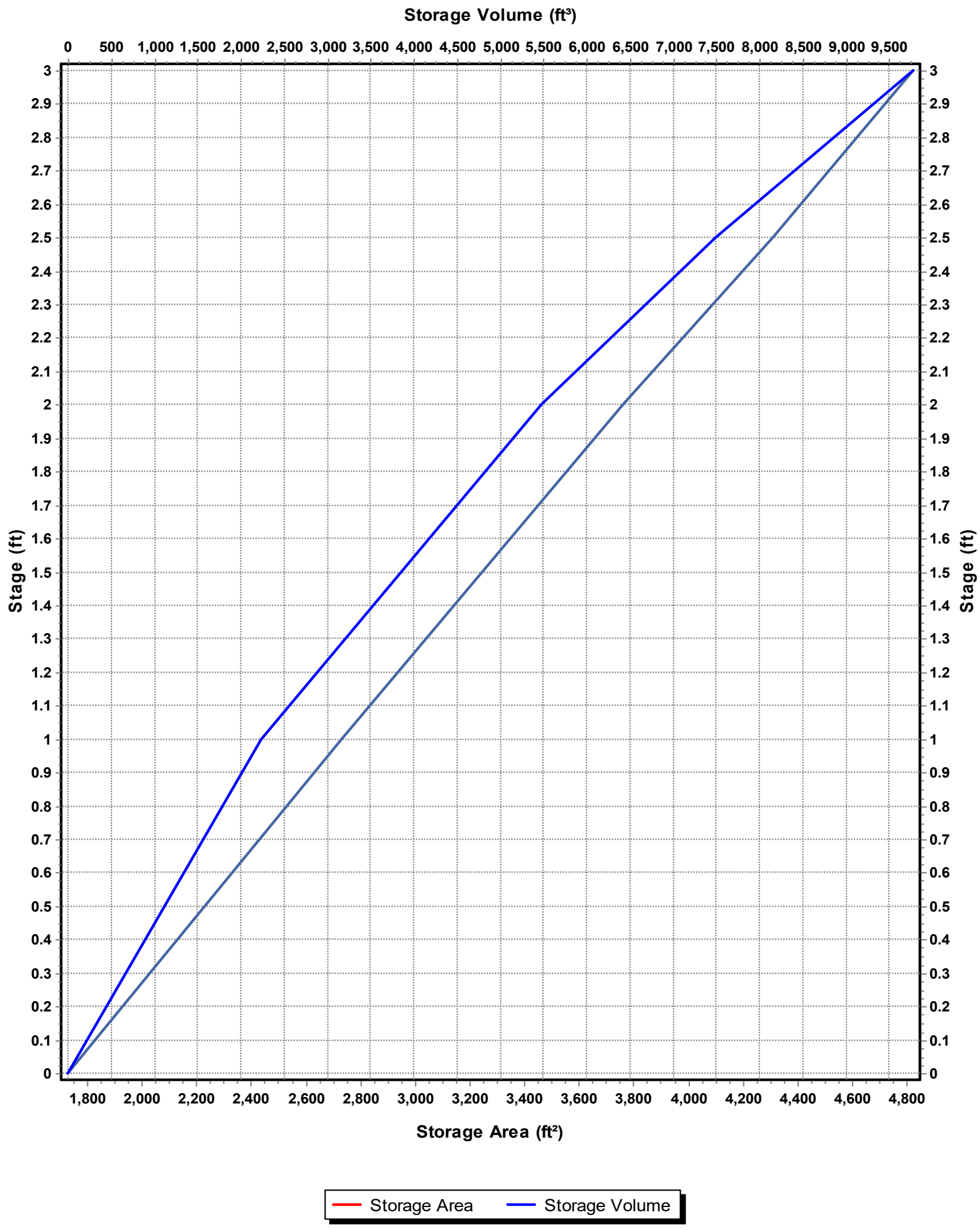
Invert Elevation (ft)	114.00
Max (Rim) Elevation (ft)	117.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

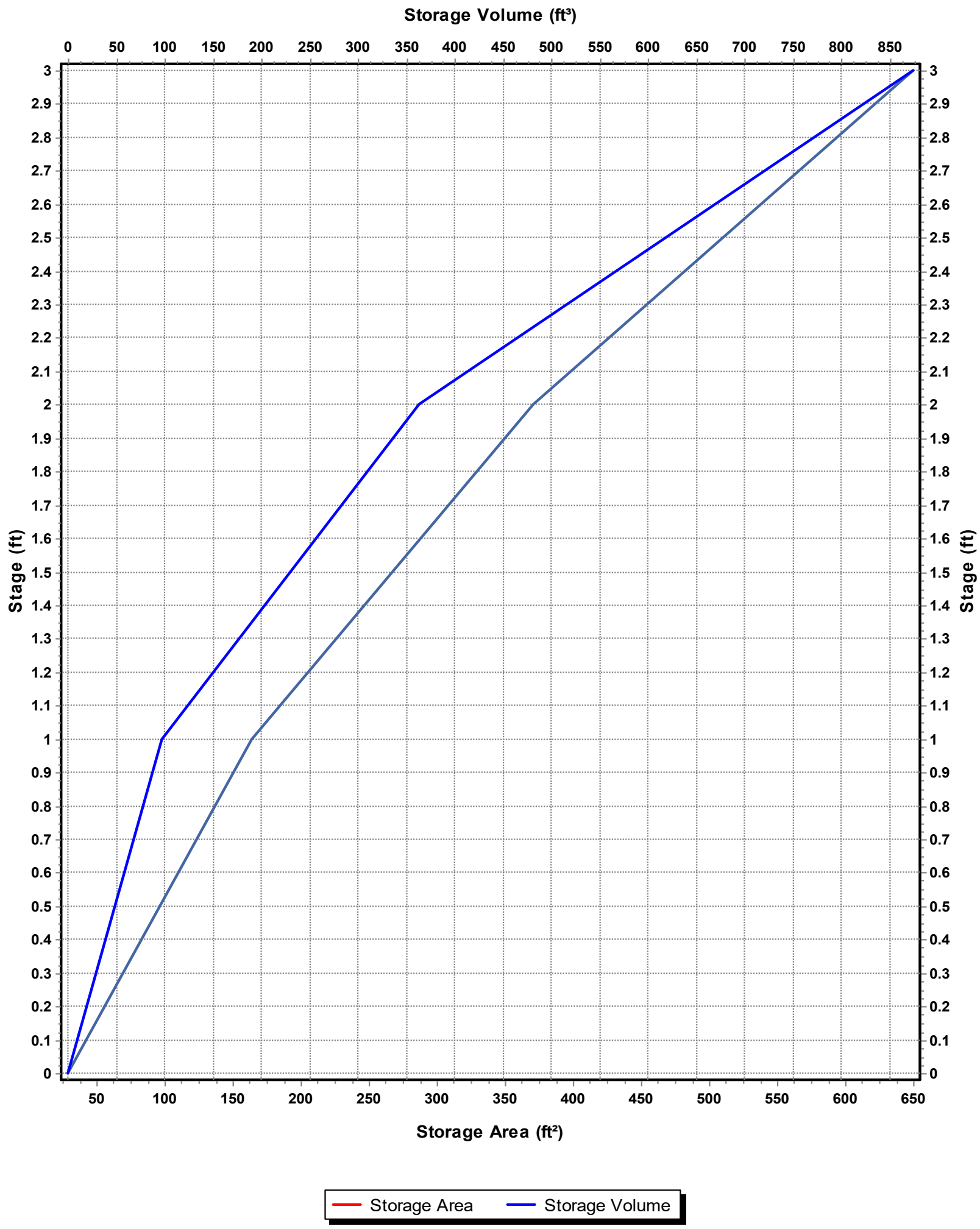
Invert Elevation (ft)	114.00
Max (Rim) Elevation (ft)	117.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

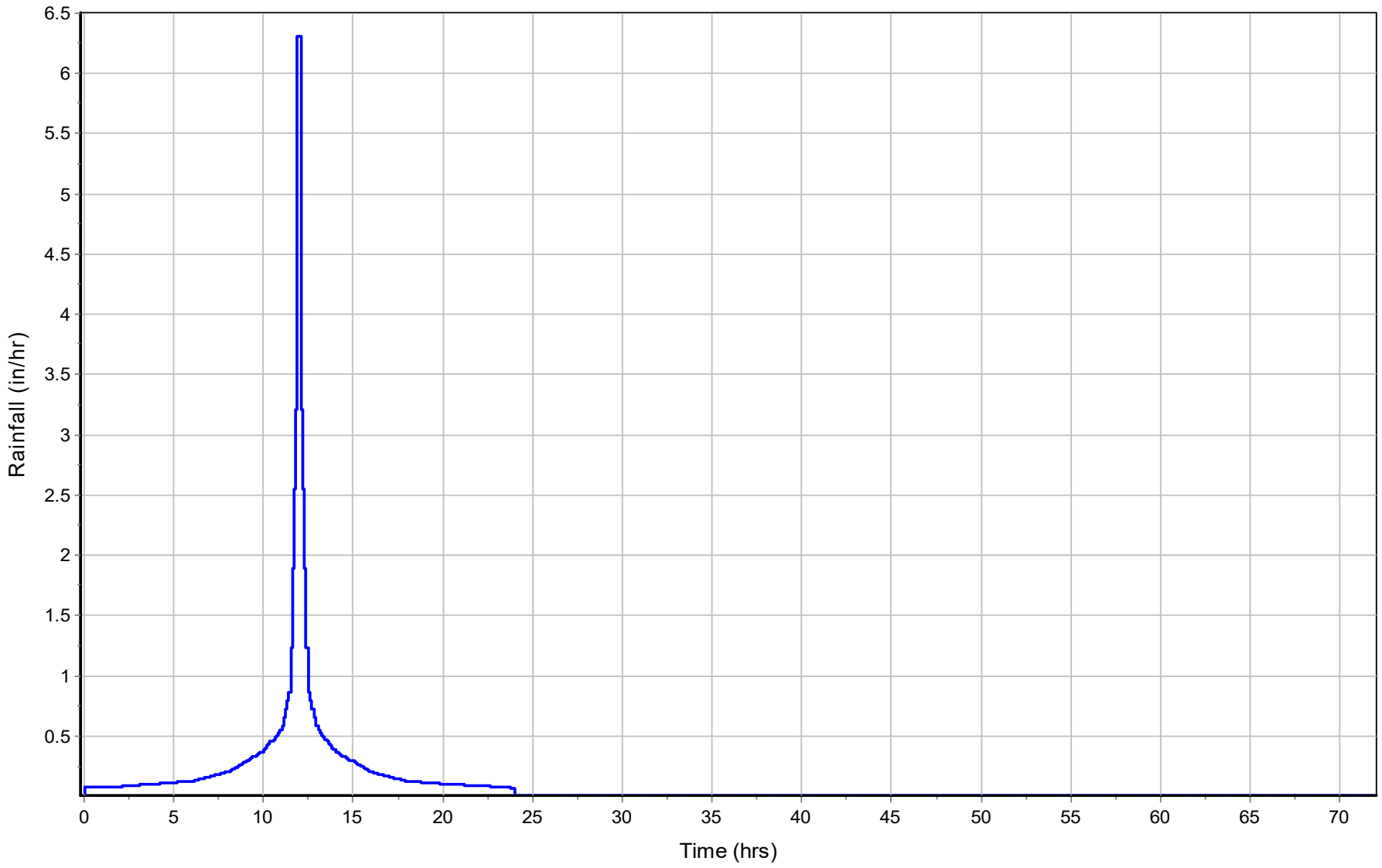
Total TOC (min) 3.15

Subbasin Runoff Results

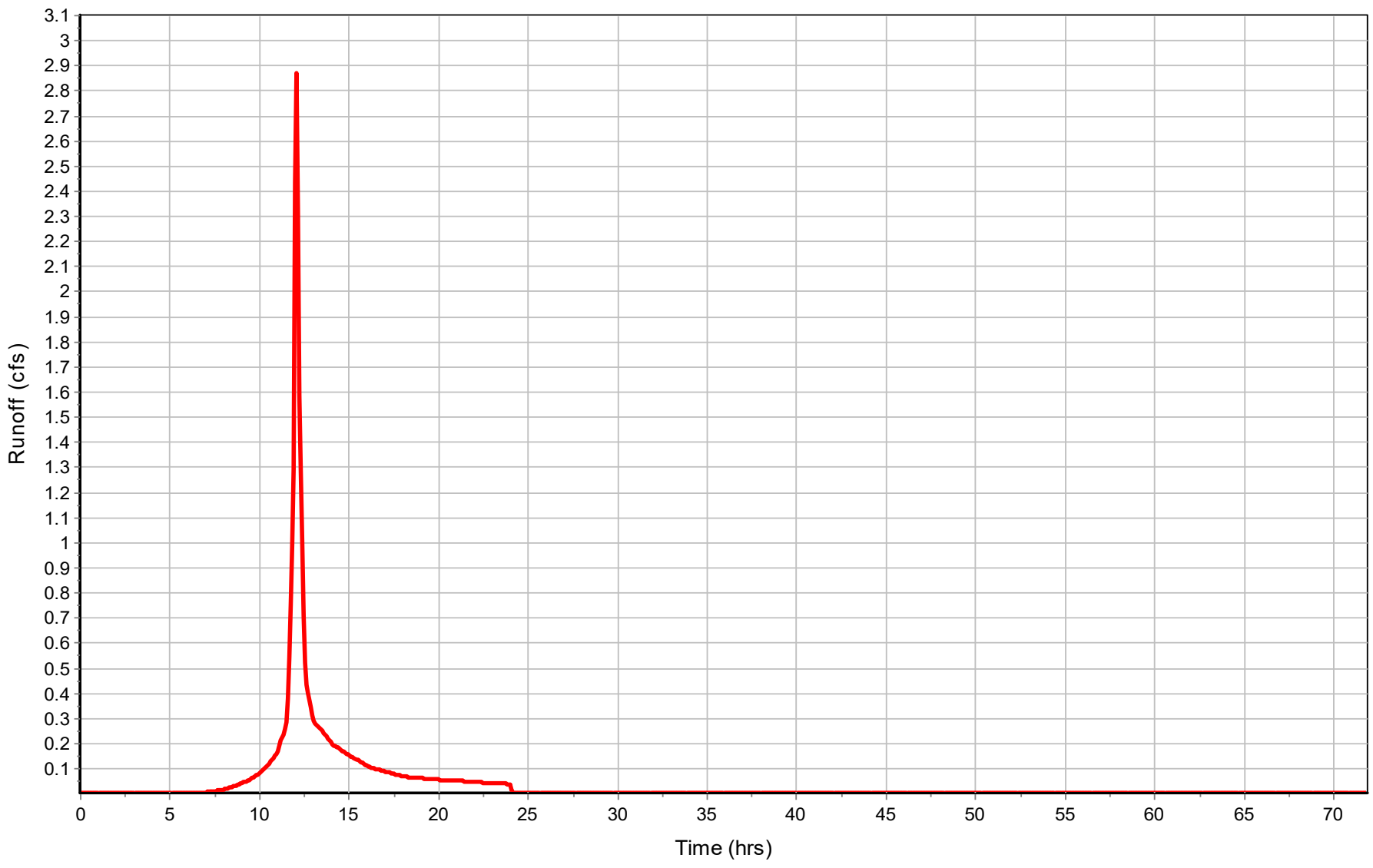
Total Rainfall (in)	7.51
Total Runoff (in)	4.71
Peak Runoff (cfs)	2.92
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:03:09

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

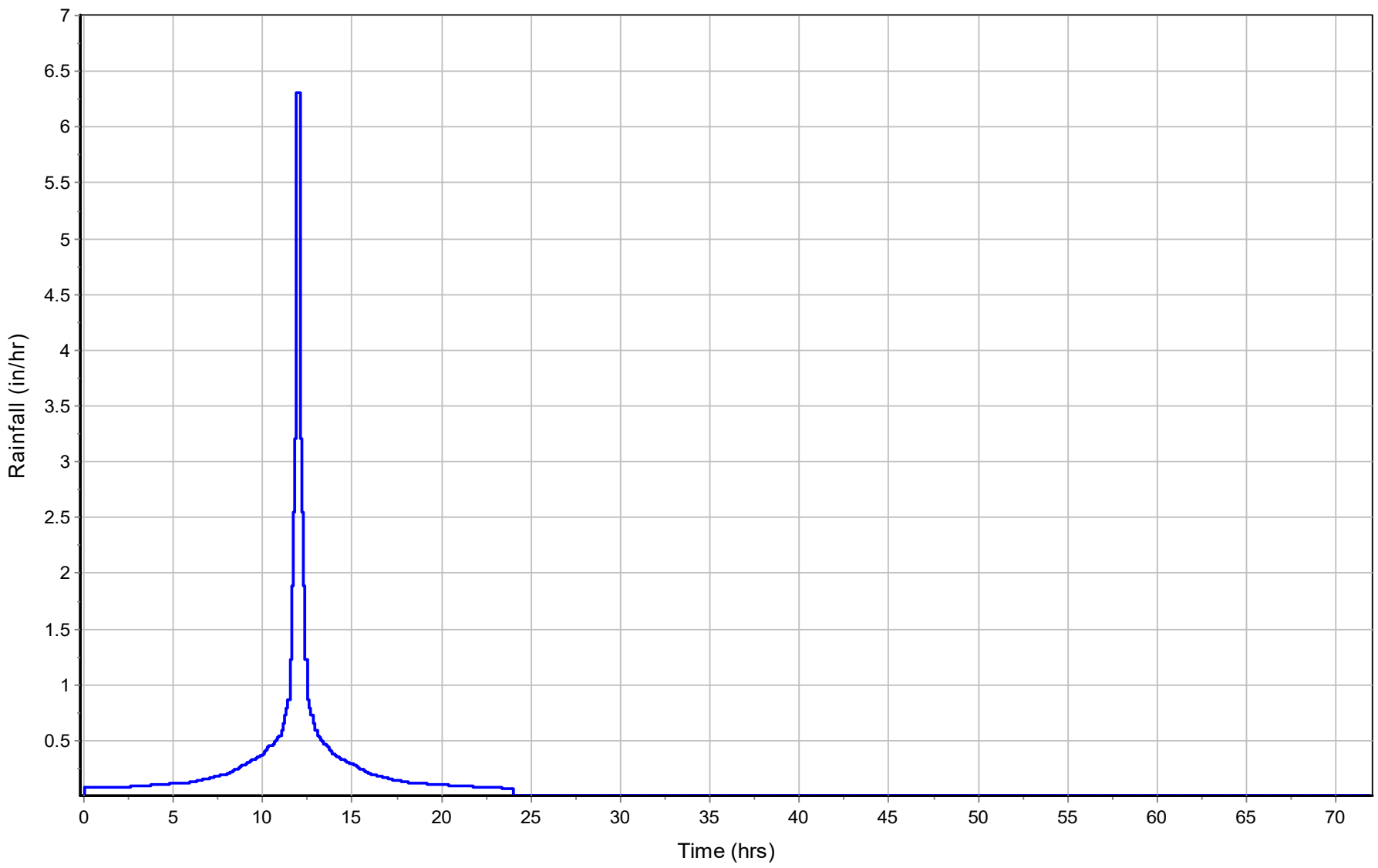
Total TOC (min) 39.09

Subbasin Runoff Results

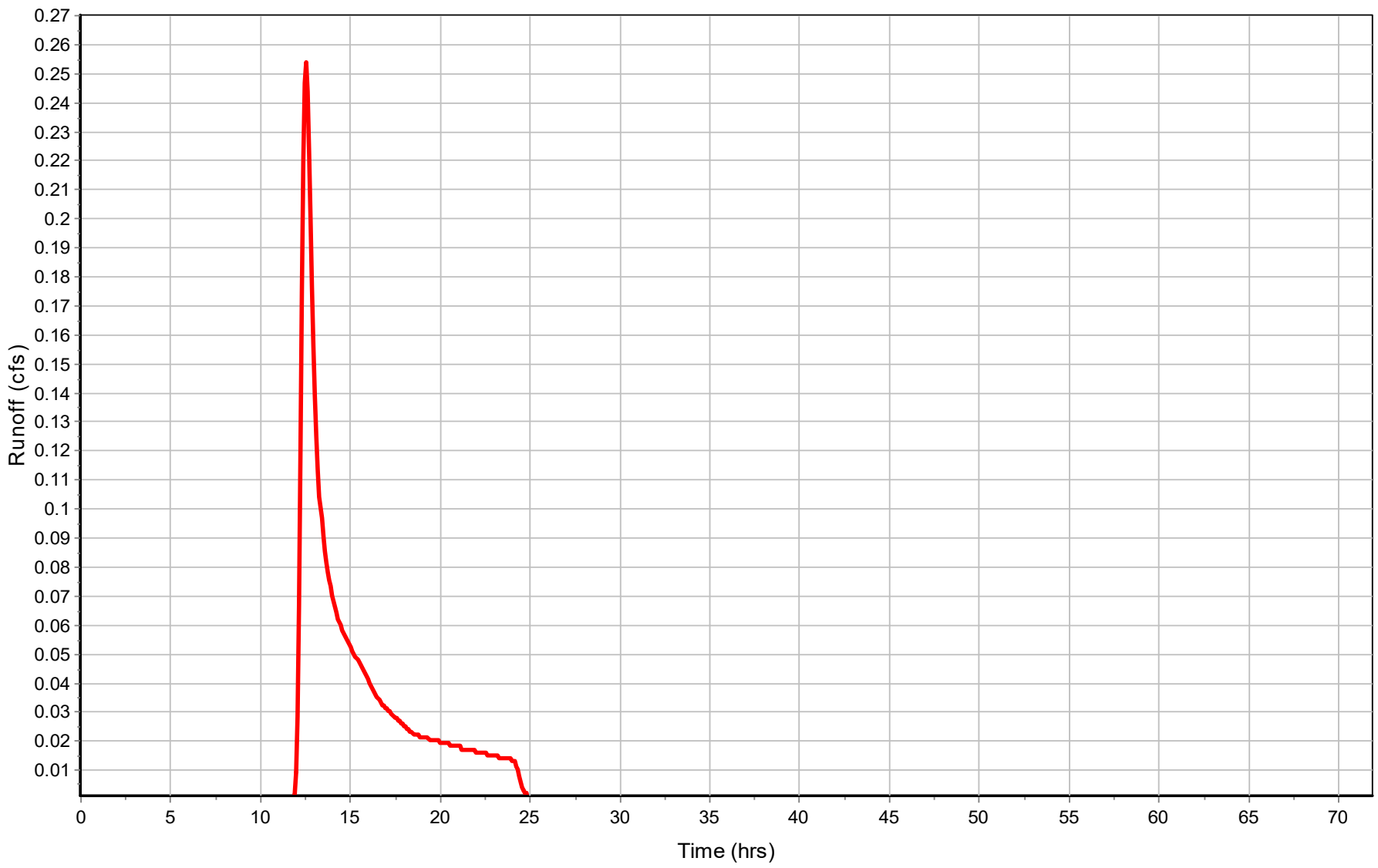
Total Rainfall (in) 7.51
Total Runoff (in) 1.3
Peak Runoff (cfs) 0.25
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:39:05

Subbasin : Sub-E01

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A1

Input Data

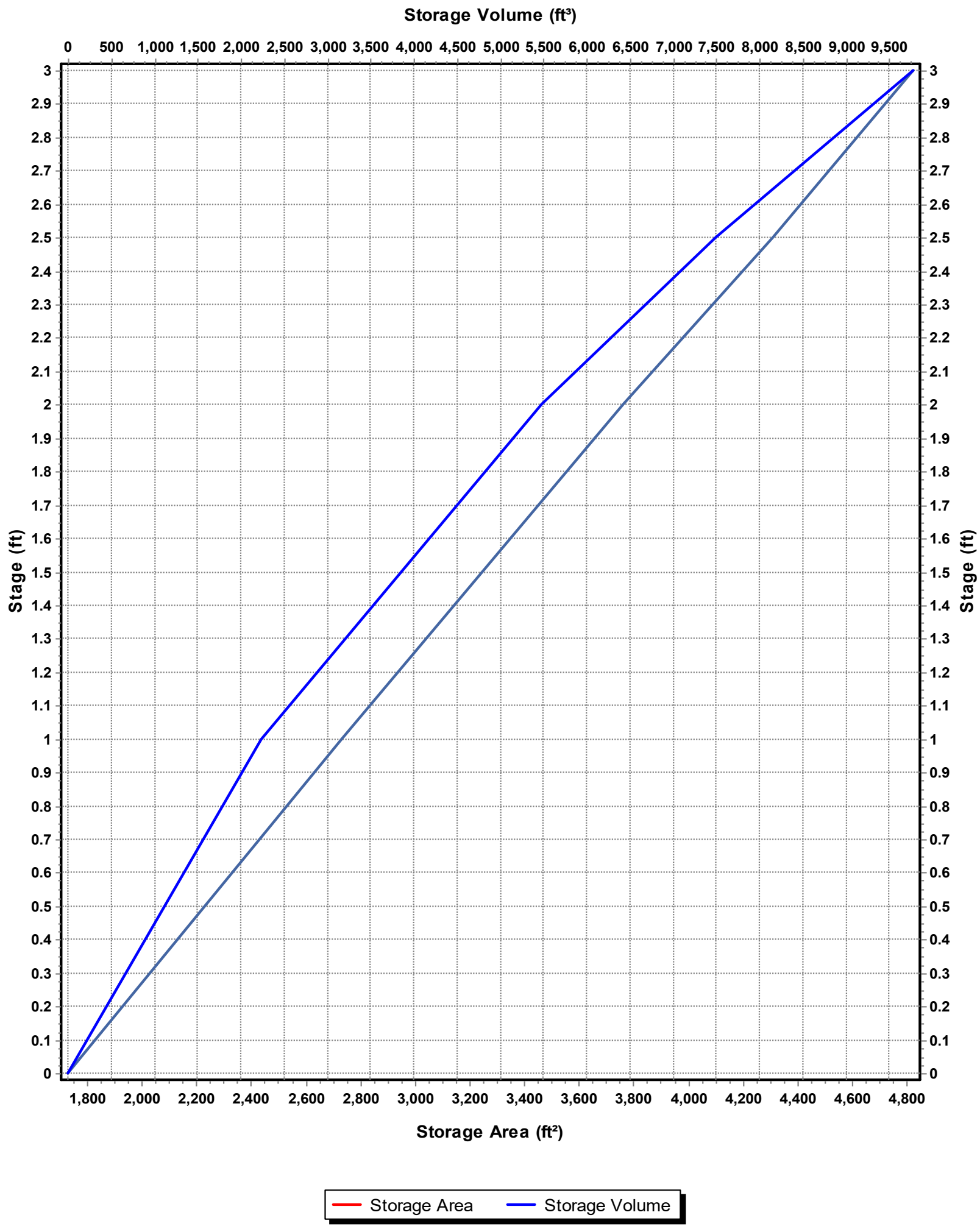
Invert Elevation (ft)	114.00
Max (Rim) Elevation (ft)	117.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

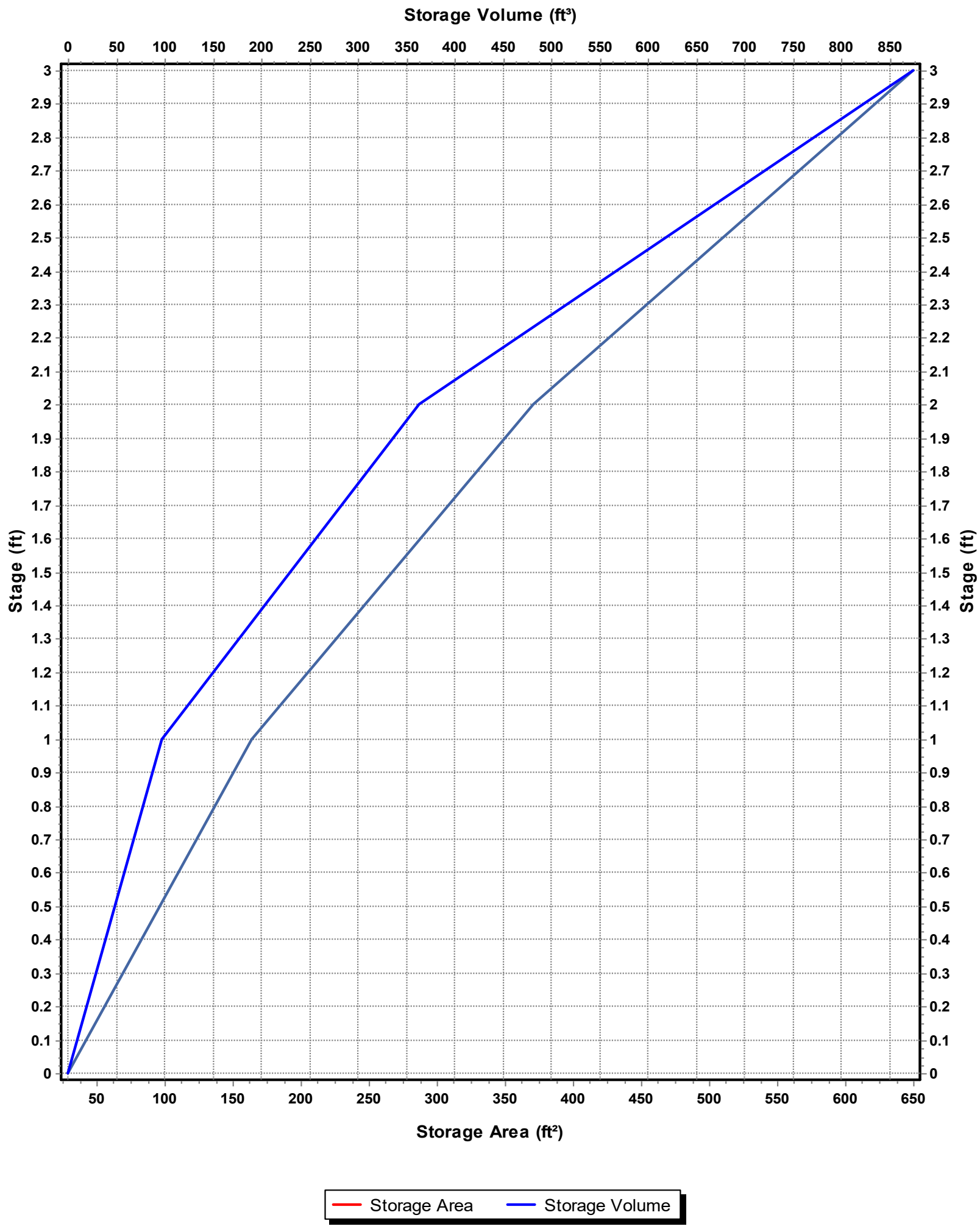
Invert Elevation (ft)	114.00
Max (Rim) Elevation (ft)	117.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

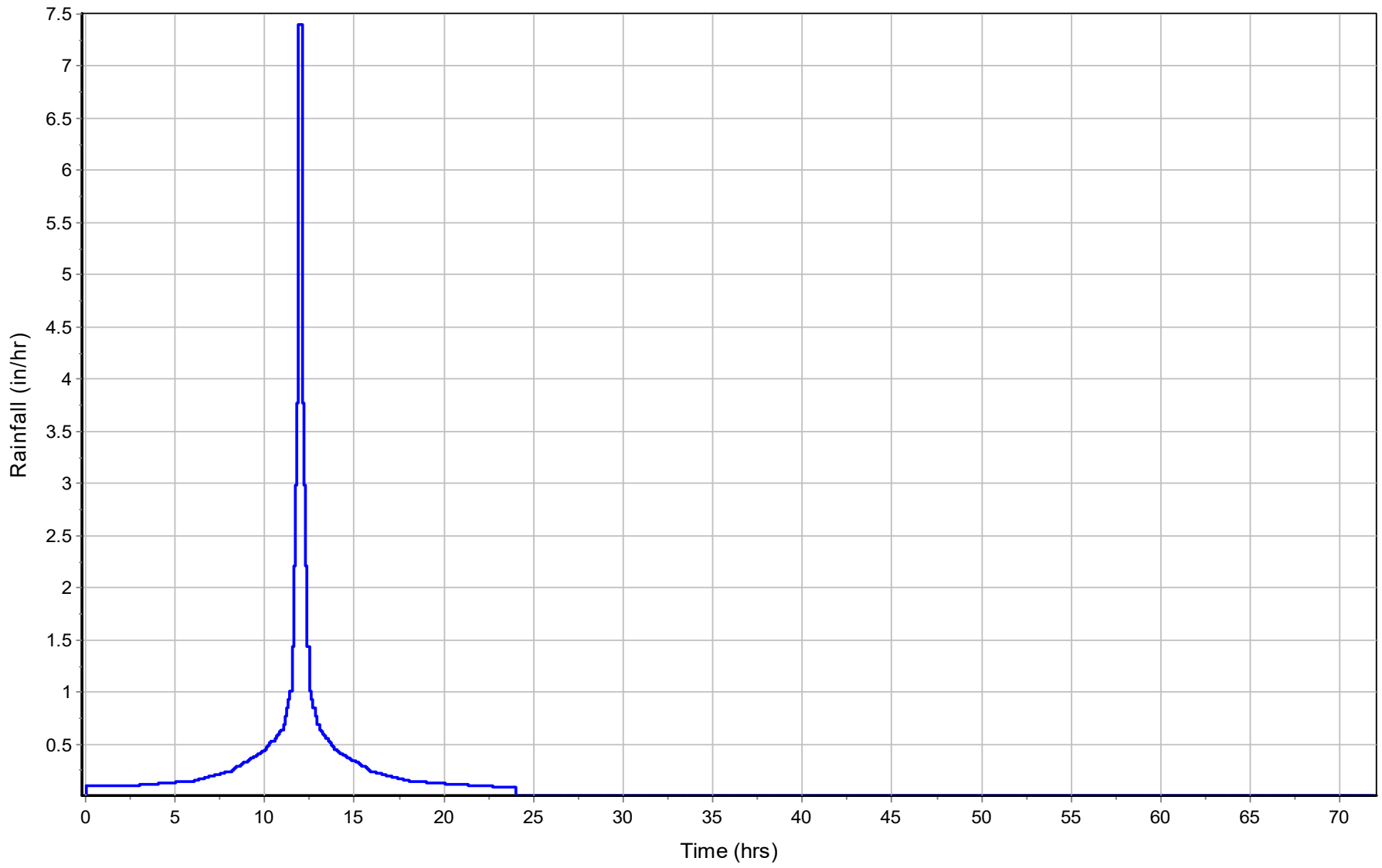
Total TOC (min) 3.15

Subbasin Runoff Results

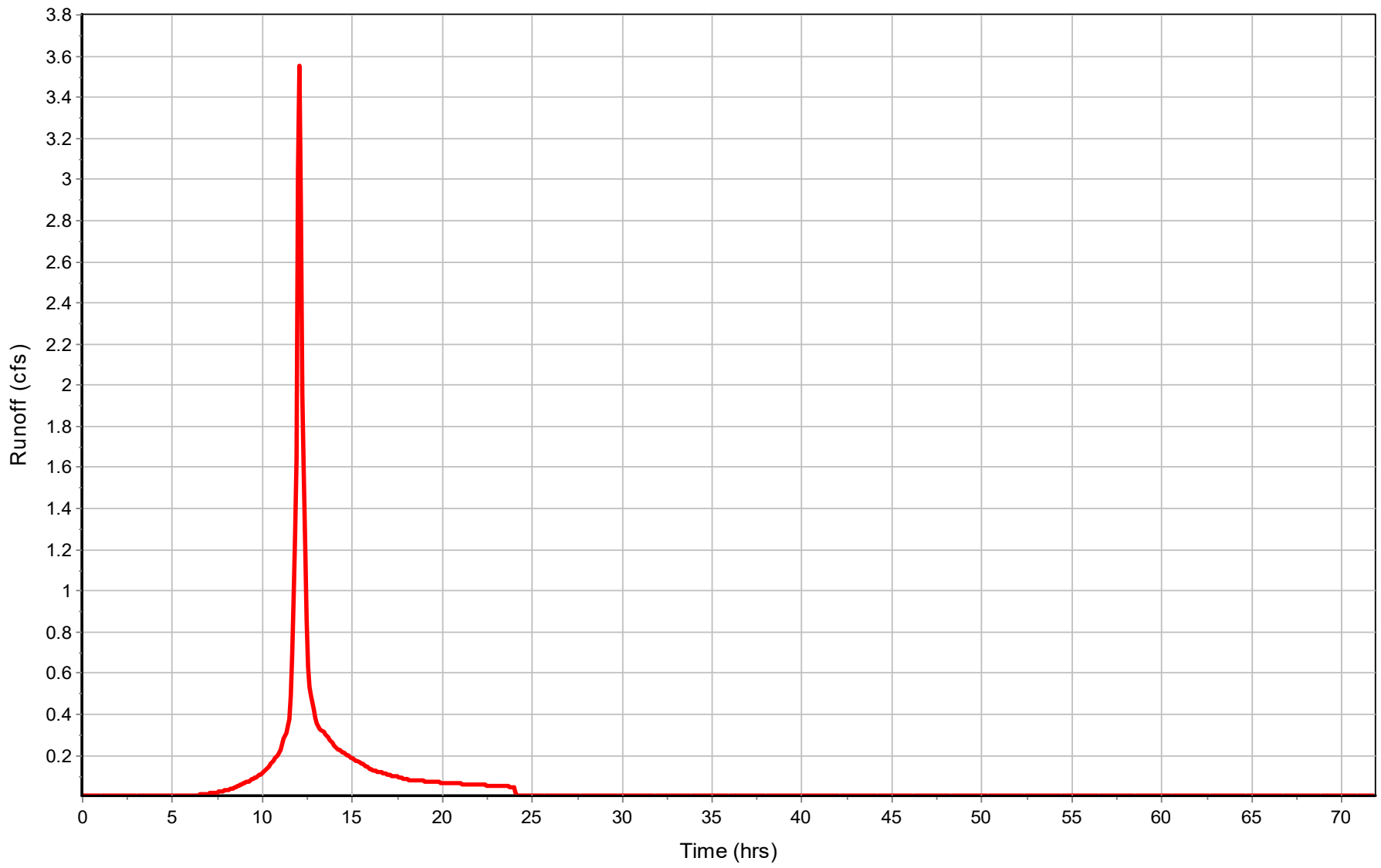
Total Rainfall (in)	8.8
Total Runoff (in)	5.89
Peak Runoff (cfs)	3.61
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:03:09

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

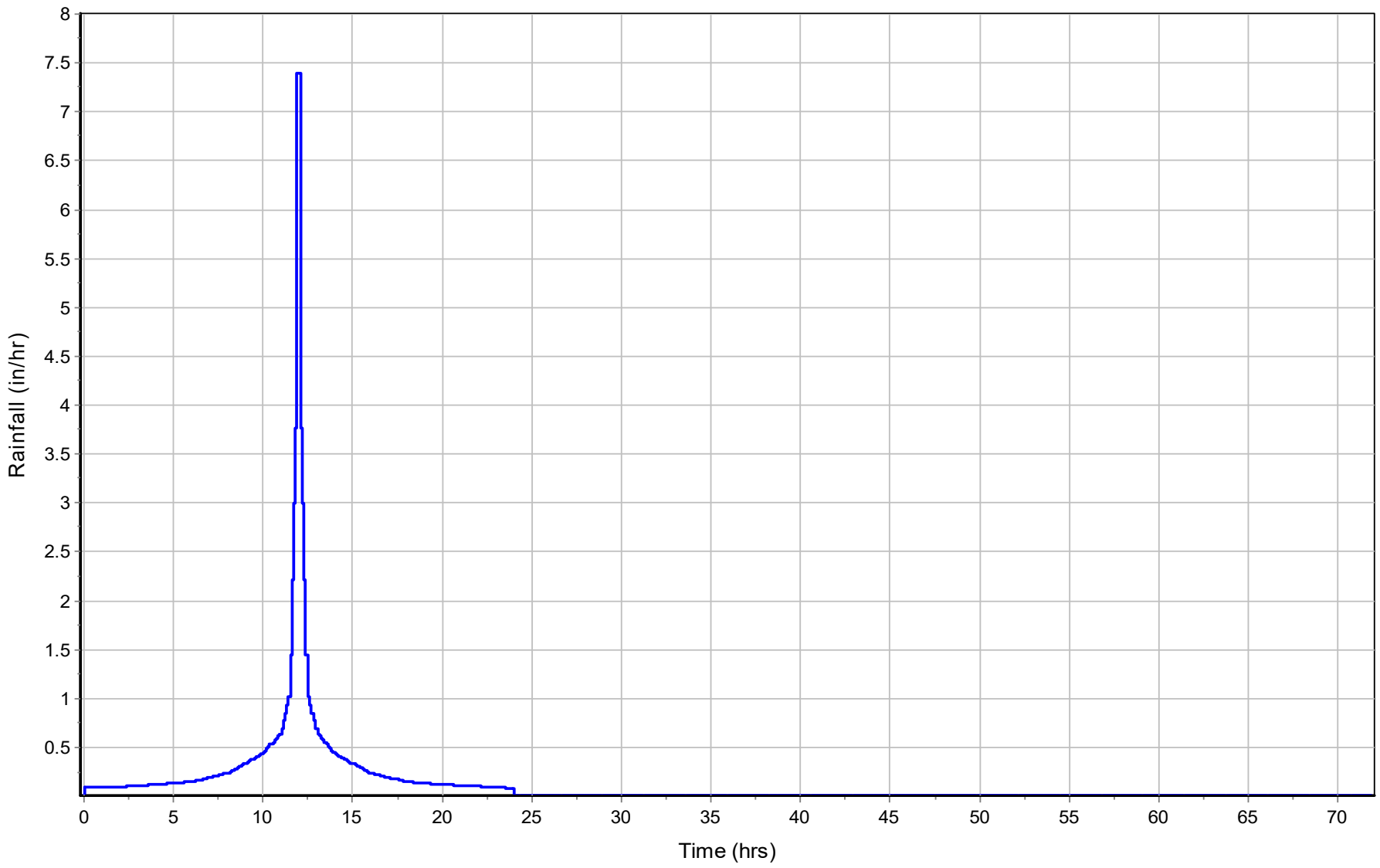
Total TOC (min) 39.09

Subbasin Runoff Results

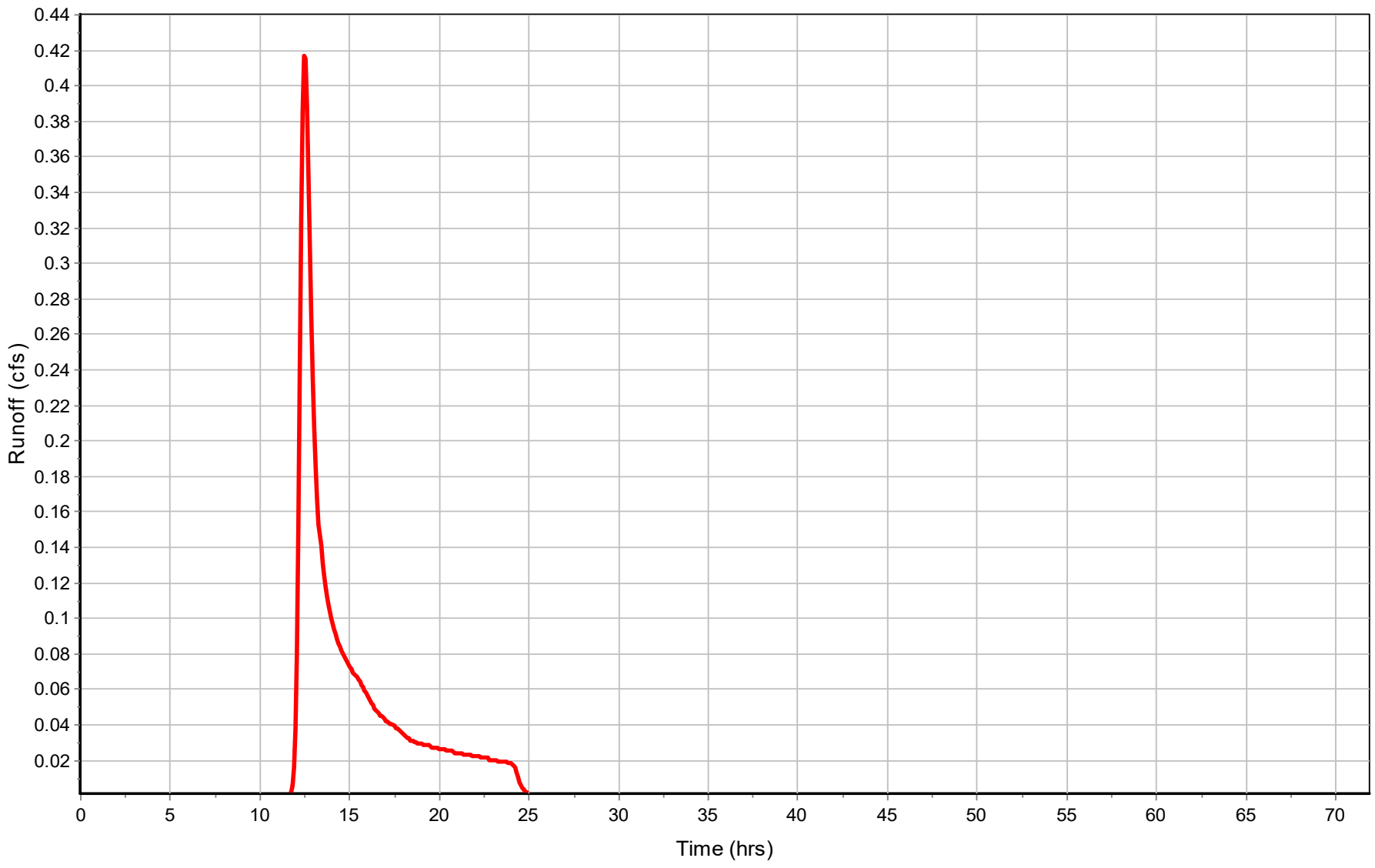
Total Rainfall (in) 8.8
Total Runoff (in) 1.95
Peak Runoff (cfs) 0.42
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:39:05

Subbasin : Sub-E01

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A1

Input Data

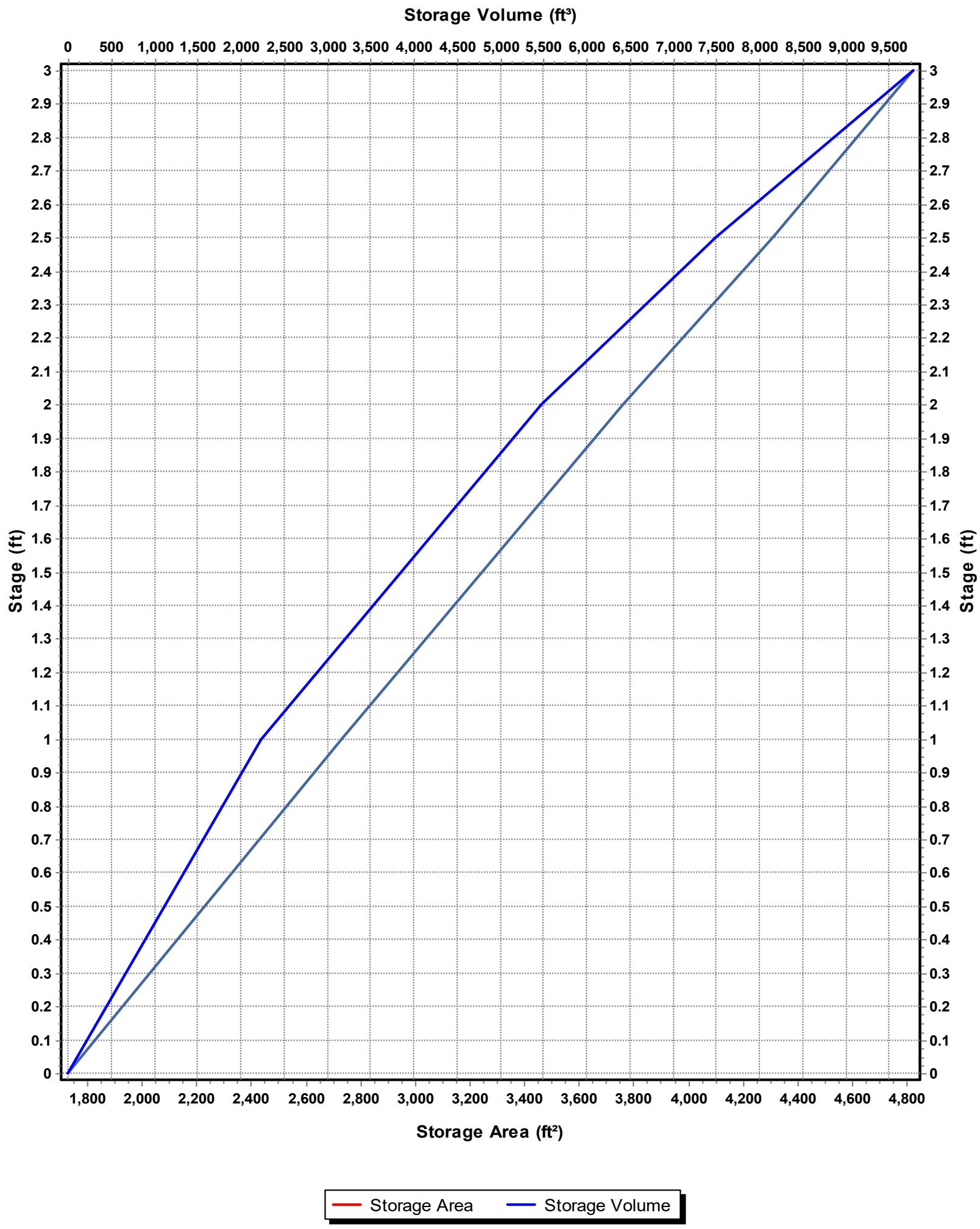
Invert Elevation (ft)	114.00
Max (Rim) Elevation (ft)	117.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

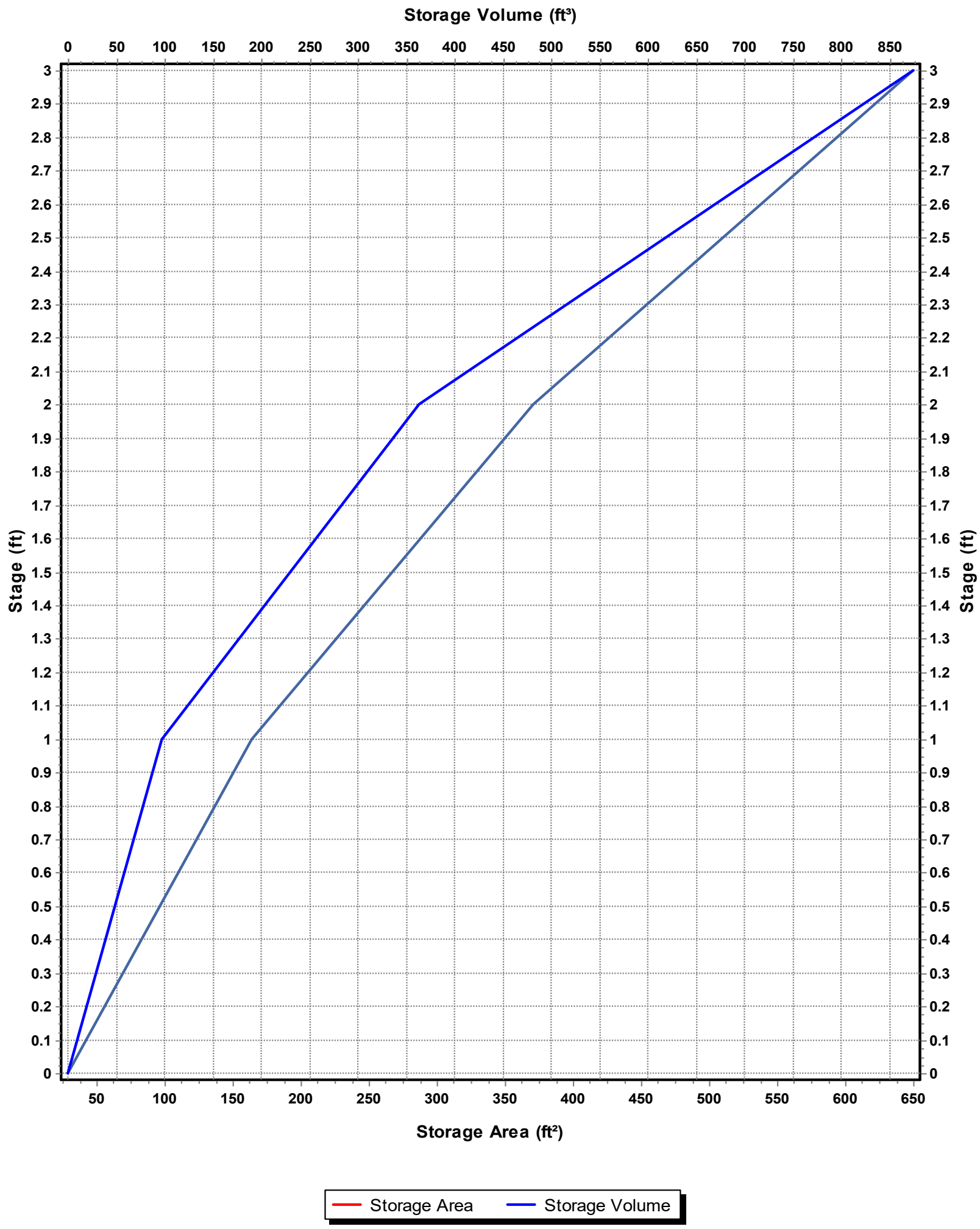
Invert Elevation (ft)	114.00
Max (Rim) Elevation (ft)	117.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	114.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

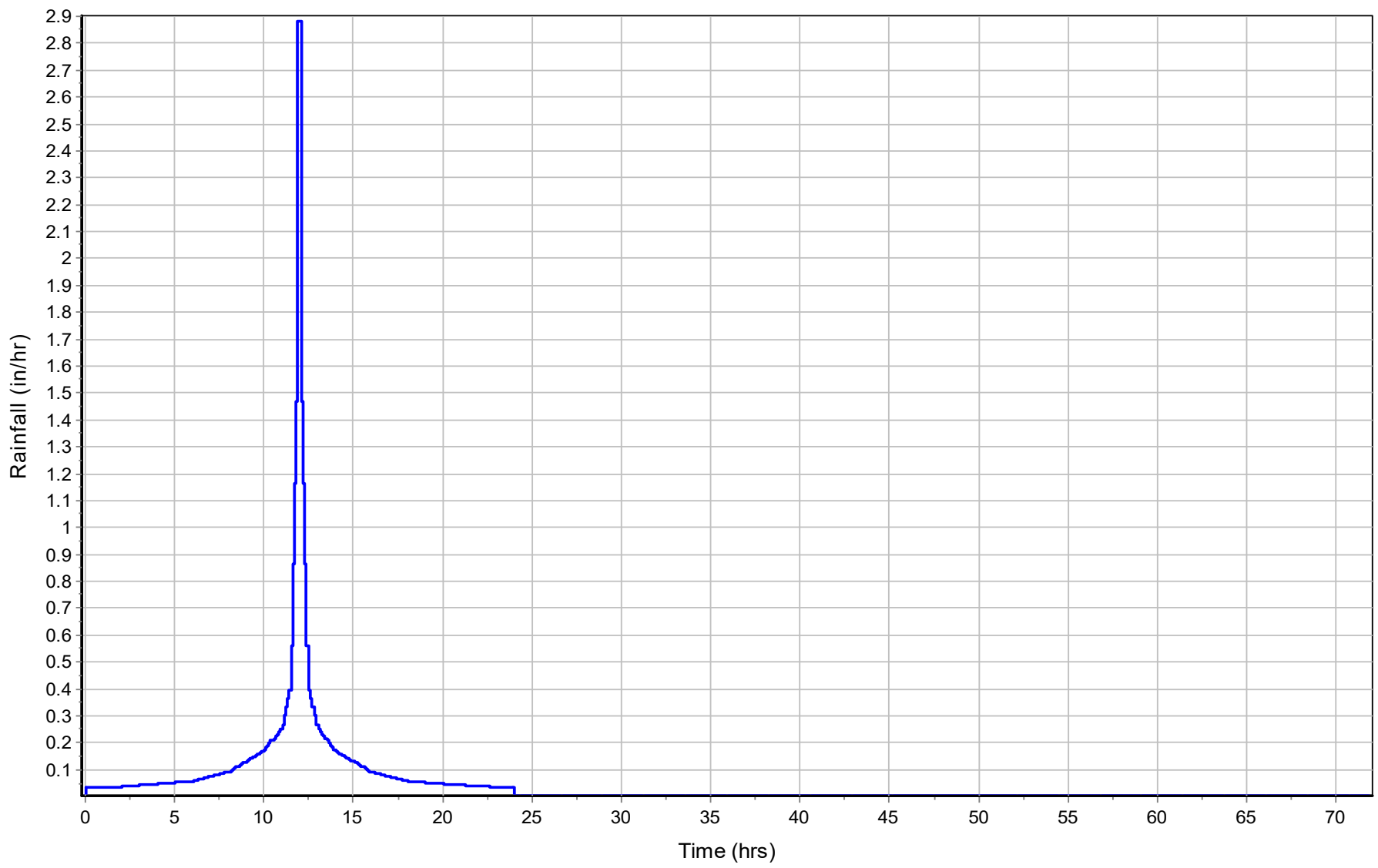
Total TOC (min) 2.31

Subbasin Runoff Results

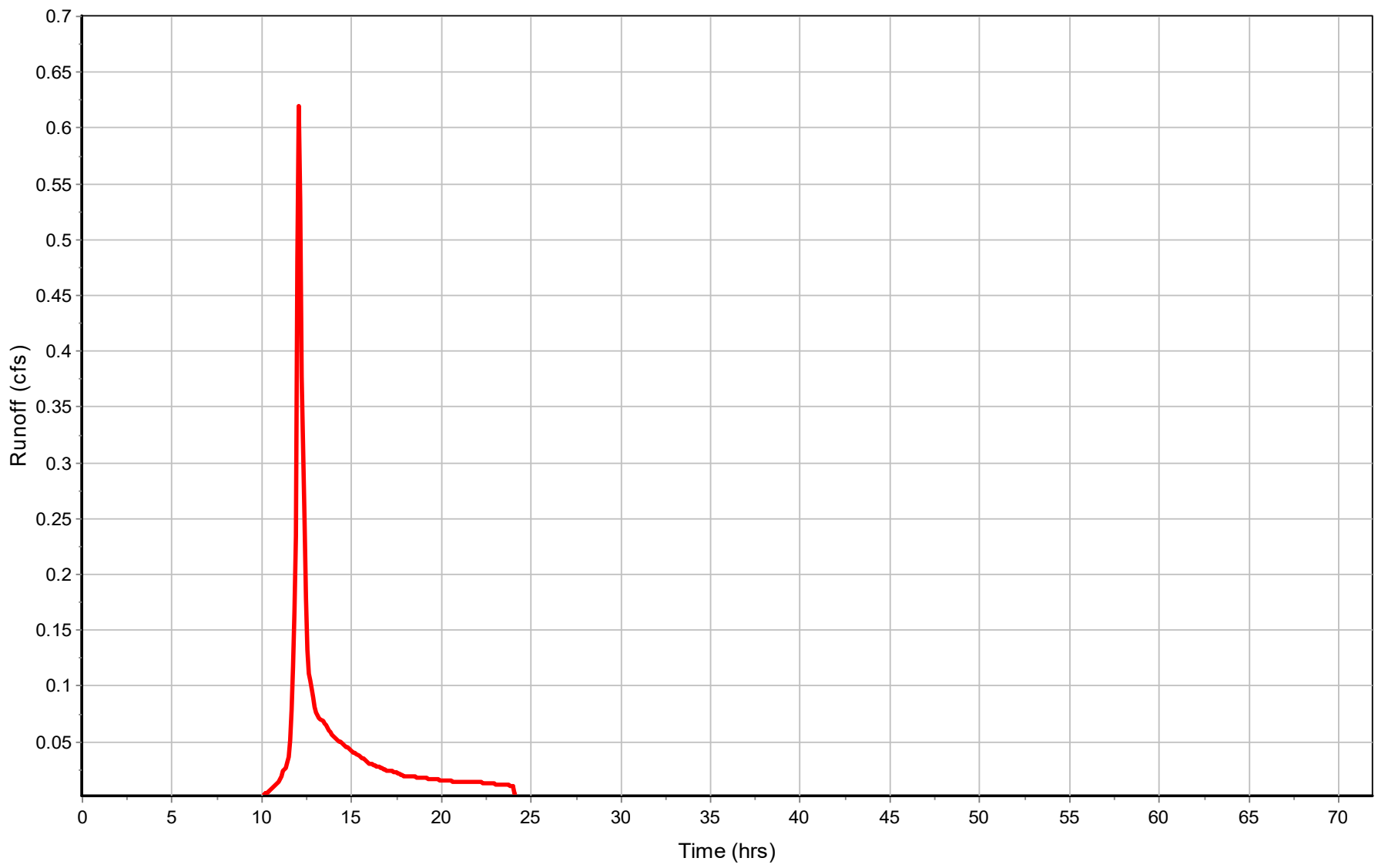
Total Rainfall (in)	3.43
Total Runoff (in)	1.32
Peak Runoff (cfs)	0.65
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:02:19

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

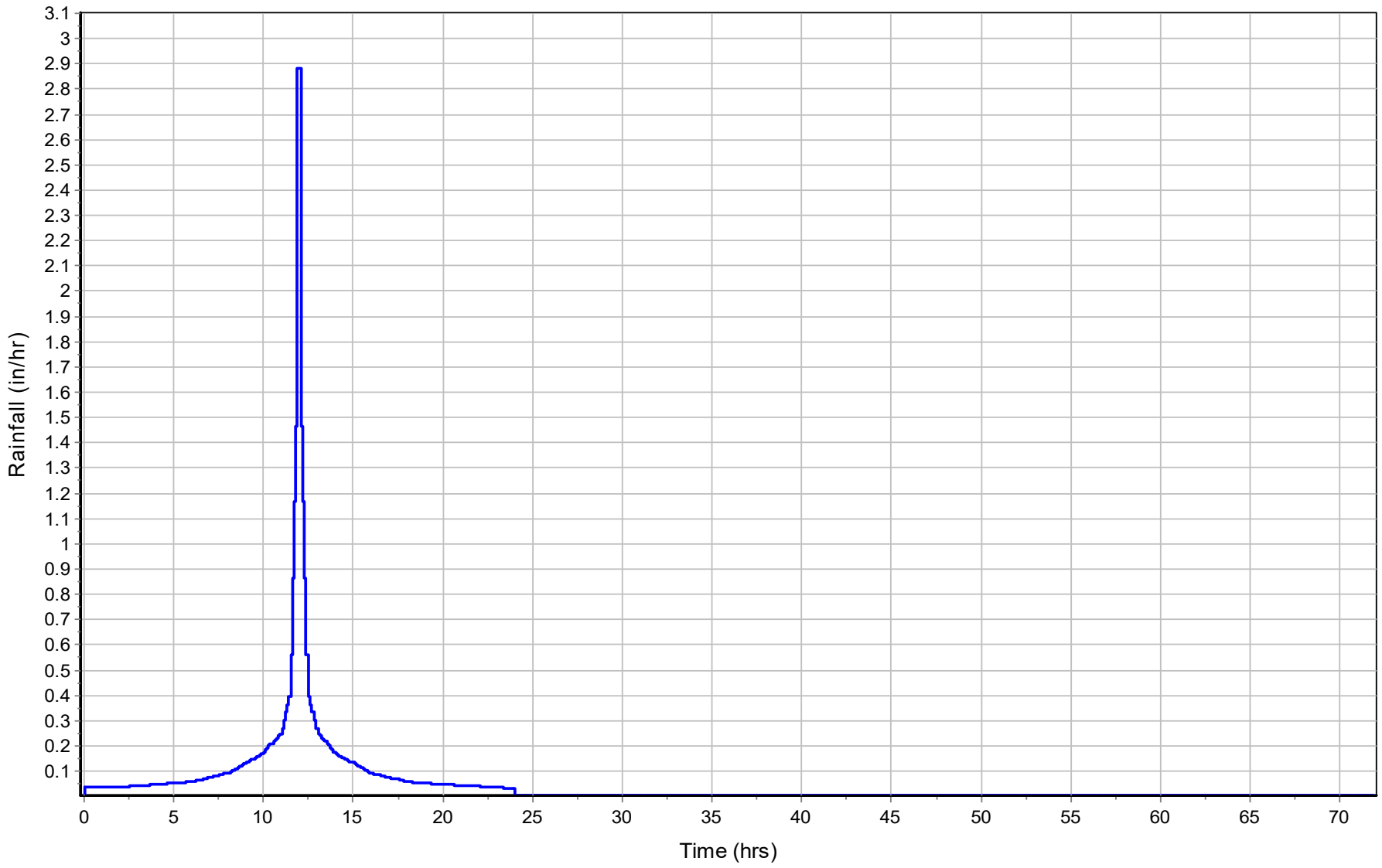
Total TOC (min) 19.54

Subbasin Runoff Results

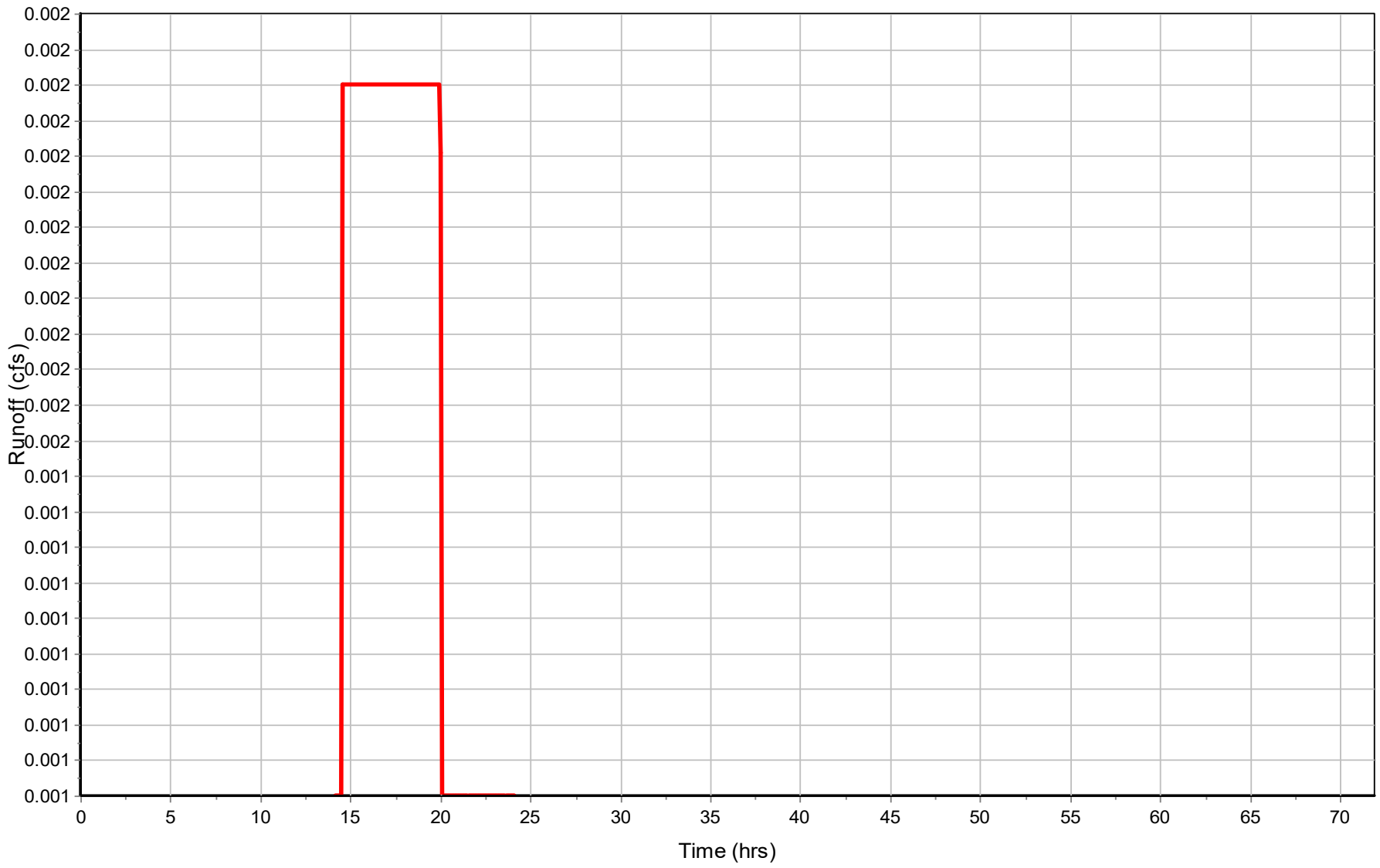
Total Rainfall (in) 3.43
Total Runoff (in) 0.04
Peak Runoff (cfs) 0
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:19:32

Subbasin : Sub-E02

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-02A

Input Data

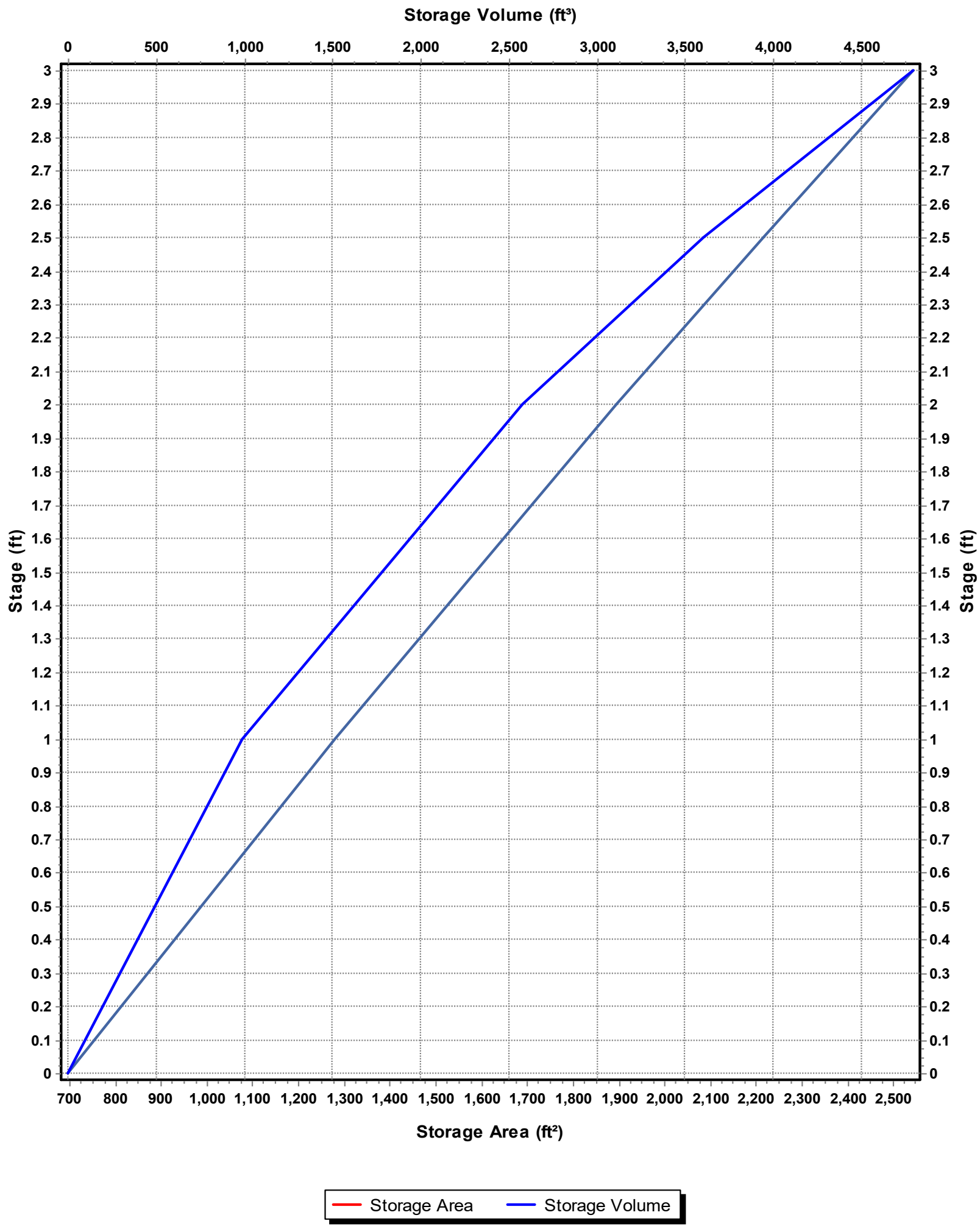
Invert Elevation (ft)	115.00
Max (Rim) Elevation (ft)	118.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	115.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

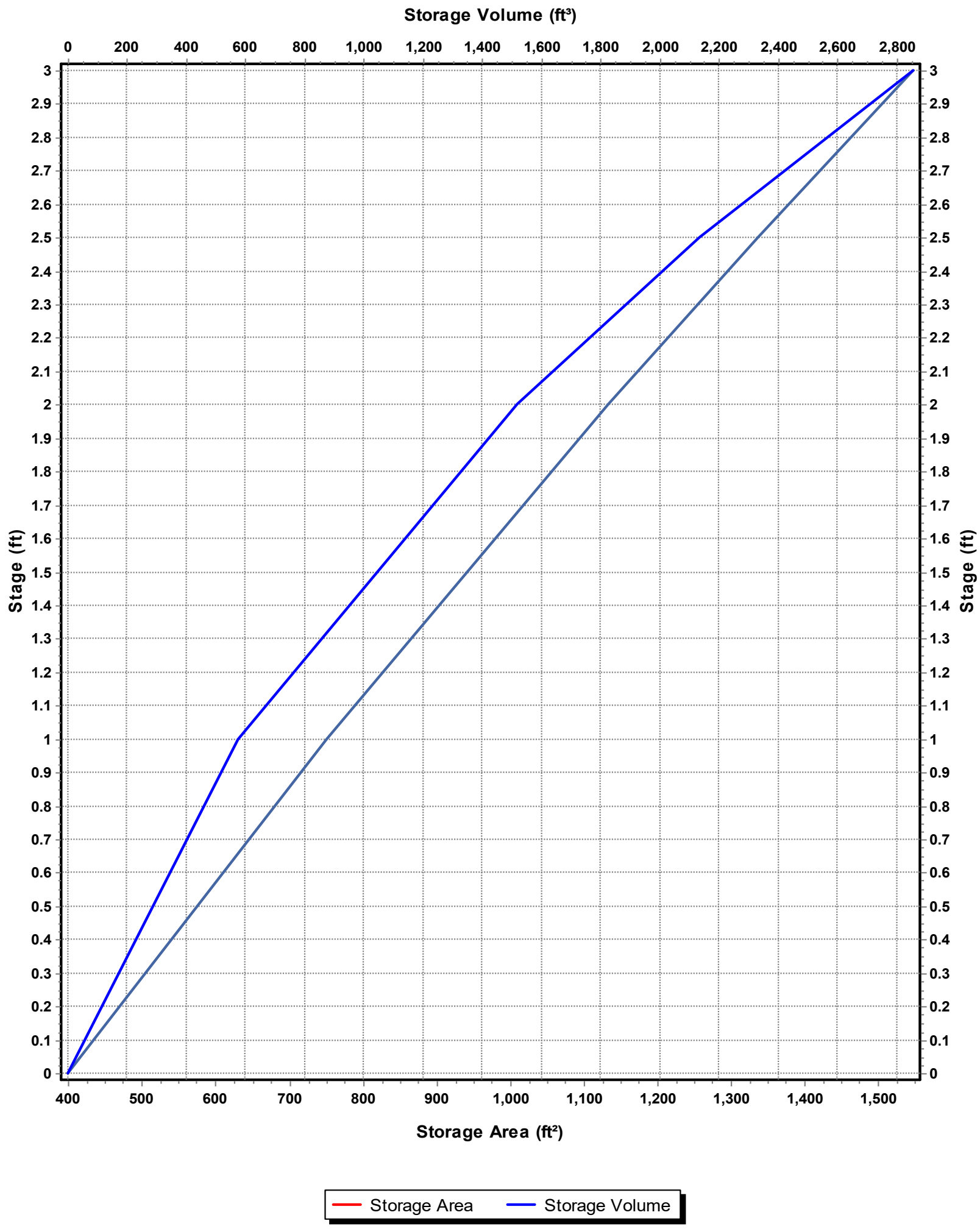
Invert Elevation (ft)	115.00
Max (Rim) Elevation (ft)	118.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	115.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

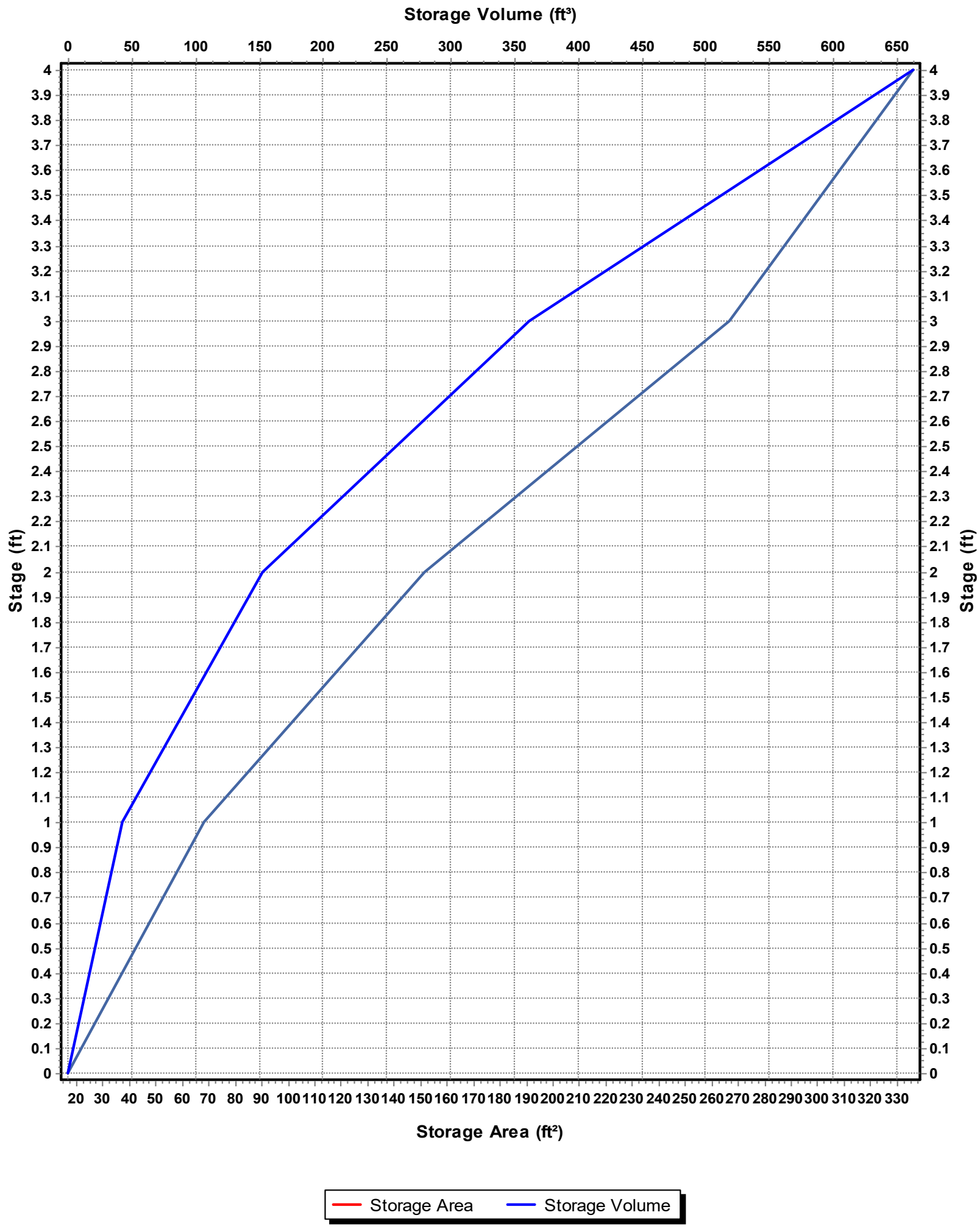
Invert Elevation (ft)	114.50
Max (Rim) Elevation (ft)	118.00
Max (Rim) Offset (ft)	3.50
Initial Water Elevation (ft)	114.50
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

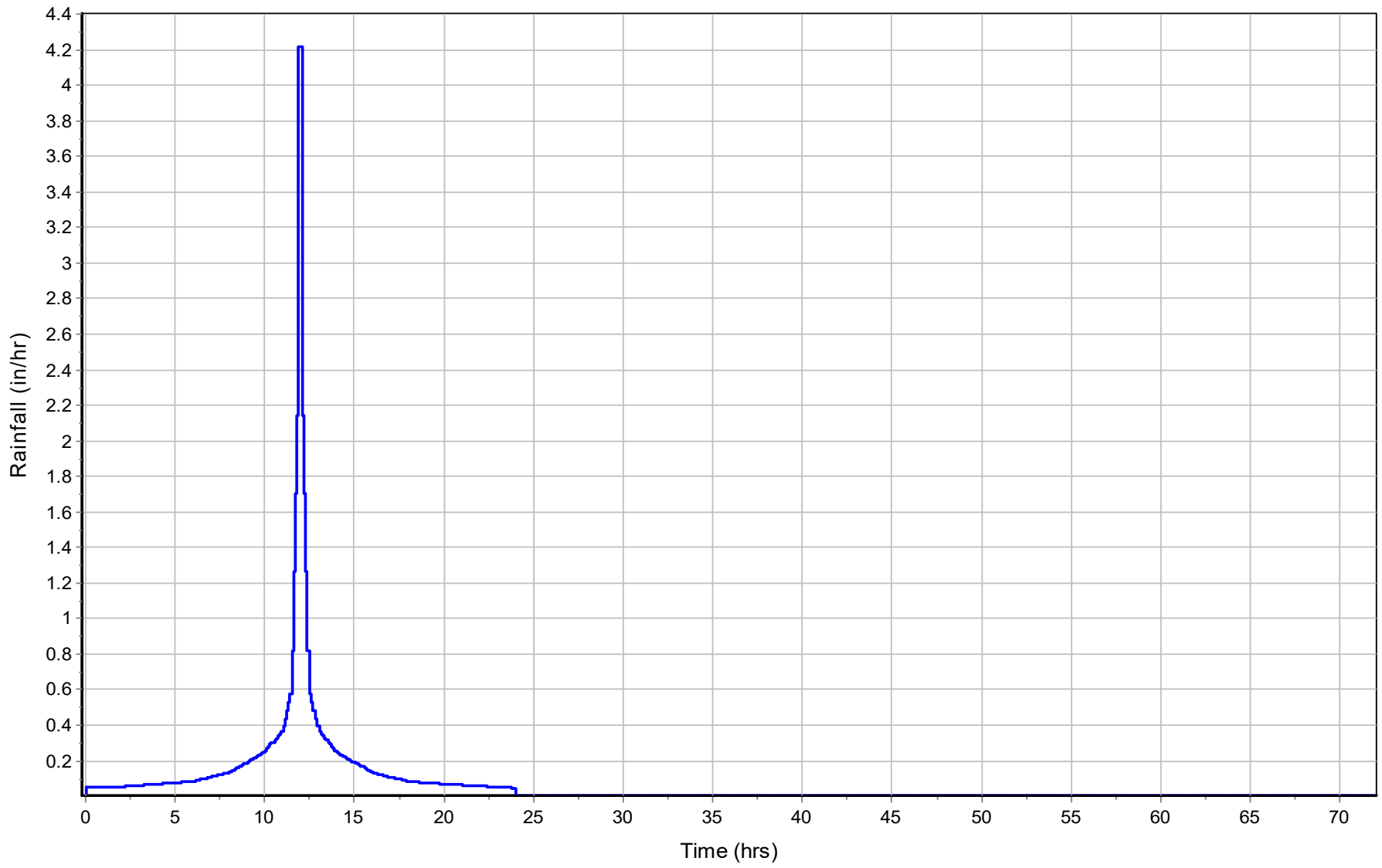
Total TOC (min) 2.31

Subbasin Runoff Results

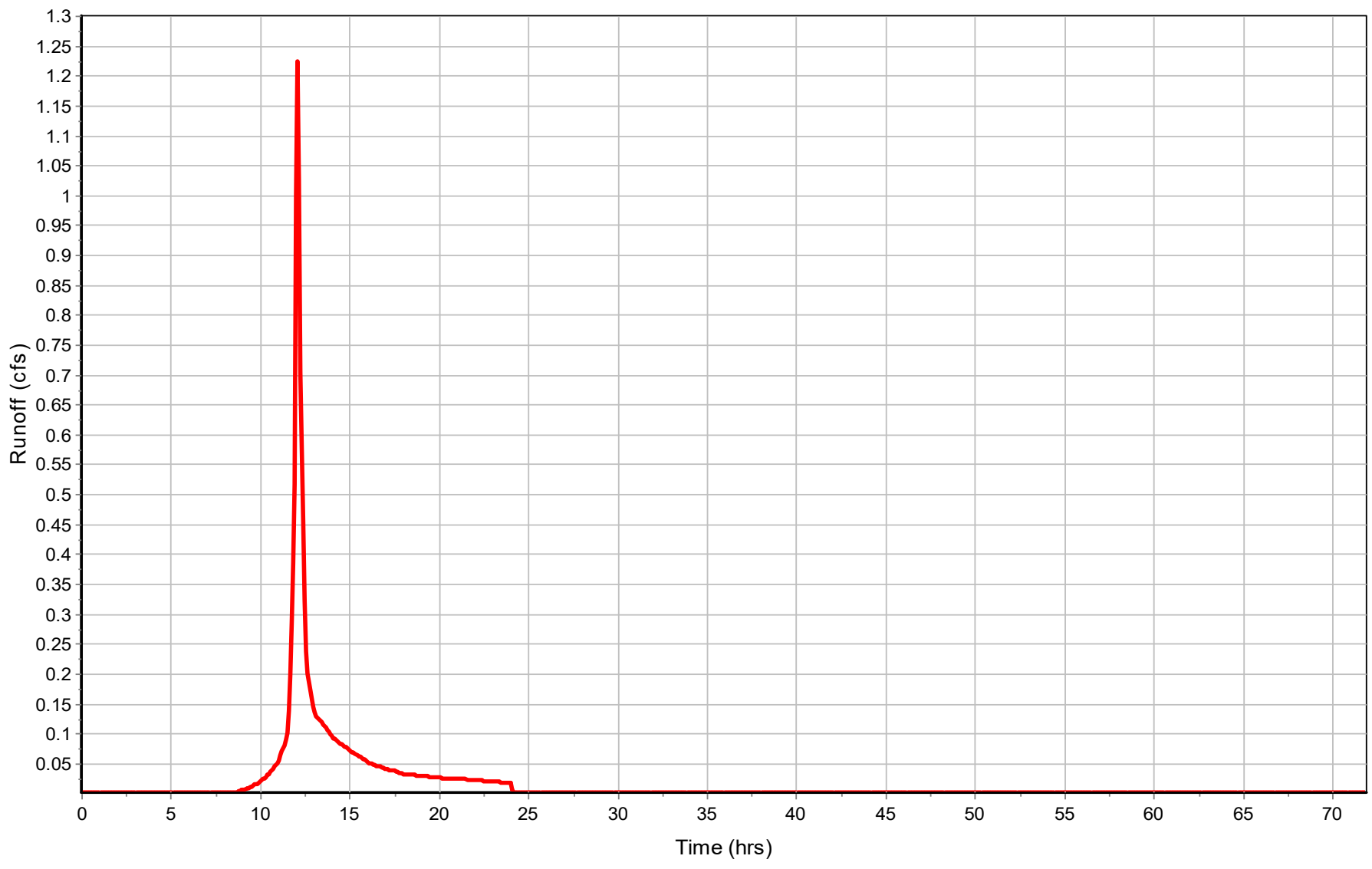
Total Rainfall (in) 5.01
Total Runoff (in) 2.54
Peak Runoff (cfs) 1.26
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:02:19

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

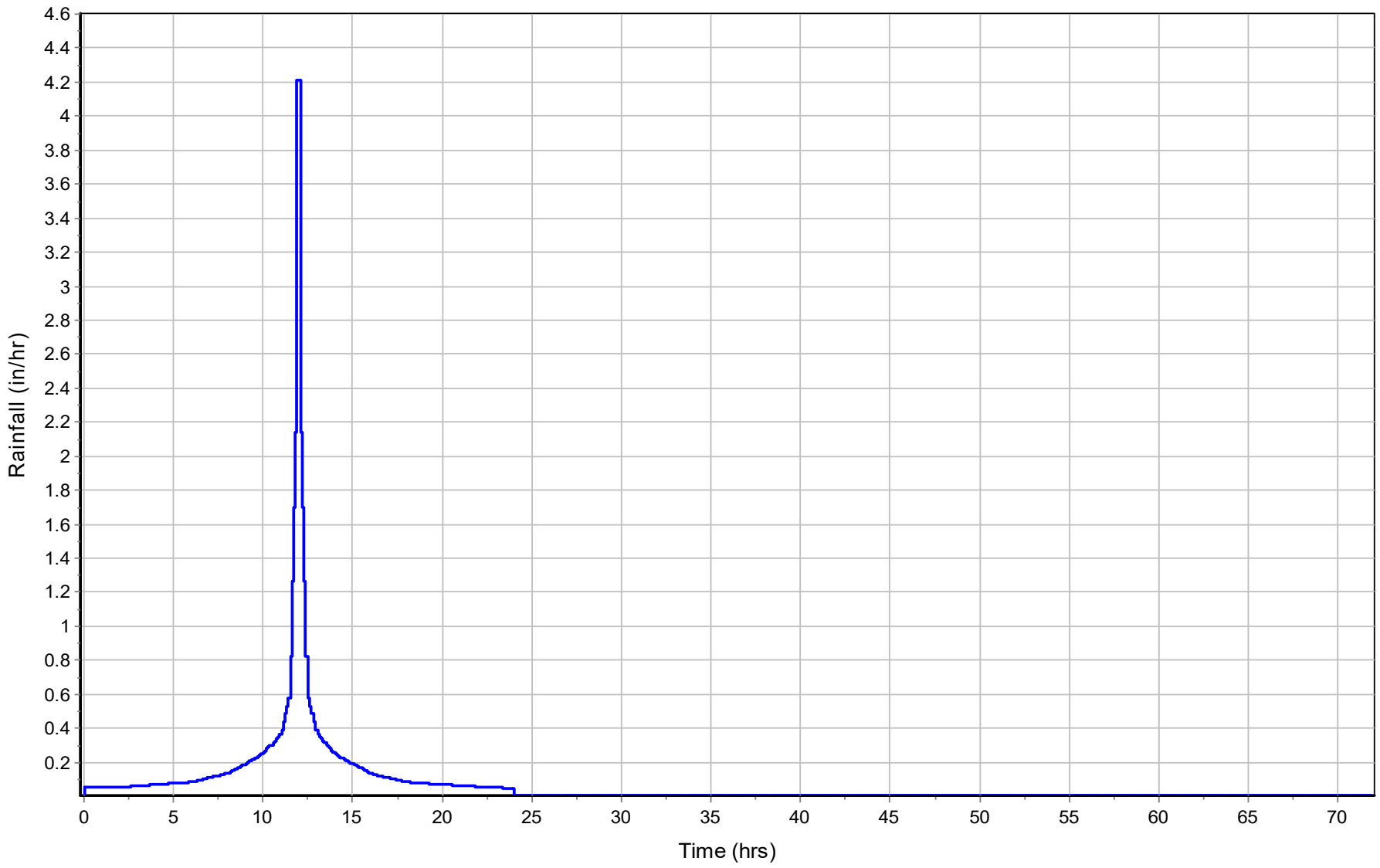
Total TOC (min) 19.54

Subbasin Runoff Results

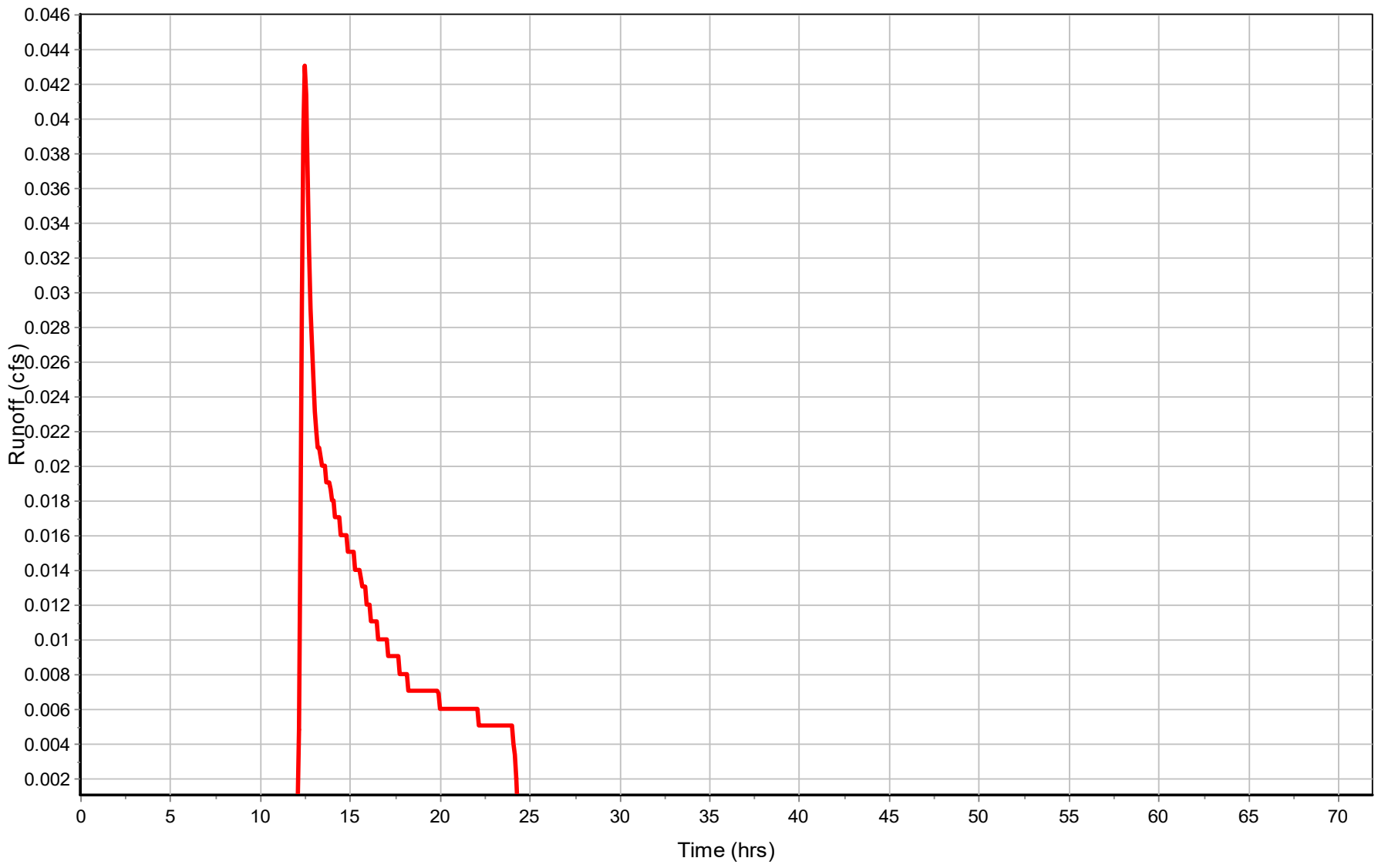
Total Rainfall (in) 5.01
Total Runoff (in) 0.36
Peak Runoff (cfs) 0.04
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:19:32

Subbasin : Sub-E02

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-02A

Input Data

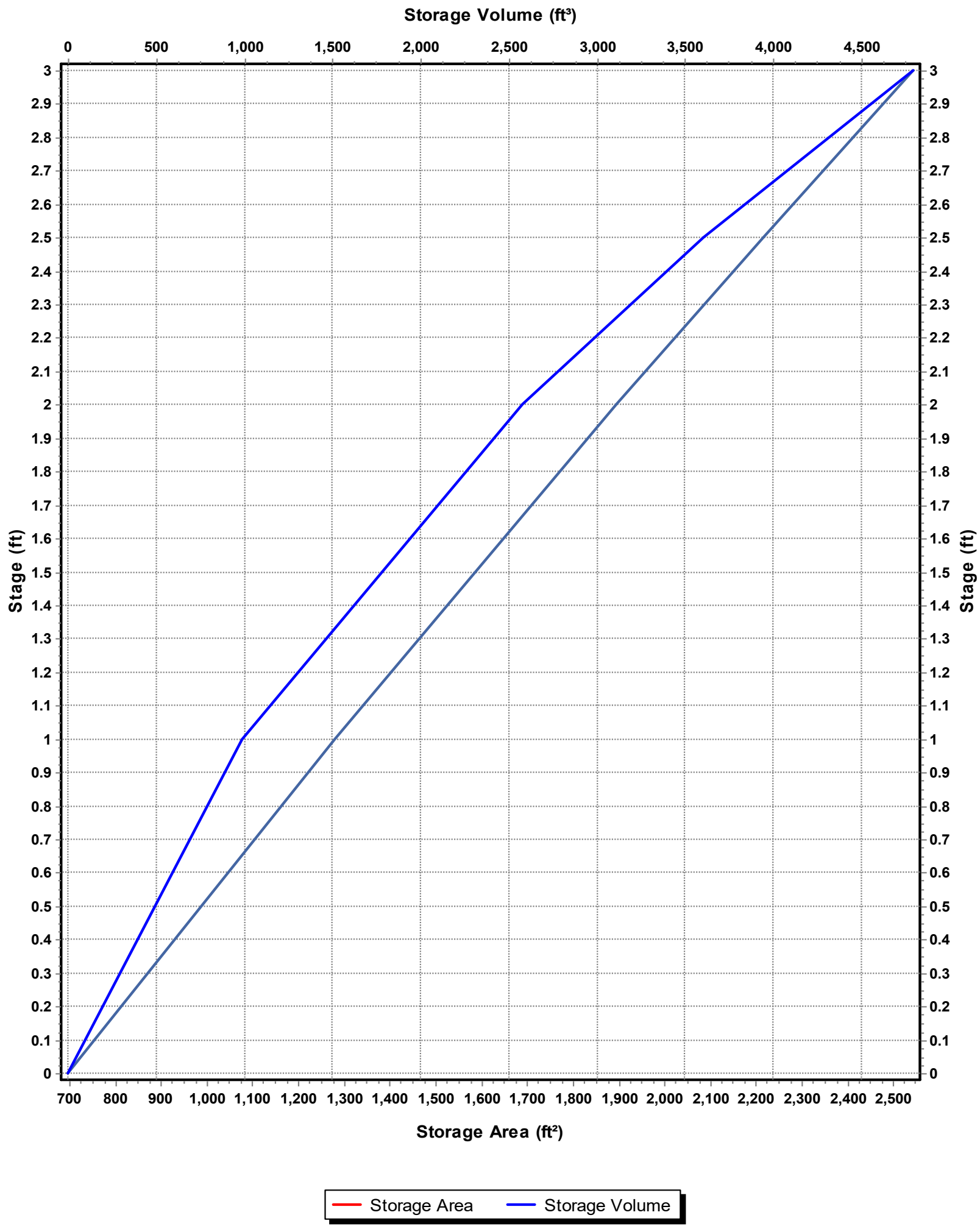
Invert Elevation (ft)	115.00
Max (Rim) Elevation (ft)	118.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	115.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

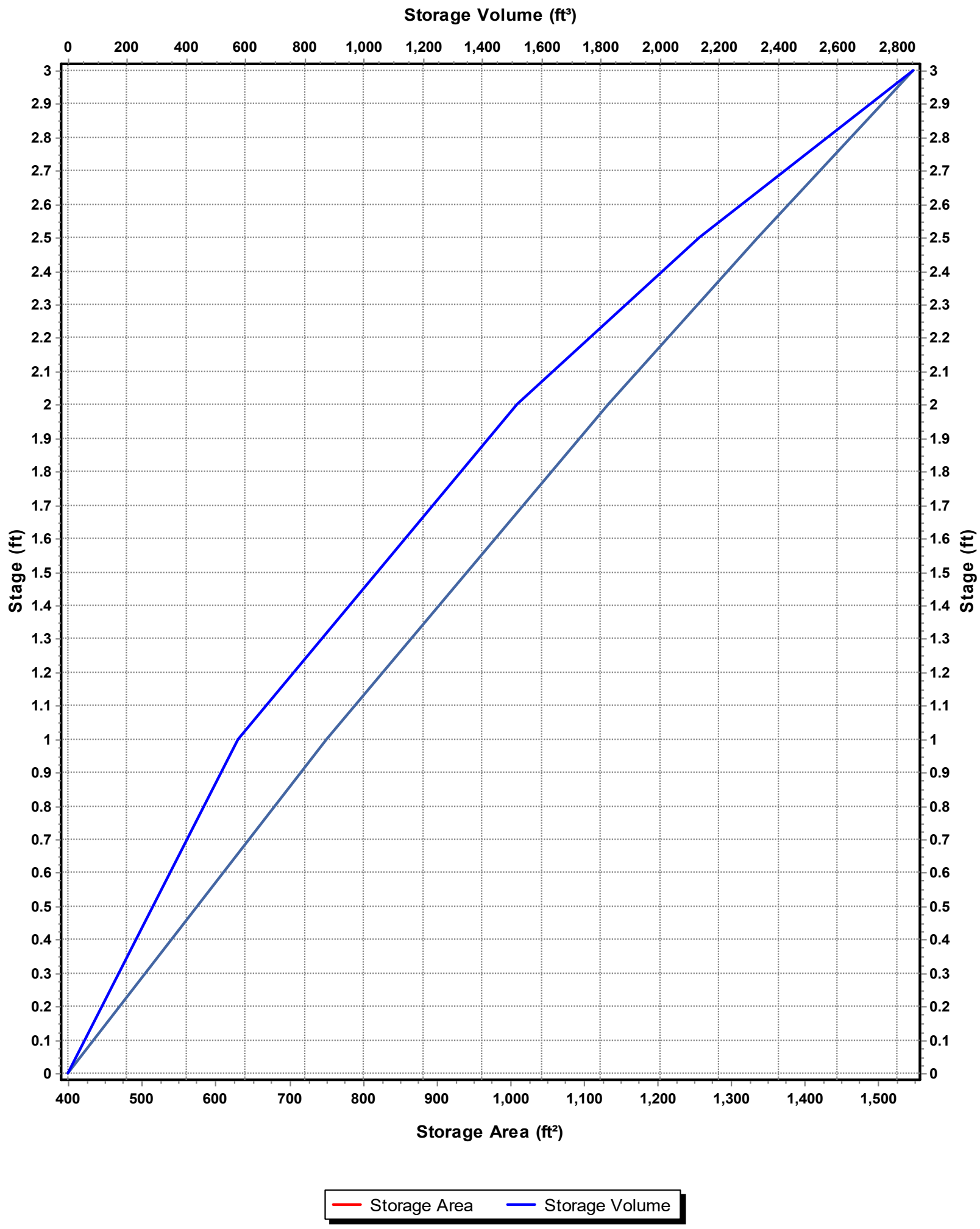
Invert Elevation (ft)	115.00
Max (Rim) Elevation (ft)	118.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	115.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

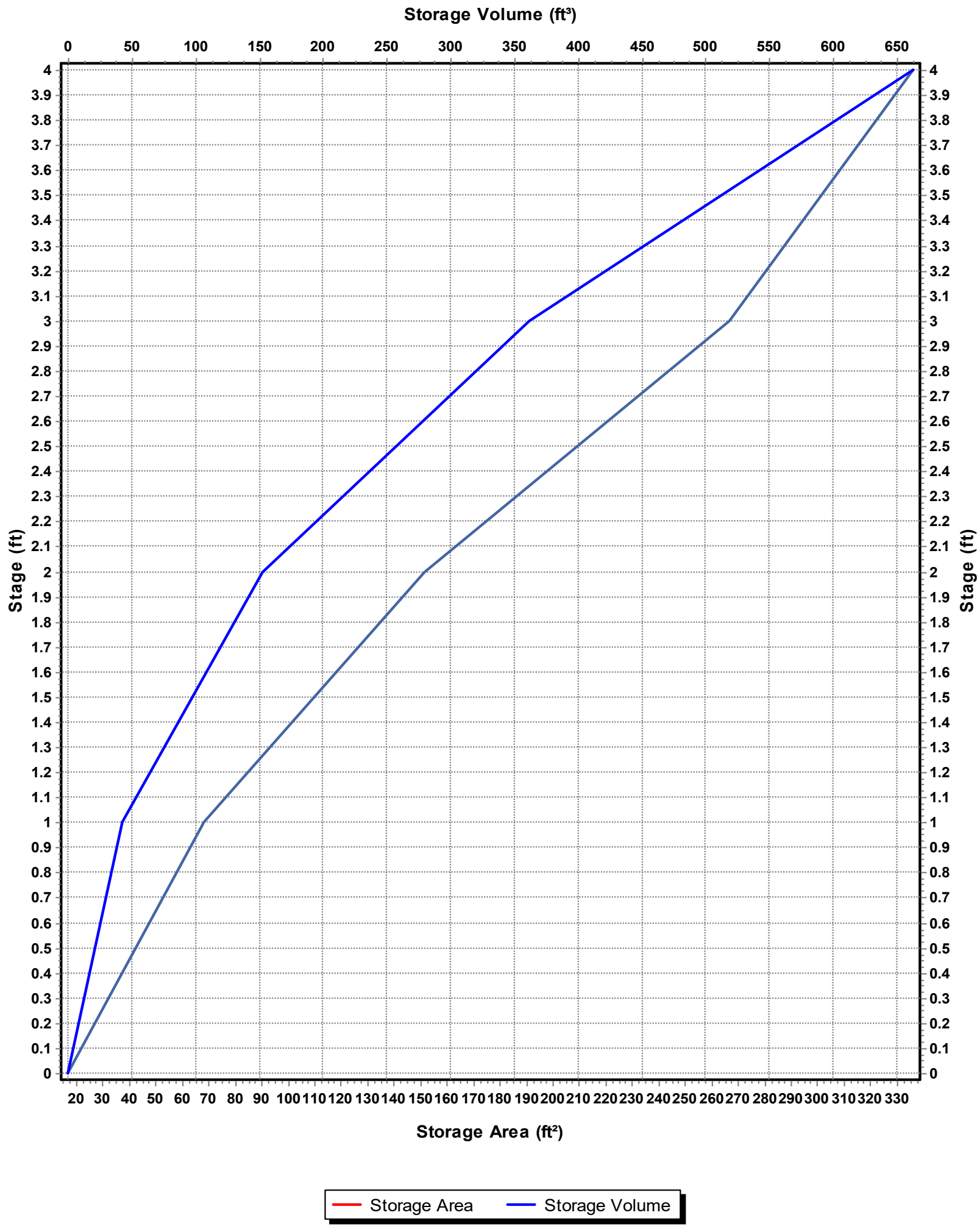
Invert Elevation (ft)	114.50
Max (Rim) Elevation (ft)	118.00
Max (Rim) Offset (ft)	3.50
Initial Water Elevation (ft)	114.50
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

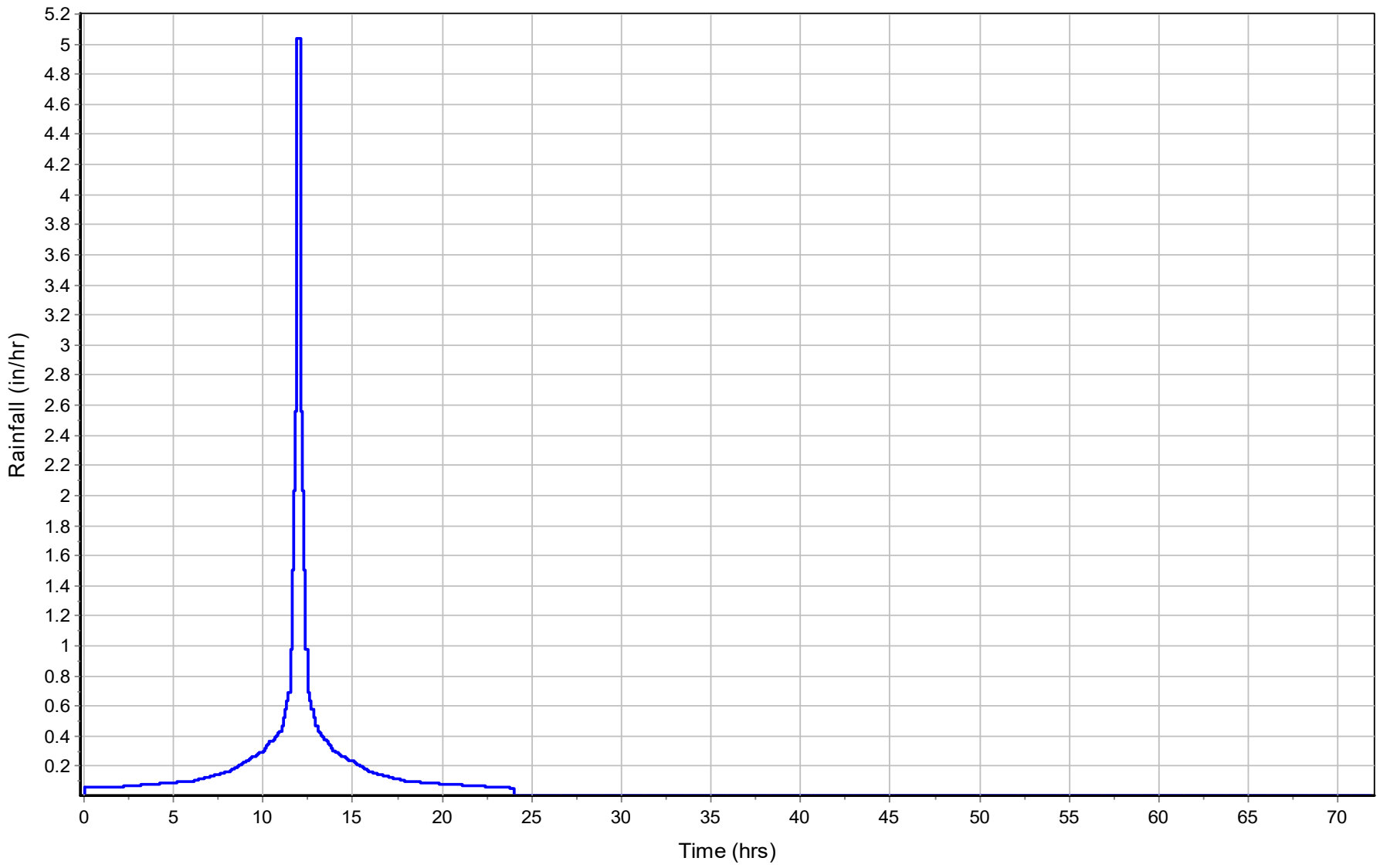
Total TOC (min) 2.31

Subbasin Runoff Results

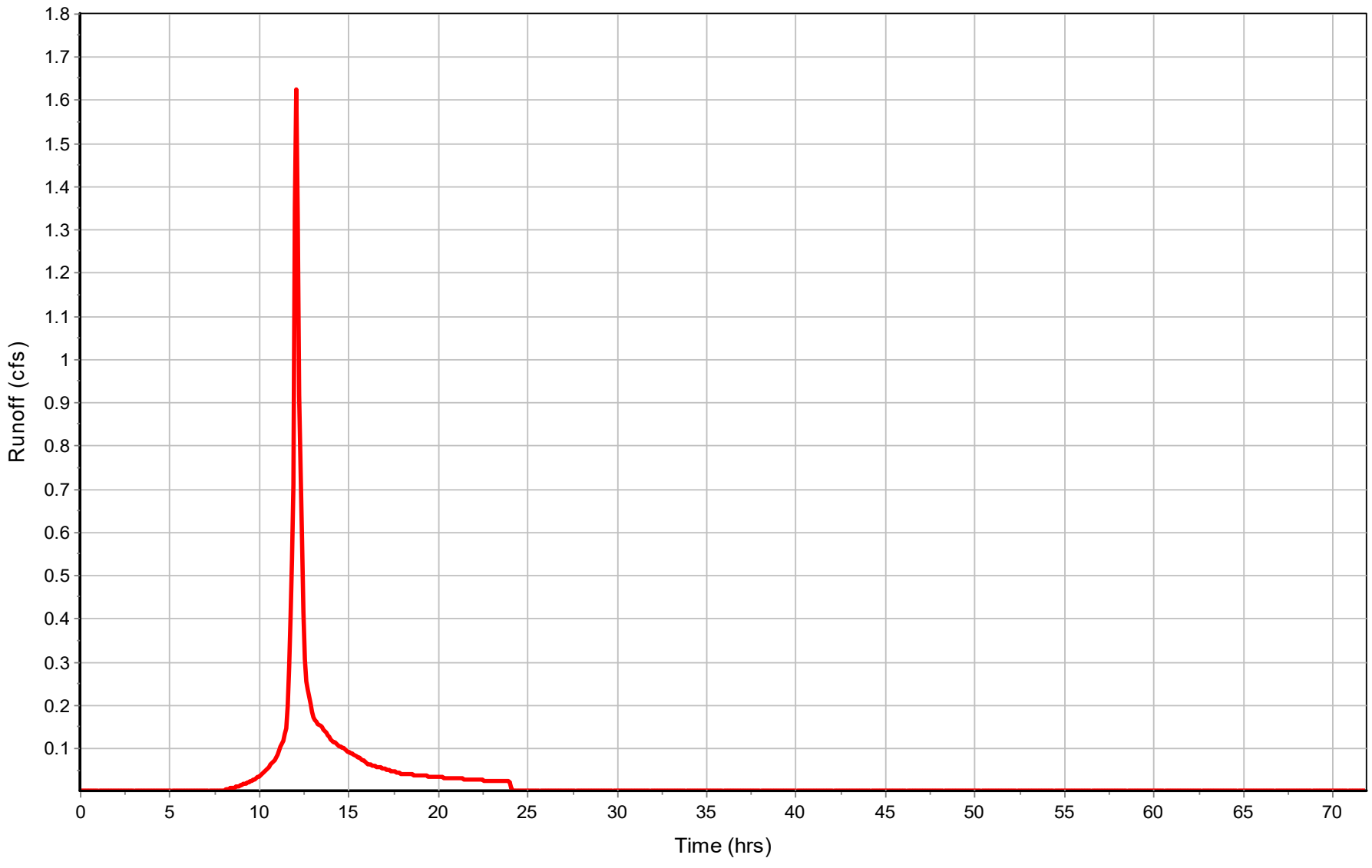
Total Rainfall (in)	5.99
Total Runoff (in)	3.37
Peak Runoff (cfs)	1.67
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:02:19

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

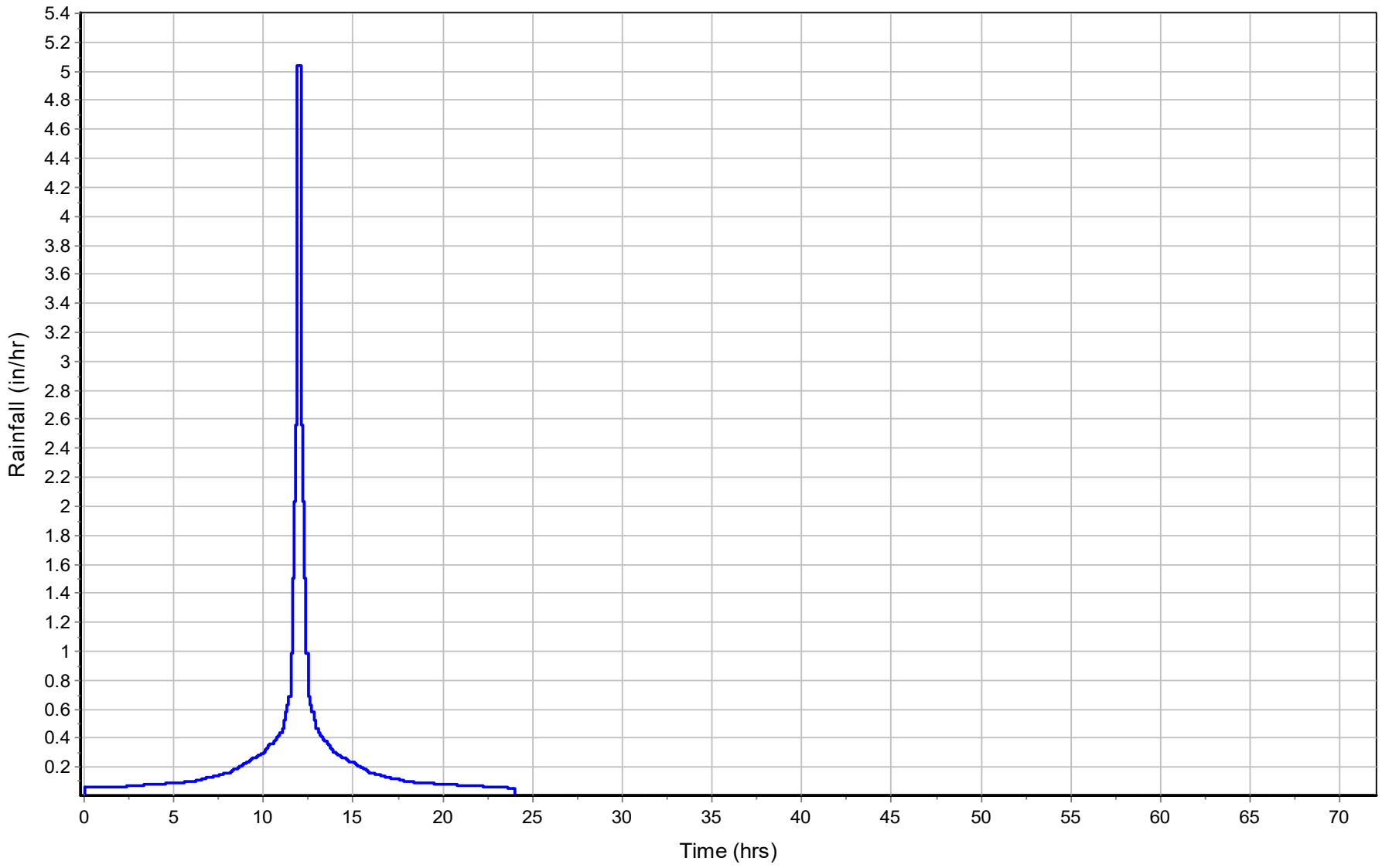
Total TOC (min) 19.54

Subbasin Runoff Results

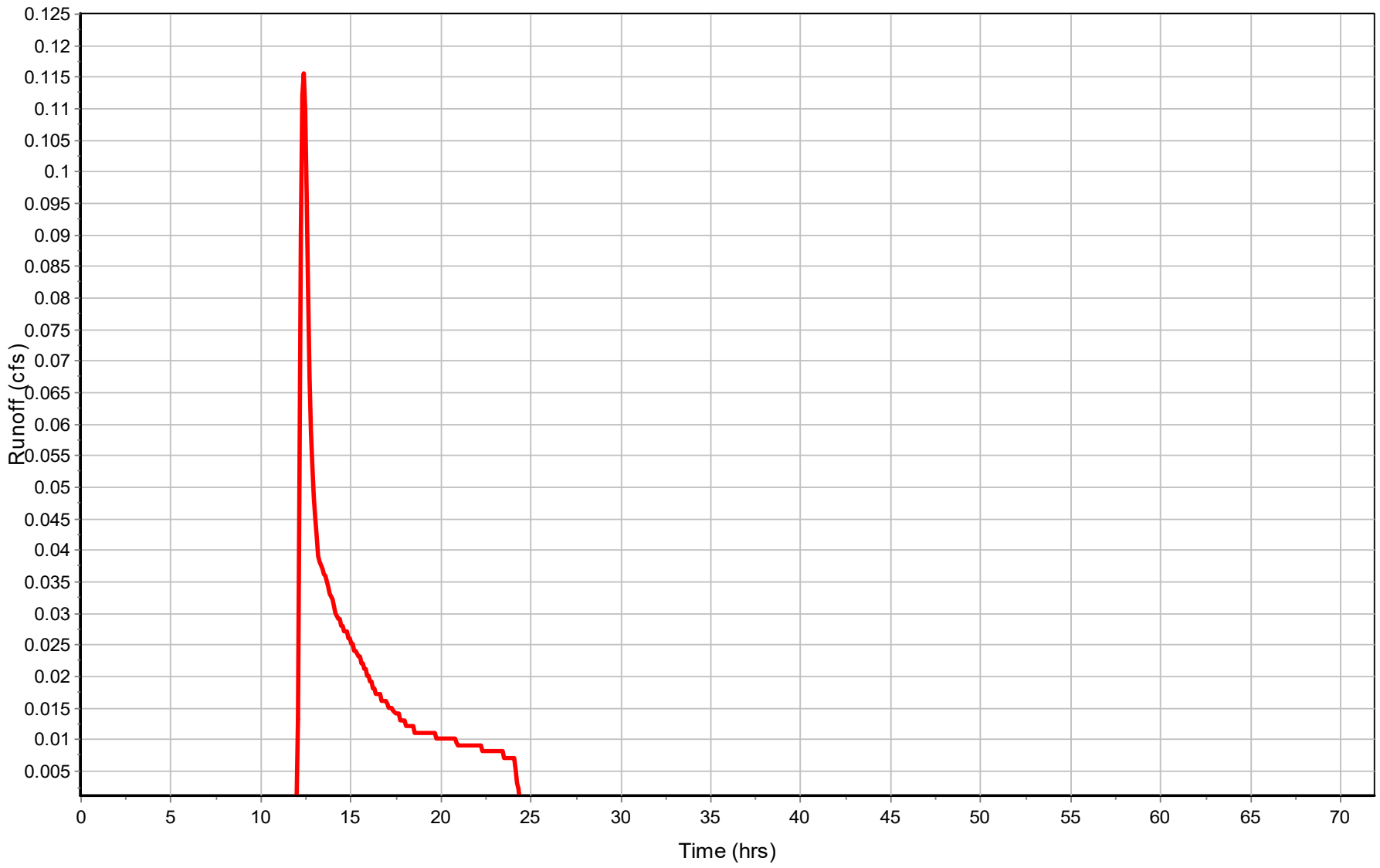
Total Rainfall (in) 5.99
Total Runoff (in) 0.67
Peak Runoff (cfs) 0.12
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:19:32

Subbasin : Sub-E02

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-02A

Input Data

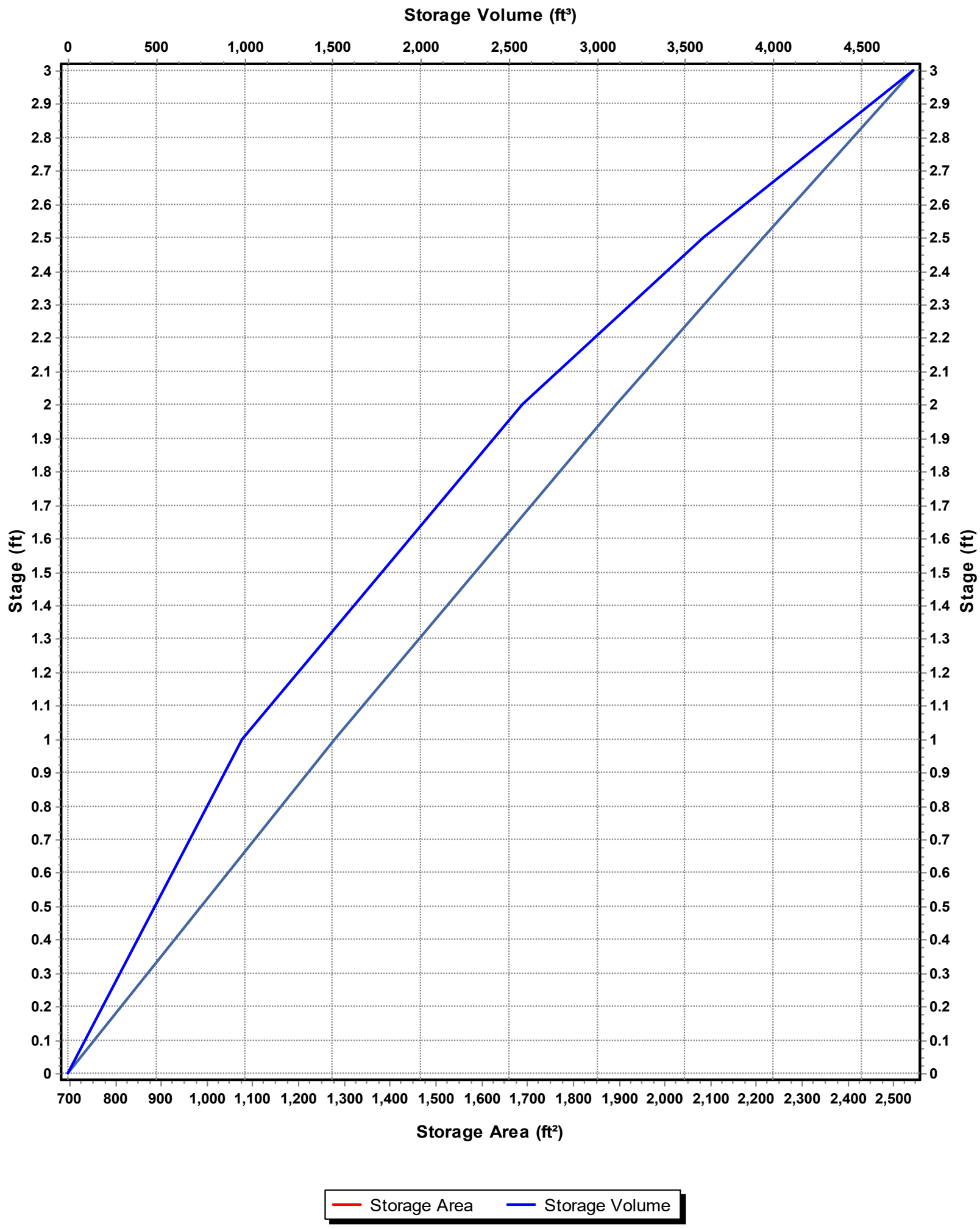
Invert Elevation (ft)	115.00
Max (Rim) Elevation (ft)	118.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	115.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

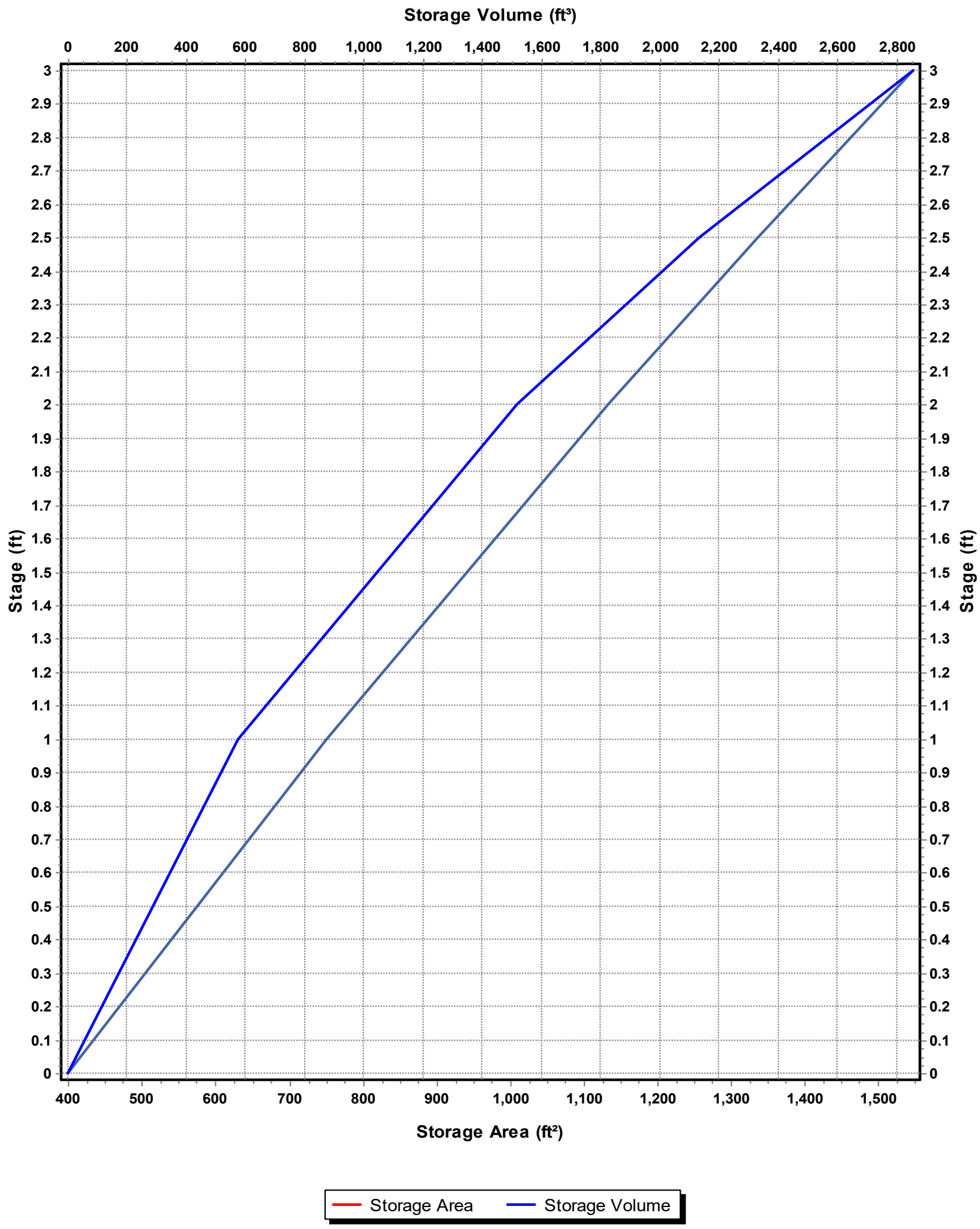
Invert Elevation (ft)	115.00
Max (Rim) Elevation (ft)	118.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	115.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

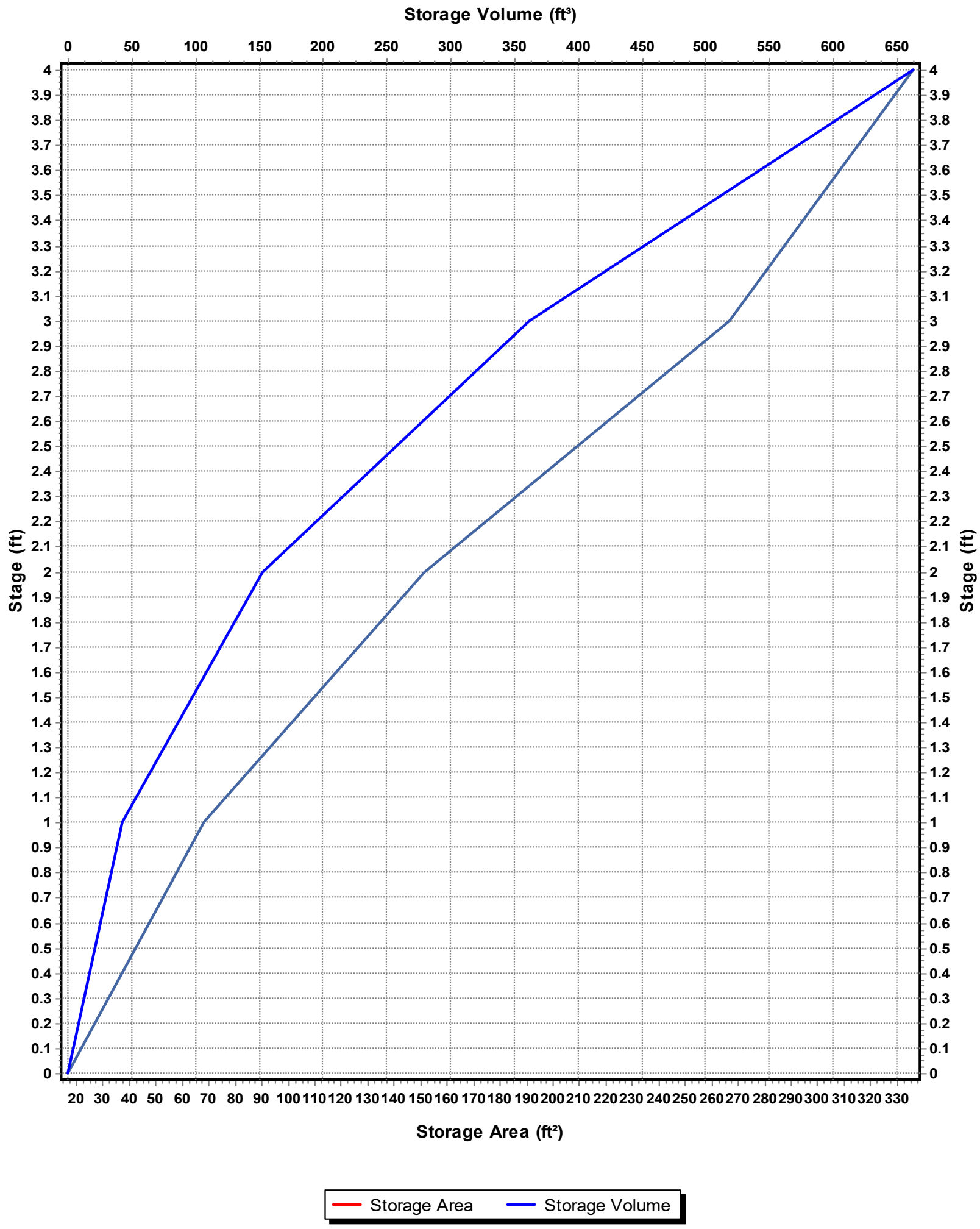
Invert Elevation (ft)	114.50
Max (Rim) Elevation (ft)	118.00
Max (Rim) Offset (ft)	3.50
Initial Water Elevation (ft)	114.50
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

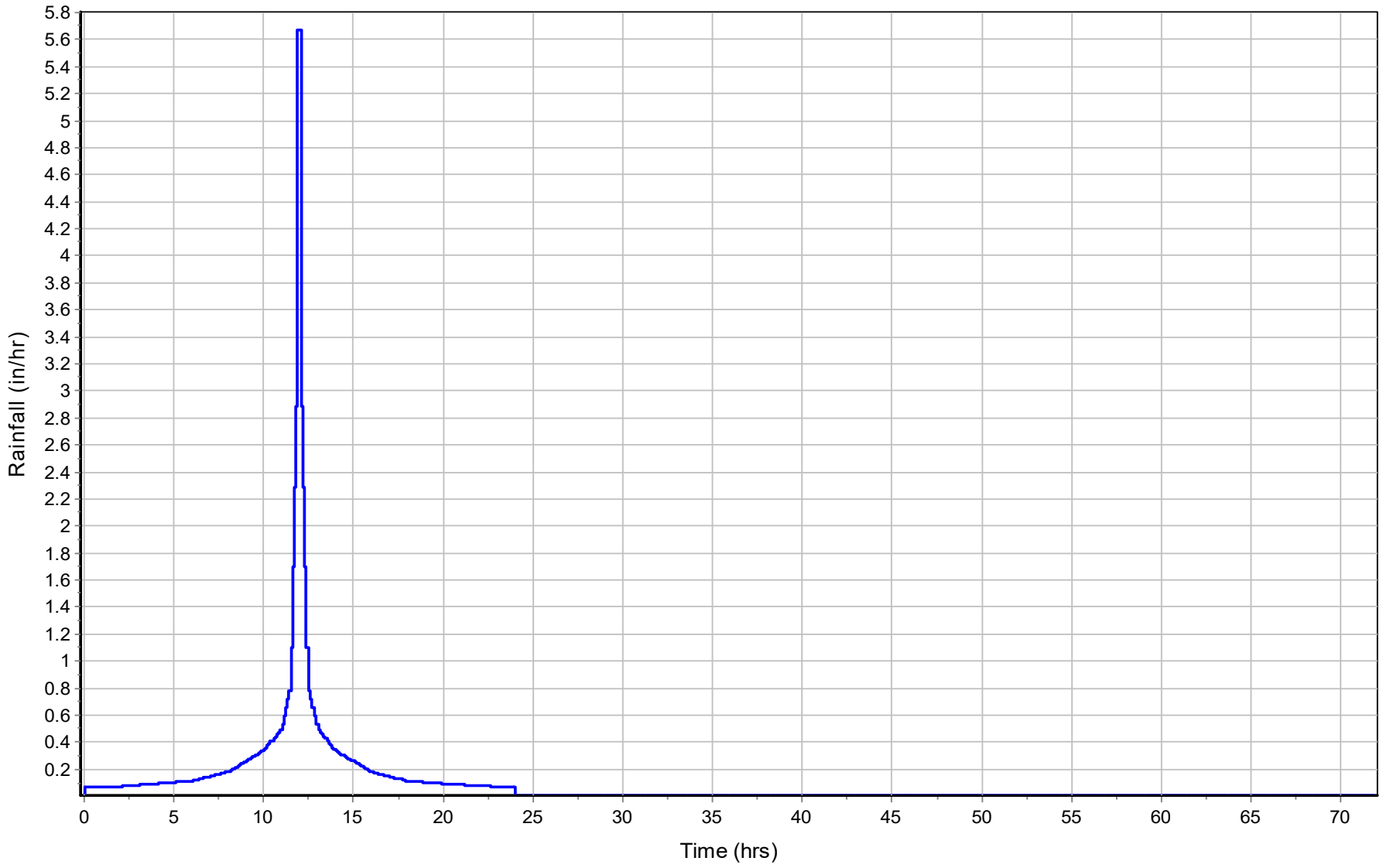
Total TOC (min) 2.31

Subbasin Runoff Results

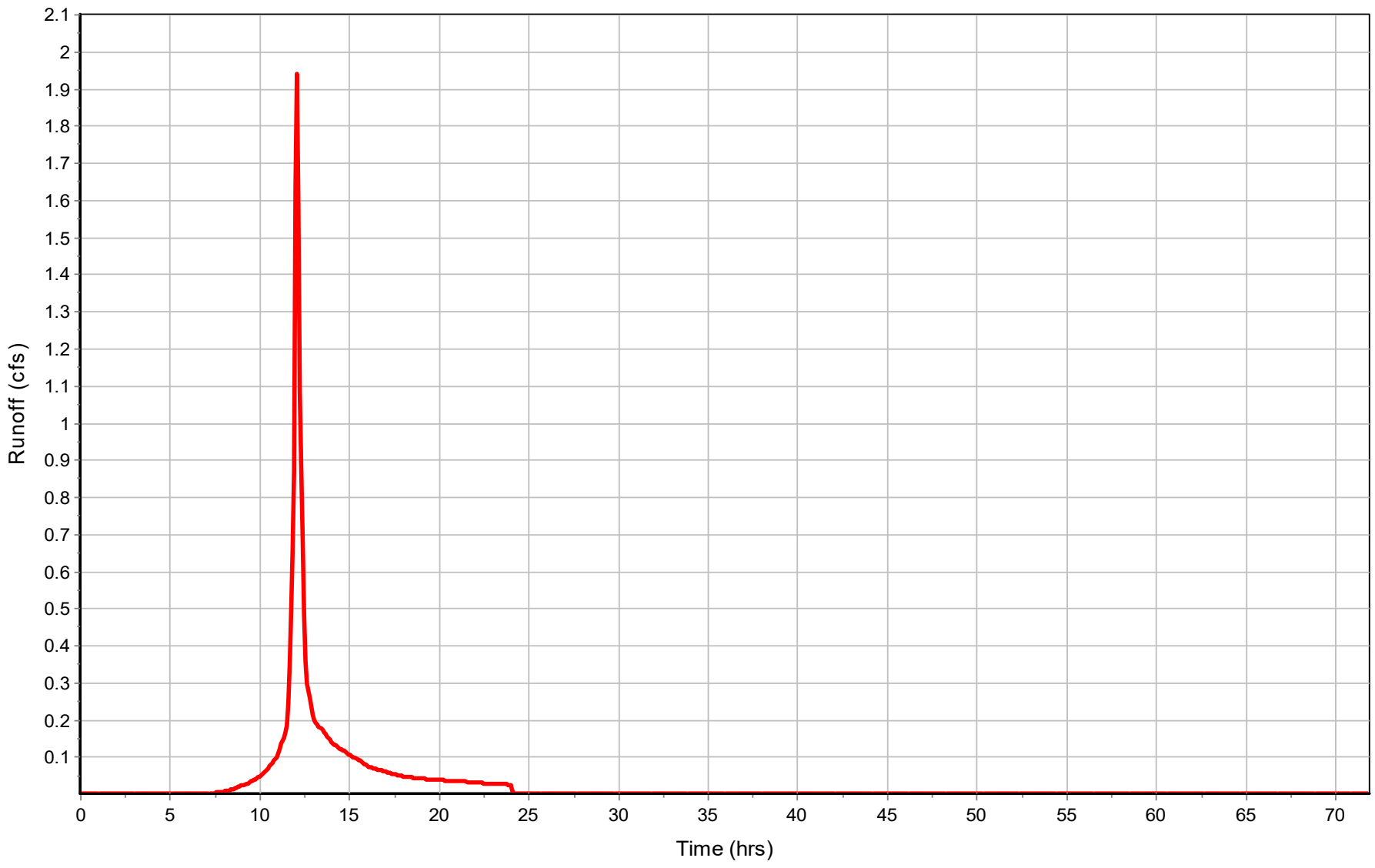
Total Rainfall (in)	6.74
Total Runoff (in)	4.03
Peak Runoff (cfs)	1.98
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:02:19

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

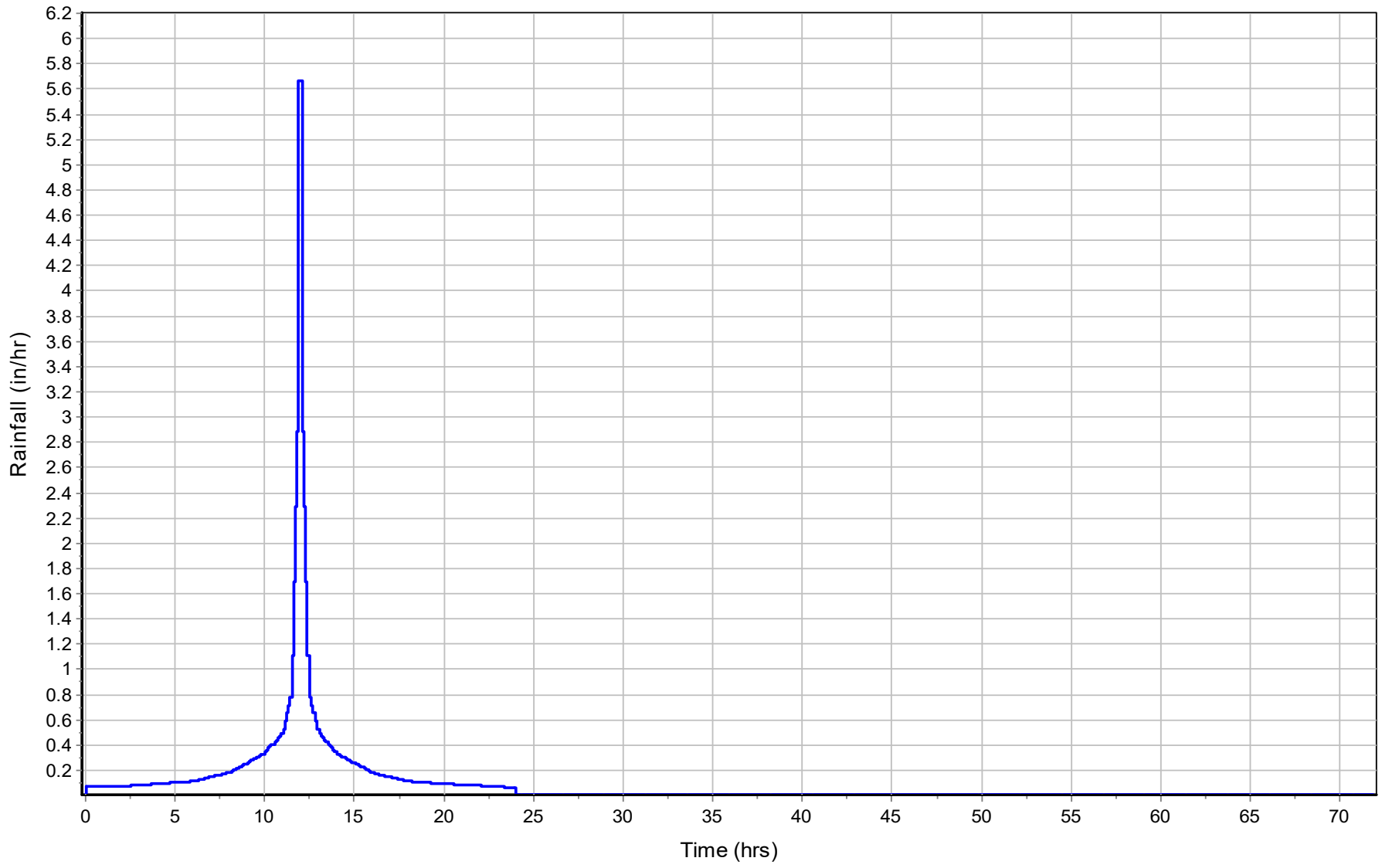
Total TOC (min) 19.54

Subbasin Runoff Results

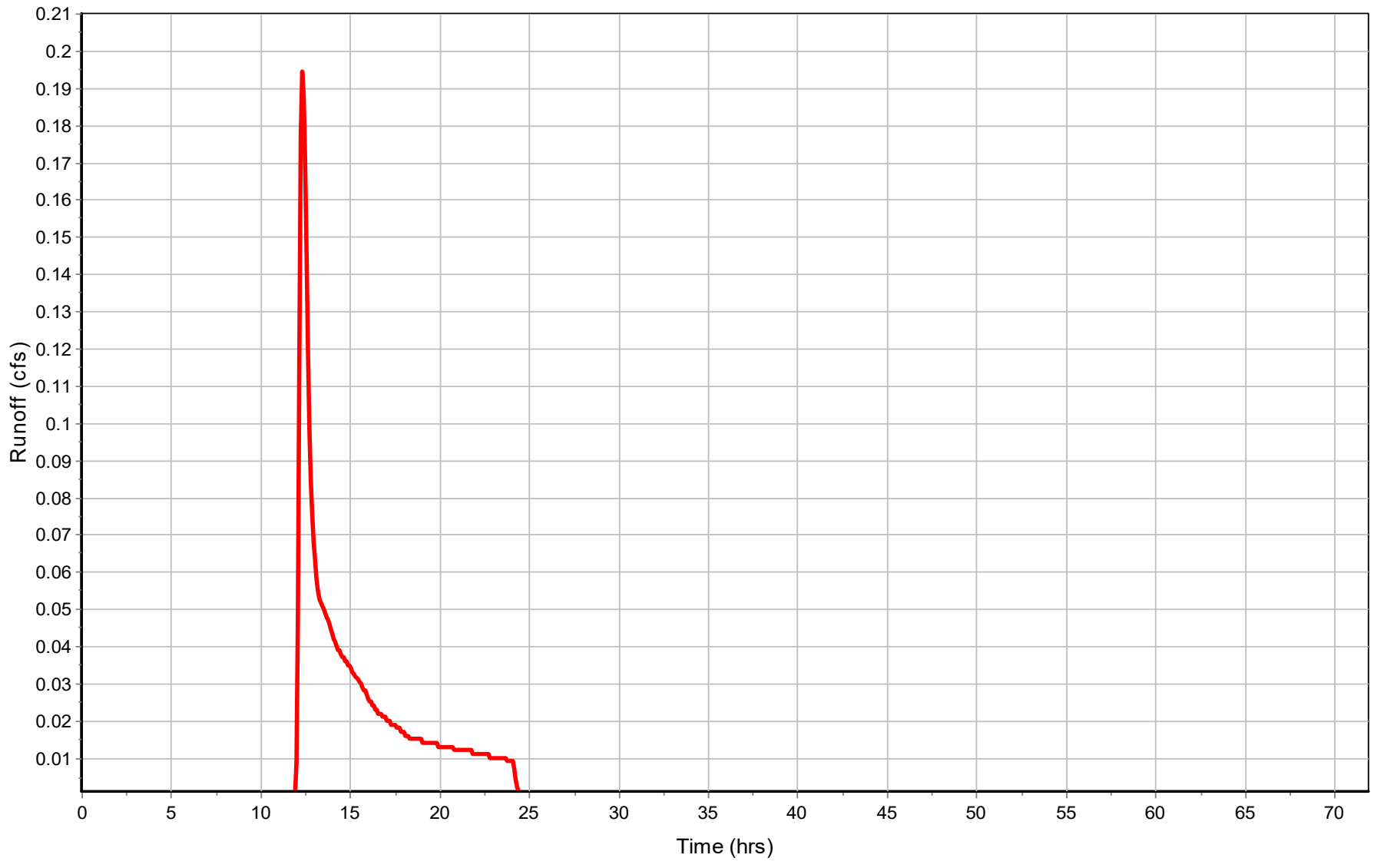
Total Rainfall (in) 6.74
Total Runoff (in) 0.96
Peak Runoff (cfs) 0.19
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:19:32

Subbasin : Sub-E02

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-02A

Input Data

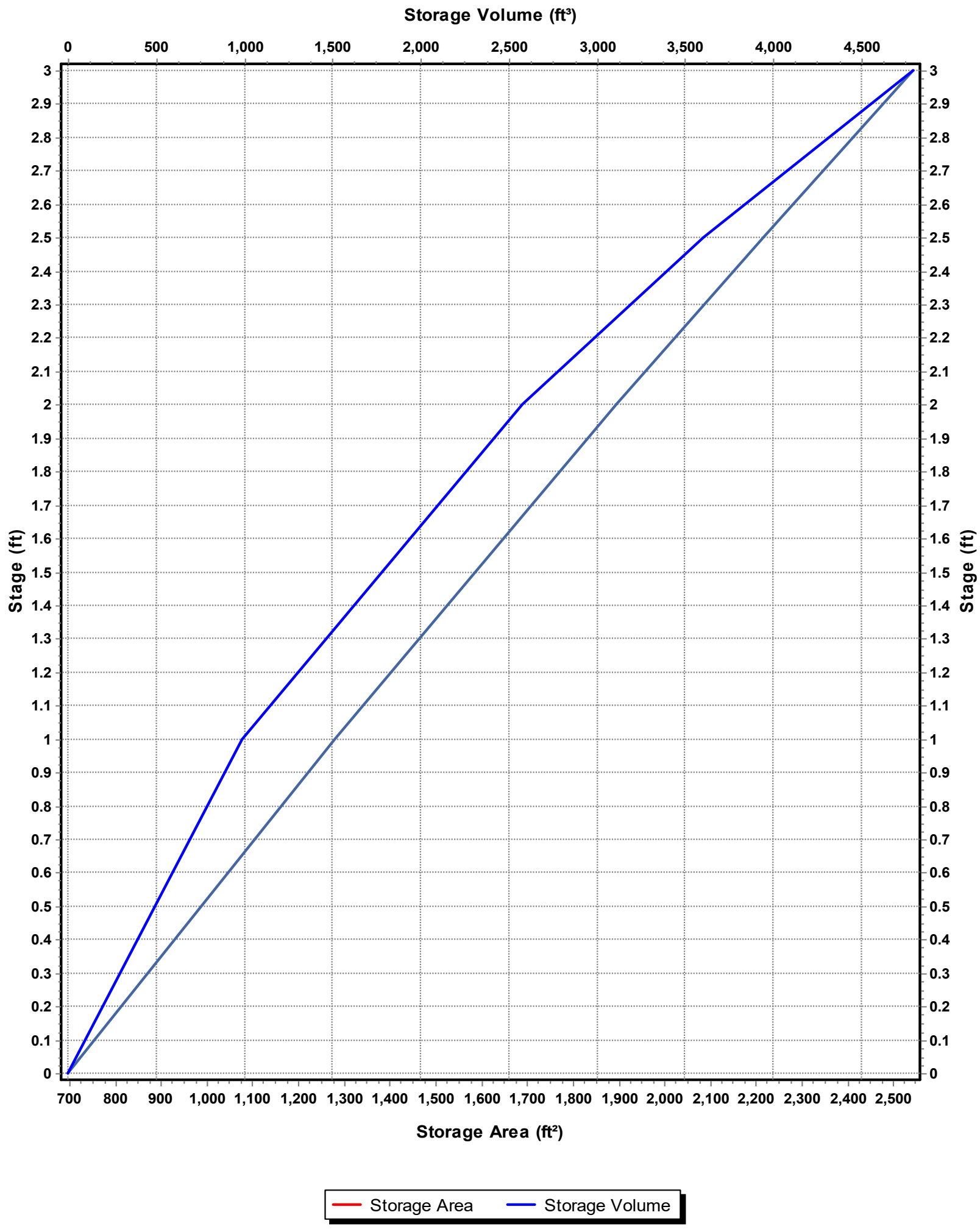
Invert Elevation (ft)	115.00
Max (Rim) Elevation (ft)	118.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	115.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

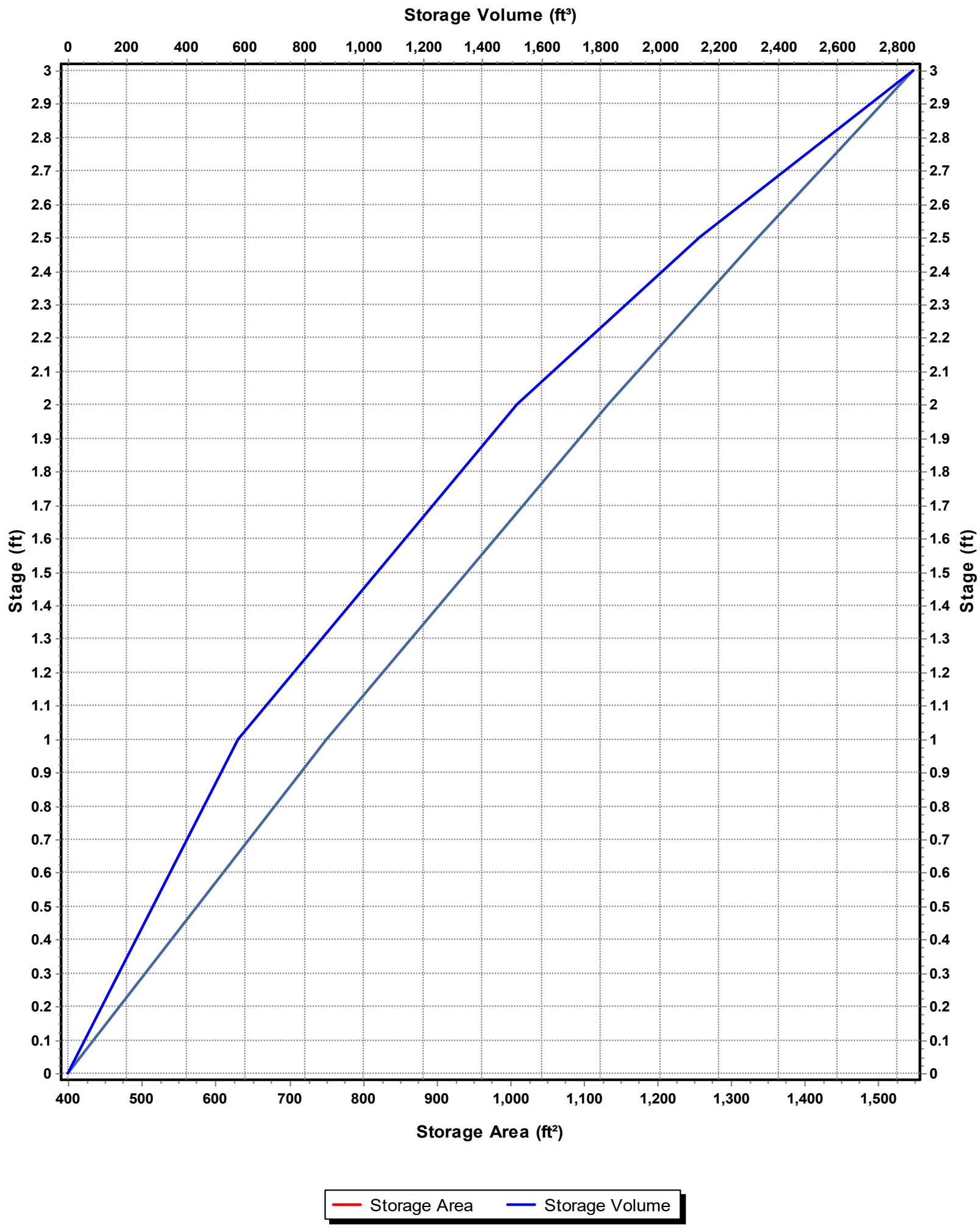
Invert Elevation (ft)	115.00
Max (Rim) Elevation (ft)	118.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	115.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

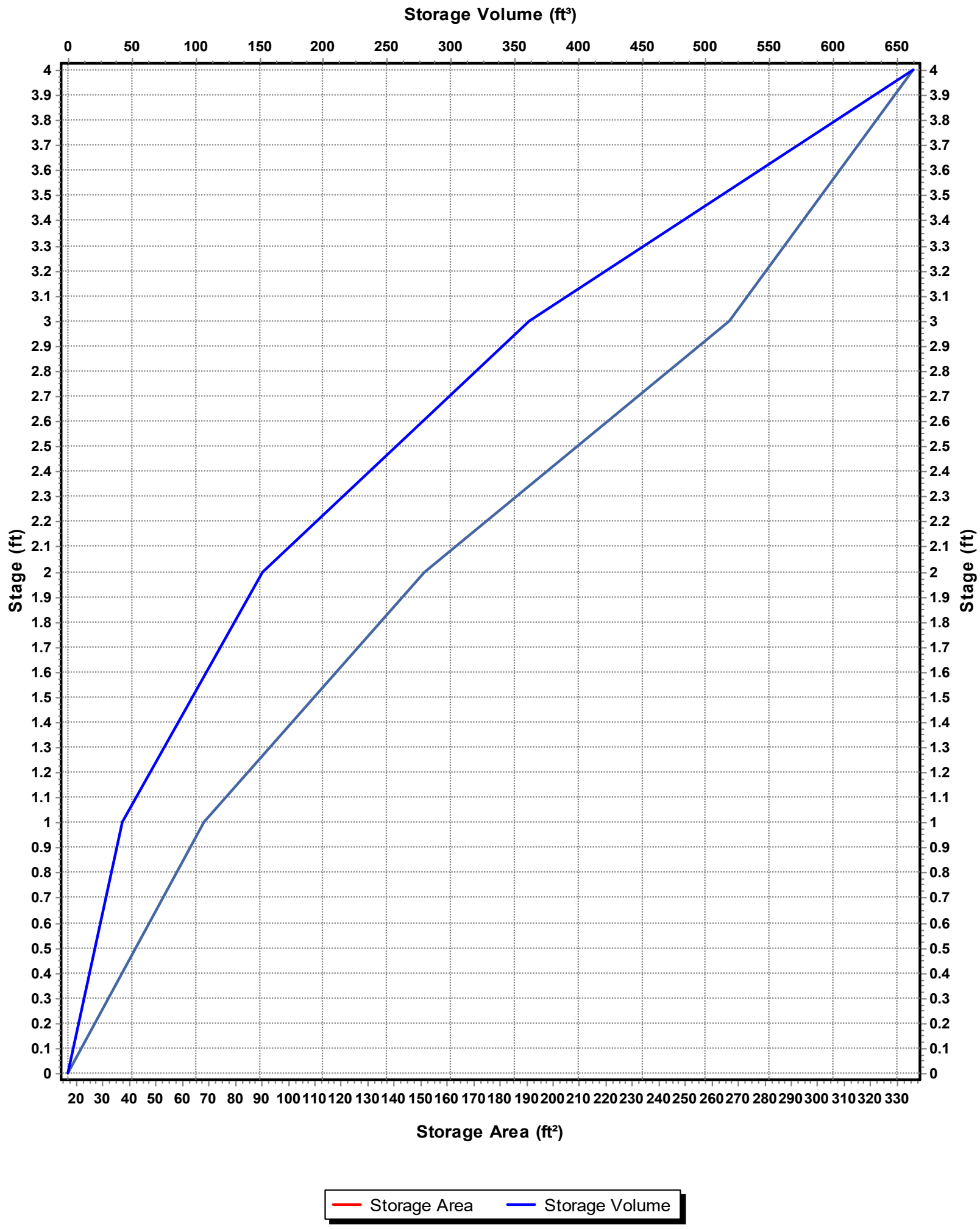
Invert Elevation (ft)	114.50
Max (Rim) Elevation (ft)	118.00
Max (Rim) Offset (ft)	3.50
Initial Water Elevation (ft)	114.50
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

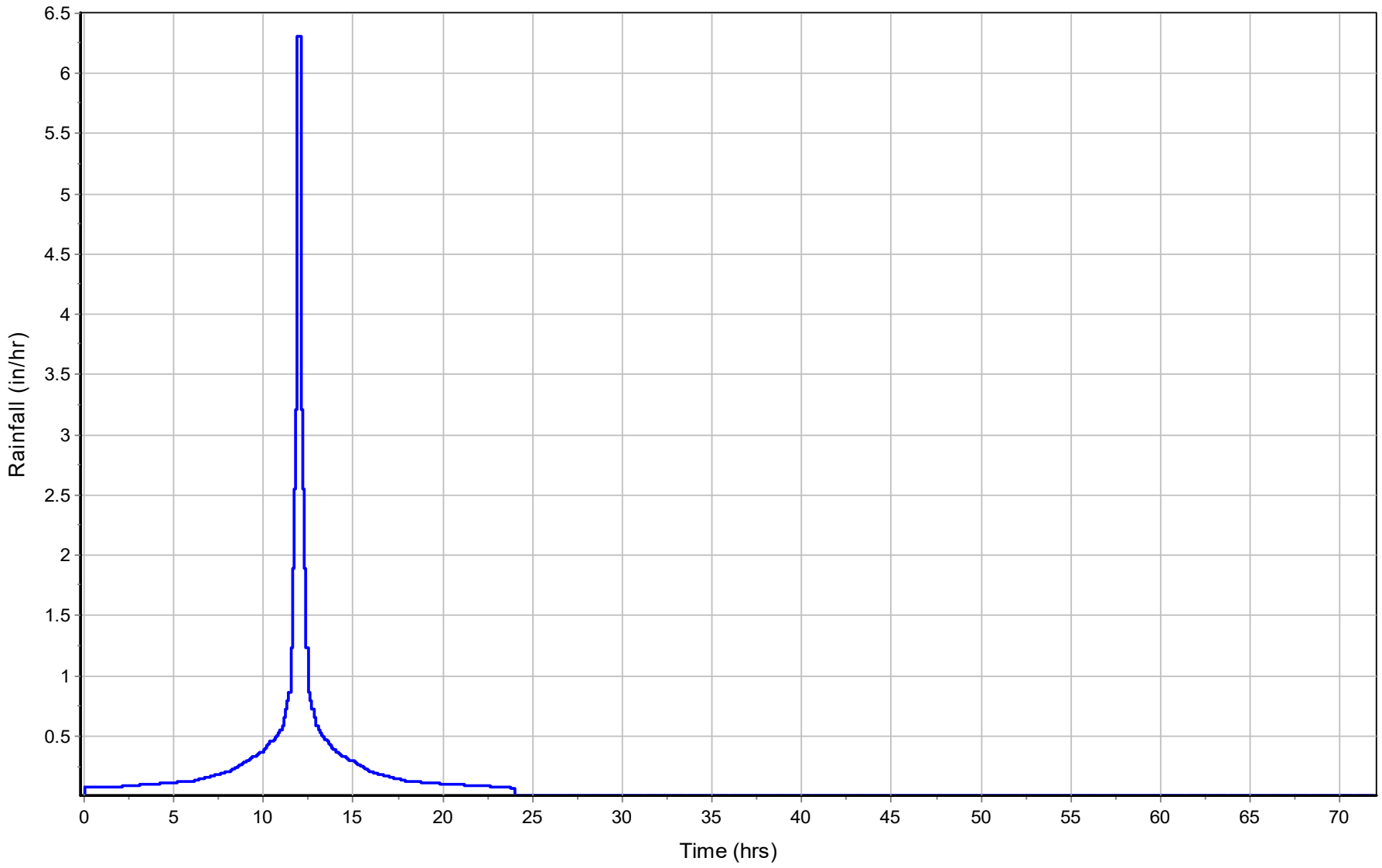
Total TOC (min) 2.31

Subbasin Runoff Results

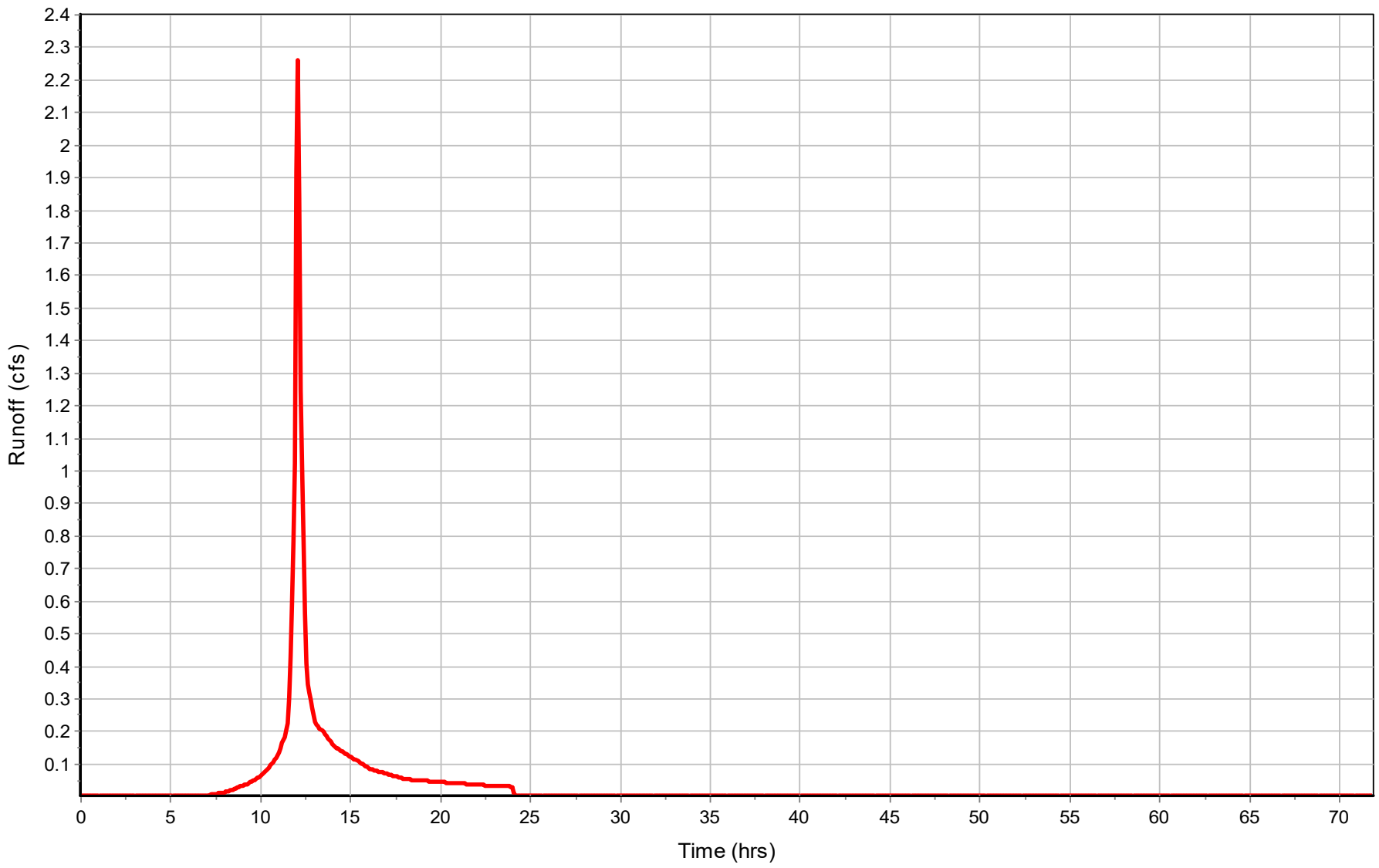
Total Rainfall (in)	7.51
Total Runoff (in)	4.71
Peak Runoff (cfs)	2.3
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:02:19

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

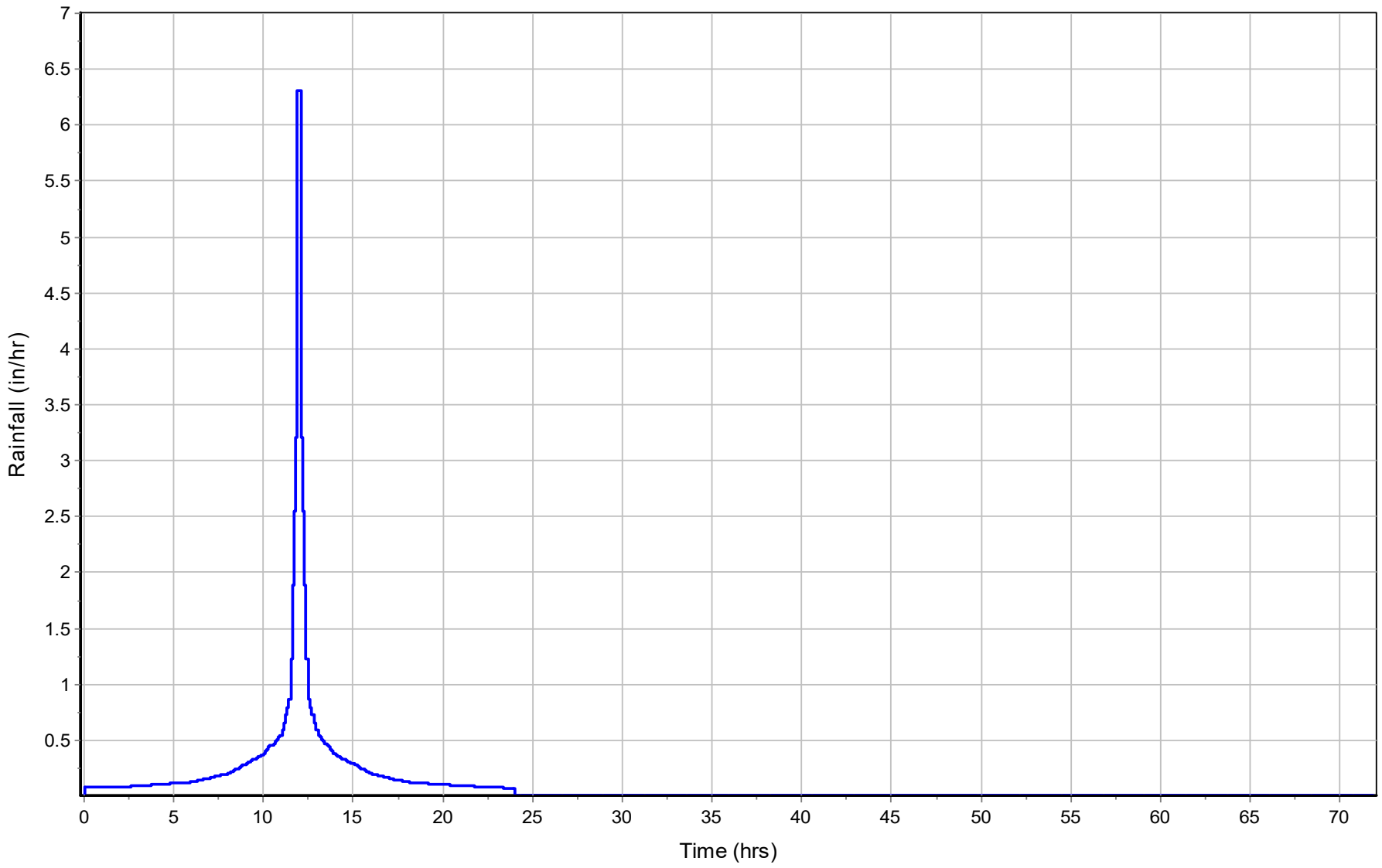
Total TOC (min) 19.54

Subbasin Runoff Results

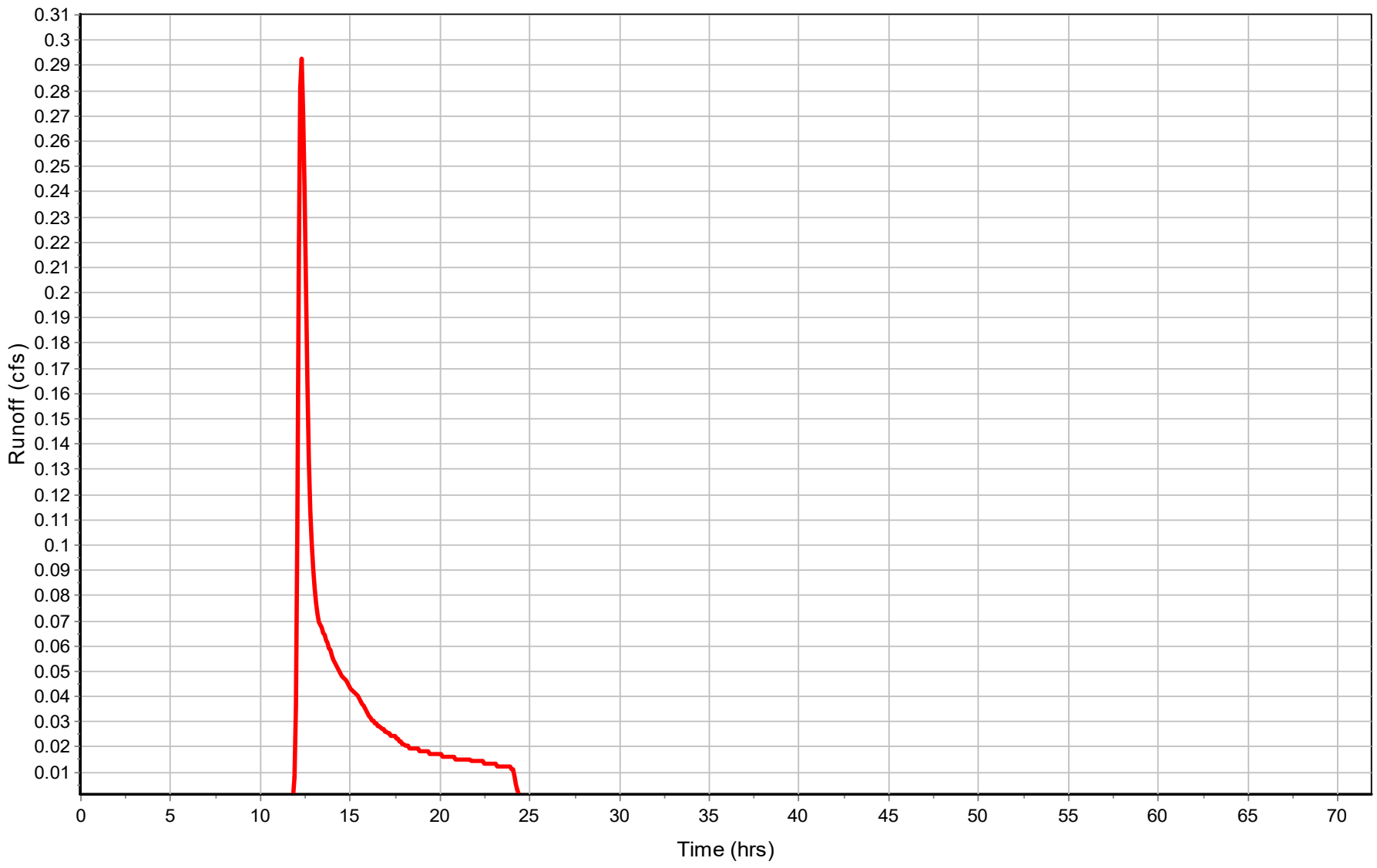
Total Rainfall (in) 7.51
Total Runoff (in) 1.3
Peak Runoff (cfs) 0.29
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:19:32

Subbasin : Sub-E02

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-02A

Input Data

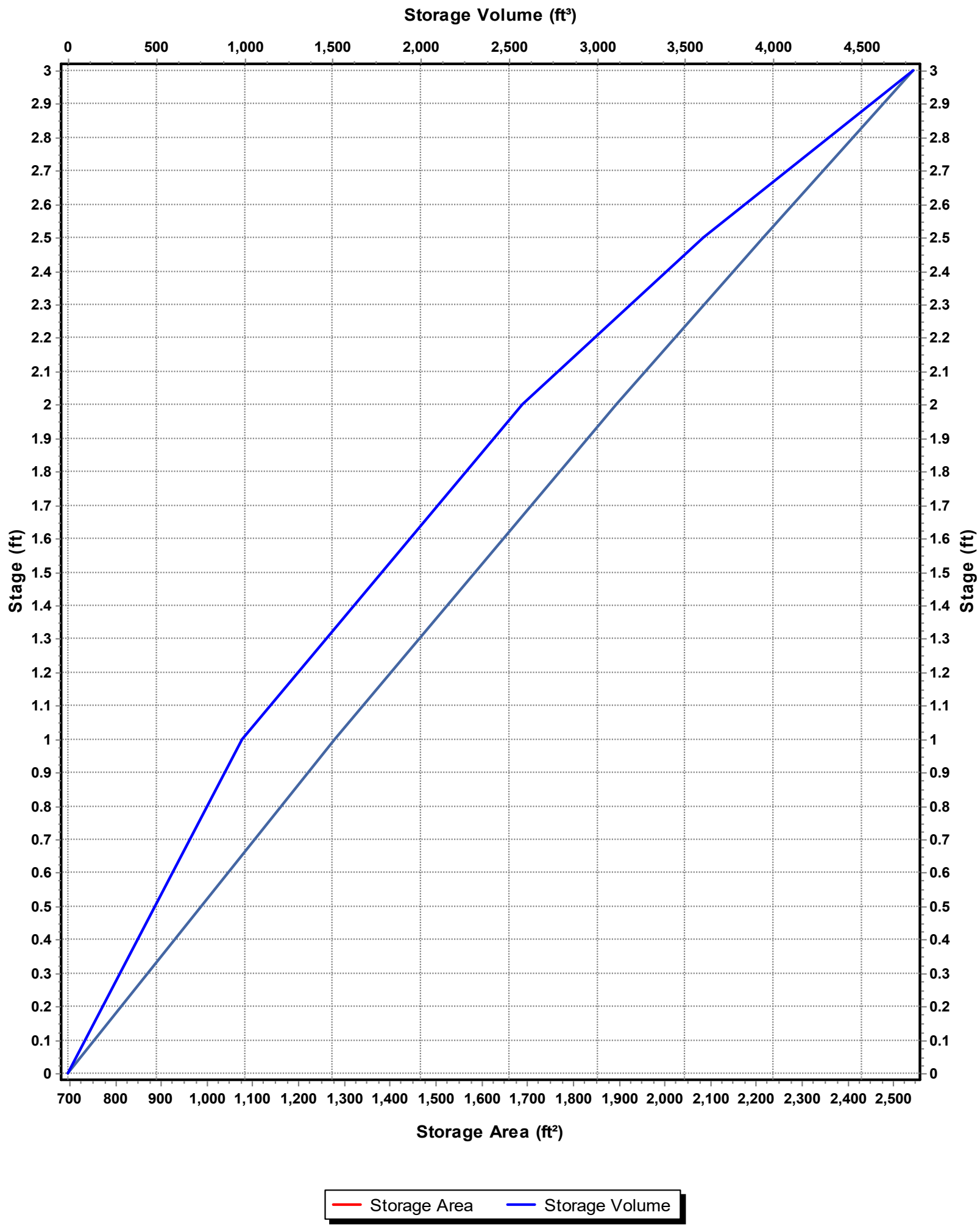
Invert Elevation (ft)	115.00
Max (Rim) Elevation (ft)	118.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	115.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

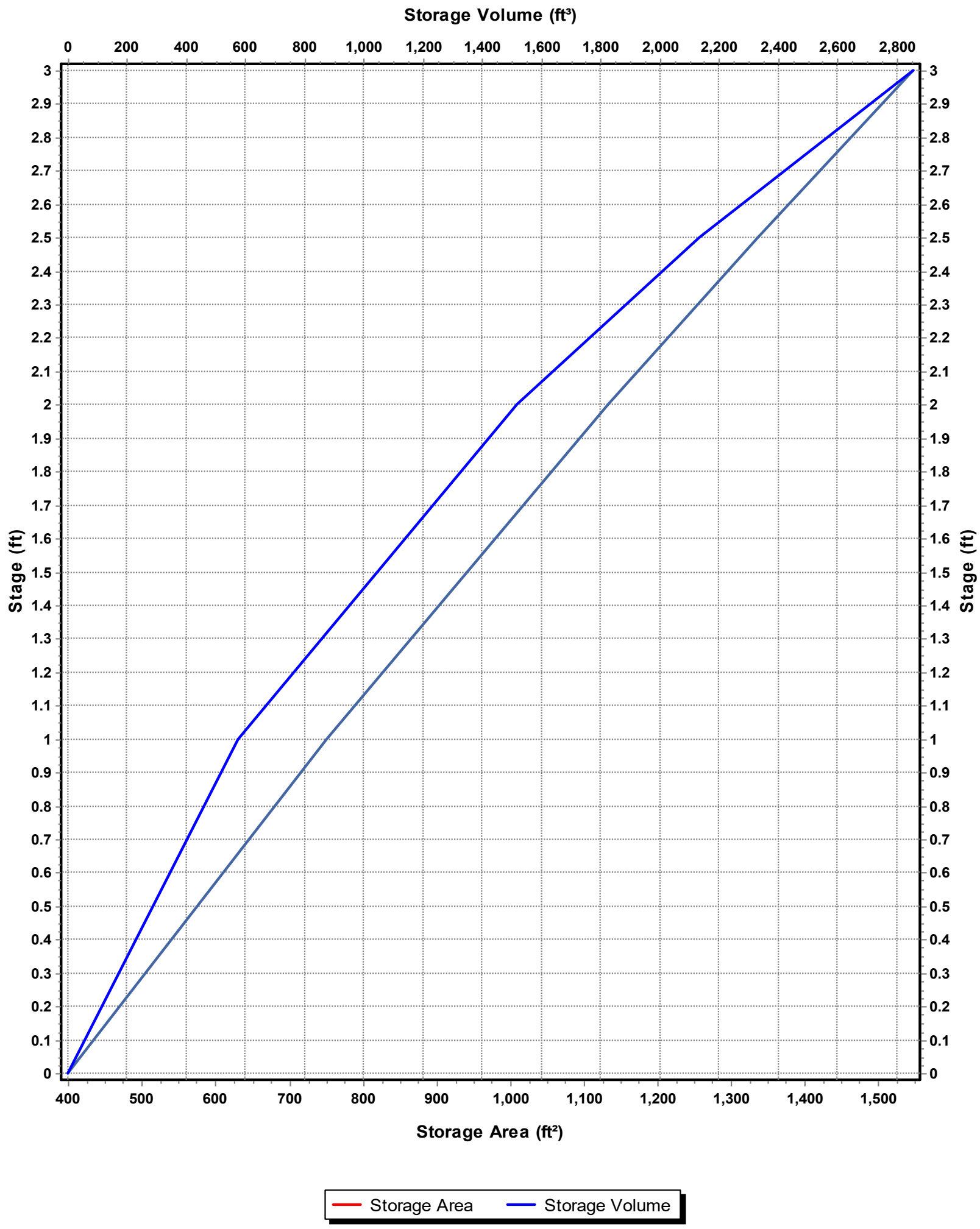
Invert Elevation (ft)	115.00
Max (Rim) Elevation (ft)	118.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	115.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

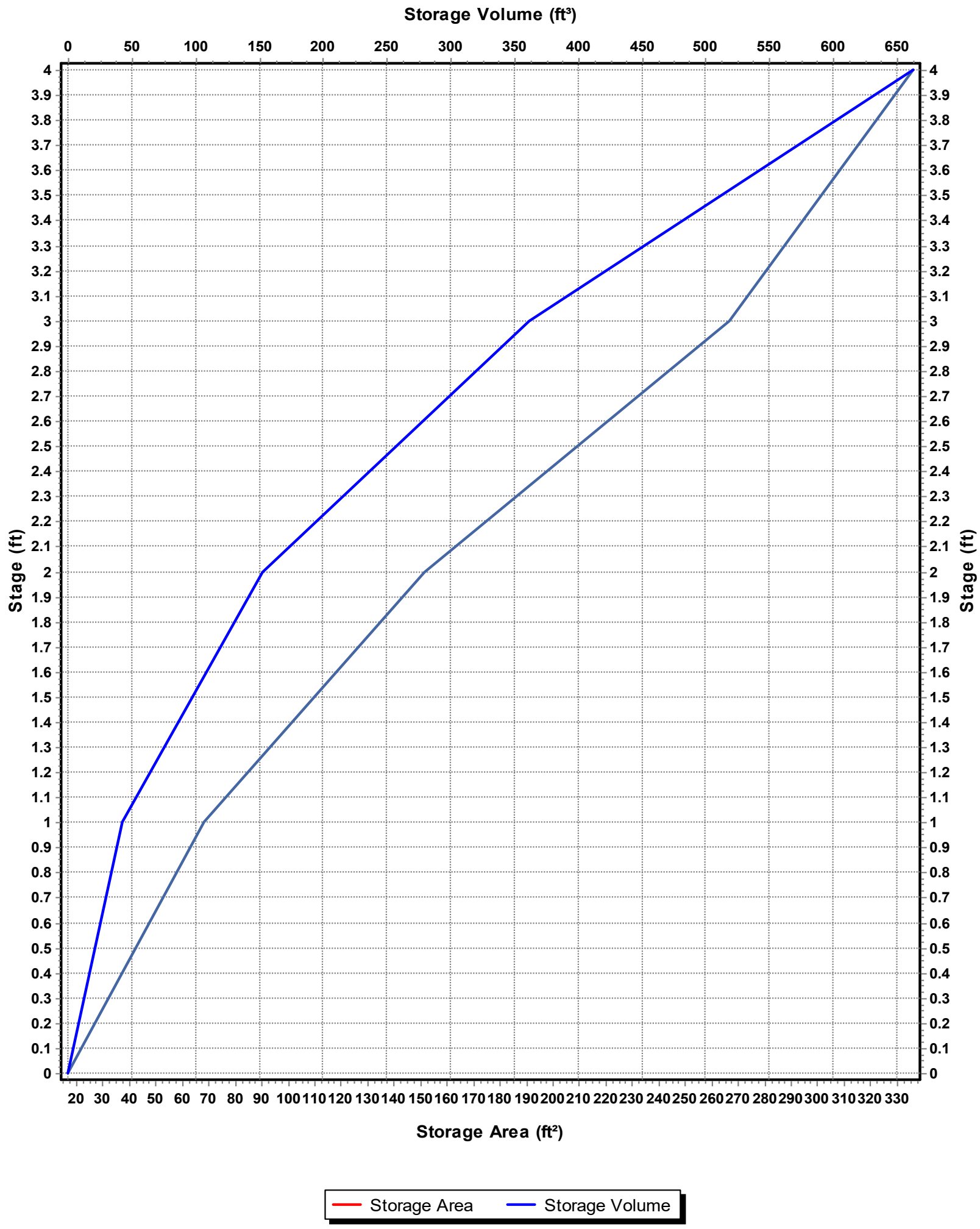
Invert Elevation (ft)	114.50
Max (Rim) Elevation (ft)	118.00
Max (Rim) Offset (ft)	3.50
Initial Water Elevation (ft)	114.50
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

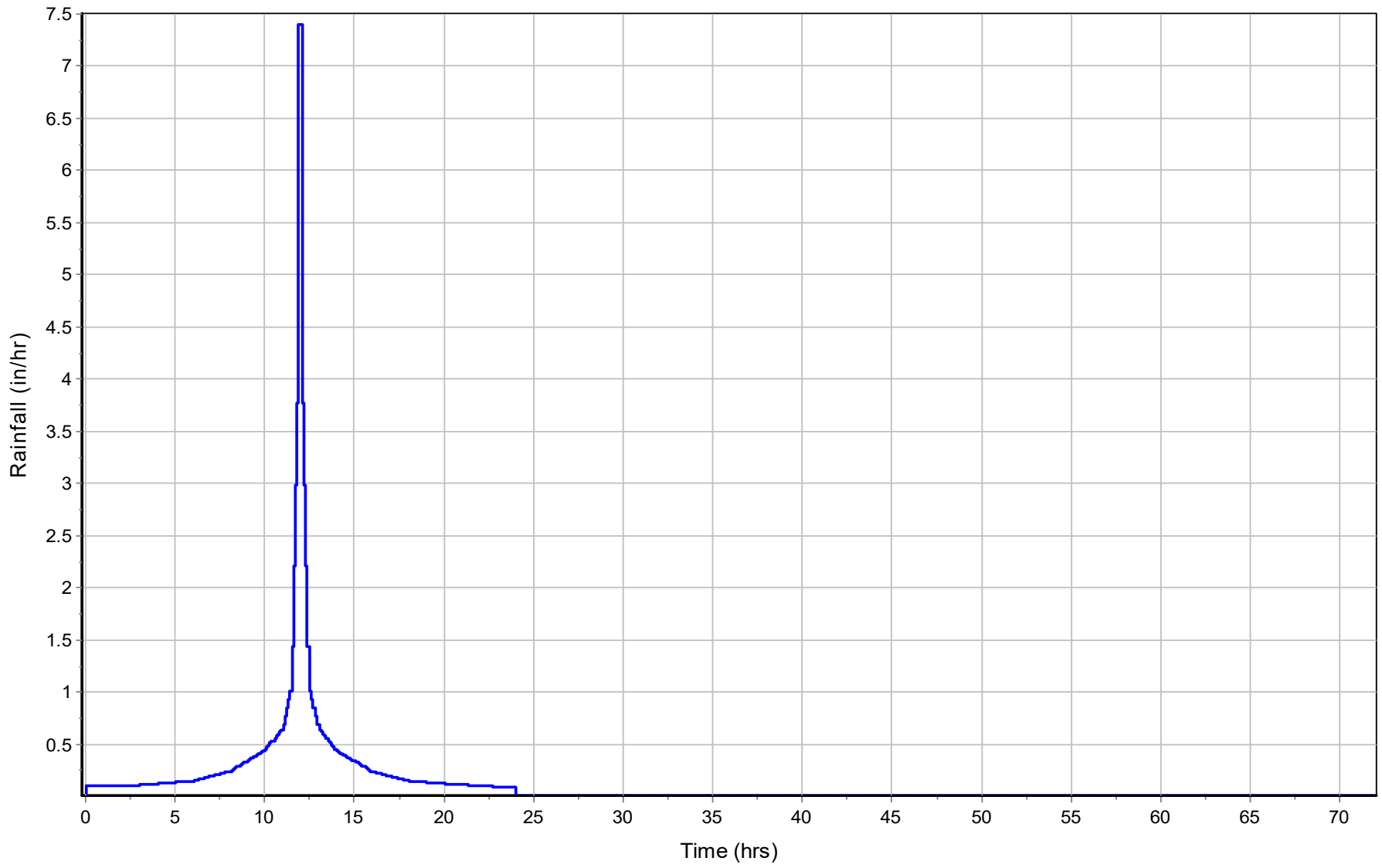
Total TOC (min) 2.31

Subbasin Runoff Results

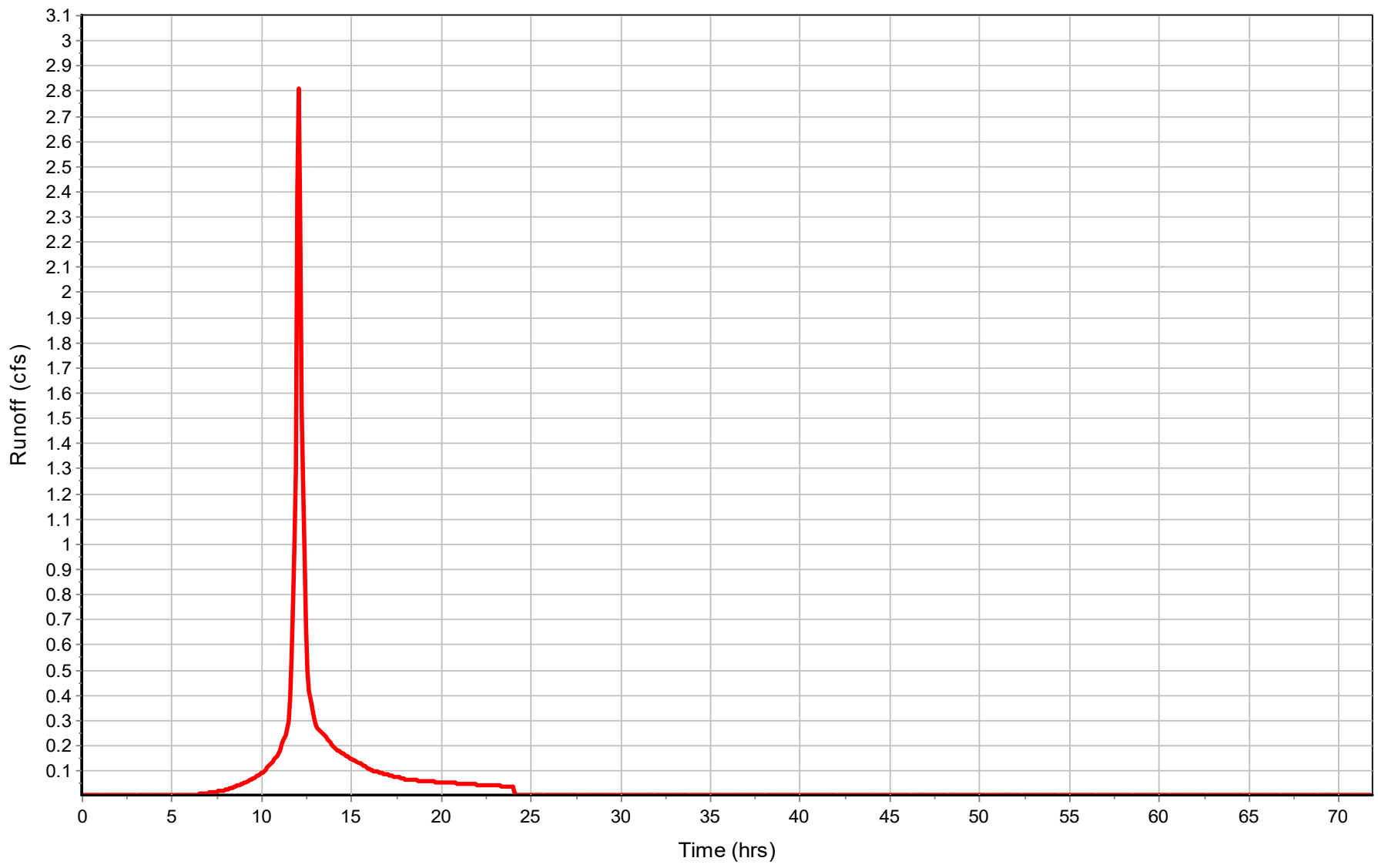
Total Rainfall (in)	8.8
Total Runoff (in)	5.89
Peak Runoff (cfs)	2.85
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:02:19

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

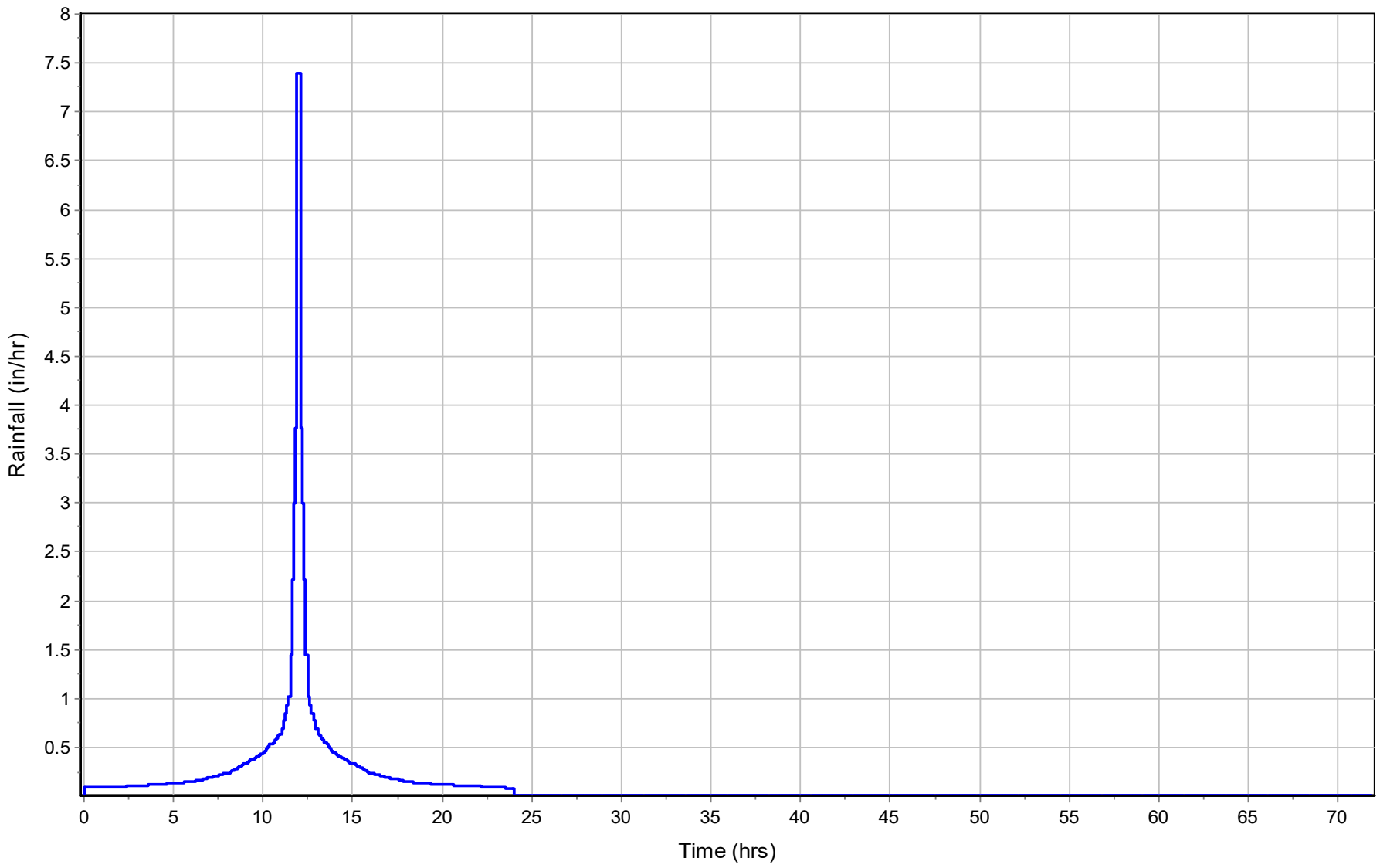
Total TOC (min) 19.54

Subbasin Runoff Results

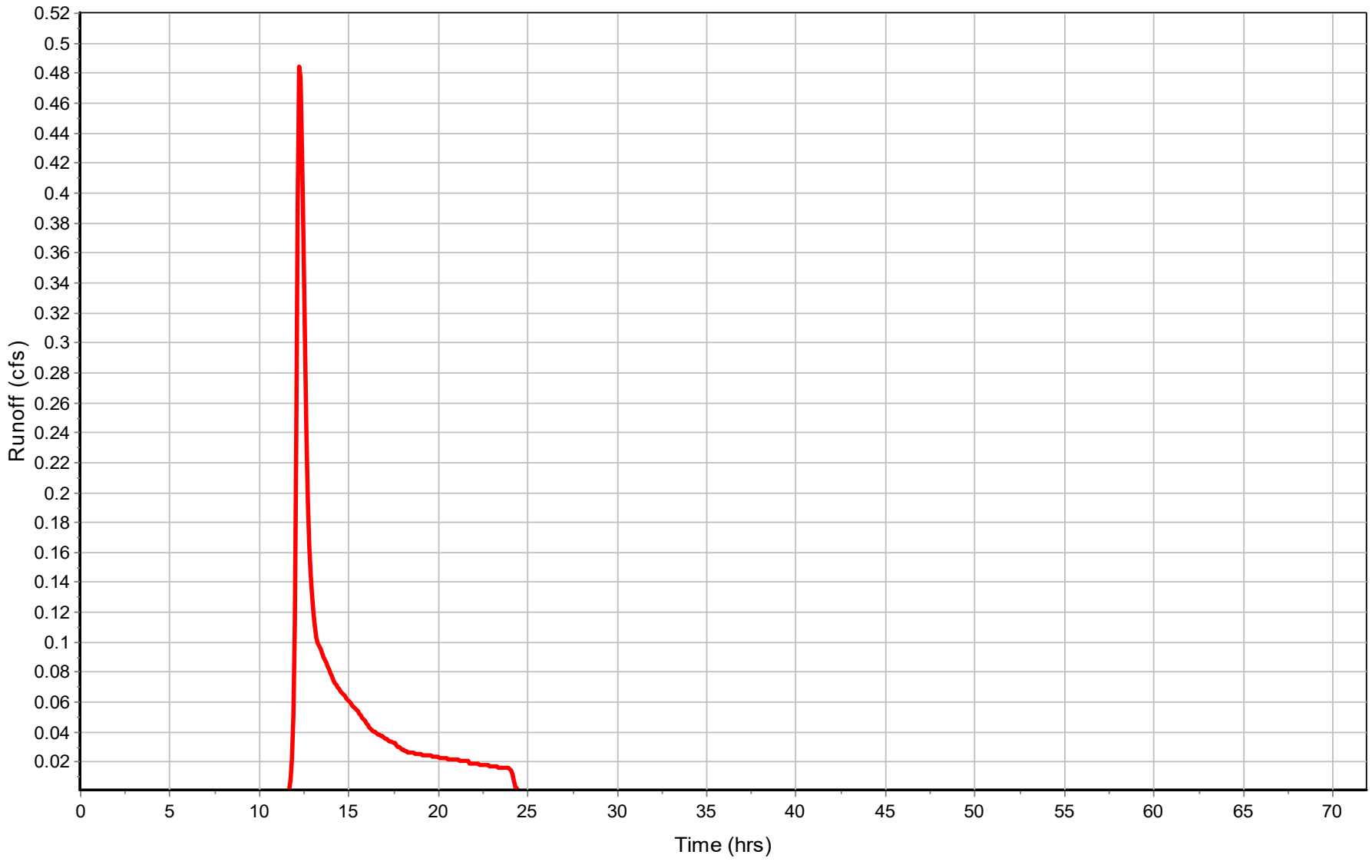
Total Rainfall (in) 8.8
Total Runoff (in) 1.95
Peak Runoff (cfs) 0.49
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:19:32

Subbasin : Sub-E02

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-02A

Input Data

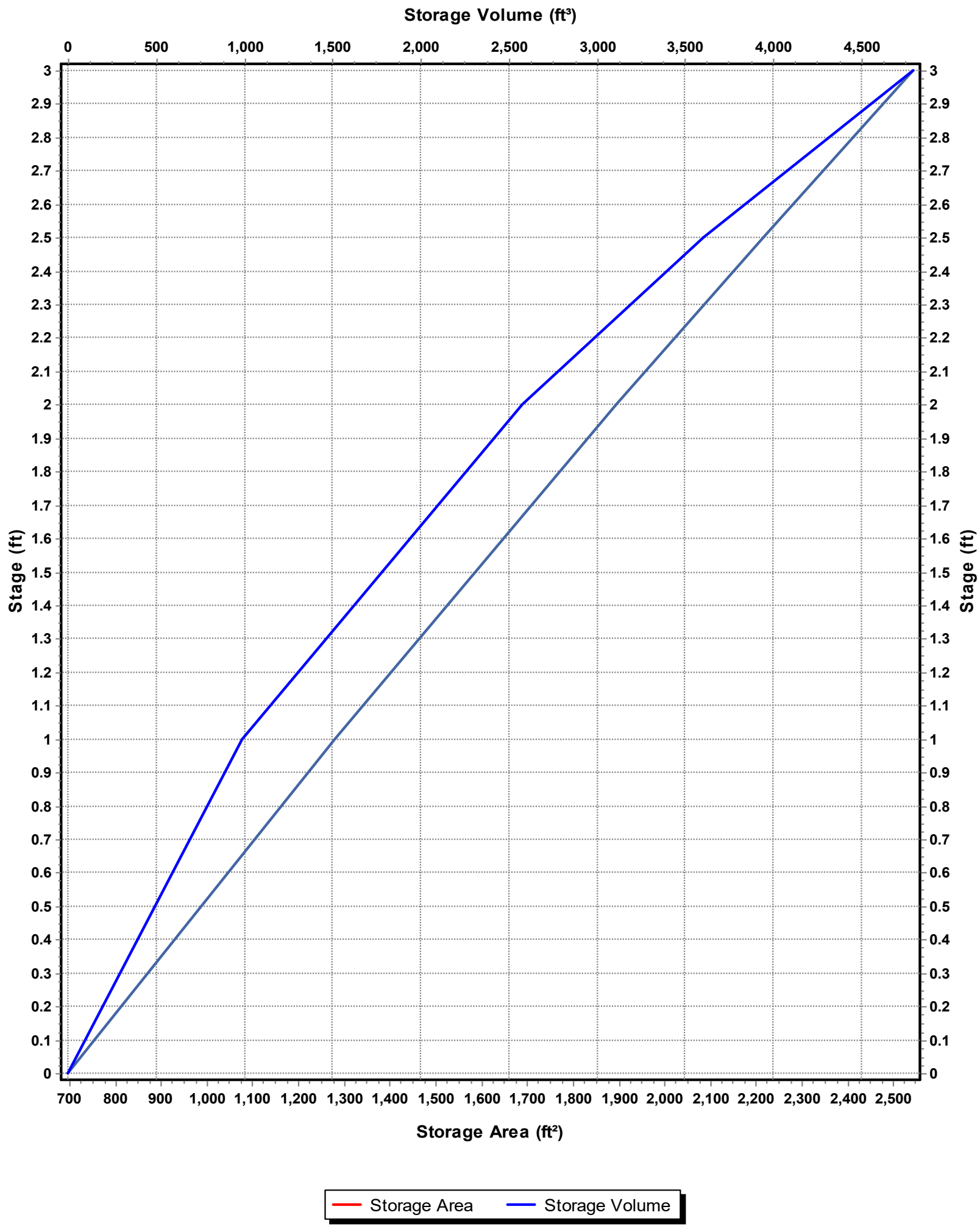
Invert Elevation (ft)	115.00
Max (Rim) Elevation (ft)	118.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	115.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

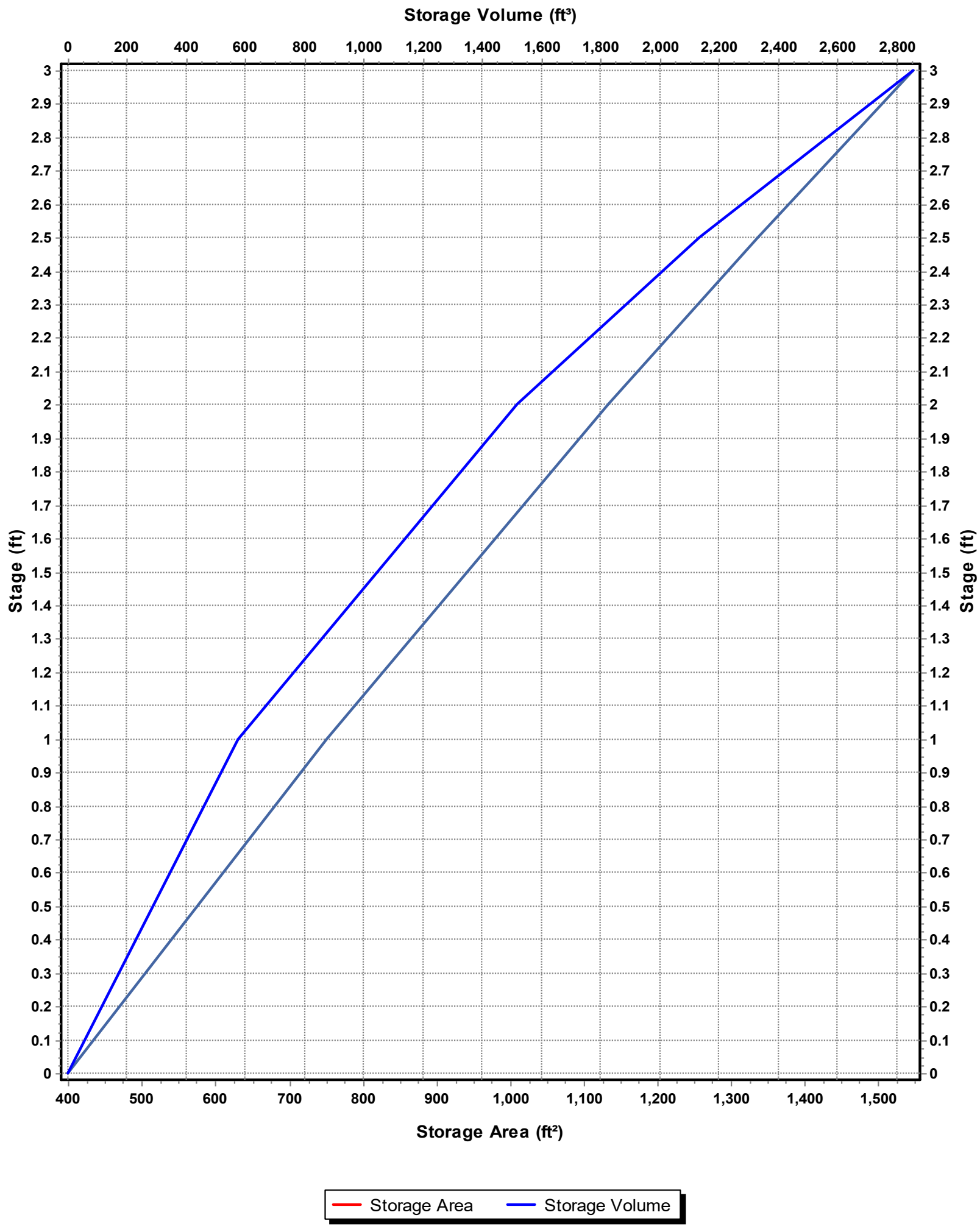
Invert Elevation (ft)	115.00
Max (Rim) Elevation (ft)	118.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	115.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

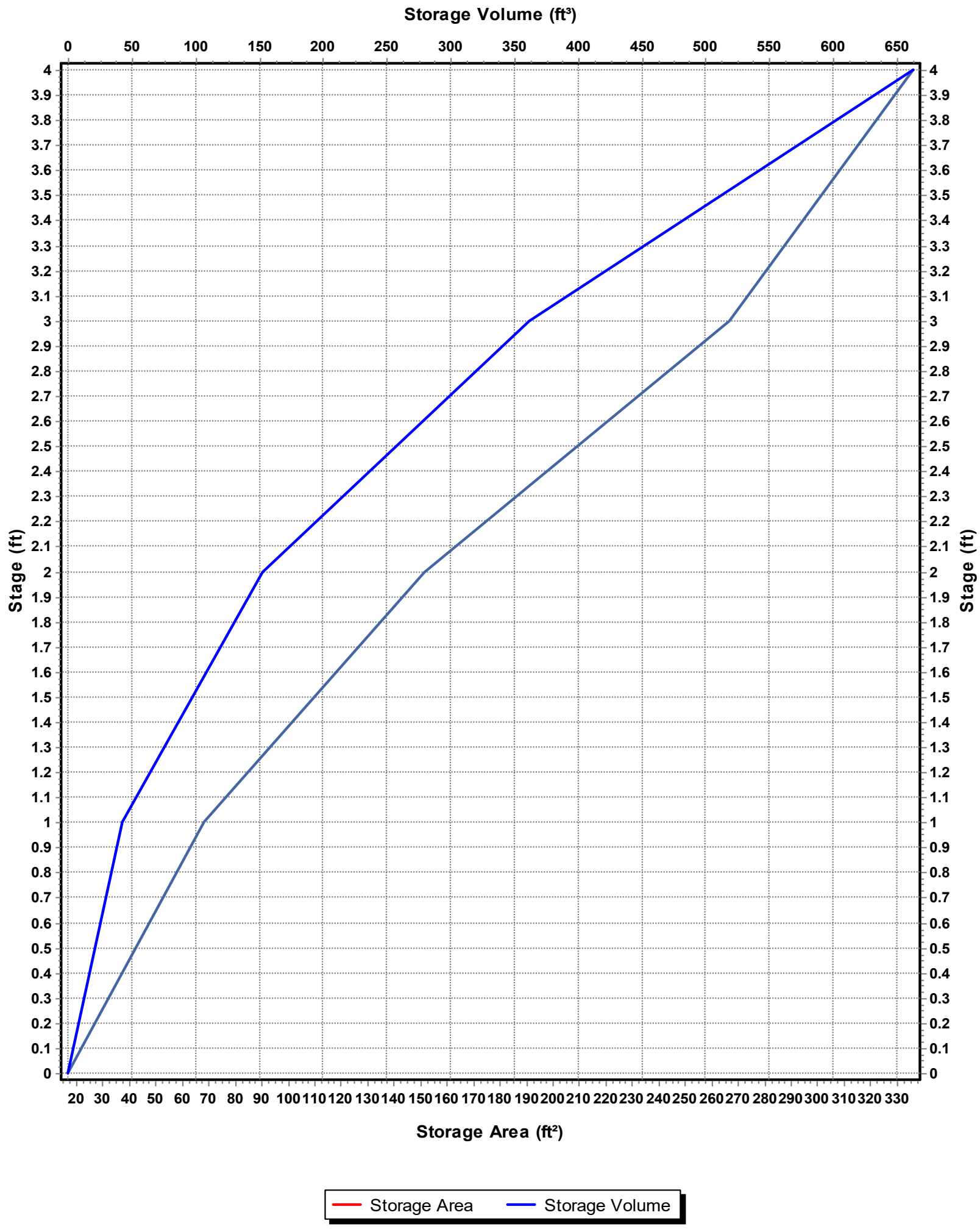
Invert Elevation (ft)	114.50
Max (Rim) Elevation (ft)	118.00
Max (Rim) Offset (ft)	3.50
Initial Water Elevation (ft)	114.50
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

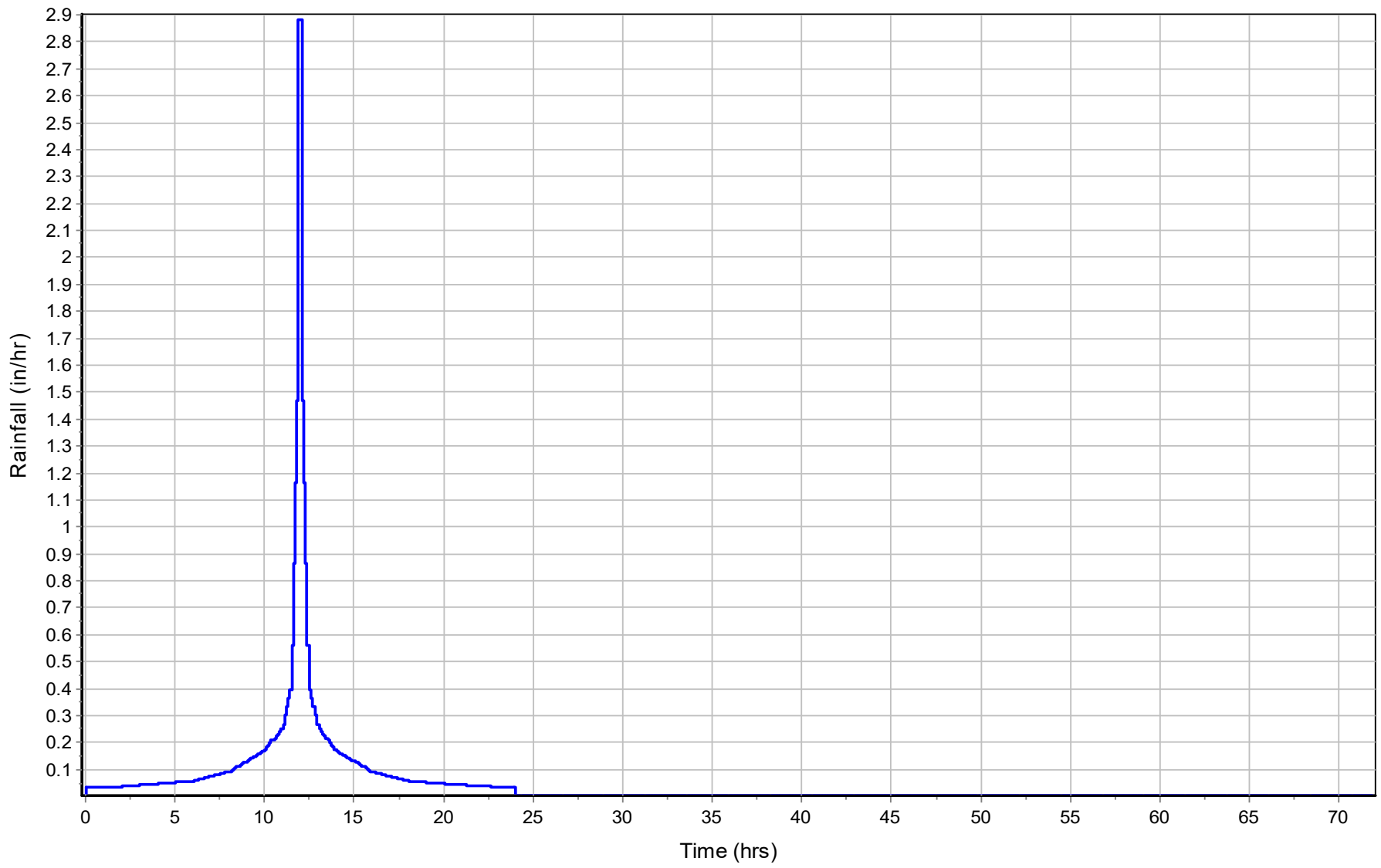
Total TOC (min) 2.97

Subbasin Runoff Results

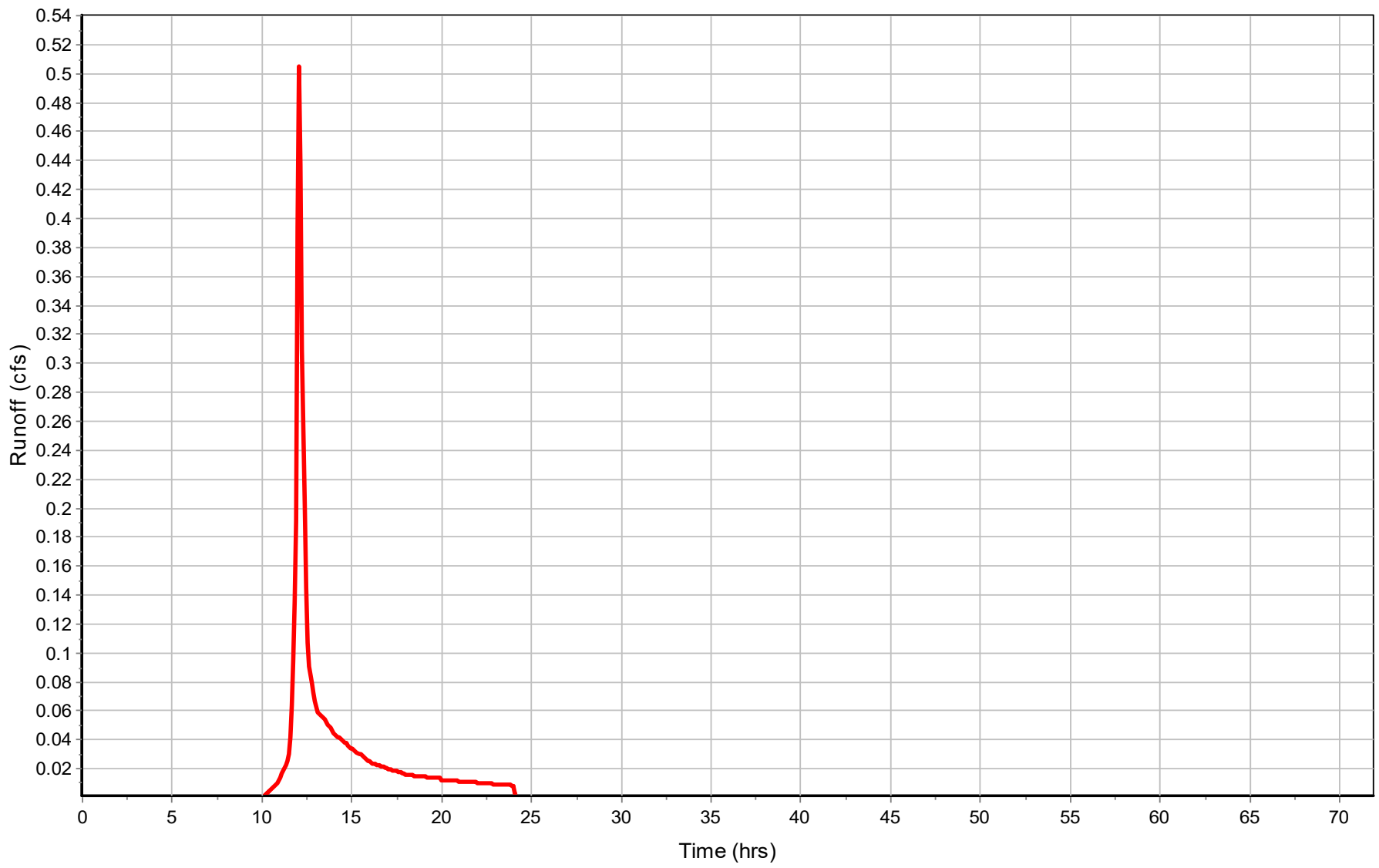
Total Rainfall (in) 3.43
Total Runoff (in) 1.31
Peak Runoff (cfs) 0.53
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:02:58

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

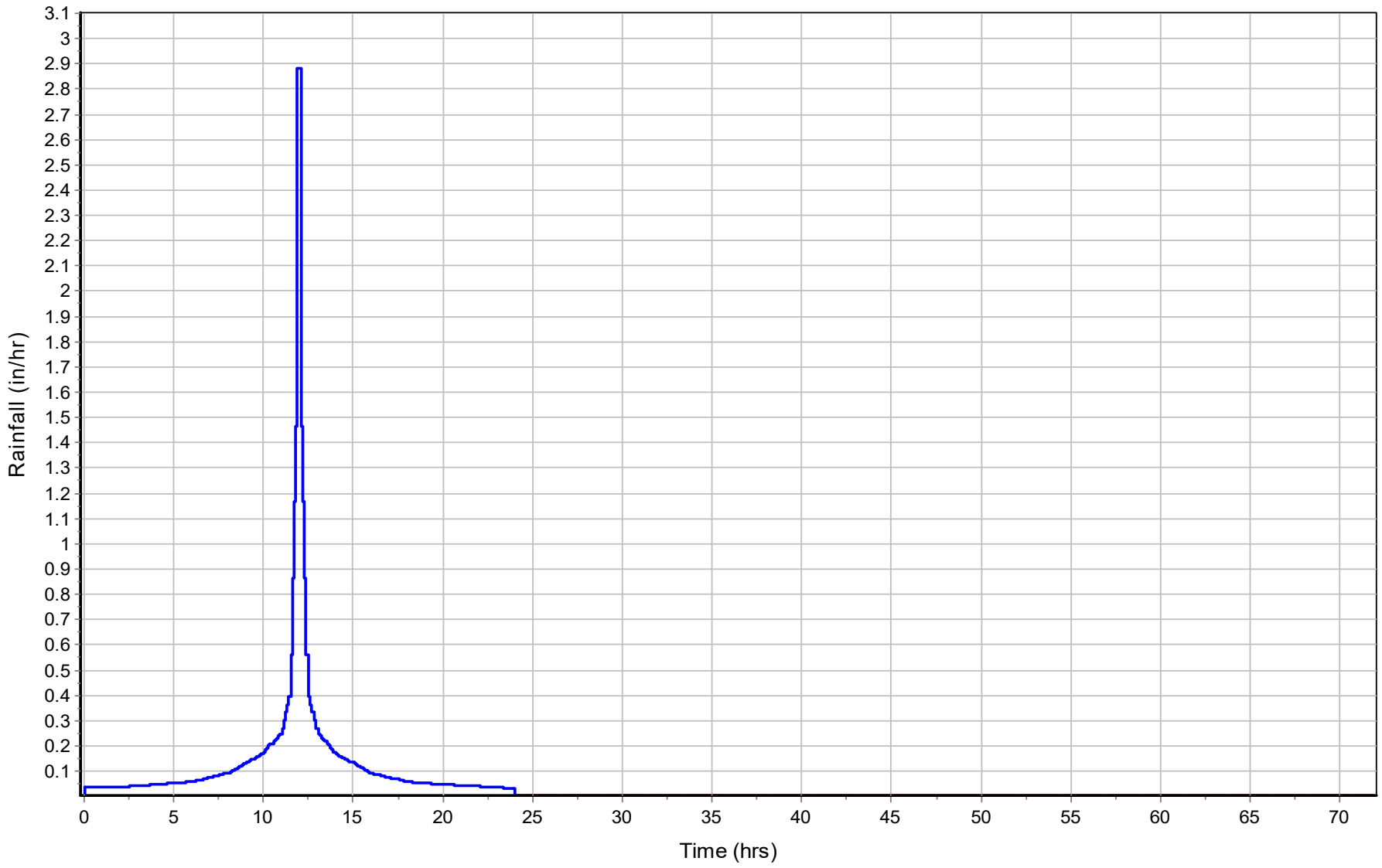
Total TOC (min) 36.74

Subbasin Runoff Results

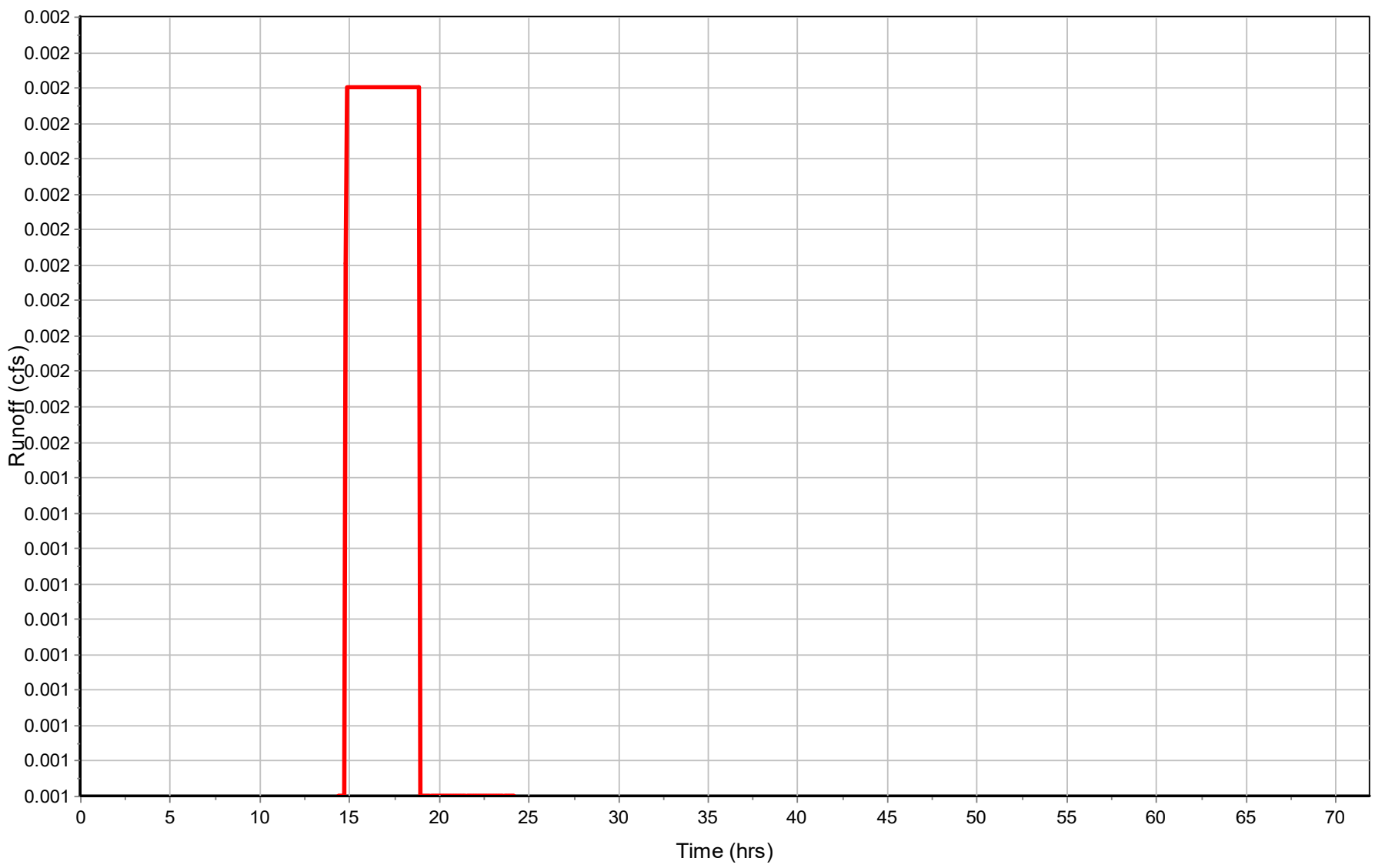
Total Rainfall (in) 3.43
Total Runoff (in) 0.04
Peak Runoff (cfs) 0
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:36:44

Subbasin : Sub-E03

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A3

Input Data

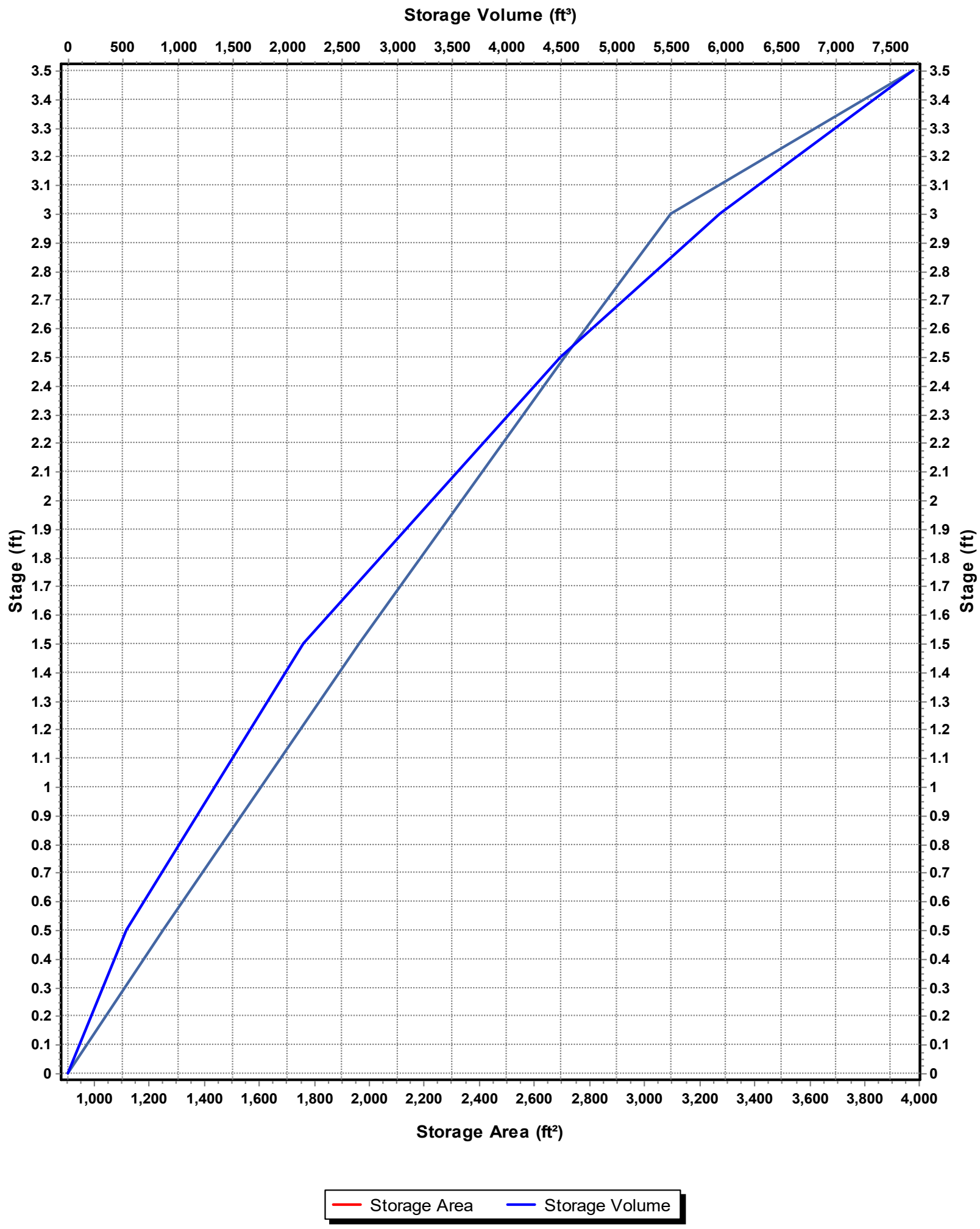
Invert Elevation (ft)	114.00
Max (Rim) Elevation (ft)	117.50
Max (Rim) Offset (ft)	3.50
Initial Water Elevation (ft)	114.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

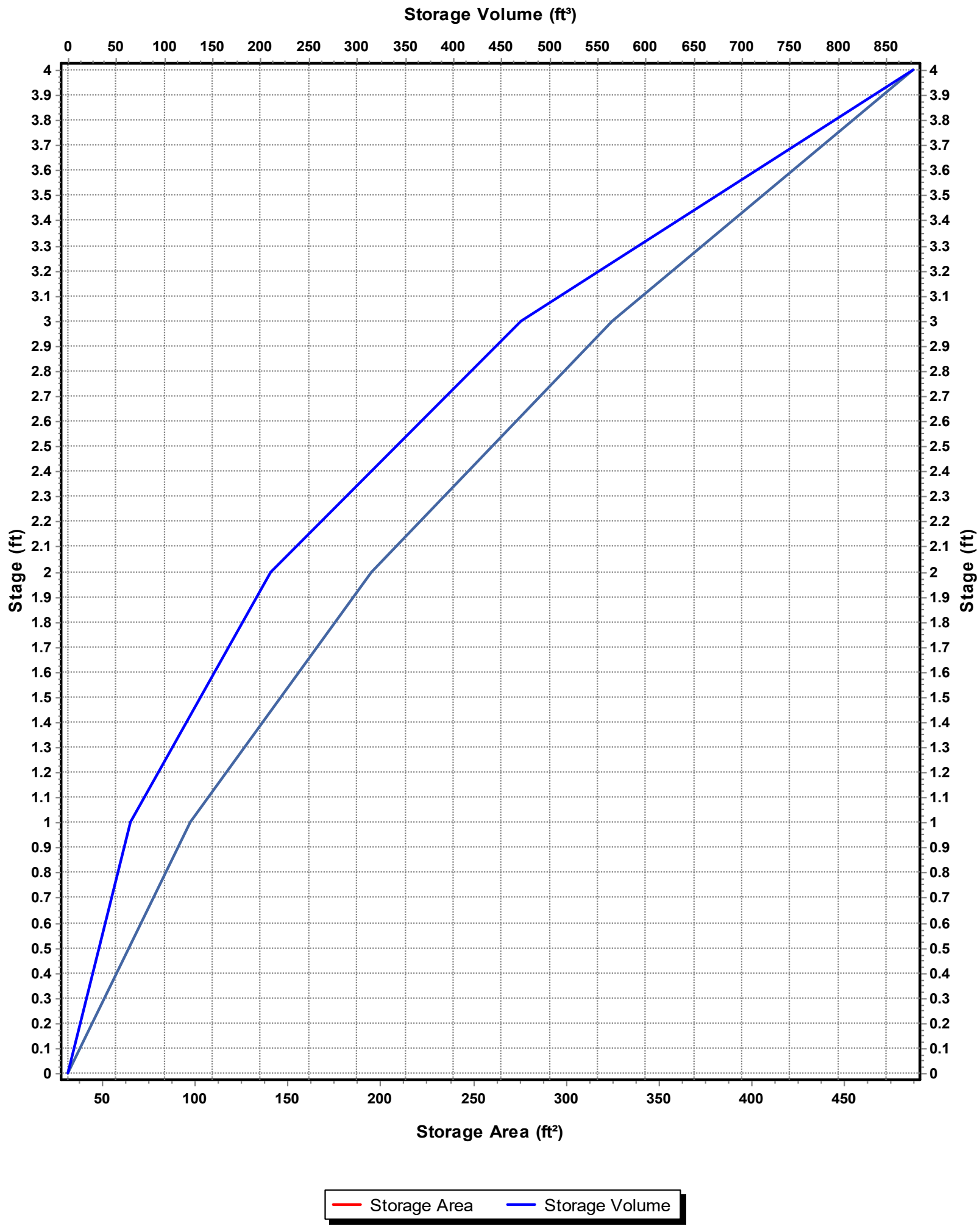
Invert Elevation (ft)	113.50
Max (Rim) Elevation (ft)	117.50
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	113.50
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

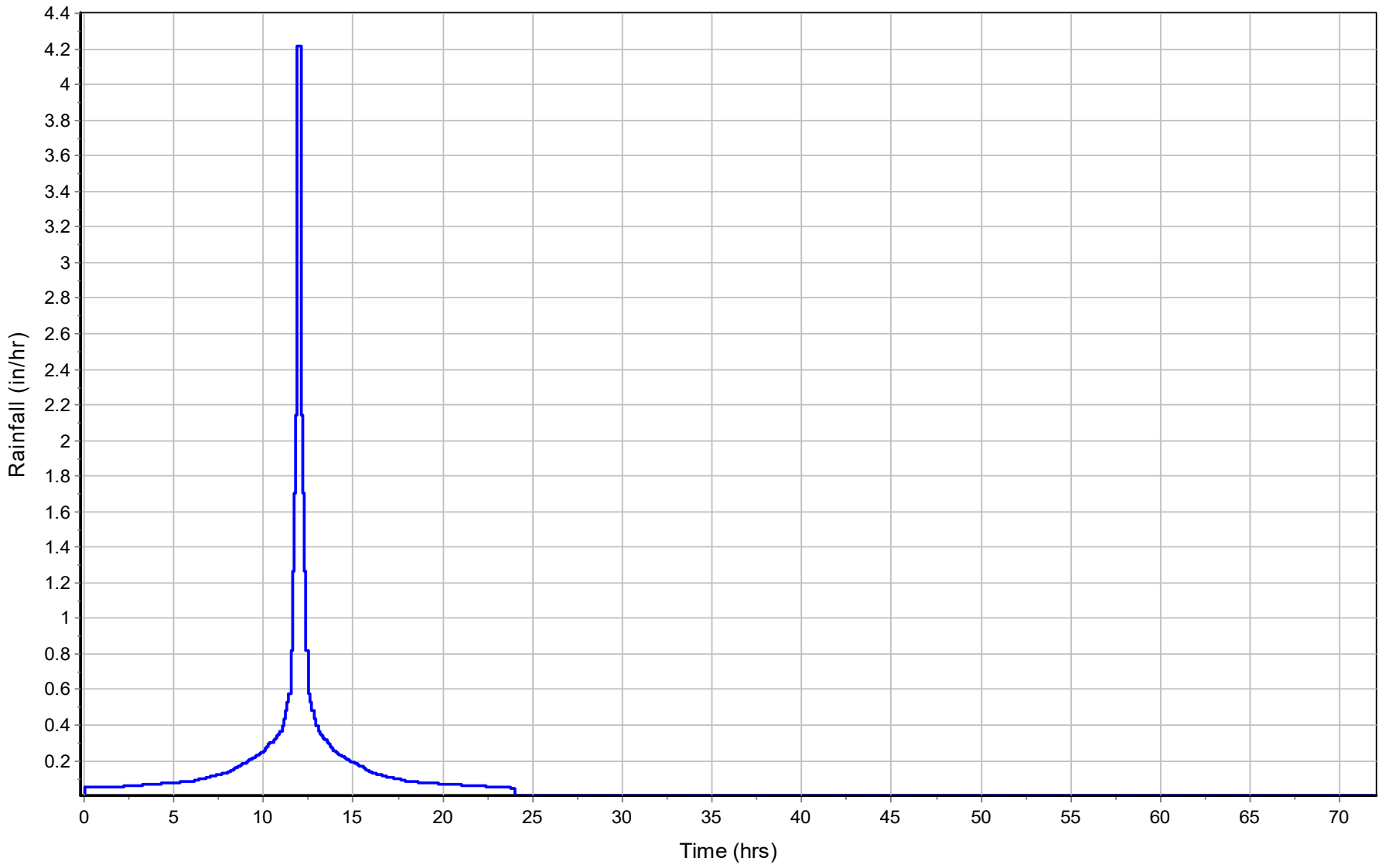
Total TOC (min) 2.97

Subbasin Runoff Results

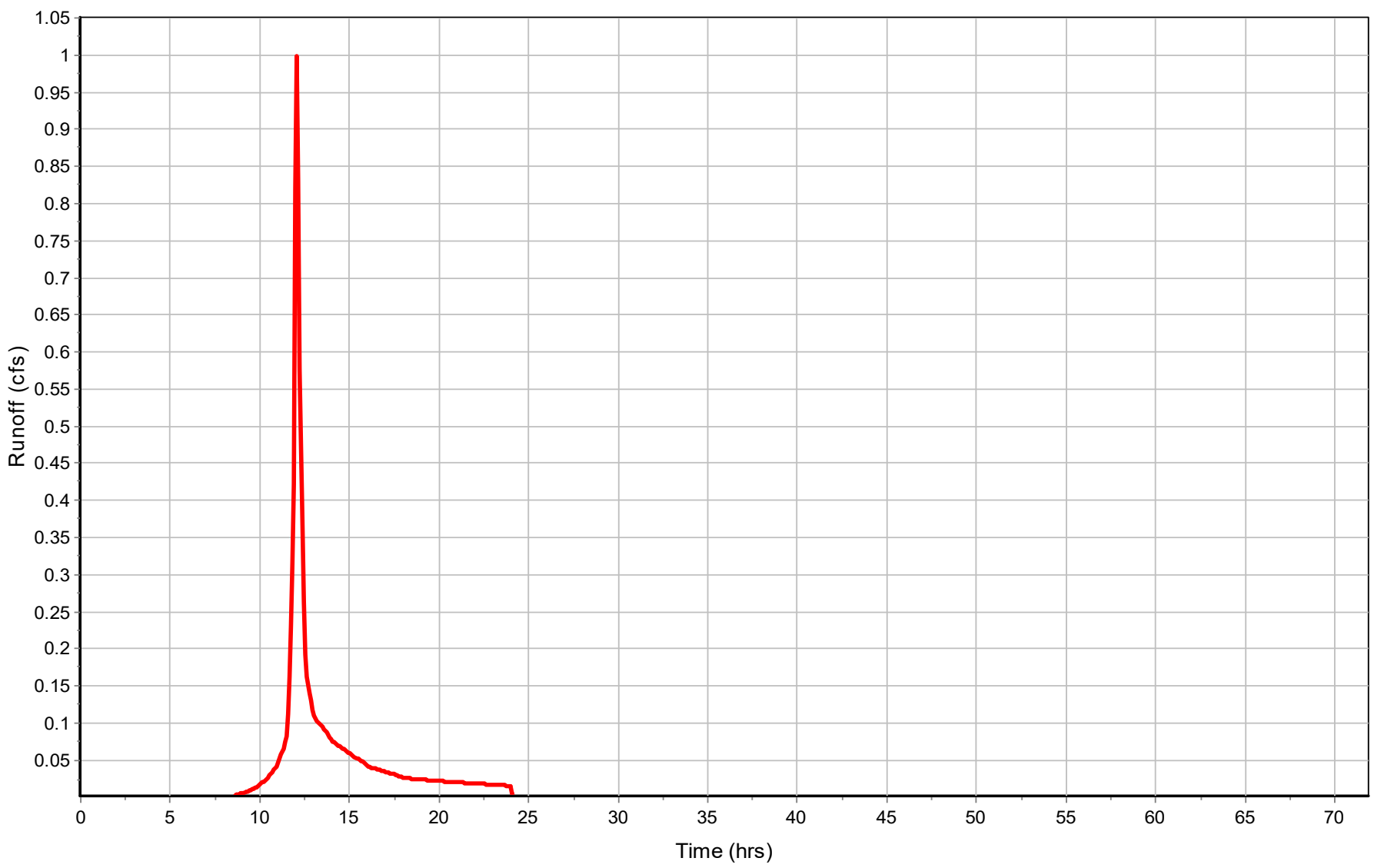
Total Rainfall (in)	5.01
Total Runoff (in)	2.54
Peak Runoff (cfs)	1.03
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:02:58

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

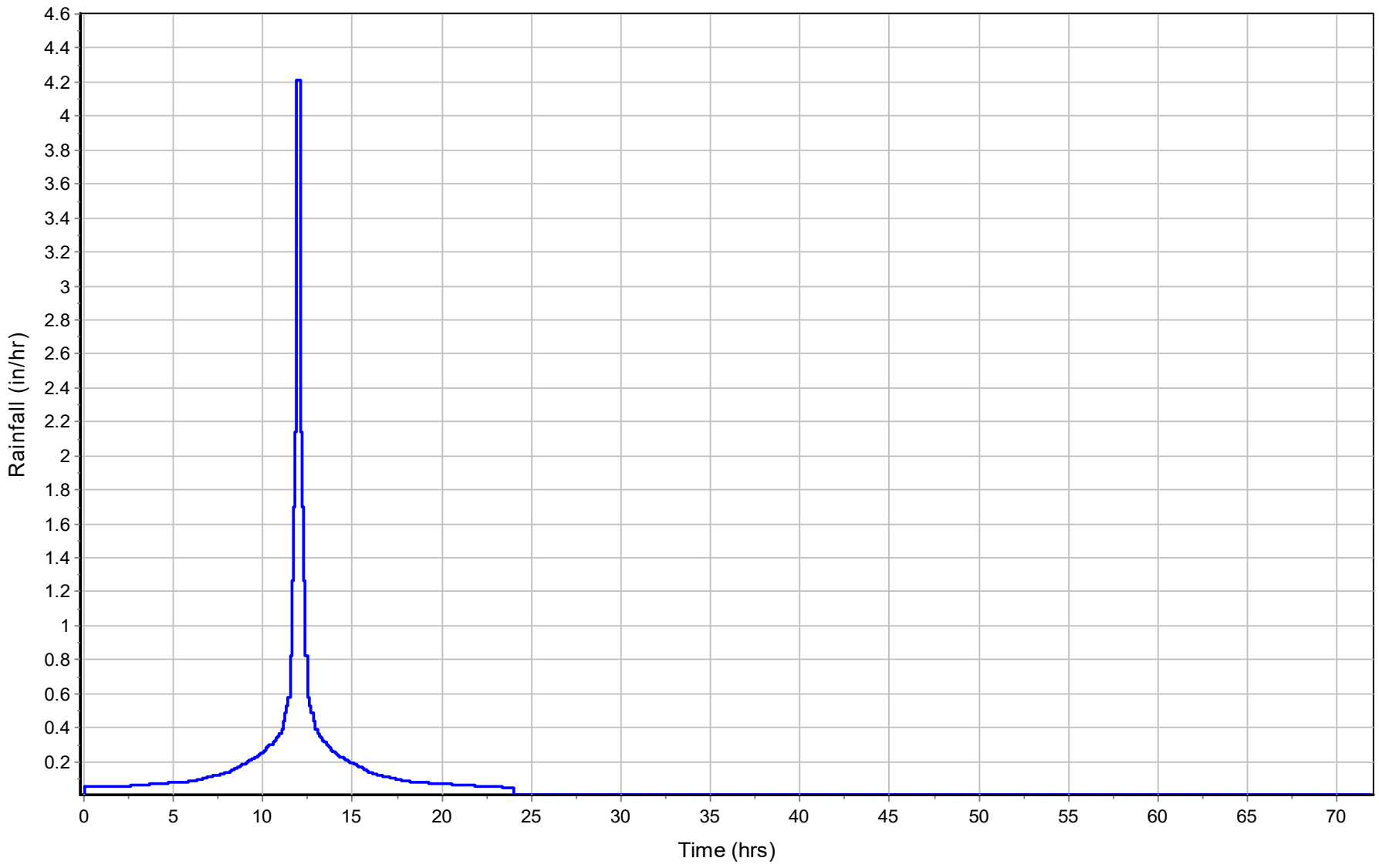
Total TOC (min) 36.74

Subbasin Runoff Results

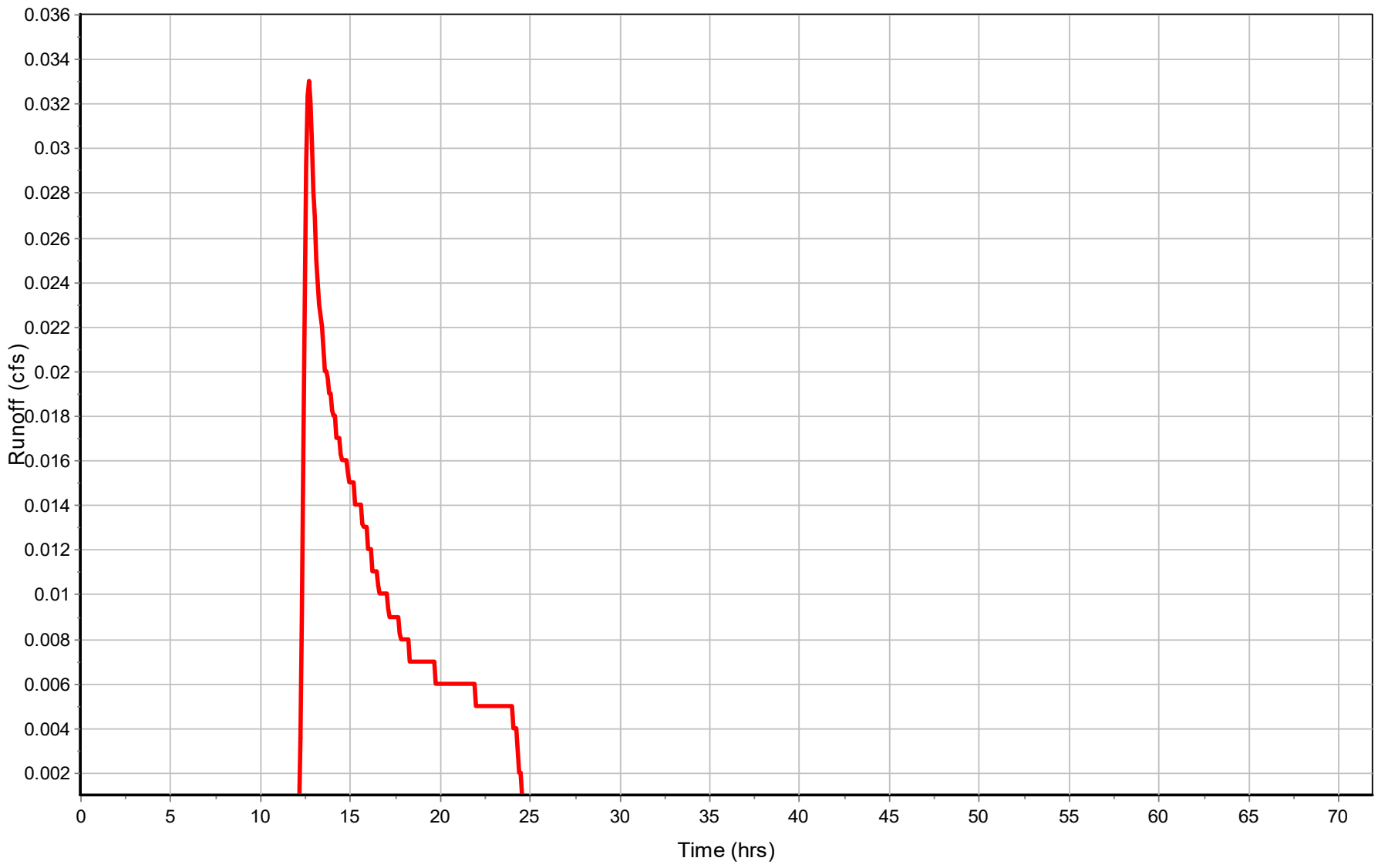
Total Rainfall (in) 5.01
Total Runoff (in) 0.36
Peak Runoff (cfs) 0.03
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:36:44

Subbasin : Sub-E03

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A3

Input Data

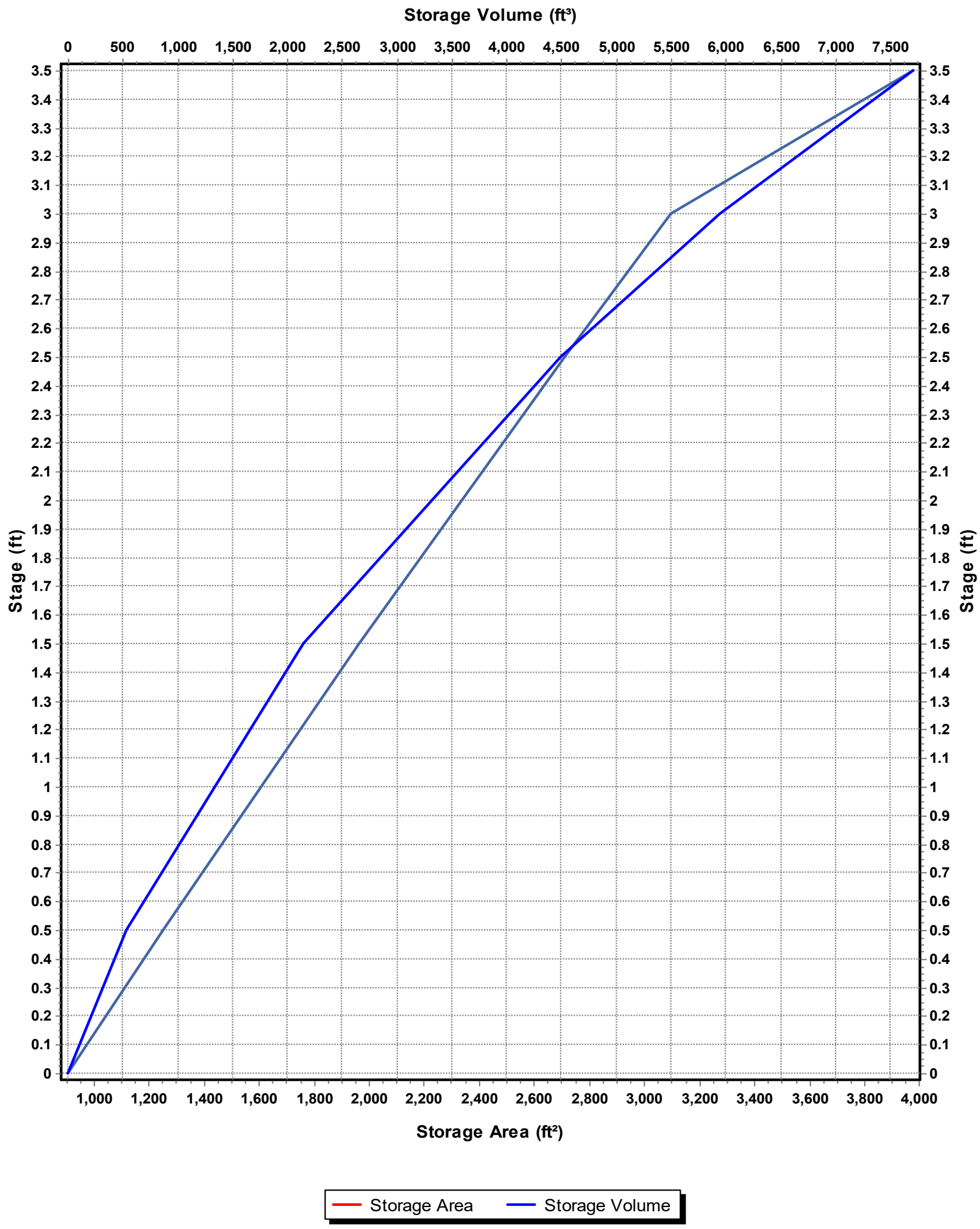
Invert Elevation (ft)	114.00
Max (Rim) Elevation (ft)	117.50
Max (Rim) Offset (ft)	3.50
Initial Water Elevation (ft)	114.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

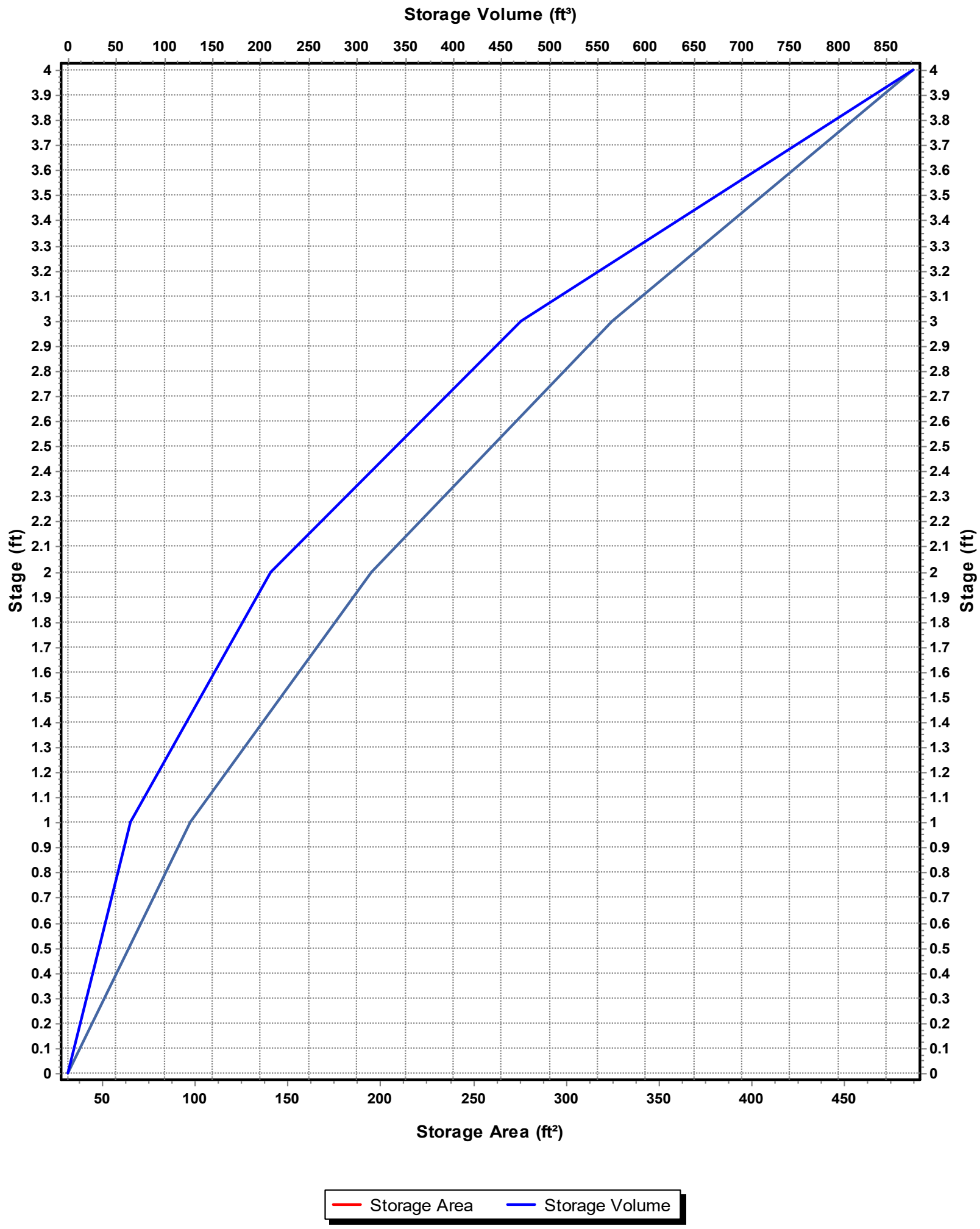
Invert Elevation (ft)	113.50
Max (Rim) Elevation (ft)	117.50
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	113.50
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

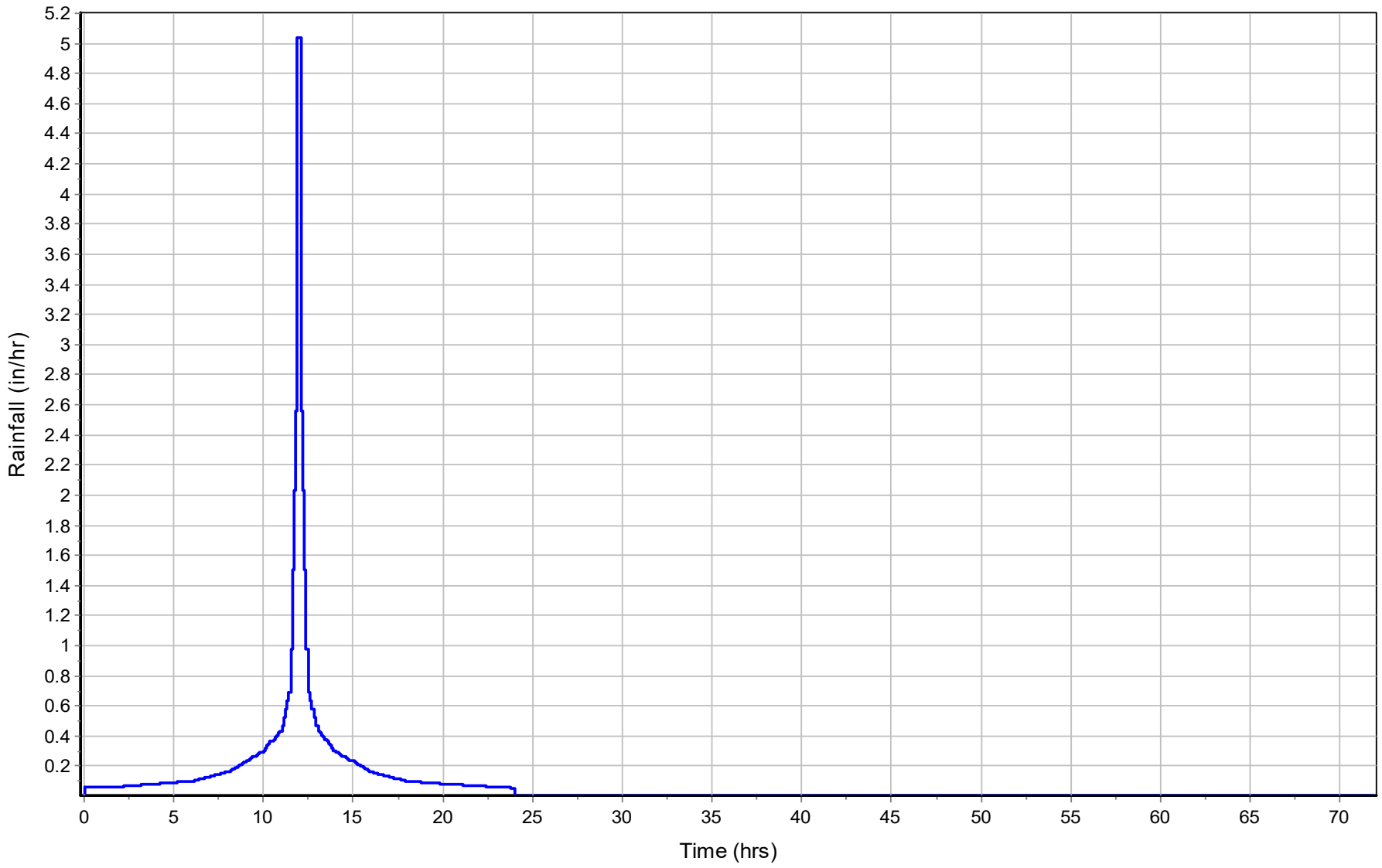
Total TOC (min) 2.97

Subbasin Runoff Results

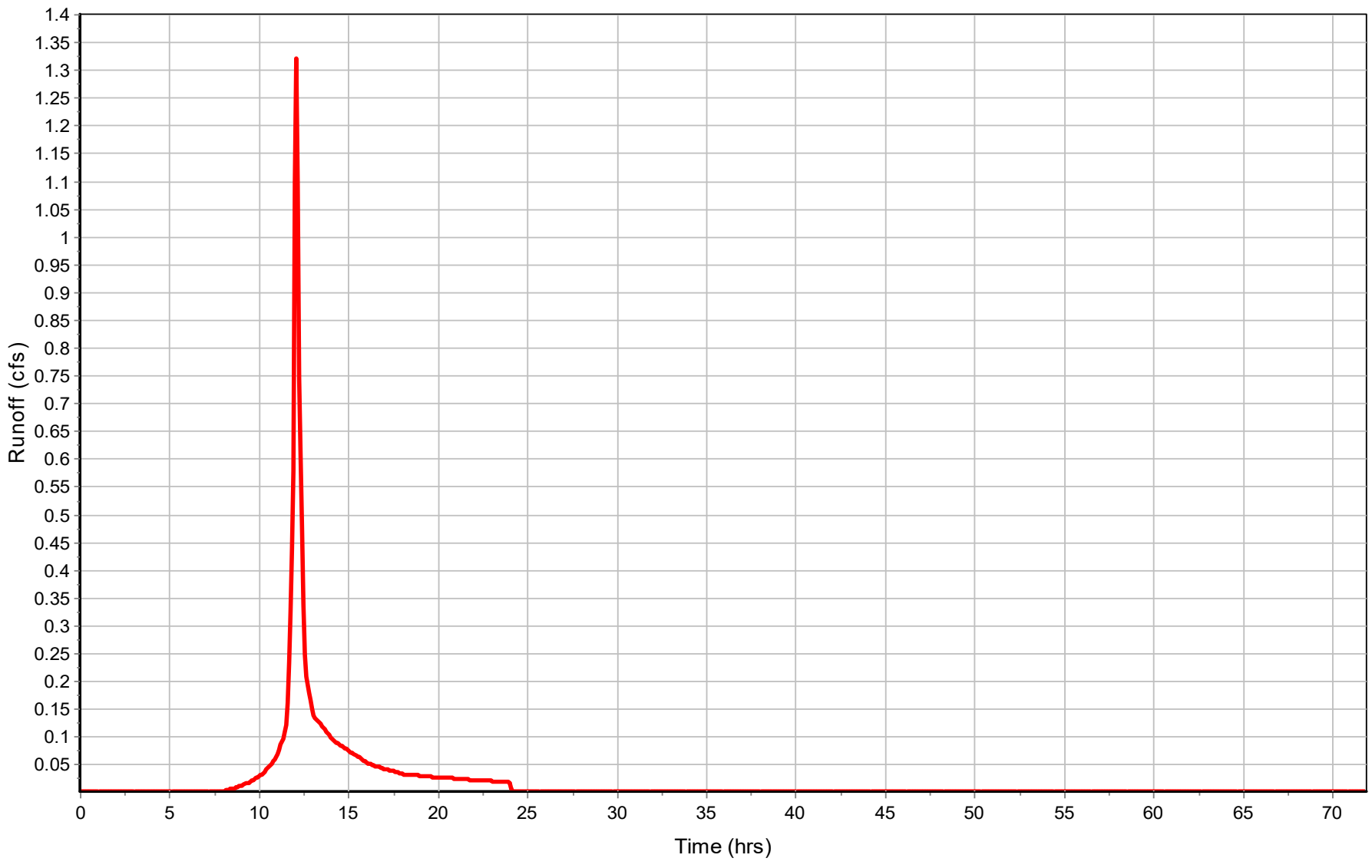
Total Rainfall (in)	5.99
Total Runoff (in)	3.37
Peak Runoff (cfs)	1.35
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:02:58

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

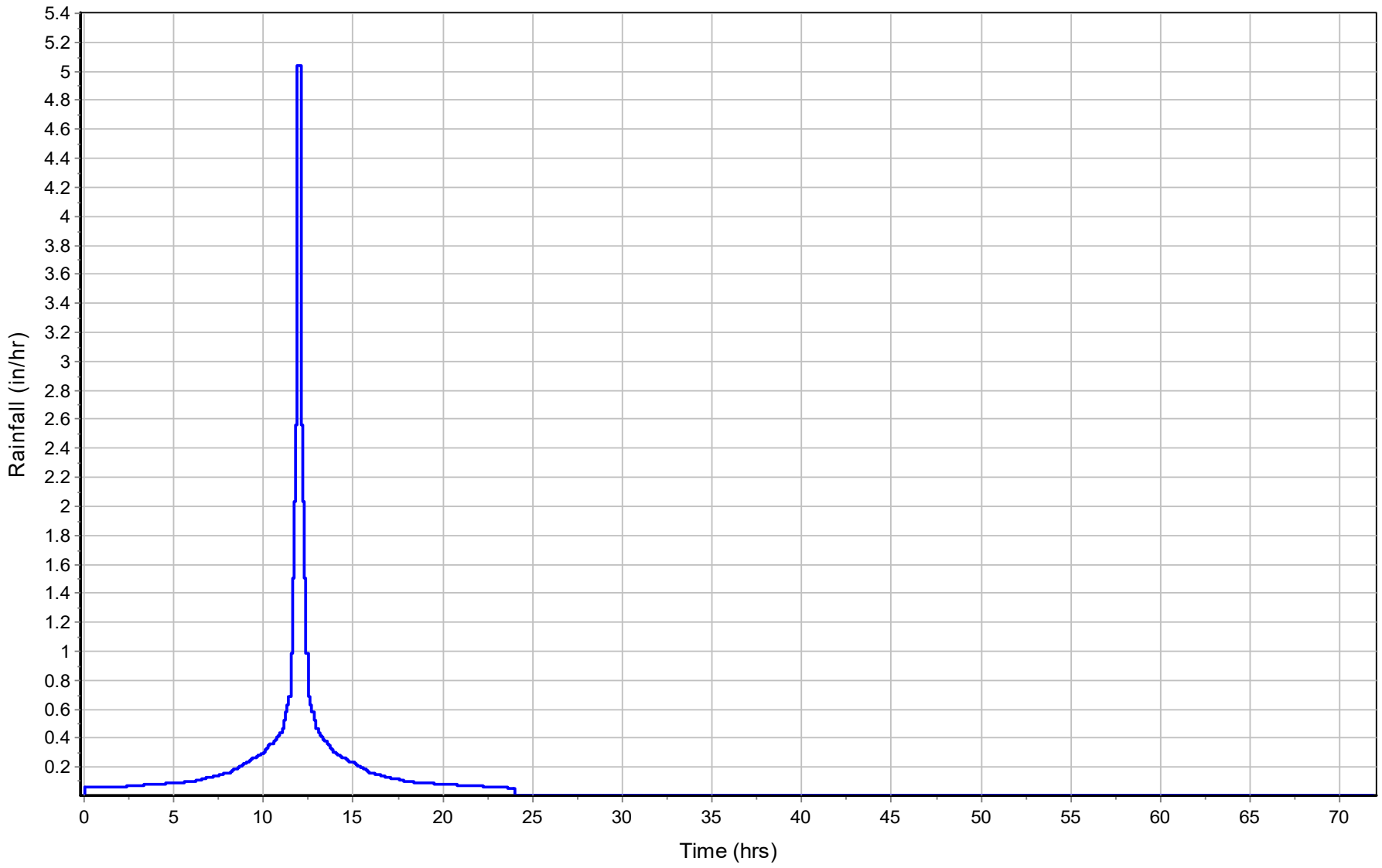
Total TOC (min) 36.74

Subbasin Runoff Results

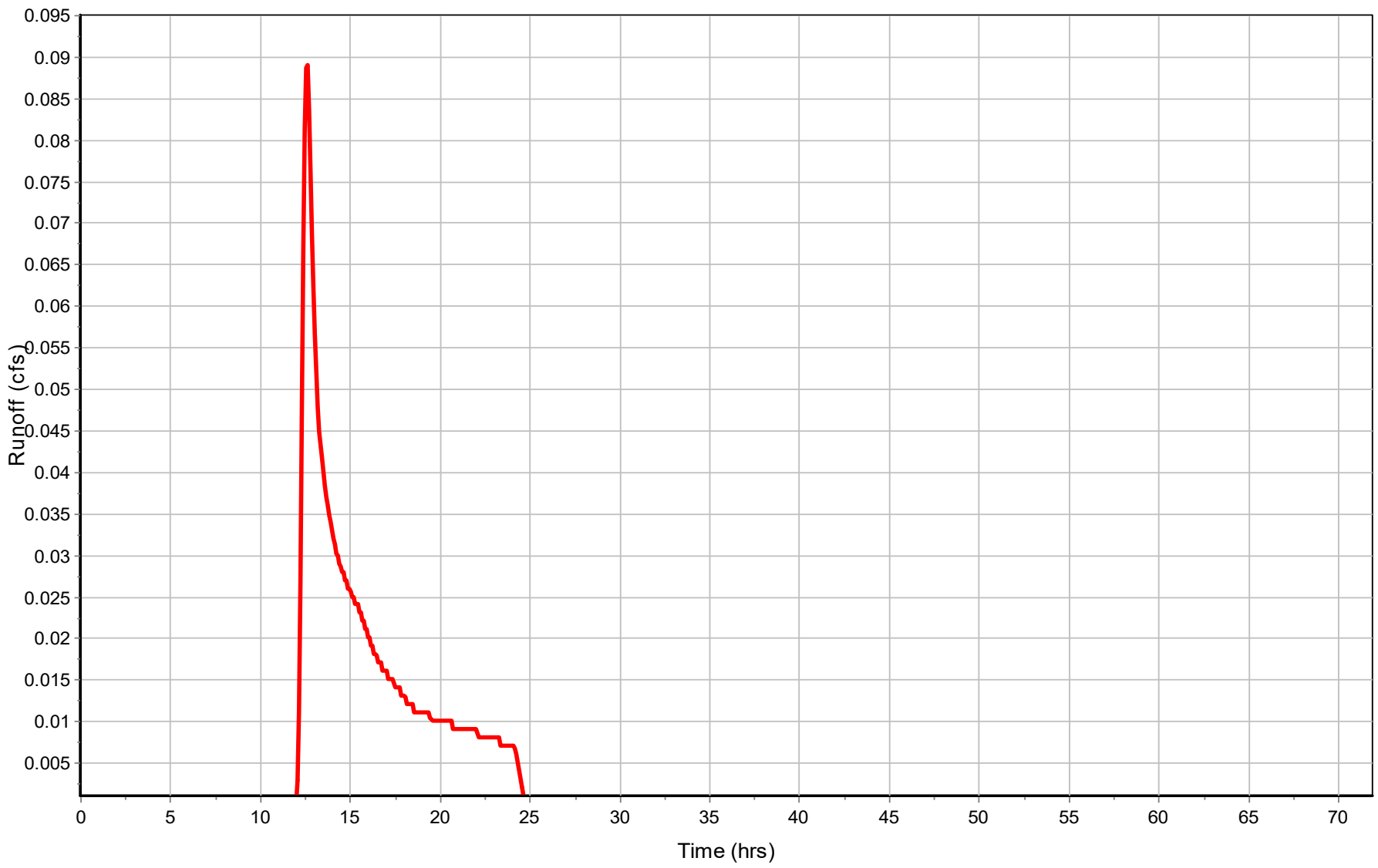
Total Rainfall (in) 5.99
Total Runoff (in) 0.67
Peak Runoff (cfs) 0.09
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:36:44

Subbasin : Sub-E03

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A3

Input Data

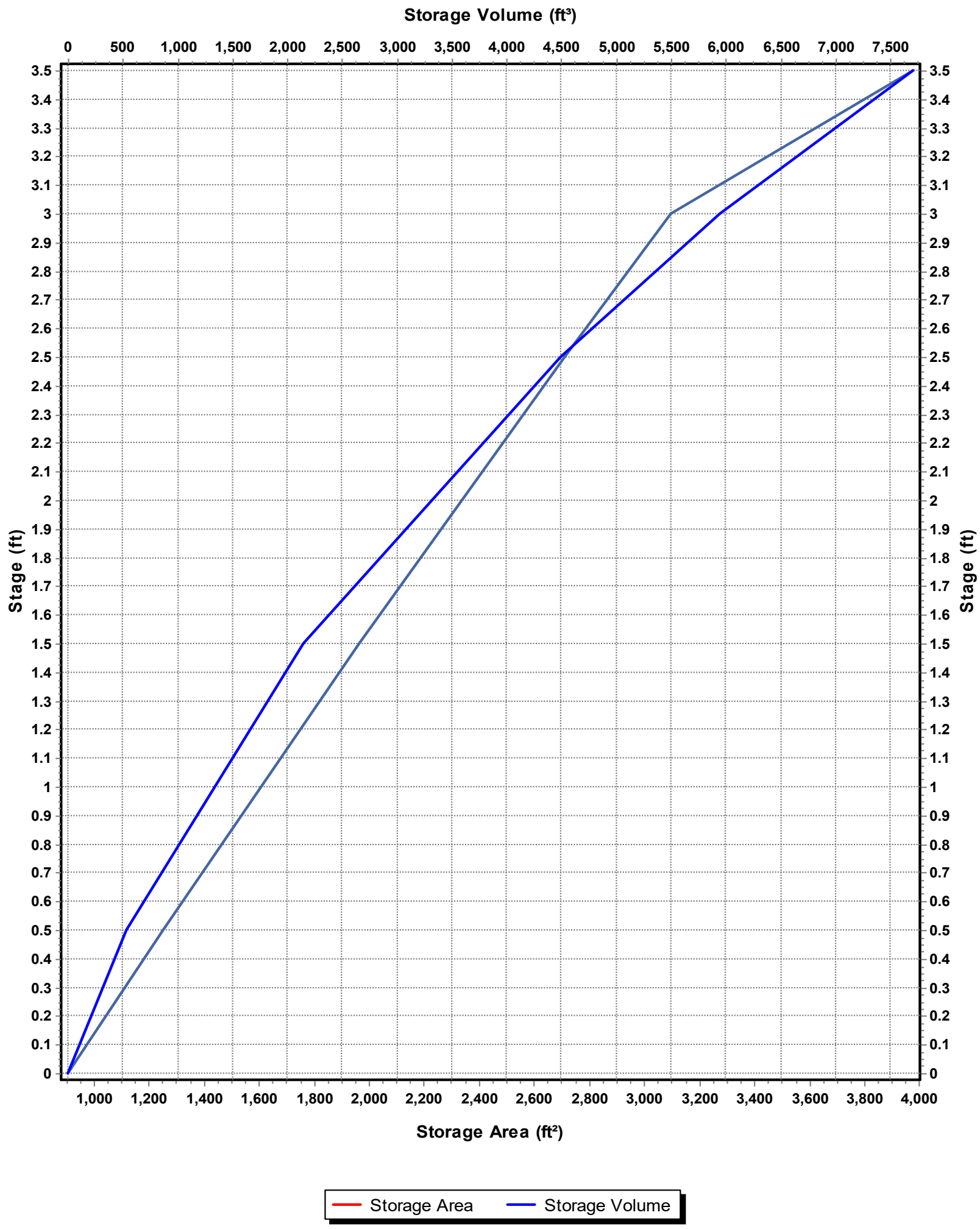
Invert Elevation (ft)	114.00
Max (Rim) Elevation (ft)	117.50
Max (Rim) Offset (ft)	3.50
Initial Water Elevation (ft)	114.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

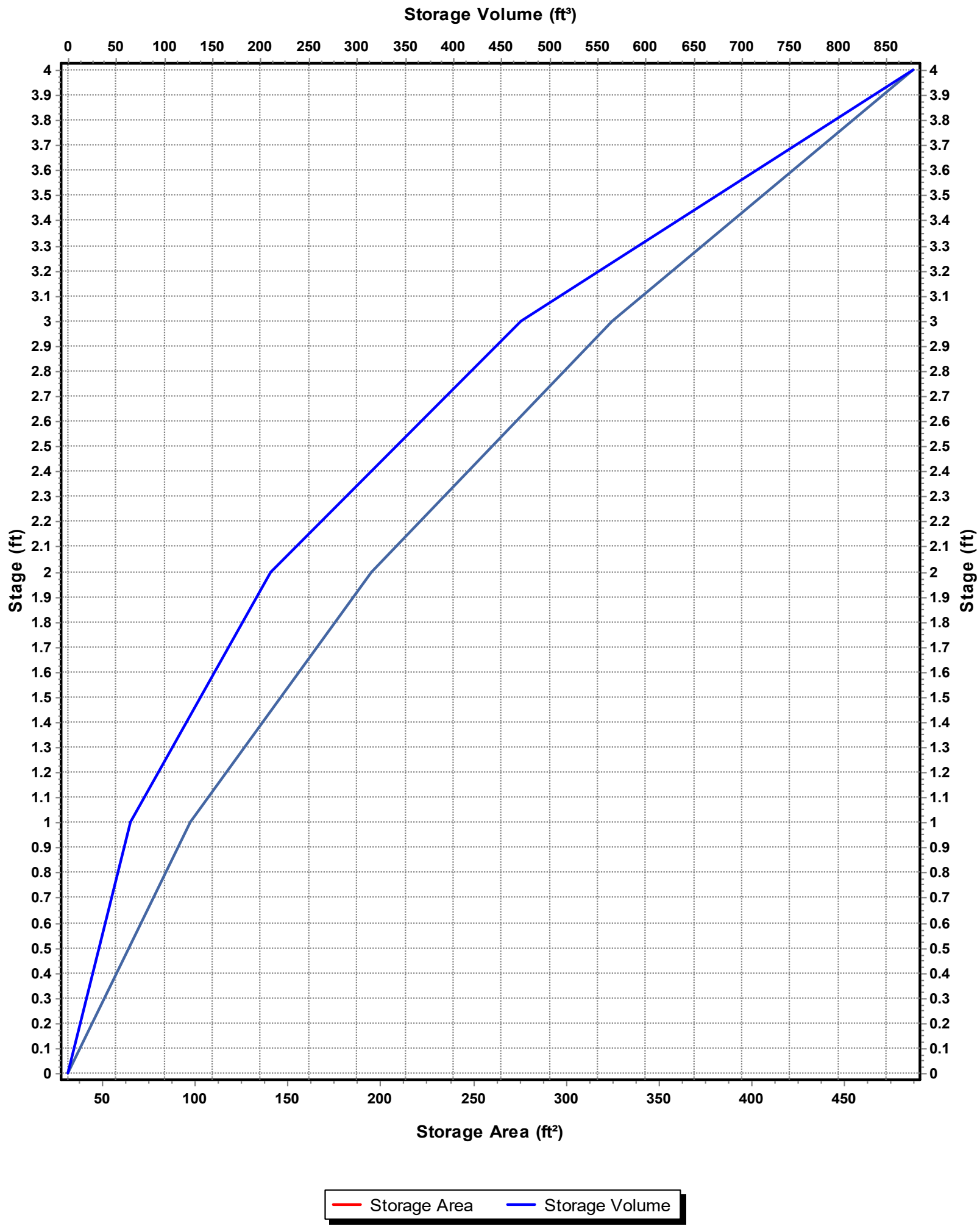
Invert Elevation (ft)	113.50
Max (Rim) Elevation (ft)	117.50
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	113.50
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

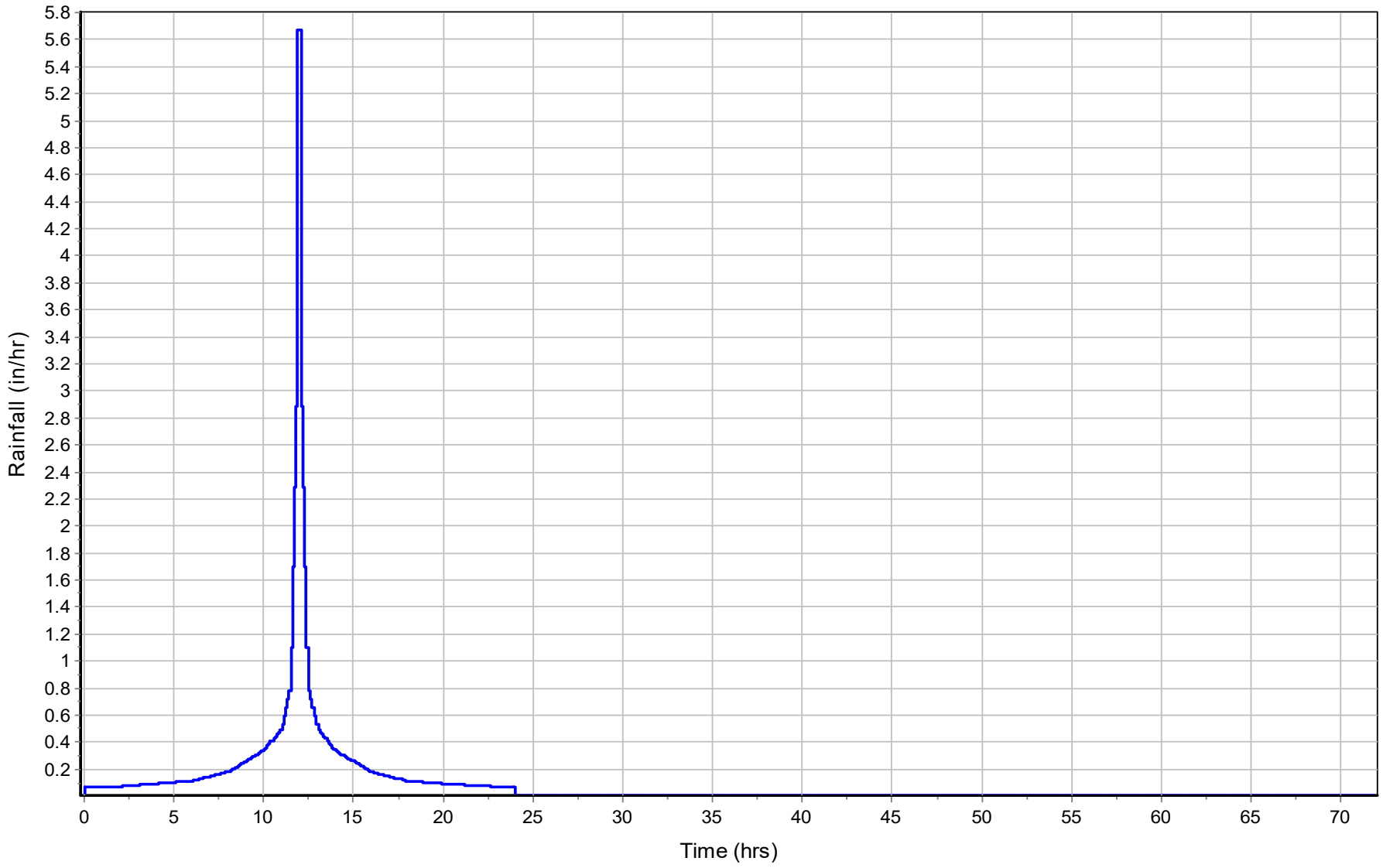
Total TOC (min) 2.97

Subbasin Runoff Results

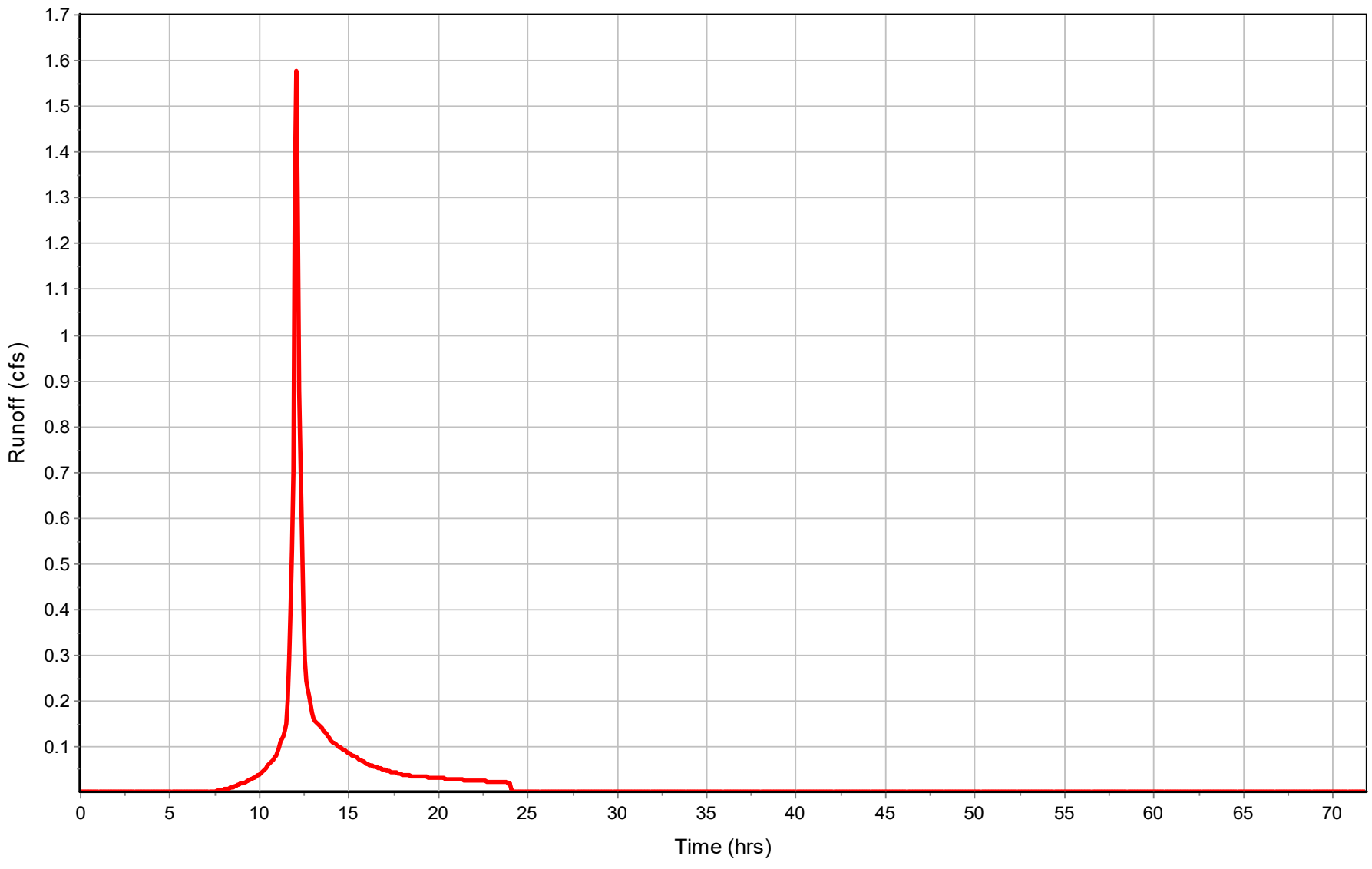
Total Rainfall (in)	6.74
Total Runoff (in)	4.03
Peak Runoff (cfs)	1.61
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:02:58

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

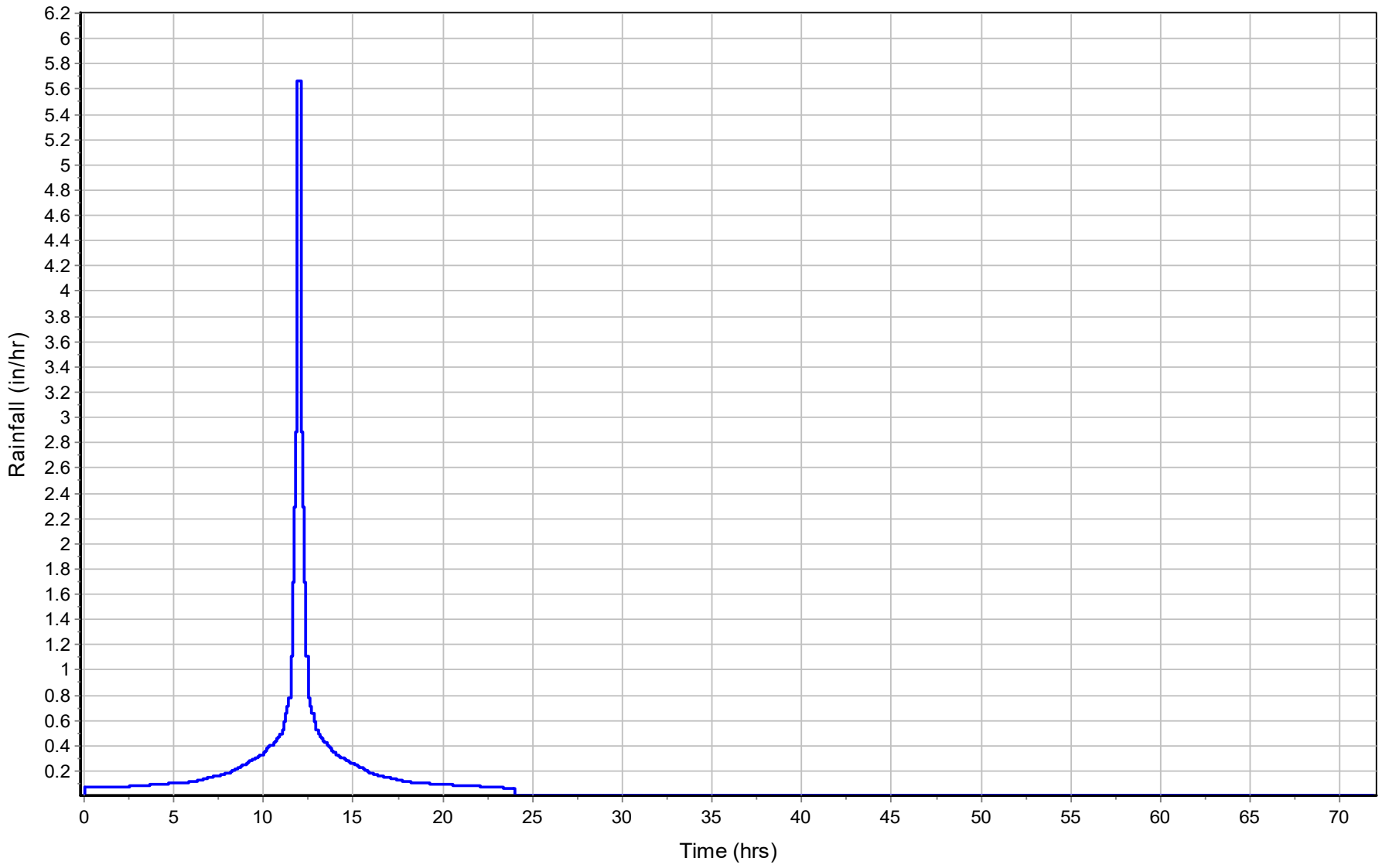
Total TOC (min) 36.74

Subbasin Runoff Results

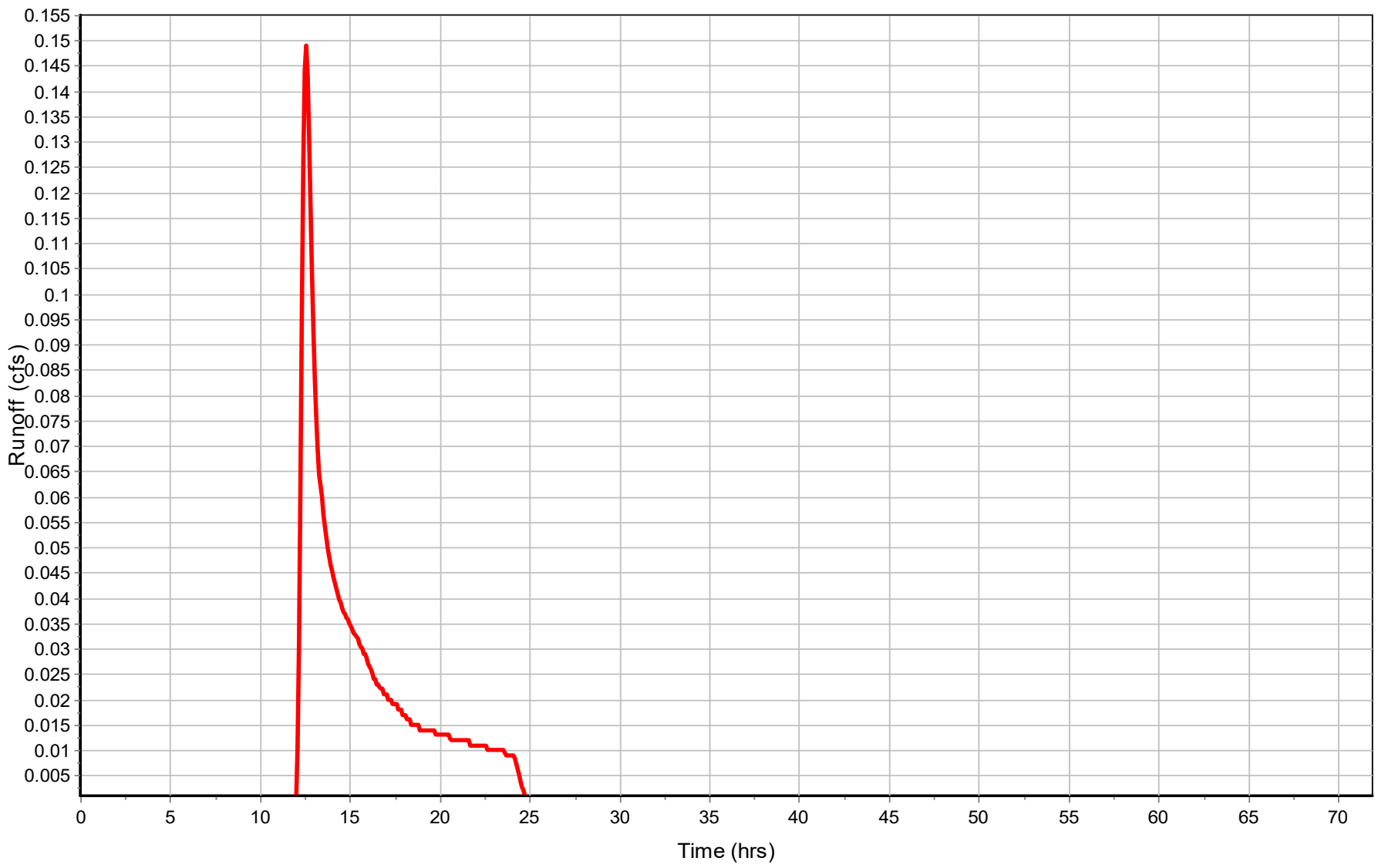
Total Rainfall (in) 6.74
Total Runoff (in) 0.96
Peak Runoff (cfs) 0.15
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:36:44

Subbasin : Sub-E03

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A3

Input Data

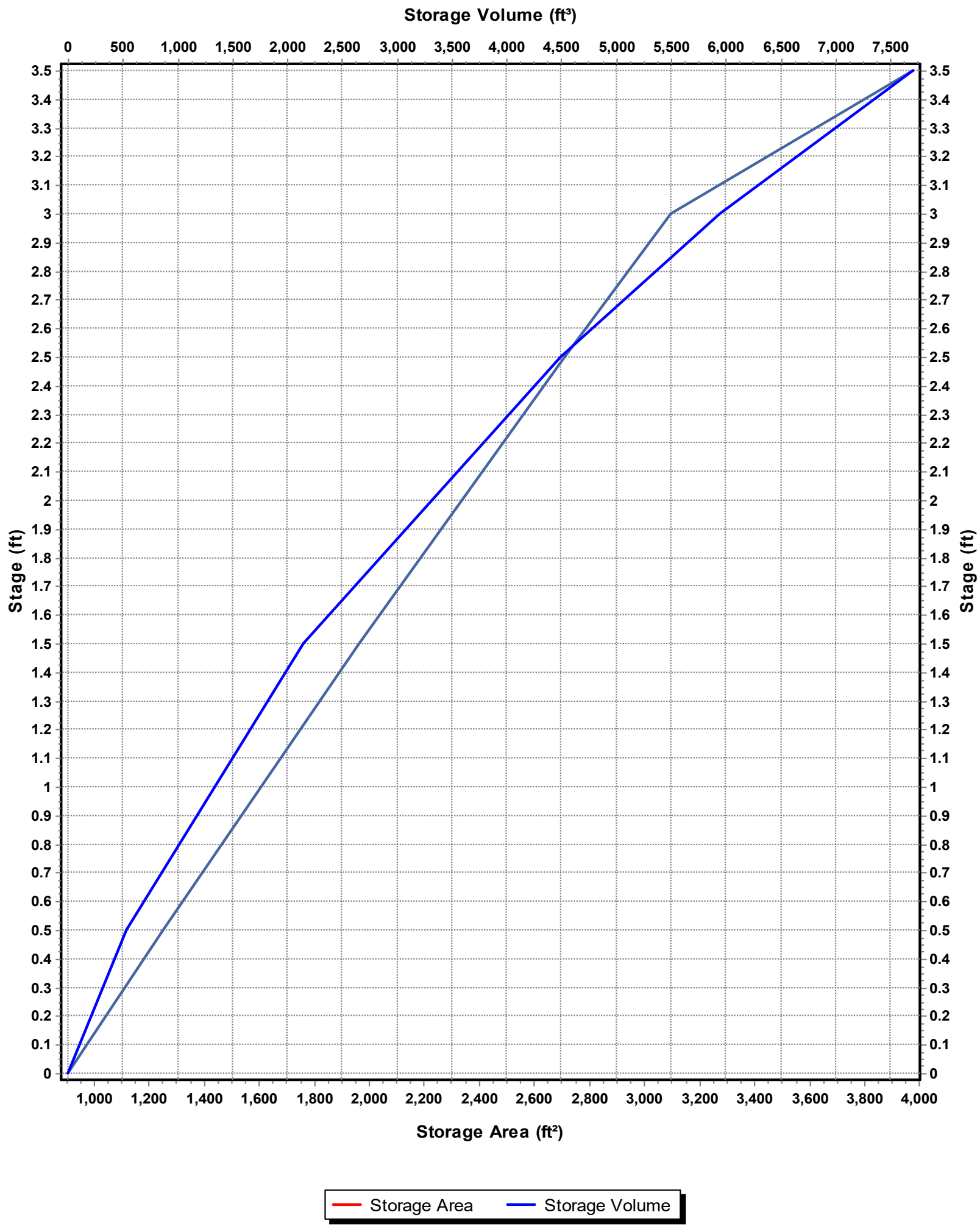
Invert Elevation (ft)	114.00
Max (Rim) Elevation (ft)	117.50
Max (Rim) Offset (ft)	3.50
Initial Water Elevation (ft)	114.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

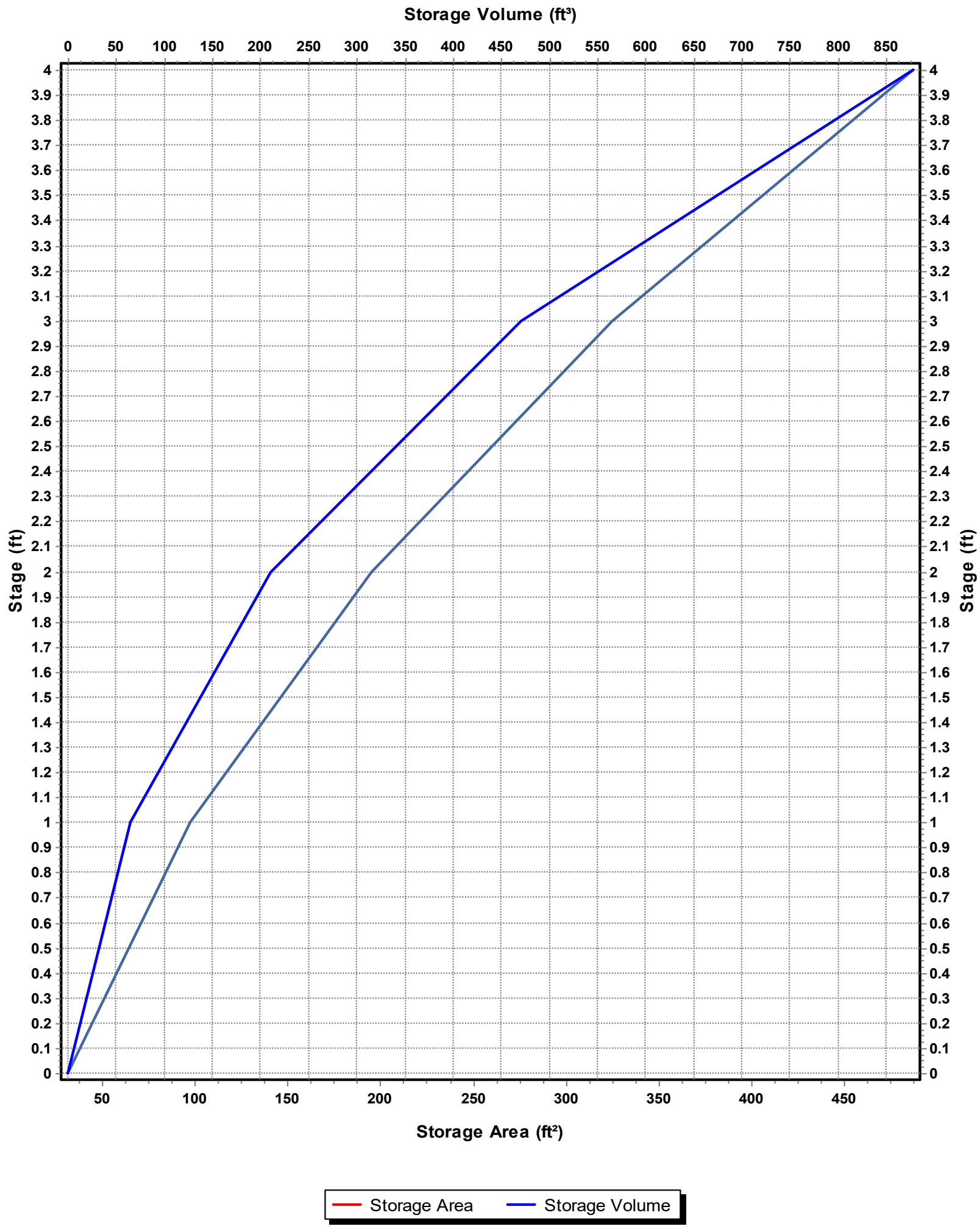
Invert Elevation (ft)	113.50
Max (Rim) Elevation (ft)	117.50
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	113.50
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

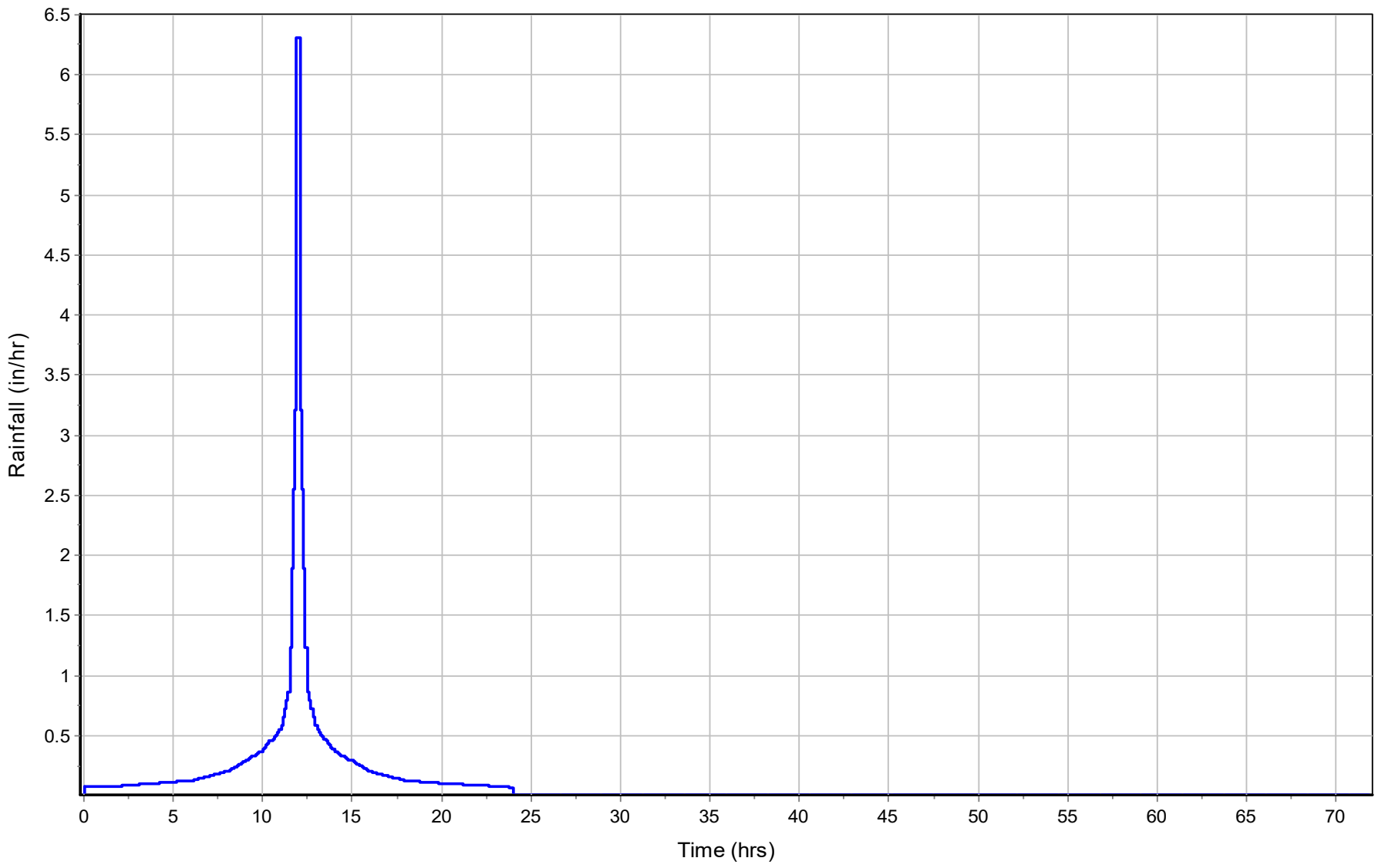
Total TOC (min) 2.97

Subbasin Runoff Results

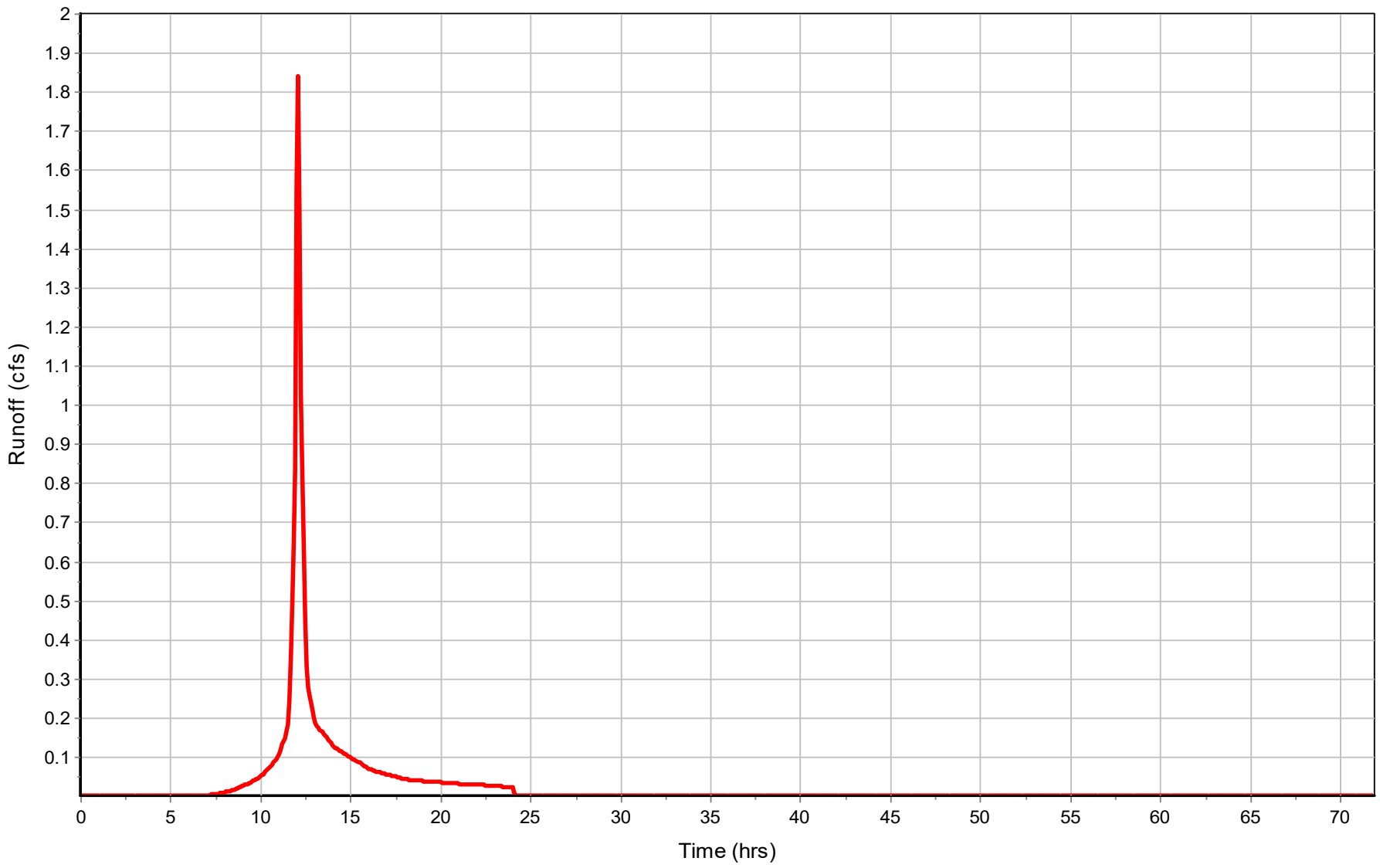
Total Rainfall (in)	7.51
Total Runoff (in)	4.71
Peak Runoff (cfs)	1.87
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:02:58

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

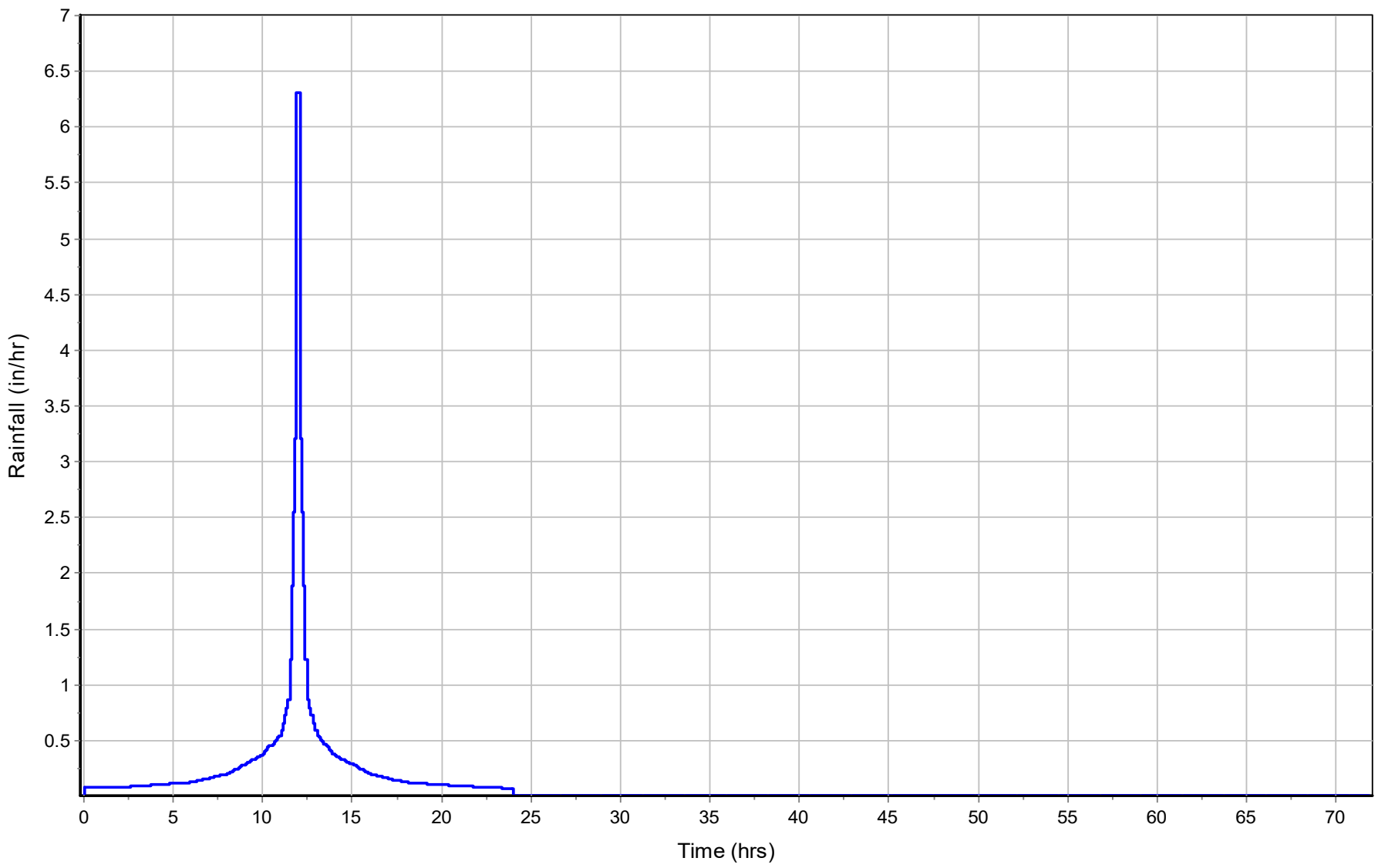
Total TOC (min) 36.74

Subbasin Runoff Results

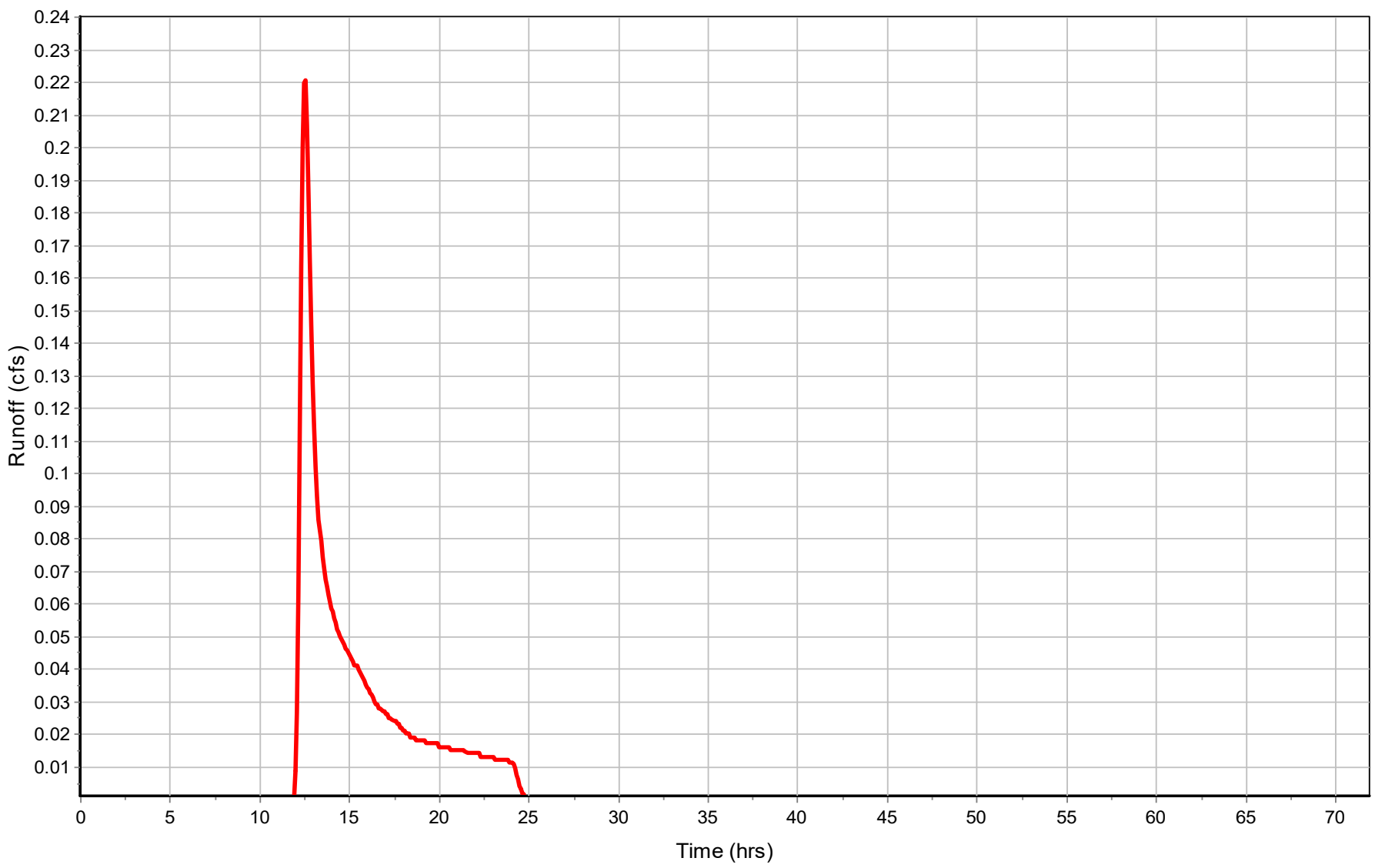
Total Rainfall (in) 7.51
Total Runoff (in) 1.3
Peak Runoff (cfs) 0.22
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:36:44

Subbasin : Sub-E03

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A3

Input Data

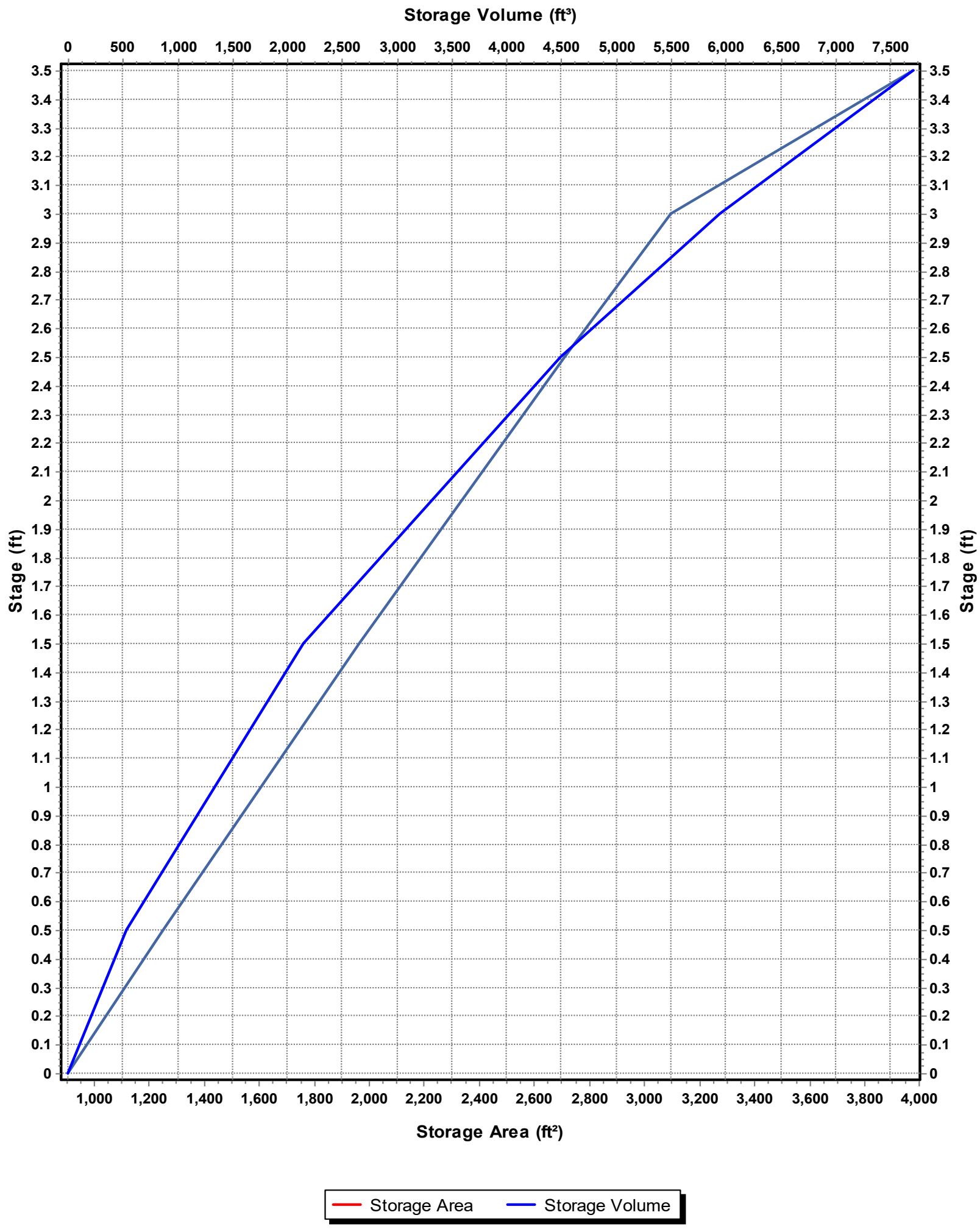
Invert Elevation (ft)	114.00
Max (Rim) Elevation (ft)	117.50
Max (Rim) Offset (ft)	3.50
Initial Water Elevation (ft)	114.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

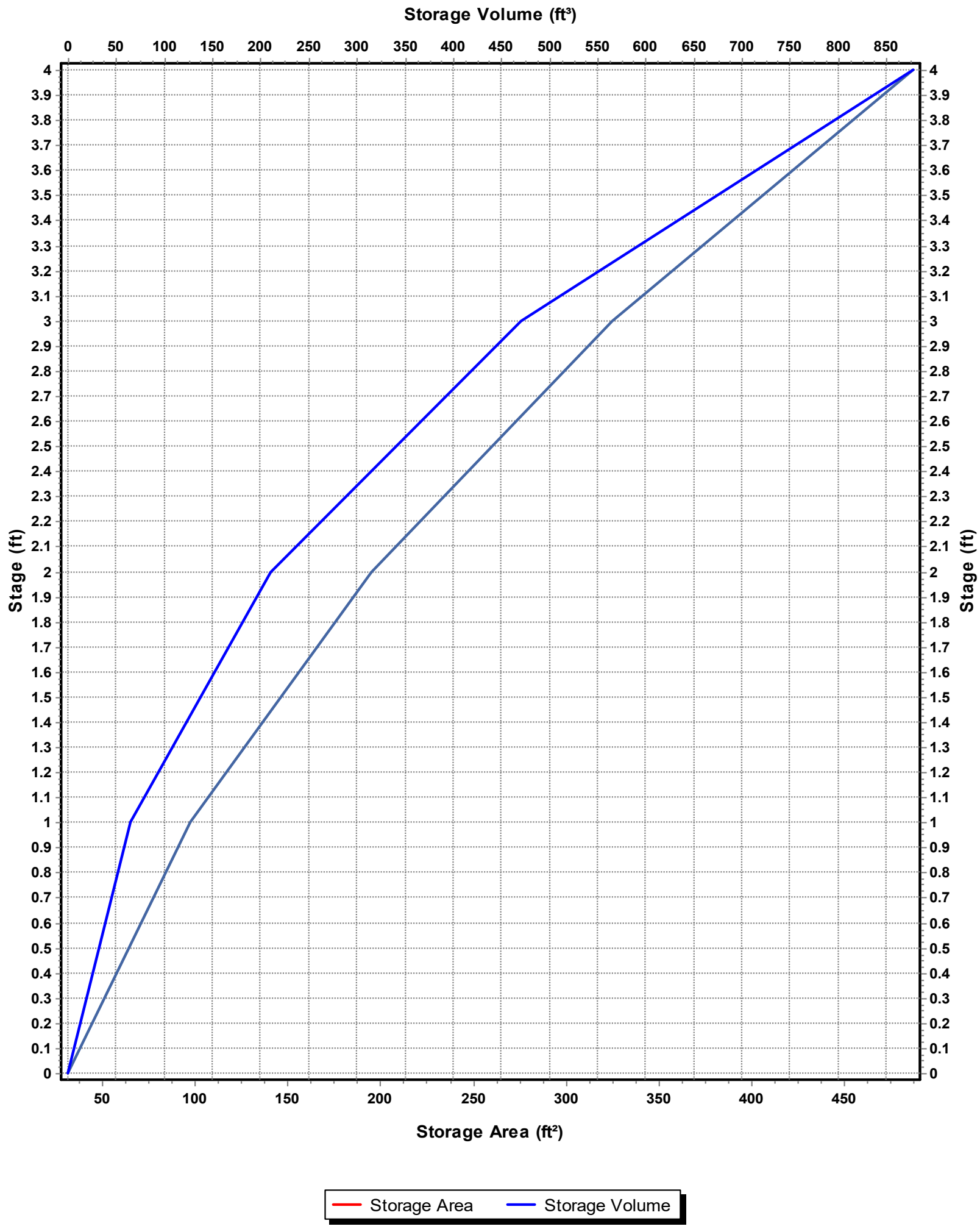
Invert Elevation (ft)	113.50
Max (Rim) Elevation (ft)	117.50
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	113.50
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

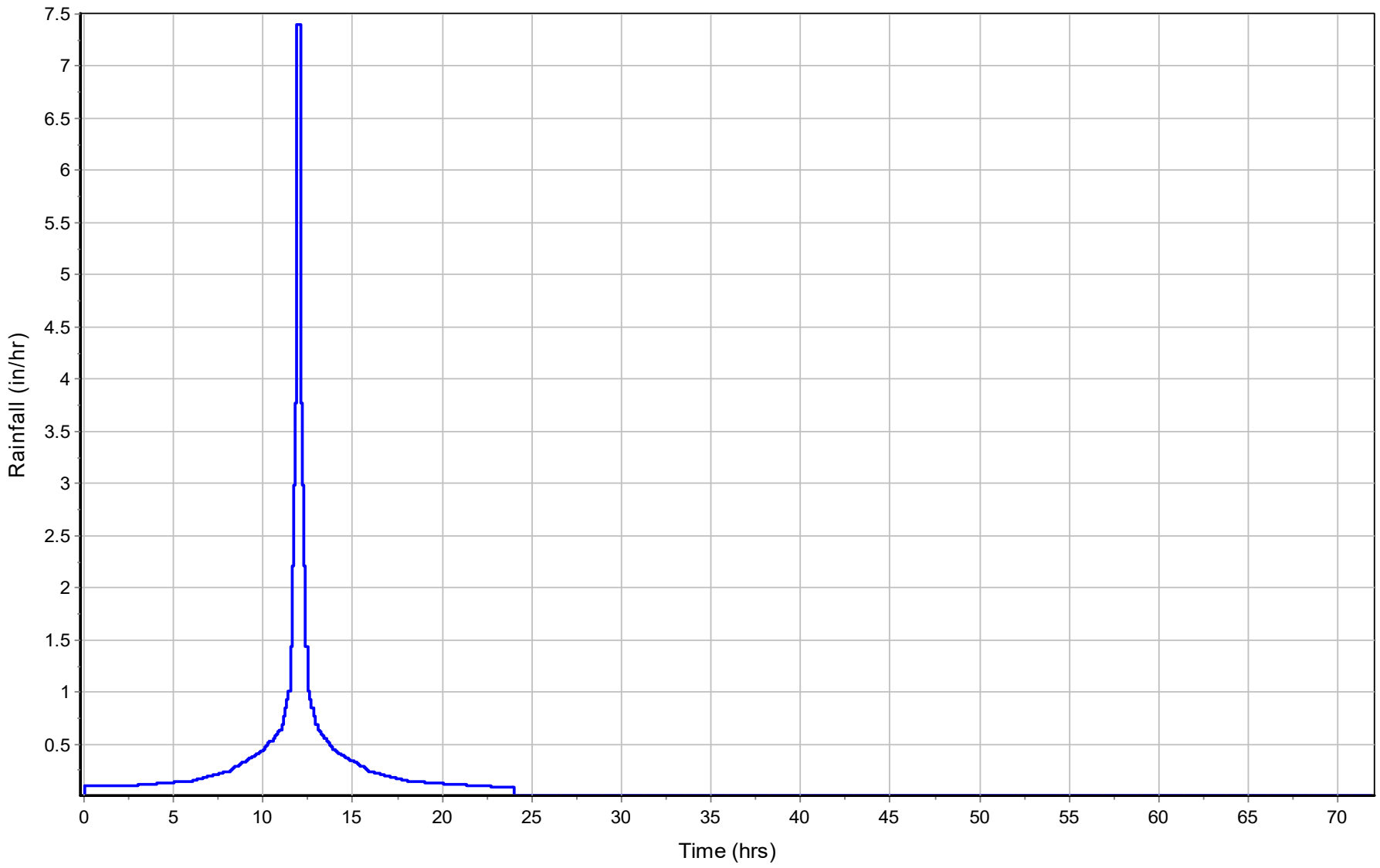
Total TOC (min) 2.97

Subbasin Runoff Results

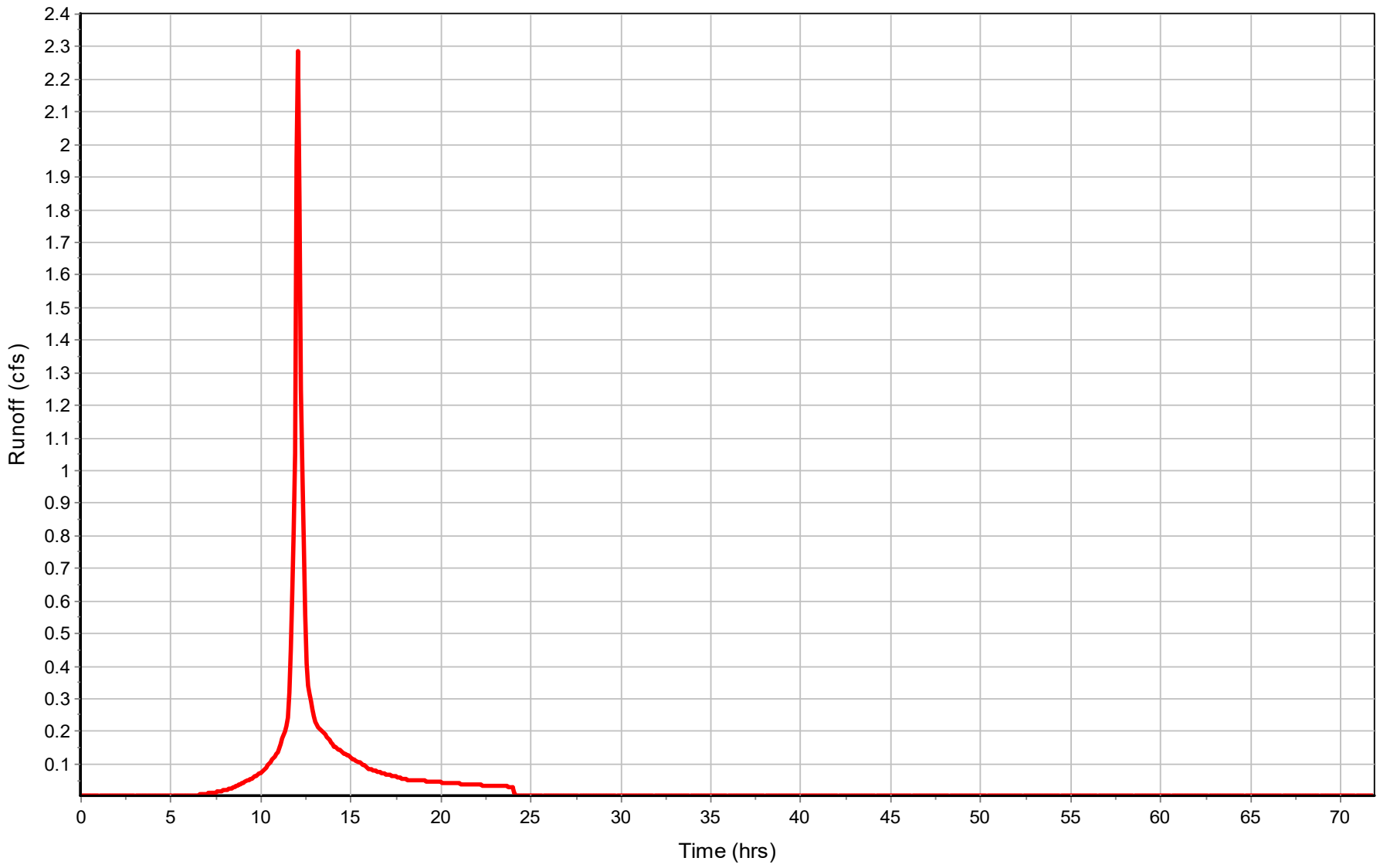
Total Rainfall (in)	8.8
Total Runoff (in)	5.89
Peak Runoff (cfs)	2.32
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:02:58

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

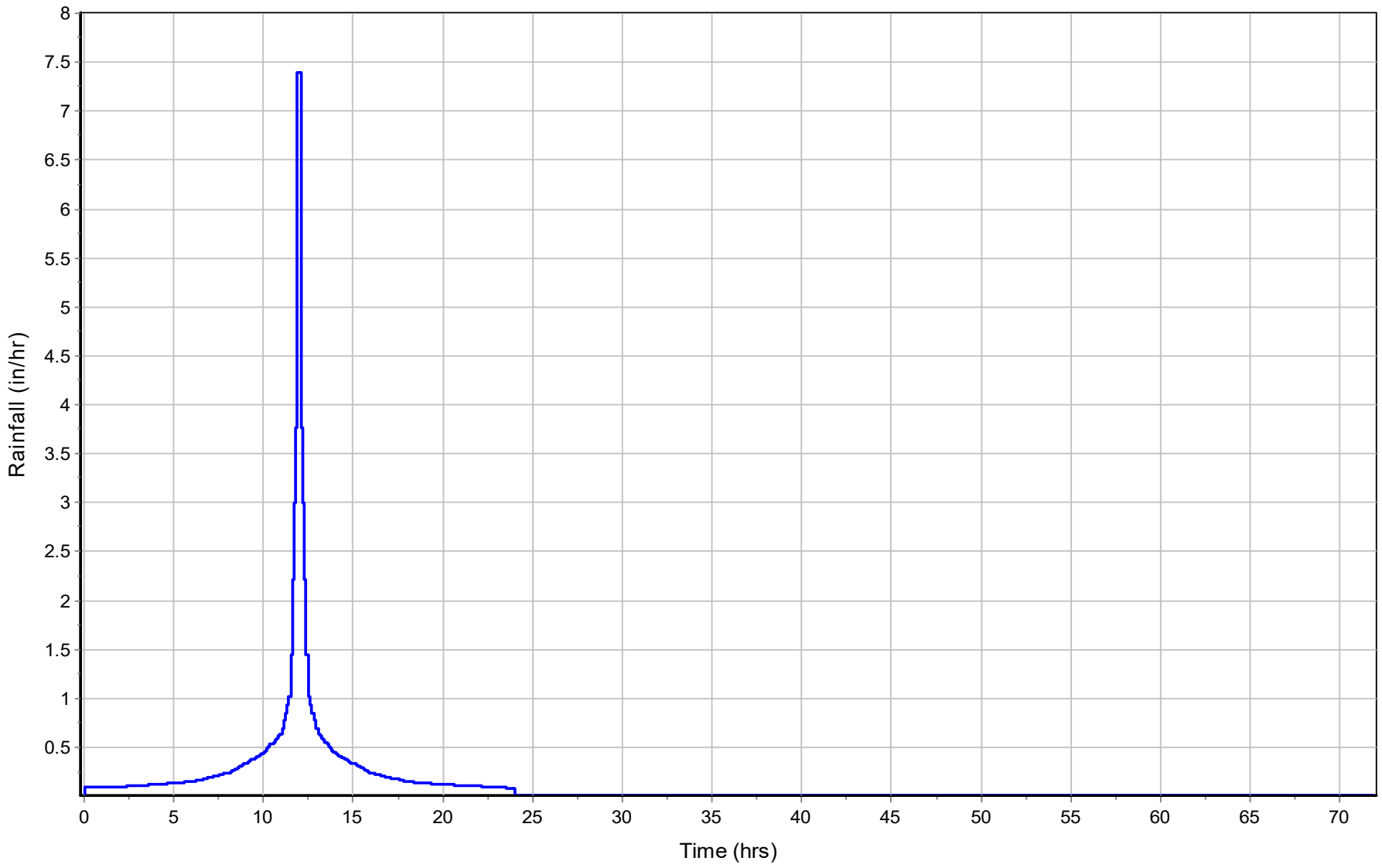
Total TOC (min) 36.74

Subbasin Runoff Results

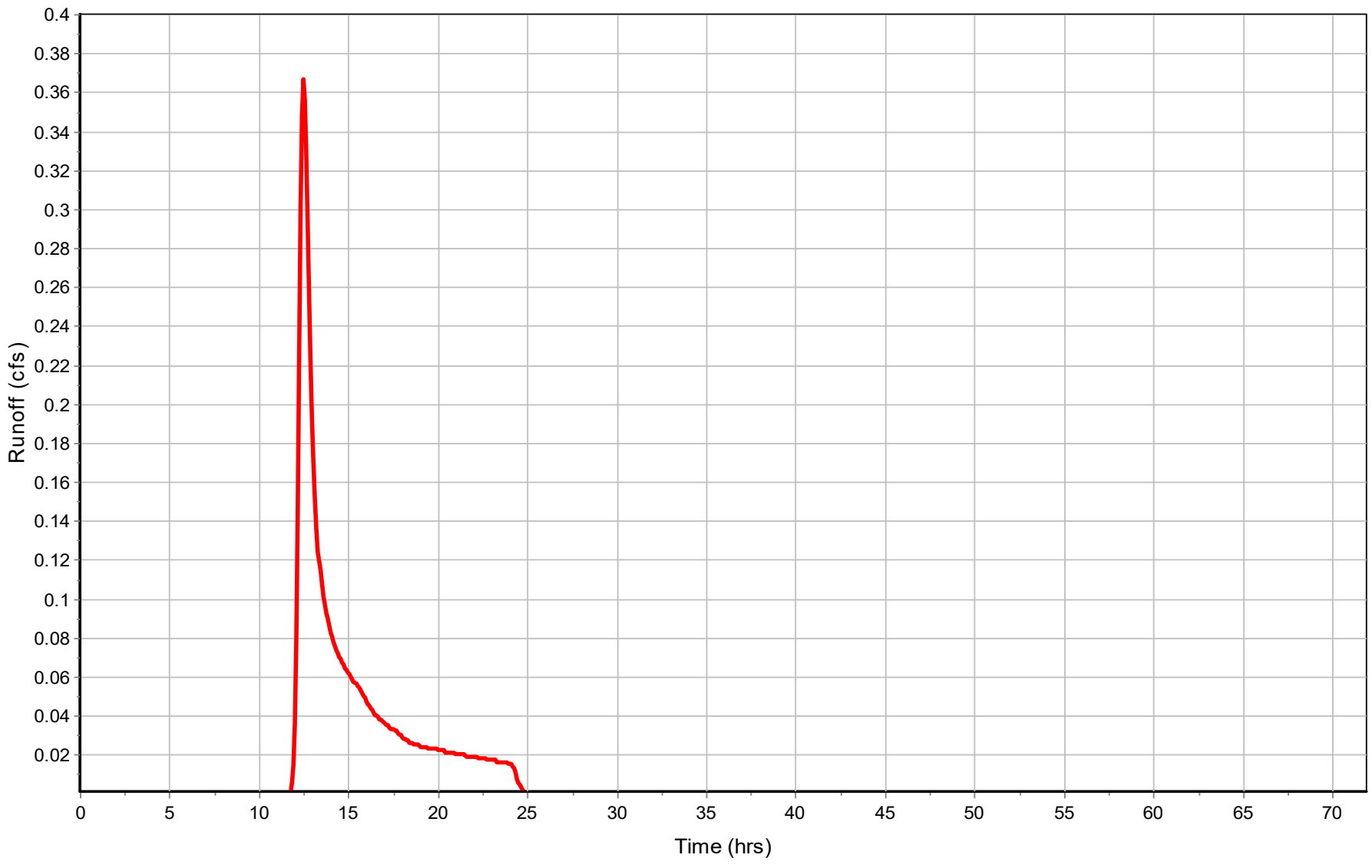
Total Rainfall (in) 8.8
Total Runoff (in) 1.95
Peak Runoff (cfs) 0.37
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:36:44

Subbasin : Sub-E03

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A3

Input Data

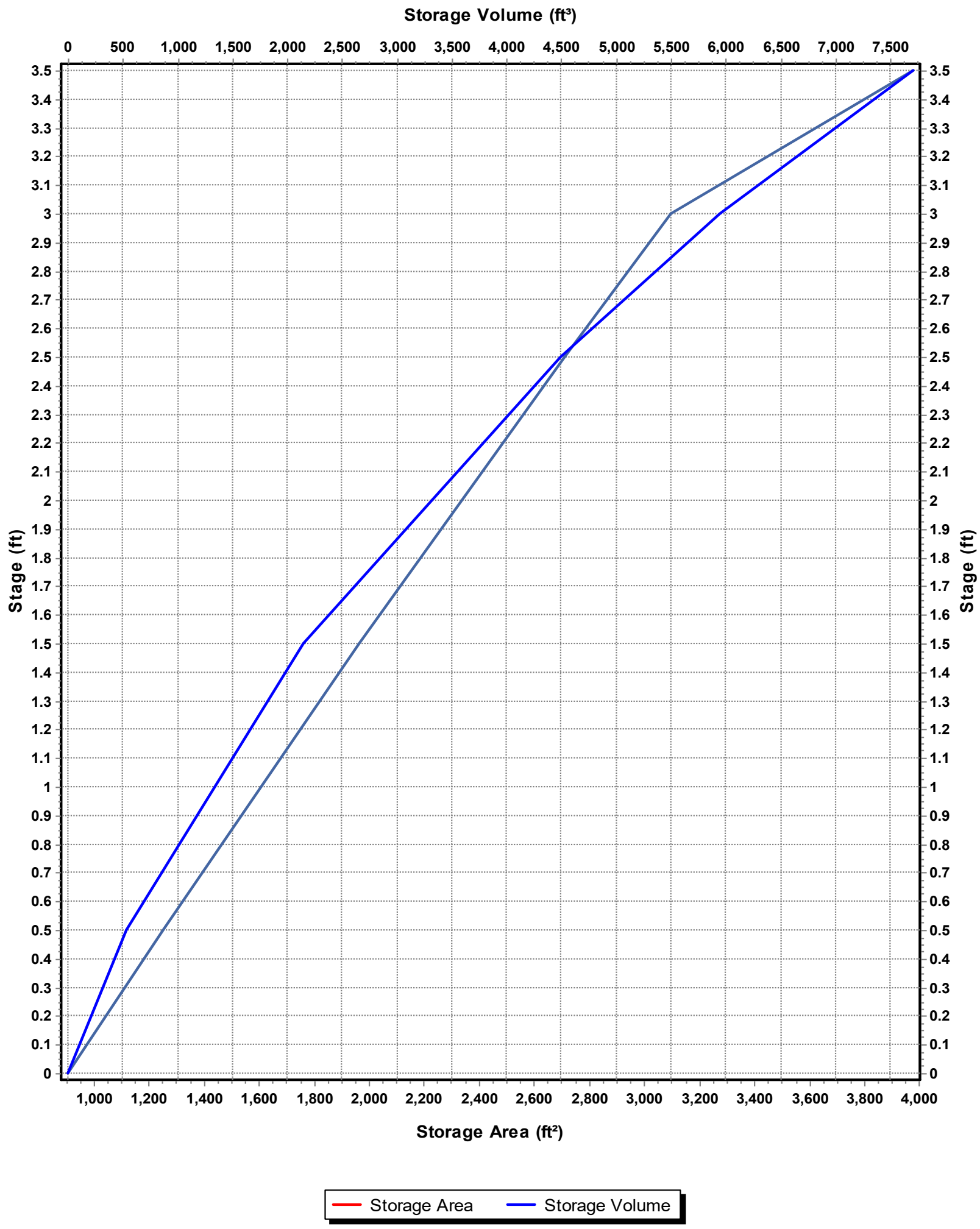
Invert Elevation (ft)	114.00
Max (Rim) Elevation (ft)	117.50
Max (Rim) Offset (ft)	3.50
Initial Water Elevation (ft)	114.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

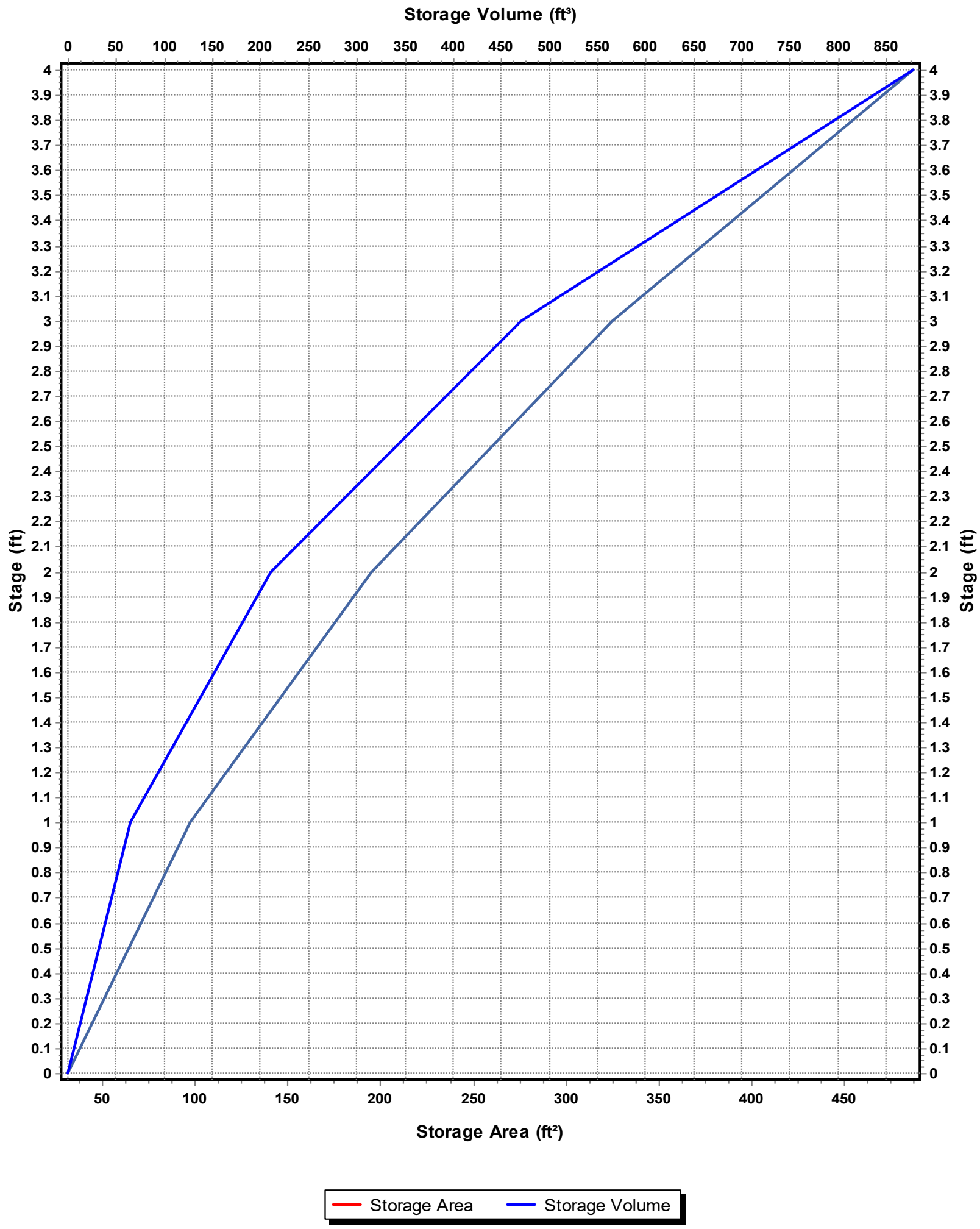
Invert Elevation (ft)	113.50
Max (Rim) Elevation (ft)	117.50
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	113.50
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

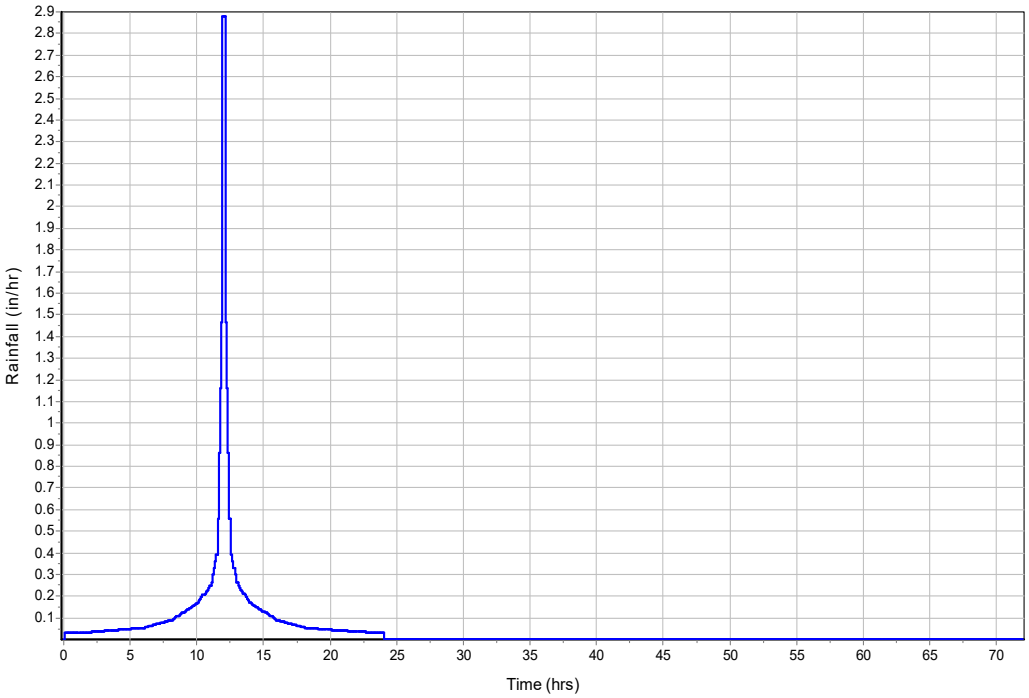
Total TOC (min) 2.39

Subbasin Runoff Results

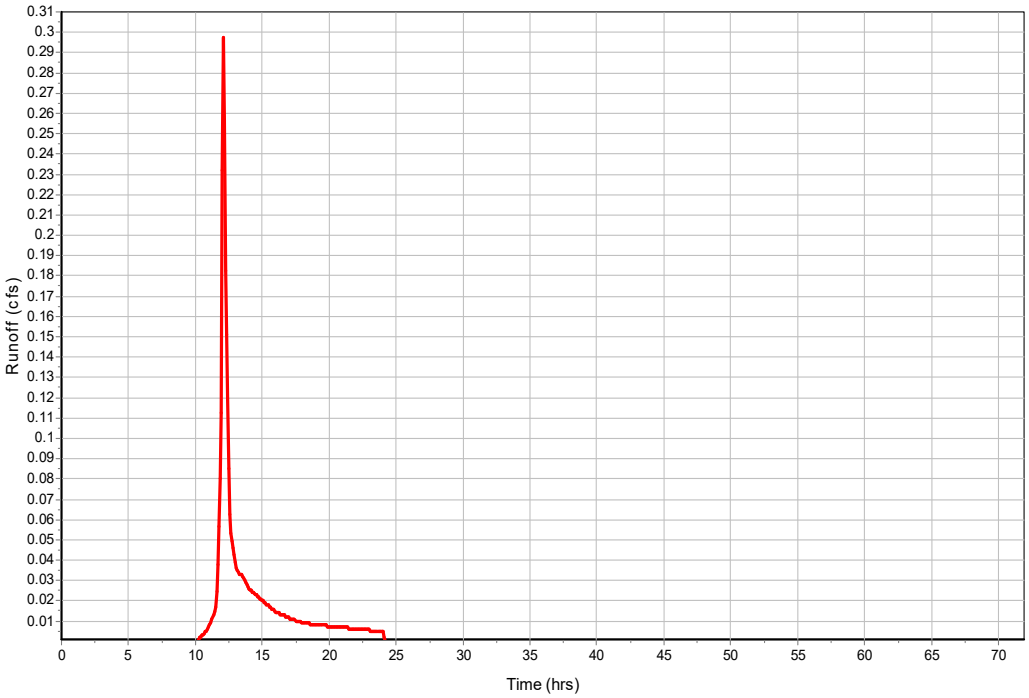
Total Rainfall (in)	3.43
Total Runoff (in)	1.31
Peak Runoff (cfs)	0.31
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:02:23

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

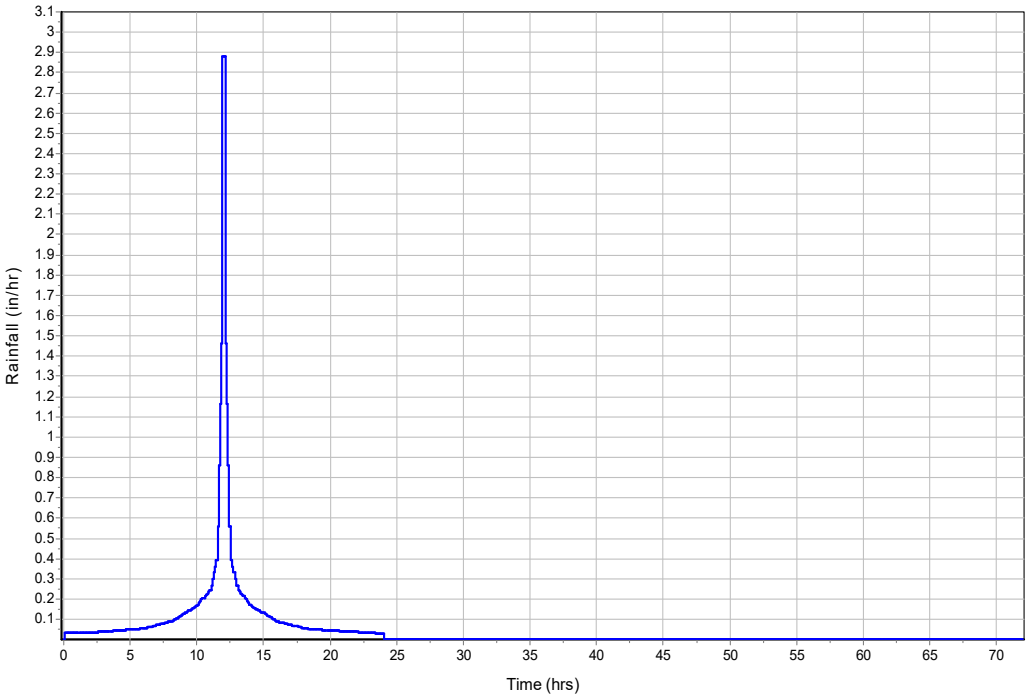
Total TOC (min) 31.55

Subbasin Runoff Results

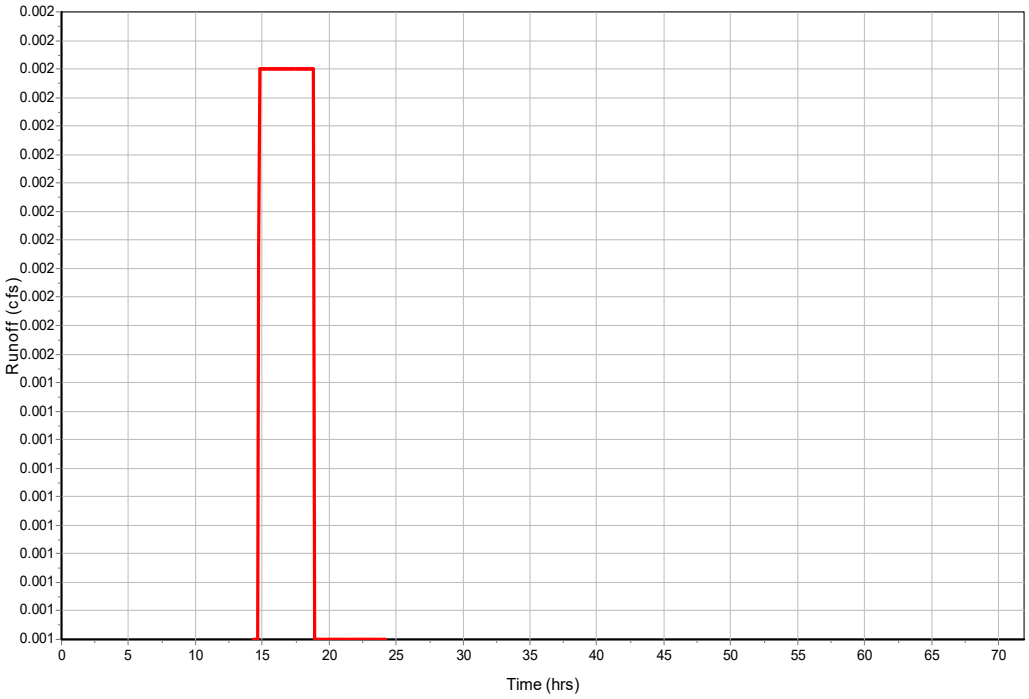
Total Rainfall (in)	3.43
Total Runoff (in)	0.04
Peak Runoff (cfs)	0
Weighted Curve Number	43
Time of Concentration (days hh:mm:ss)	0 00:31:33

Subbasin : Sub-E04

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A4

Input Data

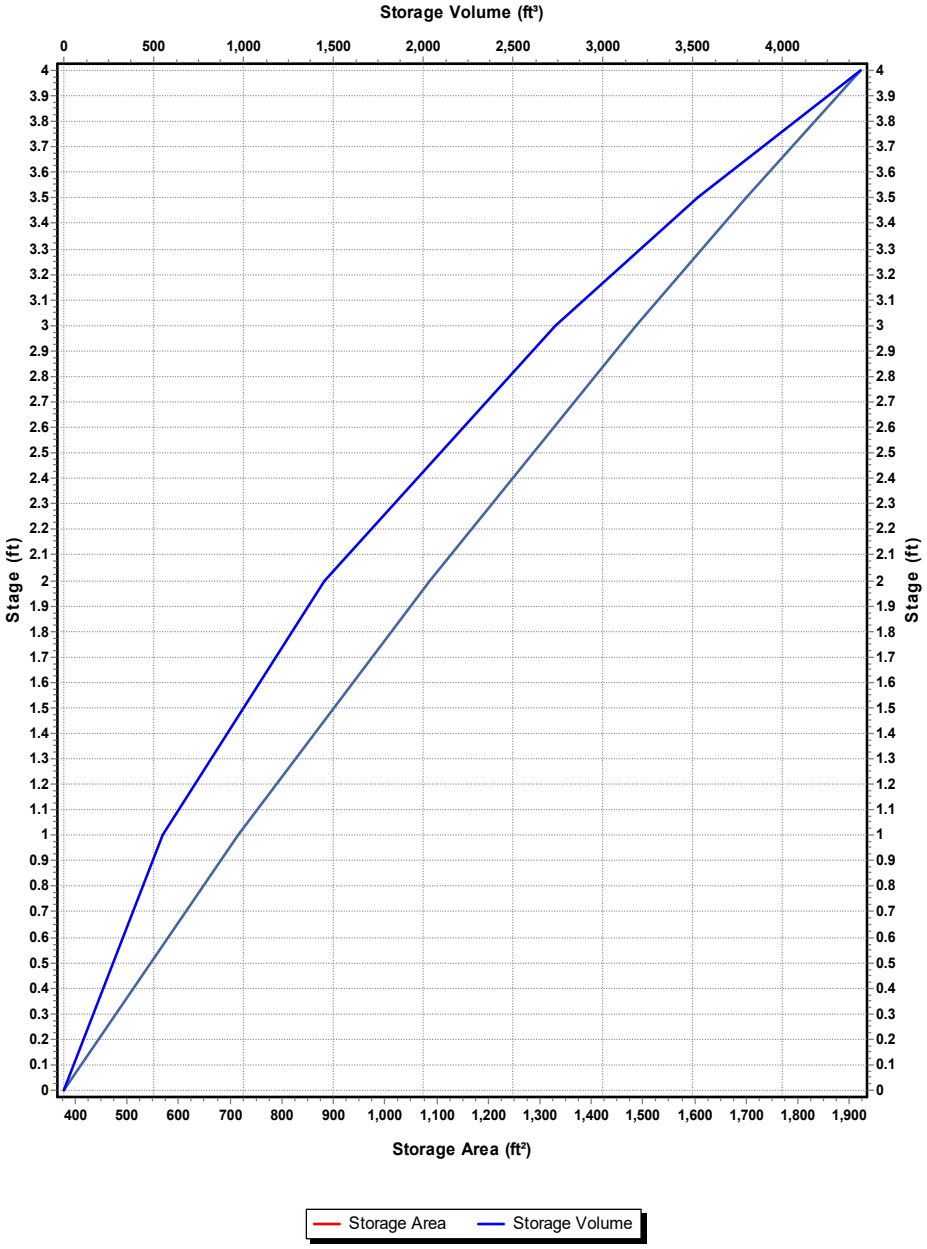
Invert Elevation (ft)	111.00
Max (Rim) Elevation (ft)	115.00
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	111.00
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

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

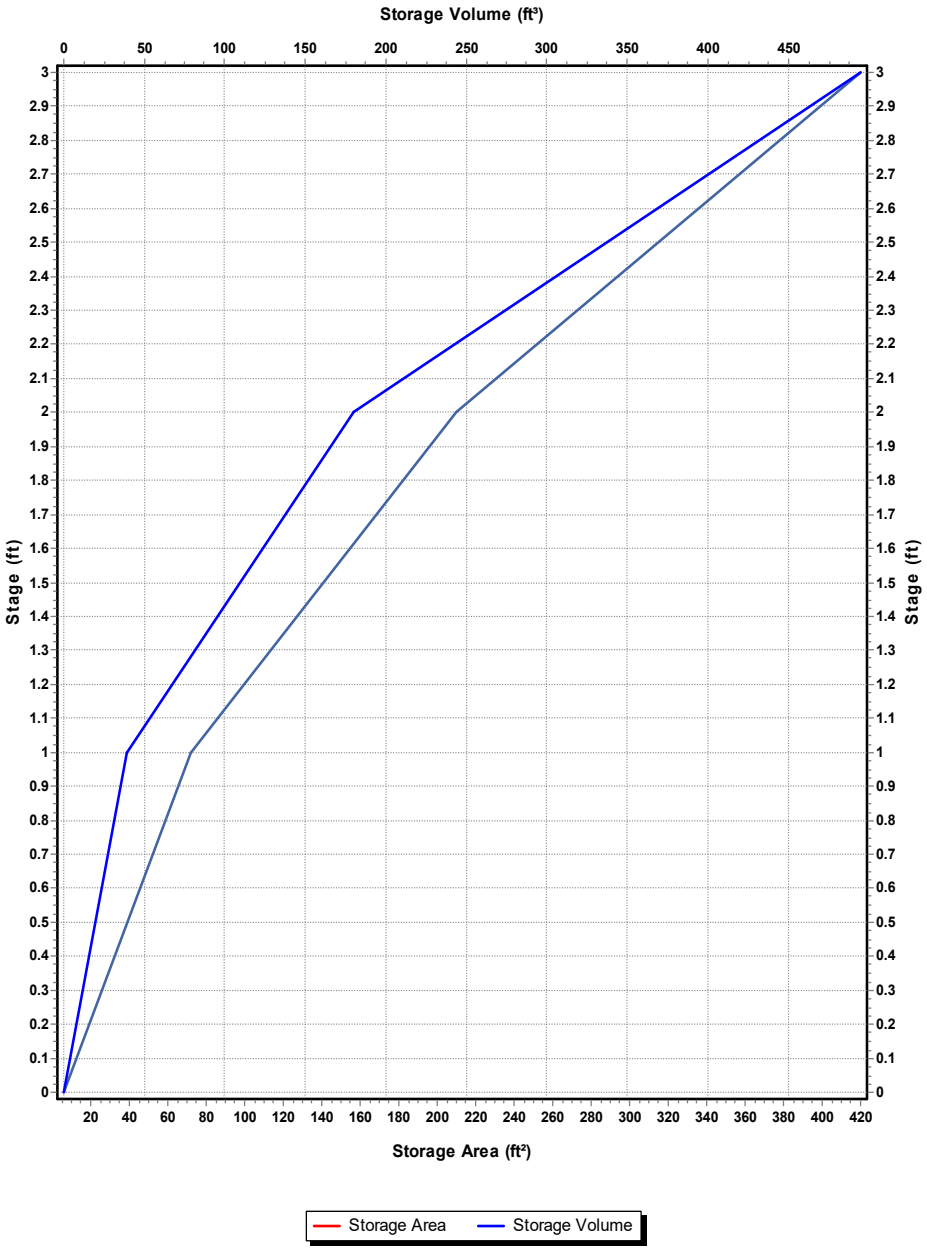
Invert Elevation (ft)	112.00
Max (Rim) Elevation (ft)	115.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	112.00
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

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

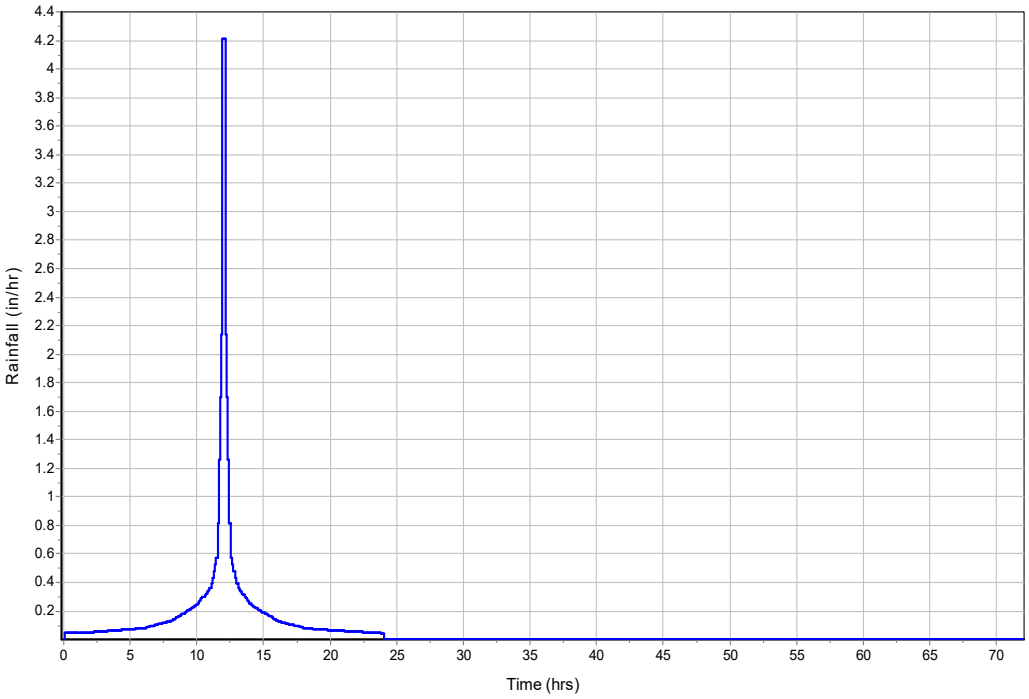
Total TOC (min) 2.39

Subbasin Runoff Results

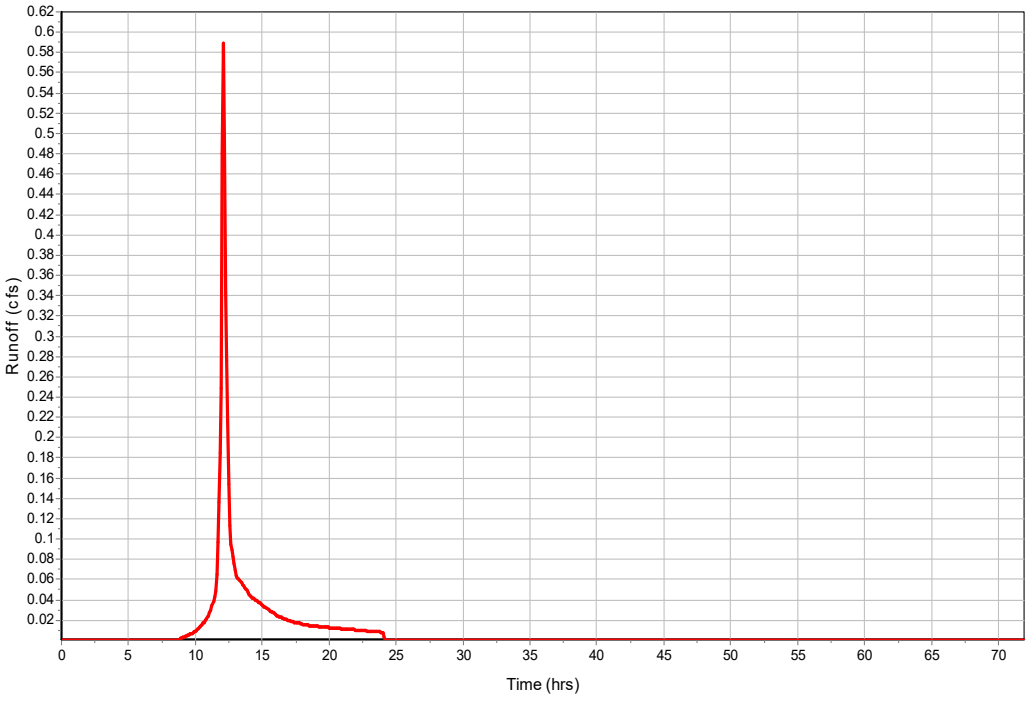
Total Rainfall (in)	5.01
Total Runoff (in)	2.54
Peak Runoff (cfs)	0.61
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:02:23

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

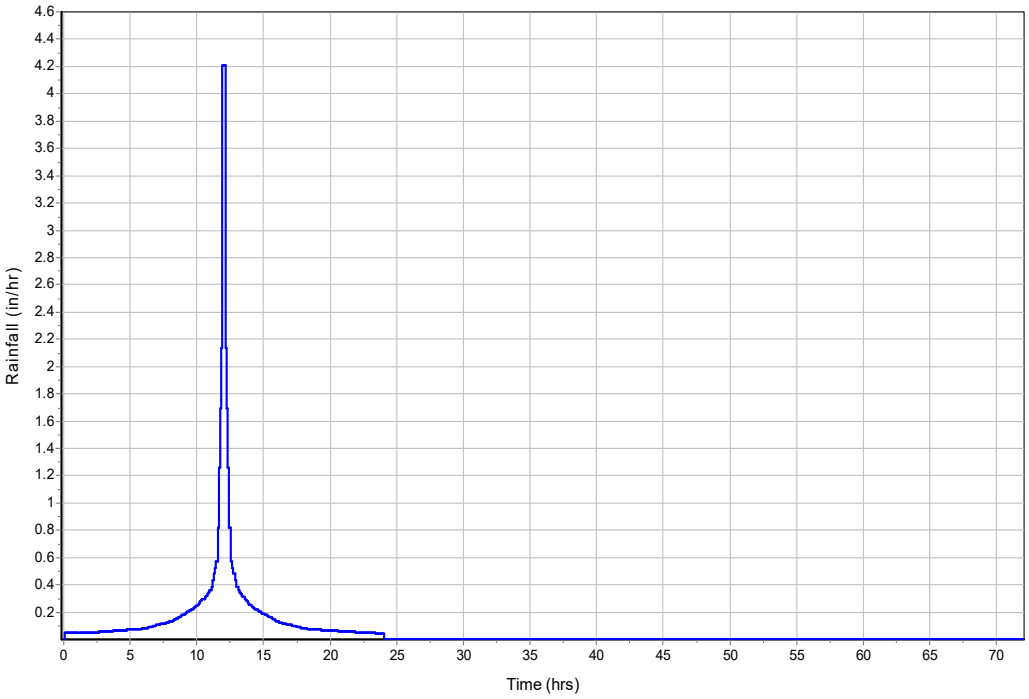
Total TOC (min) 31.55

Subbasin Runoff Results

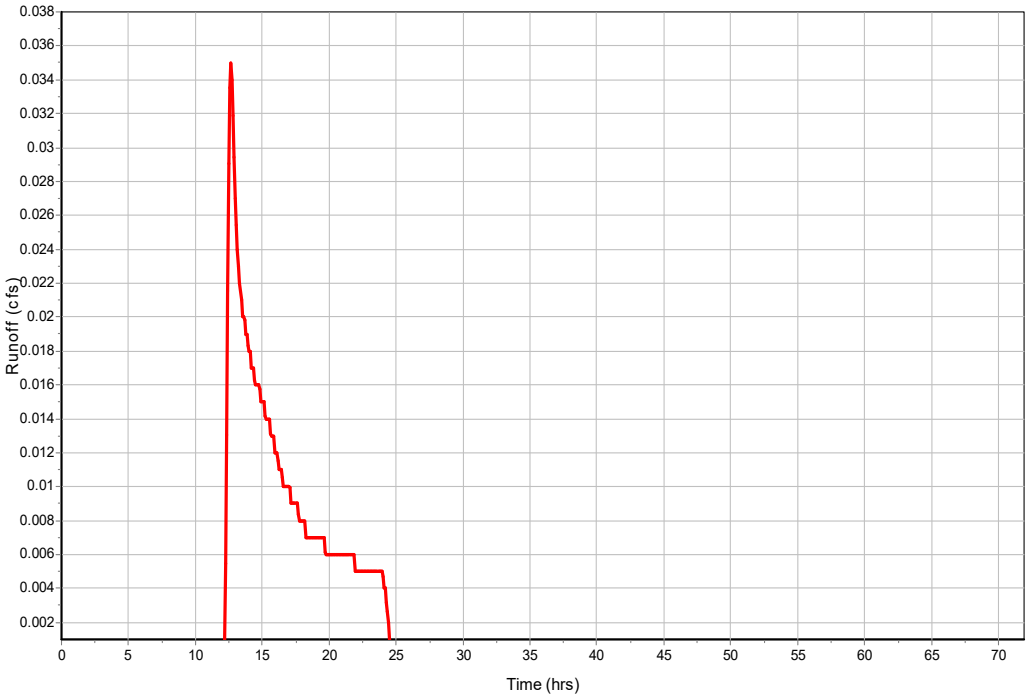
Total Rainfall (in)	5.01
Total Runoff (in)	0.36
Peak Runoff (cfs)	0.04
Weighted Curve Number	43
Time of Concentration (days hh:mm:ss)	0 00:31:33

Subbasin : Sub-E04

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A4

Input Data

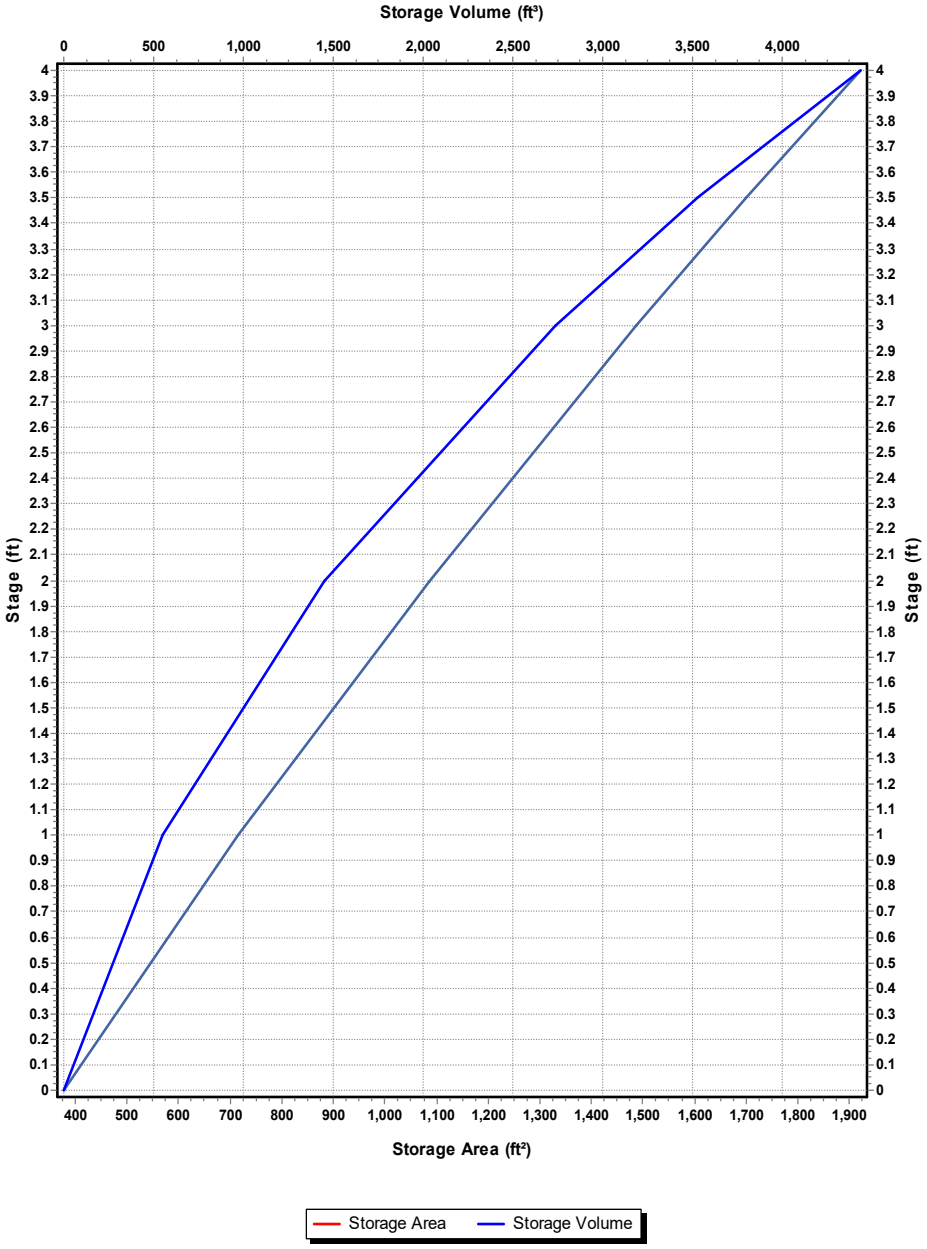
Invert Elevation (ft)	111.00
Max (Rim) Elevation (ft)	115.00
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	111.00
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

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

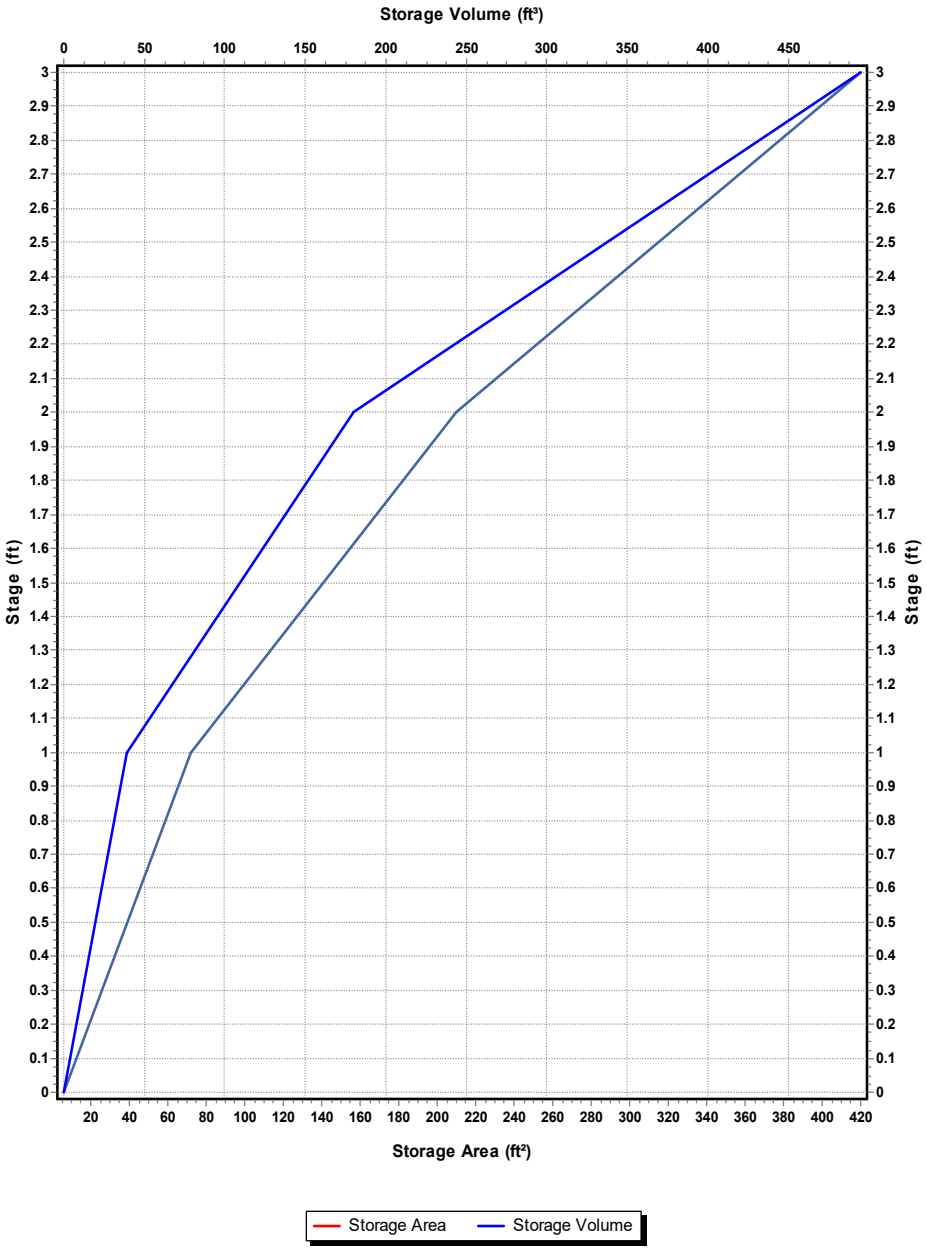
Invert Elevation (ft)	112.00
Max (Rim) Elevation (ft)	115.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	112.00
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

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

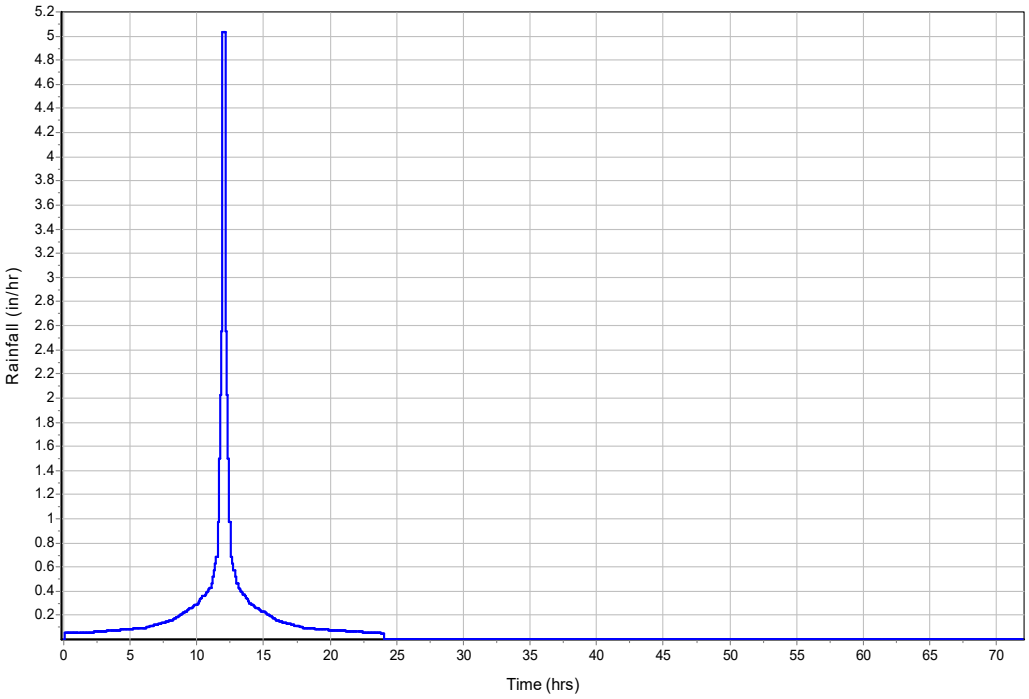
Total TOC (min) 2.39

Subbasin Runoff Results

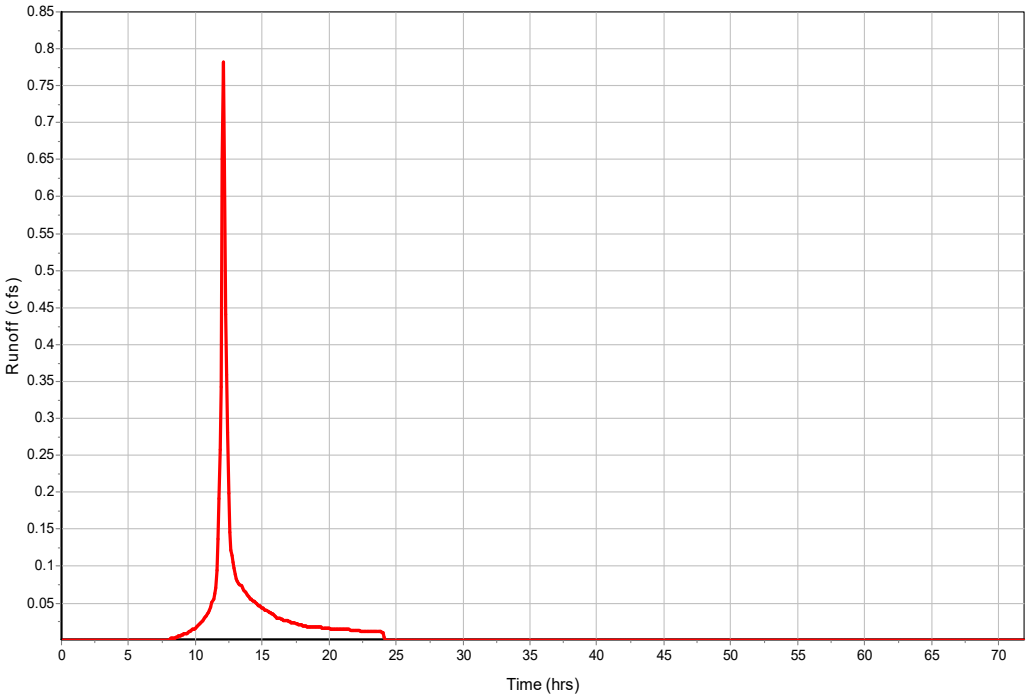
Total Rainfall (in)	5.99
Total Runoff (in)	3.37
Peak Runoff (cfs)	0.8
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:02:23

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

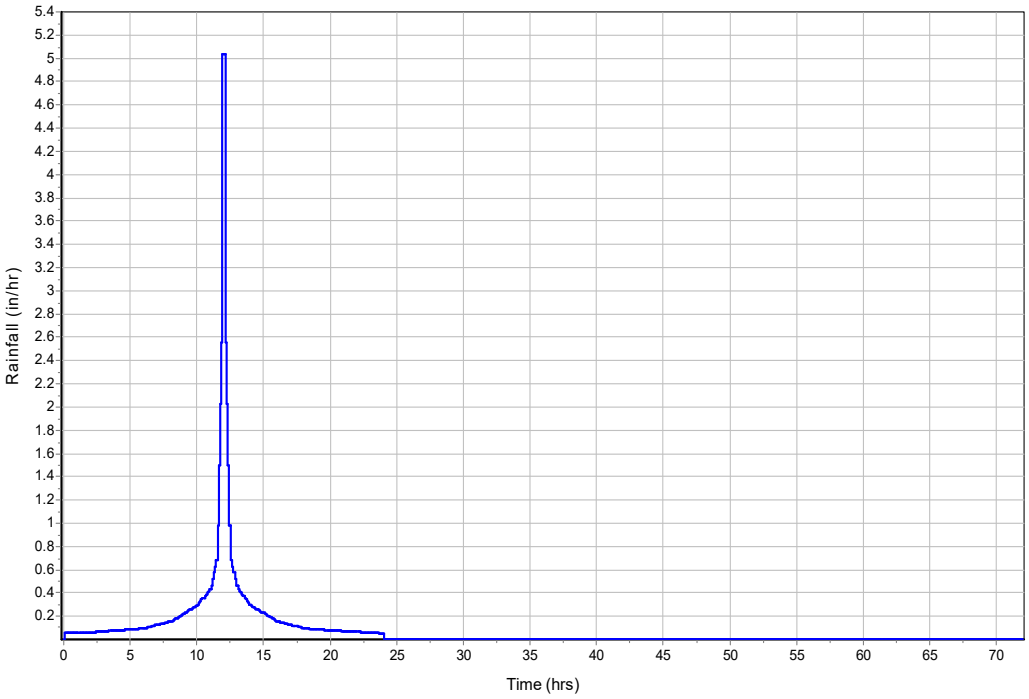
Total TOC (min) 31.55

Subbasin Runoff Results

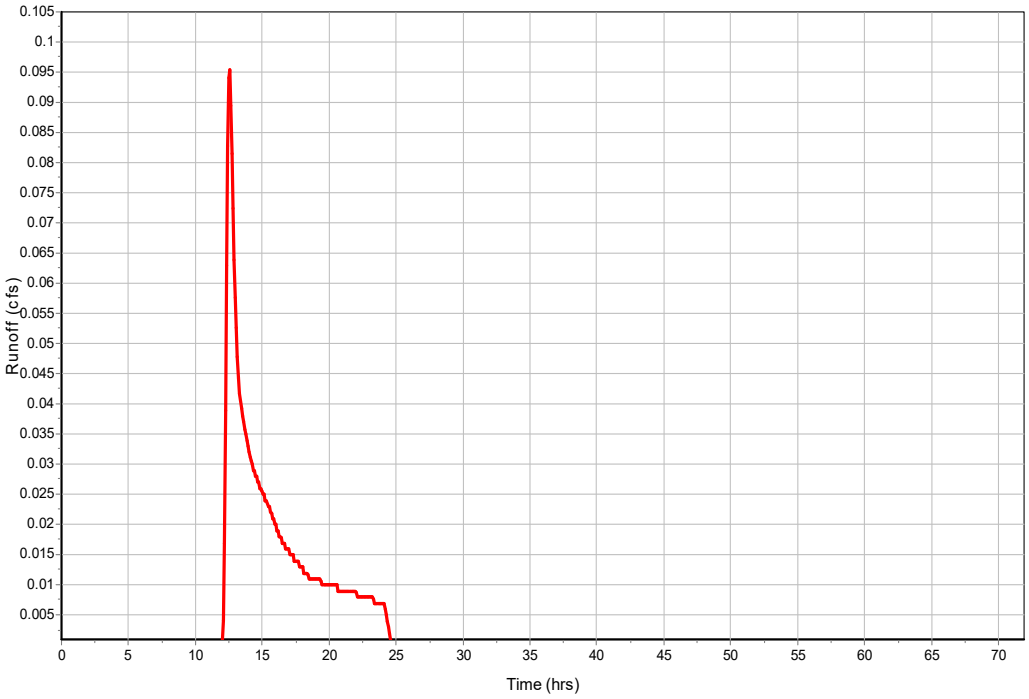
Total Rainfall (in)	5.99
Total Runoff (in)	0.67
Peak Runoff (cfs)	0.1
Weighted Curve Number	43
Time of Concentration (days hh:mm:ss)	0 00:31:33

Subbasin : Sub-E04

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A4

Input Data

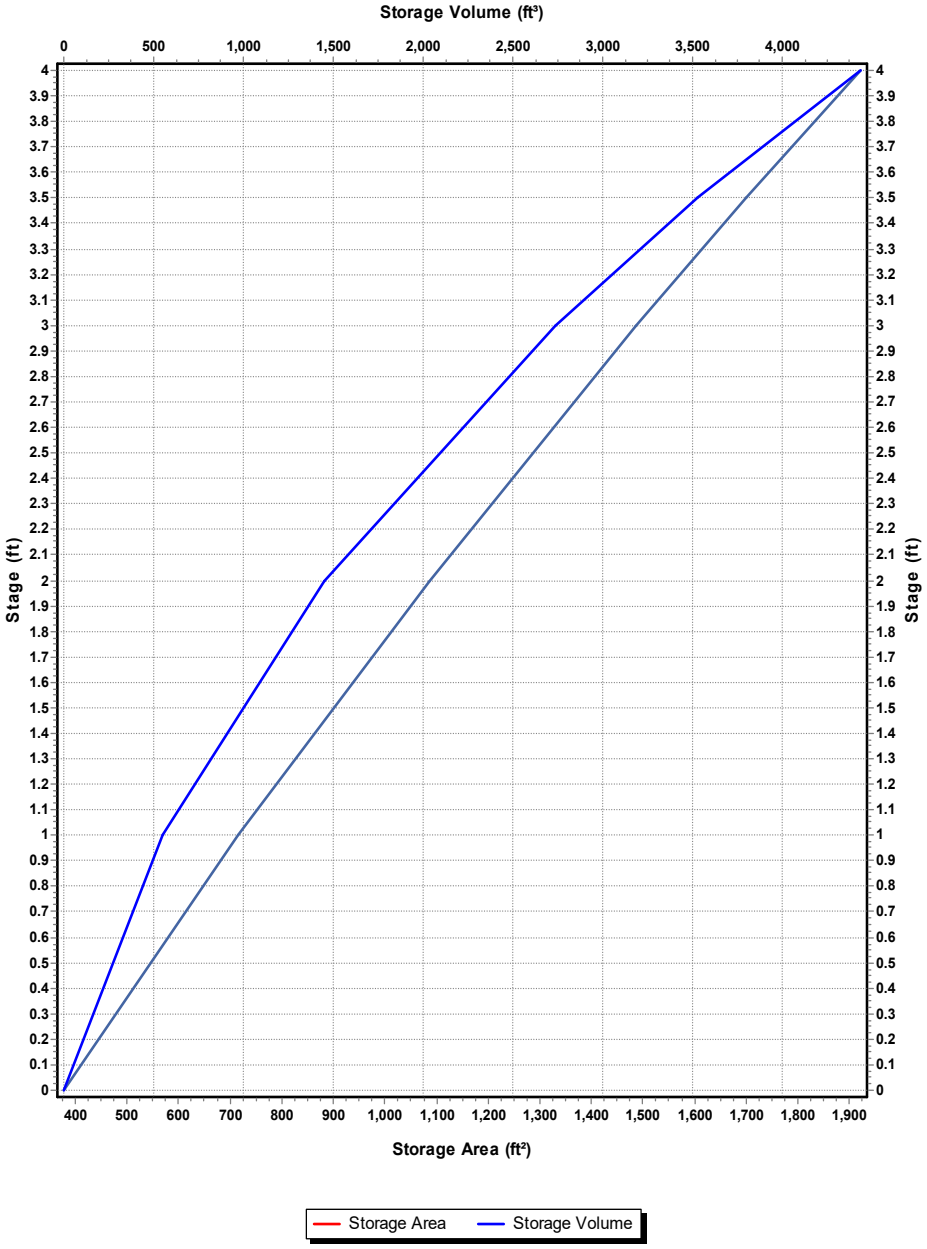
Invert Elevation (ft)	111.00
Max (Rim) Elevation (ft)	115.00
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	111.00
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

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

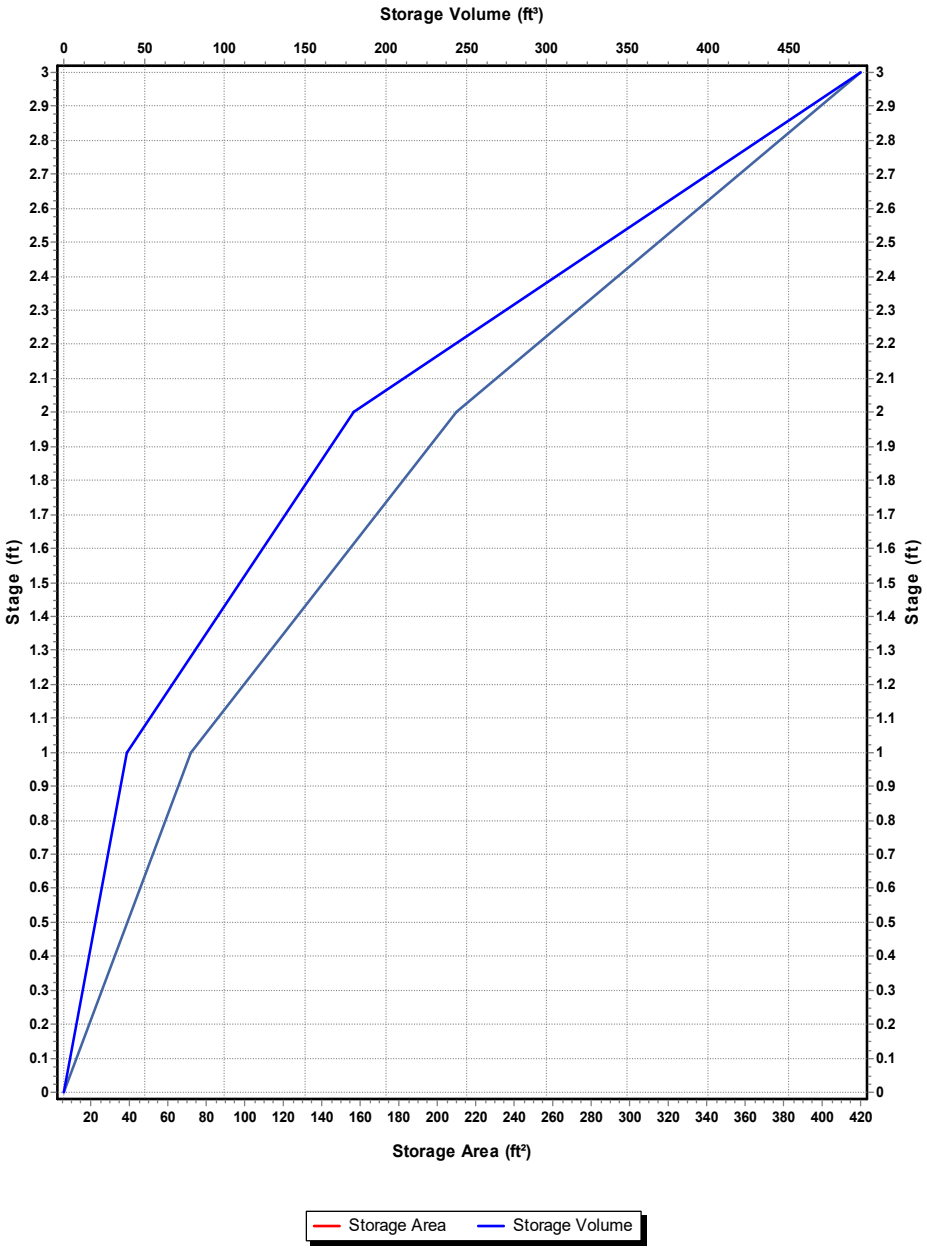
Invert Elevation (ft)	112.00
Max (Rim) Elevation (ft)	115.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	112.00
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

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

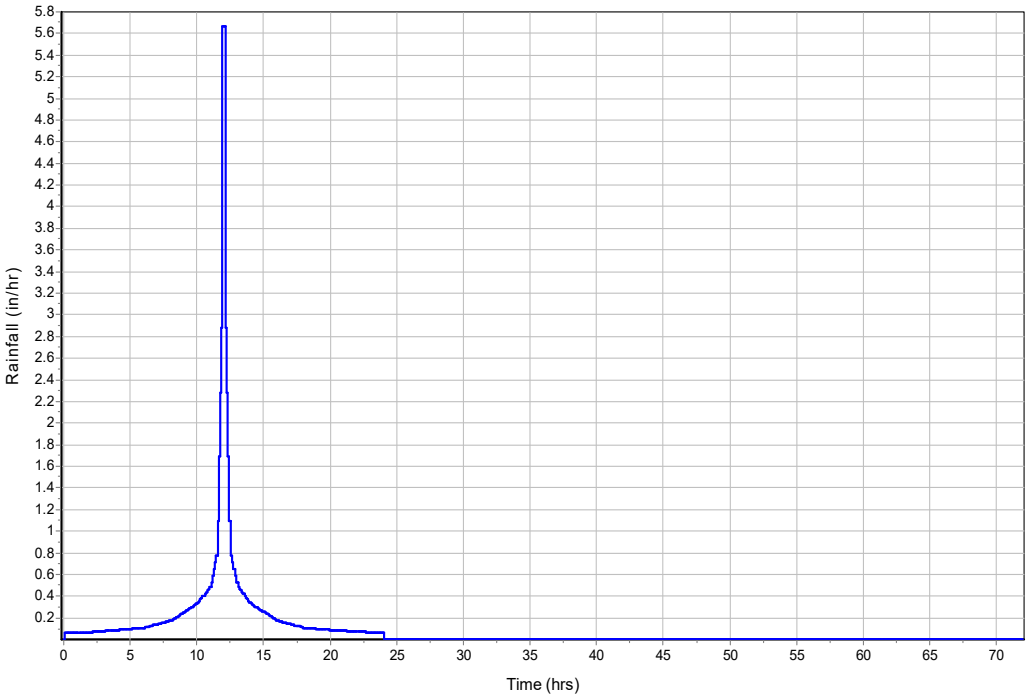
Total TOC (min) 2.39

Subbasin Runoff Results

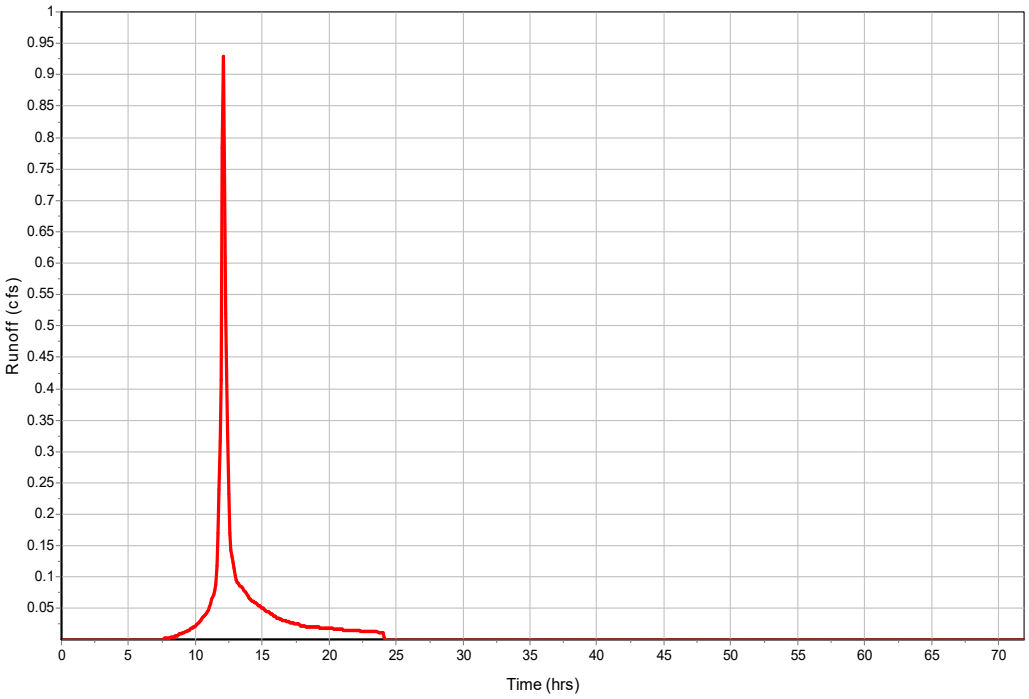
Total Rainfall (in)	6.74
Total Runoff (in)	4.03
Peak Runoff (cfs)	0.95
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:02:23

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

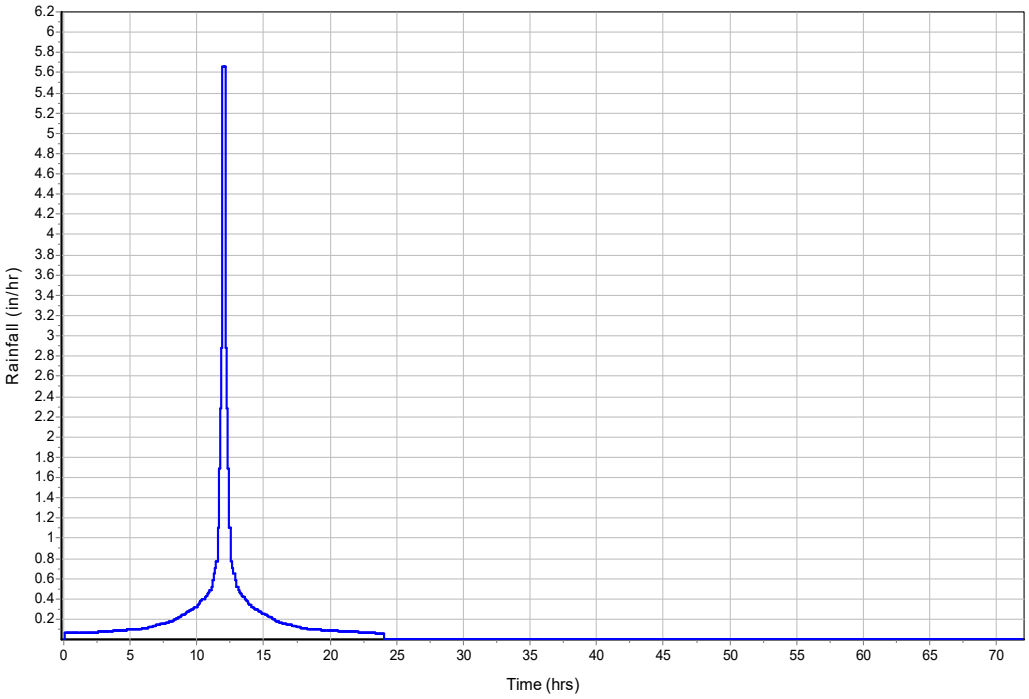
Total TOC (min) 31.55

Subbasin Runoff Results

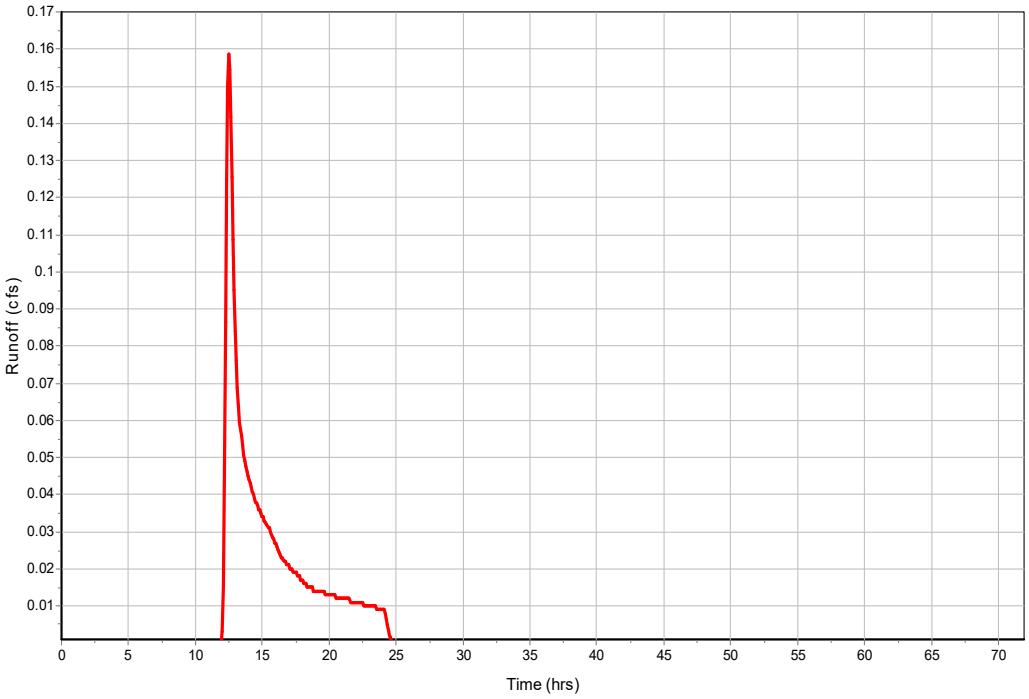
Total Rainfall (in)	6.74
Total Runoff (in)	0.96
Peak Runoff (cfs)	0.16
Weighted Curve Number	43
Time of Concentration (days hh:mm:ss)	0 00:31:33

Subbasin : Sub-E04

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A4

Input Data

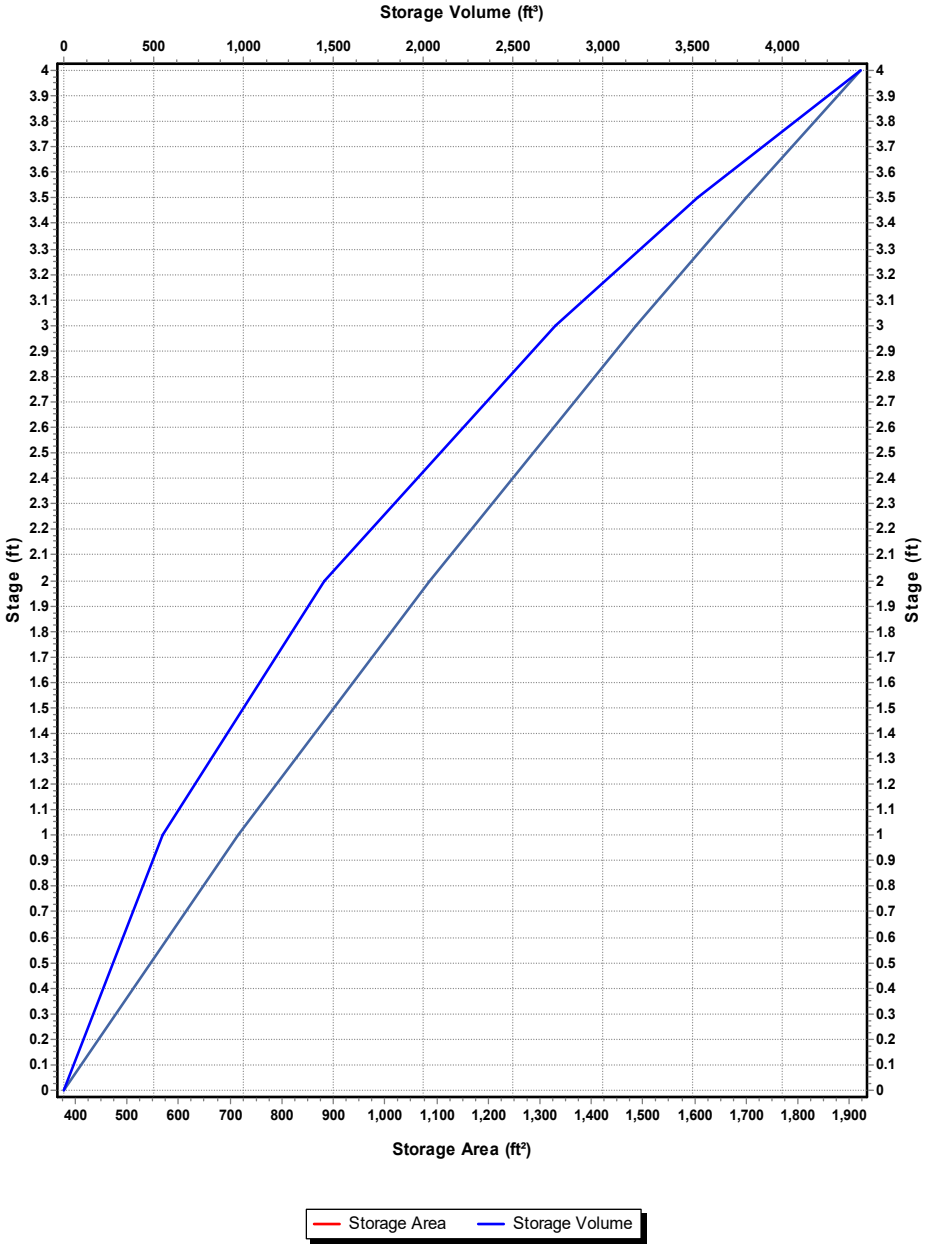
Invert Elevation (ft)	111.00
Max (Rim) Elevation (ft)	115.00
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	111.00
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

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

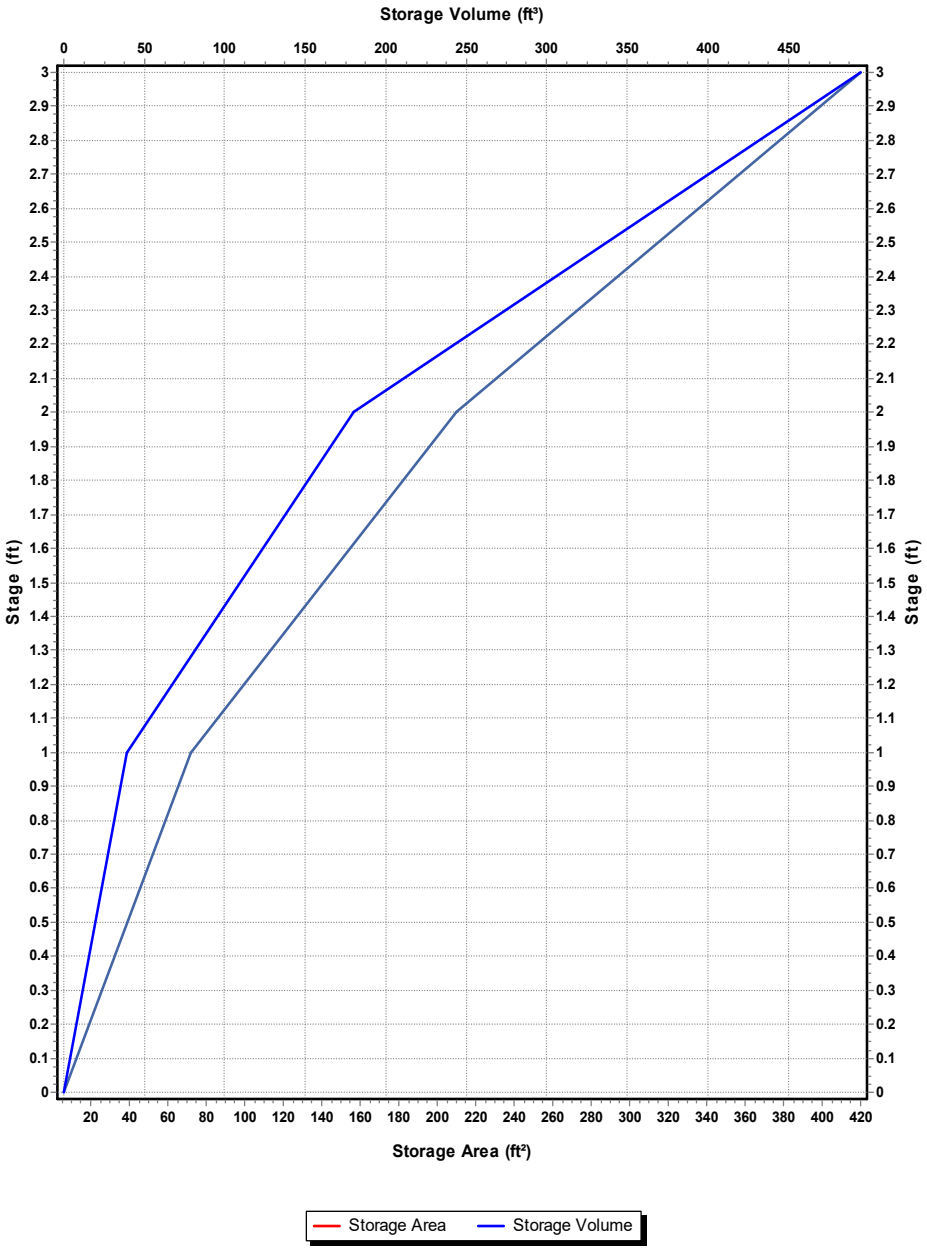
Invert Elevation (ft)	112.00
Max (Rim) Elevation (ft)	115.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	112.00
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

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

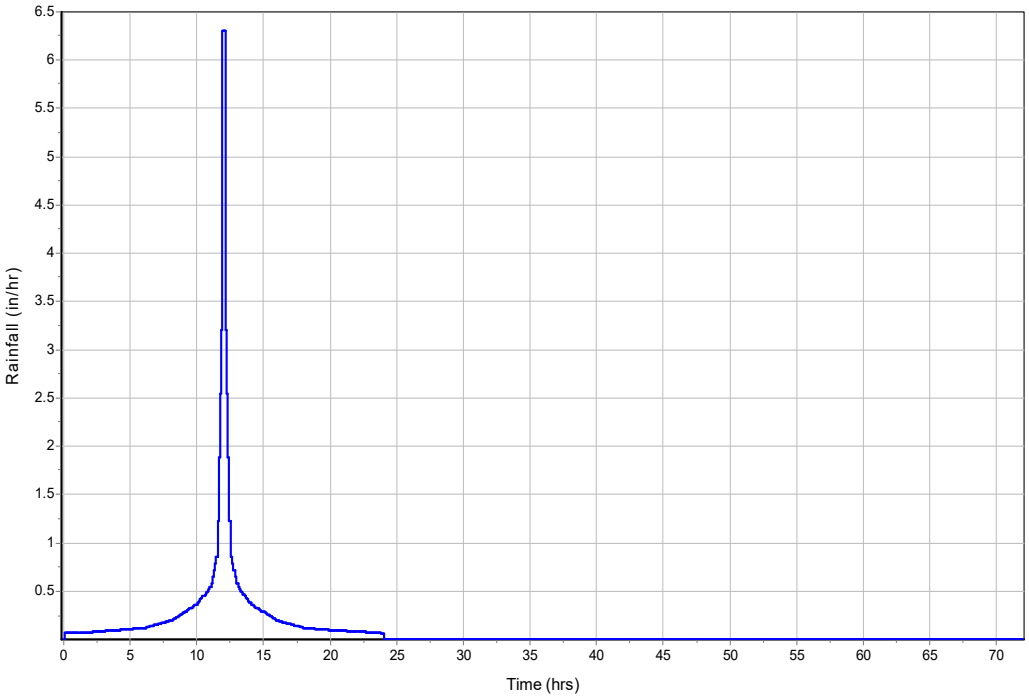
Total TOC (min) 2.39

Subbasin Runoff Results

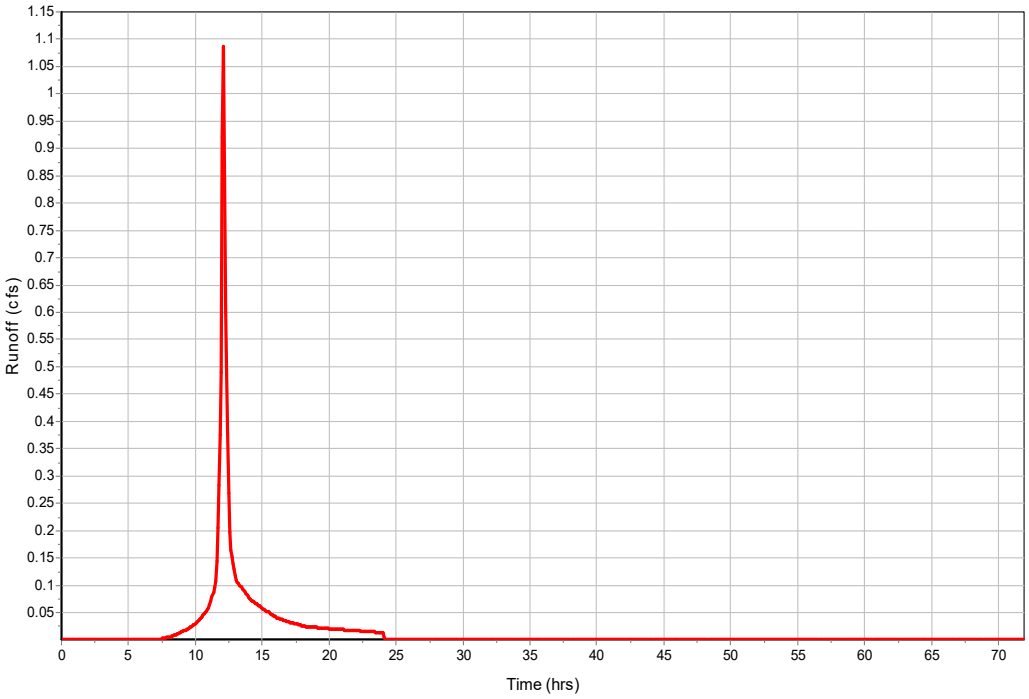
Total Rainfall (in)	7.51
Total Runoff (in)	4.71
Peak Runoff (cfs)	1.11
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:02:23

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

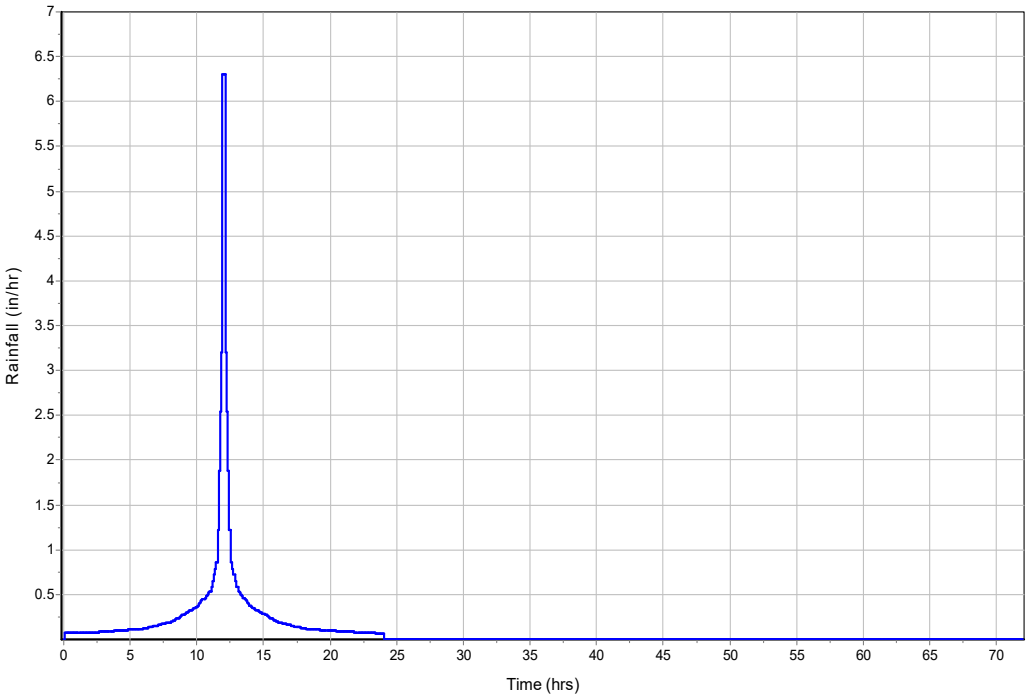
Total TOC (min) 31.55

Subbasin Runoff Results

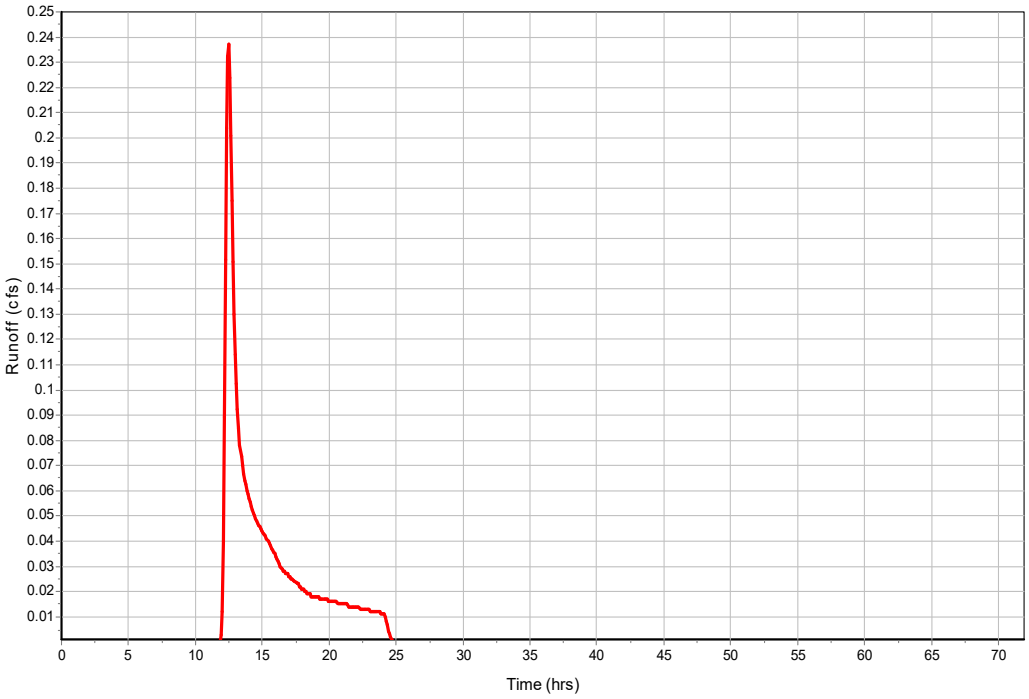
Total Rainfall (in)	7.51
Total Runoff (in)	1.3
Peak Runoff (cfs)	0.24
Weighted Curve Number	43
Time of Concentration (days hh:mm:ss)	0 00:31:33

Subbasin : Sub-E04

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A4

Input Data

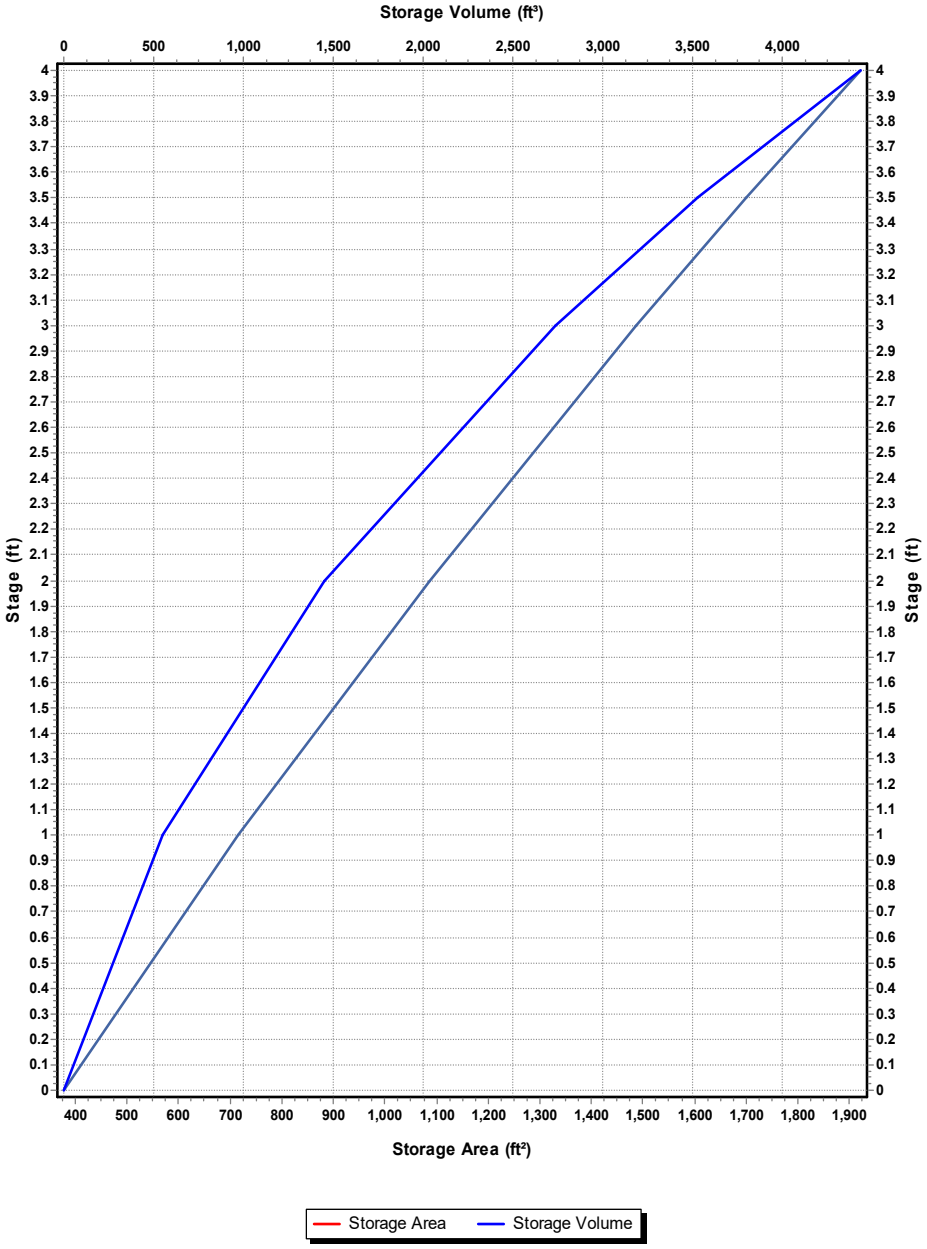
Invert Elevation (ft)	111.00
Max (Rim) Elevation (ft)	115.00
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	111.00
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

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

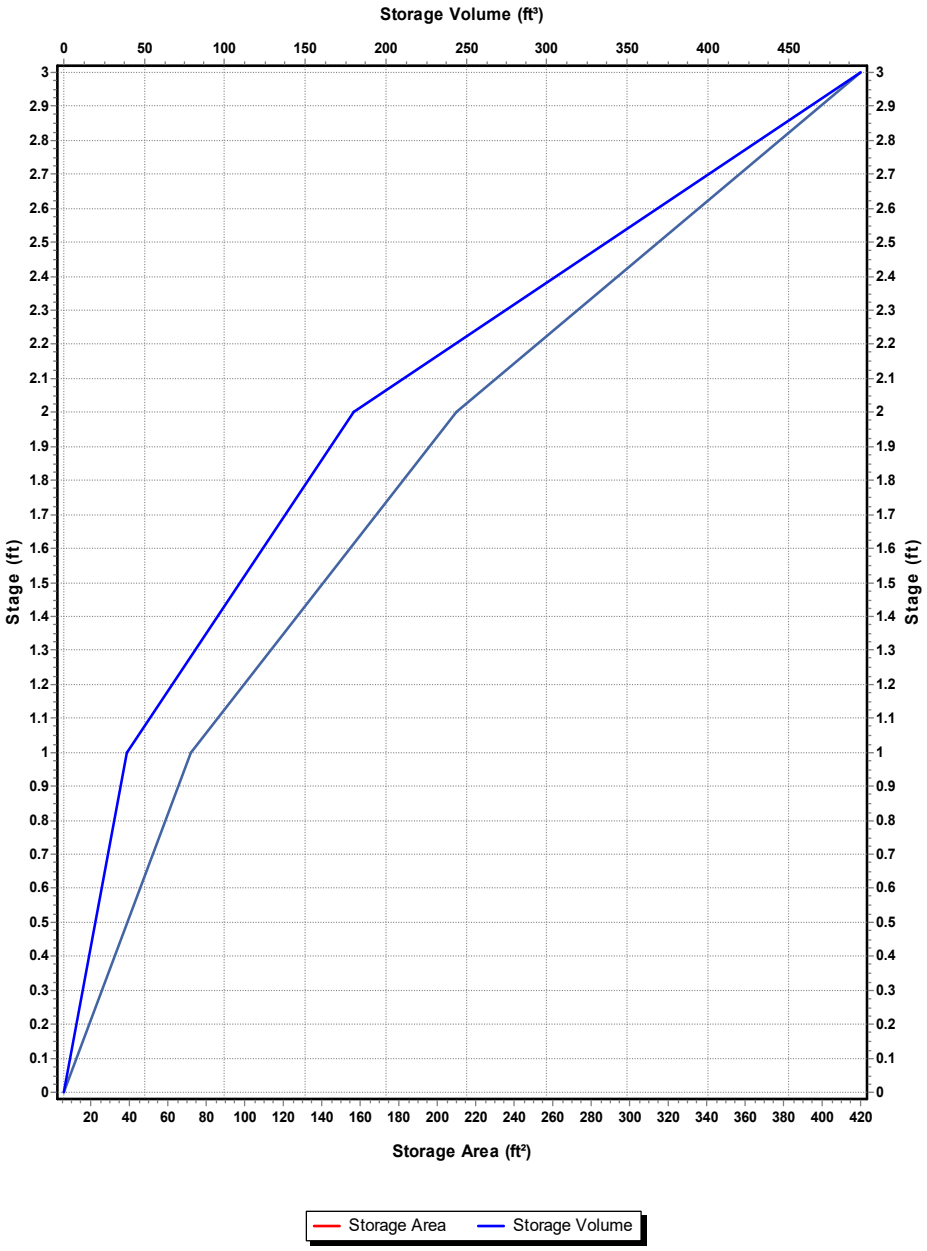
Invert Elevation (ft)	112.00
Max (Rim) Elevation (ft)	115.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	112.00
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

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

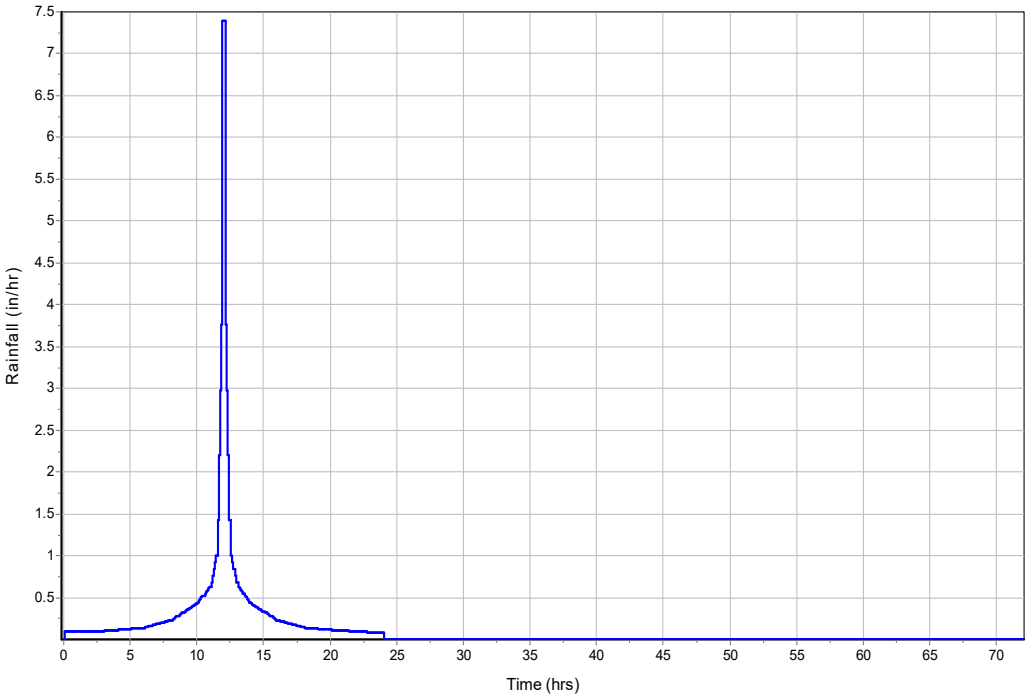
Total TOC (min) 2.39

Subbasin Runoff Results

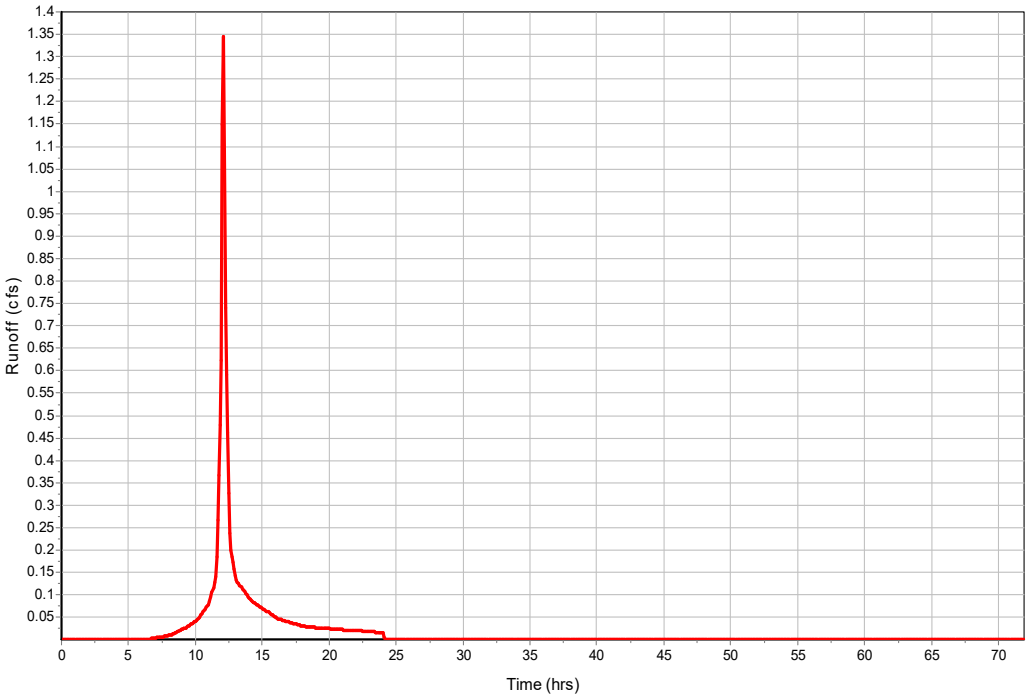
Total Rainfall (in)	8.8
Total Runoff (in)	5.89
Peak Runoff (cfs)	1.37
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:02:23

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

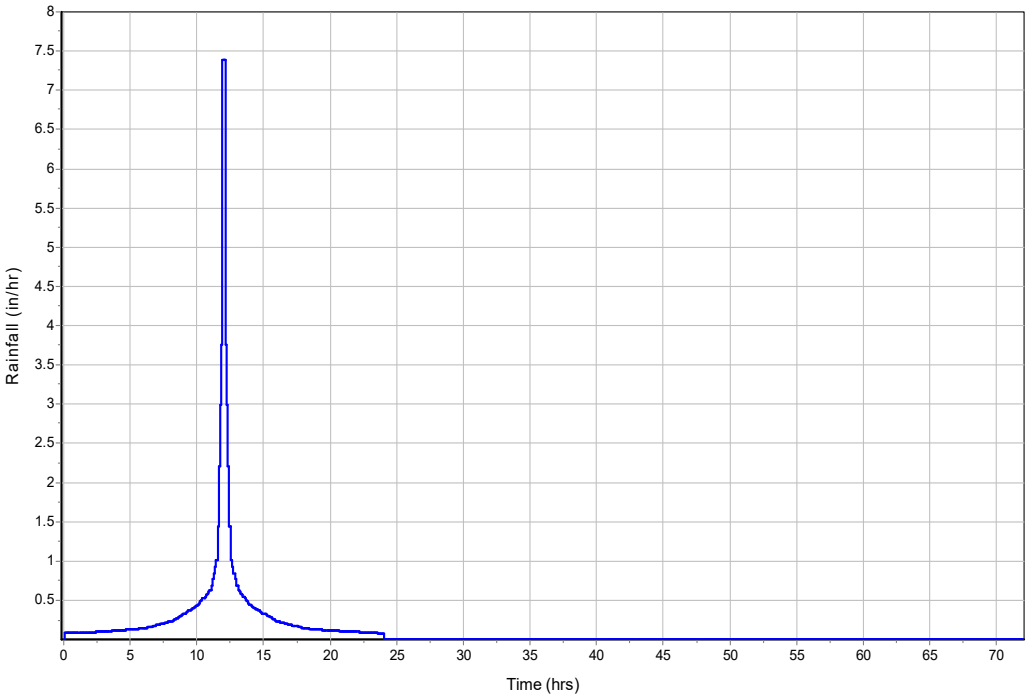
Total TOC (min) 31.55

Subbasin Runoff Results

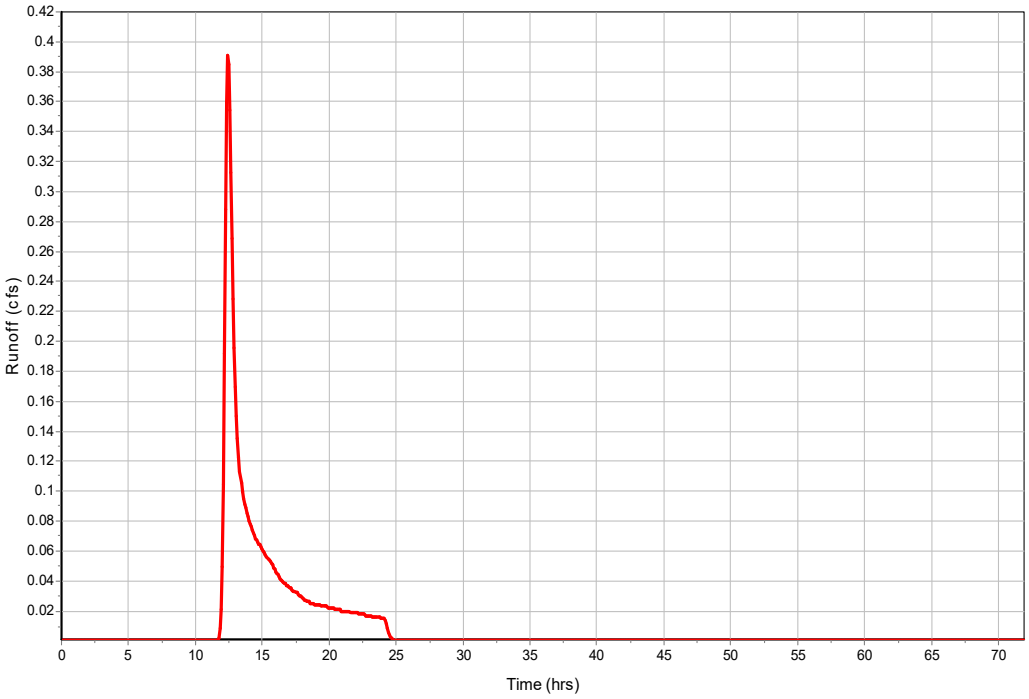
Total Rainfall (in)	8.8
Total Runoff (in)	1.95
Peak Runoff (cfs)	0.39
Weighted Curve Number	43
Time of Concentration (days hh:mm:ss)	0 00:31:33

Subbasin : Sub-E04

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A4

Input Data

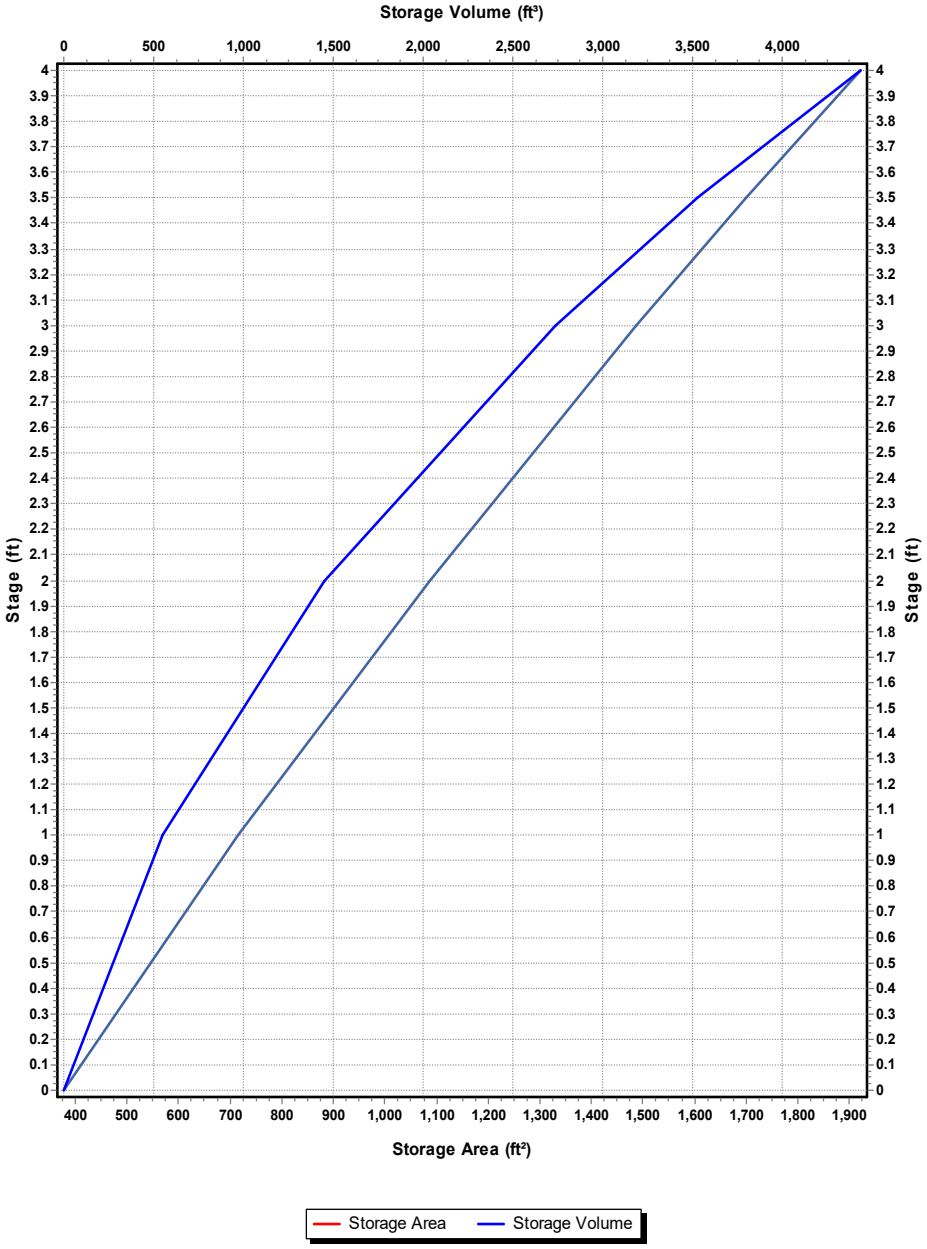
Invert Elevation (ft)	111.00
Max (Rim) Elevation (ft)	115.00
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	111.00
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

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

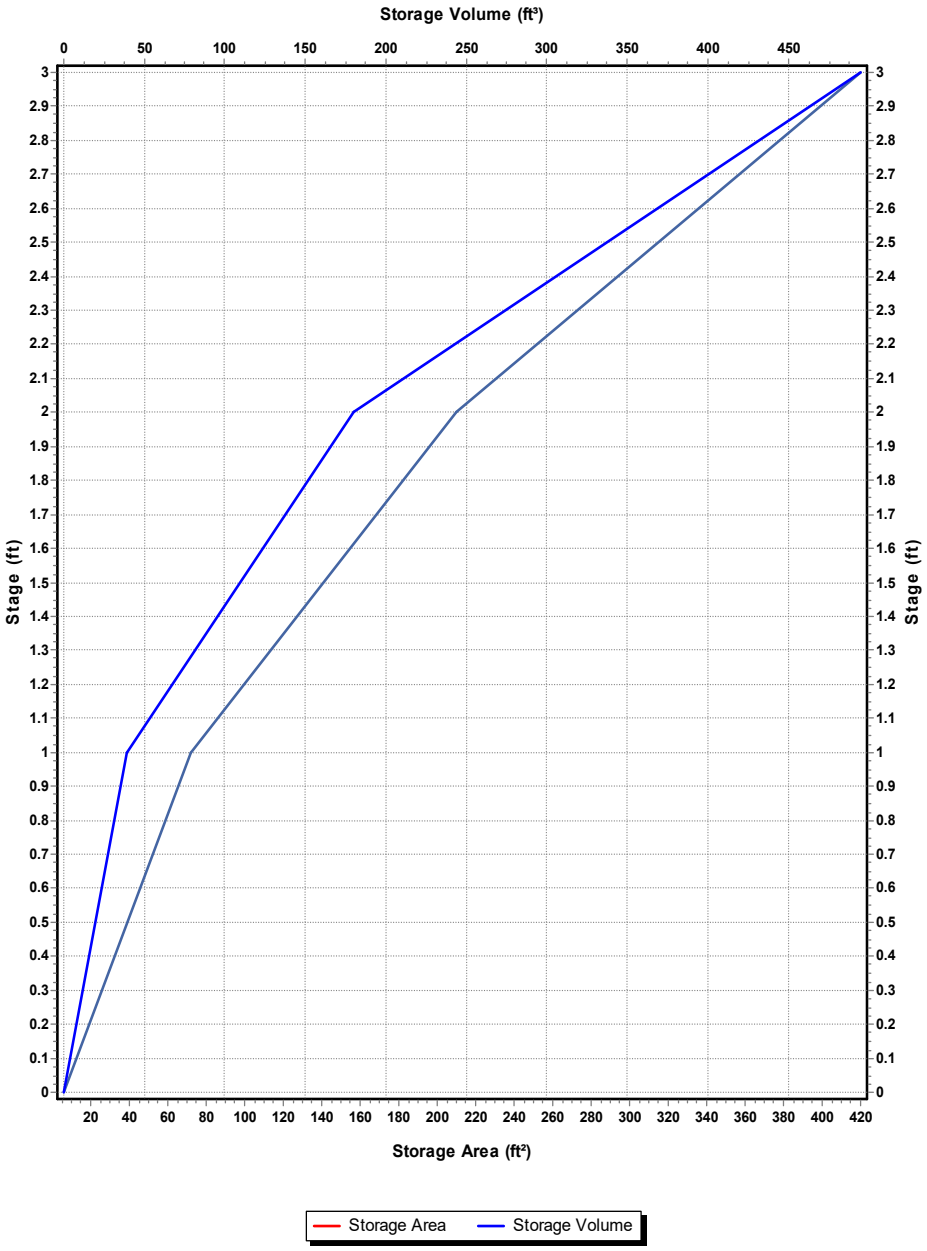
Invert Elevation (ft)	112.00
Max (Rim) Elevation (ft)	115.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	112.00
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

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

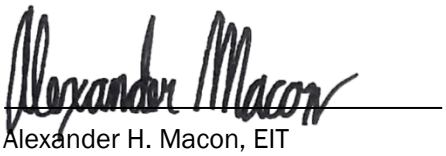
Prepared for:

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.

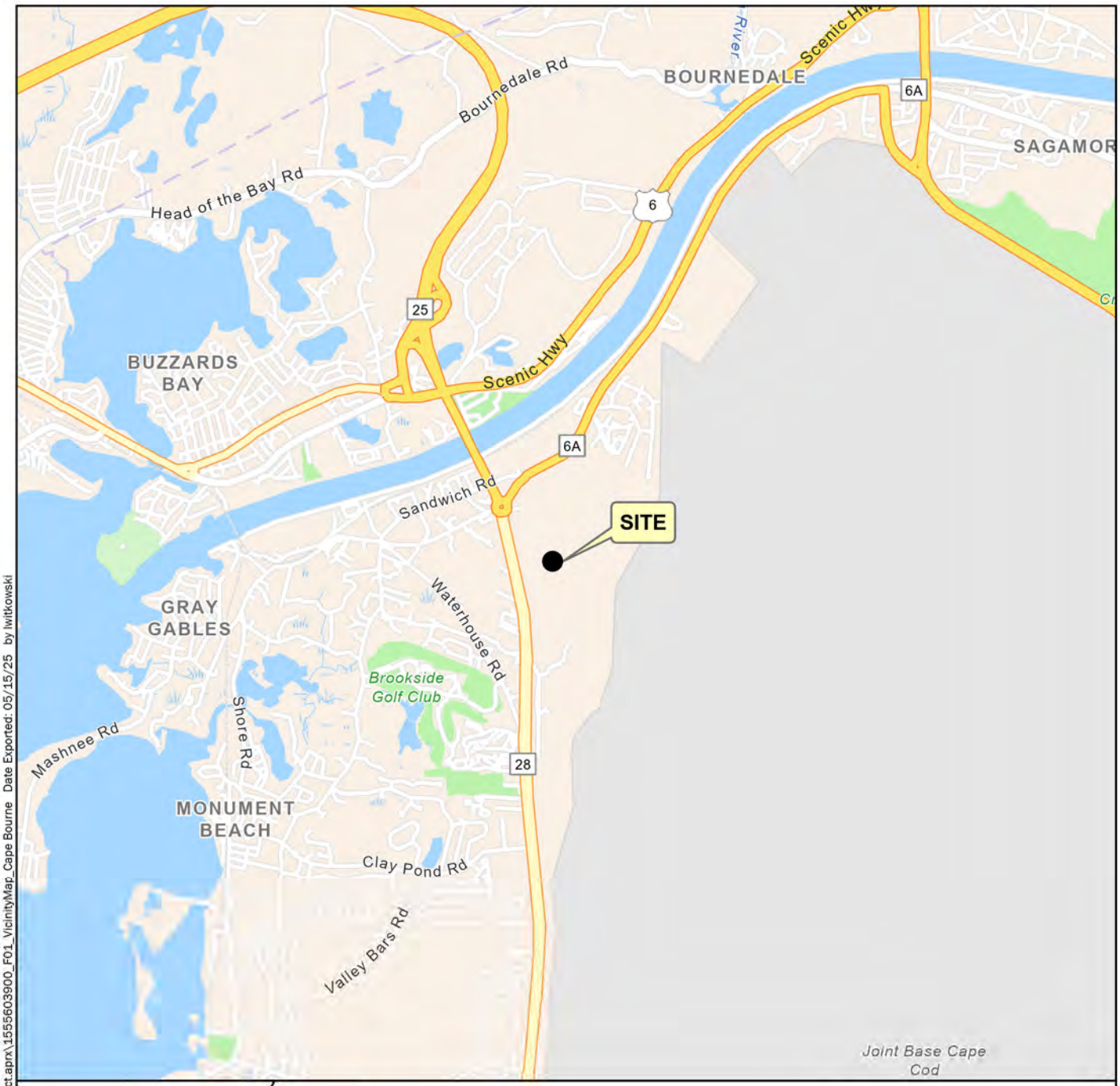
International Code Council, 2021, “International Building Code.”

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

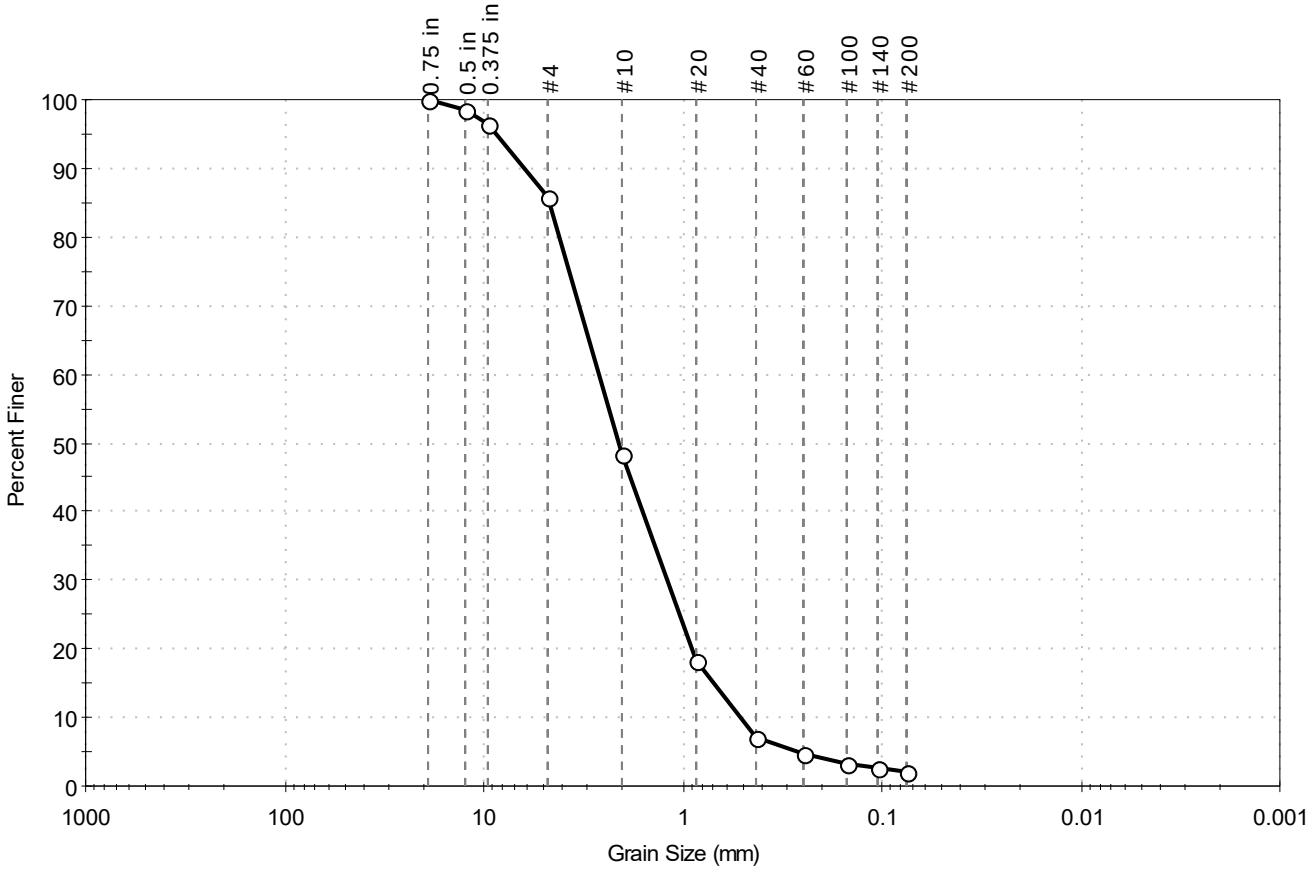
Client:	GeoEngineers, Inc.				
Project:	Cape Cod - En bridge				
Location:	MA			Project No:	GTX-320749
Boring ID:	MR-08	Sample Type:	Jar	Tested By:	ajl
Sample ID:	S-3	Test Date:	03/27/25	Checked By:	ank
Depth :	4-6	Test Id:	808069		
Test Comment:	---				
Visual Description:	Moist, brown sand				
Sample 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))

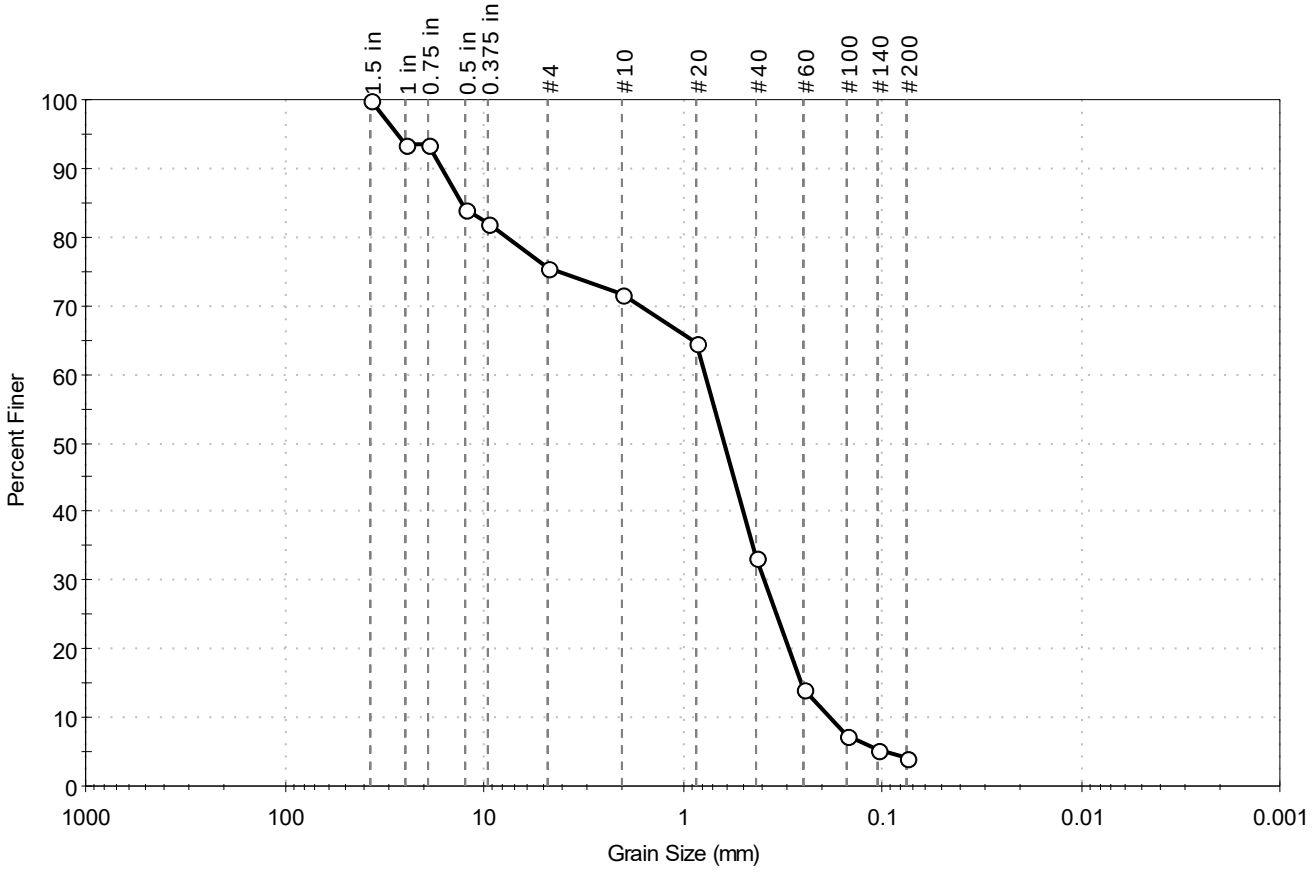
Sample / Test Description

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))

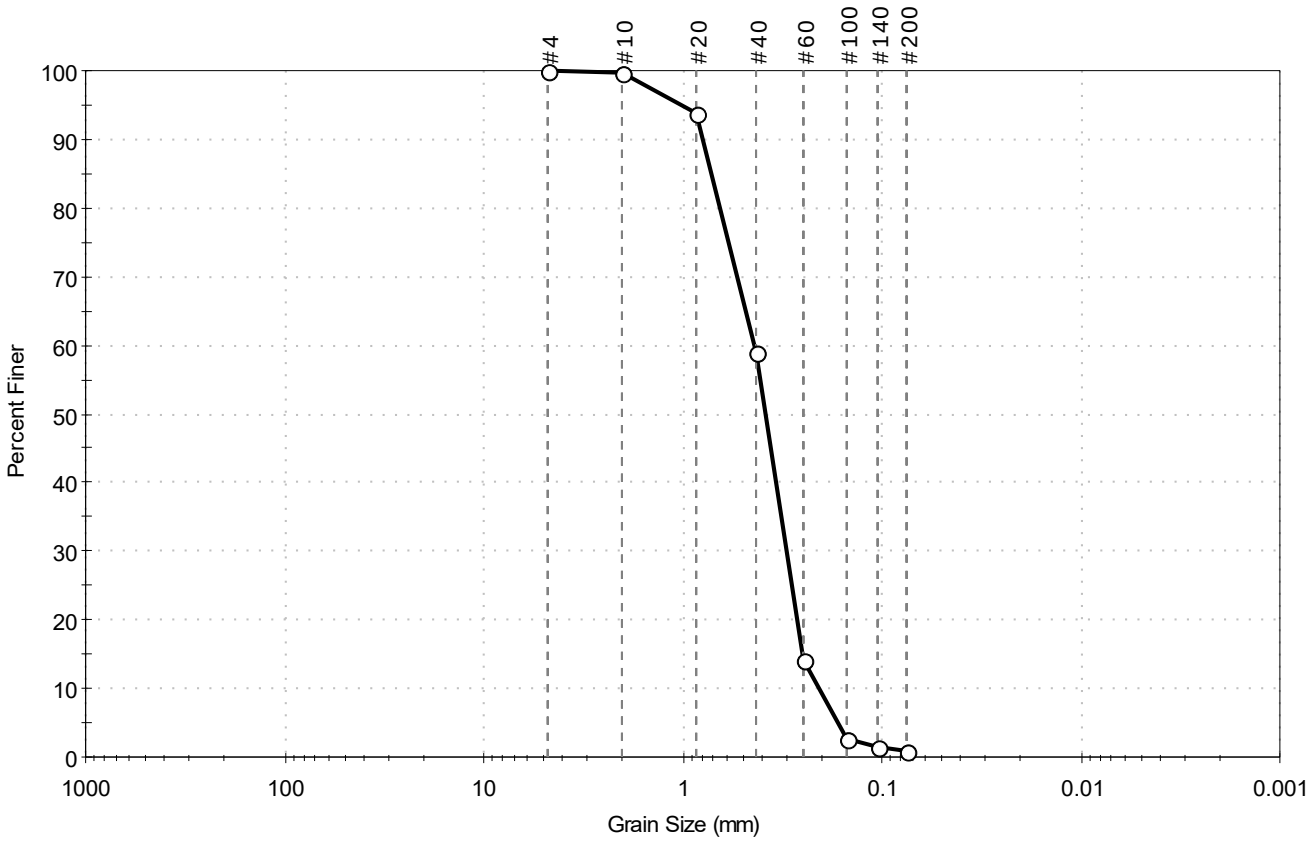
Sample / Test Description

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		

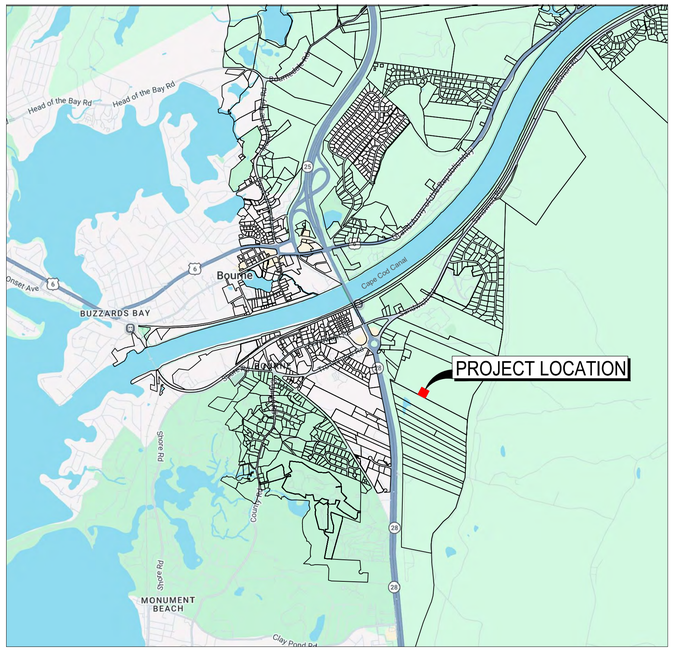
Stormwater Control Manager _____

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

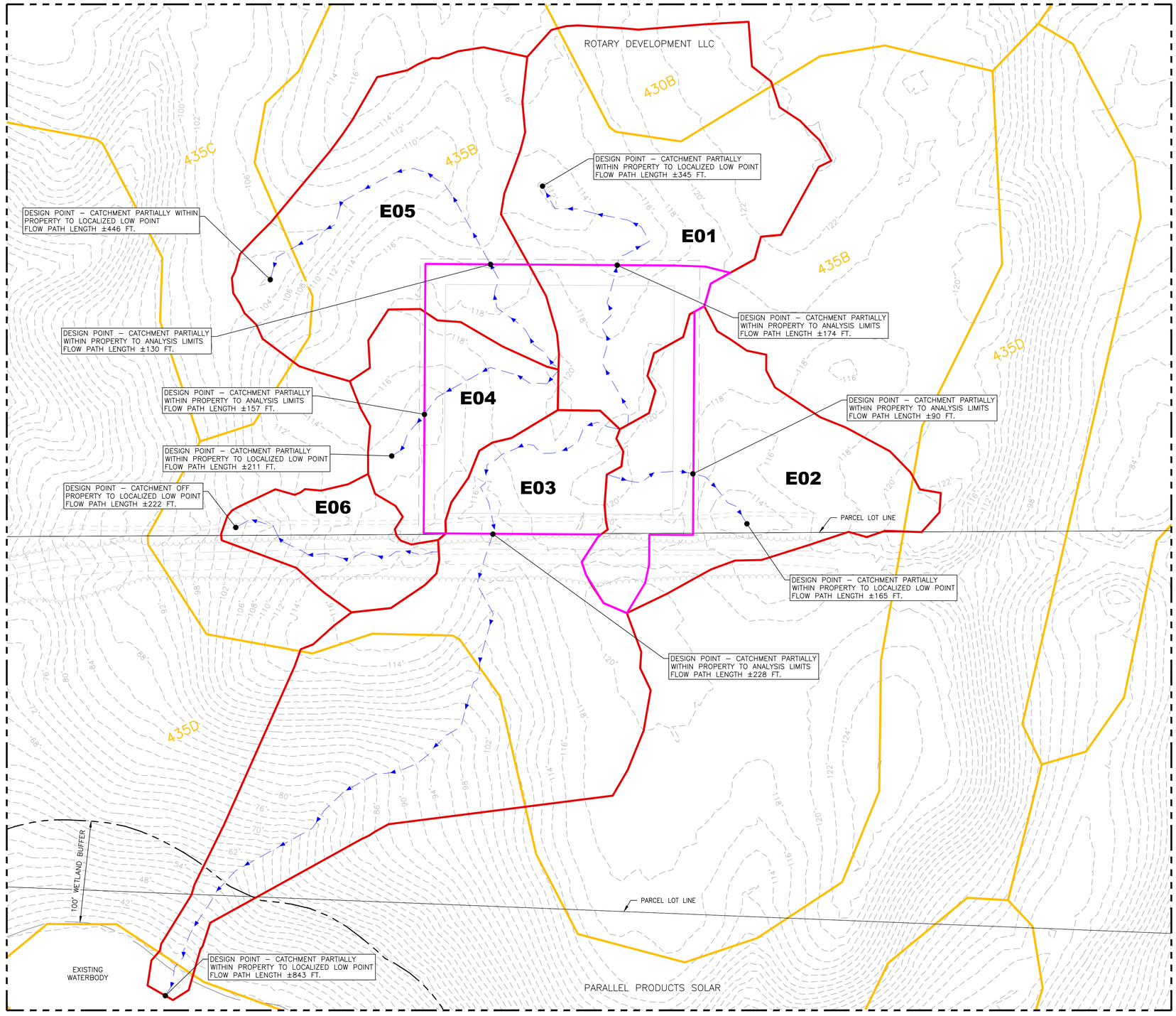
CAPE COD CANAL PIPELINE RELOCATION PROJECT
BOURNE ROTARY METER STATION
M&R 00846
TITLE: EXISTING CONDITIONS PLAN

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

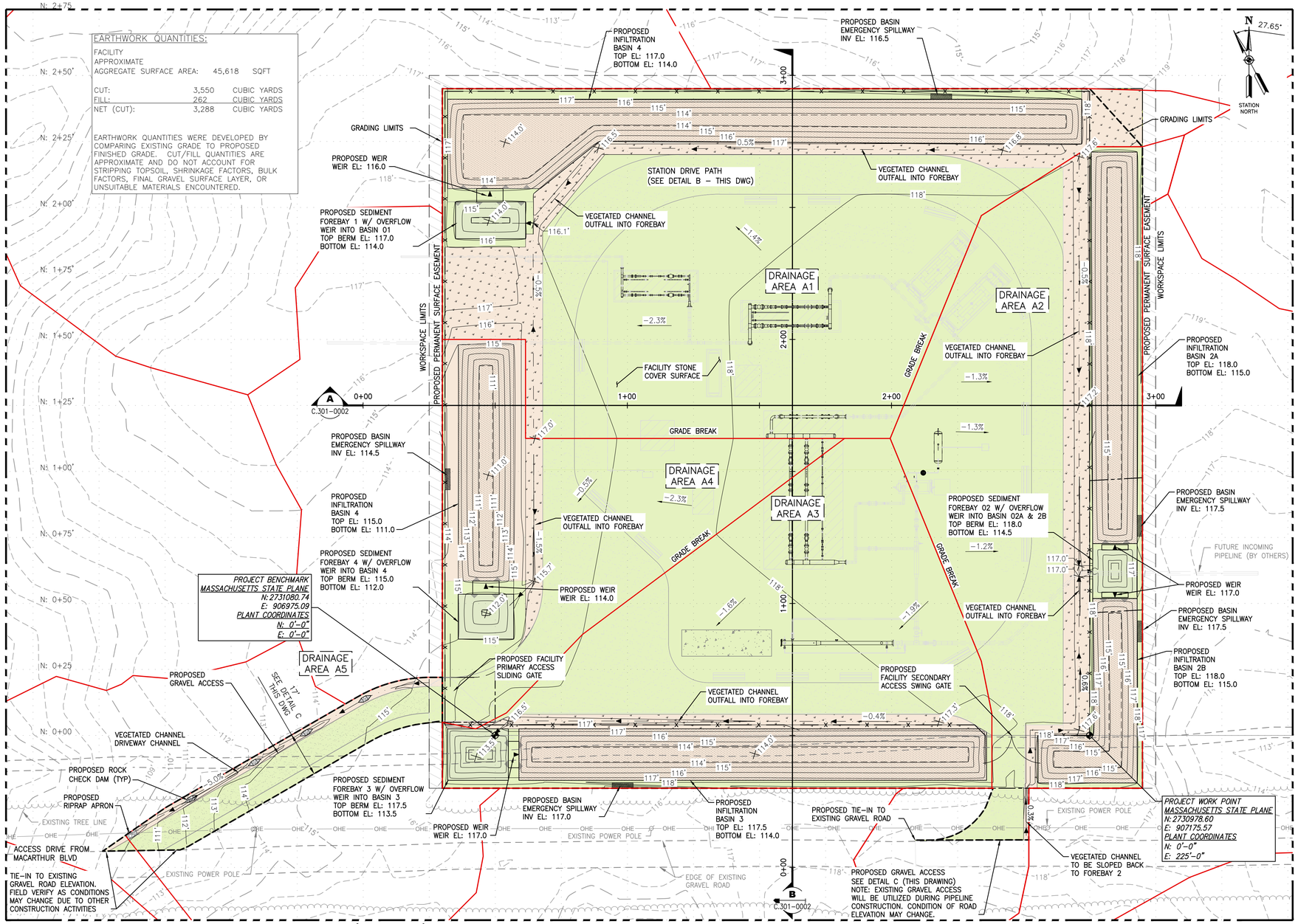
audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

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



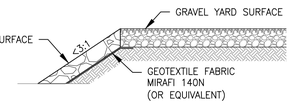
METER STATION
PLAN VIEW
SCALE: 1" = 20'–0"

NOTES:

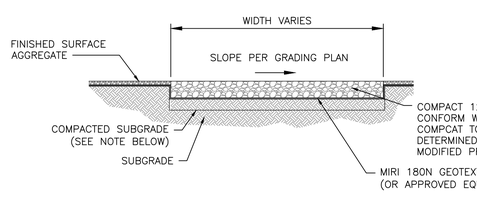
1. SITE PREPARATION METHODS SHALL FOLLOW RECOMMENDATIONS OUTLINED IN GEOTECHNICAL REPORT CAPE CANAL RELOCATION PROJECT CAPE BOURNE METERING & REGULATING STATION, BARNSTABLE COUNTY MASSACHUSETTS, PROVIDED BY GEOENGINEERS, DATED MAY 15, 2025.
2. ALL CONTOUR LABELS AND ELEVATION CALLOUTS ARE IN FEET AND 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

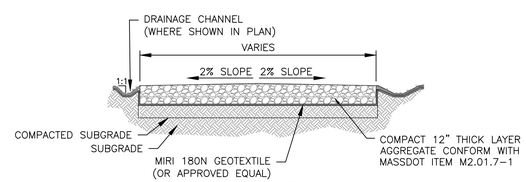


DETAIL A – TYPICAL RIPRAP SLOPE DETAIL
SCALE: NOT TO SCALE

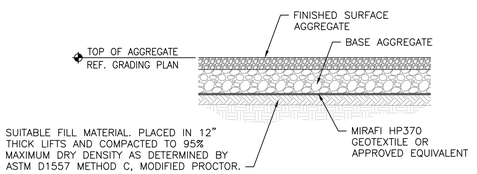


DETAIL B – TYPICAL AGGREGATE DRIVE AISLE
SCALE: NOT TO SCALE

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

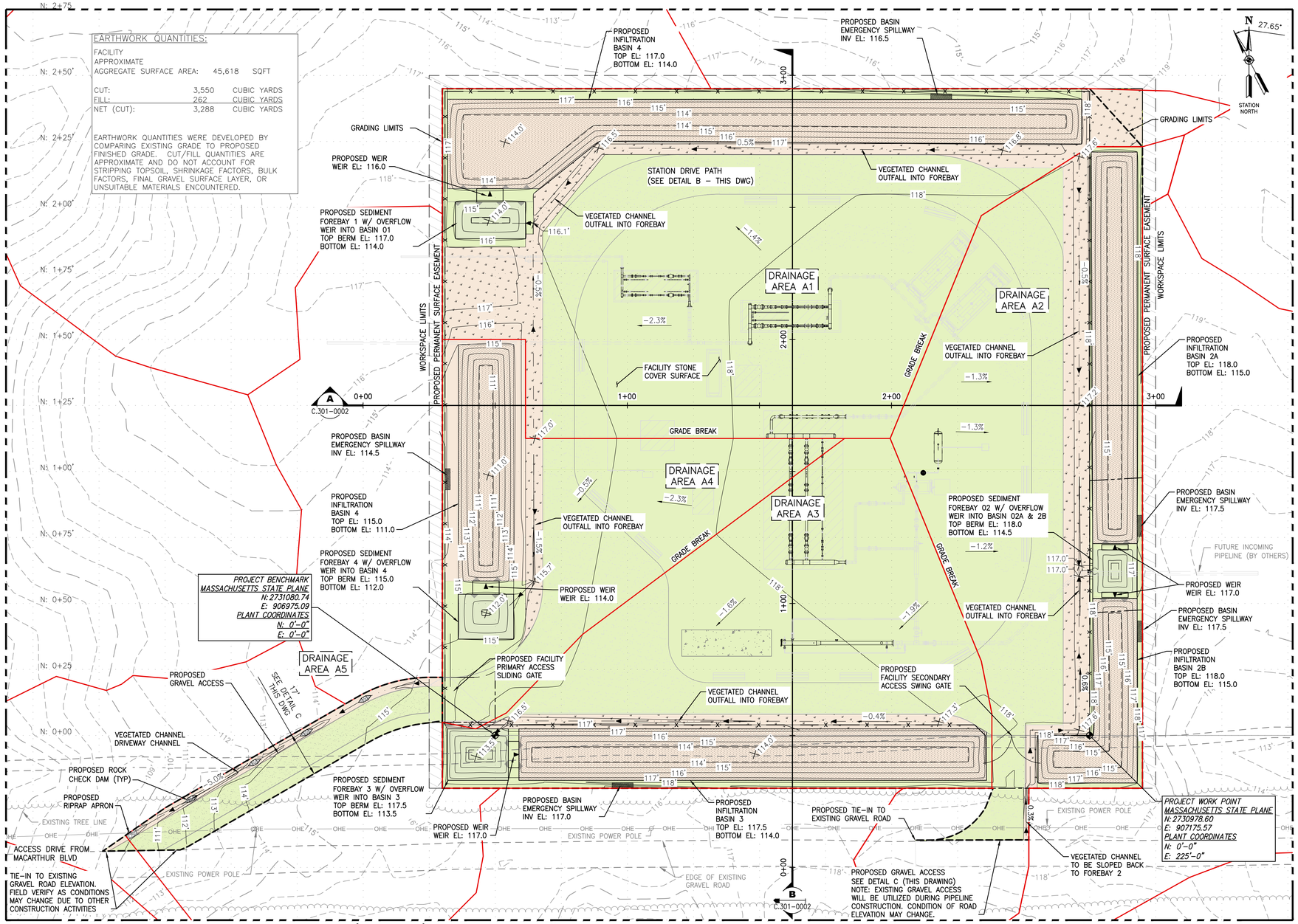
CAPE COD CANAL PIPELINE RELOCATION PROJECT
BOURNE ROTARY METER STATION
M&R 00846
TITLE: GRADING PLAN

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"

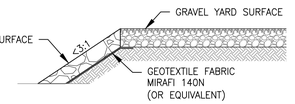
ISSUED FOR PERMIT
07/07/2026

NOTES:

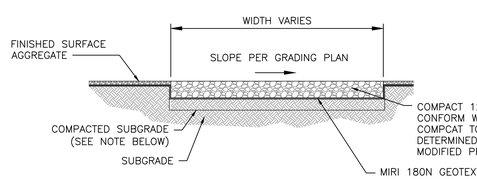
1. SITE PREPARATION METHODS SHALL FOLLOW RECOMMENDATIONS OUTLINED IN GEOTECHNICAL REPORT CAPE CANAL RELOCATION PROJECT CAPE BOURNE METERING & REGULATING STATION, BARNSTABLE COUNTY MASSACHUSETTS, PROVIDED BY GEOENGINEERS, DATED MAY 15, 2025.
2. ALL CONTOUR LABELS AND ELEVATION CALLOUTS ARE IN FEET AND 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

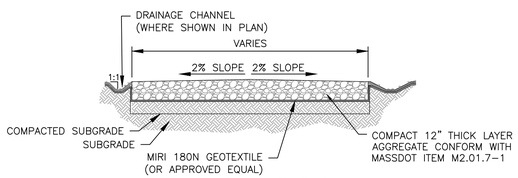


DETAIL A – TYPICAL RIPRAP SLOPE DETAIL
SCALE: NOT TO SCALE

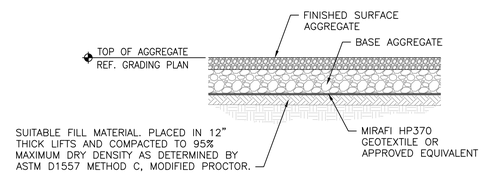


DETAIL B – TYPICAL AGGREGATE DRIVE AISLE
SCALE: NOT TO SCALE

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

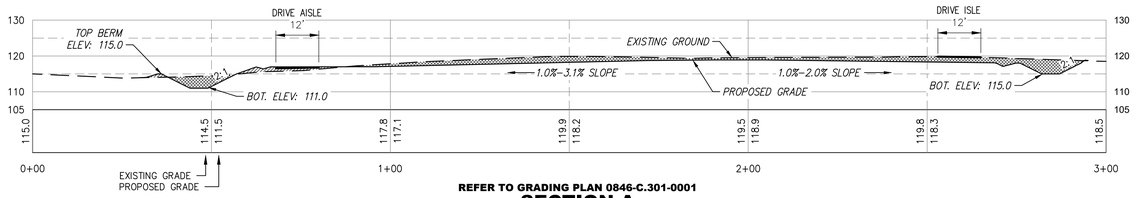
LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

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

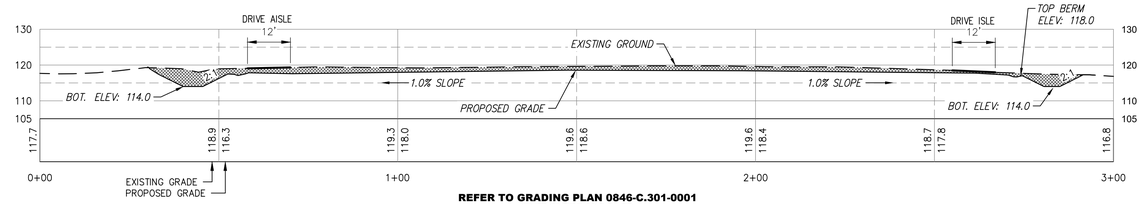


REFER TO GRADING PLAN 0846-C.301-0001

SECTION A

SCALE: 1" = 20'-0"

0 20' 40'
Scale: 1" = 20'

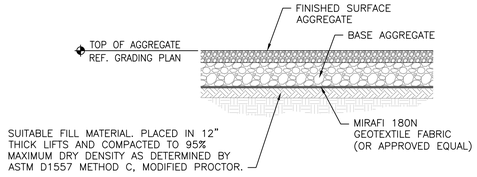


REFER TO GRADING PLAN 0846-C.301-0001

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

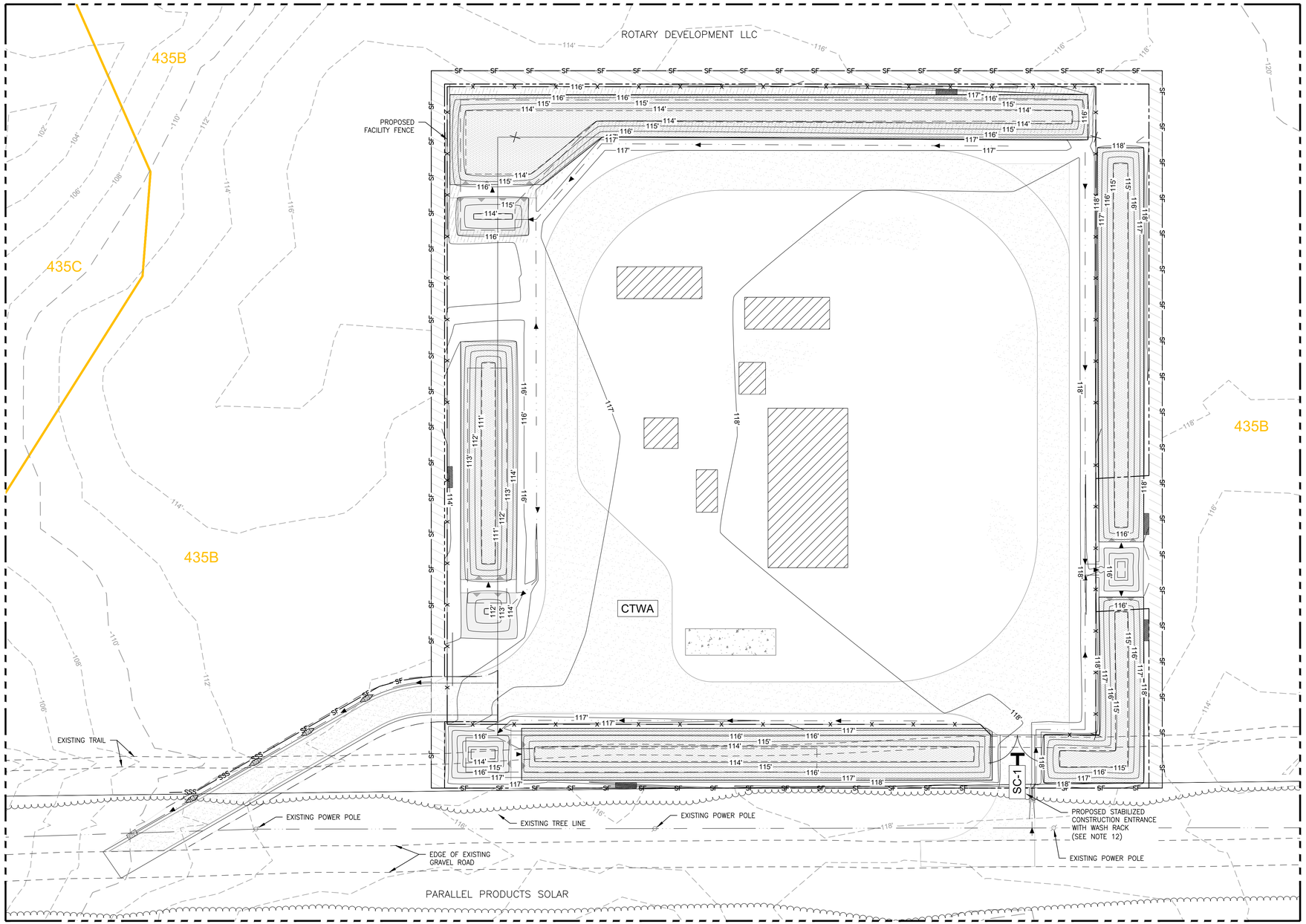
LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

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

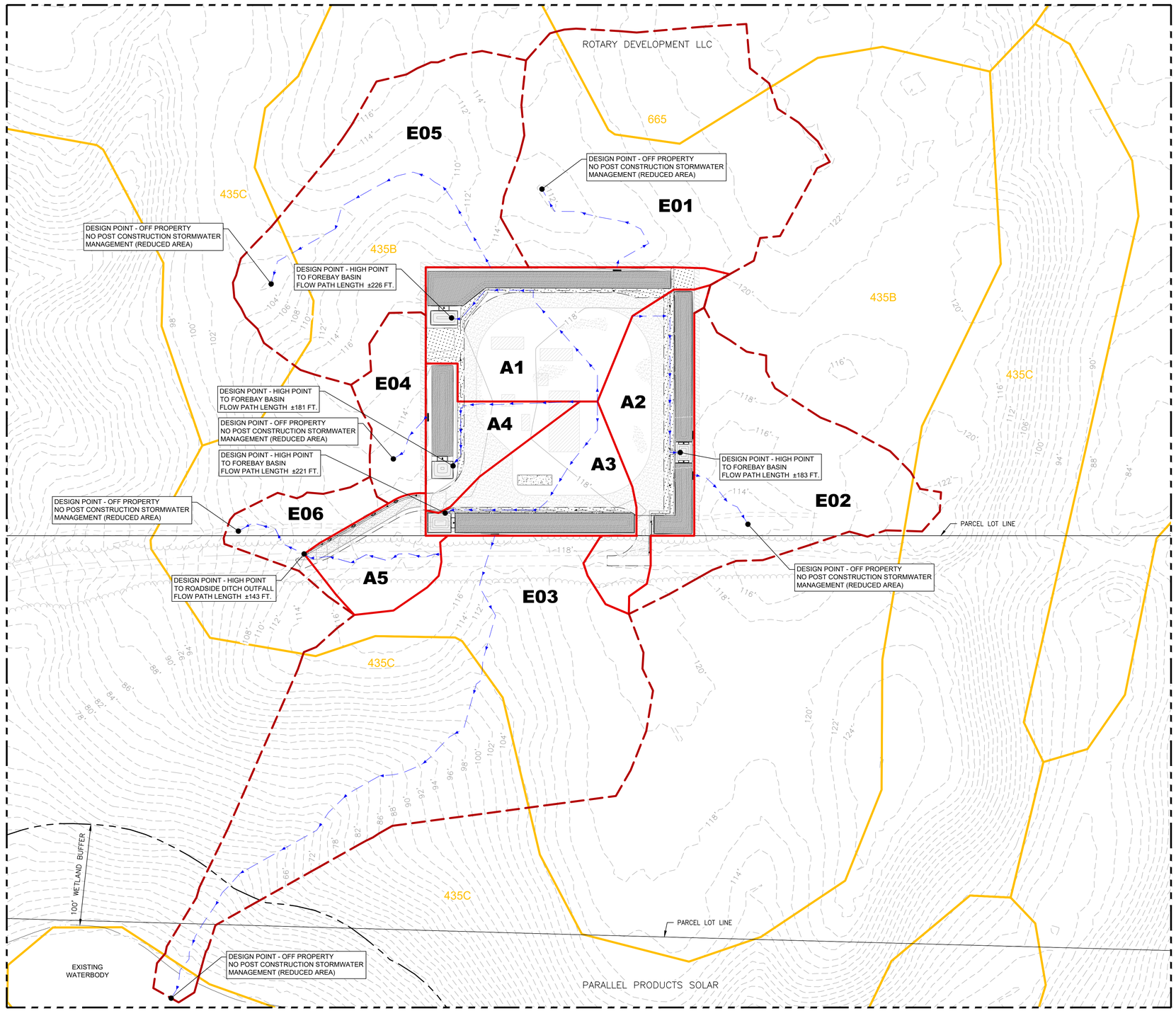
audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

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

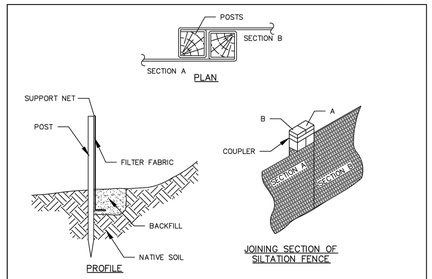
E&S CONSTRUCTION SEQUENCE AND MAINTENANCE

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:

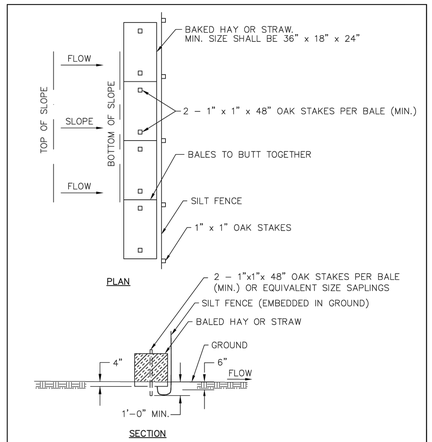
- INSPECT ALL EROSION AND SEDIMENTATION CONTROL MEASURES PERIODICALLY AND AFTER EACH RAINFALL EVENT. INSPECTION RECORDS SHALL BE MAINTAINED ONSITE BY THE CONTRACTOR.
- REPAIR OR REPLACE DAMAGED OR DETERIORATED EROSION CONTROL MEASURES IMMEDIATELY UPON IDENTIFICATION.
- REMOVE ACCUMULATED SEDIMENT FROM 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.



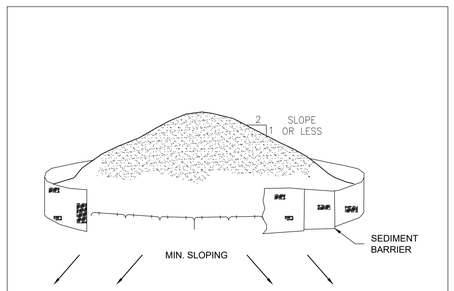
CONSTRUCTION NOTES

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



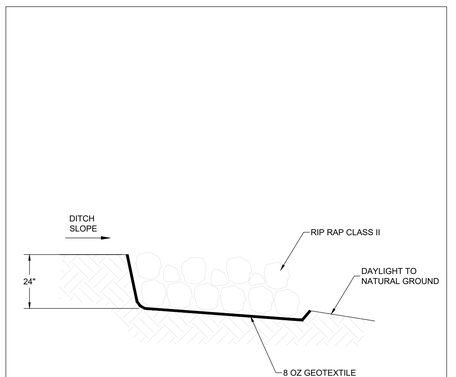
HAYBALES AND SILT FENCE



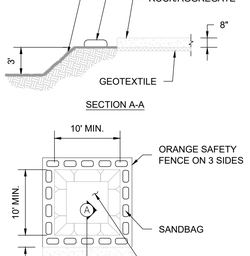
INSTALLATION NOTES:

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

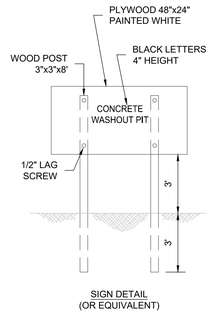


SECTION A-A

CTWA

SYMBOL

PLAN



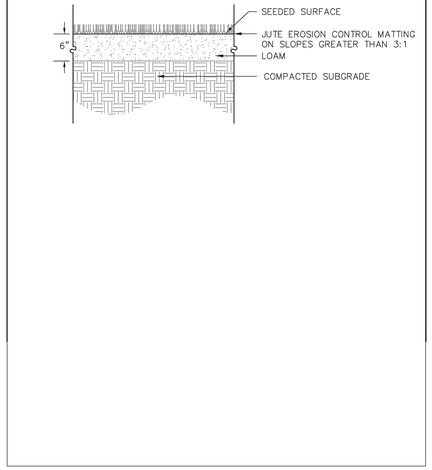
SIGN DETAIL
(OR EQUIVALENT)

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

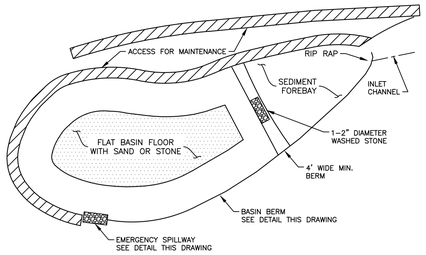
DRAWN BY:	VN	05/15/26	CAPE COD CANAL PIPELINE RELOCATION PROJECT
DESIGN CHECKER:	CR	07/07/26	BOURNE ROTARY METER STATION
DESIGN ENGINEER:	PB	07/07/26	M&R 00846
PROJECT MANAGER:	AC	07/07/26	TITLE: DETAILS

ENBRIDGE

Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713-627-5400

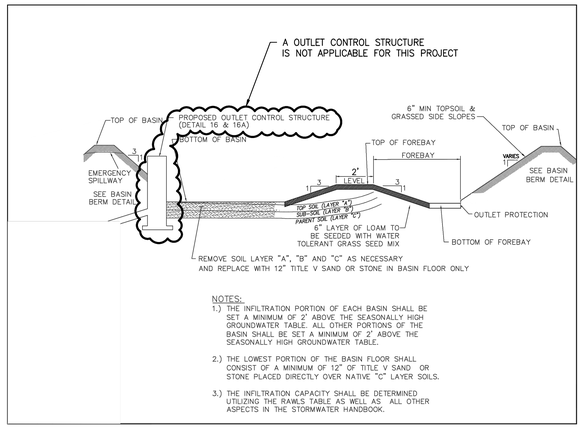
TITLE	INITIALS	DATE	YEAR: 2026	W.O.:	SCALE: N.T.S.	DWG.: 00846-C.320-0006	REV.: D

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

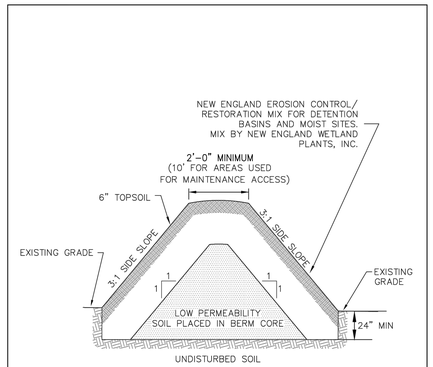


NOTES:
1.) THE INFILTRATION PORTION OF EACH BASIN SHALL BE SET A MINIMUM OF 2' ABOVE THE SEASONALLY HIGH GROUNDWATER TABLE. ALL OTHER PORTIONS OF THE BASIN SHALL BE SET A MINIMUM OF 2' ABOVE THE SEASONALLY HIGH GROUNDWATER TABLE.

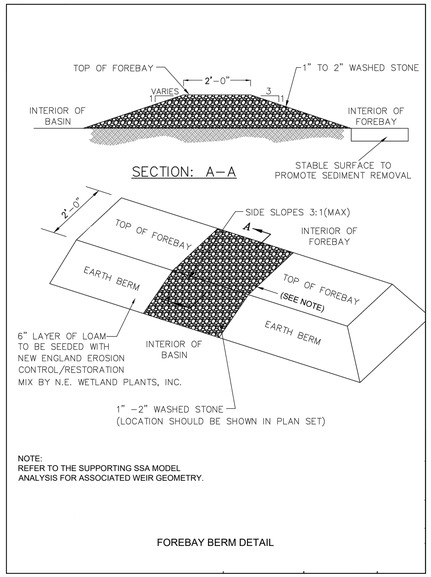
2.) THE LOWEST PORTION OF THE BASIN FLOOR SHALL CONSIST OF A MINIMUM OF 12" OF TITLE V SAND OR STONE PLACED DIRECTLY OVER NATIVE "C" LAYER SOILS.

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

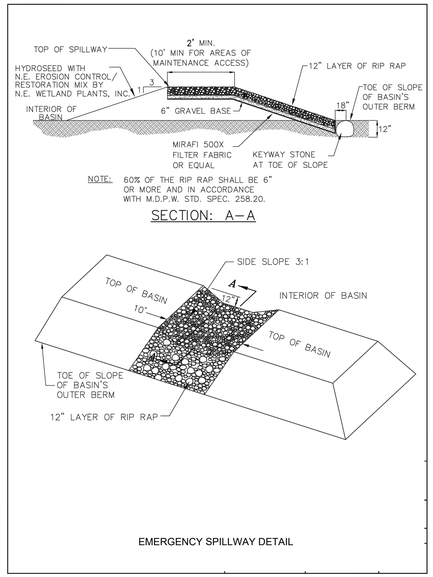


BASIN BERM DETAIL



NOTE:
REFER TO THE SUPPORTING SSA MODEL ANALYSIS FOR ASSOCIATED WEIR GEOMETRY.

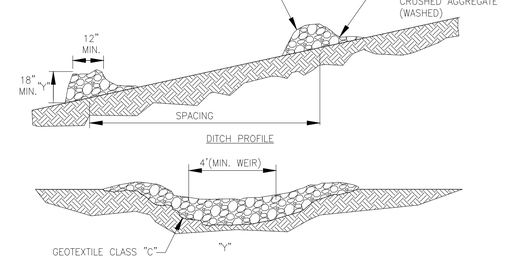
FOREBAY BERM DETAIL



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

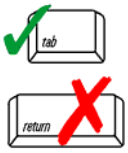
BLANK PAGE LEFT INTENTIONALLY

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.

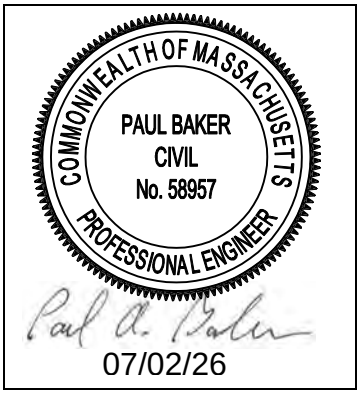
Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the 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

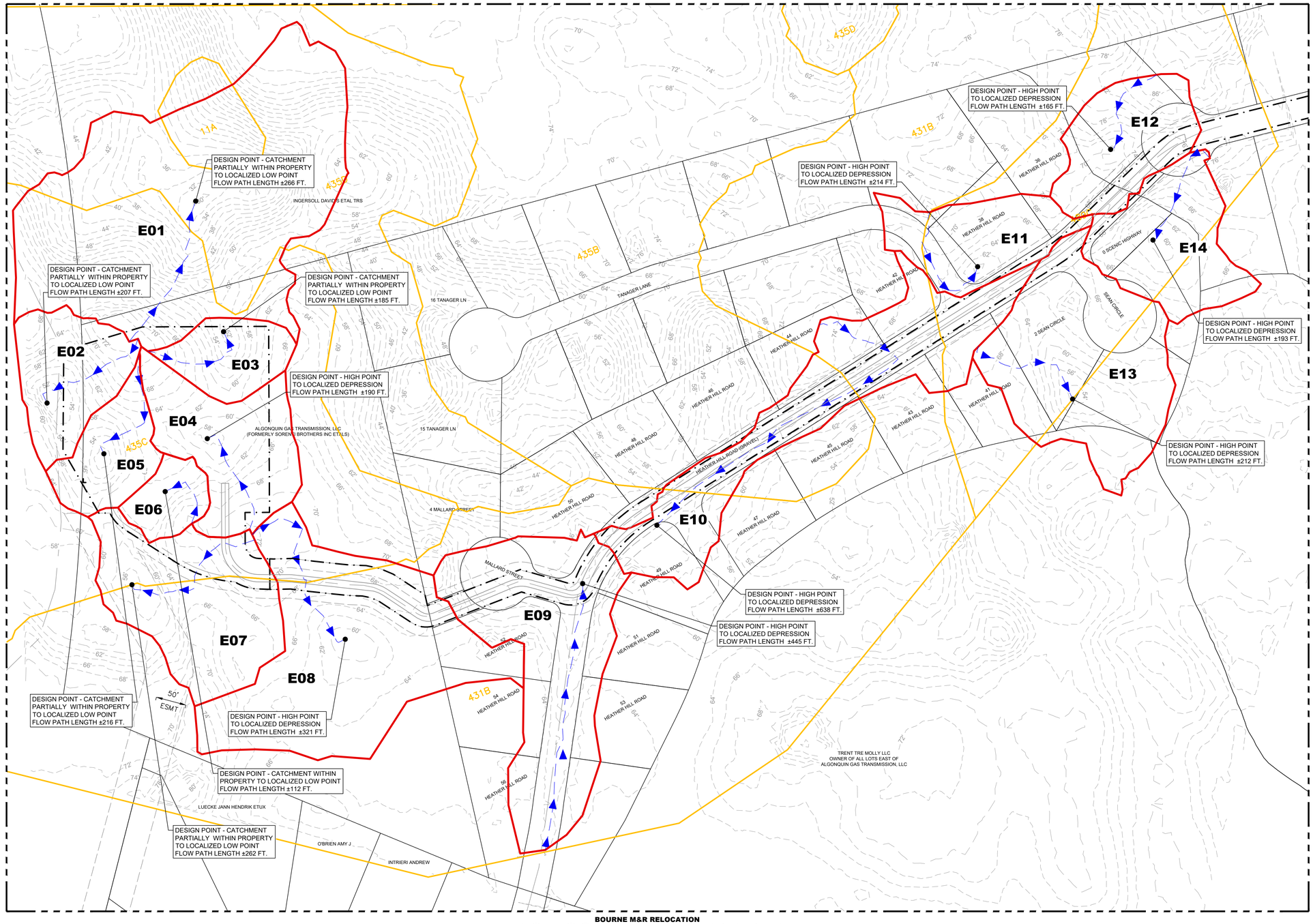
audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

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

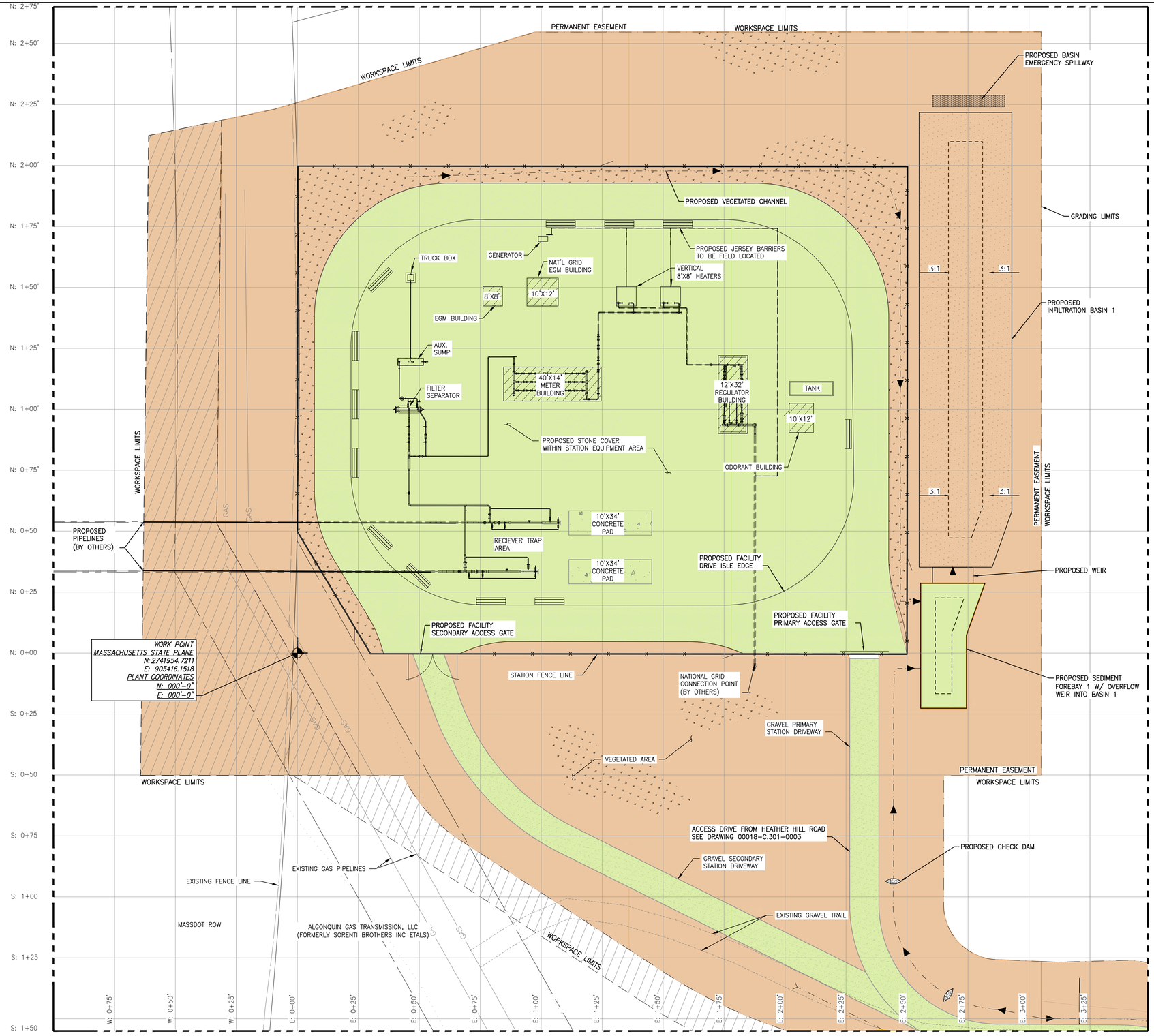
CAPE COD CANAL PIPELINE RELOCATION PROJECT
BOURNE M&R RELOCATION
M&R 00018
TITLE: EXISTING SUBCATCHMENT AREA PLAN
LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

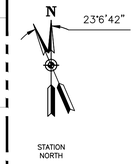
TITLE	INITIALS	DATE	YEAR:	W.O.:	SCALE:	DWG.:	REV.:
			2026		1"=80'	00018-C.320-0002	C

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	LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

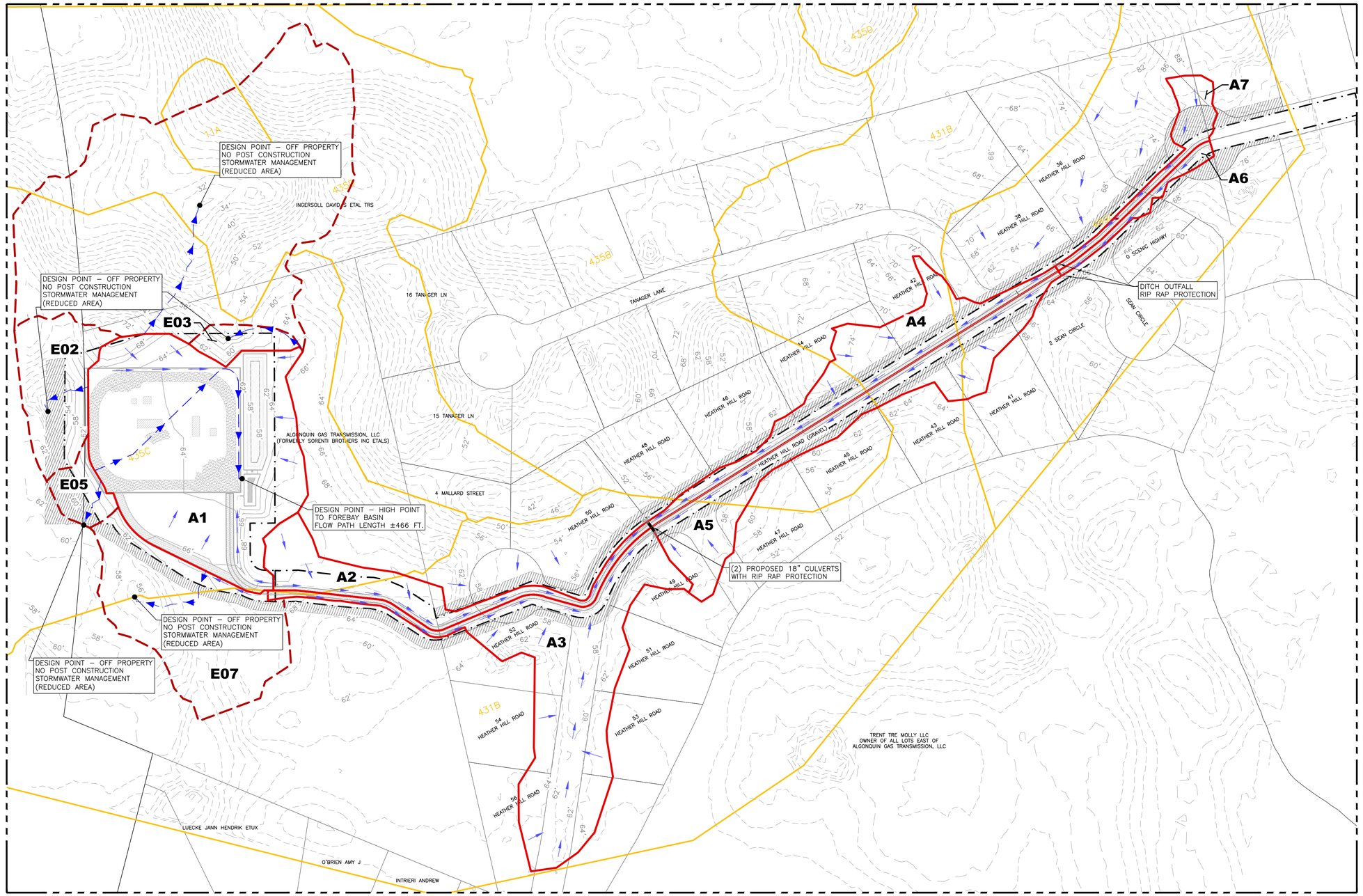
YEAR: 2026 | W.O.: | SCALE: AS NOTED | DWG.: 00018-C.320-0003 | REV.: C

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

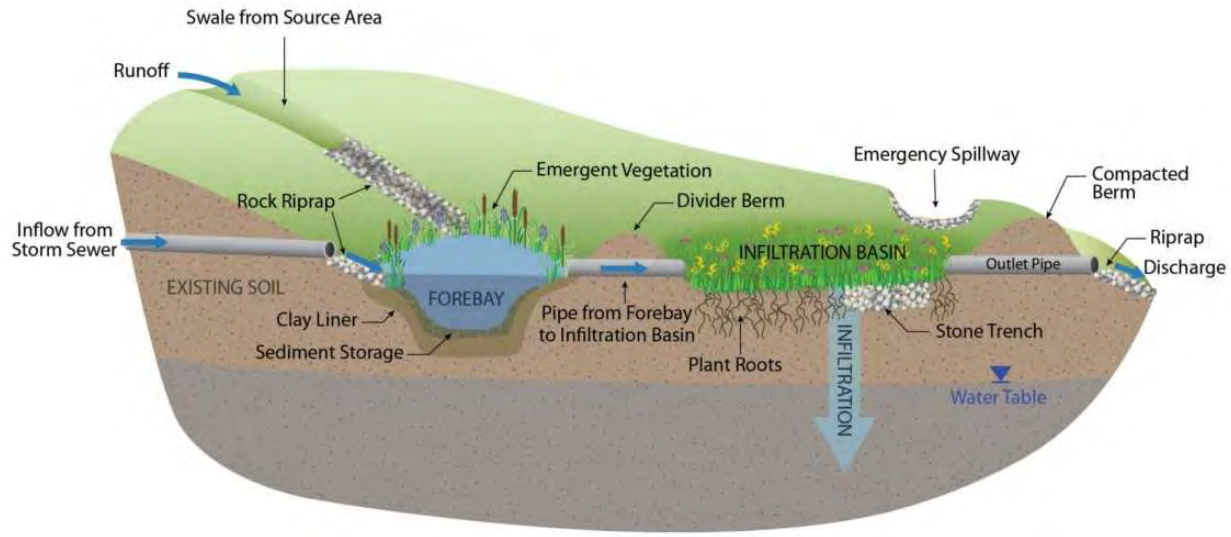


Illustration by Geosyntec Consultants, Inc.

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)

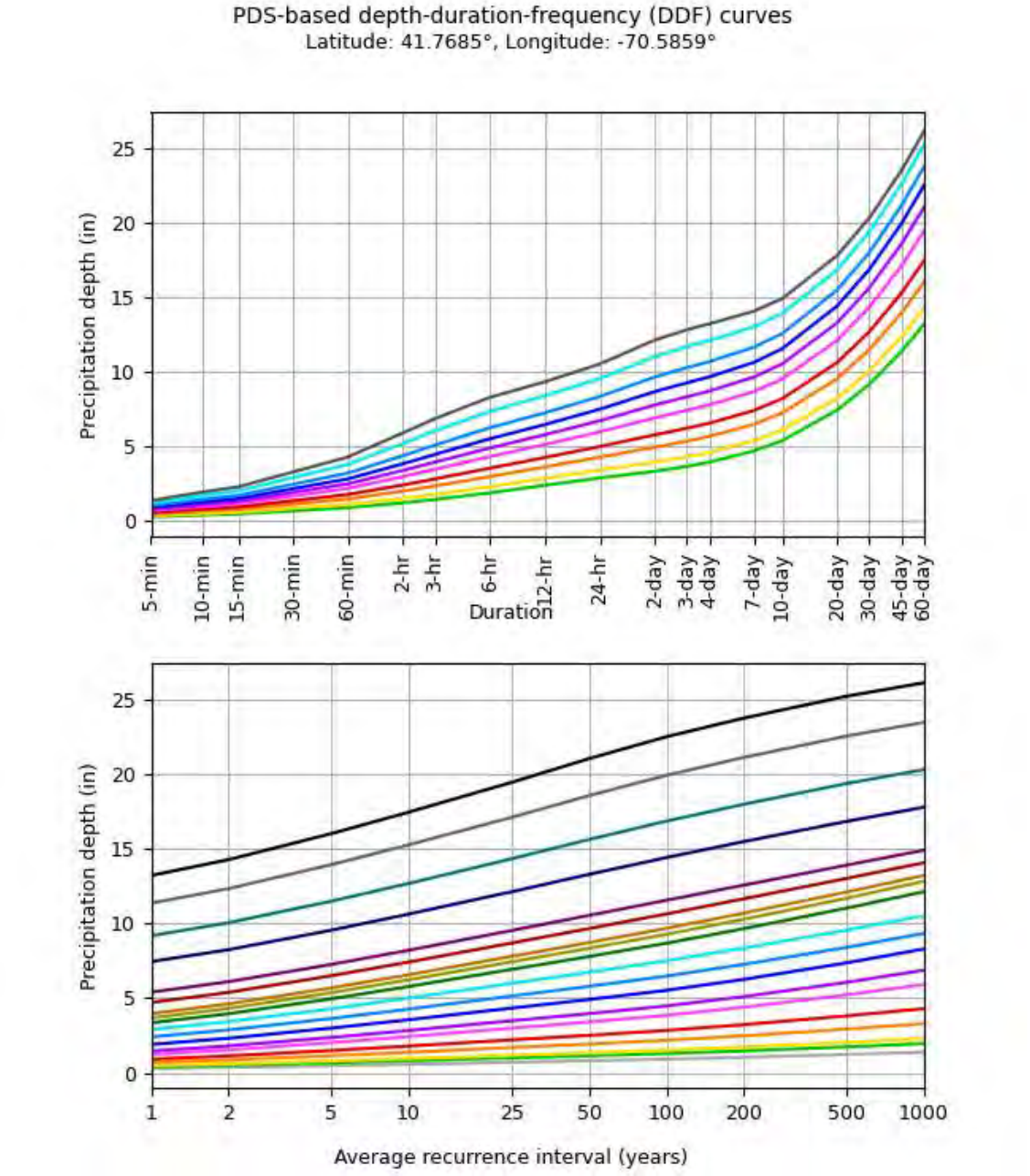
[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

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



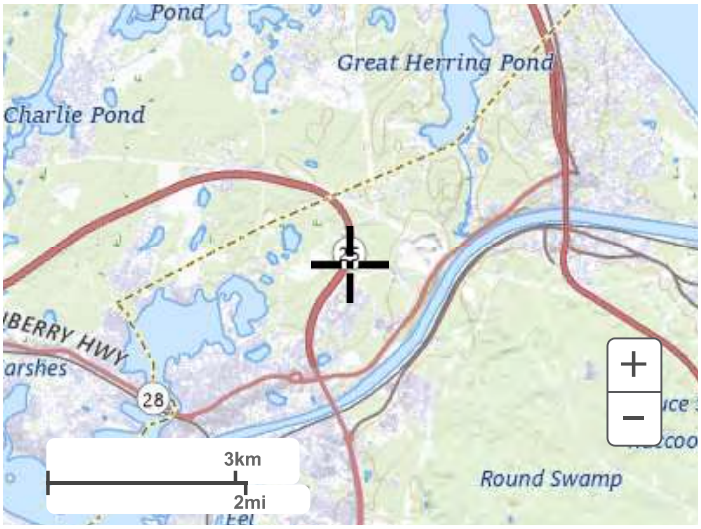
NOAA Atlas 14, Volume 10, Version 3

Created (GMT): Tue Apr 21 16:26:15 2026

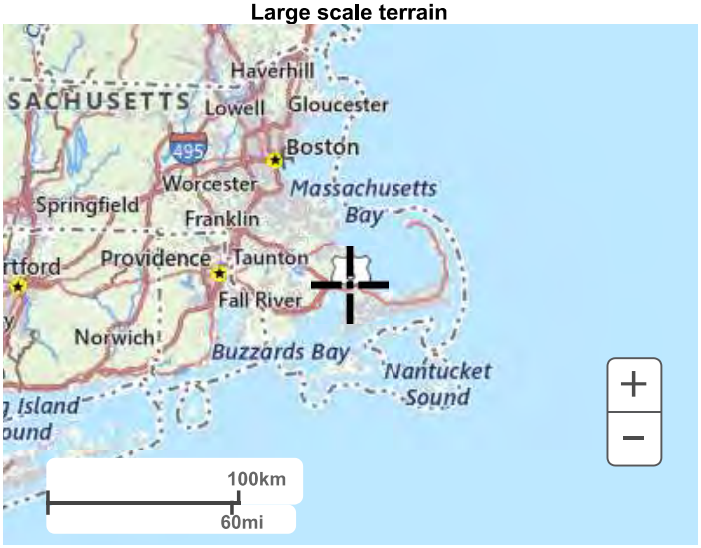
Back to Top

Maps & aerials

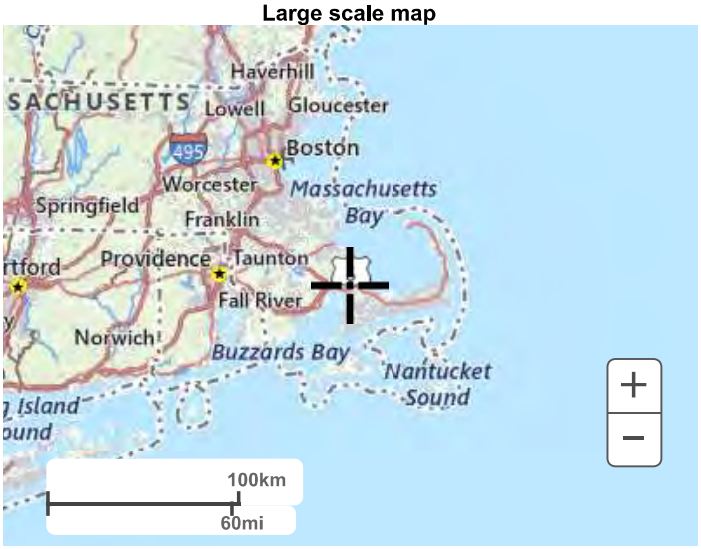
Small scale terrain



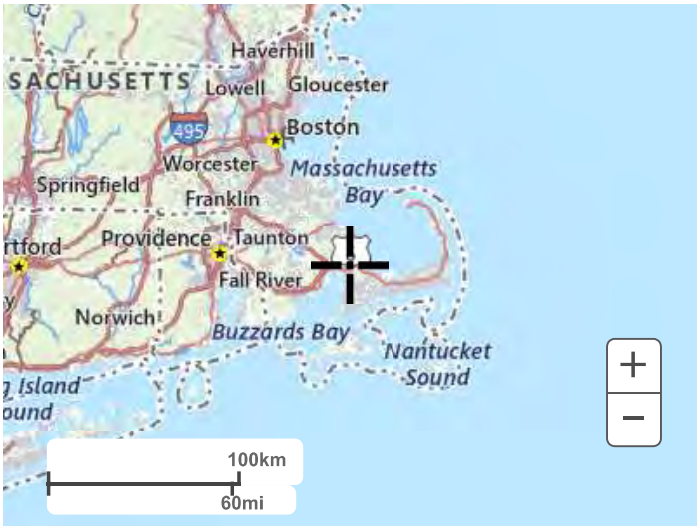
Large scale terrain



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

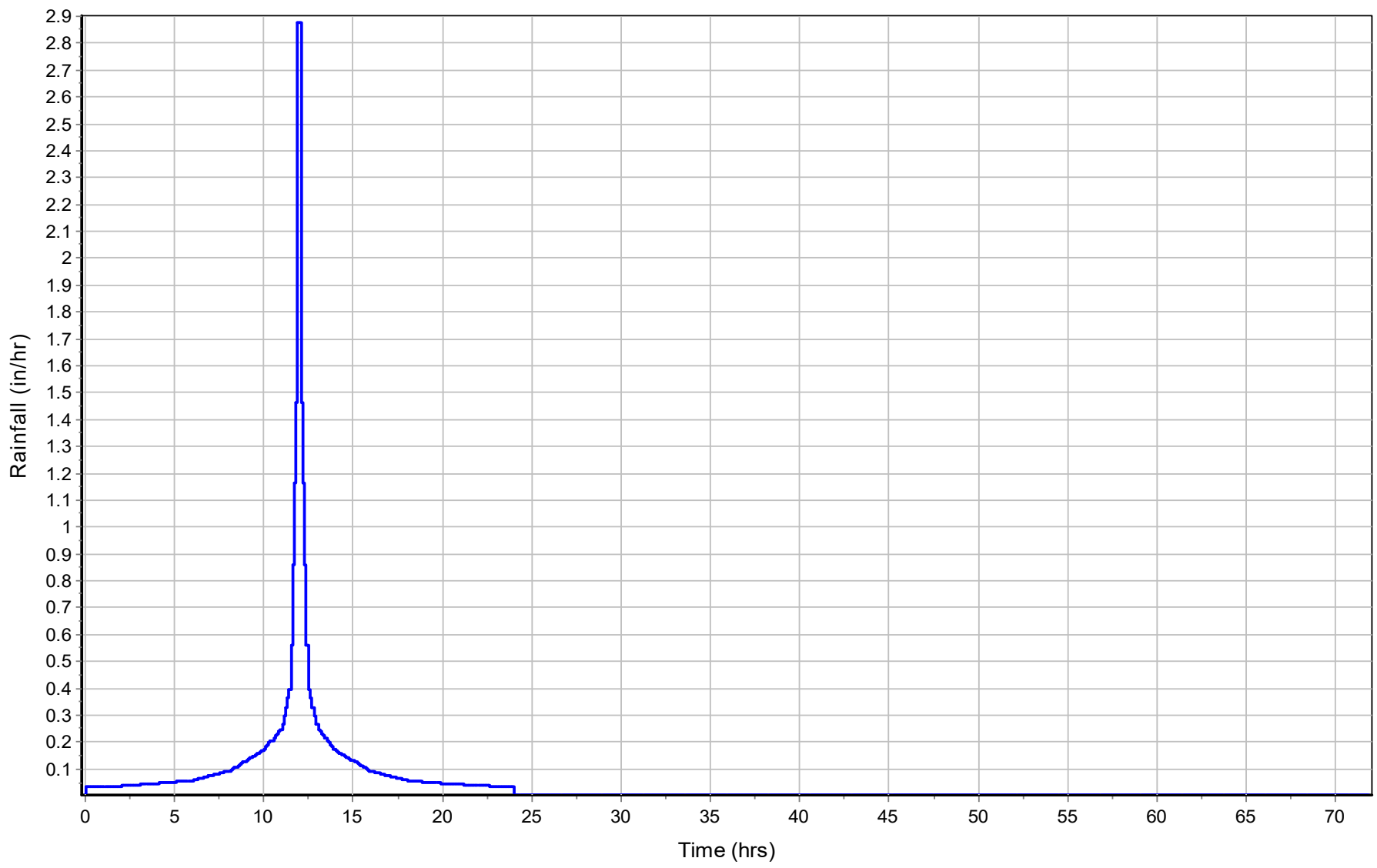
Total TOC (min) 23.77

Subbasin Runoff Results

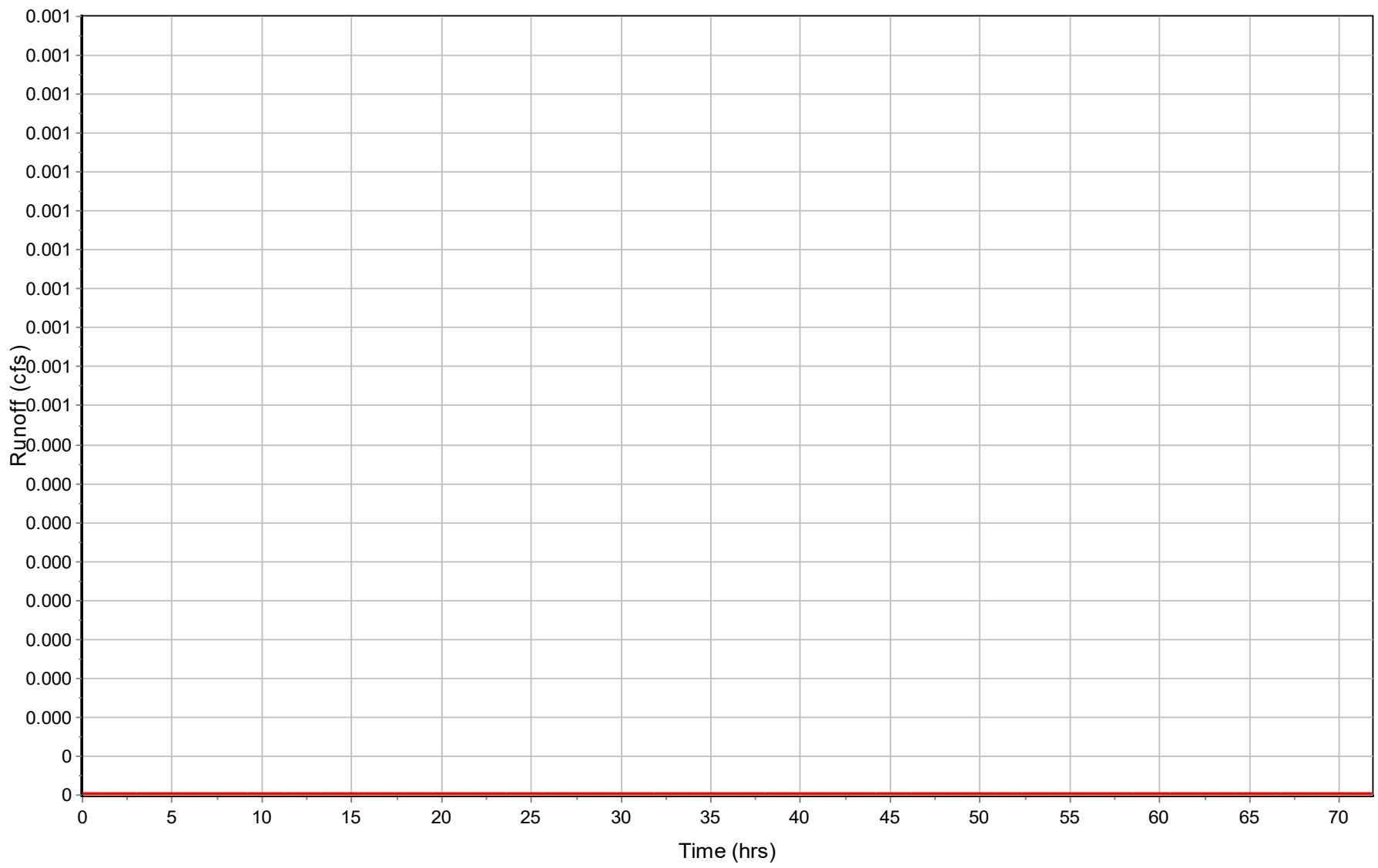
Total Rainfall (in)	3.42
Total Runoff (in)	0
Peak Runoff (cfs)	0
Weighted Curve Number	43
Time of Concentration (days hh:mm:ss)	0 00:23:46

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

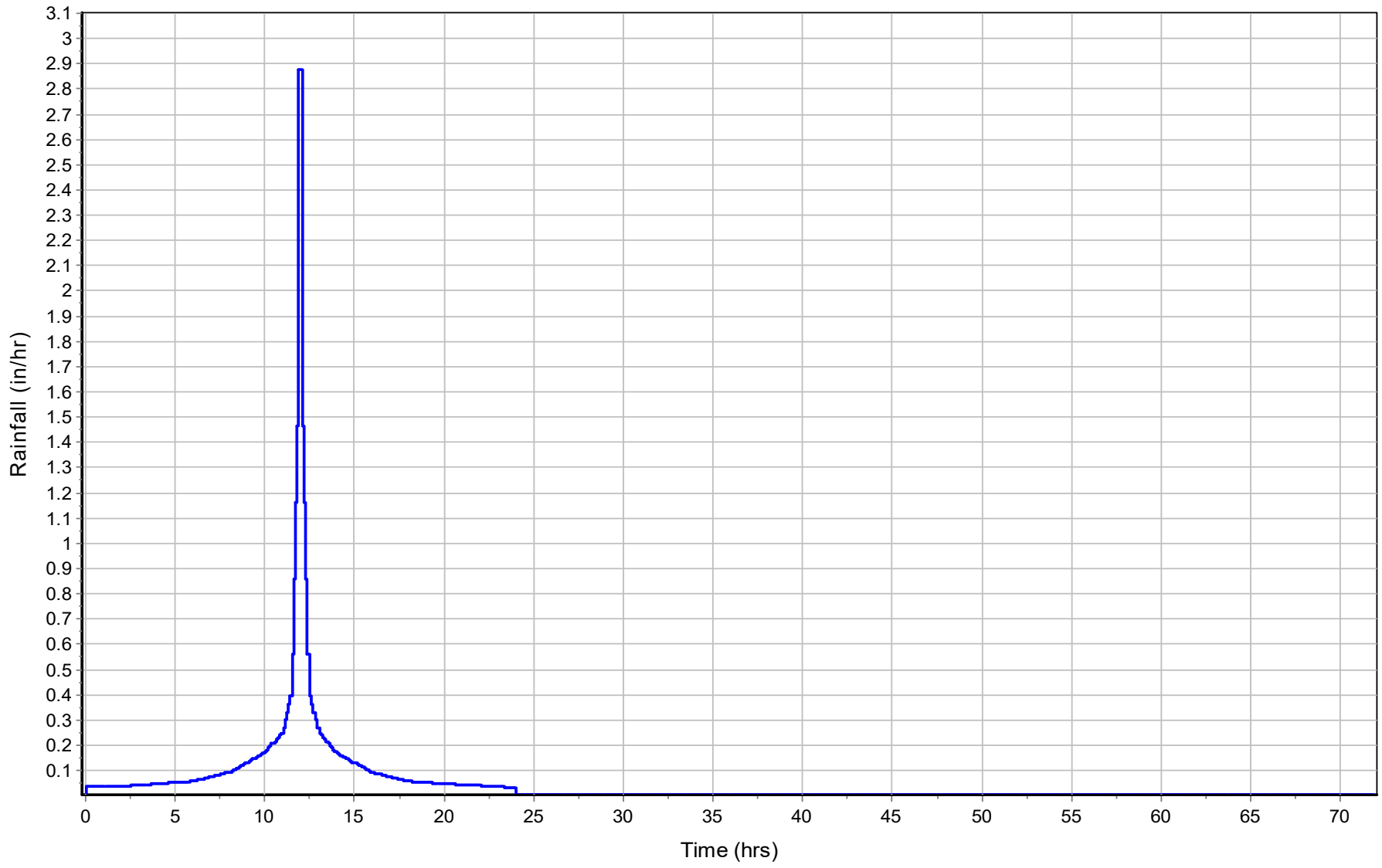
Total TOC (min) 7.35

Subbasin Runoff Results

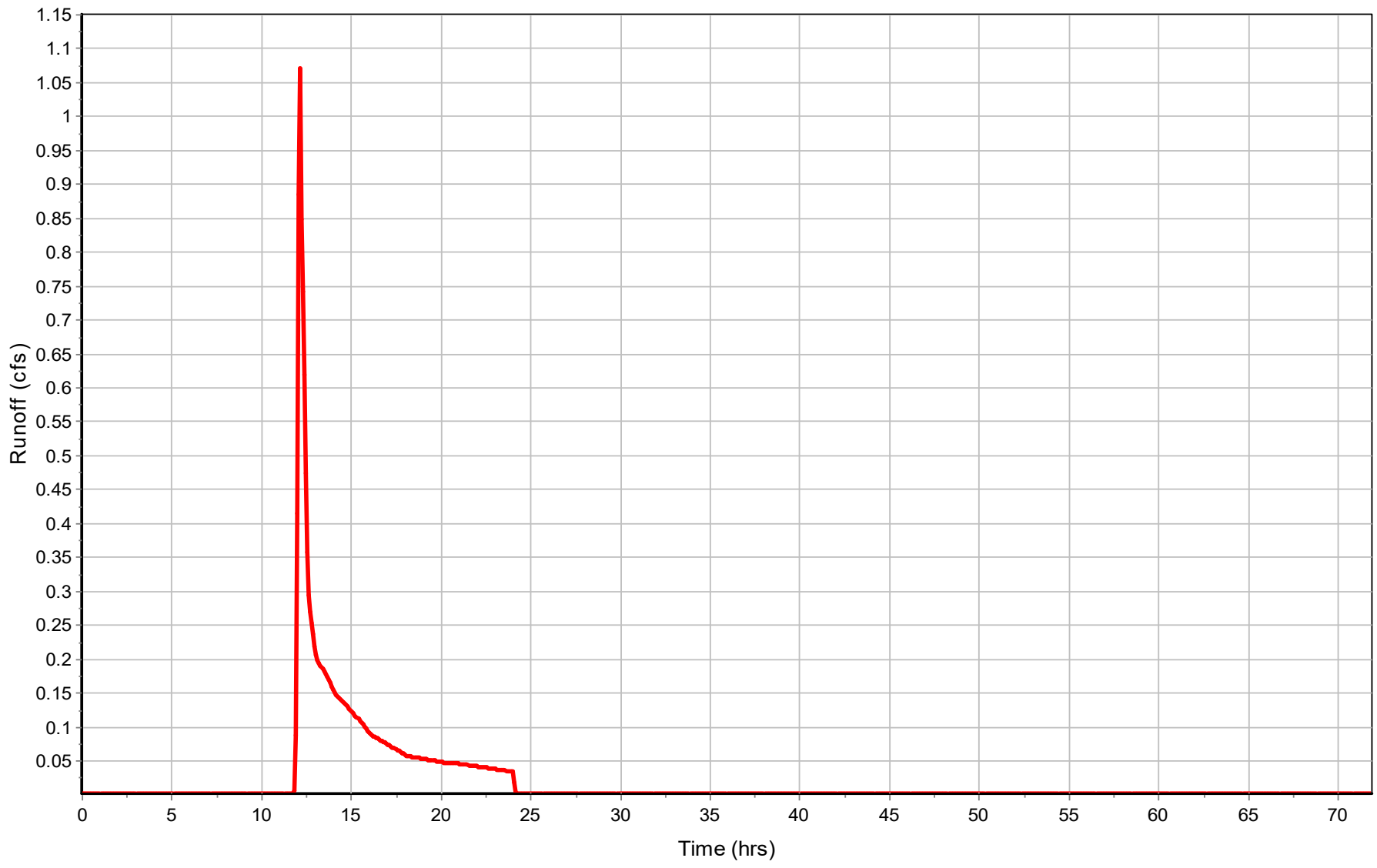
Total Rainfall (in) 3.42
Total Runoff (in) 0.56
Peak Runoff (cfs) 1.11
Weighted Curve Number 61.66
Time of Concentration (days hh:mm:ss) 0 00:07:21

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

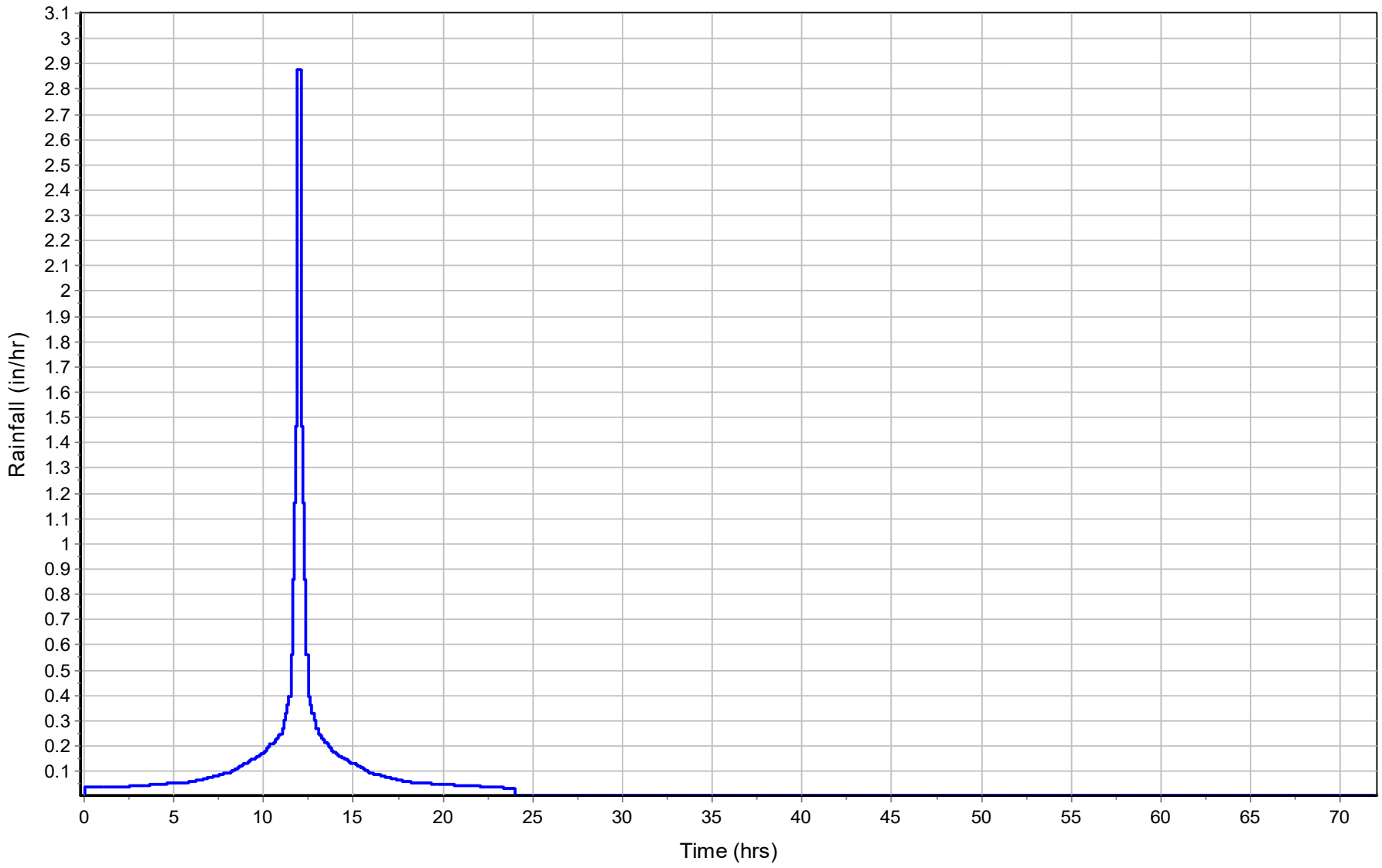
Total TOC (min) 23.82

Subbasin Runoff Results

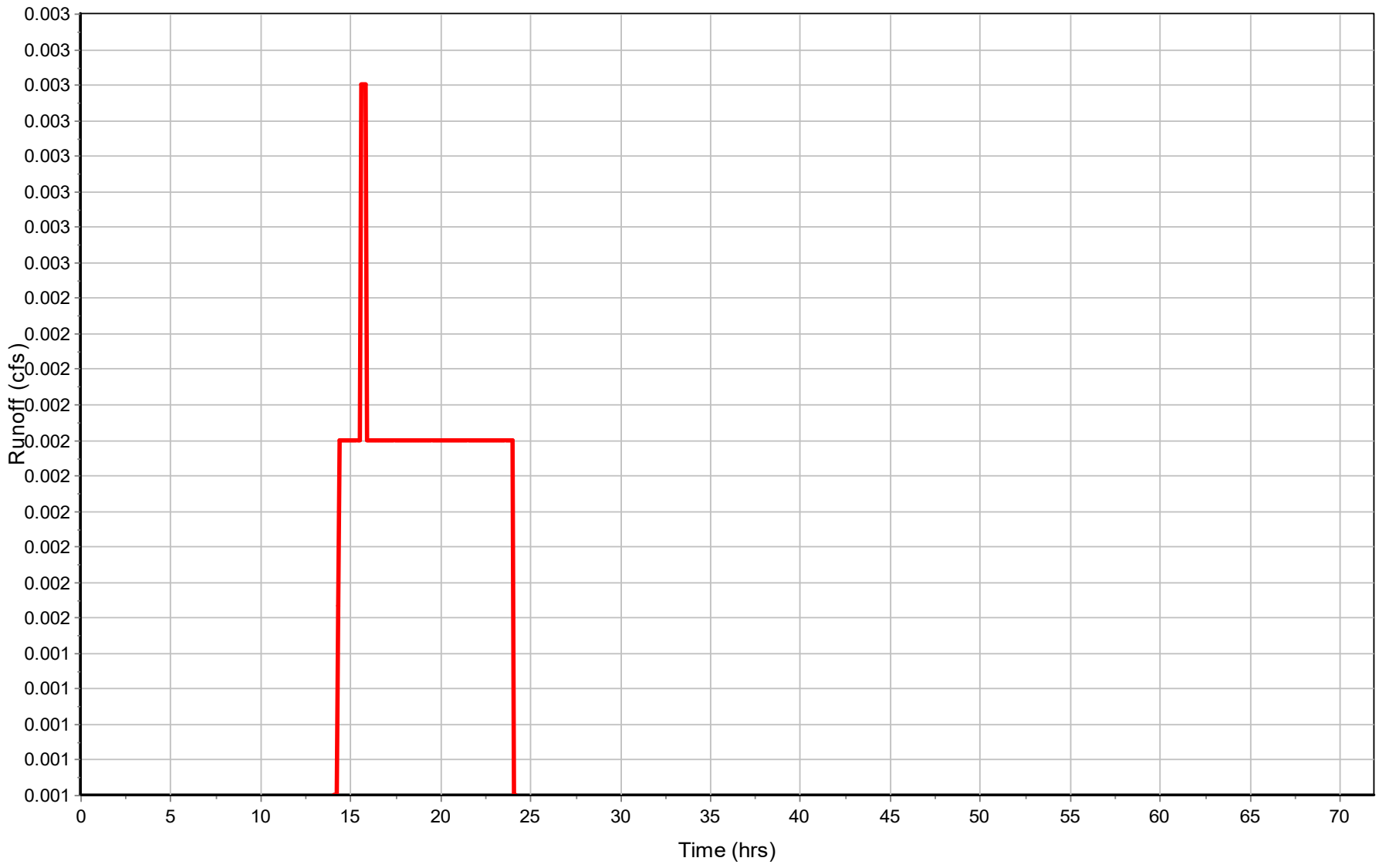
Total Rainfall (in) 3.42
Total Runoff (in) 0.04
Peak Runoff (cfs) 0
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:23:49

Subbasin : Sub-E03

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A1

Input Data

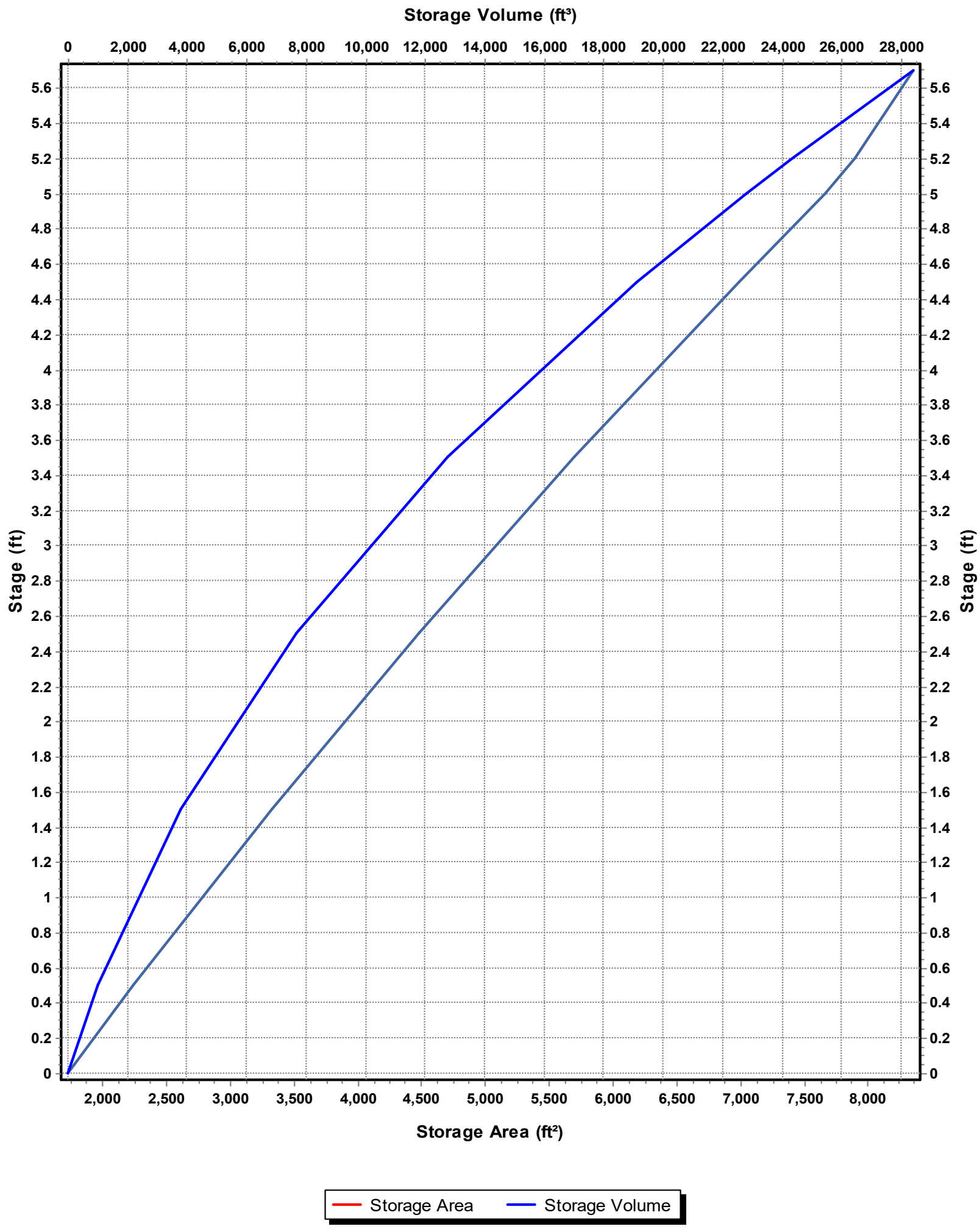
Invert Elevation (ft)	57.50
Max (Rim) Elevation (ft)	63.20
Max (Rim) Offset (ft)	5.70
Initial Water Elevation (ft)	57.50
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

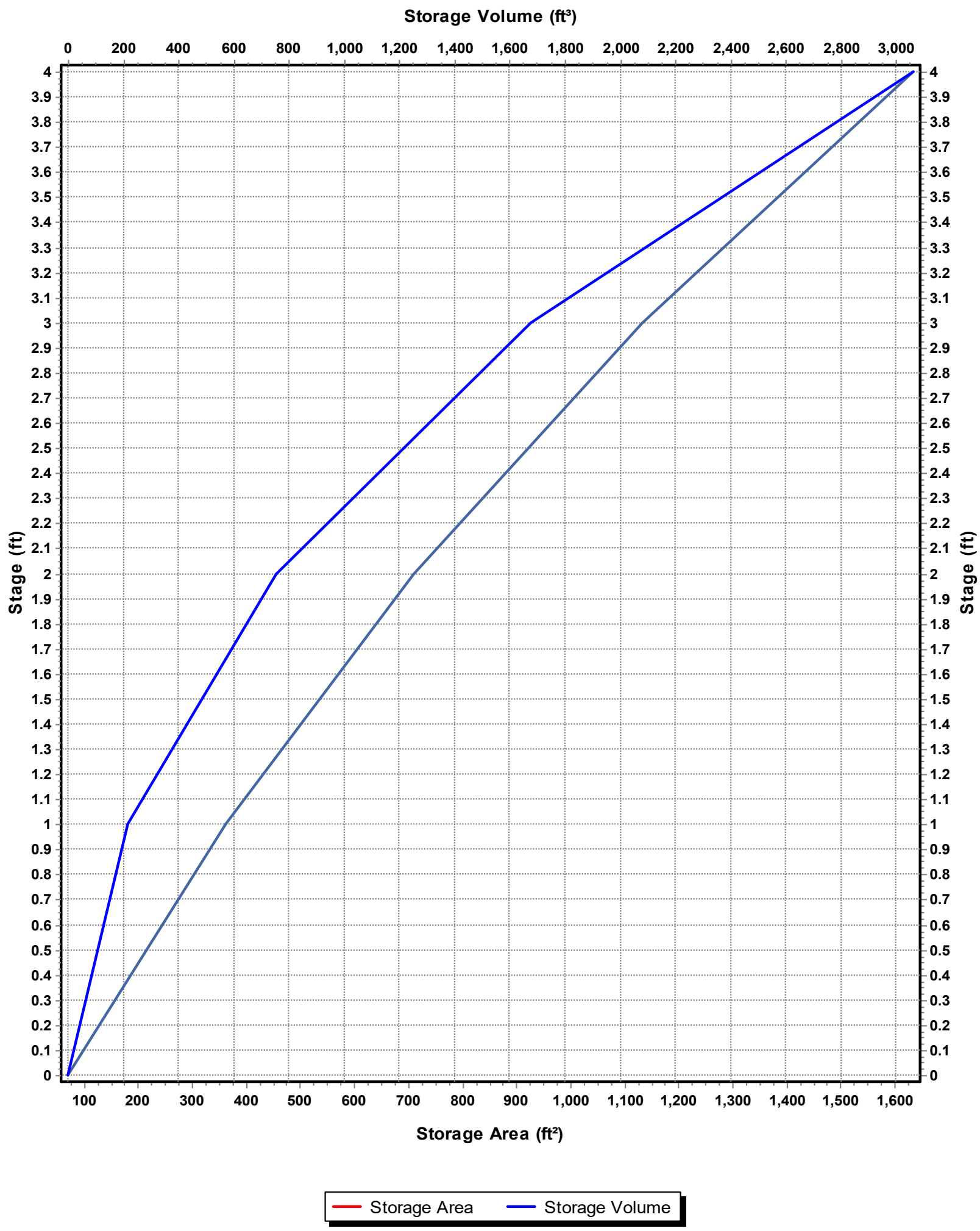
Invert Elevation (ft)	59.20
Max (Rim) Elevation (ft)	63.20
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	59.20
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

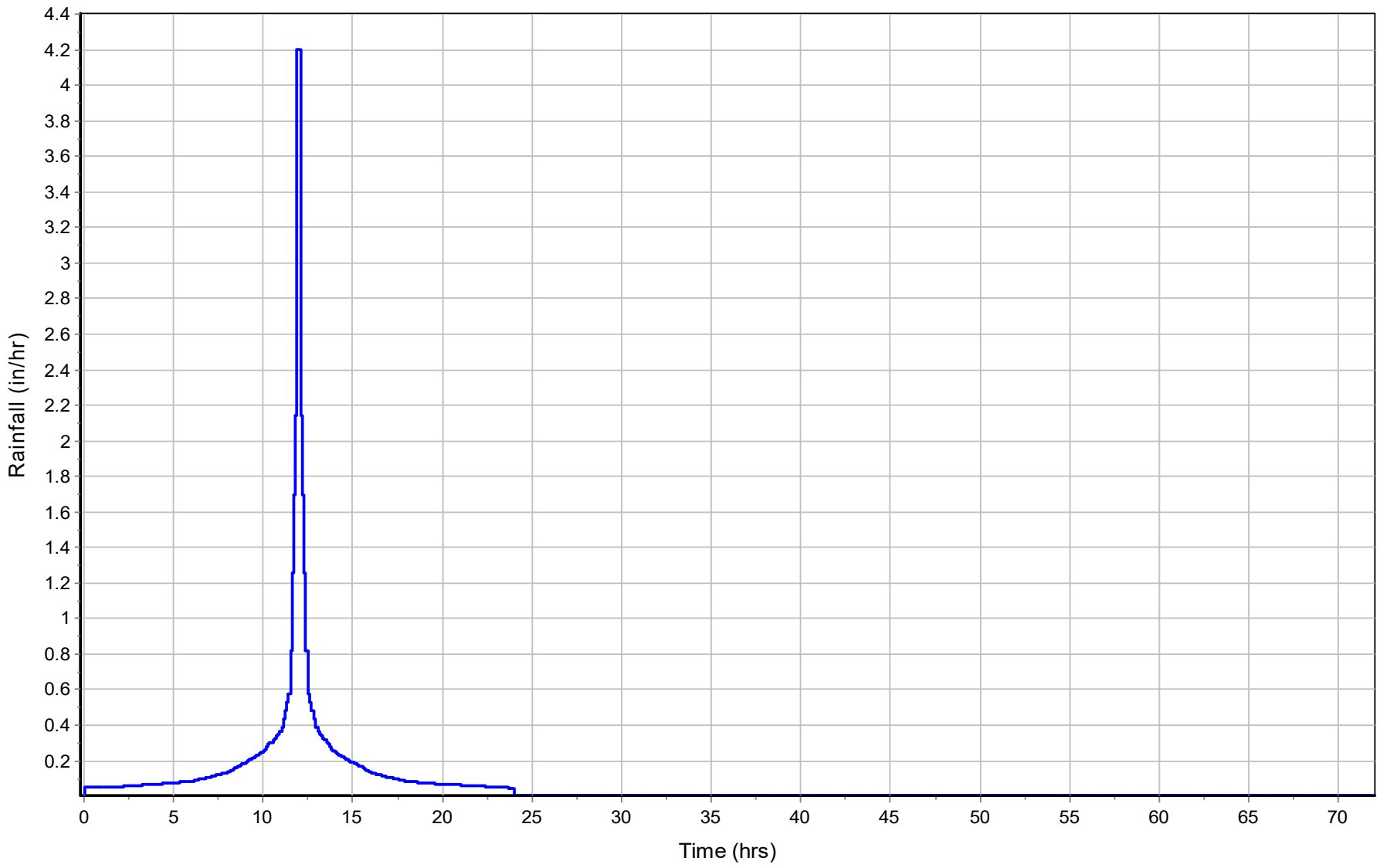
Total TOC (min) 23.77

Subbasin Runoff Results

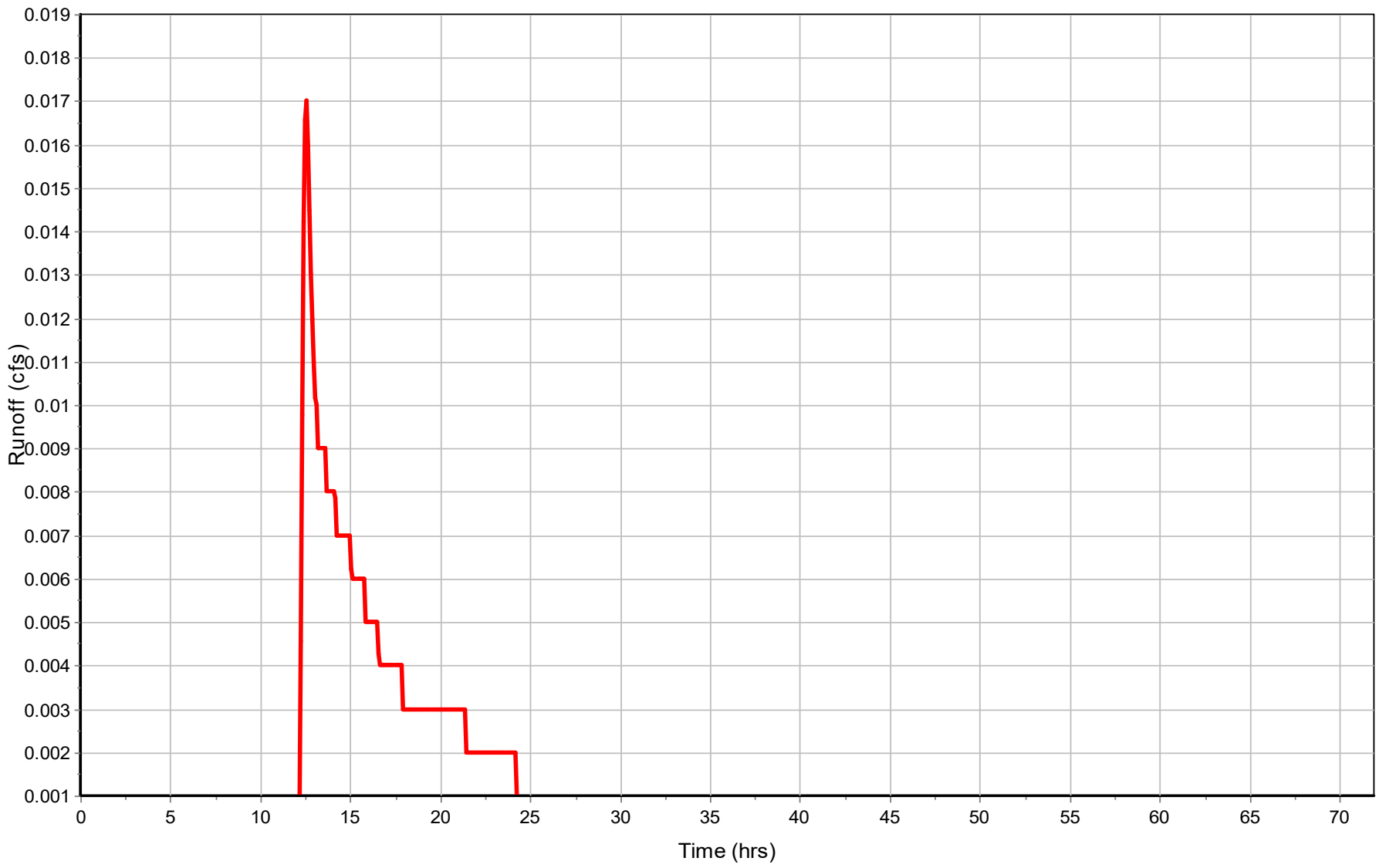
Total Rainfall (in)	5
Total Runoff (in)	0.35
Peak Runoff (cfs)	0.02
Weighted Curve Number	43
Time of Concentration (days hh:mm:ss)	0 00:23:46

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

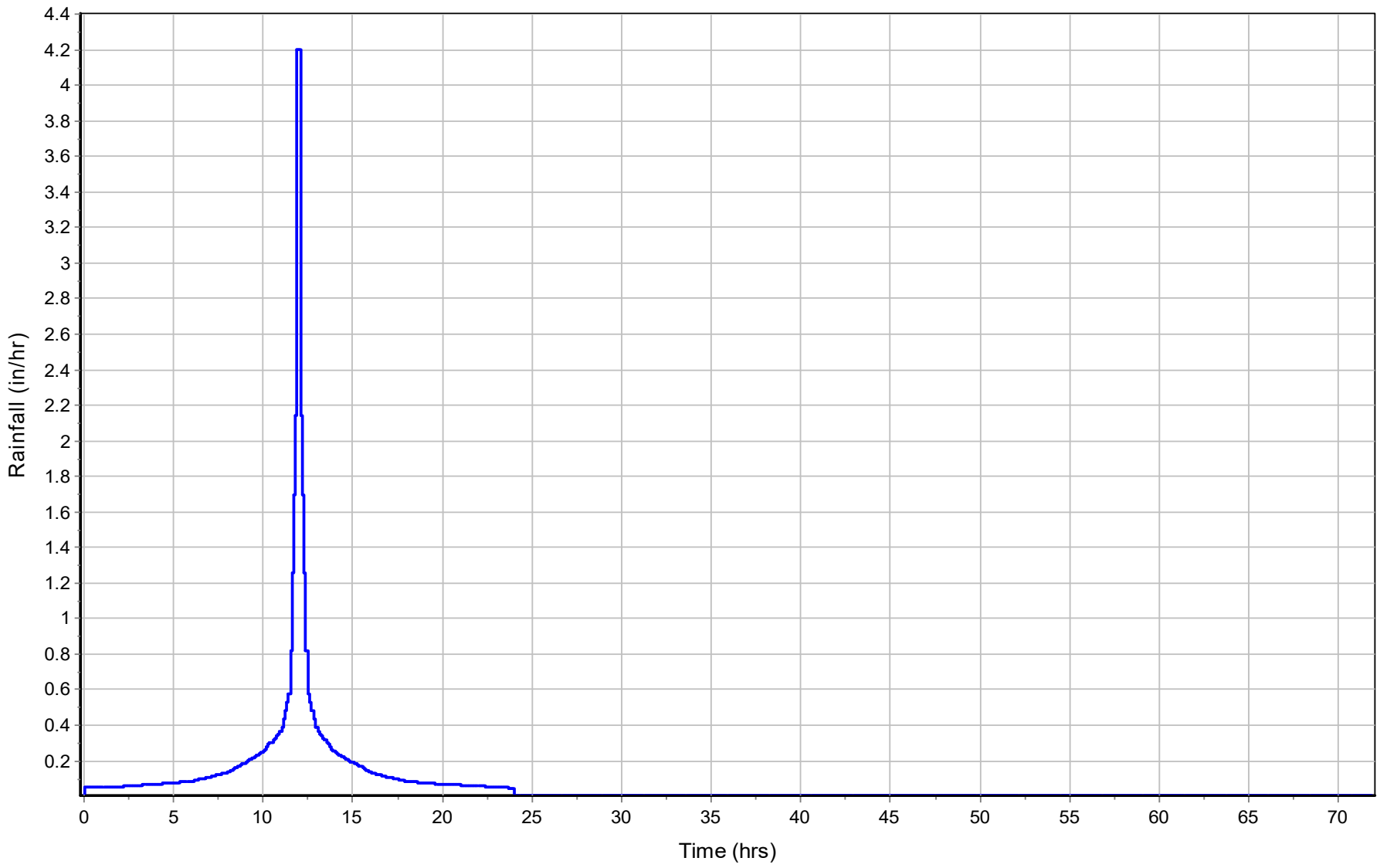
Total TOC (min) 7.35

Subbasin Runoff Results

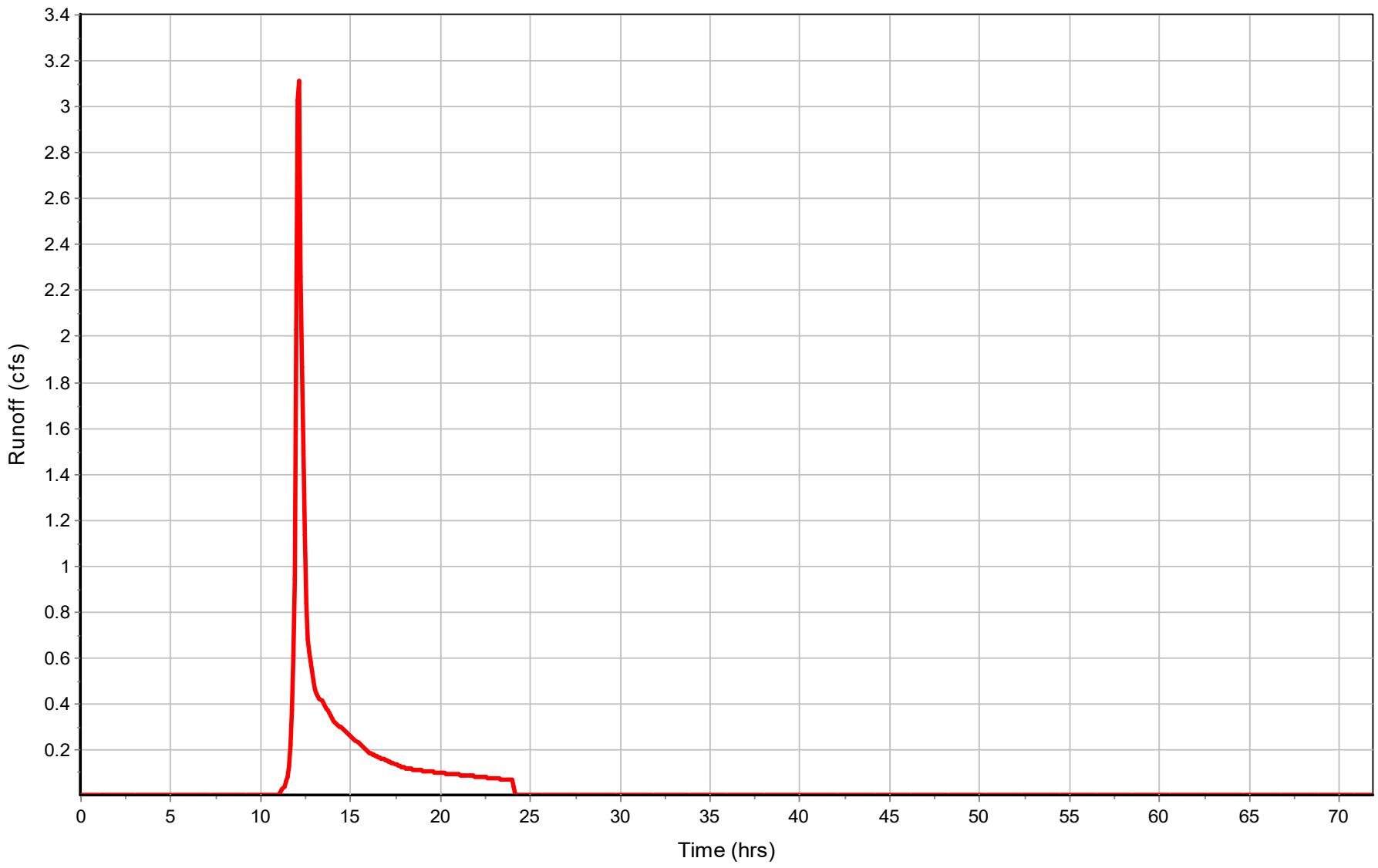
Total Rainfall (in) 5
Total Runoff (in) 1.42
Peak Runoff (cfs) 3.35
Weighted Curve Number 61.66
Time of Concentration (days hh:mm:ss) 0 00:07:21

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

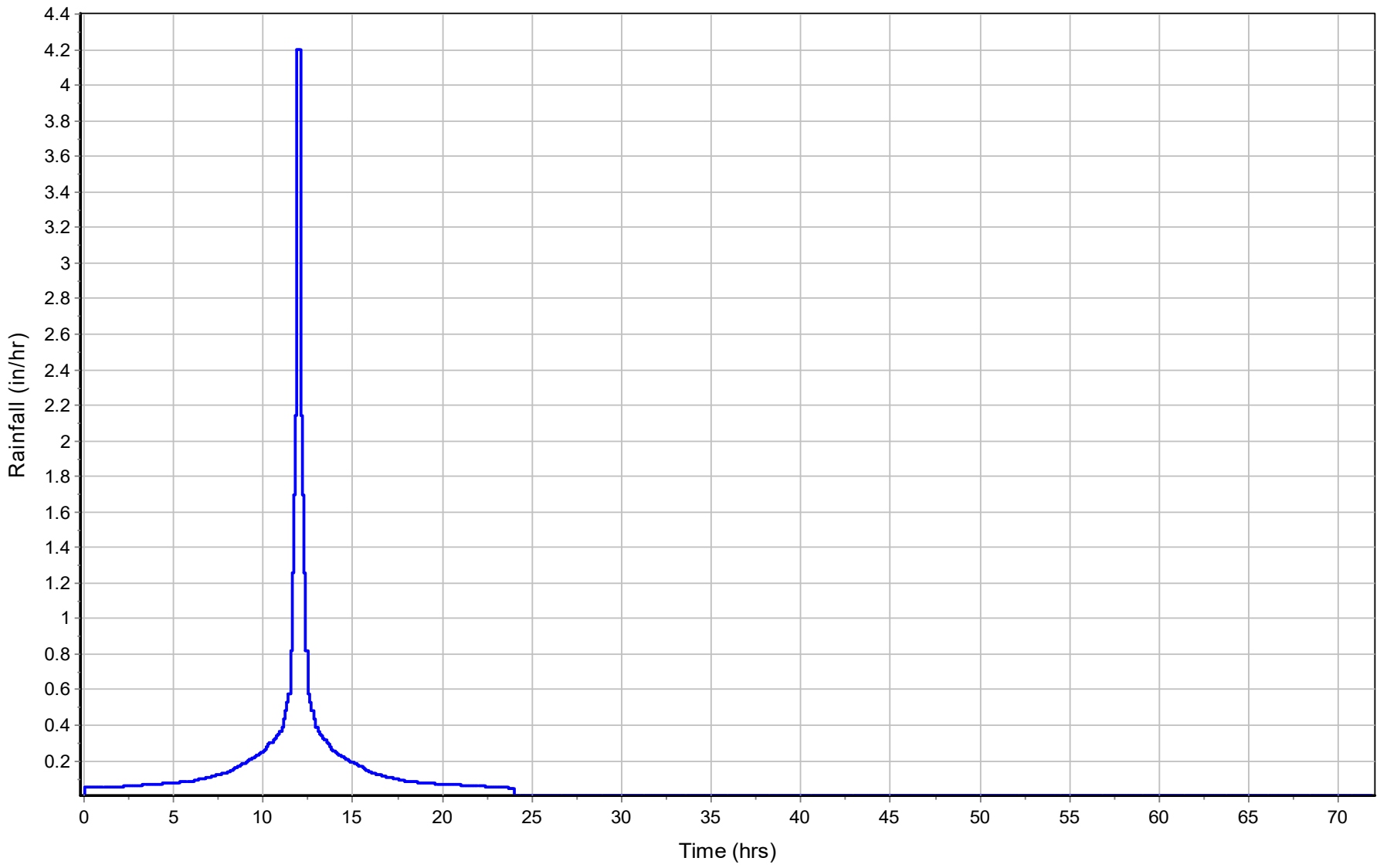
Total TOC (min) 23.82

Subbasin Runoff Results

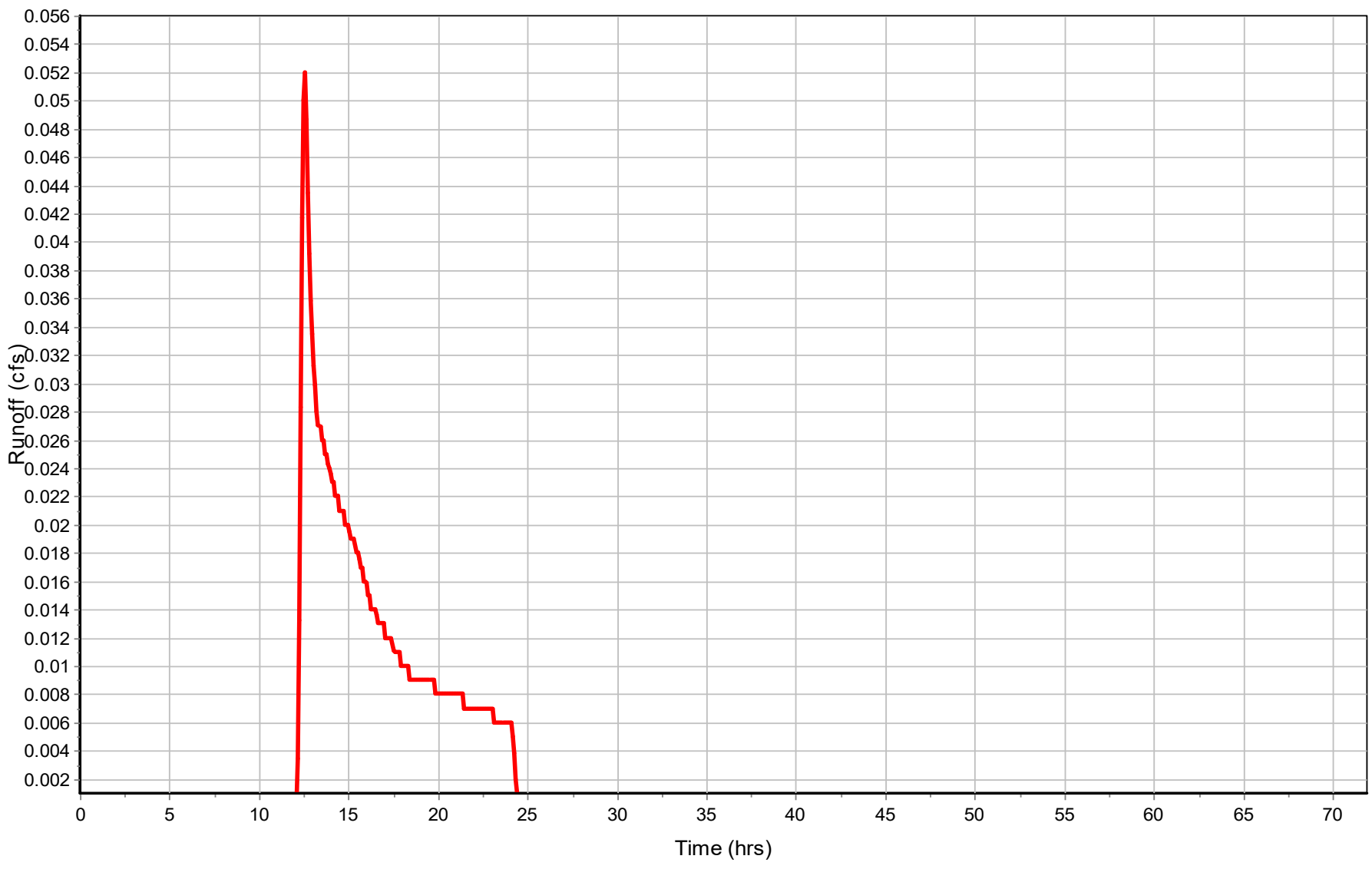
Total Rainfall (in) 5
Total Runoff (in) 0.35
Peak Runoff (cfs) 0.05
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:23:49

Subbasin : Sub-E03

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A1

Input Data

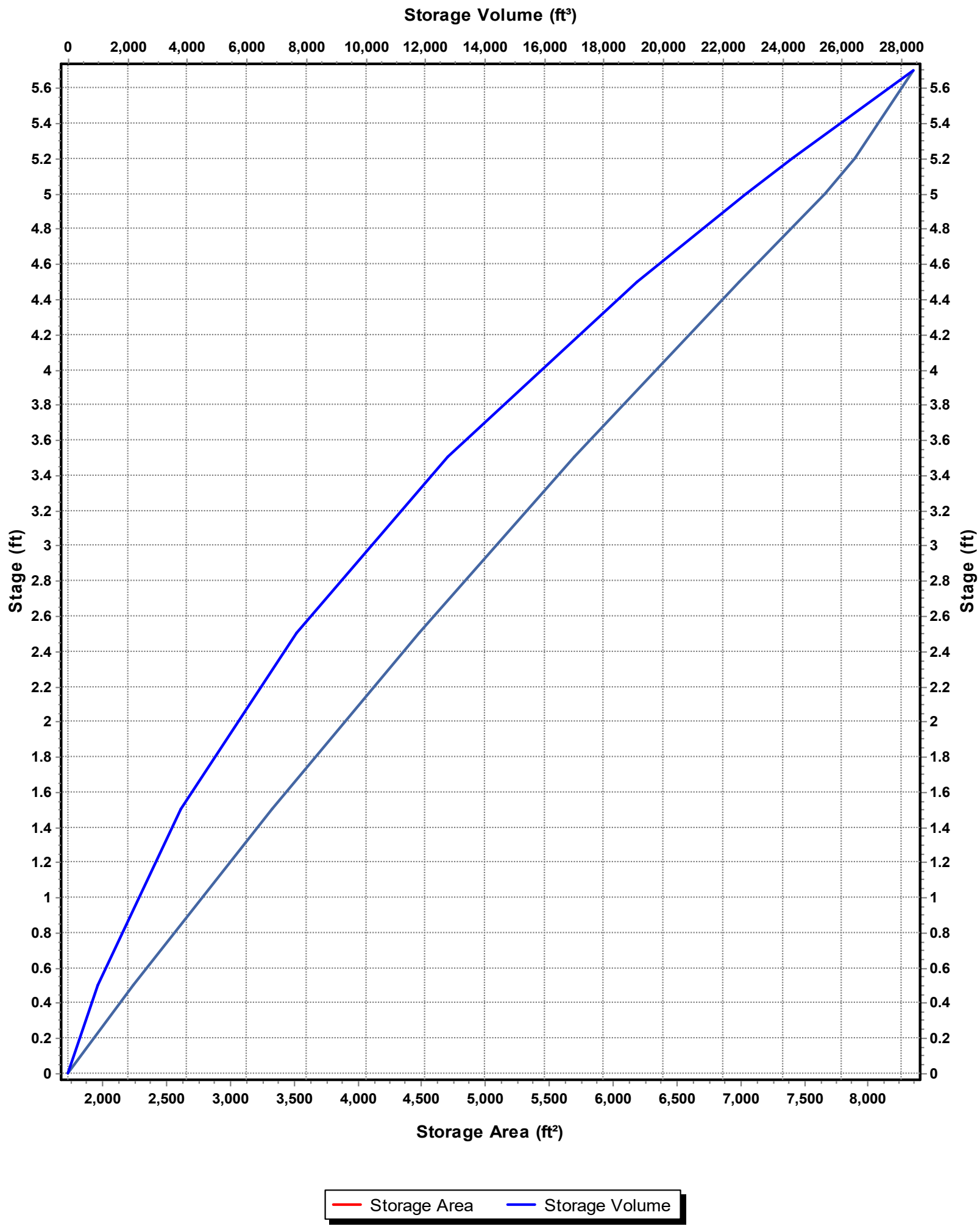
Invert Elevation (ft)	57.50
Max (Rim) Elevation (ft)	63.20
Max (Rim) Offset (ft)	5.70
Initial Water Elevation (ft)	57.50
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

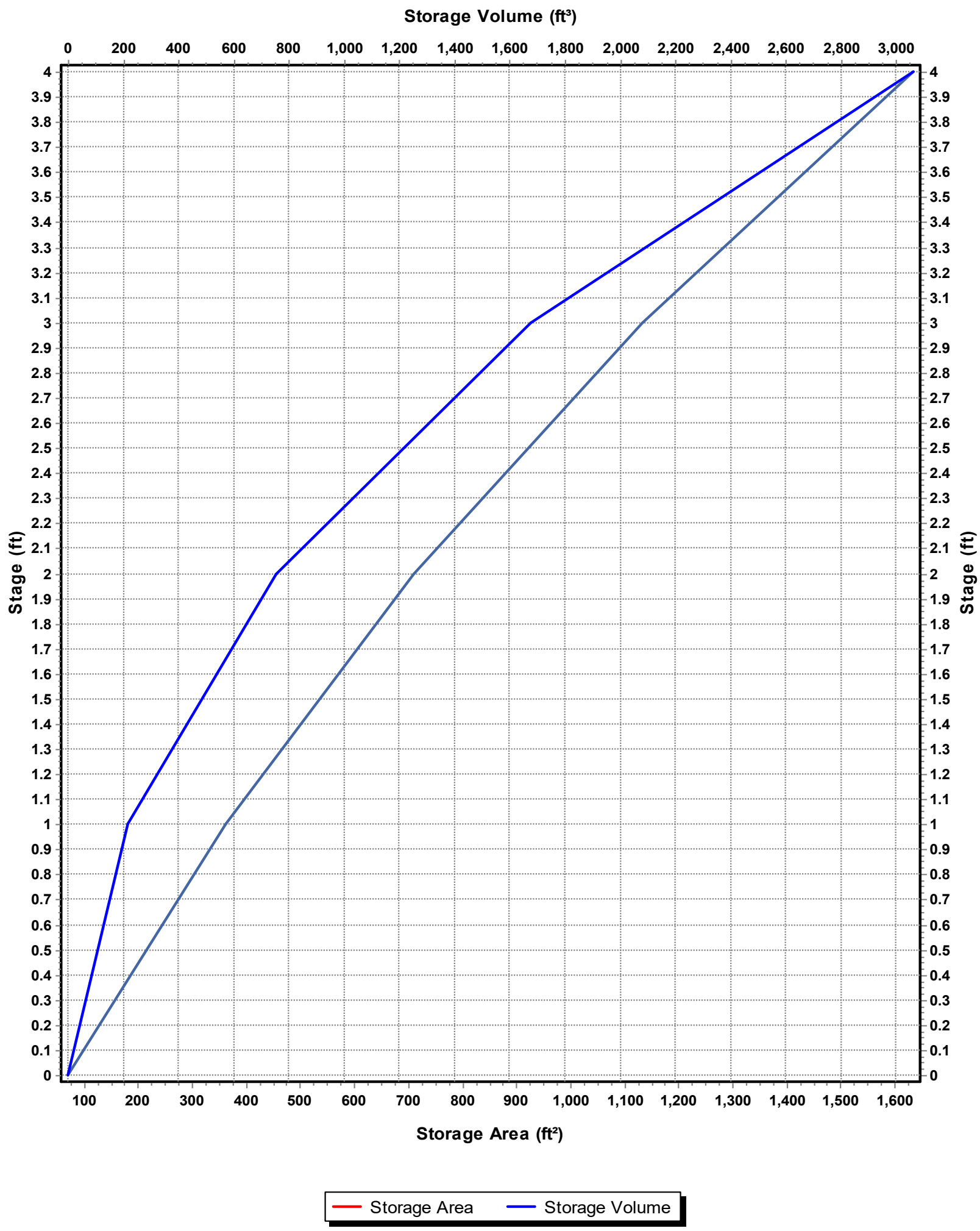
Invert Elevation (ft)	59.20
Max (Rim) Elevation (ft)	63.20
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	59.20
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

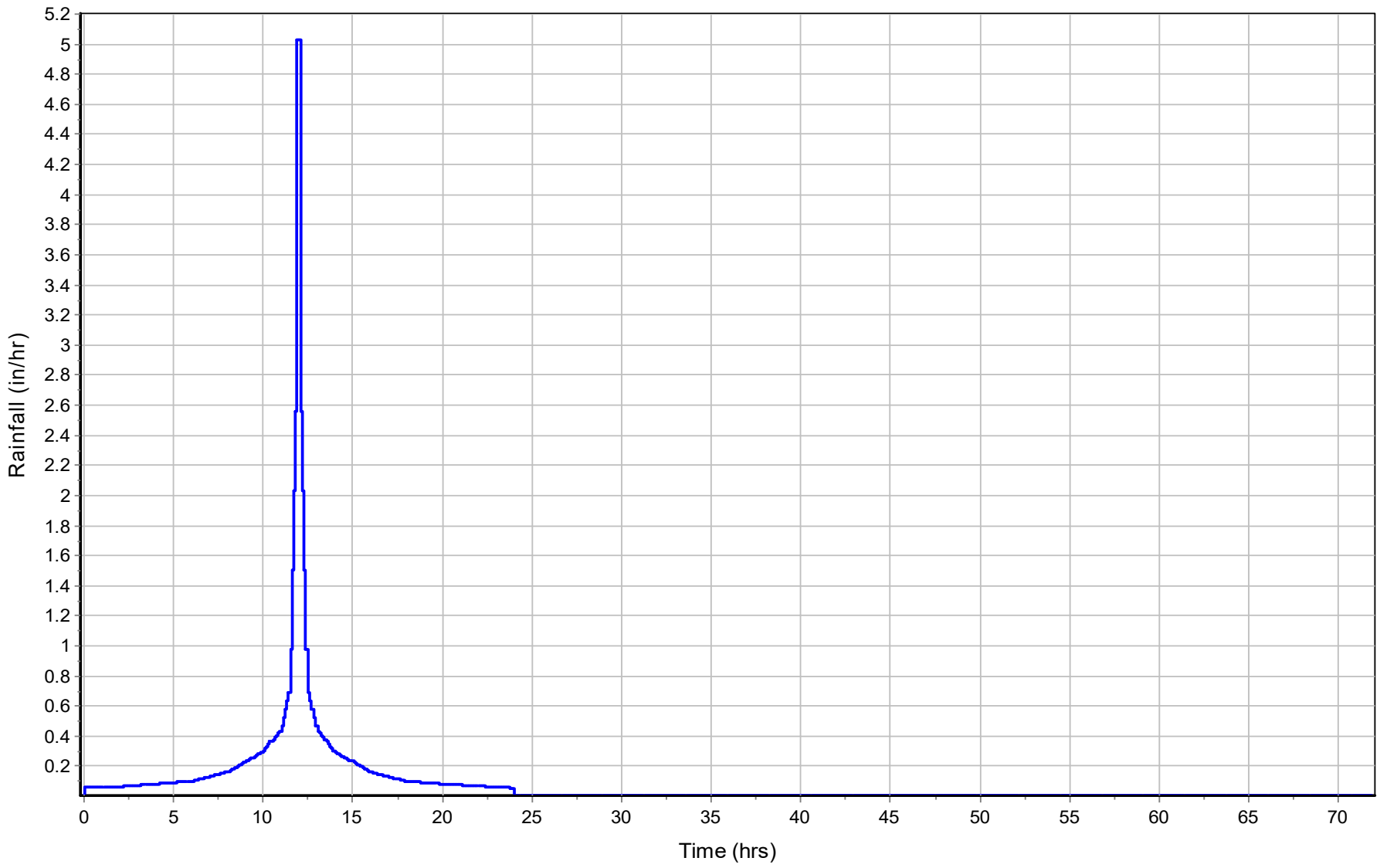
Total TOC (min) 23.77

Subbasin Runoff Results

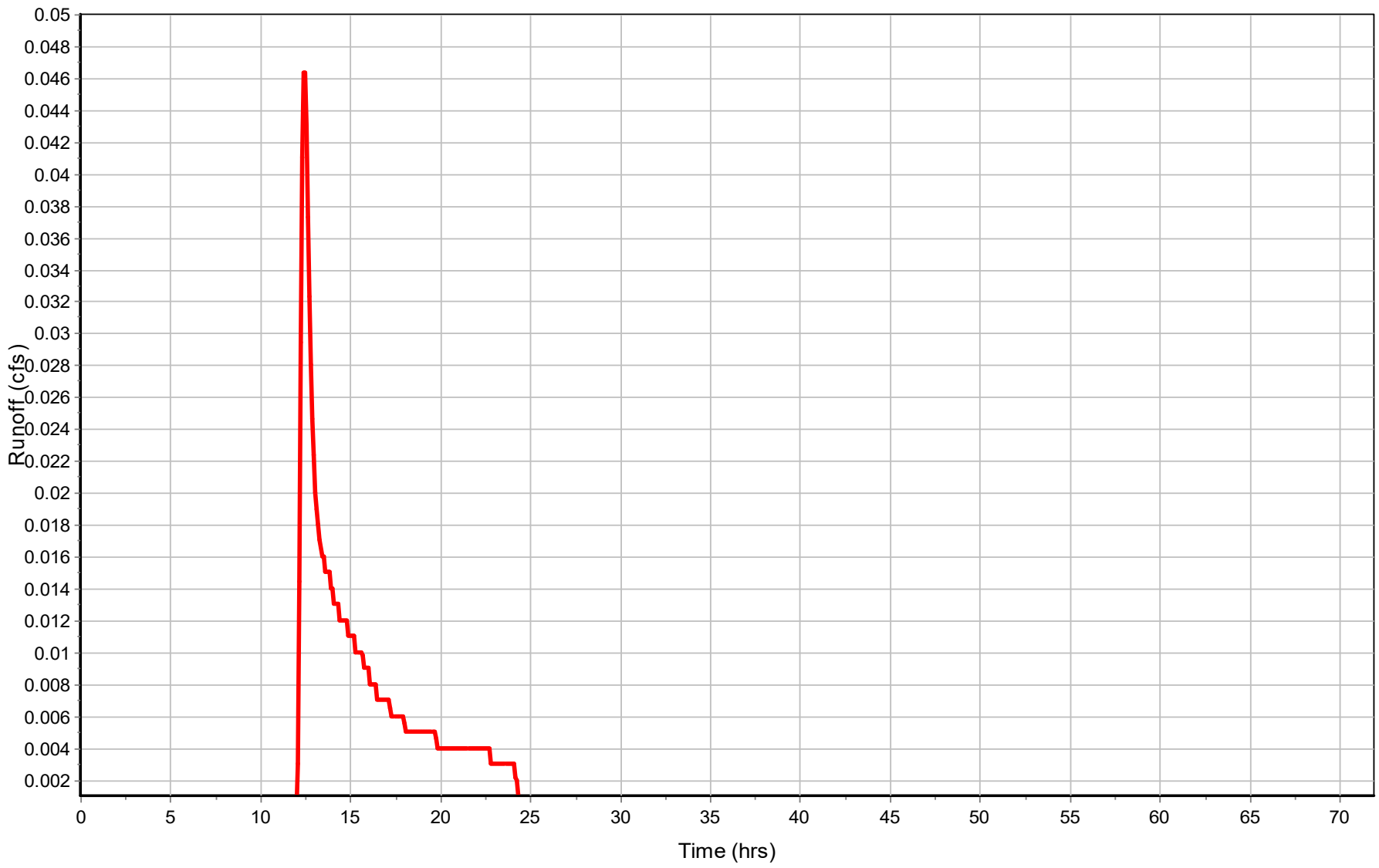
Total Rainfall (in)	5.98
Total Runoff (in)	0.67
Peak Runoff (cfs)	0.05
Weighted Curve Number	43
Time of Concentration (days hh:mm:ss)	0 00:23:46

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

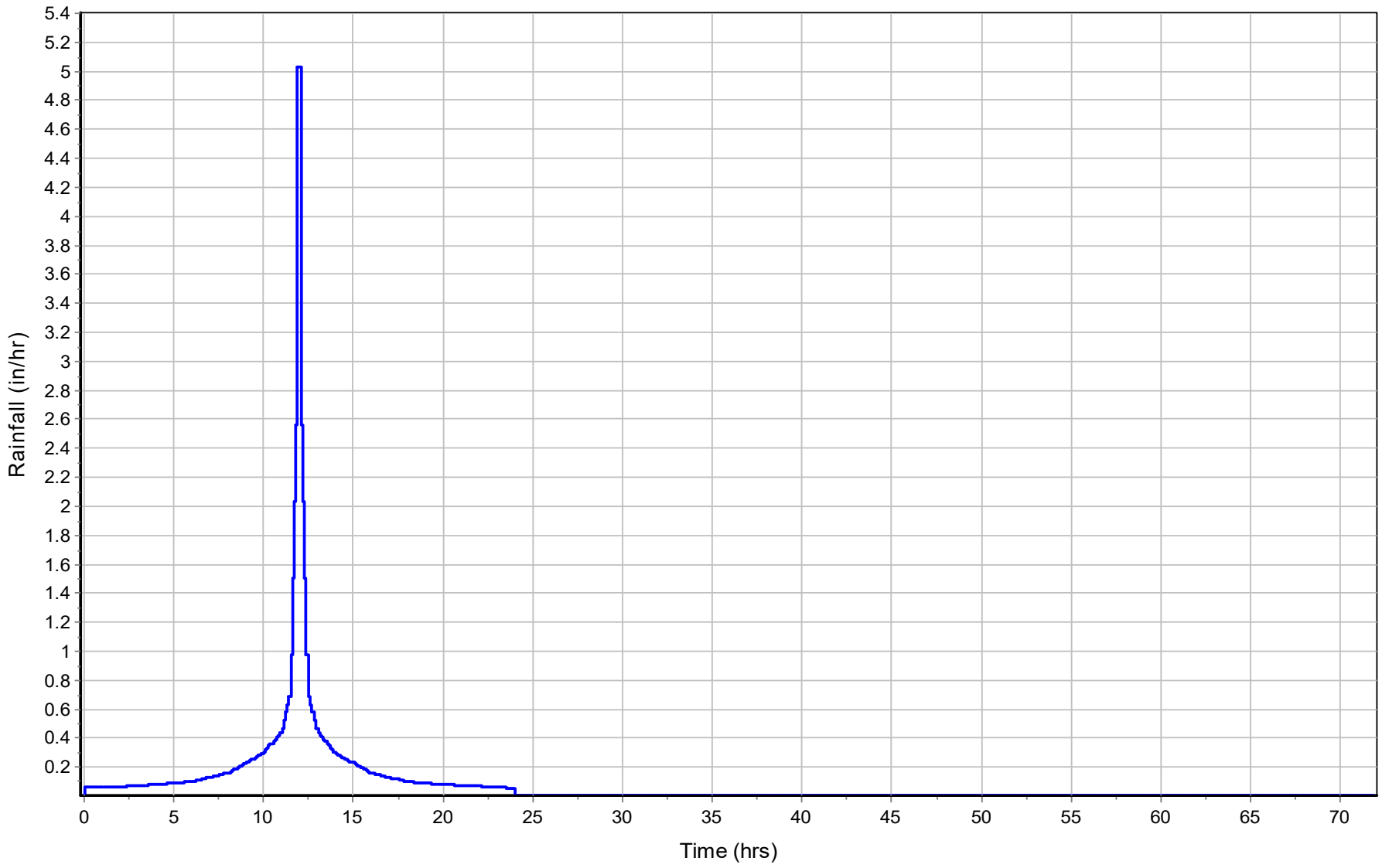
Total TOC (min) 7.35

Subbasin Runoff Results

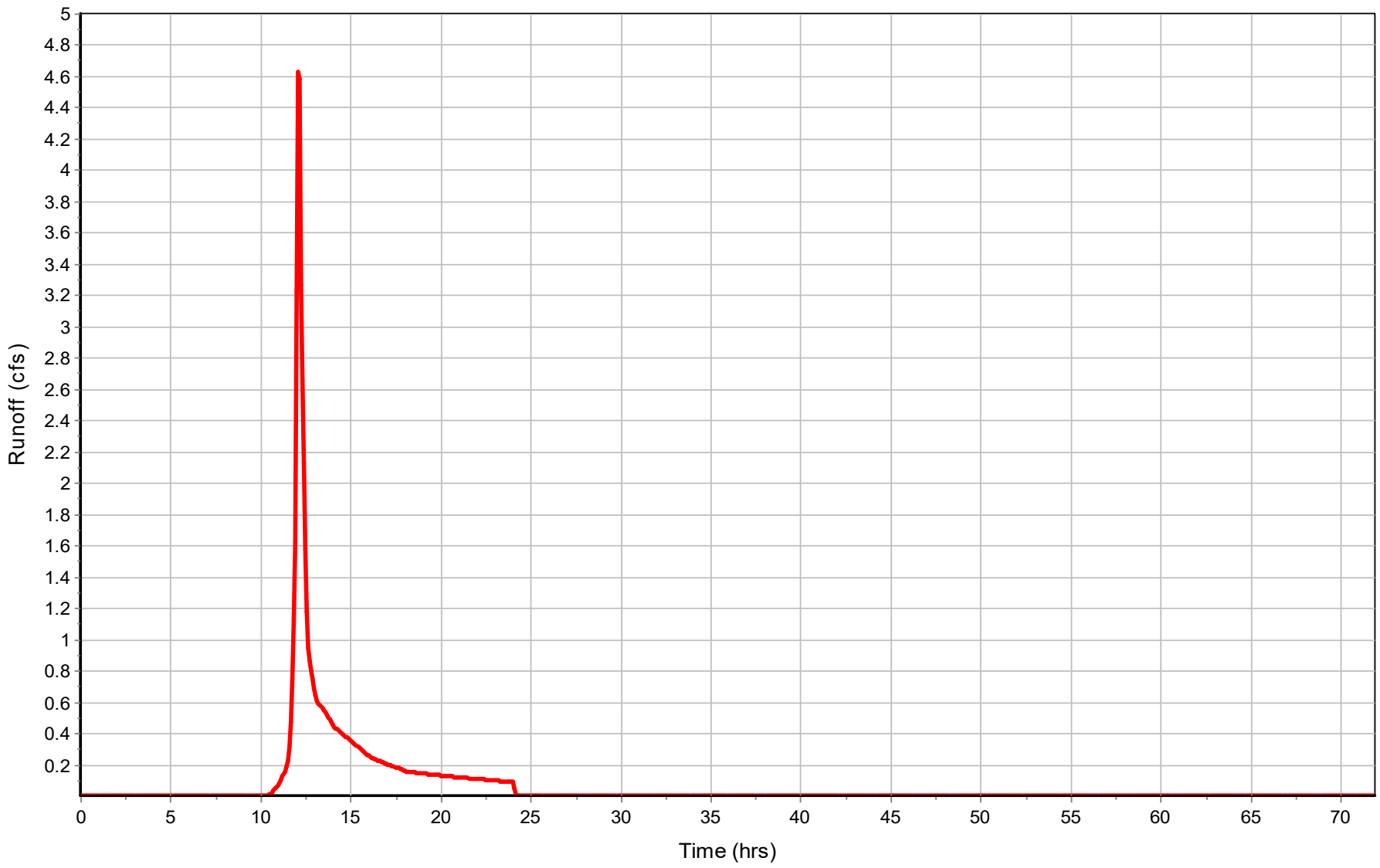
Total Rainfall (in) 5.98
Total Runoff (in) 2.05
Peak Runoff (cfs) 5
Weighted Curve Number 61.66
Time of Concentration (days hh:mm:ss) 0 00:07:21

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

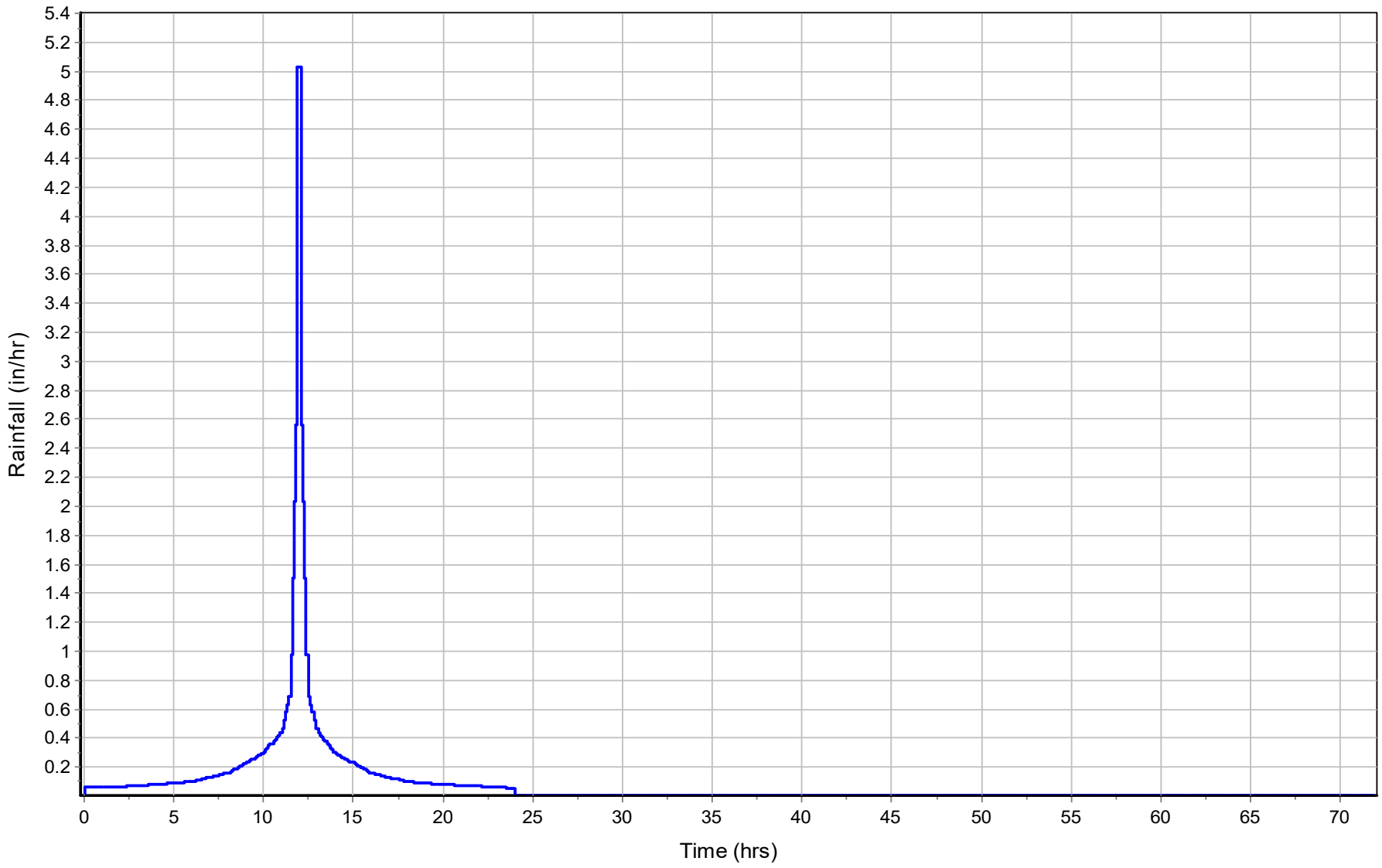
Total TOC (min) 23.82

Subbasin Runoff Results

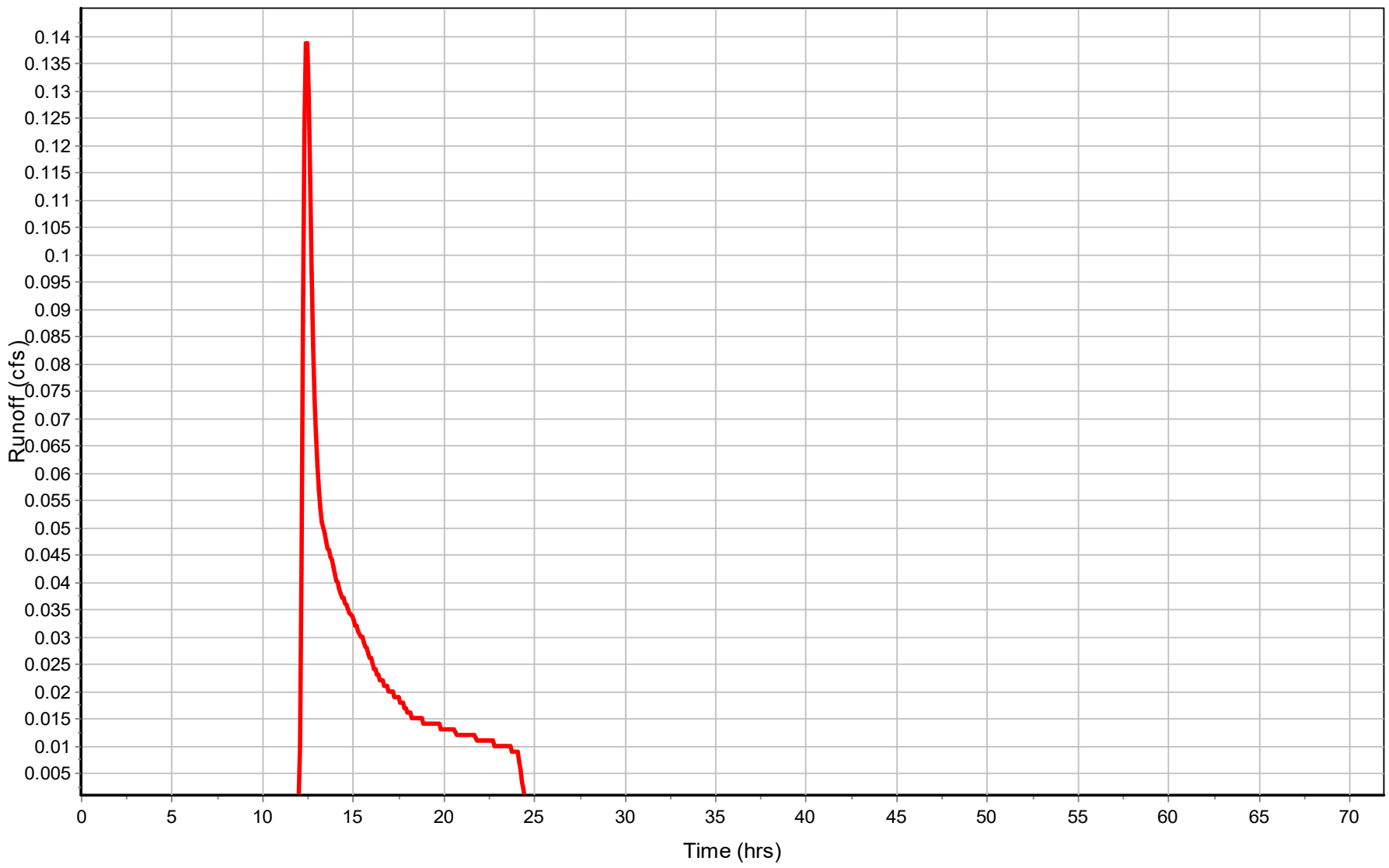
Total Rainfall (in) 5.98
Total Runoff (in) 0.67
Peak Runoff (cfs) 0.14
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:23:49

Subbasin : Sub-E03

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A1

Input Data

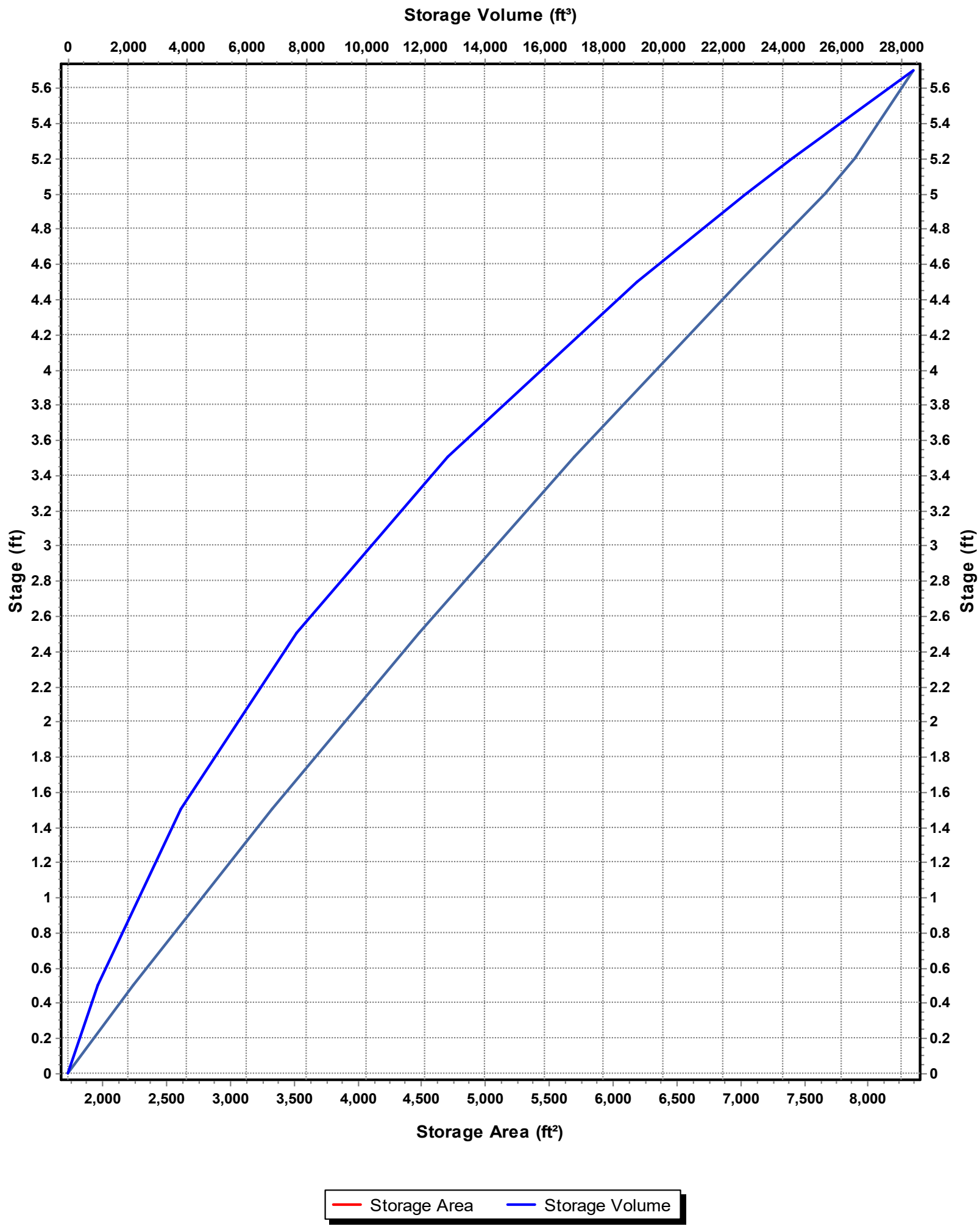
Invert Elevation (ft)	57.50
Max (Rim) Elevation (ft)	63.20
Max (Rim) Offset (ft)	5.70
Initial Water Elevation (ft)	57.50
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

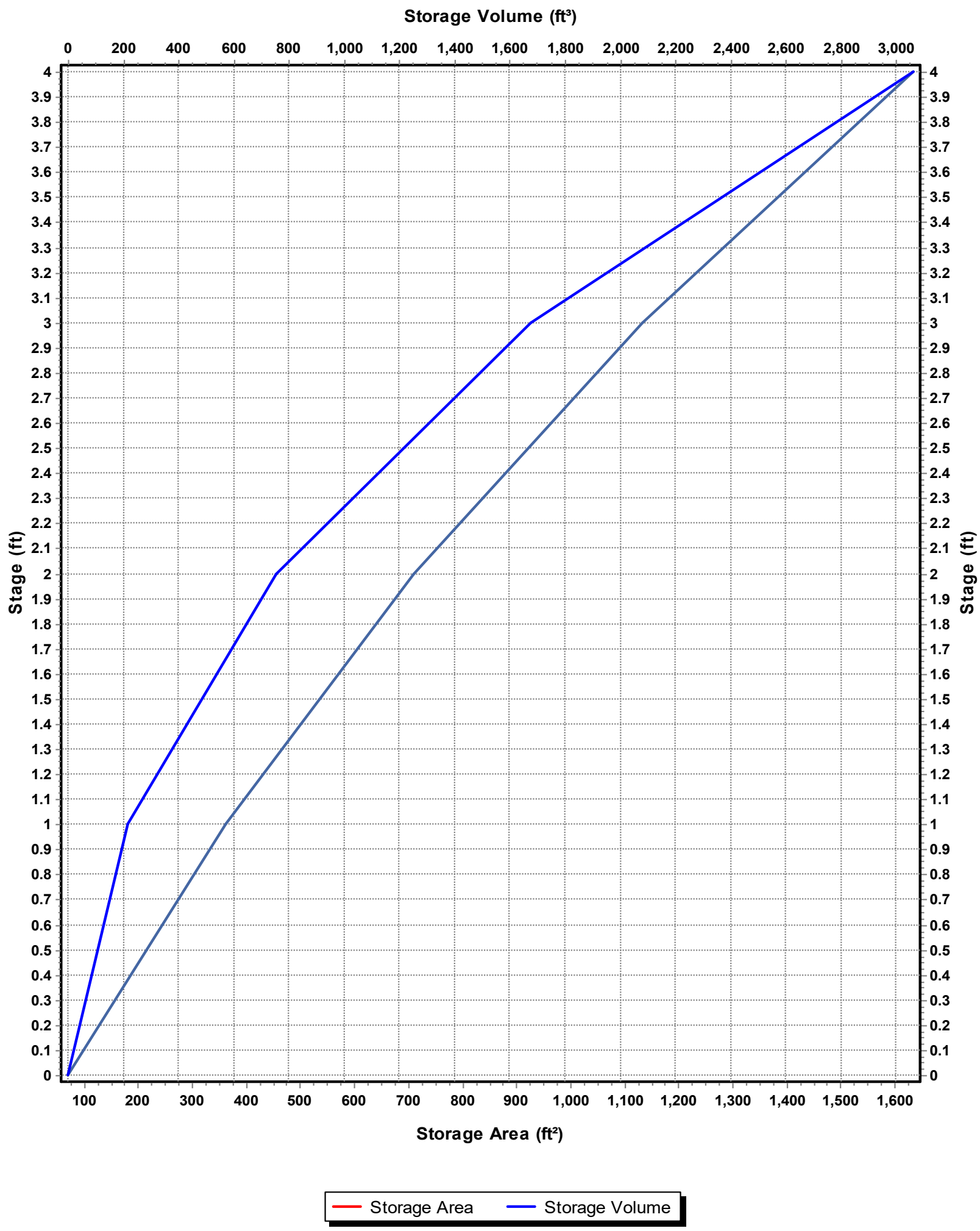
Invert Elevation (ft)	59.20
Max (Rim) Elevation (ft)	63.20
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	59.20
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

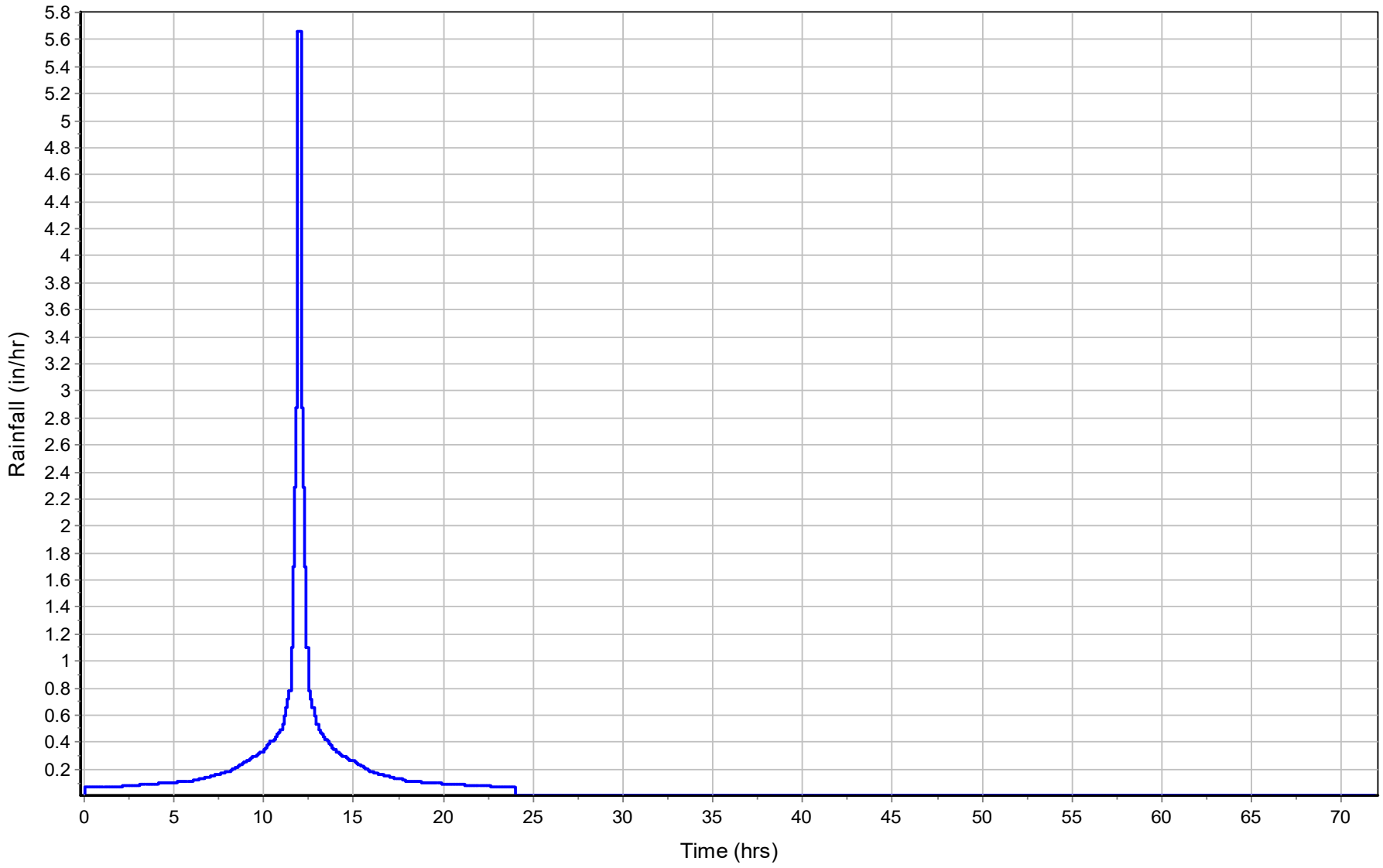
Total TOC (min) 23.77

Subbasin Runoff Results

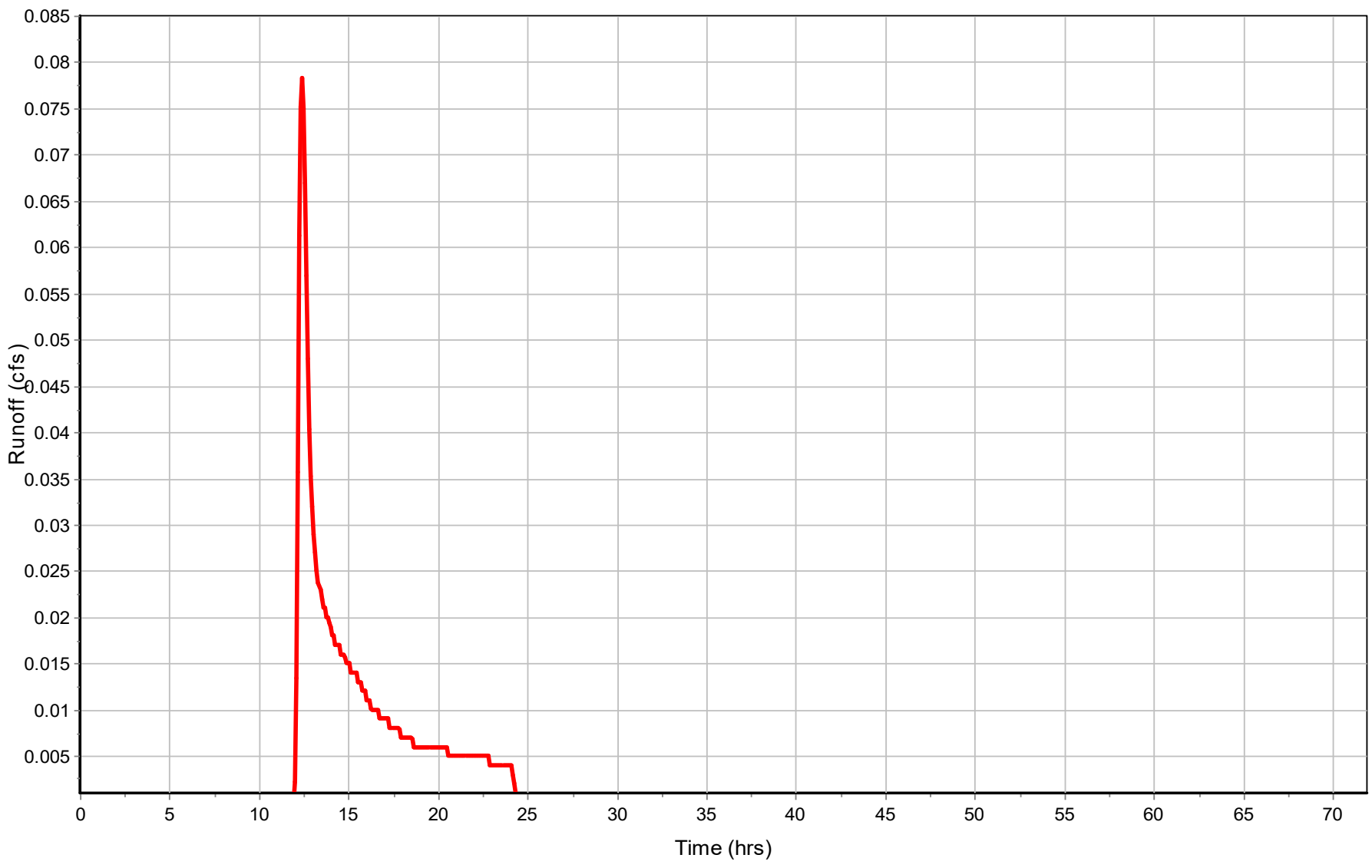
Total Rainfall (in)	6.73
Total Runoff (in)	0.96
Peak Runoff (cfs)	0.08
Weighted Curve Number	43
Time of Concentration (days hh:mm:ss)	0 00:23:46

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

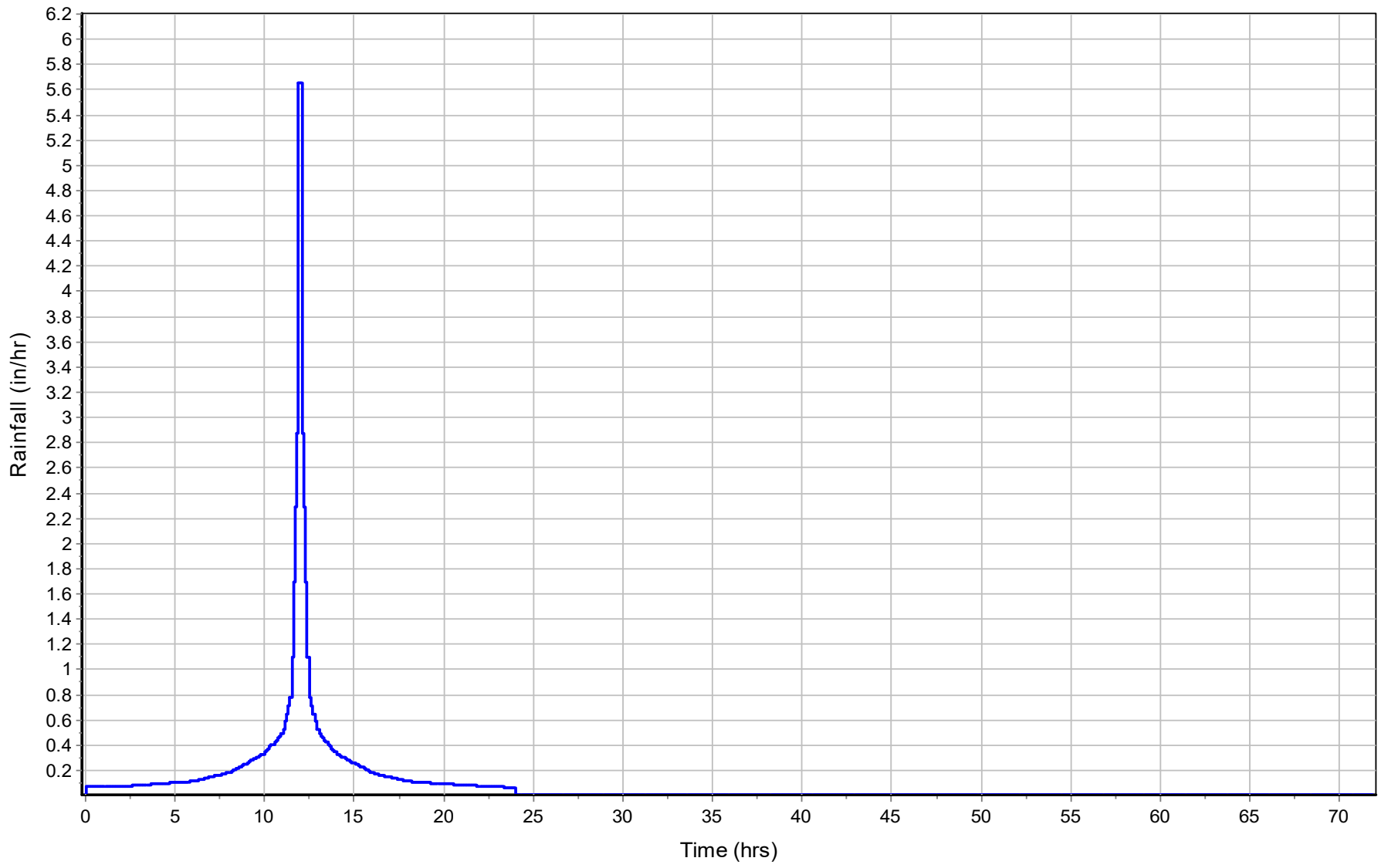
Total TOC (min) 7.35

Subbasin Runoff Results

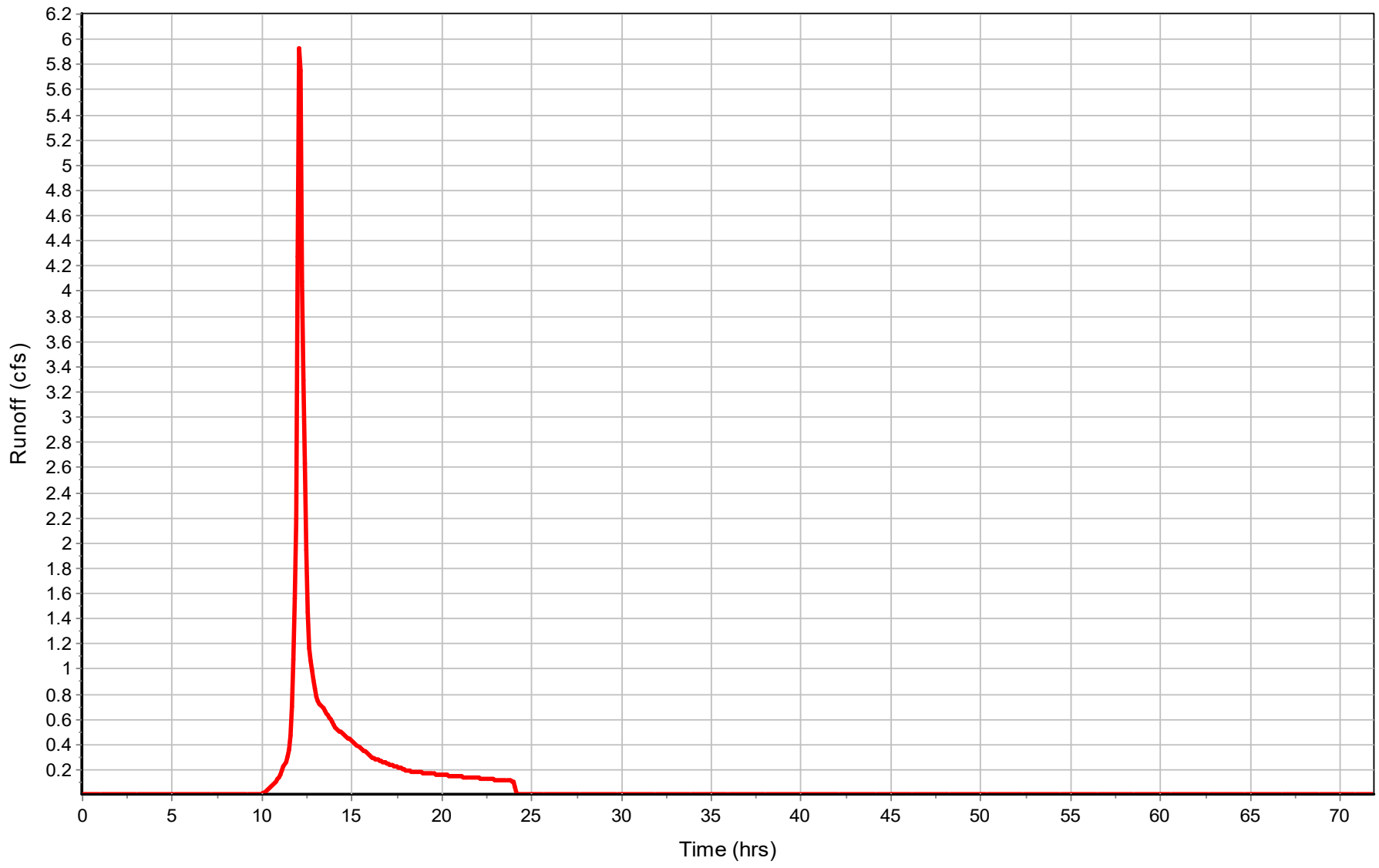
Total Rainfall (in) 6.73
Total Runoff (in) 2.57
Peak Runoff (cfs) 6.35
Weighted Curve Number 61.66
Time of Concentration (days hh:mm:ss) 0 00:07:21

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

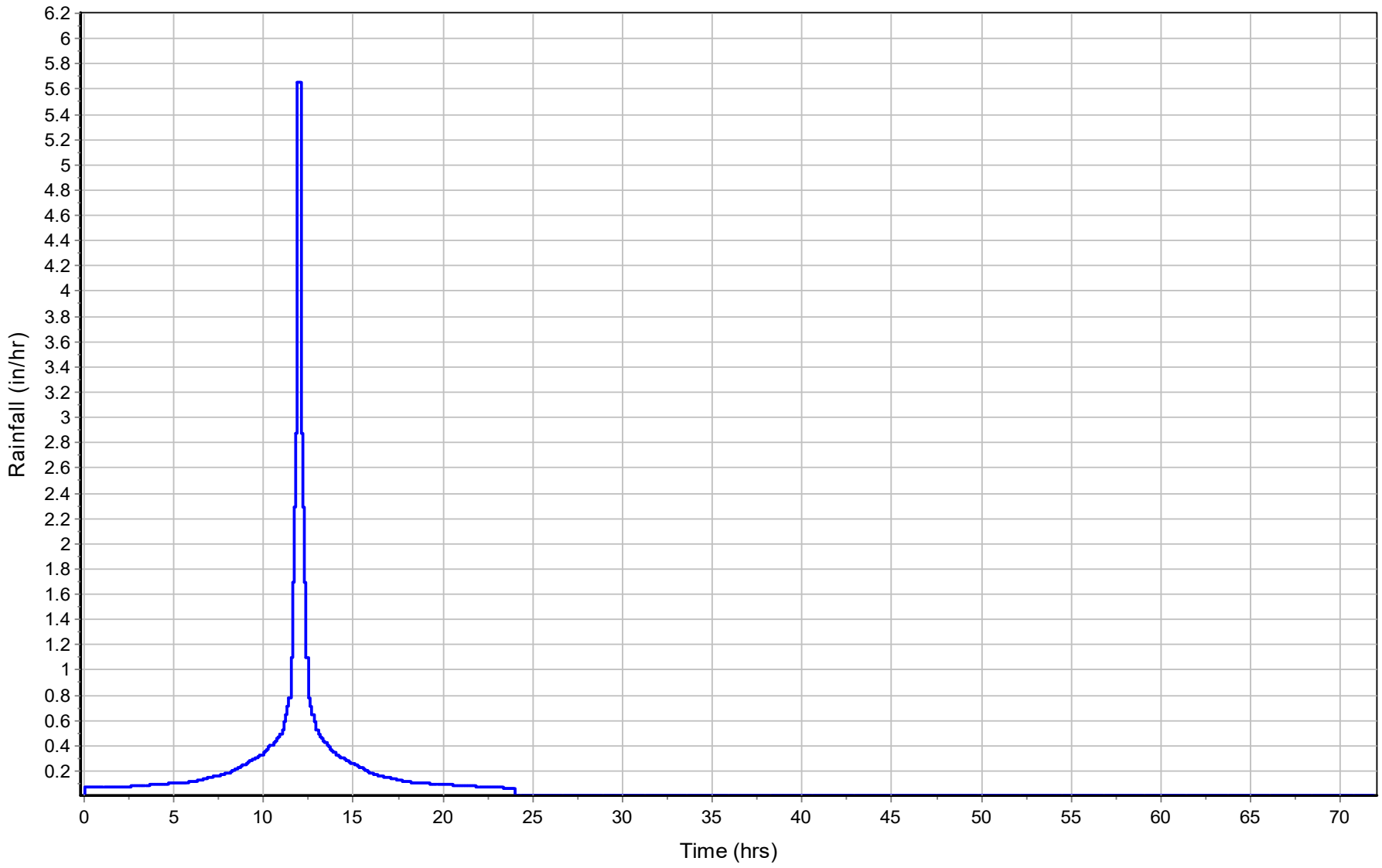
Total TOC (min) 23.82

Subbasin Runoff Results

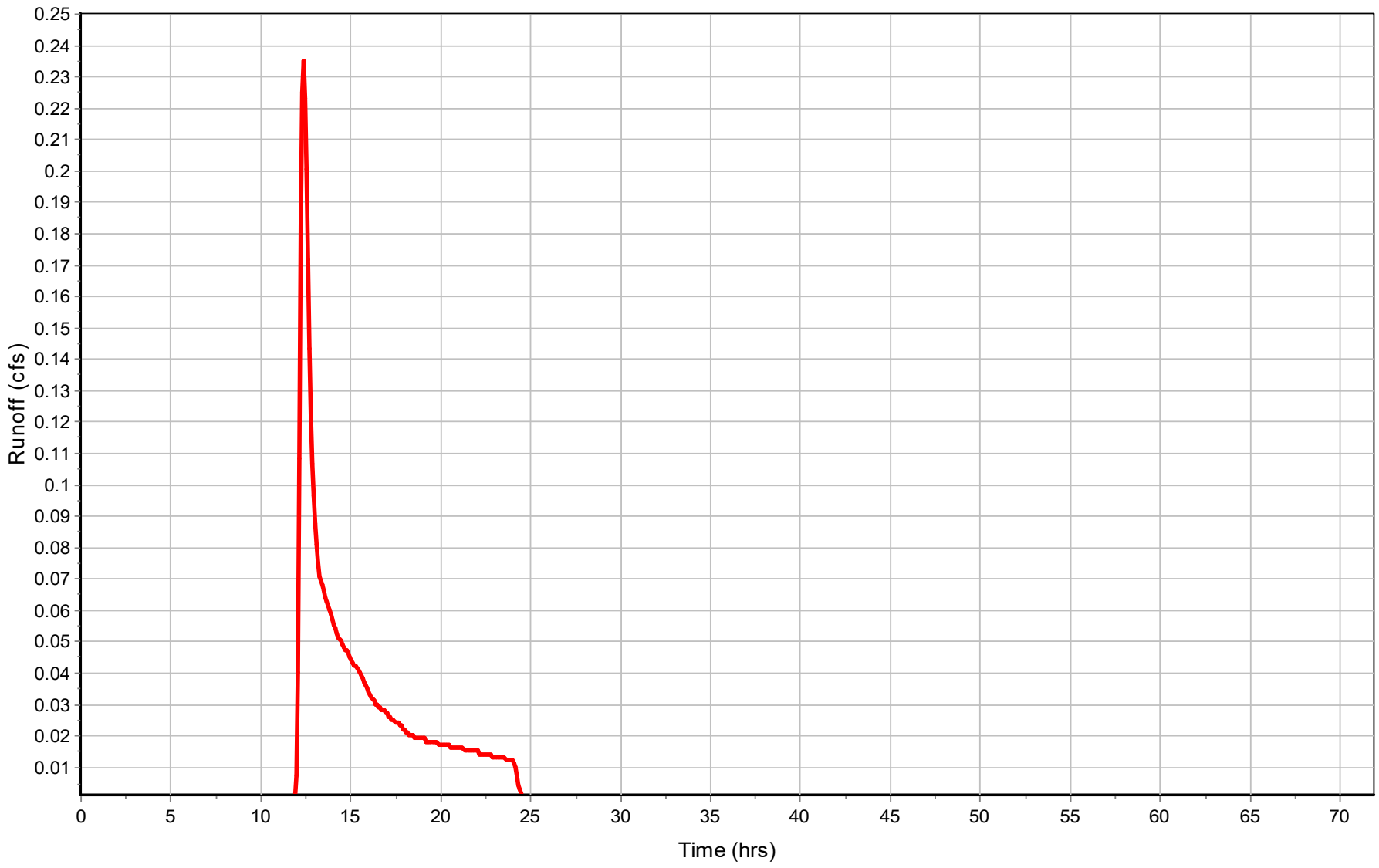
Total Rainfall (in) 6.73
Total Runoff (in) 0.96
Peak Runoff (cfs) 0.24
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:23:49

Subbasin : Sub-E03

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A1

Input Data

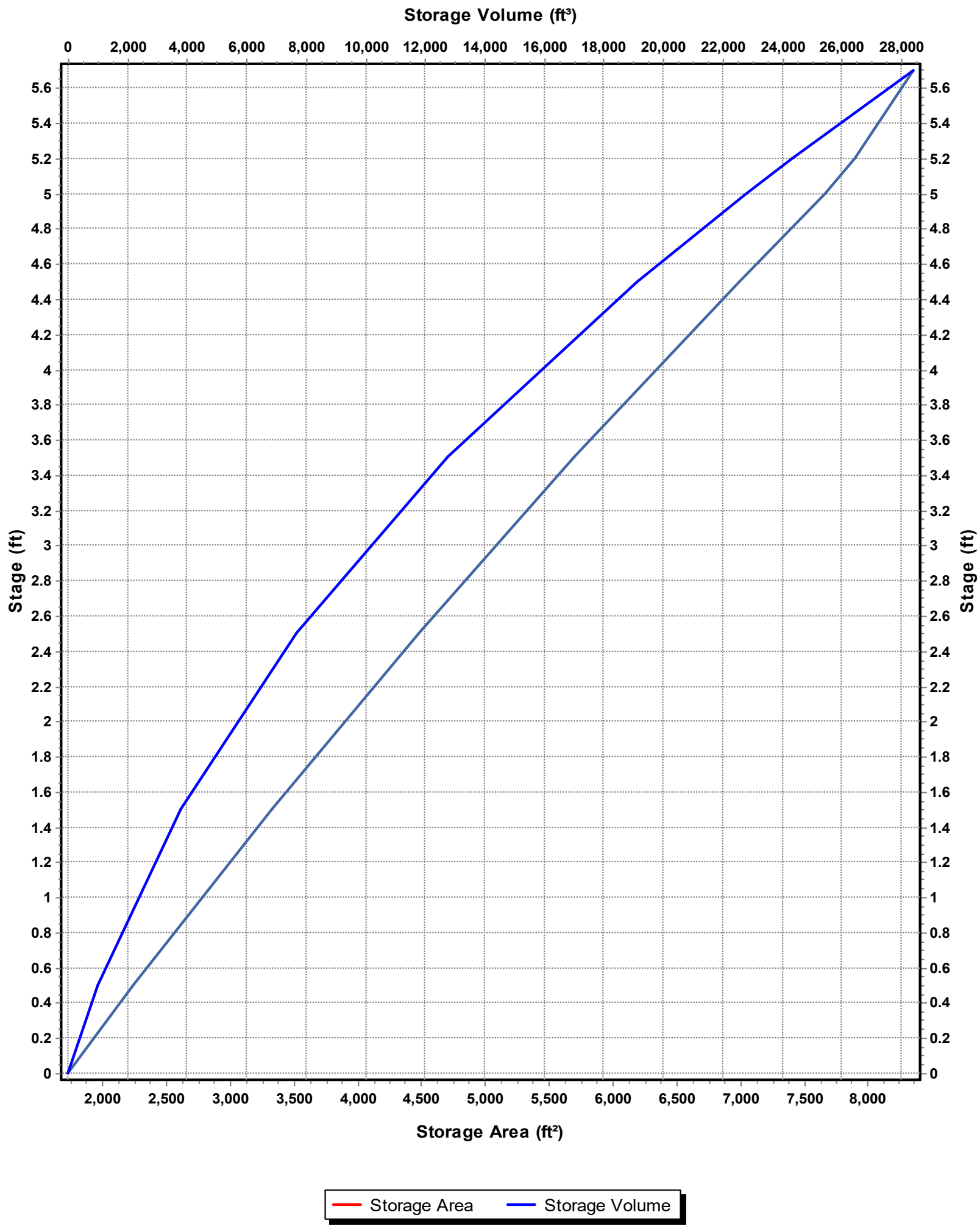
Invert Elevation (ft)	57.50
Max (Rim) Elevation (ft)	63.20
Max (Rim) Offset (ft)	5.70
Initial Water Elevation (ft)	57.50
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

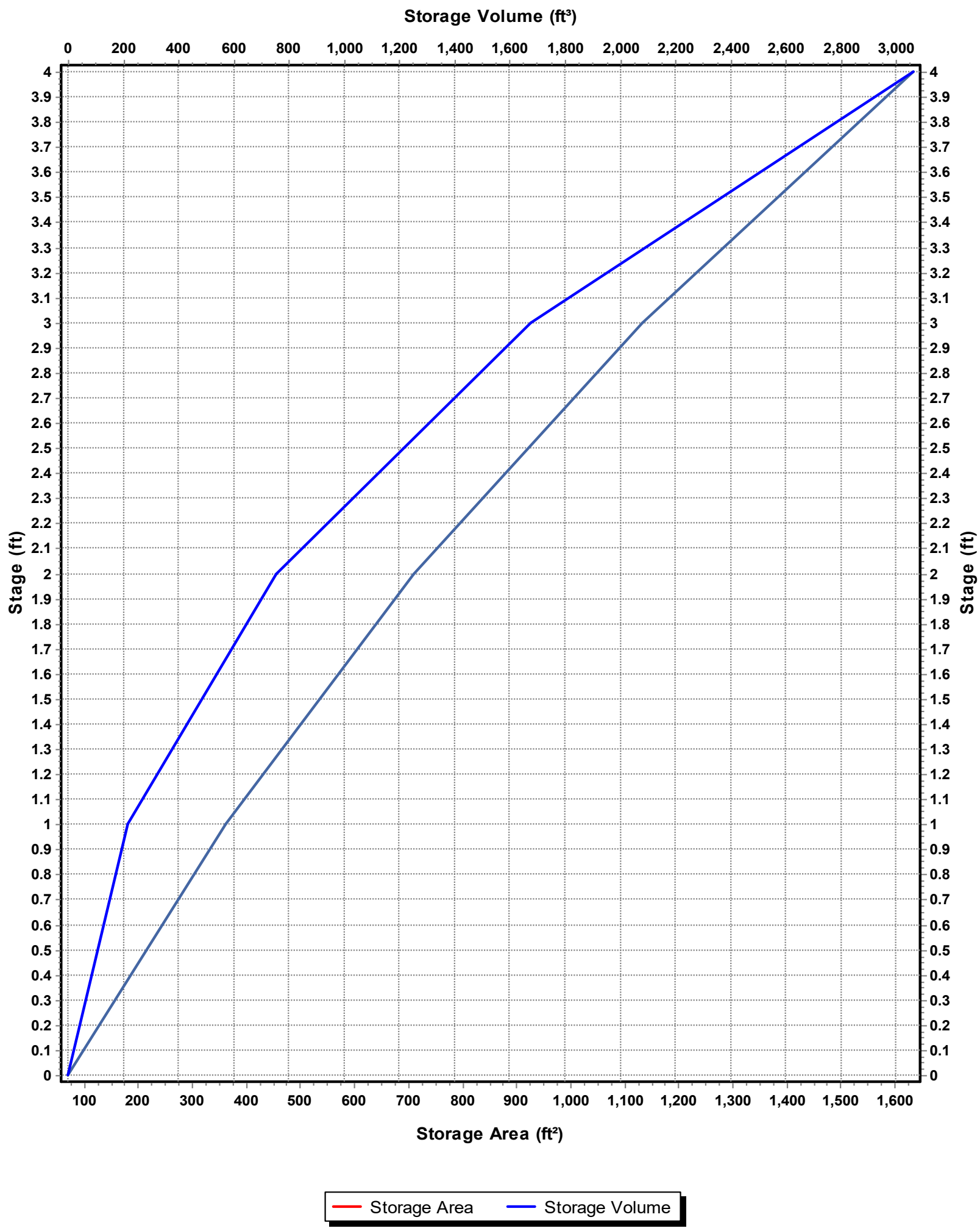
Invert Elevation (ft)	59.20
Max (Rim) Elevation (ft)	63.20
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	59.20
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

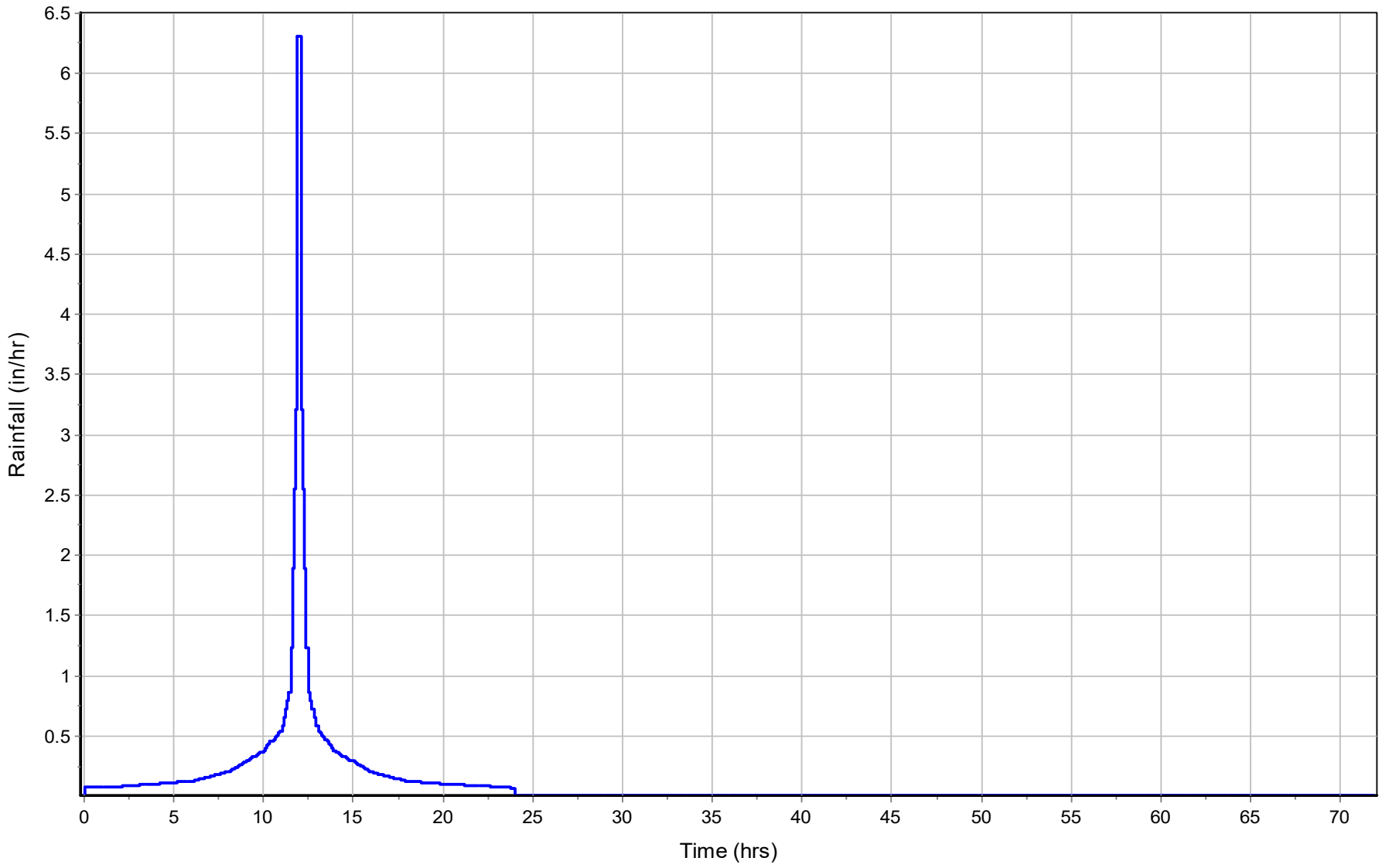
Total TOC (min) 23.77

Subbasin Runoff Results

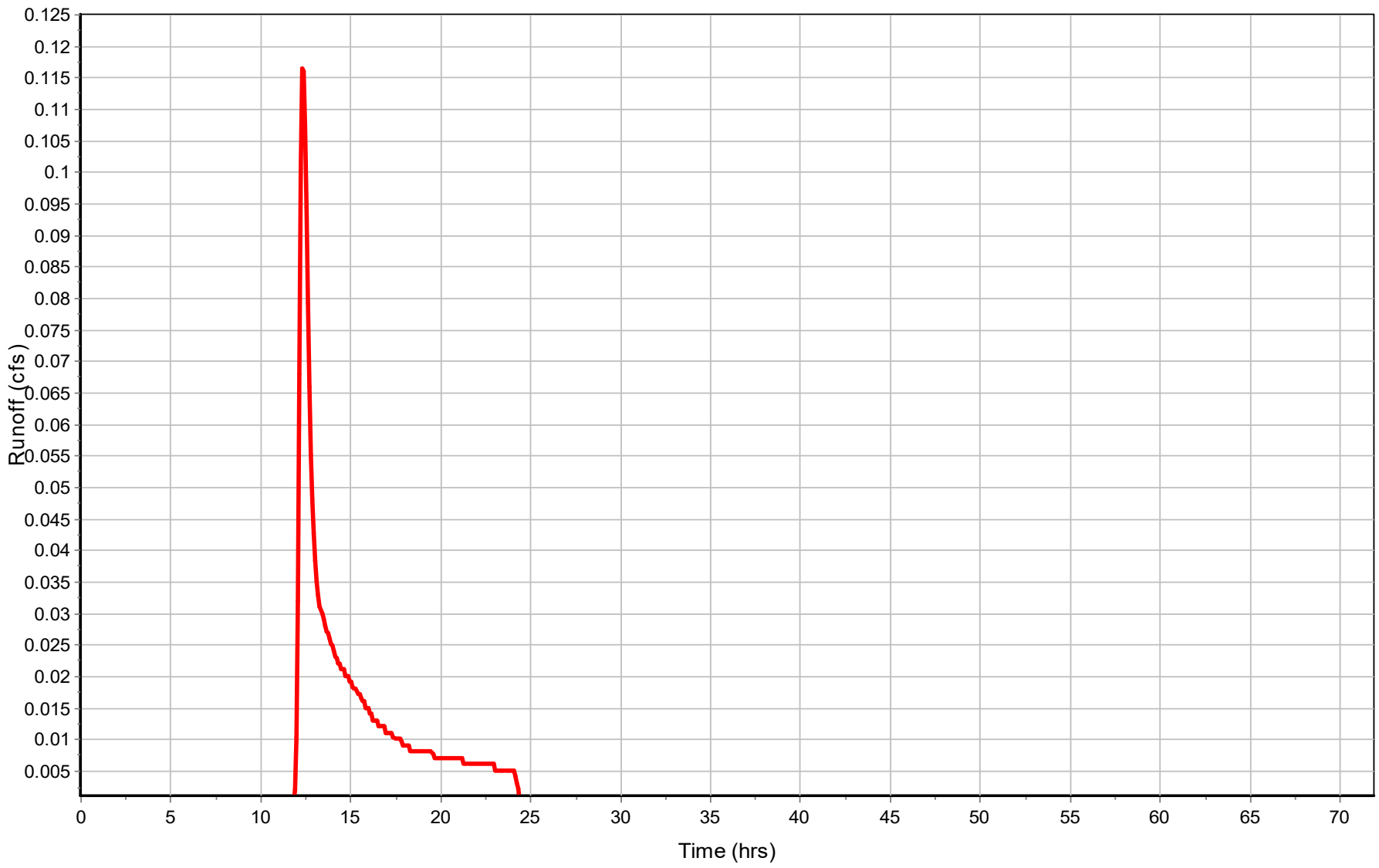
Total Rainfall (in)	7.5
Total Runoff (in)	1.3
Peak Runoff (cfs)	0.12
Weighted Curve Number	43
Time of Concentration (days hh:mm:ss)	0 00:23:46

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

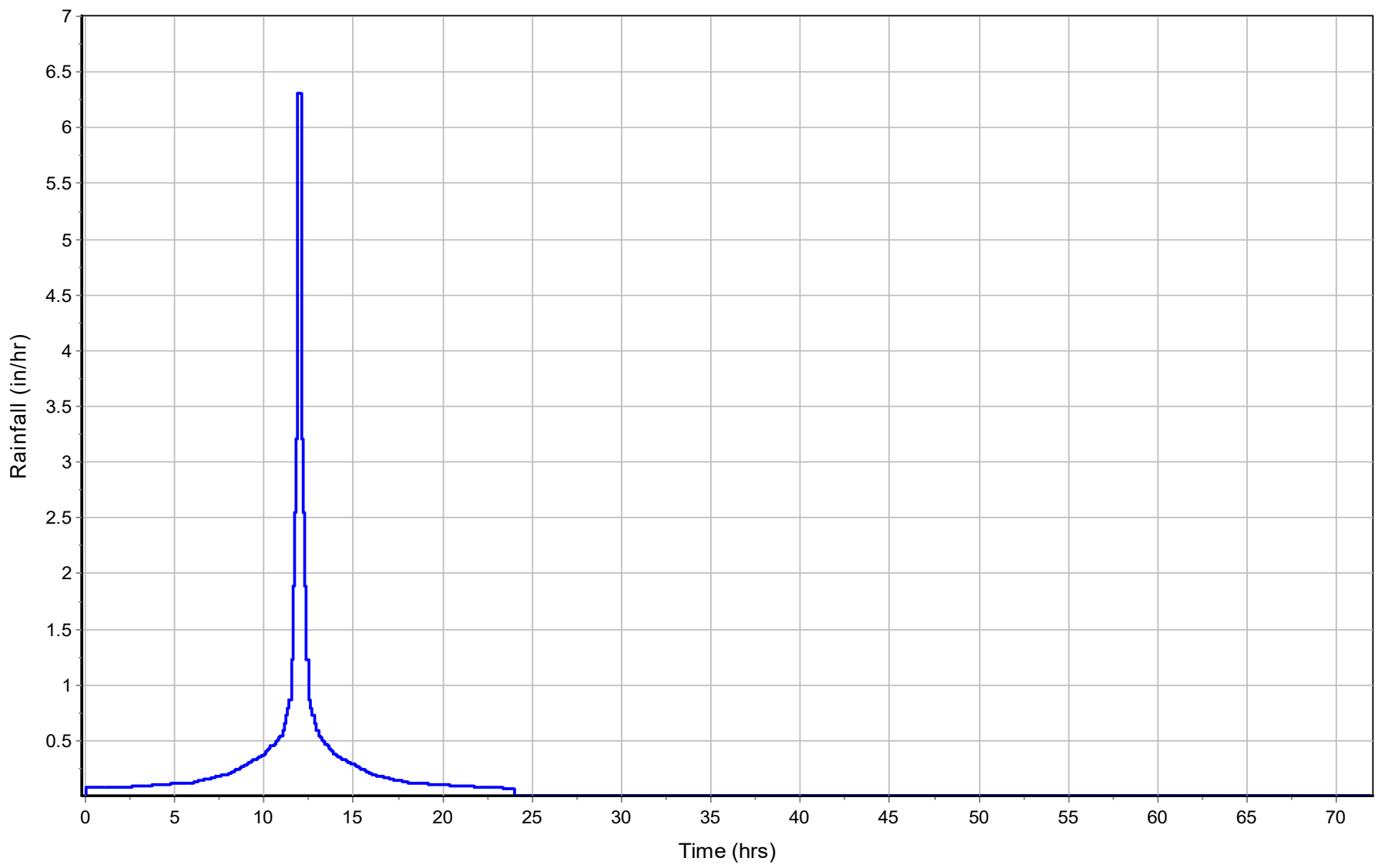
Total TOC (min) 7.35

Subbasin Runoff Results

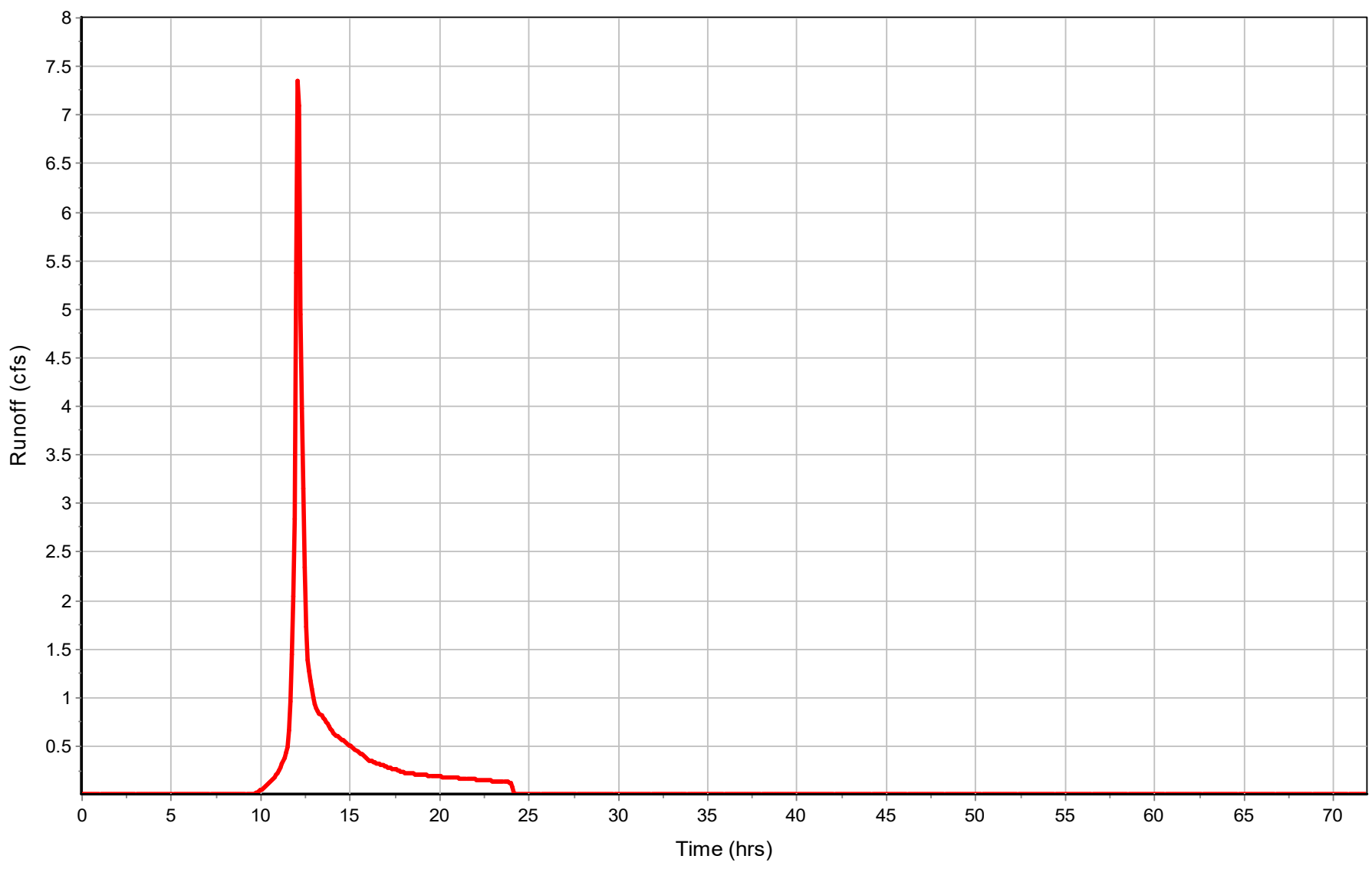
Total Rainfall (in) 7.5
Total Runoff (in) 3.14
Peak Runoff (cfs) 7.79
Weighted Curve Number 61.66
Time of Concentration (days hh:mm:ss) 0 00:07:21

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

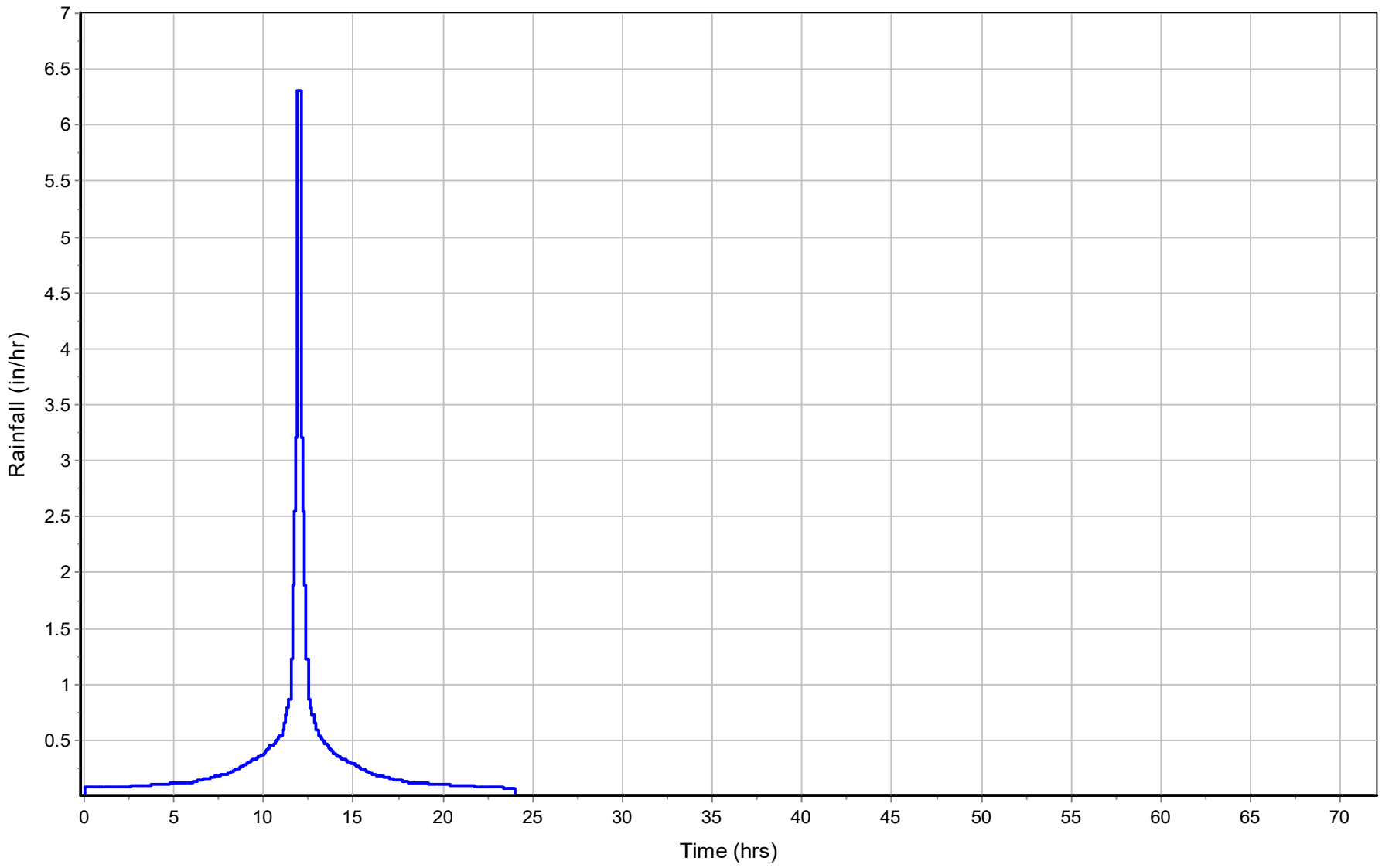
Total TOC (min) 23.82

Subbasin Runoff Results

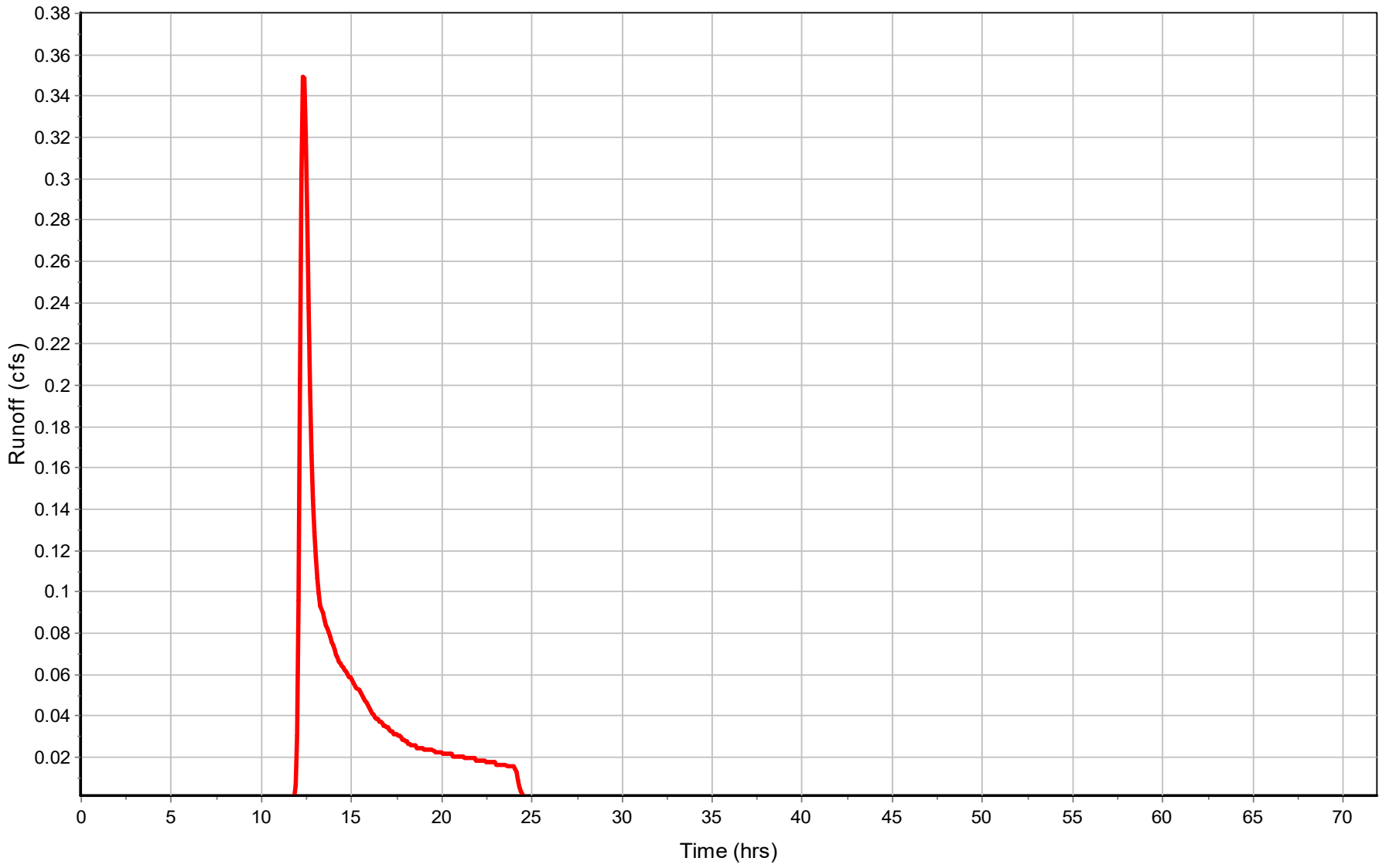
Total Rainfall (in) 7.5
Total Runoff (in) 1.3
Peak Runoff (cfs) 0.35
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:23:49

Subbasin : Sub-E03

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A1

Input Data

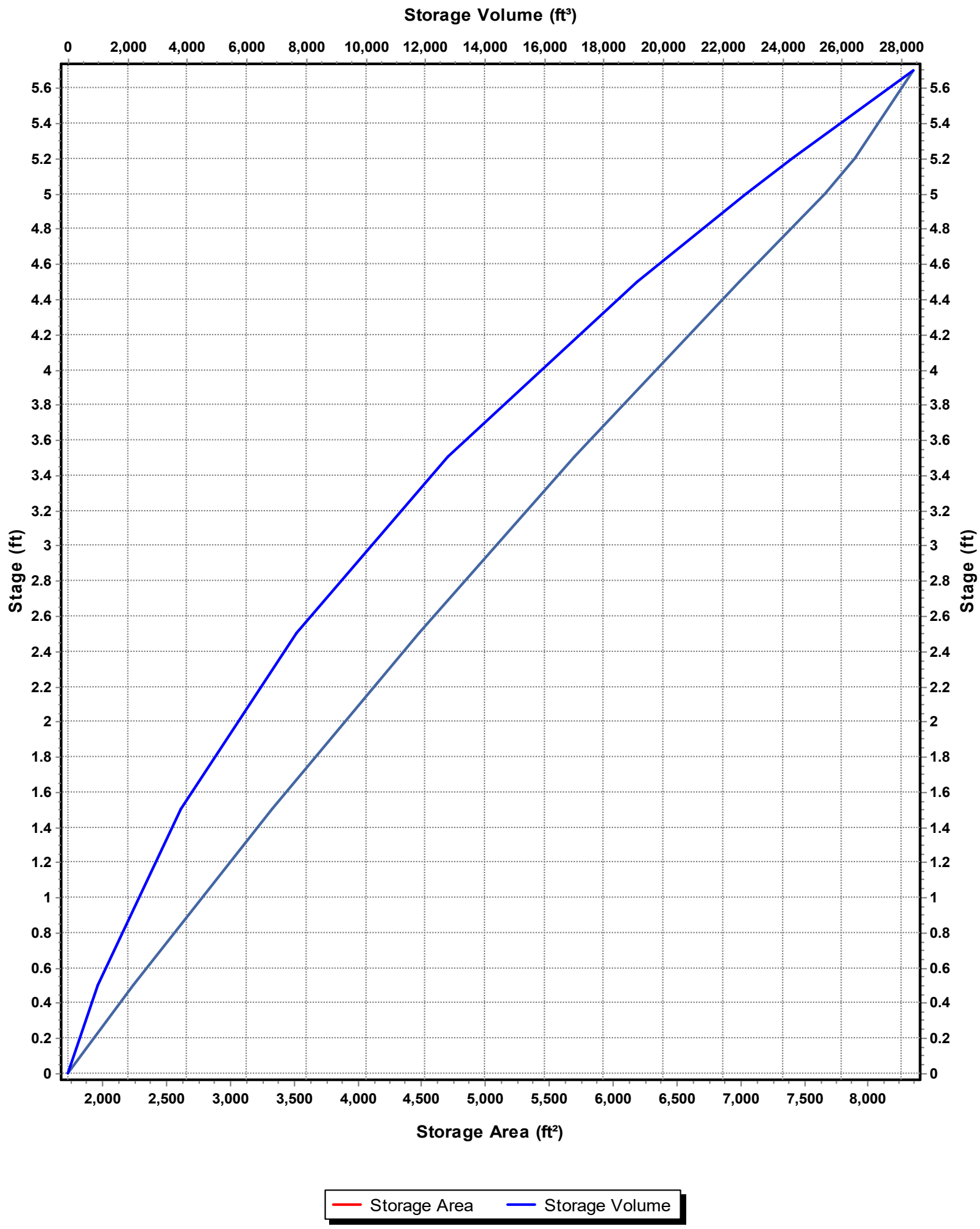
Invert Elevation (ft)	57.50
Max (Rim) Elevation (ft)	63.20
Max (Rim) Offset (ft)	5.70
Initial Water Elevation (ft)	57.50
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

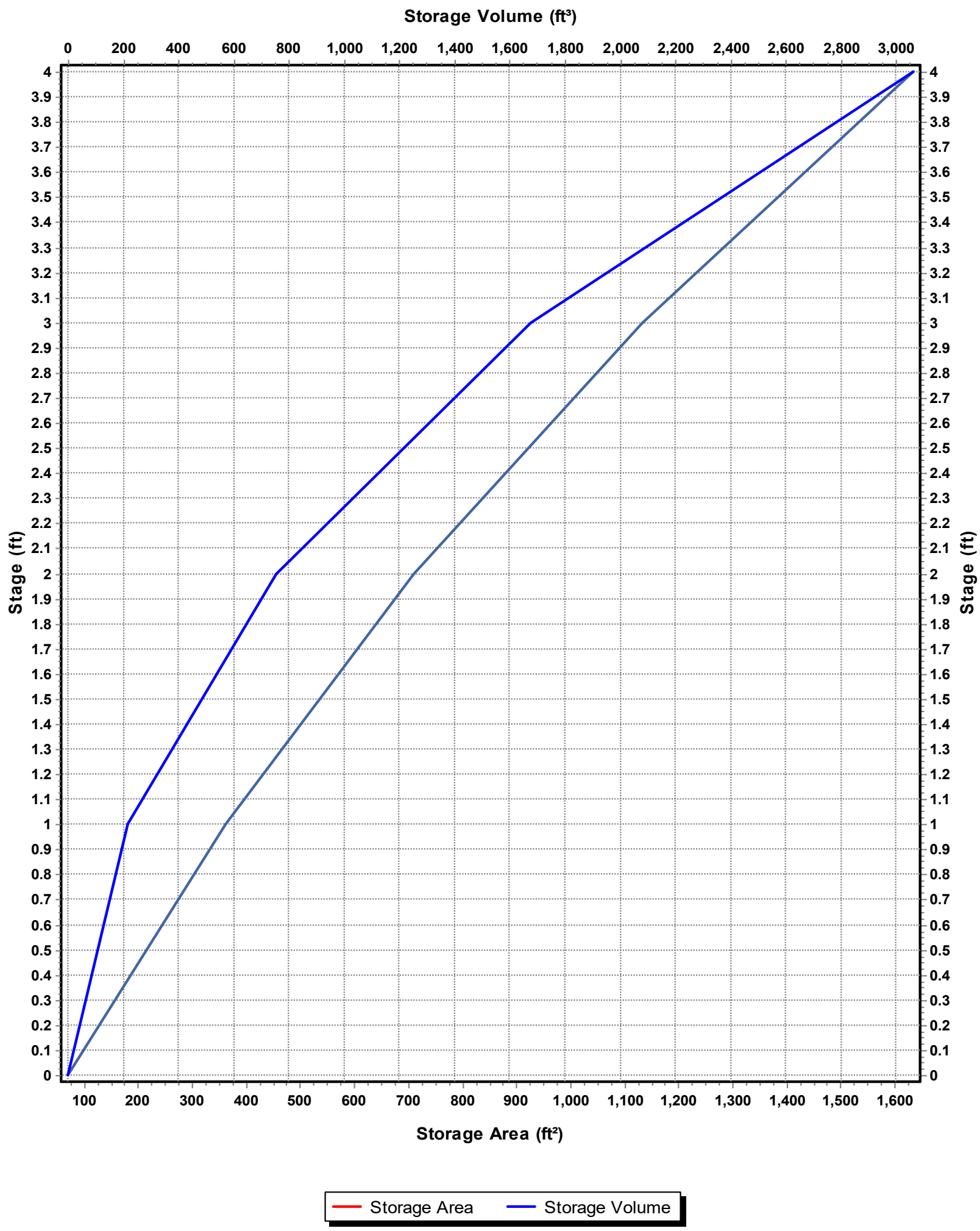
Invert Elevation (ft)	59.20
Max (Rim) Elevation (ft)	63.20
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	59.20
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

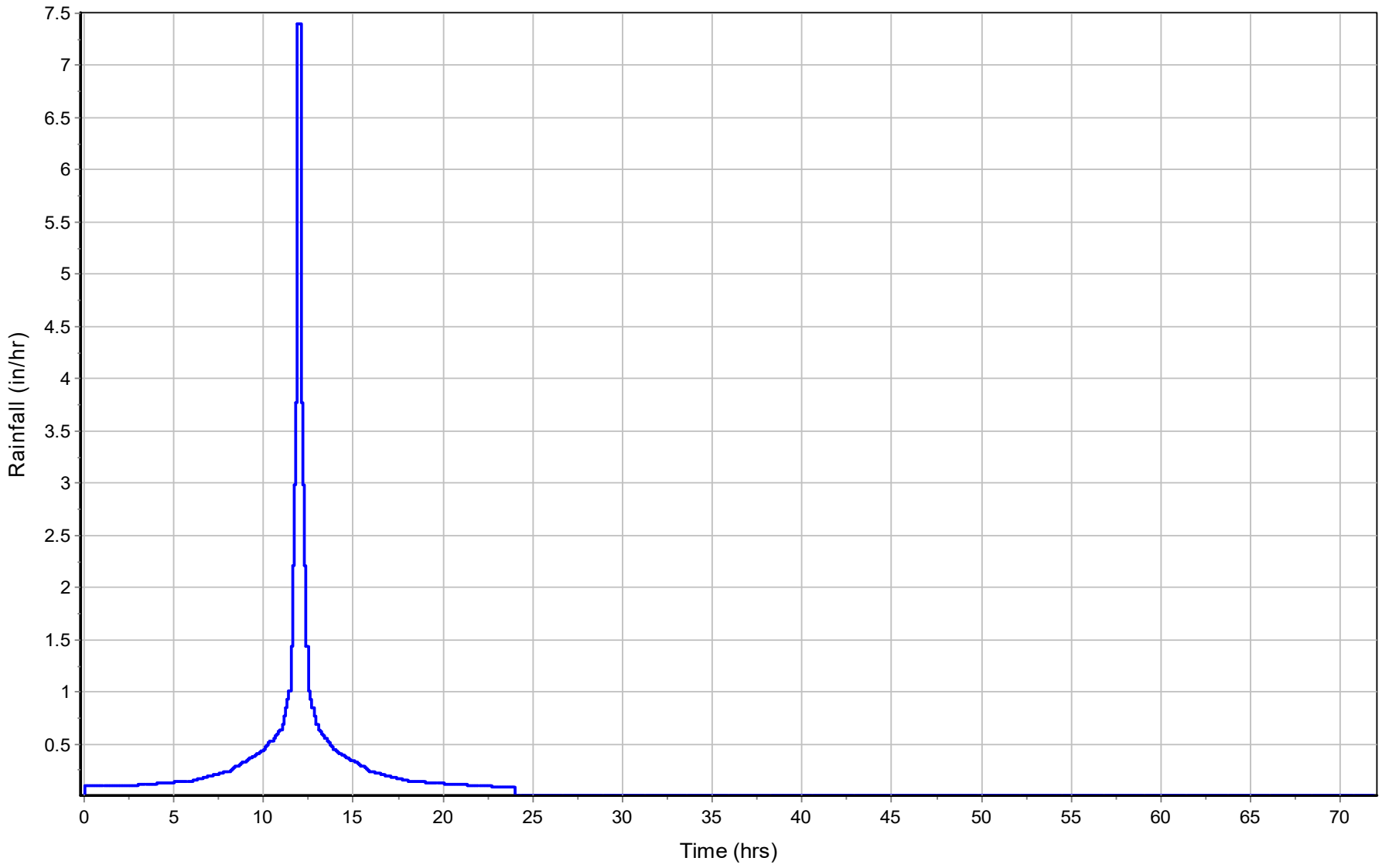
Total TOC (min) 23.77

Subbasin Runoff Results

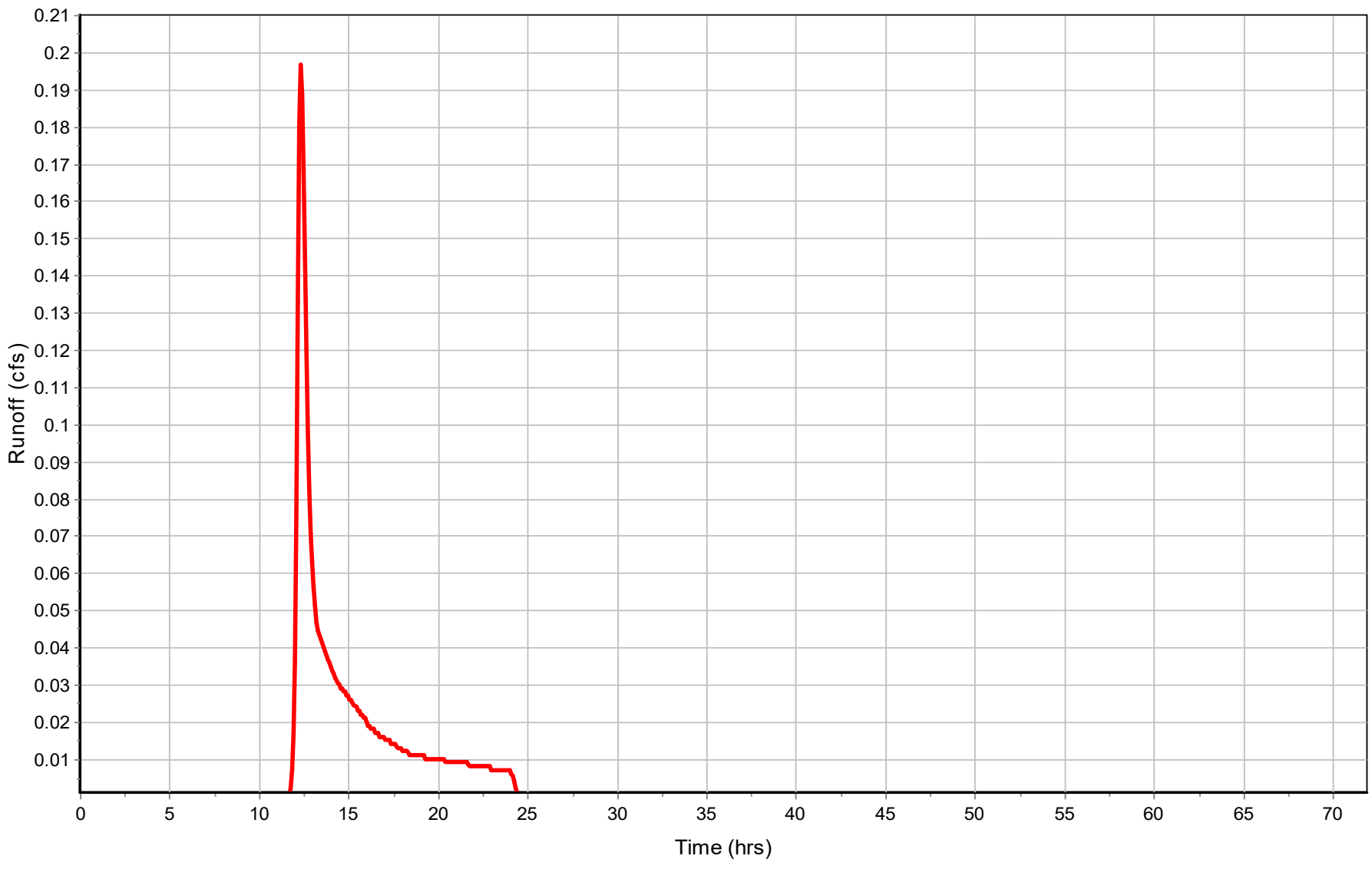
Total Rainfall (in)	8.8
Total Runoff (in)	1.95
Peak Runoff (cfs)	0.2
Weighted Curve Number	43
Time of Concentration (days hh:mm:ss)	0 00:23:46

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

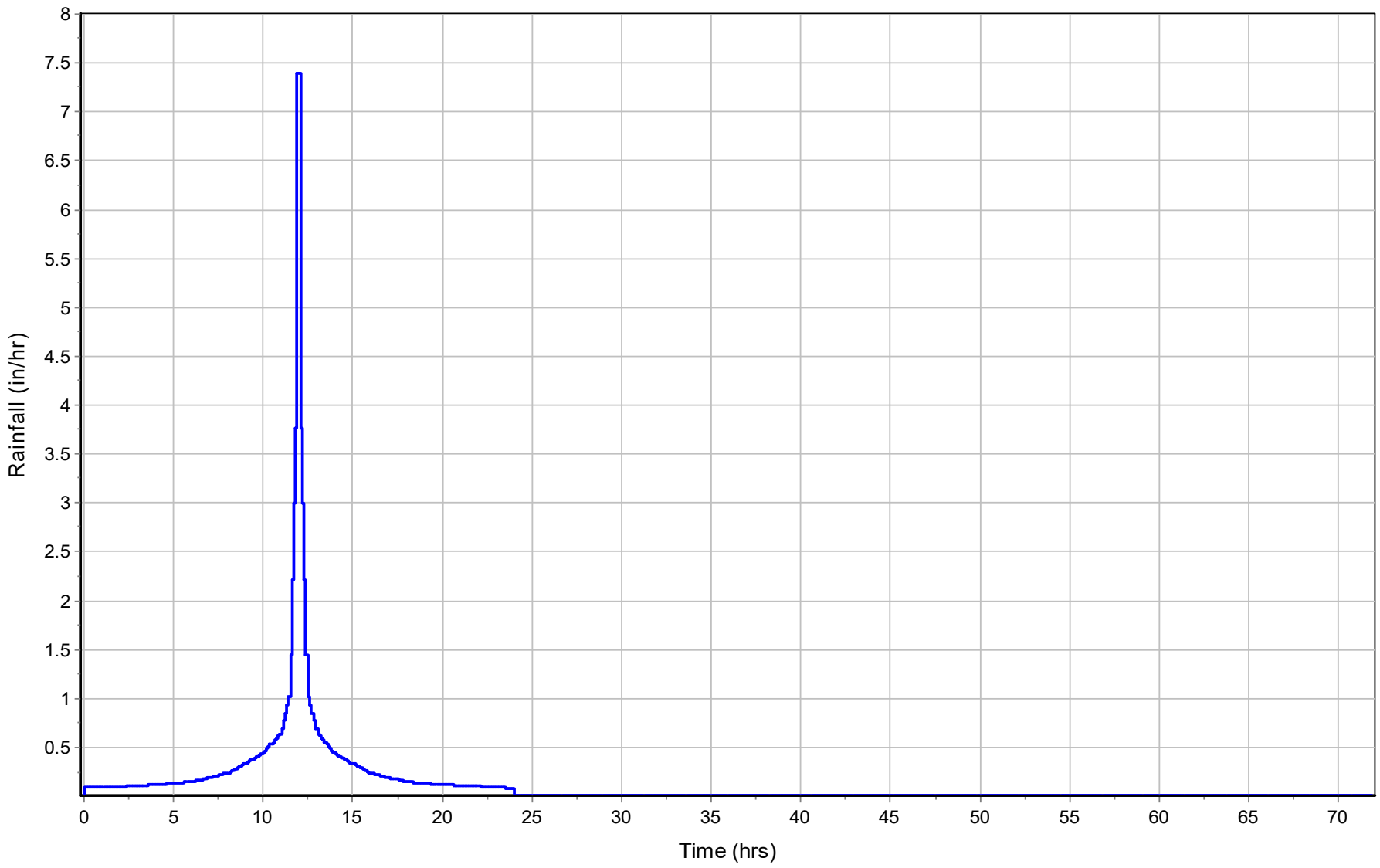
Total TOC (min) 7.35

Subbasin Runoff Results

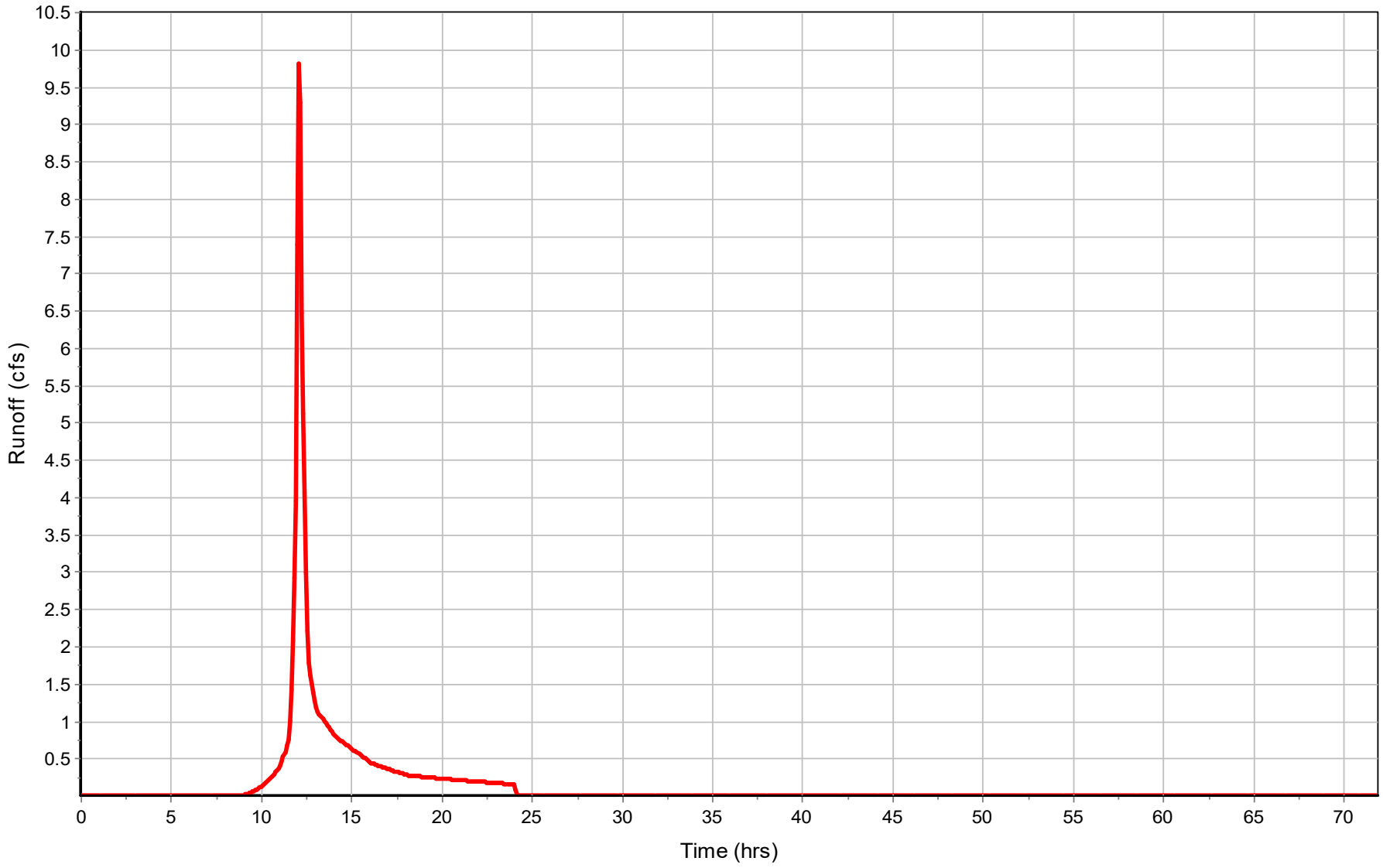
Total Rainfall (in) 8.8
Total Runoff (in) 4.15
Peak Runoff (cfs) 10.33
Weighted Curve Number 61.66
Time of Concentration (days hh:mm:ss) 0 00:07:21

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

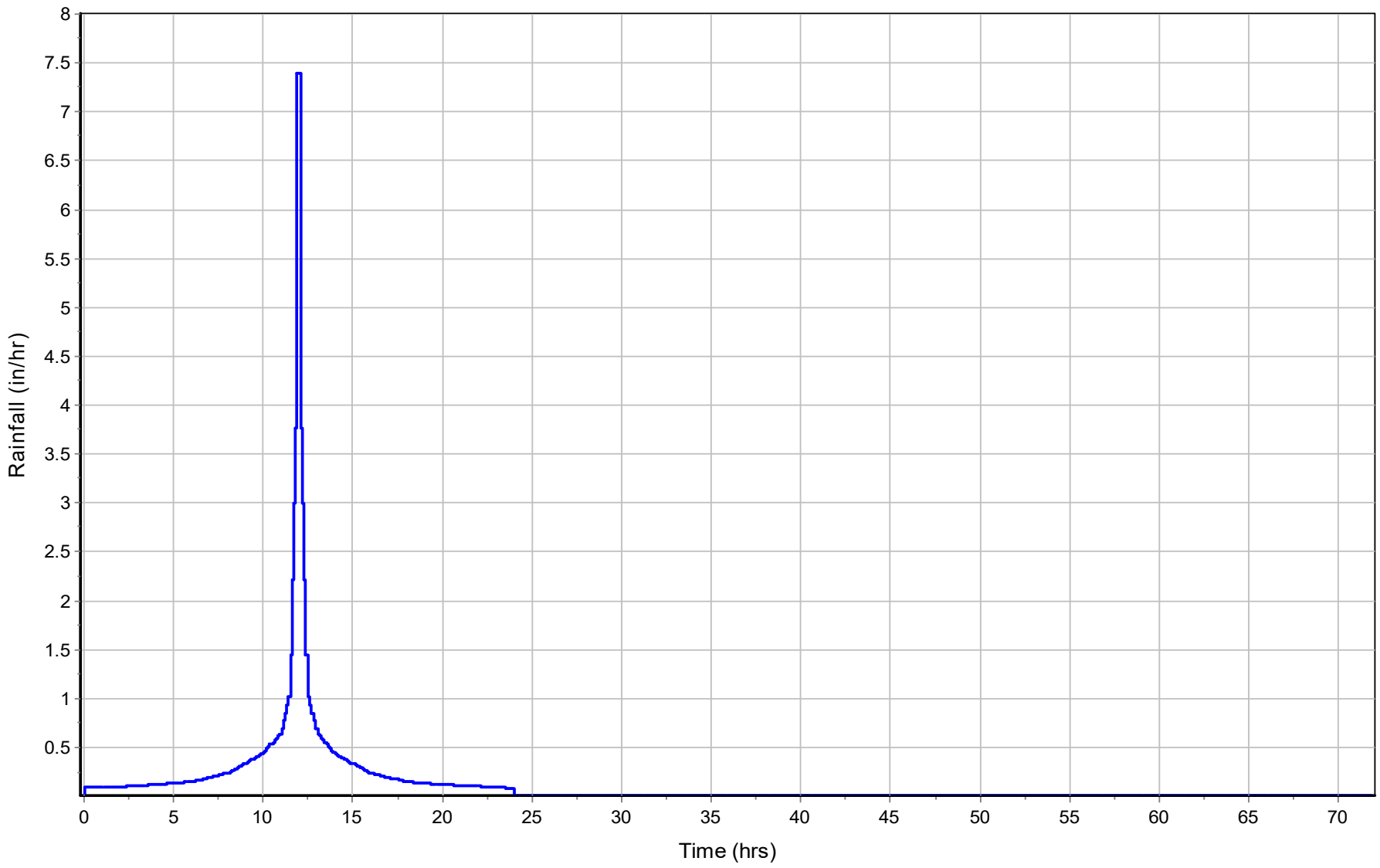
Total TOC (min) 23.82

Subbasin Runoff Results

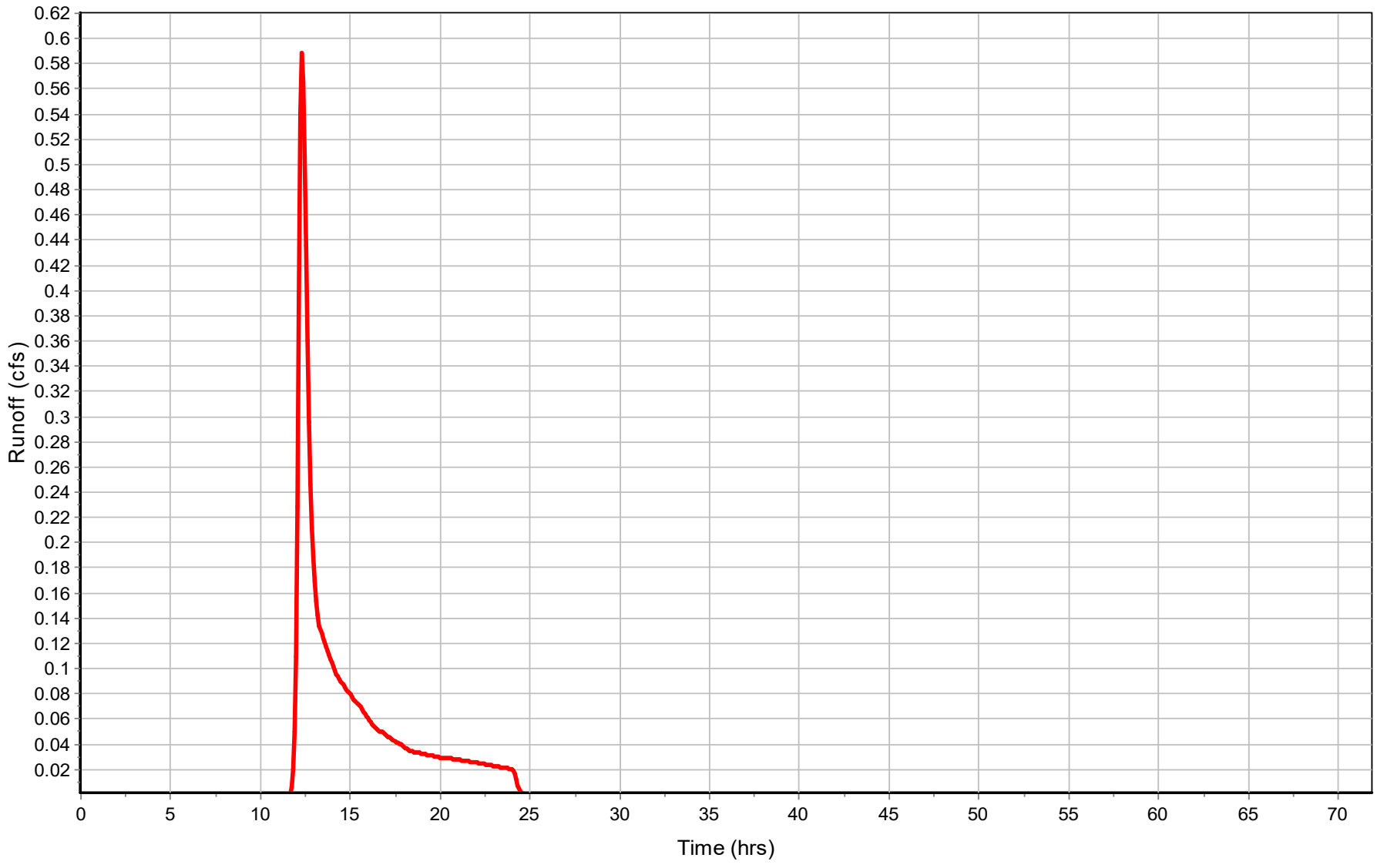
Total Rainfall (in) 8.8
Total Runoff (in) 1.95
Peak Runoff (cfs) 0.59
Weighted Curve Number 43
Time of Concentration (days hh:mm:ss) 0 00:23:49

Subbasin : Sub-E03

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : Basin-A1

Input Data

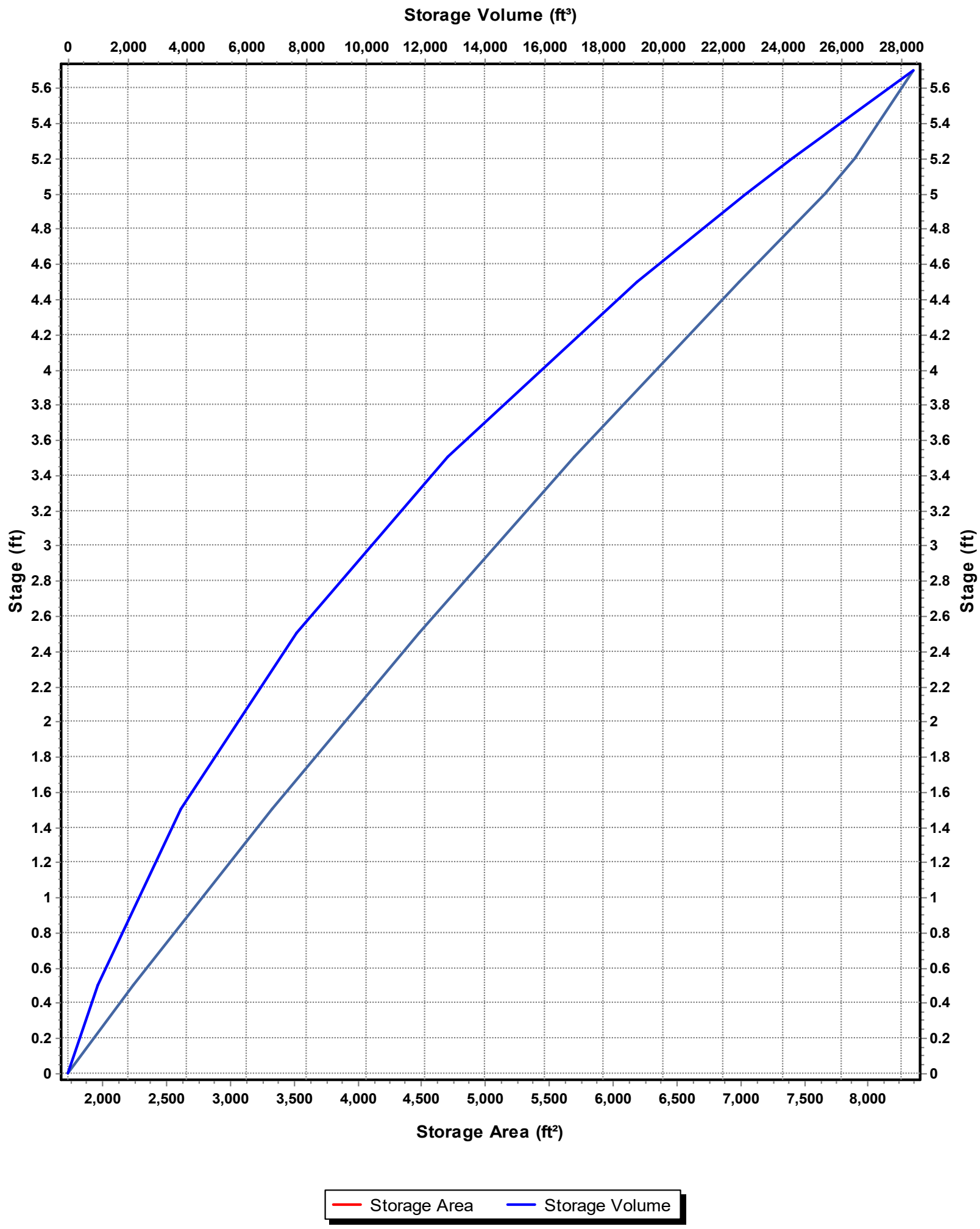
Invert Elevation (ft)	57.50
Max (Rim) Elevation (ft)	63.20
Max (Rim) Offset (ft)	5.70
Initial Water Elevation (ft)	57.50
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

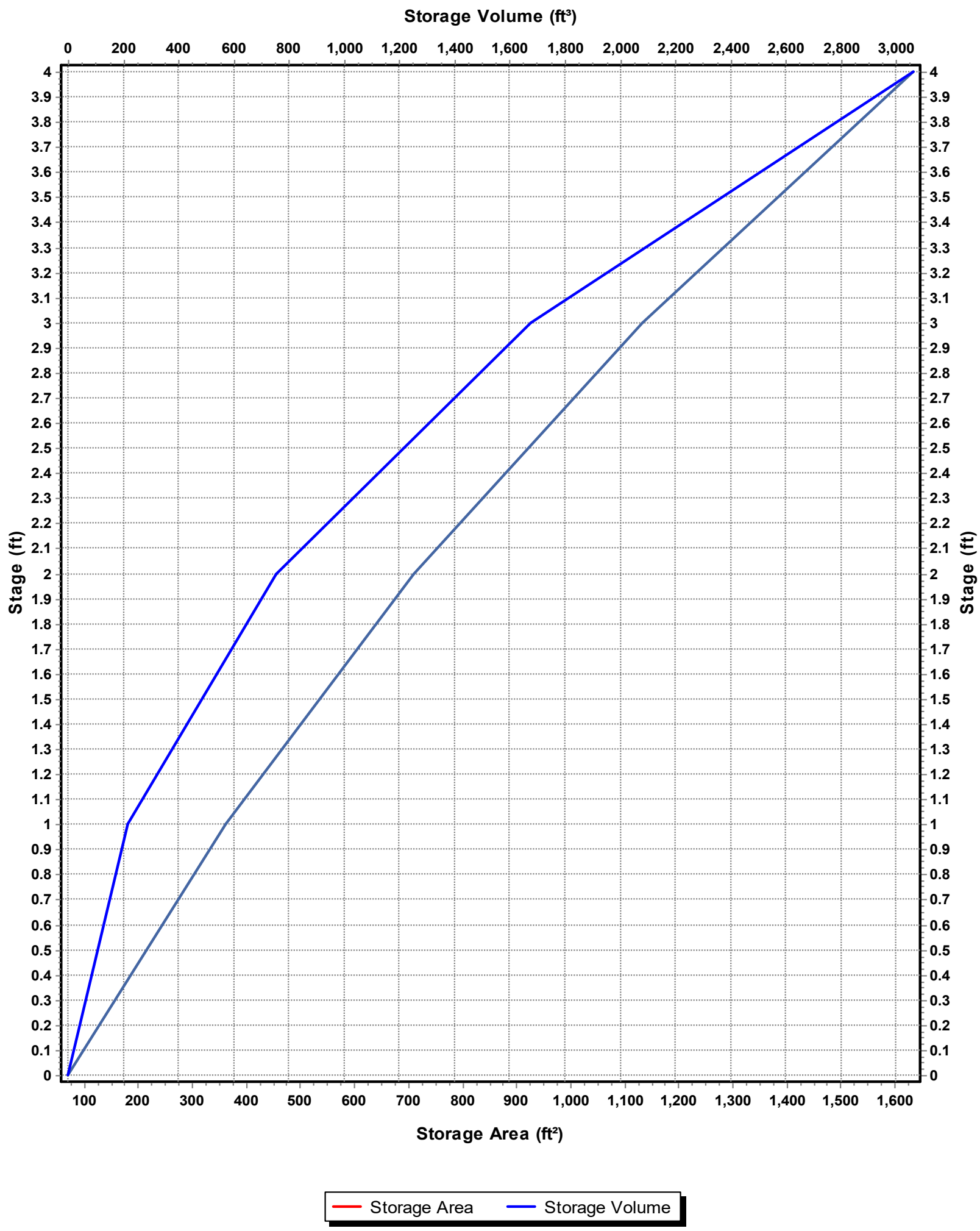
Invert Elevation (ft)	59.20
Max (Rim) Elevation (ft)	63.20
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	59.20
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

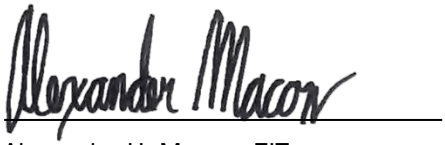
Prepared for:

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.

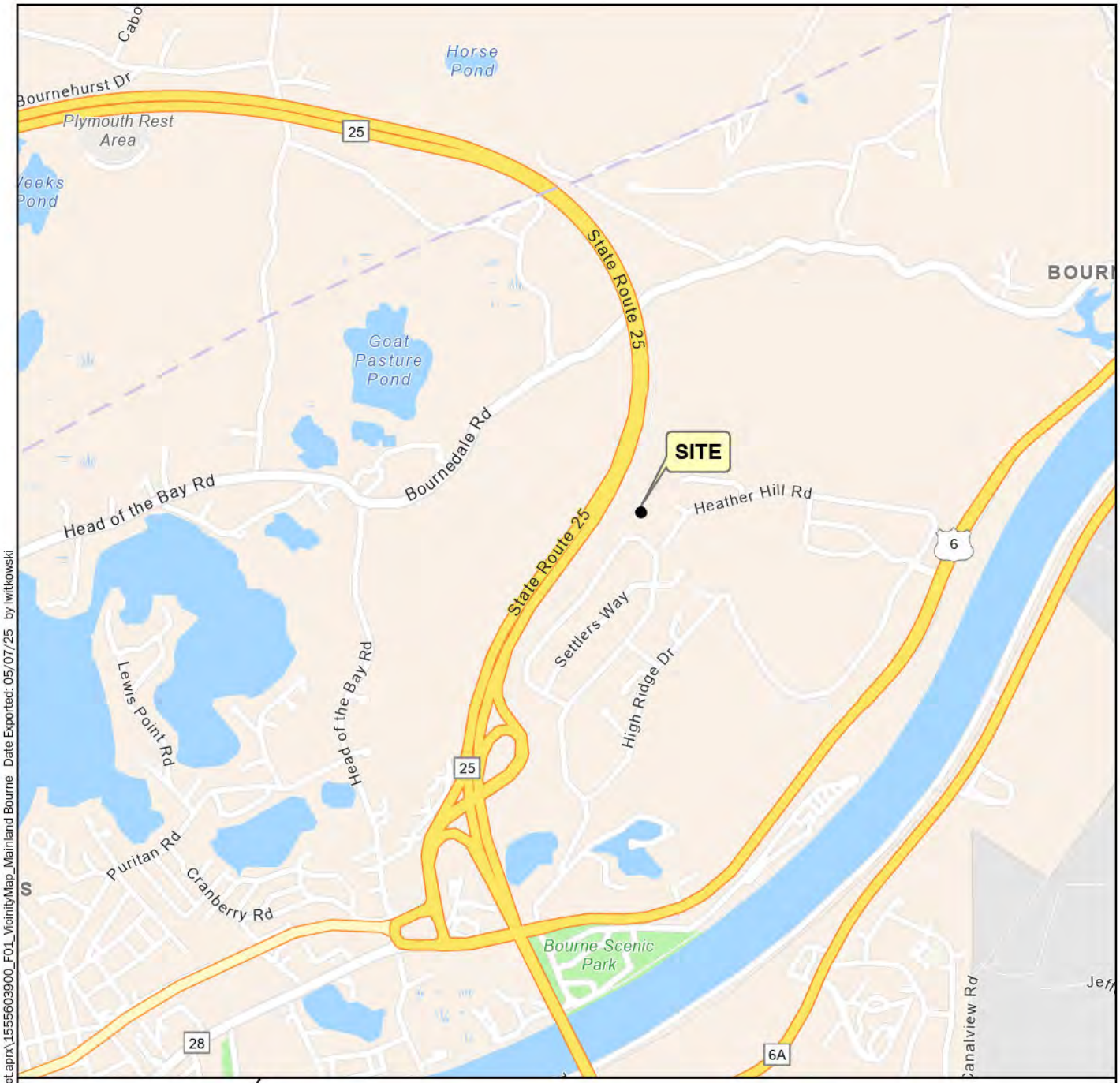
International Code Council, 2021, “International Building Code.”

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)

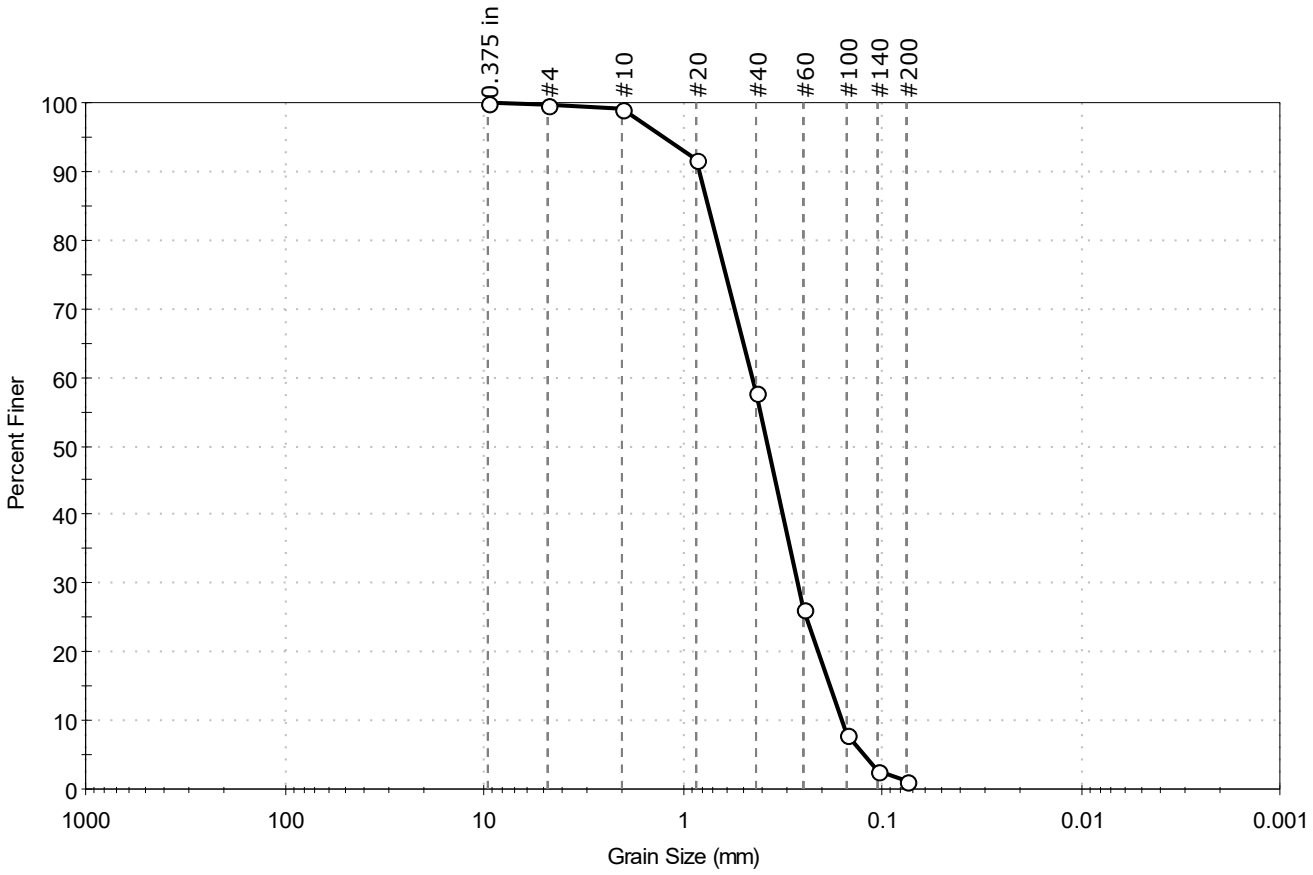
(2): Method B-Volumetric, Reconstituted (compacted)

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

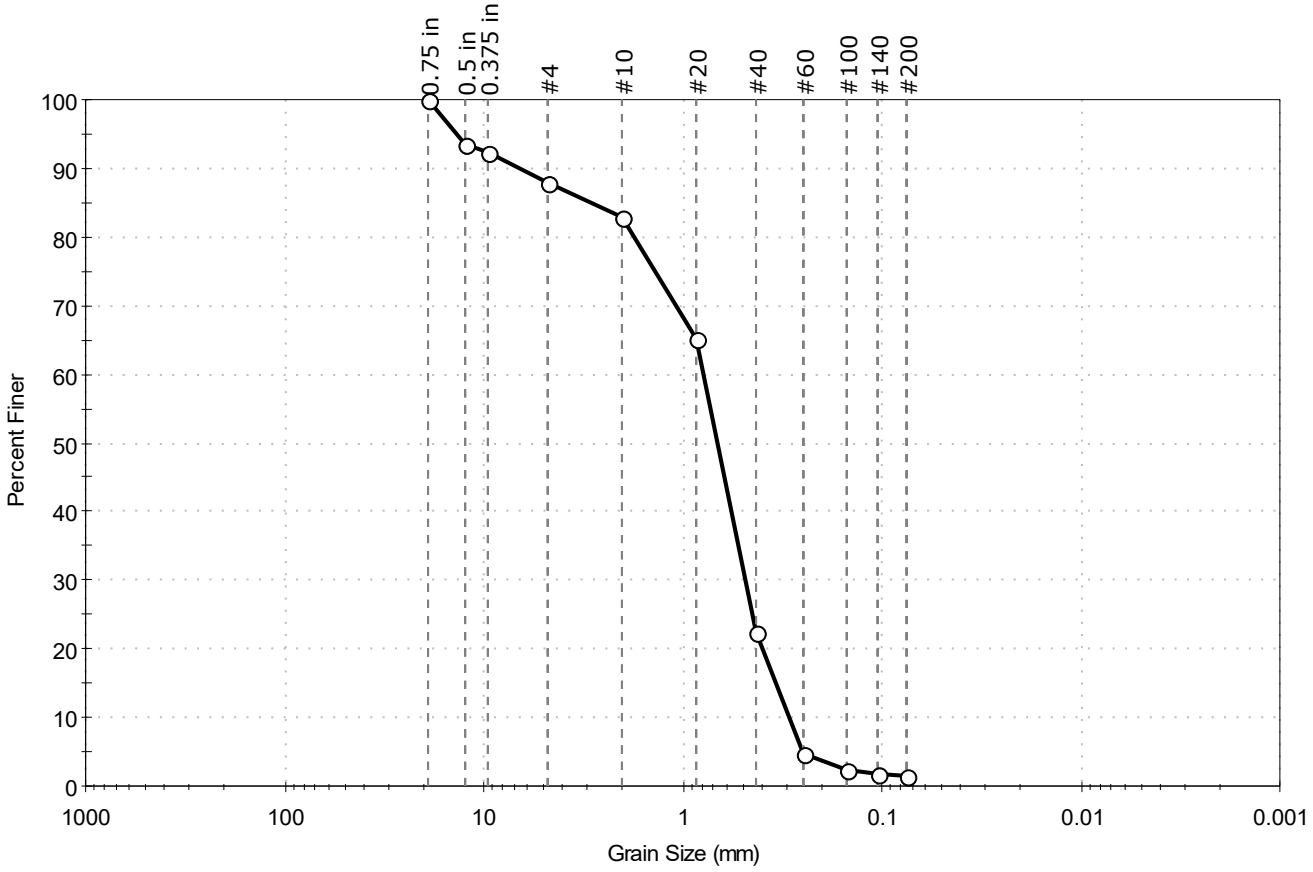
Sand/Gravel Particle Shape : ---

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

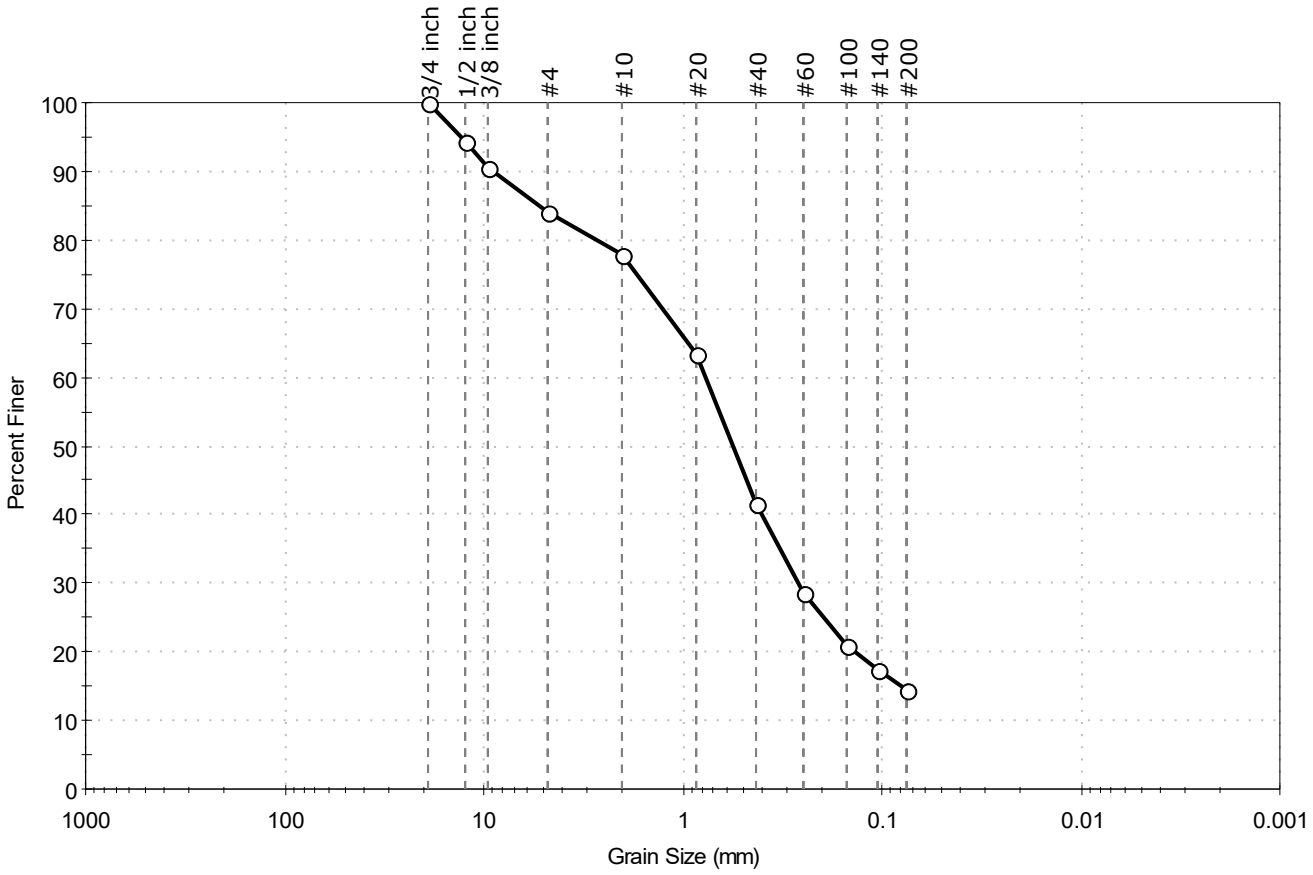
Sand/Gravel Particle Shape : ANGULAR

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

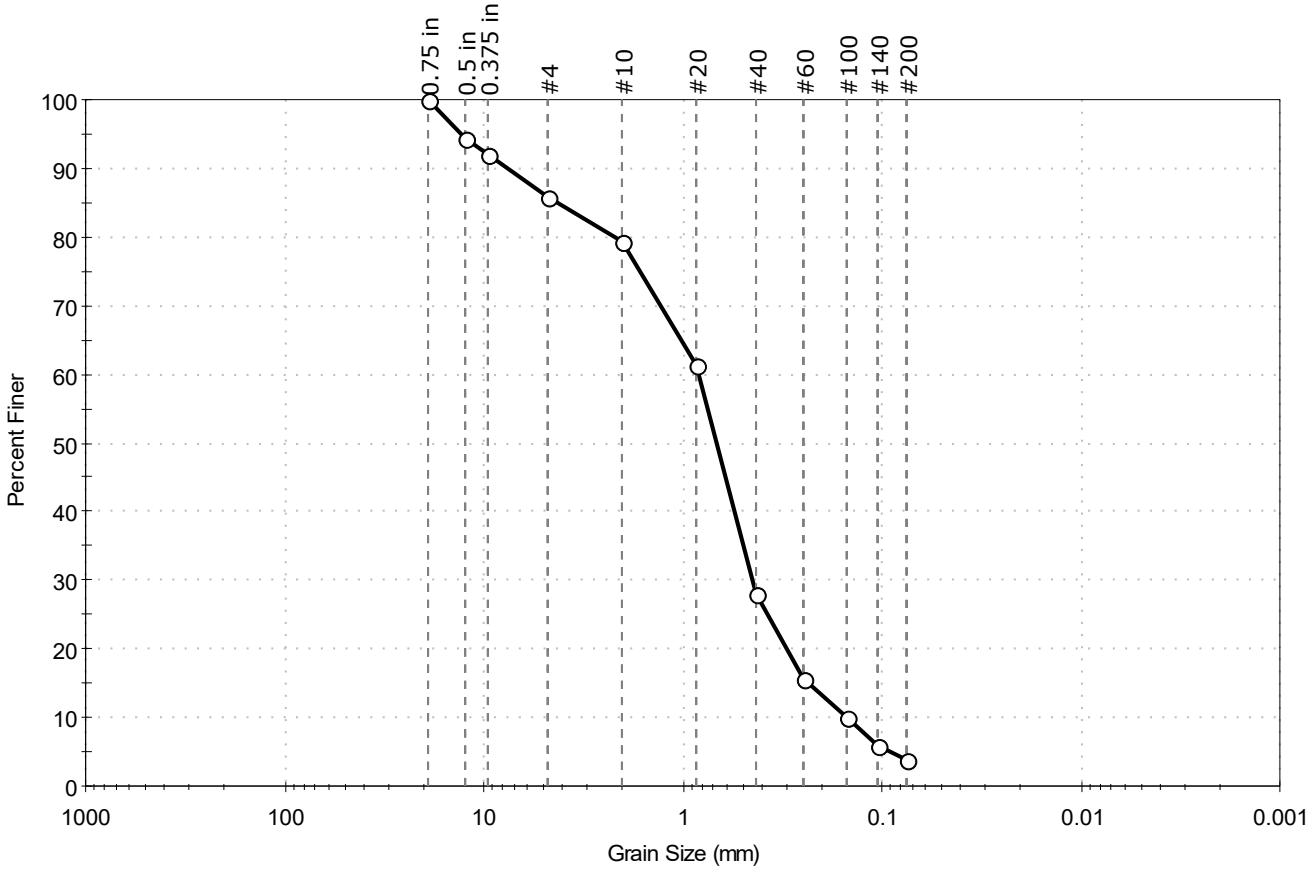
Sand/Gravel Particle Shape : ---

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		

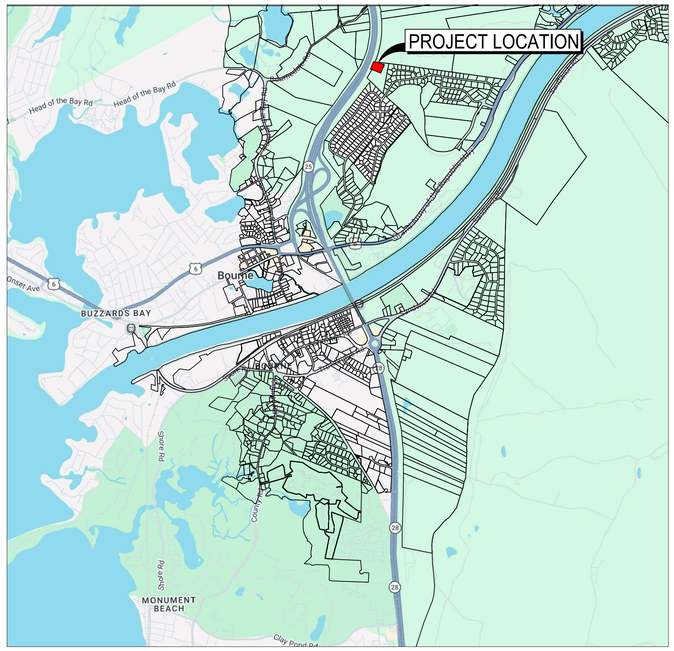
Stormwater Control Manager _____

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

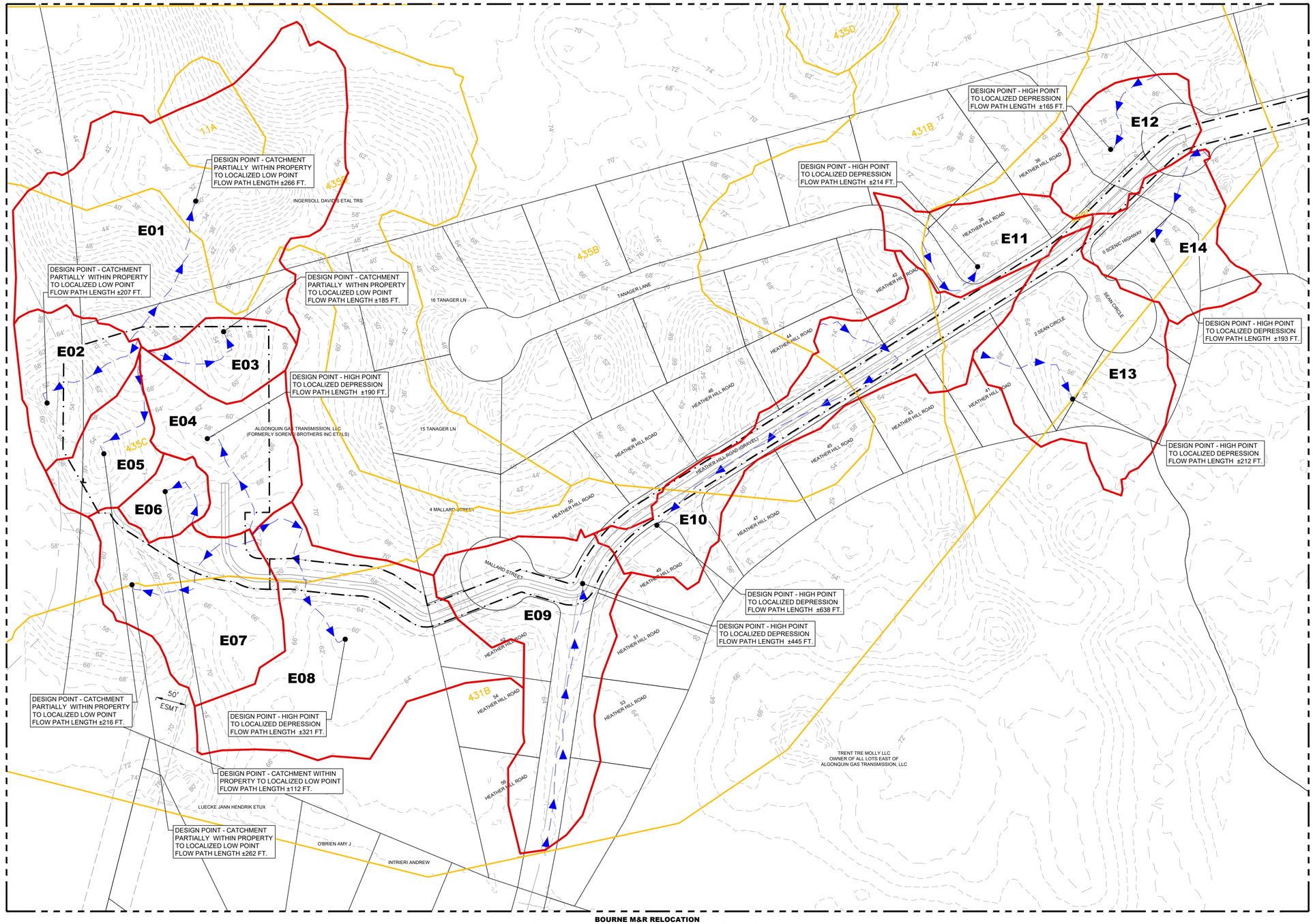
audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

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

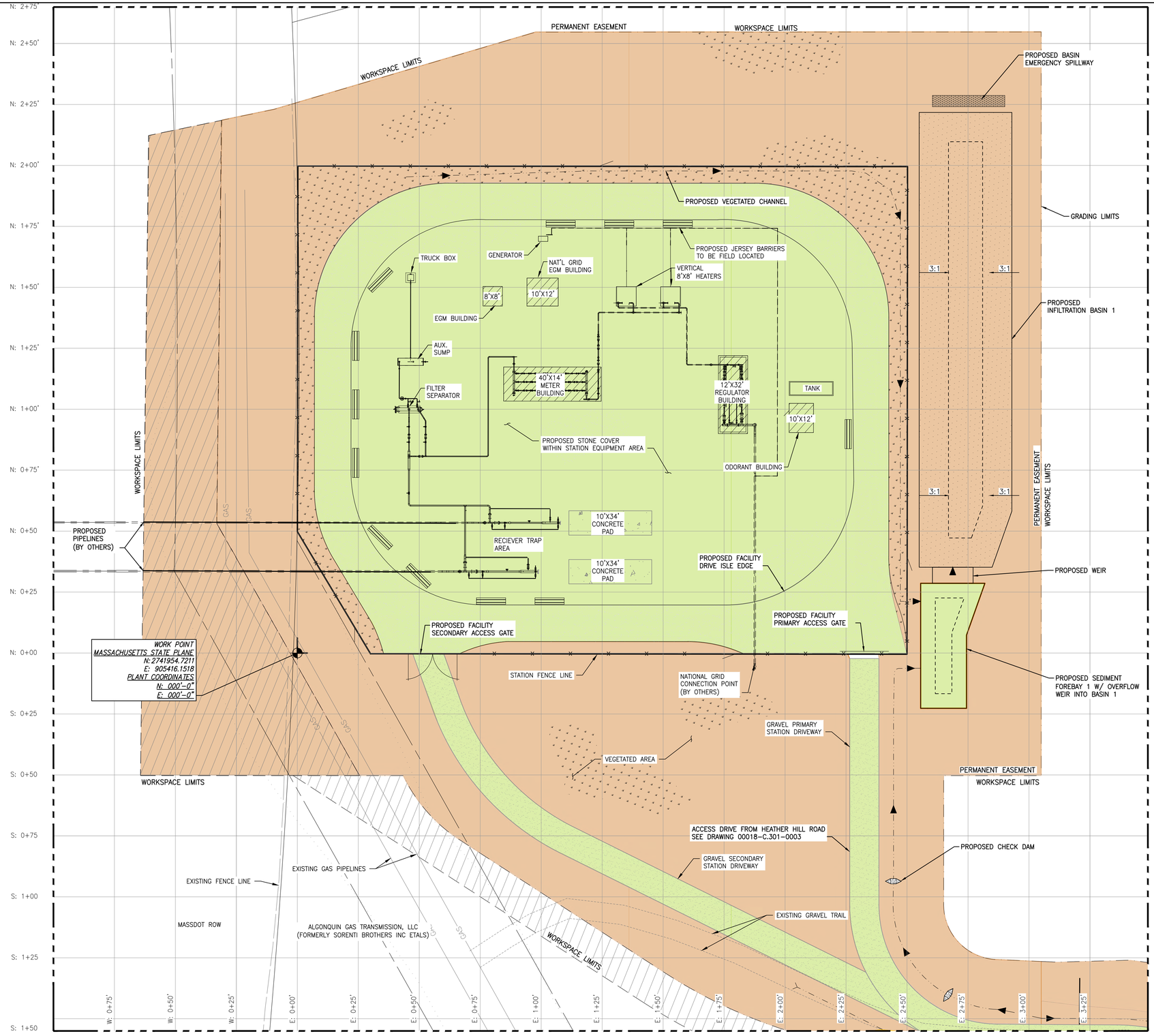
DRAWN BY:	JA	05/15/26
DESIGN CHECKER:	AE	07/02/26
DESIGN ENGINEER:	DT	07/02/26
PROJECT MANAGER:	AC	07/02/26

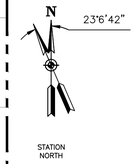
CAPE COD CANAL PIPELINE RELOCATION PROJECT
BOURNE M&R RELOCATION
M&R 00018
TITLE: EXISTING SUBCATCHMENT AREA PLAN
LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

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

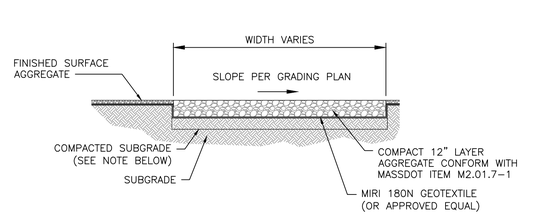
EARTHWORK QUANTITIES WERE DEVELOPED BY COMPARING EXISTING GROUND WITH PROPOSED FINISHED GRADE. CUT/FILL QUANTITIES ARE APPROXIMATE AND DO NOT ACCOUNT FOR STRIPPING TOPSOIL, FINAL GRAVEL SURFACE LAYER, SHRINKAGE FACTORS, BULK FACTORS, OR UNSUITABLE MATERIALS ENCOUNTERED.

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.

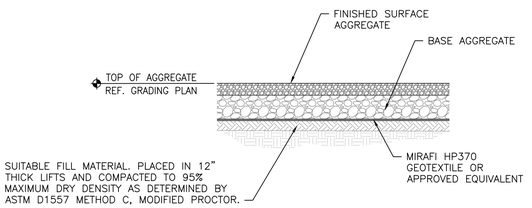
SURVEY NOTES:

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

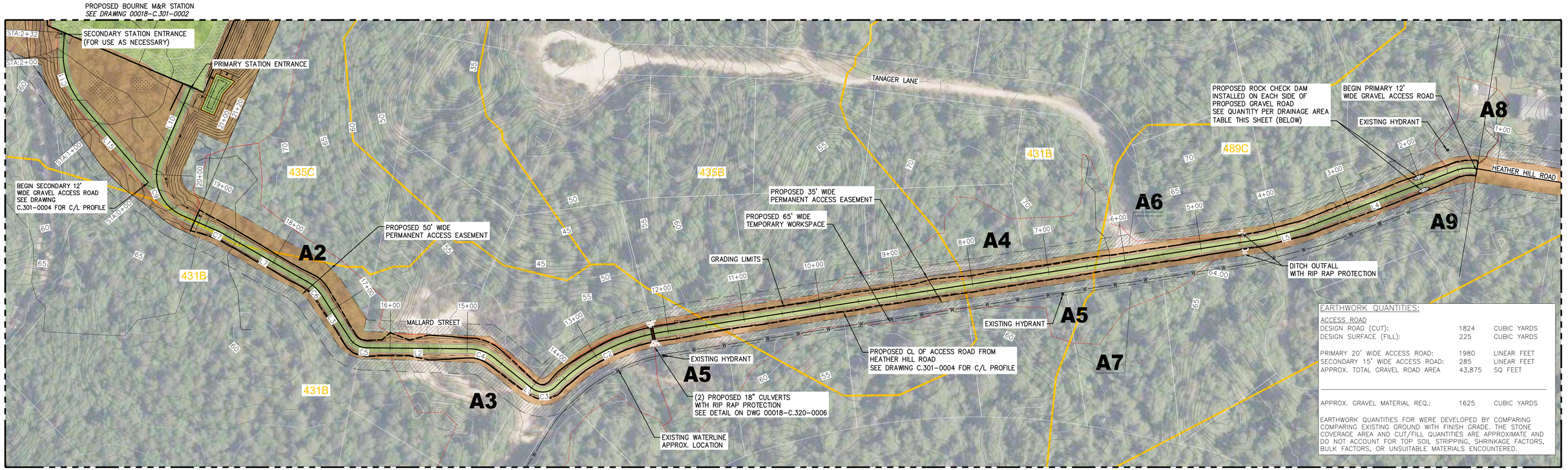
DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		E	07/02/26	CR	DT	ISSUED FOR PERMIT
00018-C.320-0007	DETAILS	D	05/15/26	CR	DT	ISSUED FOR BID
00018-C.320-0006	DETAILS	C	05/15/26	CR	DT	ISSUED FOR PERMIT
00018-C.301-0003	CIVIL GRADING PLAN ACCESS ROAD	B	03/17/26	CR	SP	ISSUED FOR REVIEW – 90% REVIEW
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:

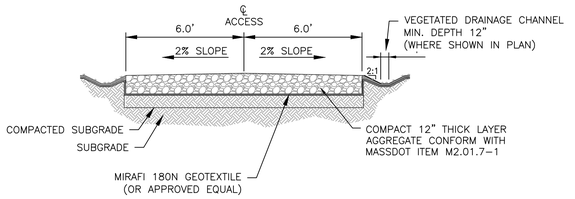
ACCESS ROAD		
DESIGN ROAD (CUT):	1824	CUBIC YARDS
DESIGN SURFACE (FILL):	225	CUBIC YARDS
PRIMARY 20' WIDE ACCESS ROAD:	1980	LINEAR FEET
SECONDARY 15' WIDE ACCESS ROAD:	285	LINEAR FEET
APPROX. TOTAL GRAVEL ROAD AREA	43,875	SQ FEET
APPROX. GRAVEL MATERIAL REQ.:	1625	CUBIC YARDS

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'

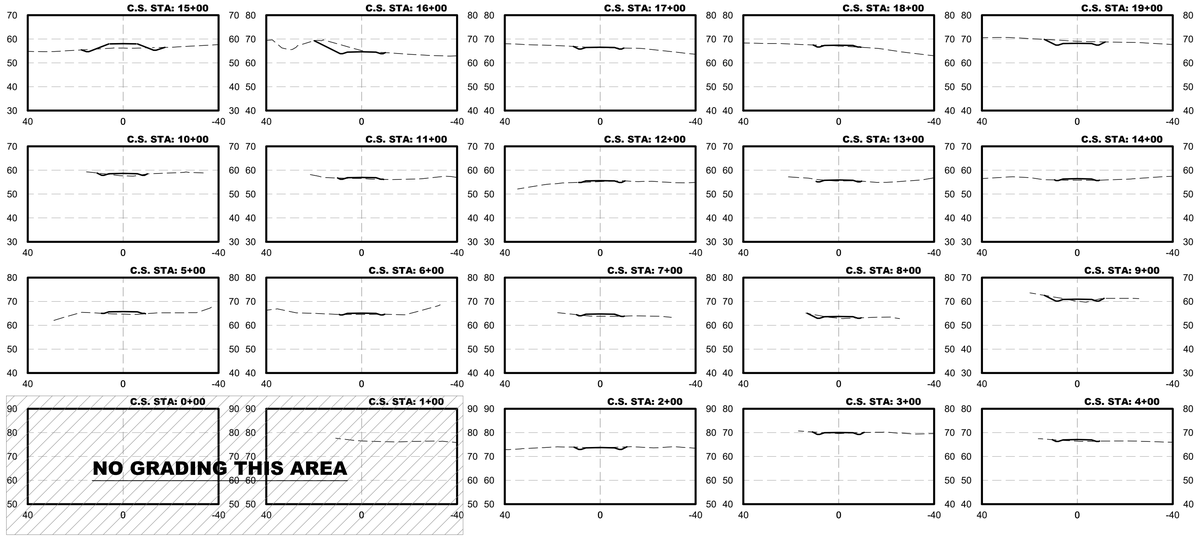


DETAIL B – TYPICAL AGGREGATE ACCESS ROAD

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

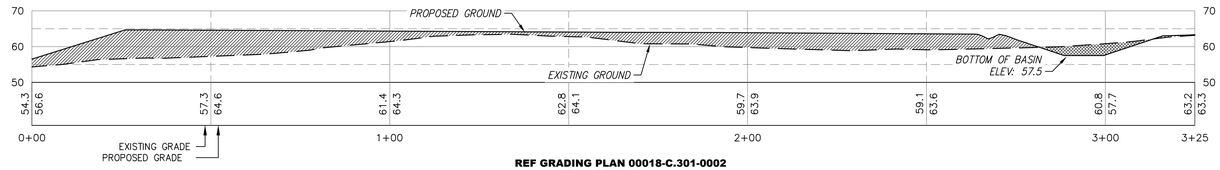
audubon Engineering
3505 W. SAM HOUSTON PKWY. N., SUITE 100
HOUSTON, TX 77043
PHONE: (281) 669-0590

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

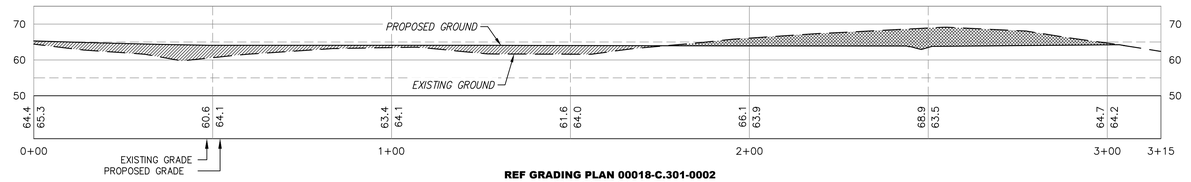
S:\AE\Projects\Enbridge\Mass\026356-001\200_Civil_Structural\170_Drawings\Grading\Mainland Bourne\00018-C.301-0003.dwg – PLOT TIME: 7/2/2026 1:45 PM



REF GRADING PLAN 00018-C.301-0002

SECTION A

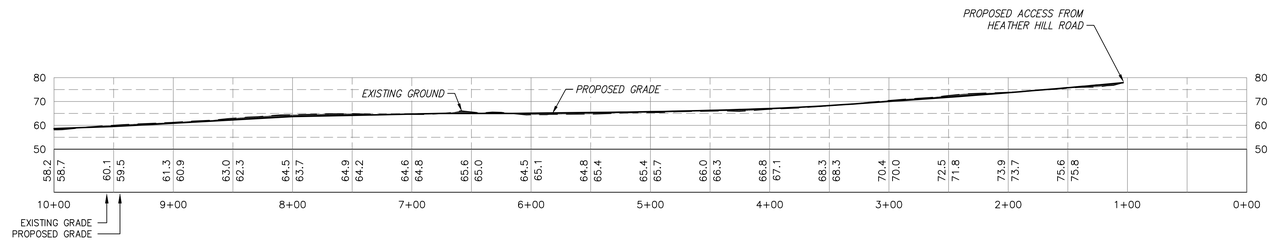
SCALES: HORIZ. 1" = 20'-0"



REF GRADING PLAN 00018-C.301-0002

SECTION B

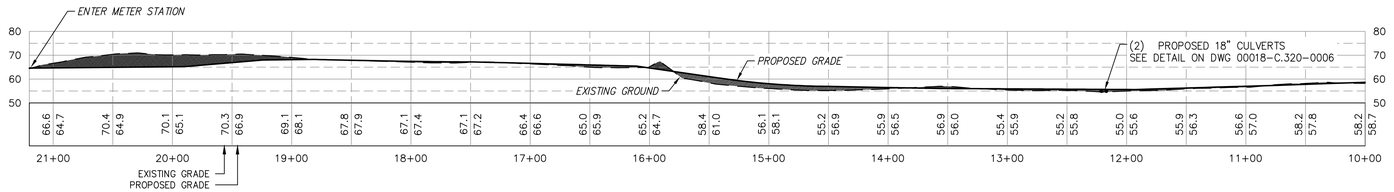
SCALES: HORIZ. 1" = 20'-0"



CL STA: 0+00 THRU 10+00 / REF GRADING PLAN 00018-C-301-0003

ACCESS ROAD C/L PROFILE

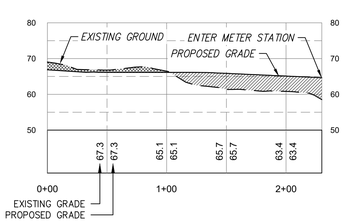
SCALES: HORIZ. 1" = 60'-0" / VERT. 1" = 30'-0"



CL STA: 10+00 THRU 20+45 / REF GRADING PLAN 00018-C-301-0003

ACCESS ROAD C/L PROFILE

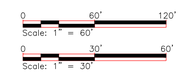
SCALES: HORIZ. 1" = 60'-0" / VERT. 1" = 30'-0"



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

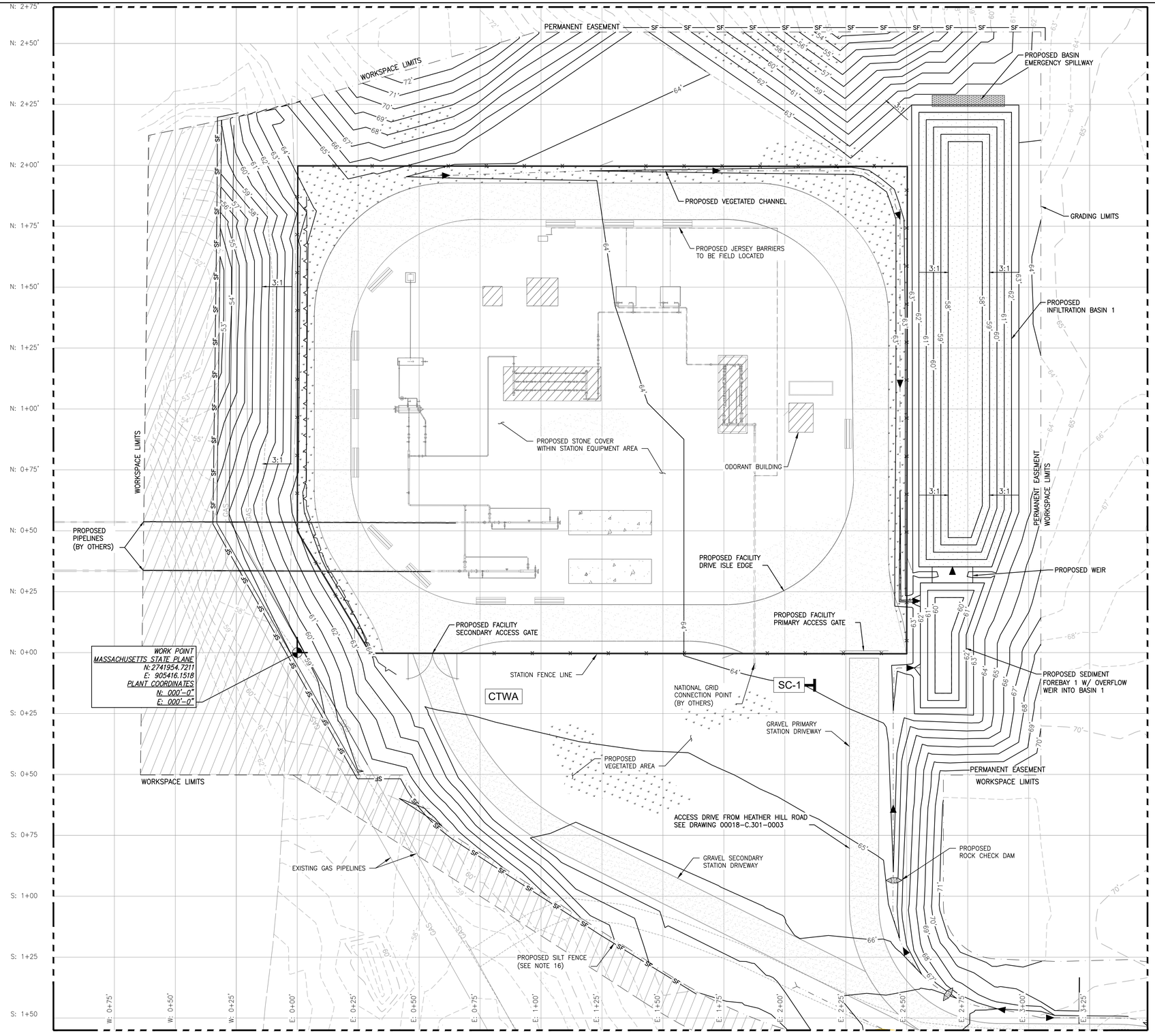
DRAWN BY:	CR	05/08/25	CAPE COD CANAL PIPELINE RELOCATION PROJECT
DESIGN CHECKER:	DT	07/02/26	BOURNE M&R RELOCATION
DESIGN ENGINEER:	PB	07/02/26	M&R 00018
PROJECT MANAGER:	AC	07/02/26	TITLE: CIVIL GRADE PROFILE AND SECTIONS

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	

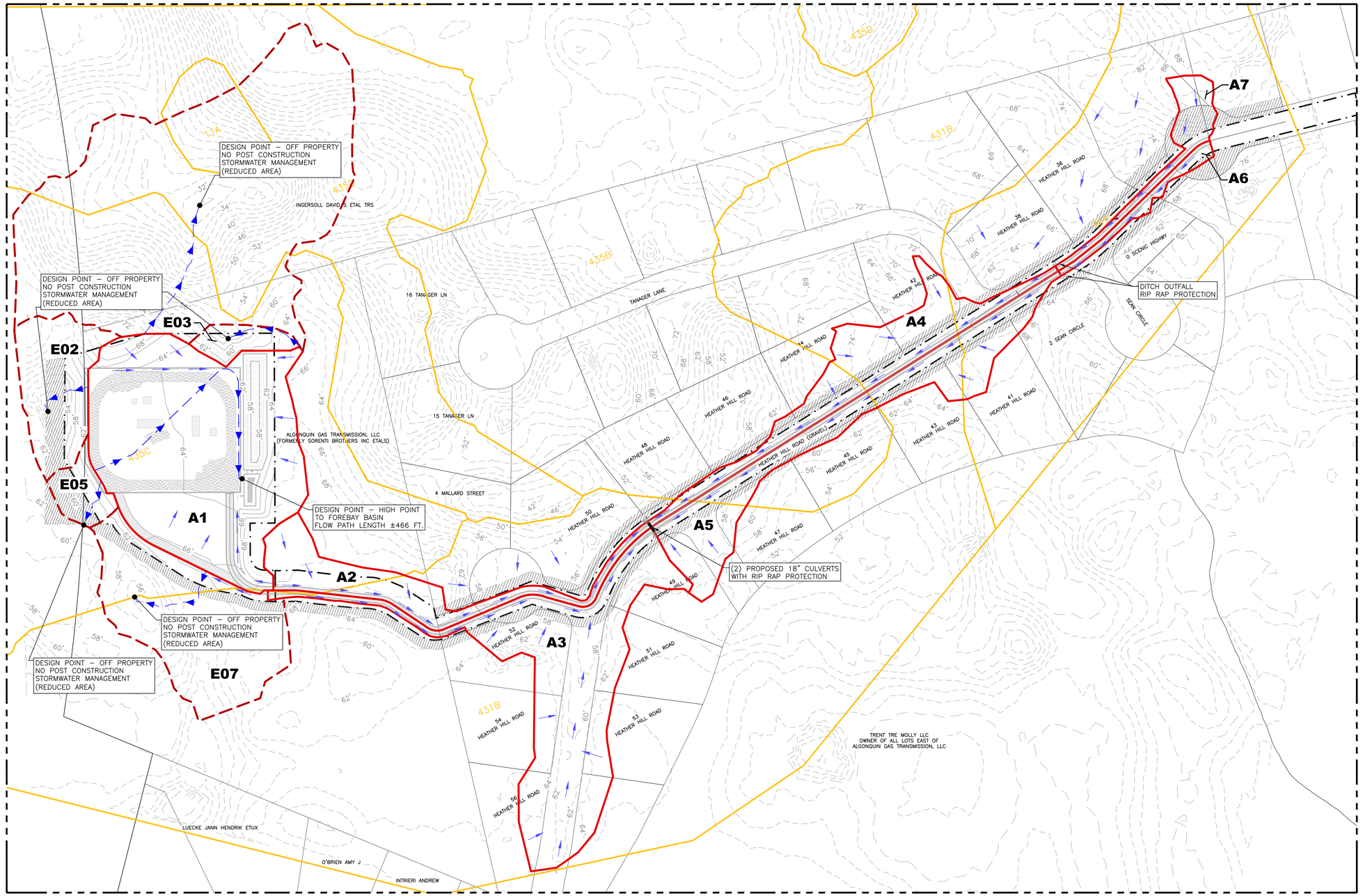
CAPE COD CANAL PIPELINE RELOCATION PROJECT
BOURNE M&R RELOCATION
M&R 00018
TITLE: CONSTRUCTION EROSION AND SEDIMENT CONTROL PLAN

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

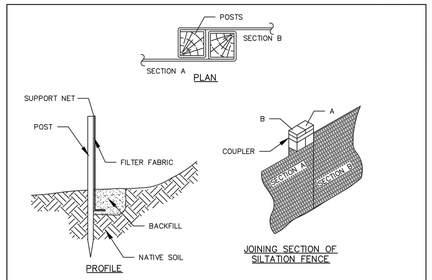
E&S CONSTRUCTION SEQUENCE AND MAINTENANCE

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:

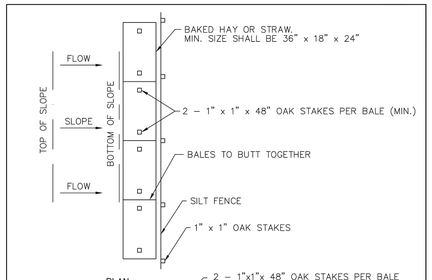
- INSPECT ALL EROSION AND SEDIMENTATION CONTROL MEASURES PERIODICALLY AND AFTER EACH RAINFALL EVENT. INSPECTION RECORDS SHALL BE MAINTAINED ONSITE BY THE CONTRACTOR.
- REPAIR OR REPLACE DAMAGED OR DETERIORATED EROSION CONTROL MEASURES IMMEDIATELY UPON IDENTIFICATION.
- REMOVE ACCUMULATED SEDIMENT FROM 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.



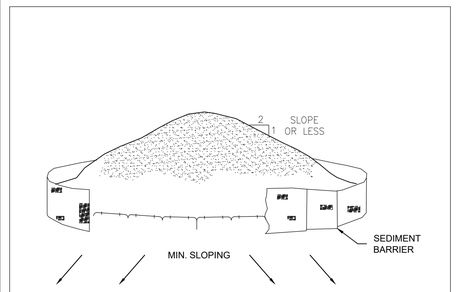
CONSTRUCTION NOTES

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



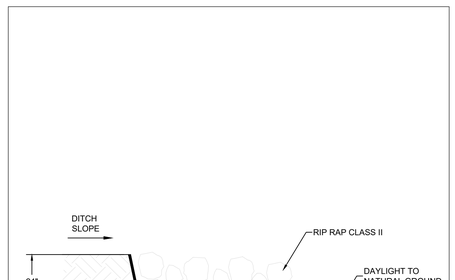
HAYBALES AND SILT FENCE



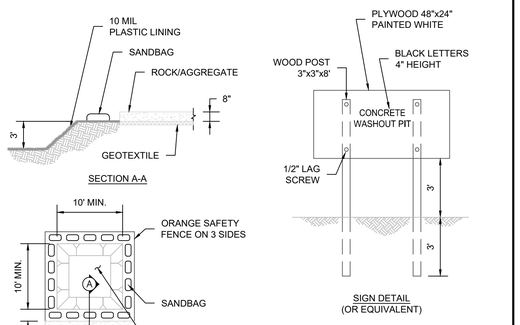
INSTALLATION NOTES:

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



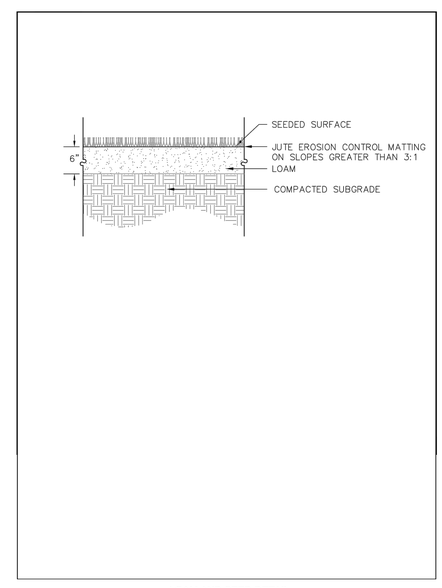
CONCRETE TRUCK WASHOUT AREA

SCALE: N.T.S.

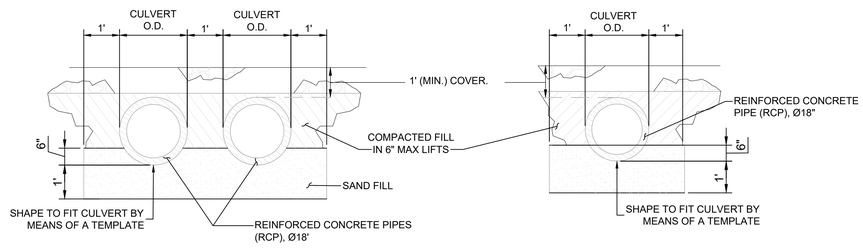
SIGN DETAIL
(OR EQUIVALENT)

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.

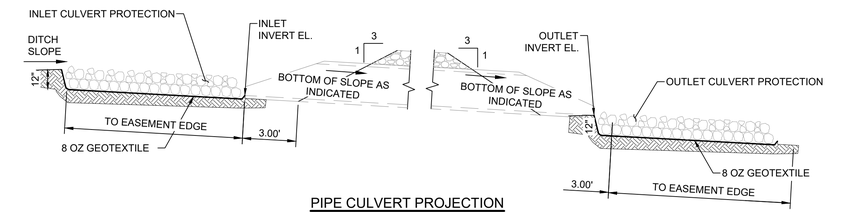


LOAM AND SEED DETAIL



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

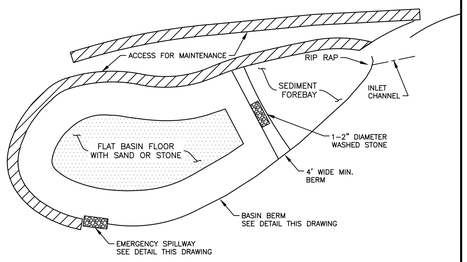
audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669–0590

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

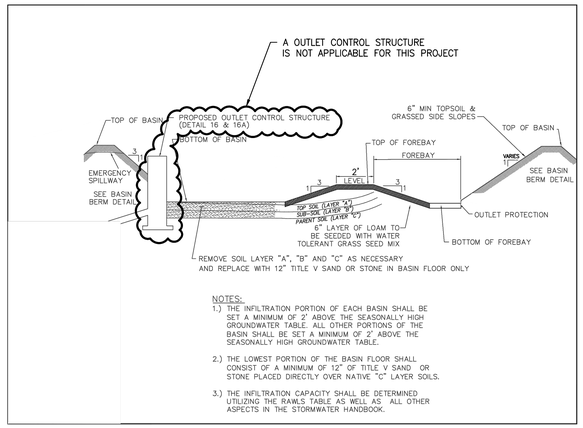
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 7134275400

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

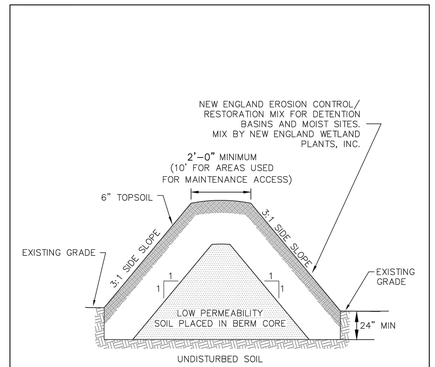


NOTES:
1.) THE INFILTRATION PORTION OF EACH BASIN SHALL BE SET A MINIMUM OF 2' ABOVE THE SEASONALLY HIGH GROUNDWATER TABLE. ALL OTHER PORTIONS OF THE BASIN SHALL BE SET A MINIMUM OF 2' ABOVE THE SEASONALLY HIGH GROUNDWATER TABLE.

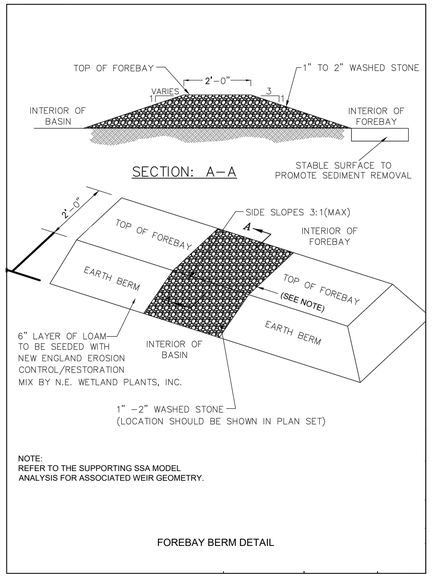
2.) THE LOWEST PORTION OF THE BASIN FLOOR SHALL CONSIST OF A MINIMUM OF 12" OF TITLE V SAND OR STONE PLACED DIRECTLY OVER NATIVE "C" LAYER SOILS.

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

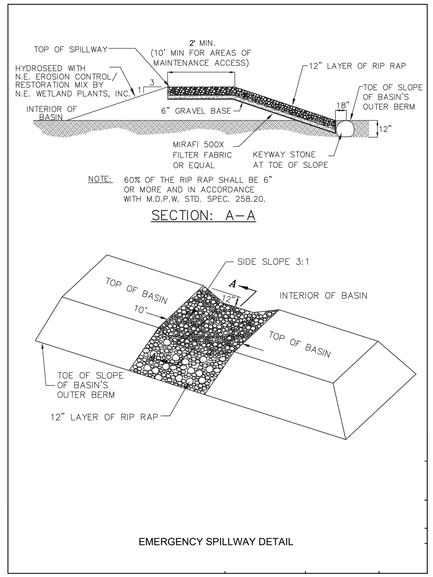


BASIN BERM DETAIL



NOTE:
REFER TO THE SUPPORTING SSA MODEL ANALYSIS FOR ASSOCIATED WEIR GEOMETRY.

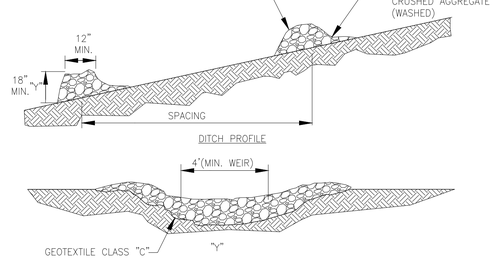
FOREBAY BERM DETAIL



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

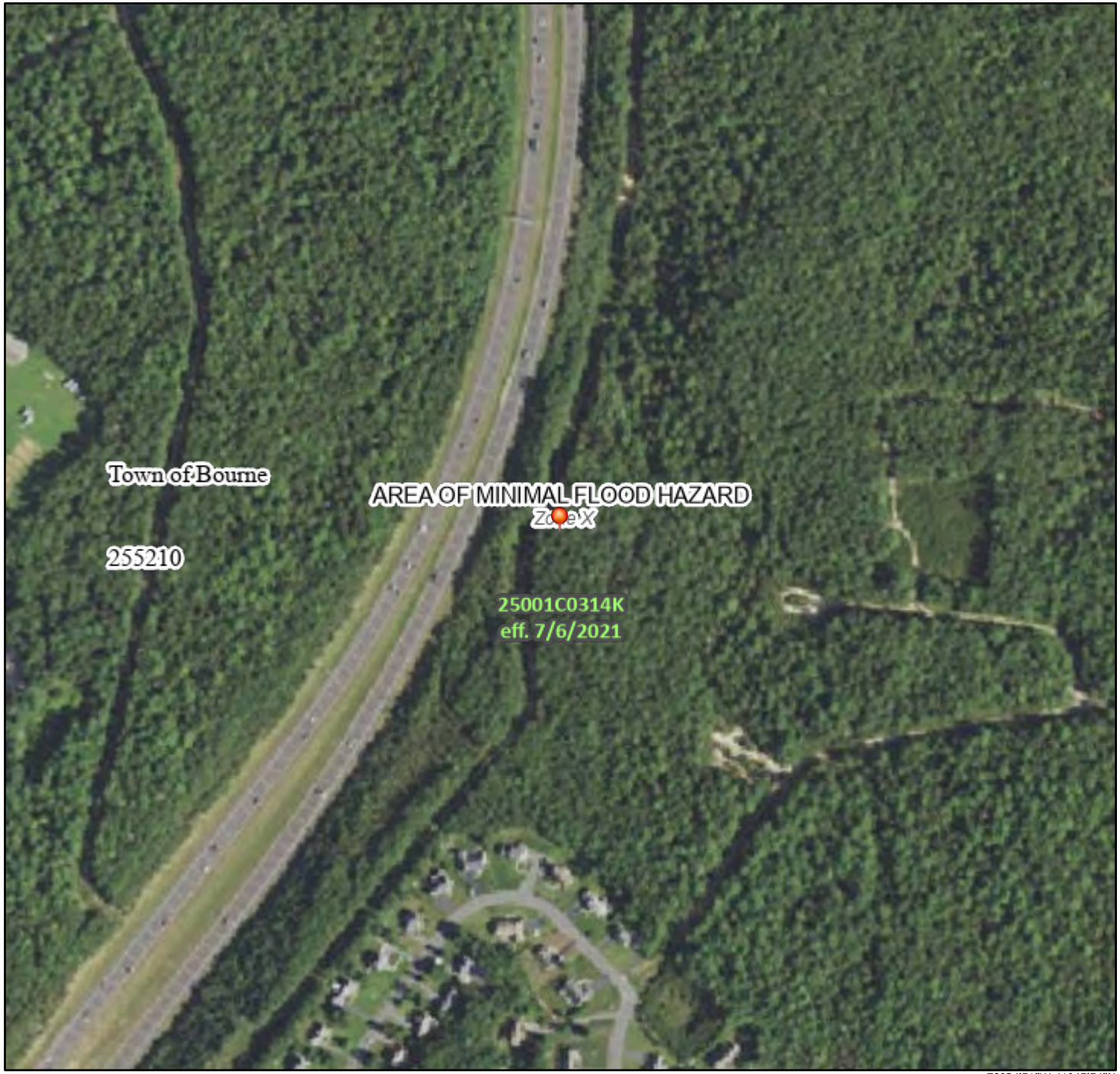
Attachment G – Standard 9 Supporting Information

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

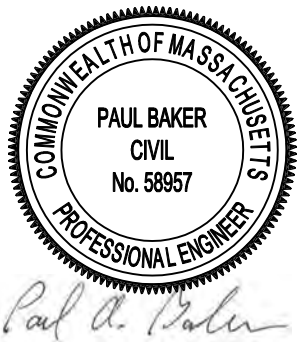
Prepared For: Algonquin Gas Transmission, LLC

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

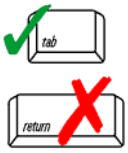
1 Checklist for Stormwater Report

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.

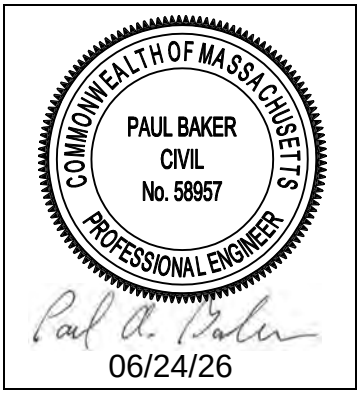
Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the 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

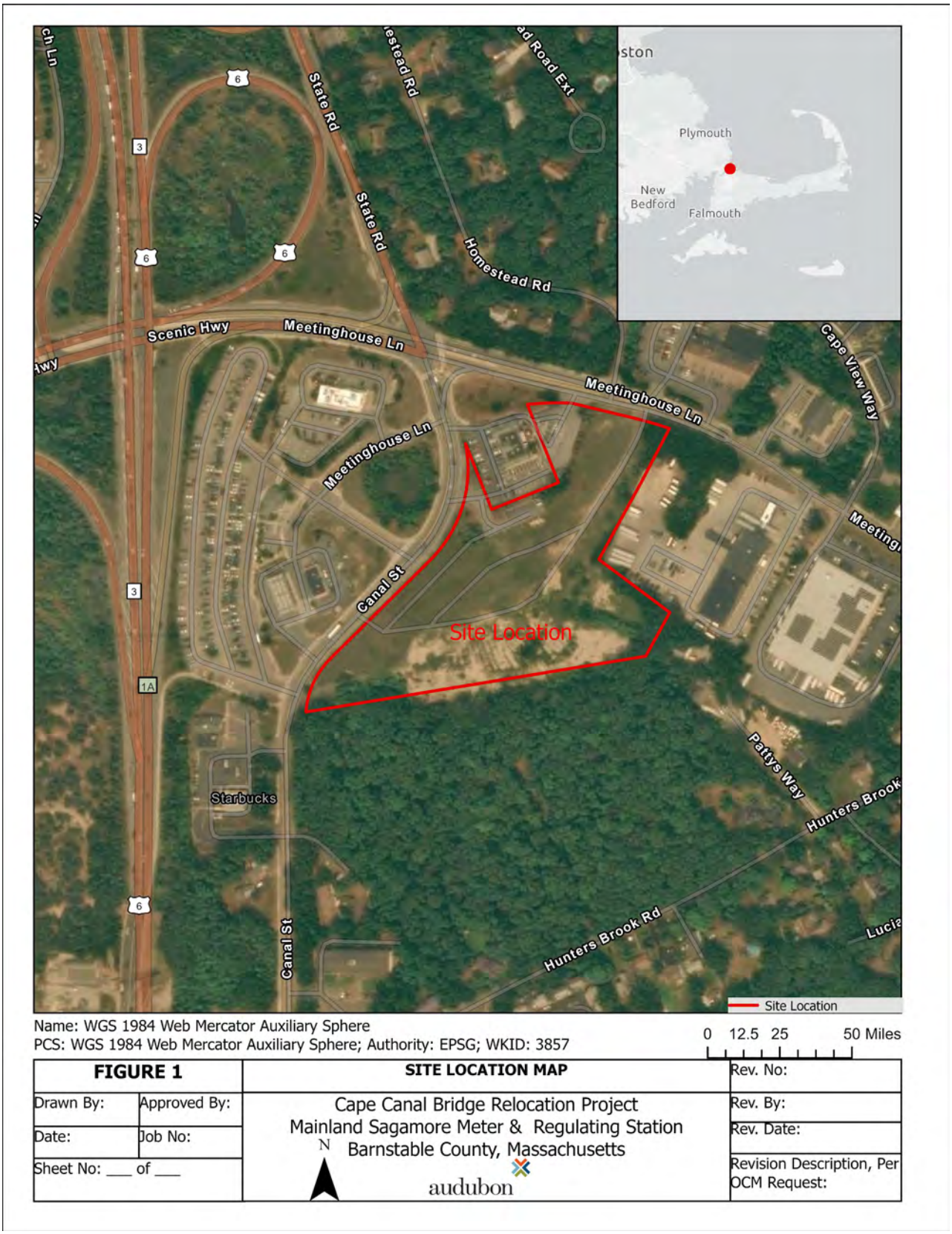


Figure A - Site Location Map (Aerial)



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

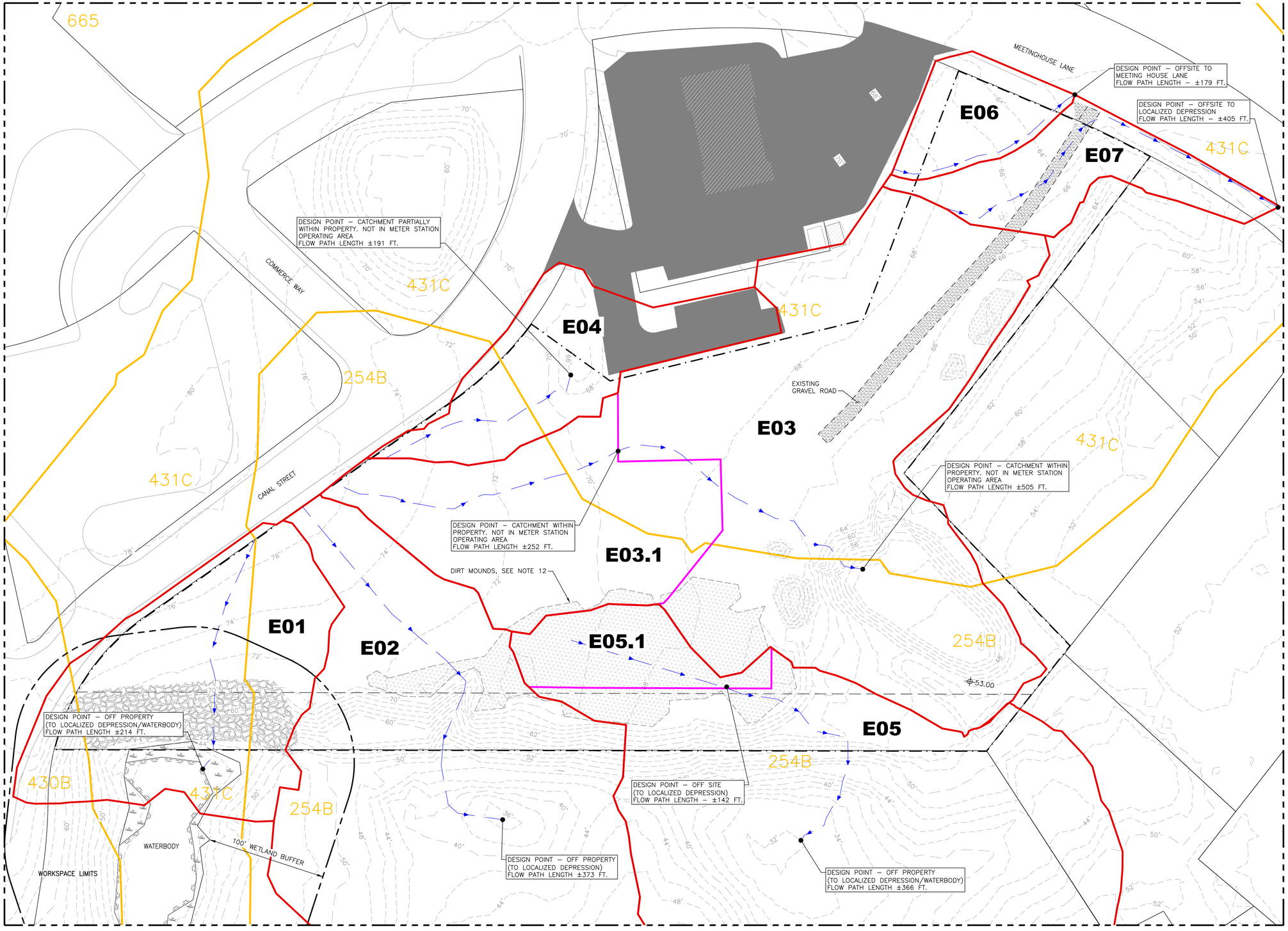
audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

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

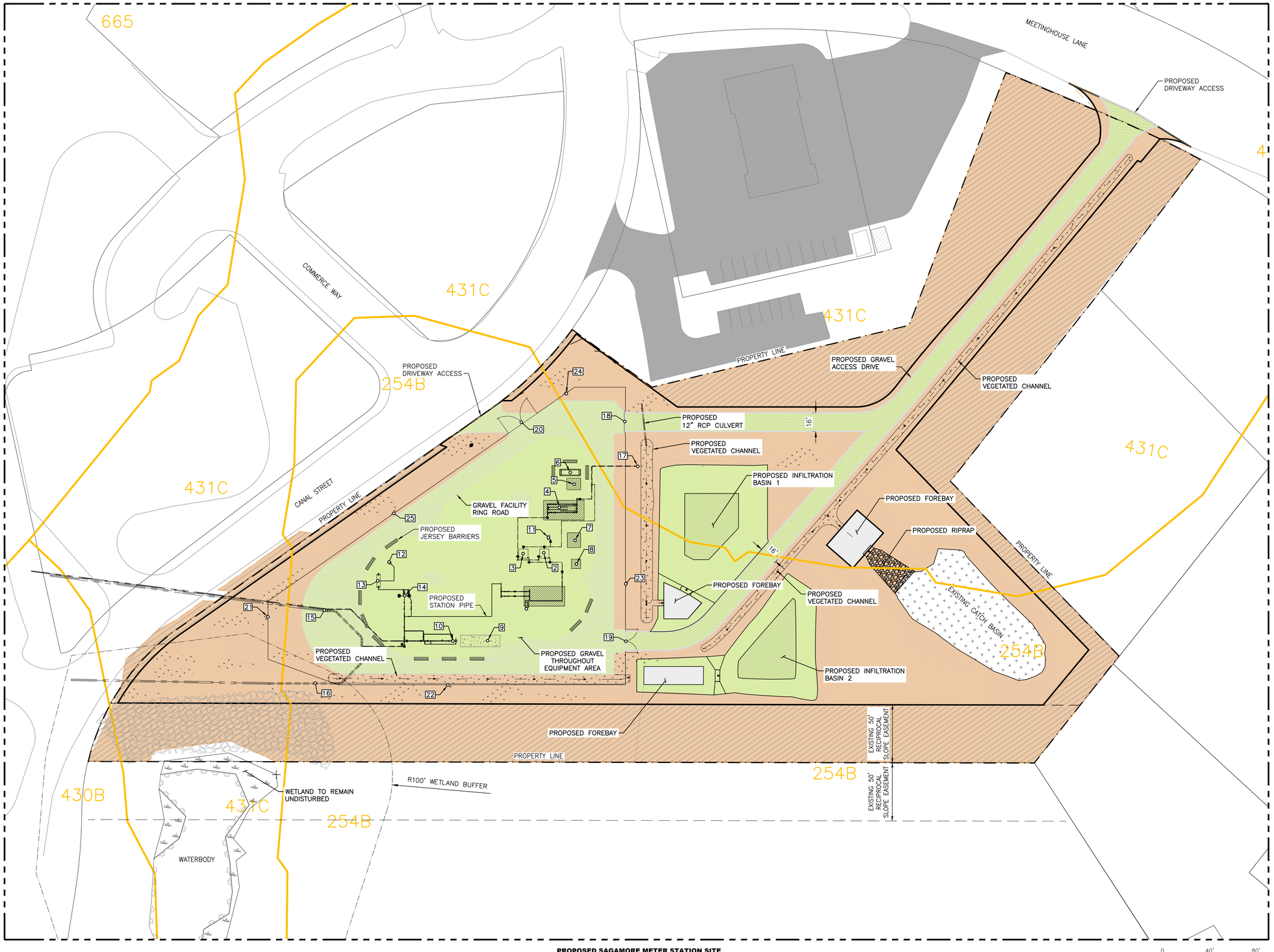
DRAWN BY:	CR	05/15/26	CAPE COD CANAL PIPELINE RELOCATION PROJECT
DESIGN CHECKER:	DT	06/18/26	SAGAMORE M&R RELOCATION
DESIGN ENGINEER:	PB	06/18/26	M&R 00051
PROJECT MANAGER:	AC	06/18/26	TITLE: EXISTING SUBCATCHMENT AREAS PLAN
TITLE	INITIALS	DATE	LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

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

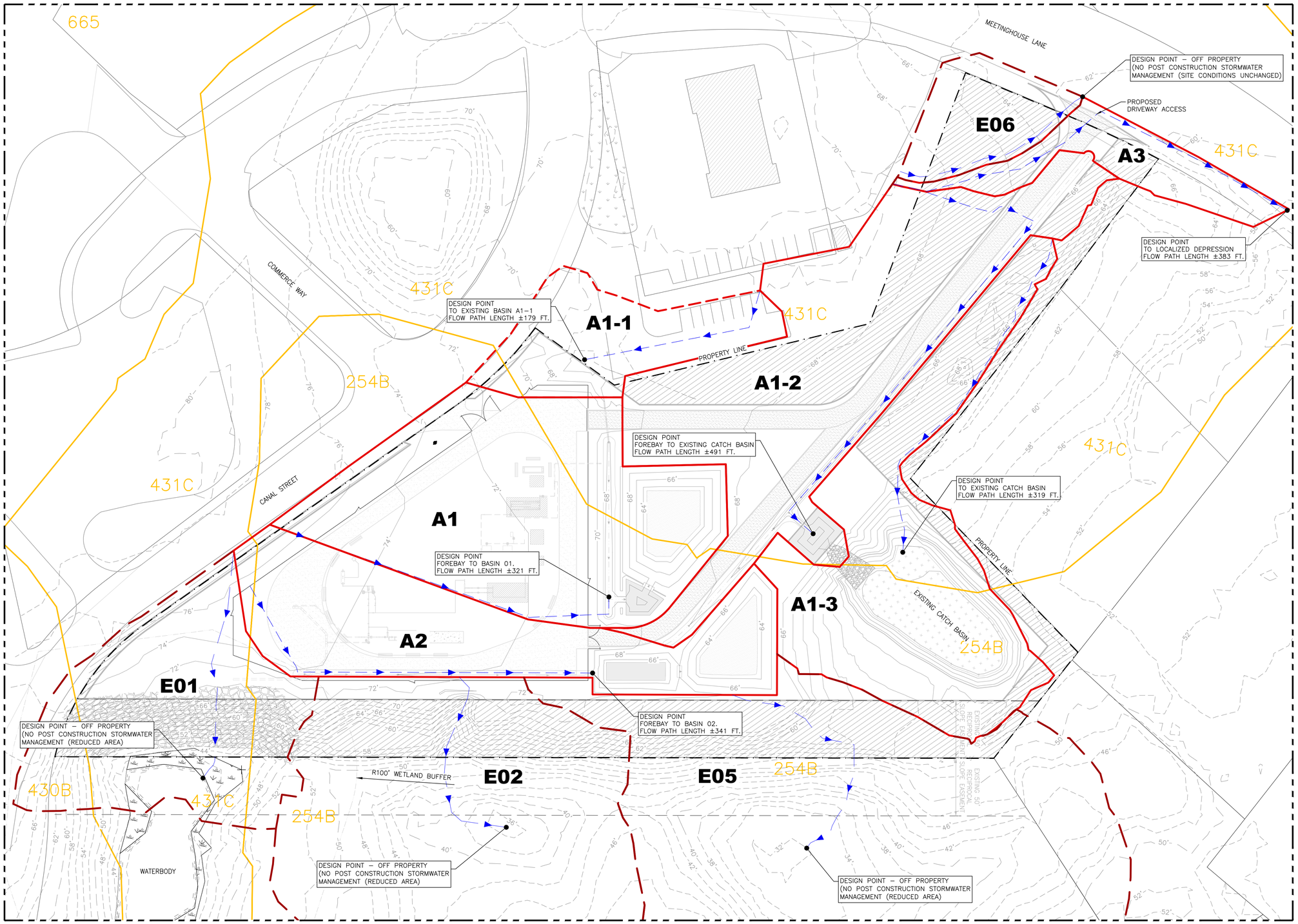
audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

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

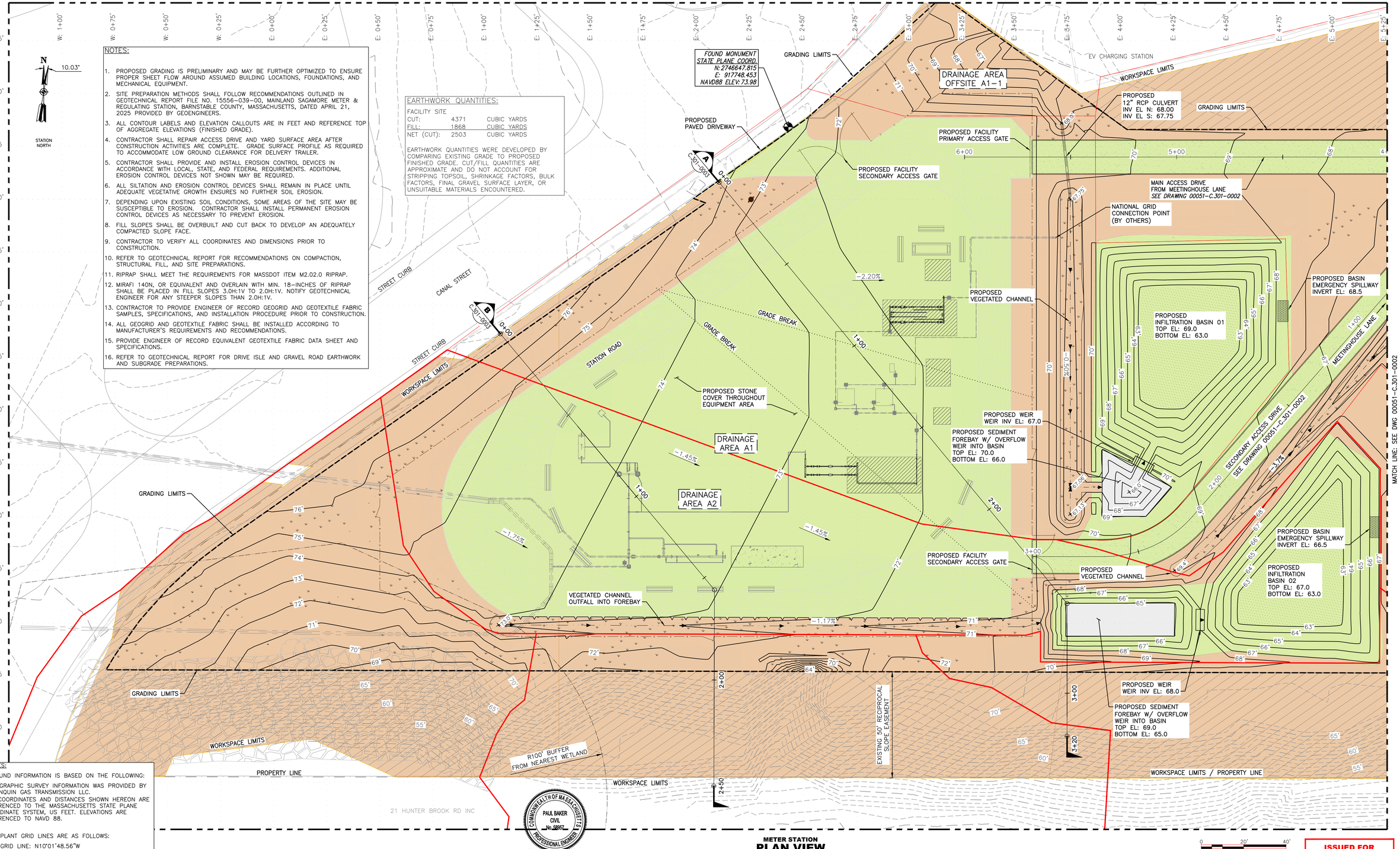
audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

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

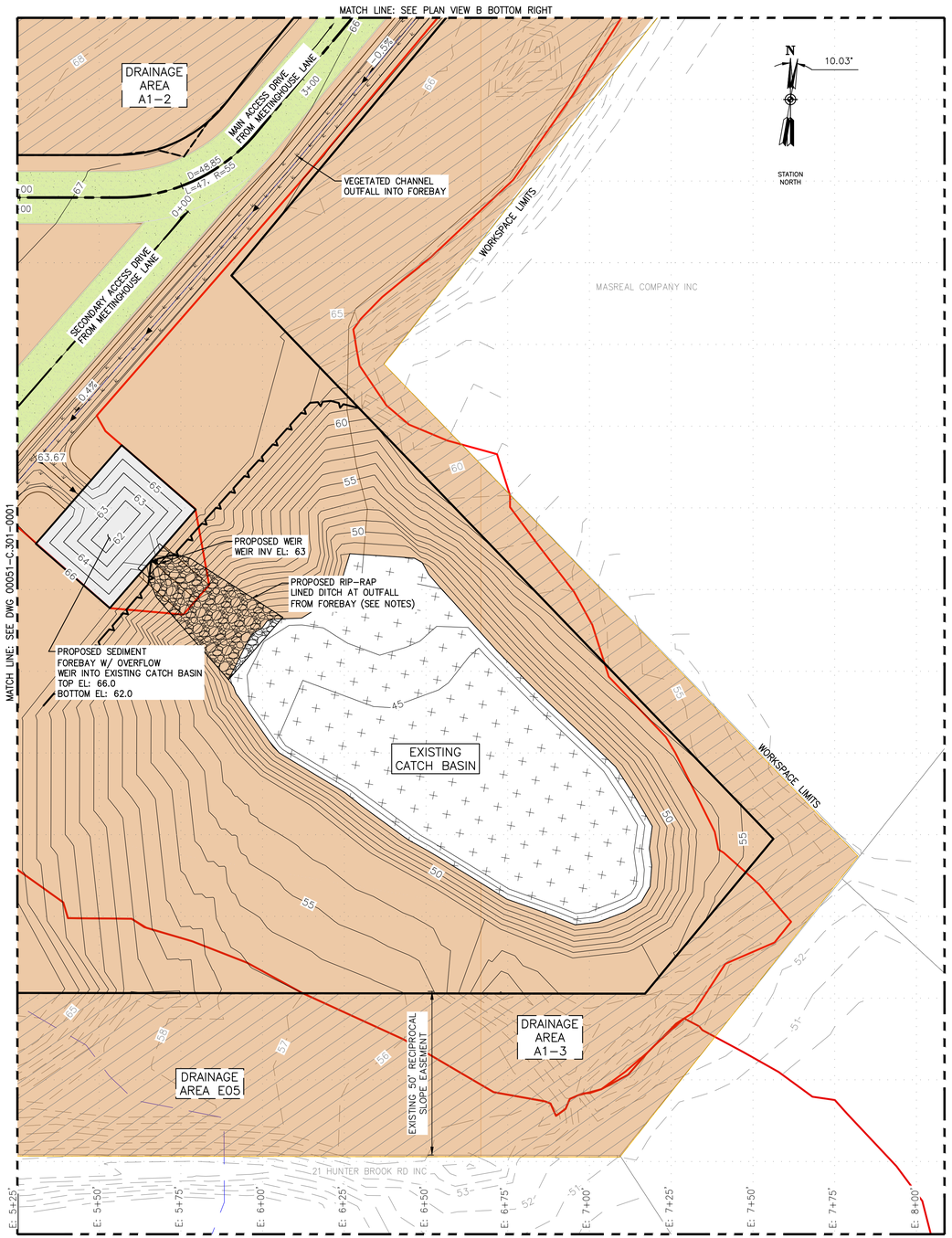
DRAWN BY:	CR	04/20/25	
DESIGN CHECKER:	AE	06/18/26	
DESIGN ENGINEER:	PB	06/18/26	
PROJECT MANAGER:	AC	06/18/26	
TITLE	INITIALS	DATE	

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

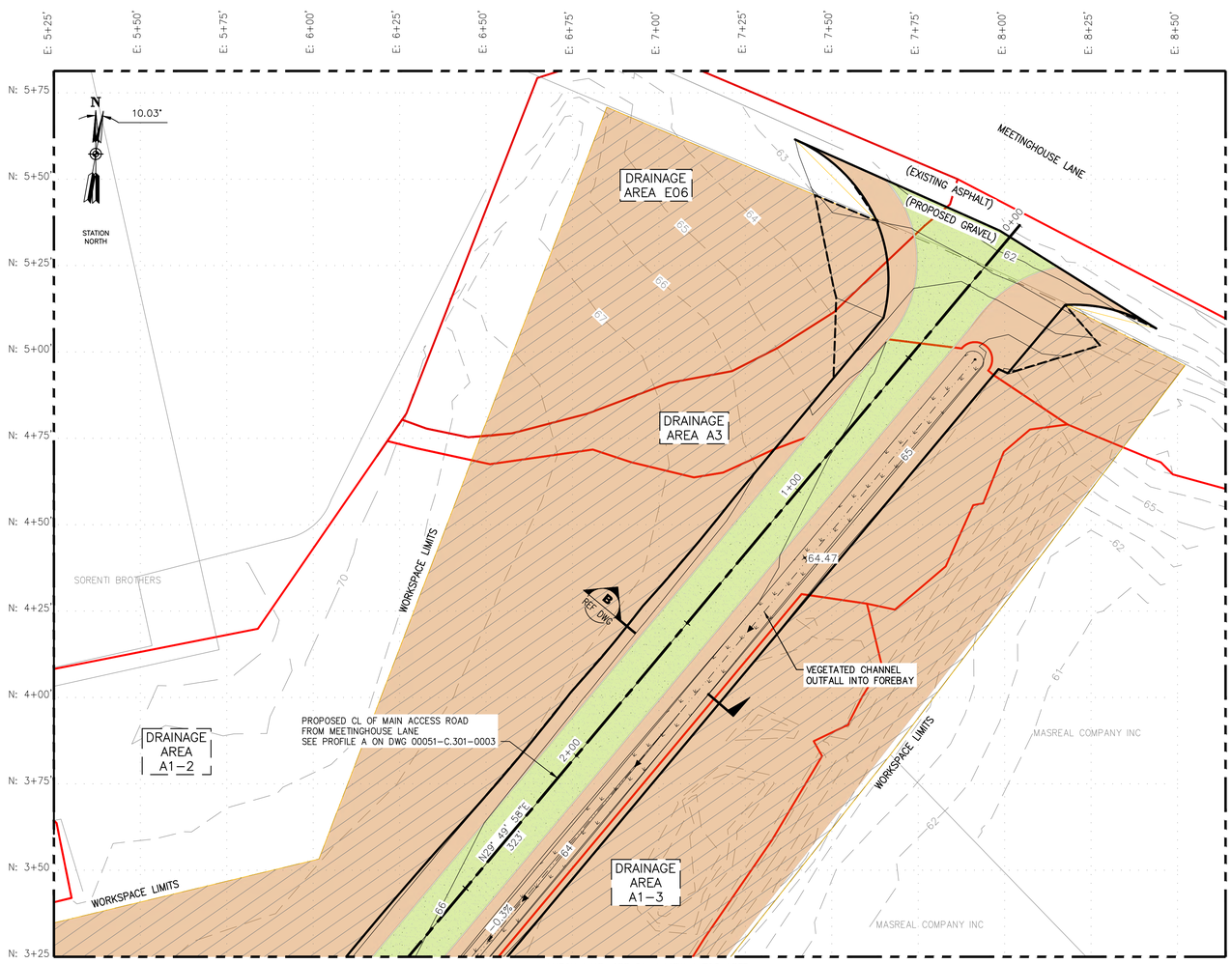
S:\AE\Projects\Enbridge\Mass\026356-001\200_Civil_Structural\170_Drawings\Grading\Mainland Sagamore\00051-C.301-0002.dwg — PLOT TIME: 6/24/2026 12:49 AM



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		

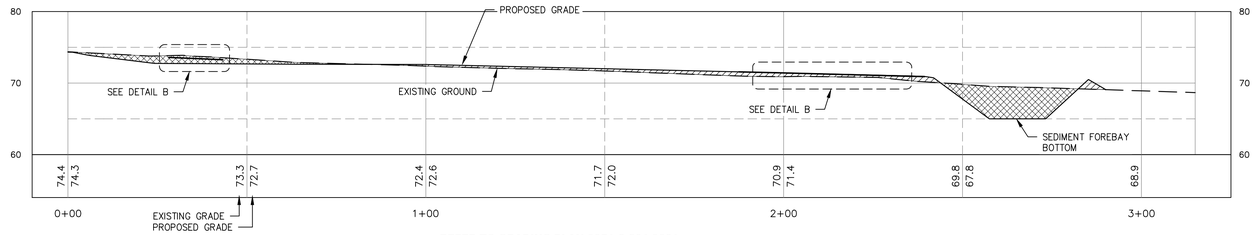
DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		E	06/18/26	CR	DT	ISSUED FOR PERMIT
		D	05/15/26	CR	DT	ISSUED FOR BID
		C	05/15/26	CR	DT	ISSUED FOR PERMIT
00051-C.301-0003	CIVIL GRADING SECTIONS AND DETAILS	B	03/03/26	CR	PB	ISSUED FOR REVIEW – 90% REVIEW
00051-C.301-0001	CIVIL GRADING PLAN	A	05/29/25	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

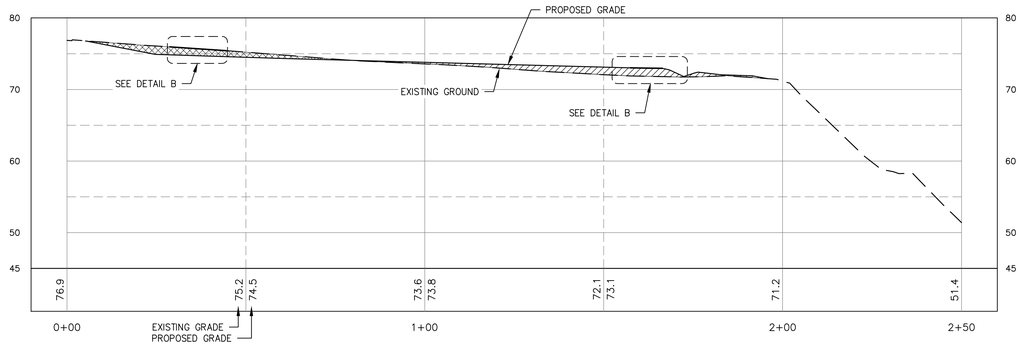
ENBRIDGE
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713.627.5400



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

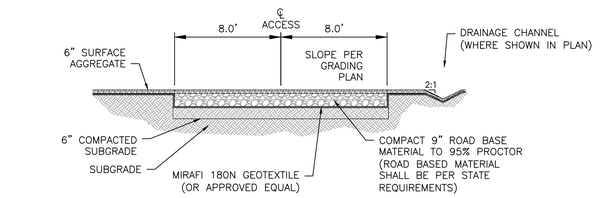
      DIRECTION BACK   S31° 01' 52.19"W
         RADIUS        55.000'
         DELTA         48°56'19"(RT)
         LENGTH        46.978'
         TANGENT       25.029'
         CHORD DIRECTION     S55° 30' 01.82"W   DISTANCE   45.563'
      DIRECTION AHEAD S79° 58' 11.44"W

   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)

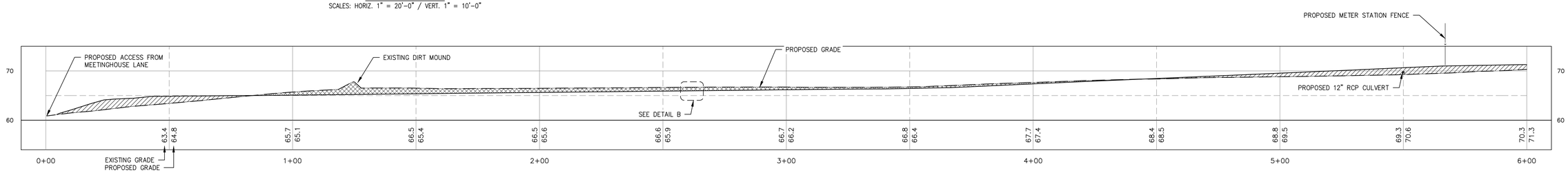
   N 2,746,468.2437   E 917,897.3850                    3+00.00
END SECONDARY DRIVEWAY
**********************************************************

ALIGNMENT LENGTH: 300.000'
```



DETAIL B – TYPICAL AGGREGATE ACCESS/FACILITY ROAD

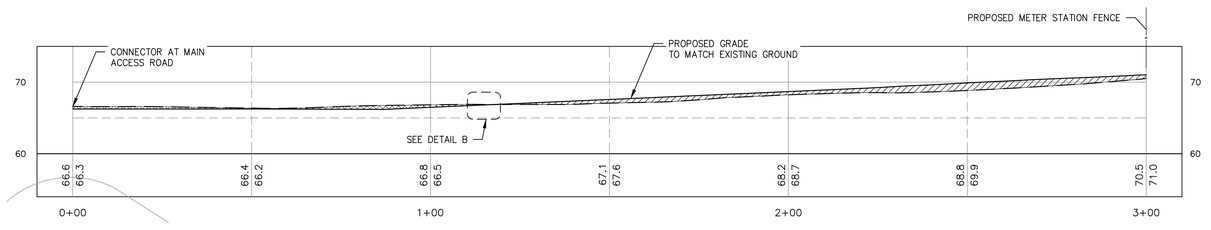
SCALE: NOT TO SCALE



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

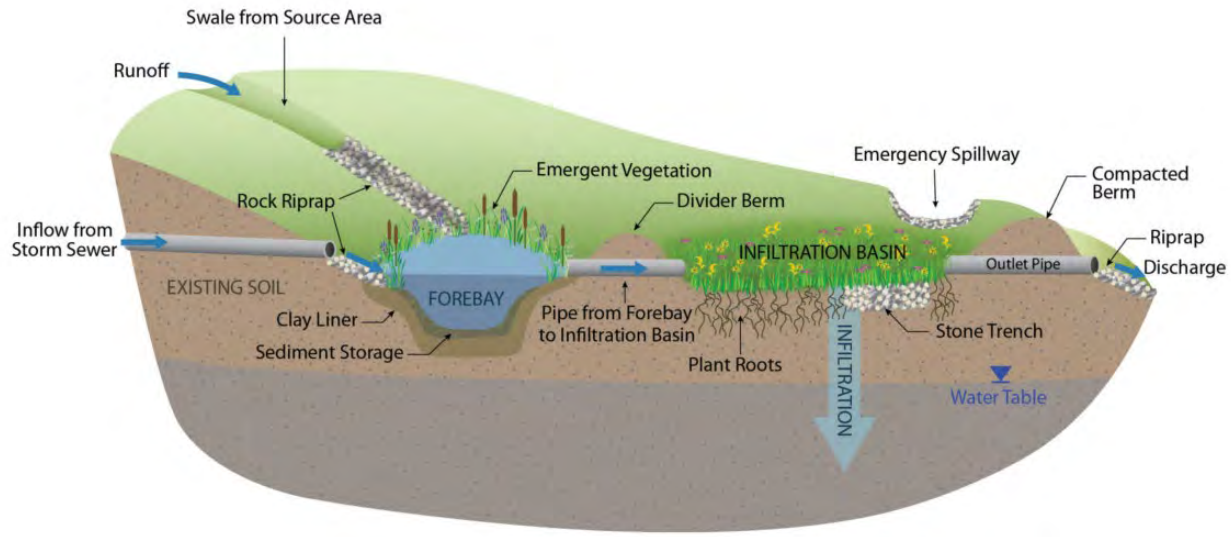


Illustration by Geosyntec Consultants, Inc.

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)

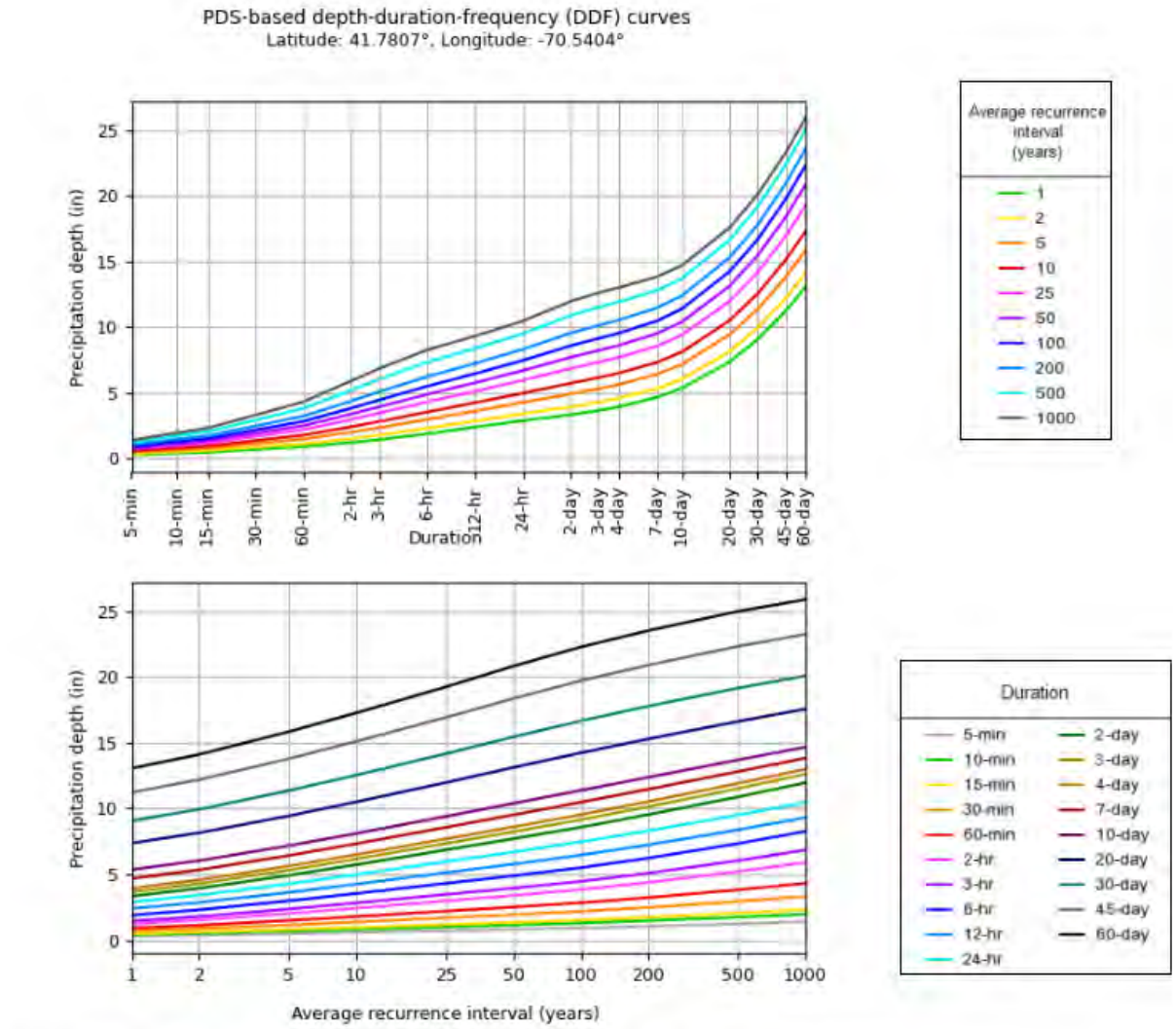
[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

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

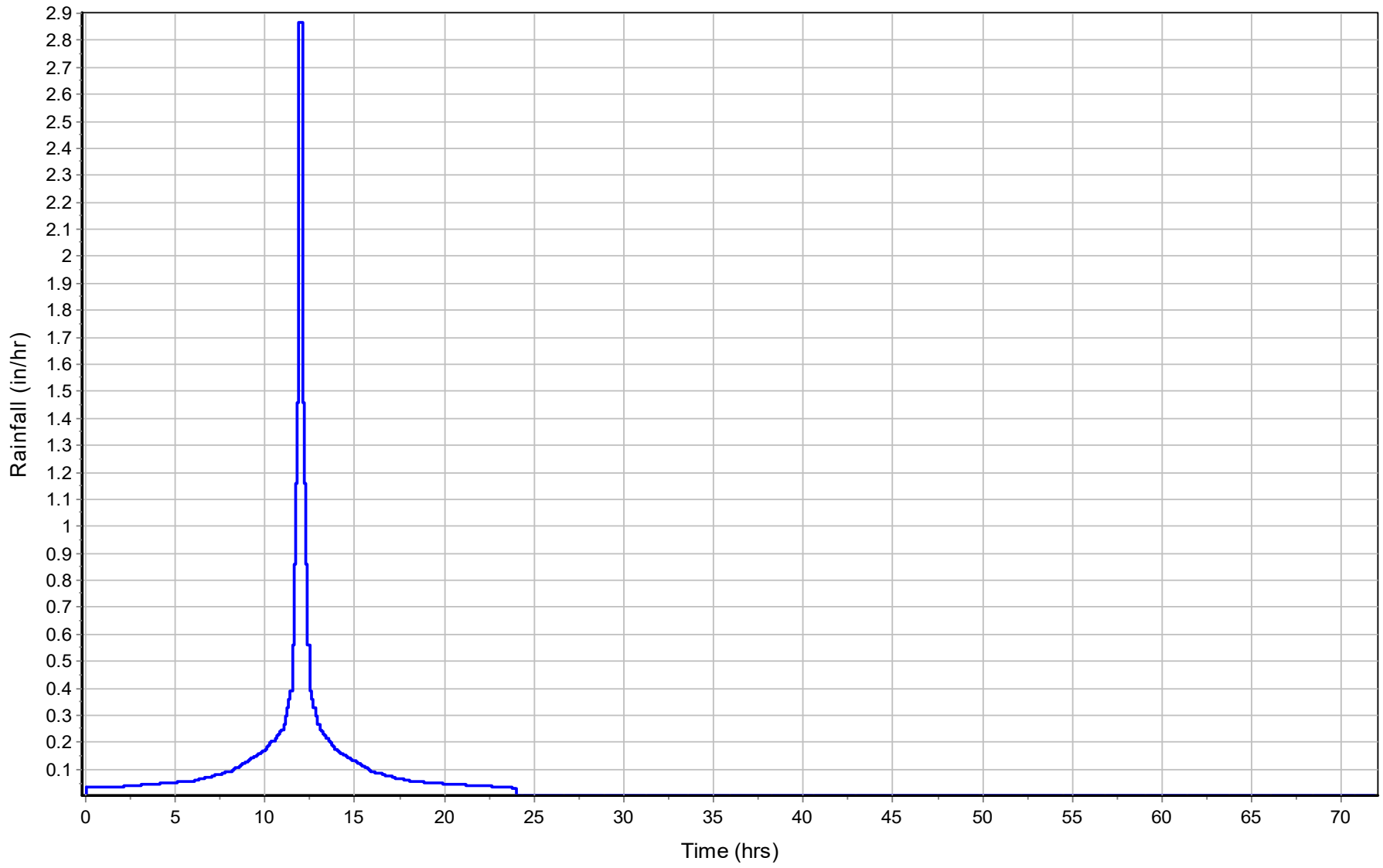
Total TOC (min) 4.58

Subbasin Runoff Results

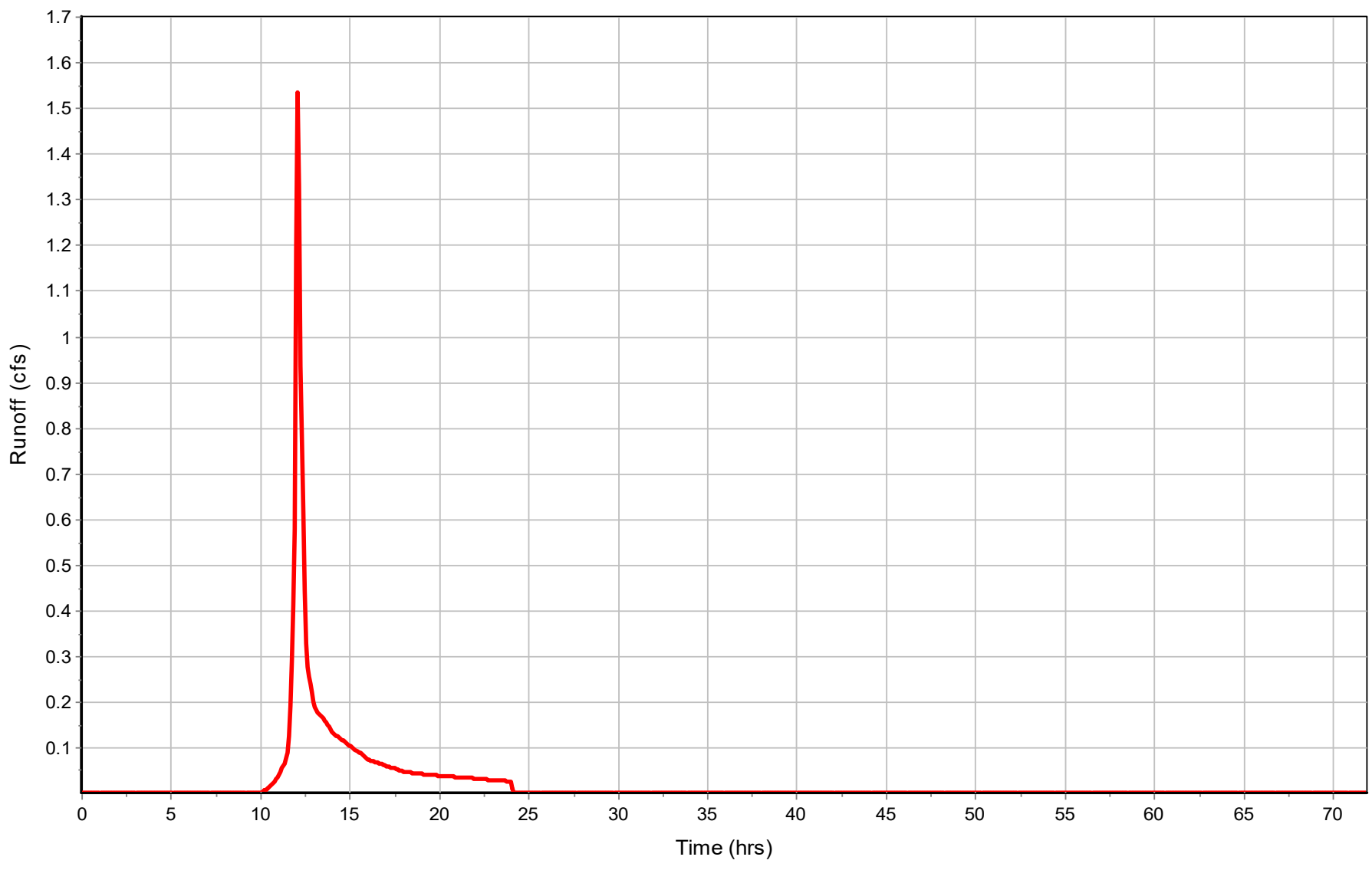
Total Rainfall (in) 3.41
Total Runoff (in) 1.3
Peak Runoff (cfs) 1.61
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:04:35

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

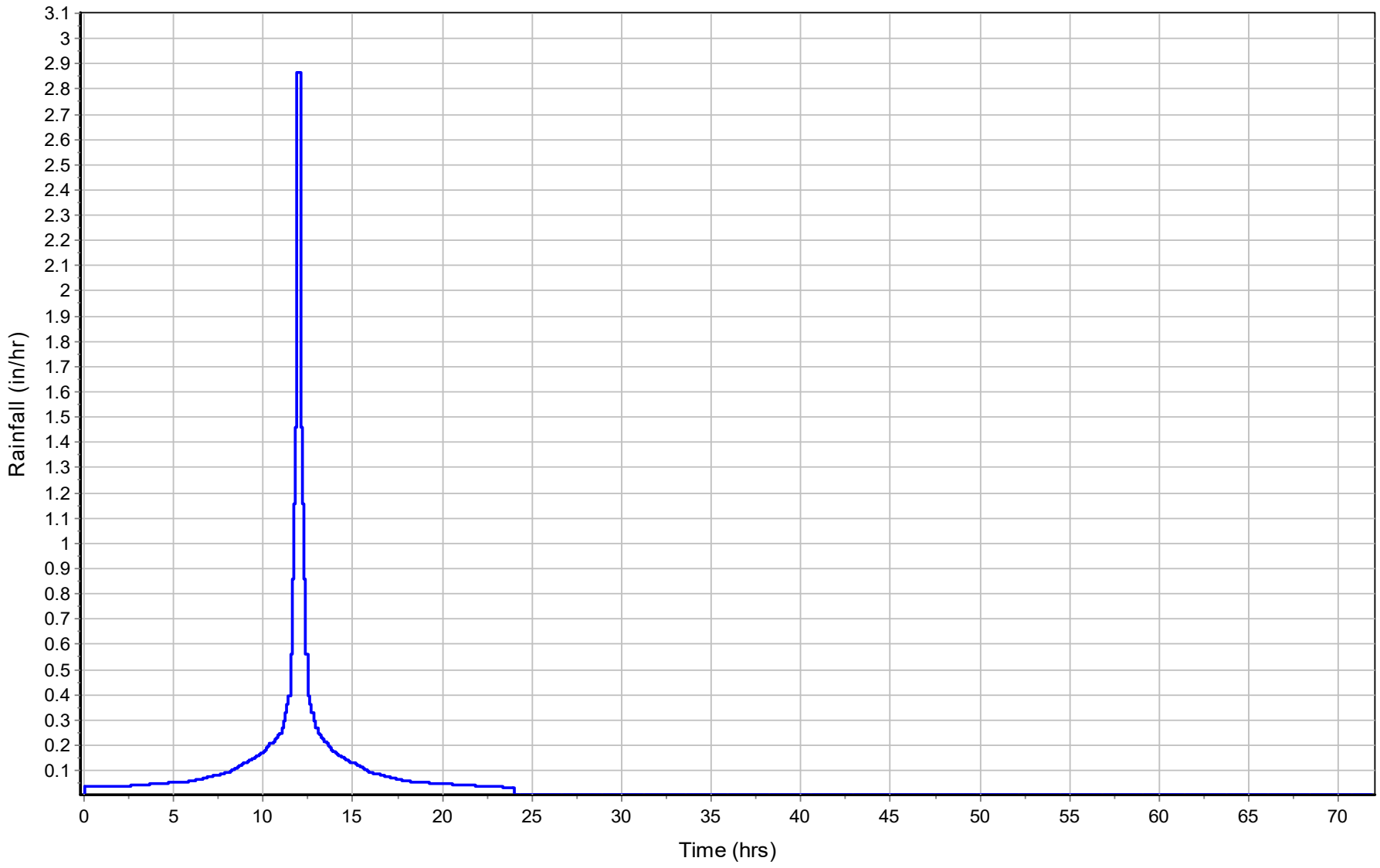
Total TOC (min) 10.92

Subbasin Runoff Results

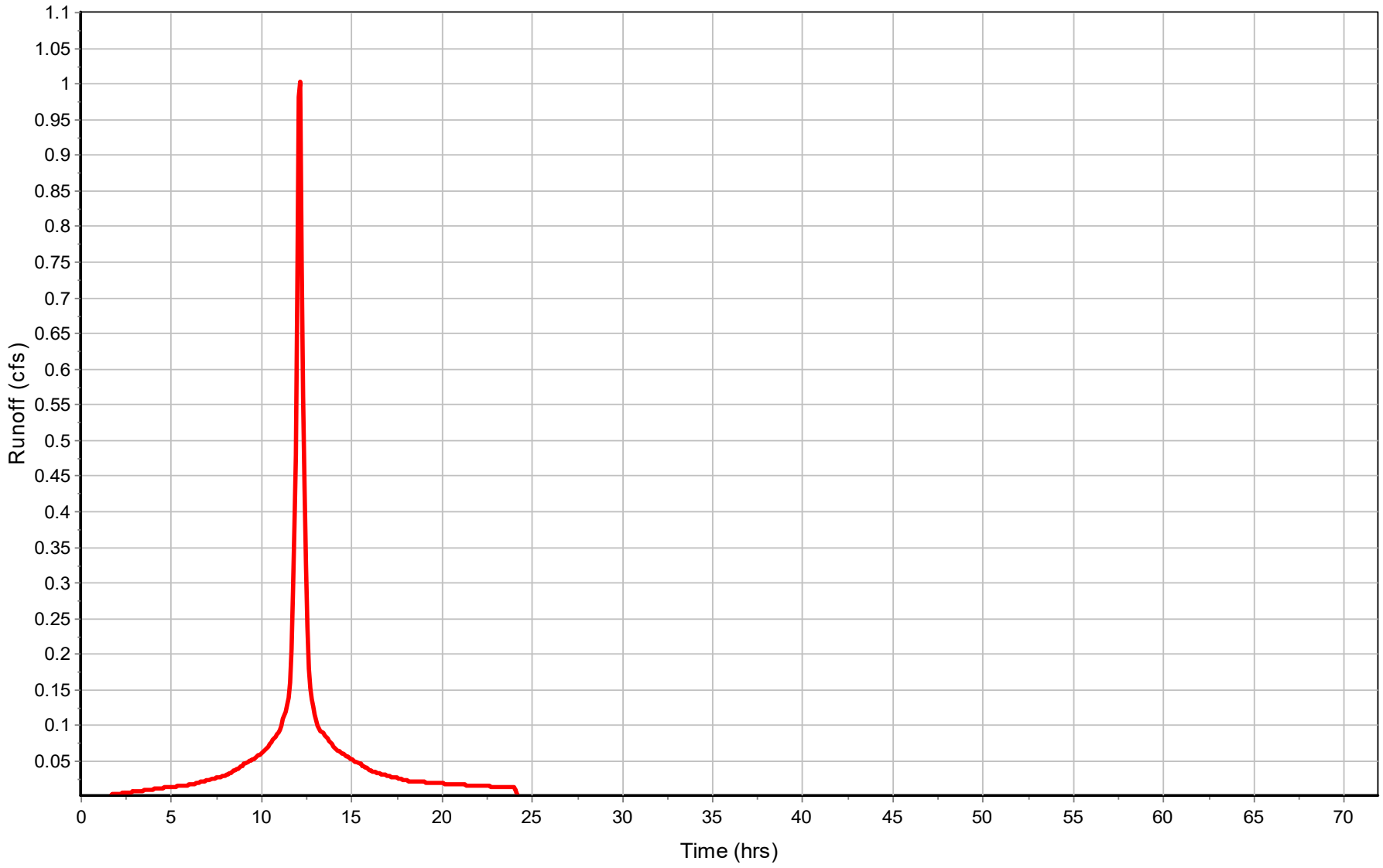
Total Rainfall (in) 3.41
Total Runoff (in) 3.18
Peak Runoff (cfs) 1.03
Weighted Curve Number 98
Time of Concentration (days hh:mm:ss) 0 00:10:55

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

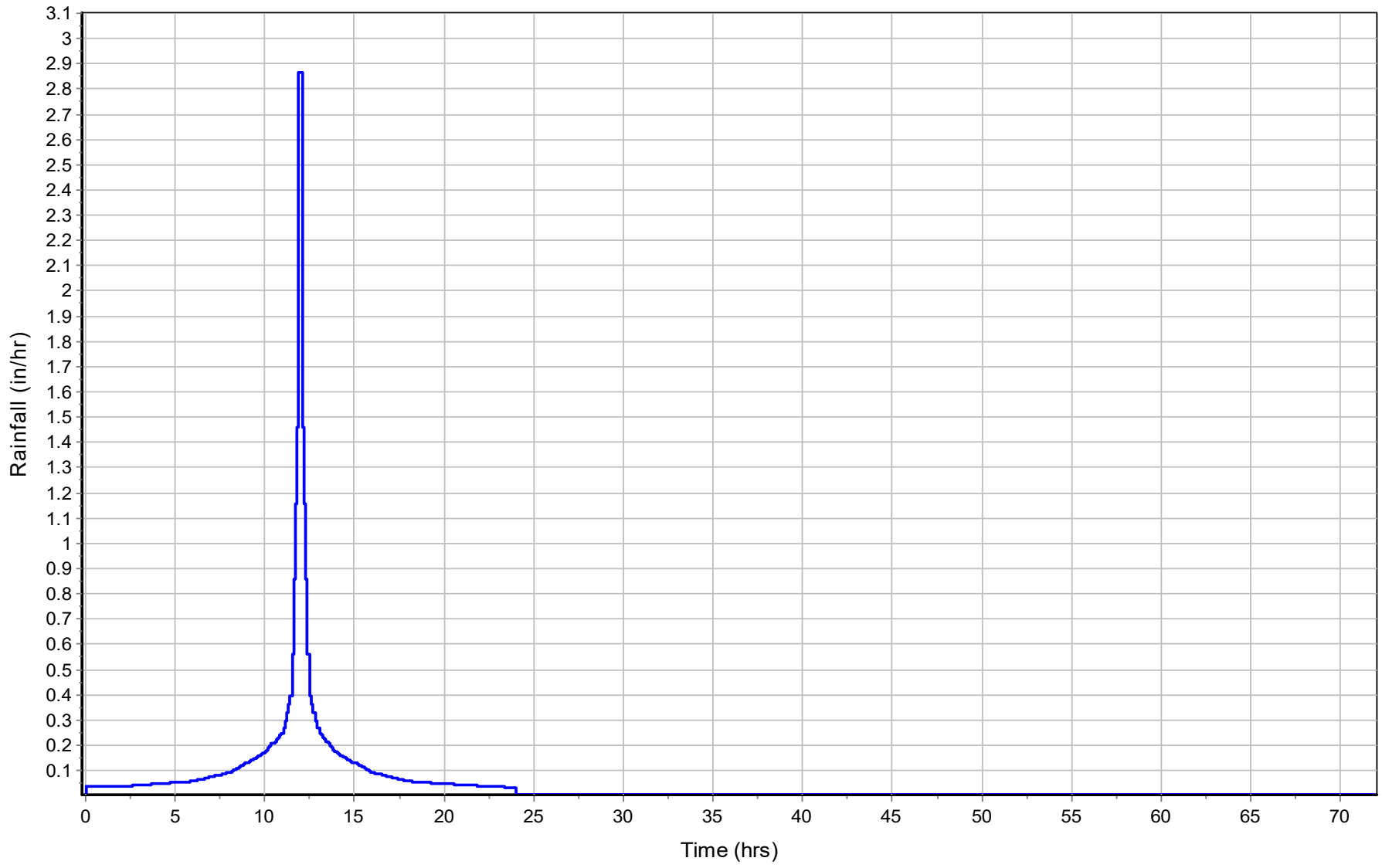
Total TOC (min) 3.41

Subbasin Runoff Results

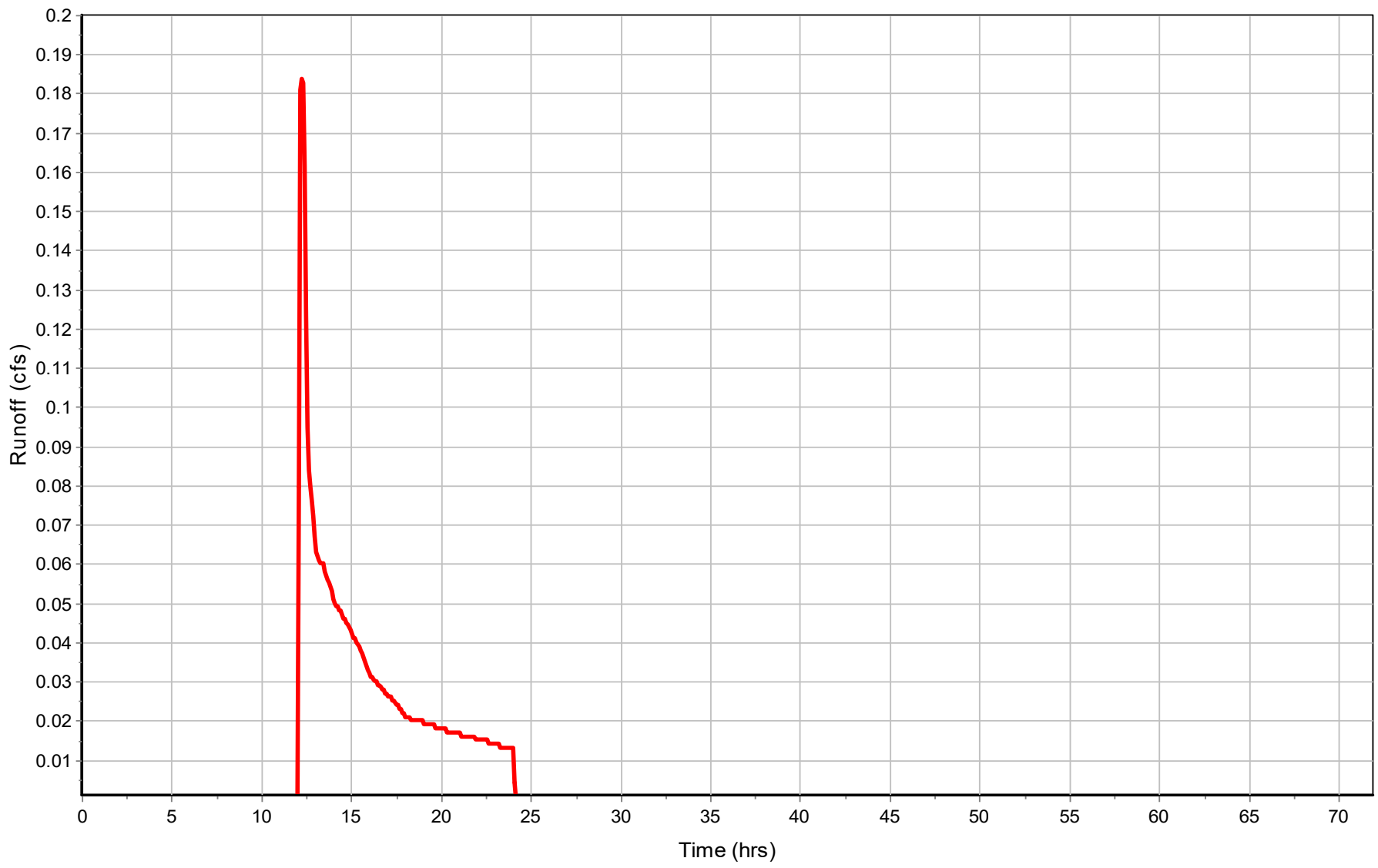
Total Rainfall (in) 3.41
Total Runoff (in) 0.3
Peak Runoff (cfs) 0.18
Weighted Curve Number 54.63
Time of Concentration (days hh:mm:ss) 0 00:03:25

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

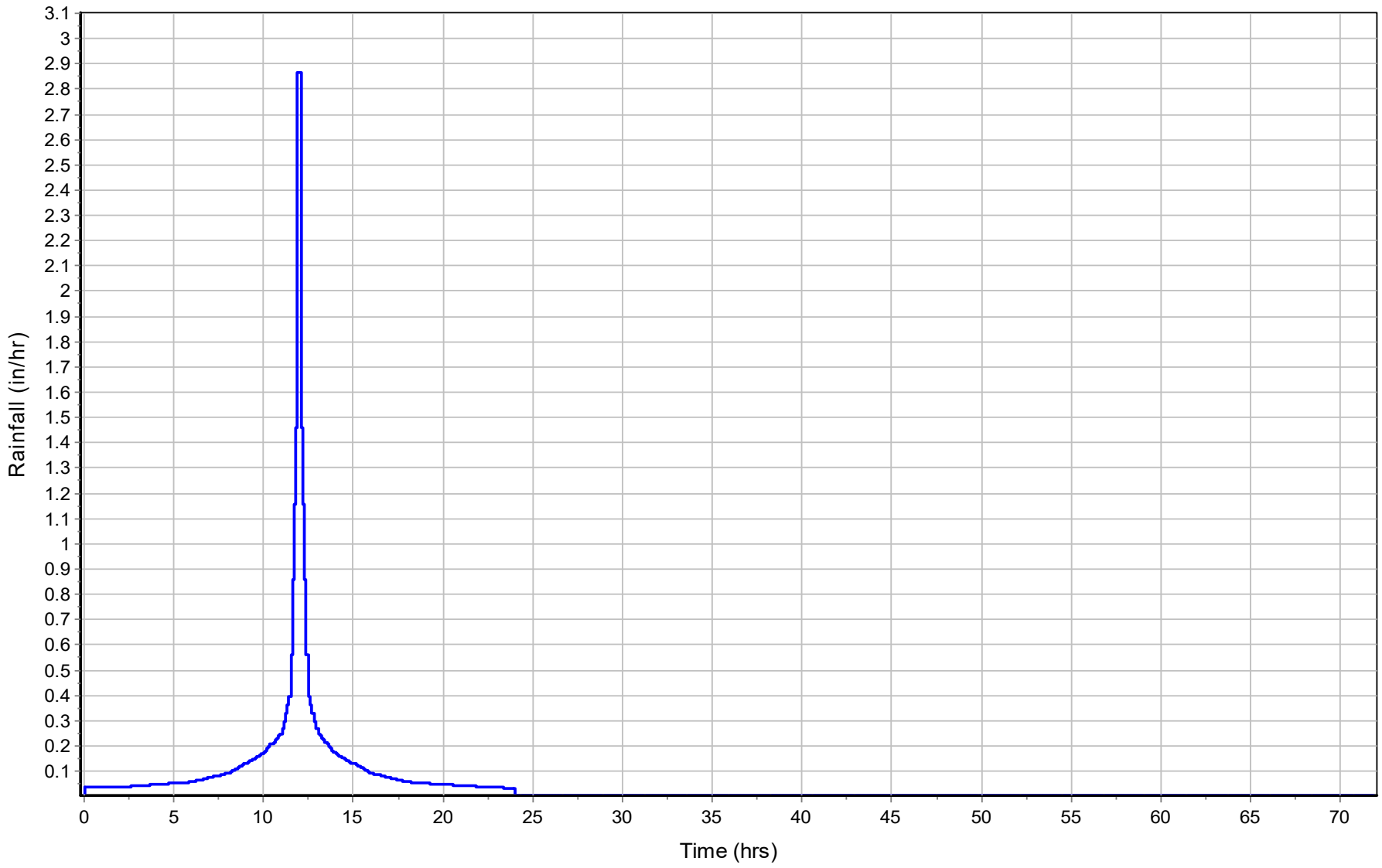
Total TOC (min) 40.27

Subbasin Runoff Results

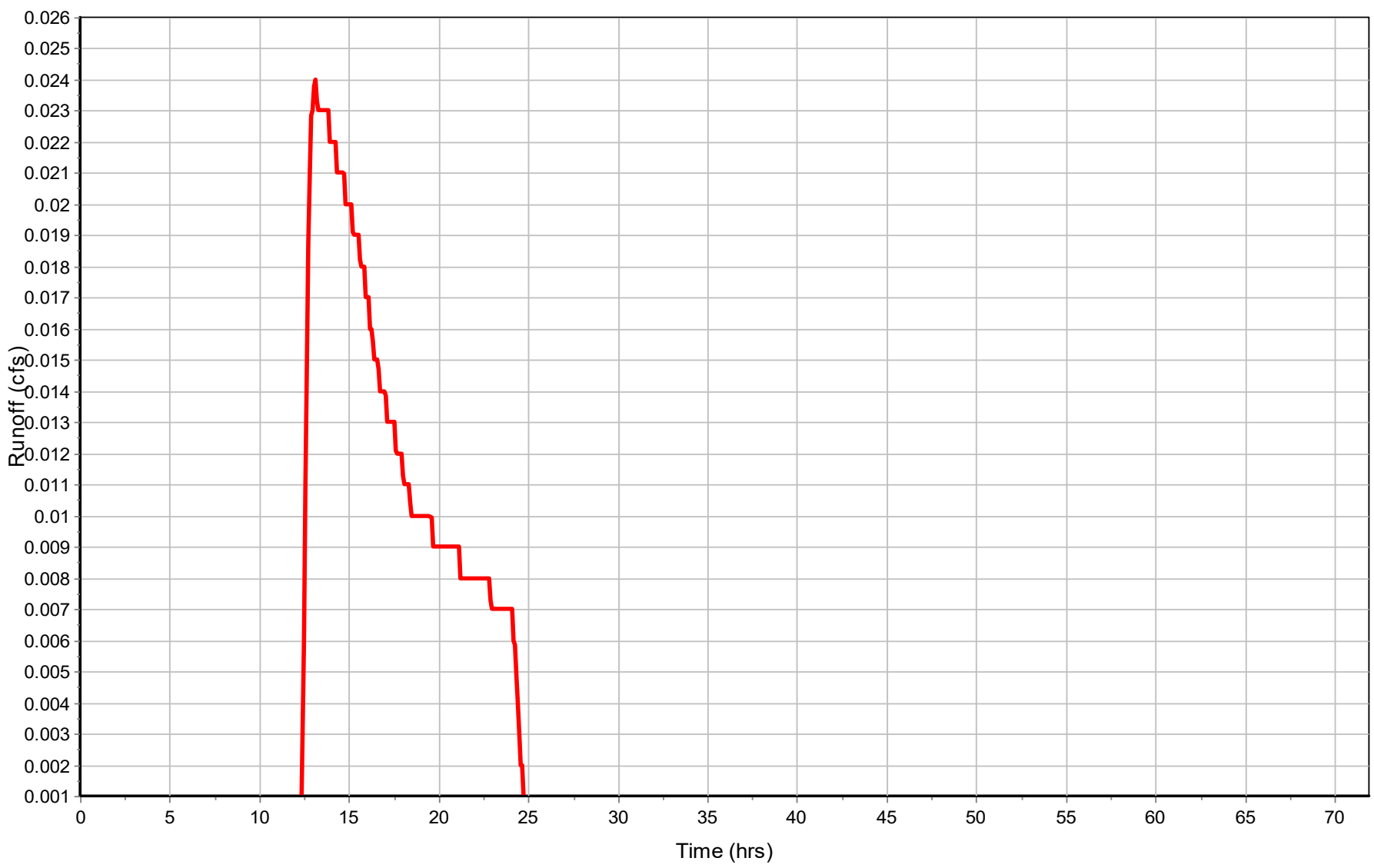
Total Rainfall (in) 3.41
Total Runoff (in) 0.15
Peak Runoff (cfs) 0.02
Weighted Curve Number 49
Time of Concentration (days hh:mm:ss) 0 00:40:16

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

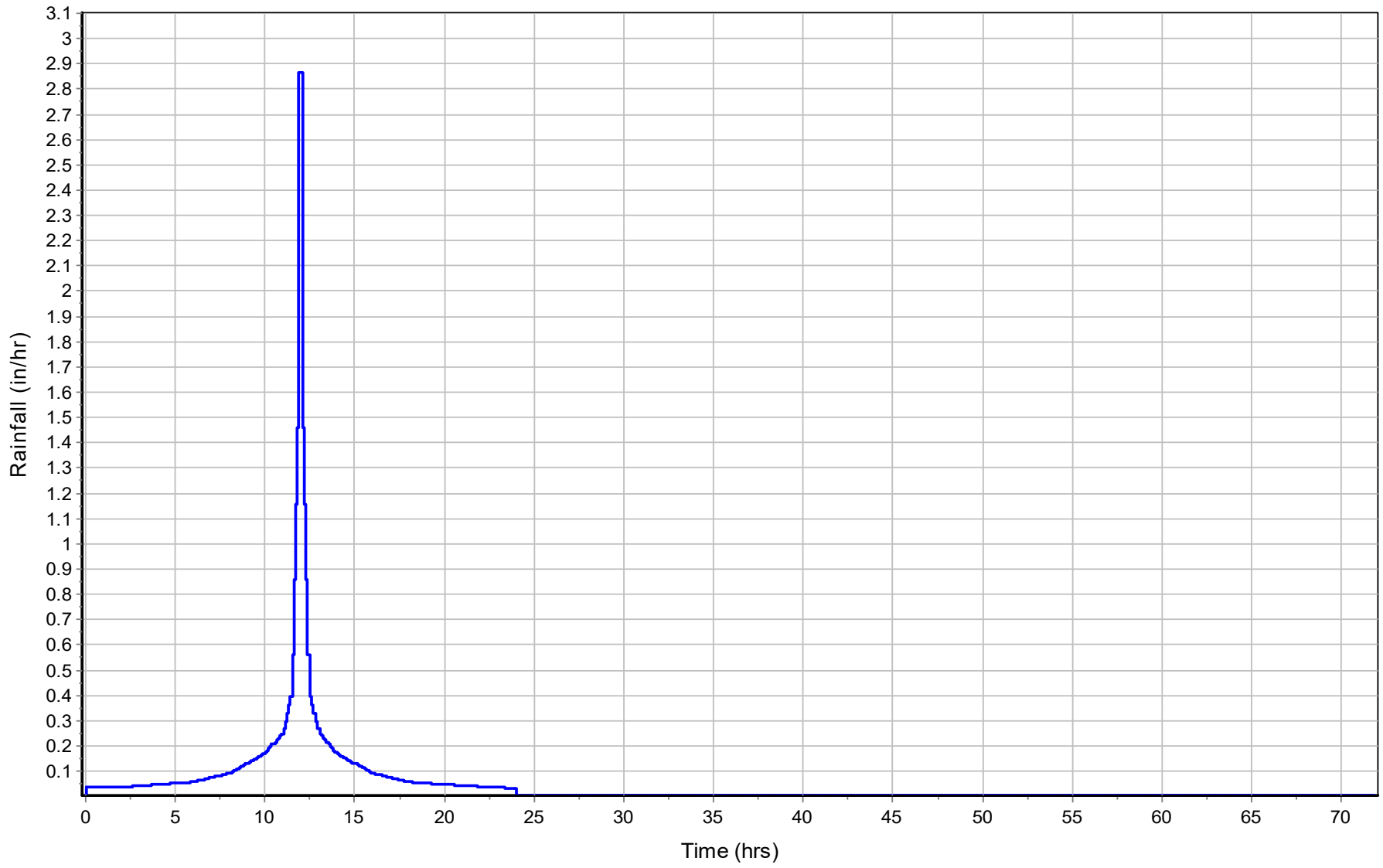
Total TOC (min) 3.51

Subbasin Runoff Results

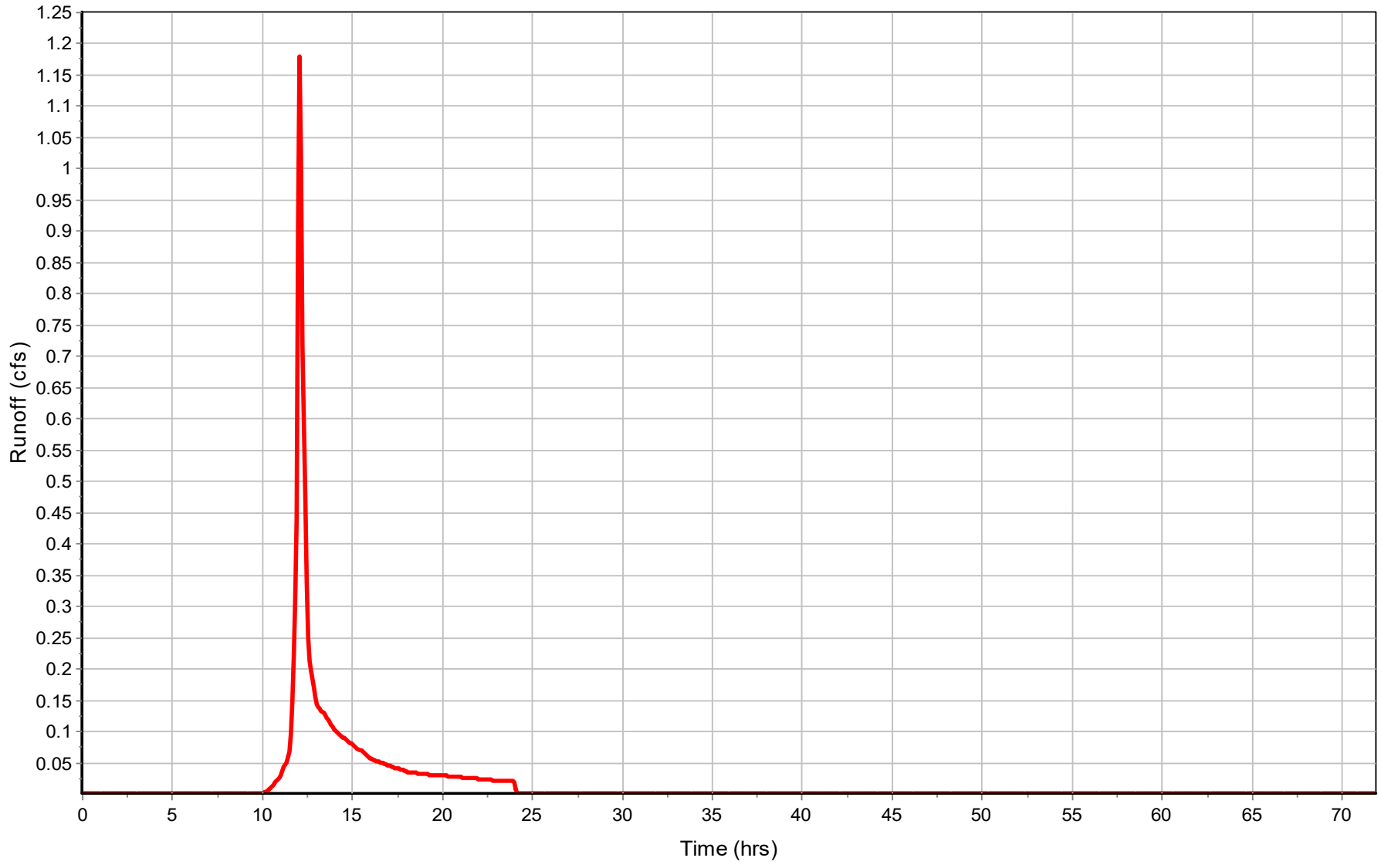
Total Rainfall (in) 3.41
Total Runoff (in) 1.3
Peak Runoff (cfs) 1.23
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:03:31

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

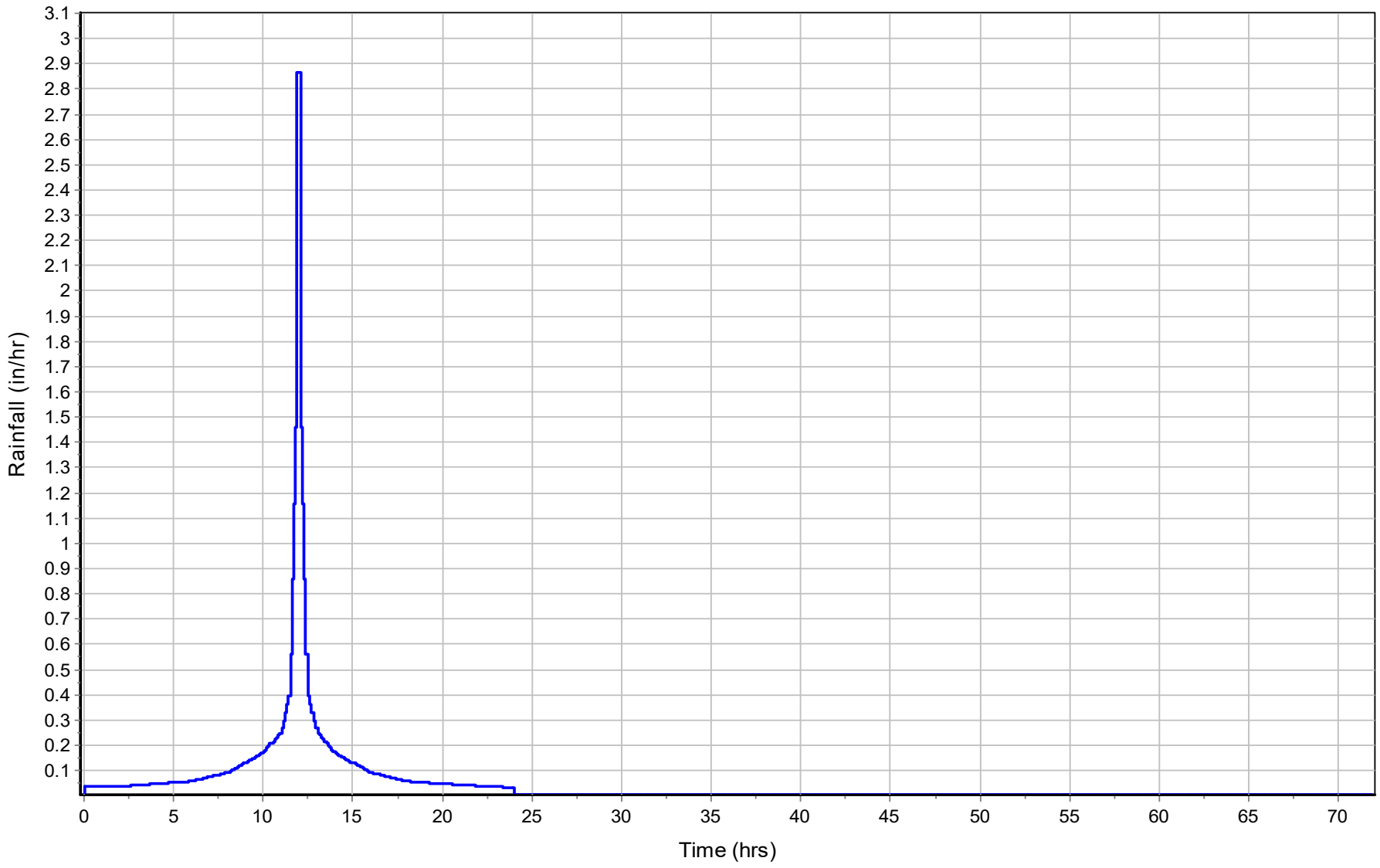
Total TOC (min) 36.12

Subbasin Runoff Results

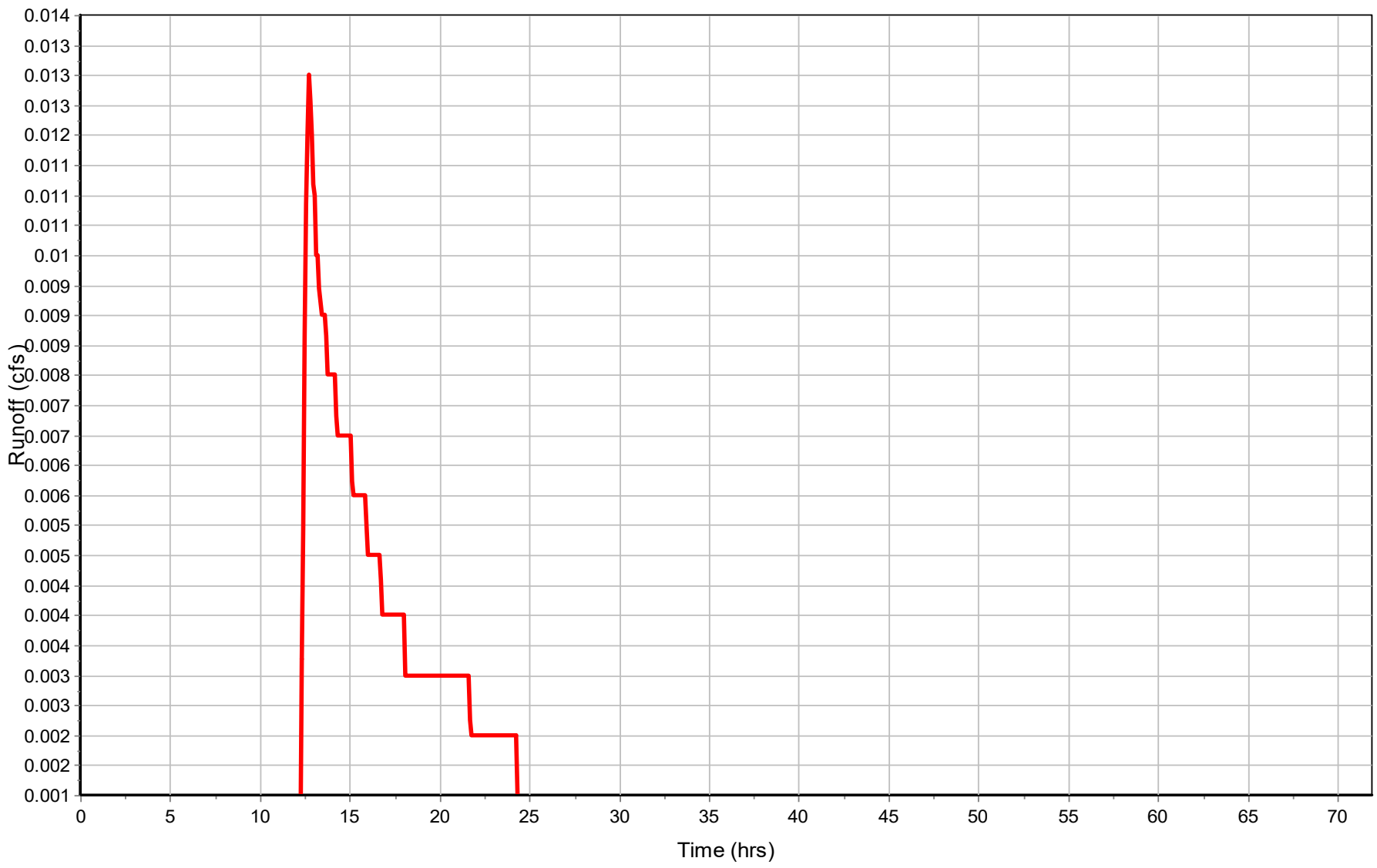
Total Rainfall (in) 3.41
Total Runoff (in) 0.22
Peak Runoff (cfs) 0.01
Weighted Curve Number 51.7
Time of Concentration (days hh:mm:ss) 0 00:36:07

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

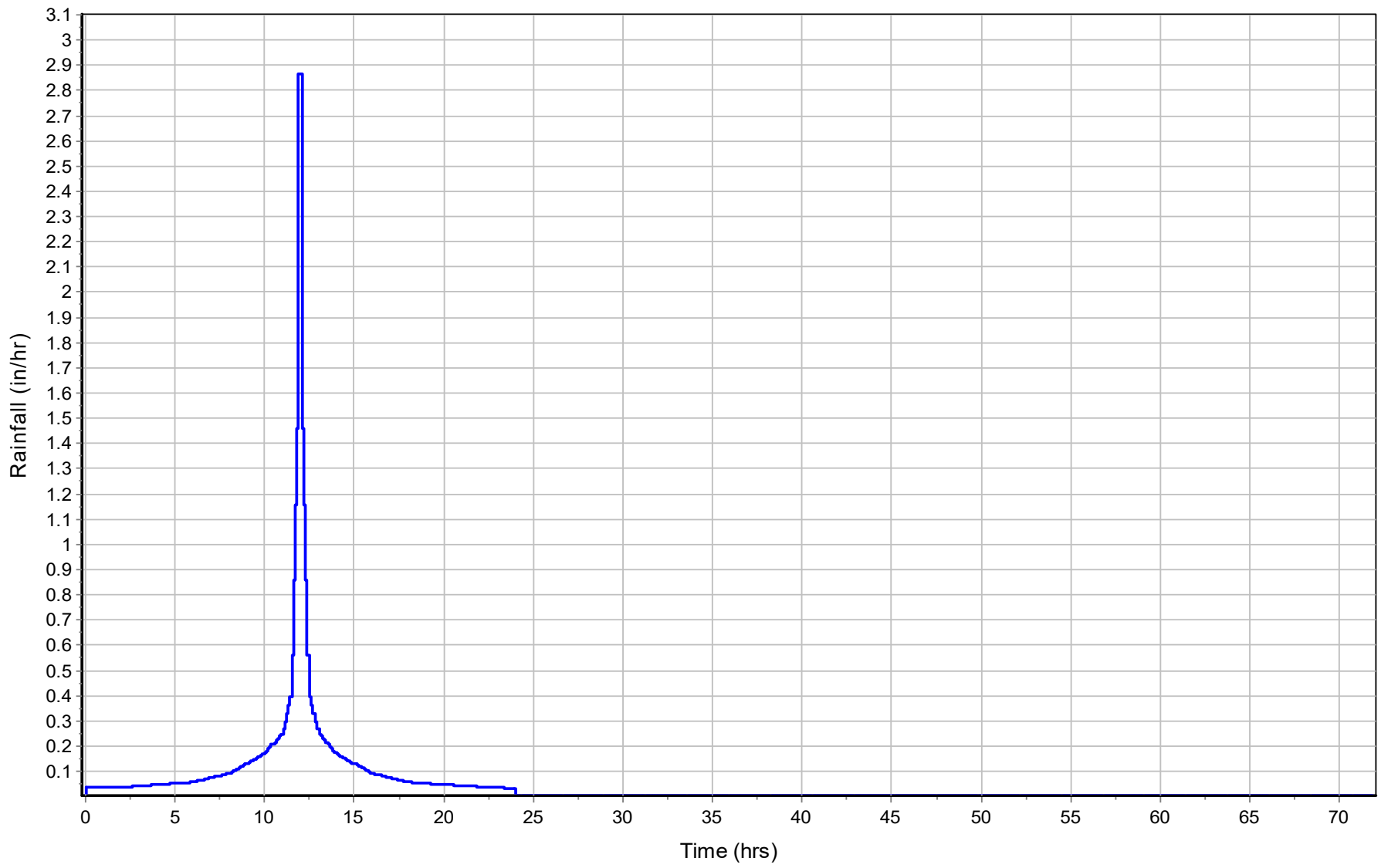
Total TOC (min) 3.14

Subbasin Runoff Results

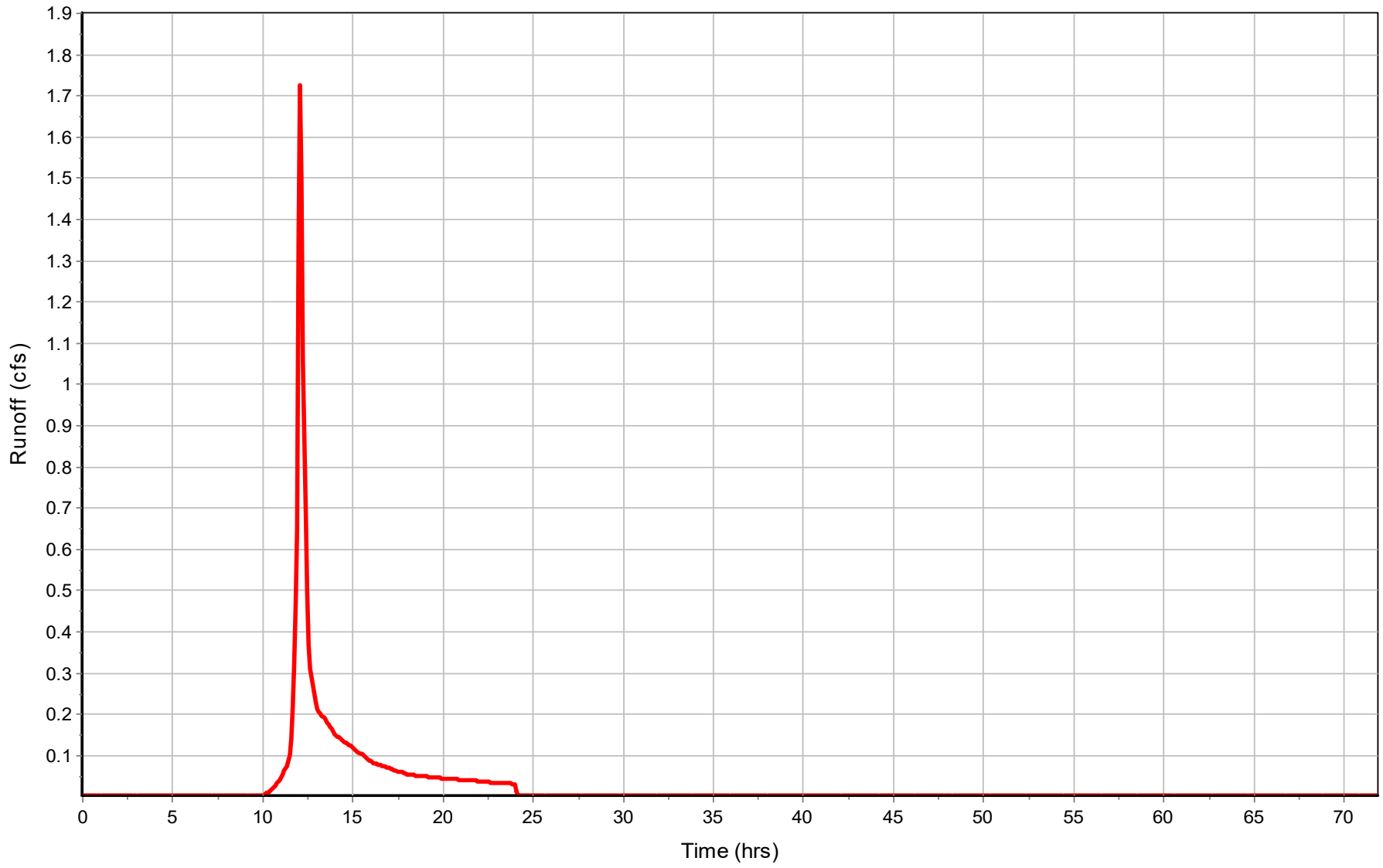
Total Rainfall (in) 3.41
Total Runoff (in) 1.3
Peak Runoff (cfs) 1.81
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:03:08

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

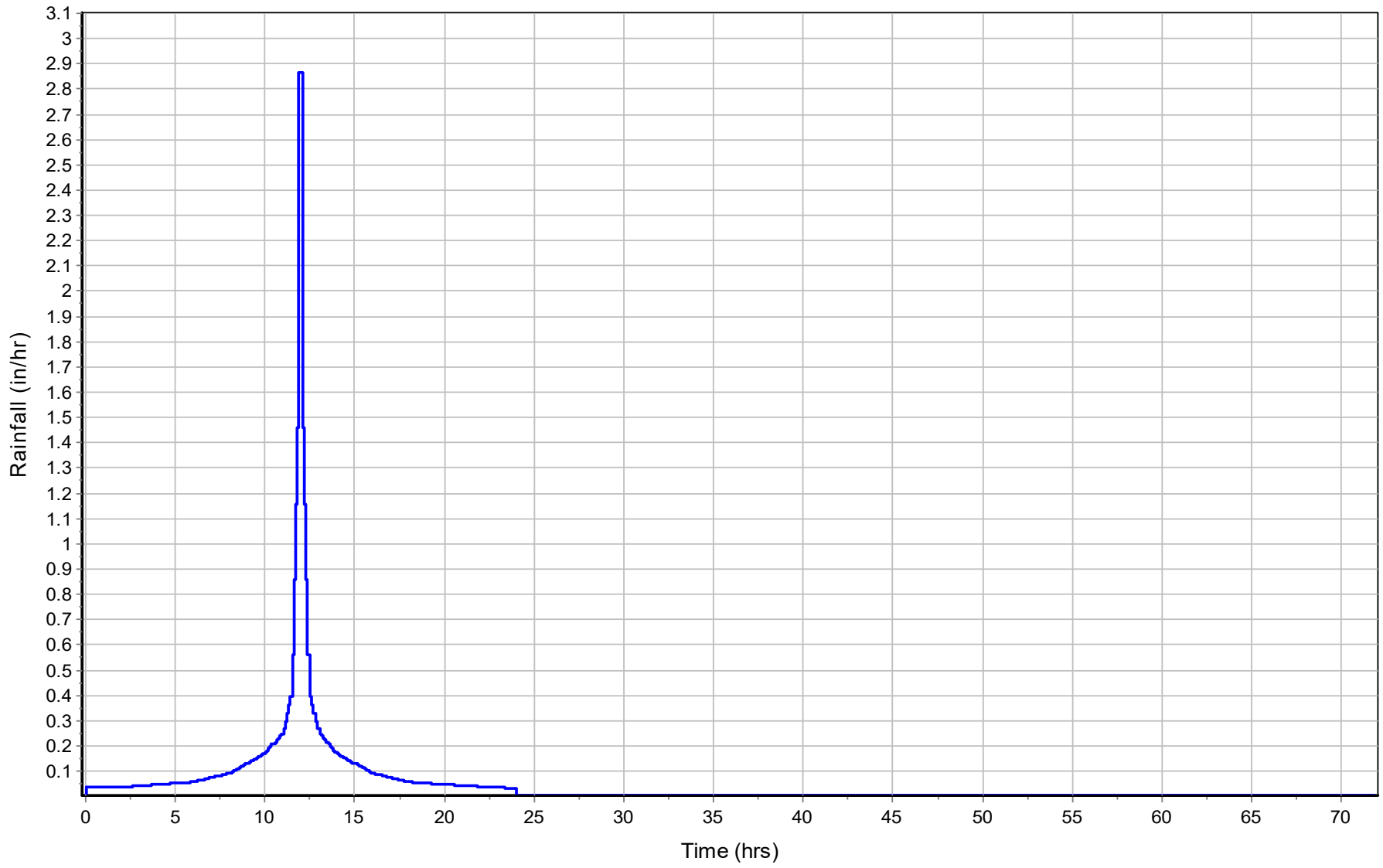
Total TOC (min) 2.17

Subbasin Runoff Results

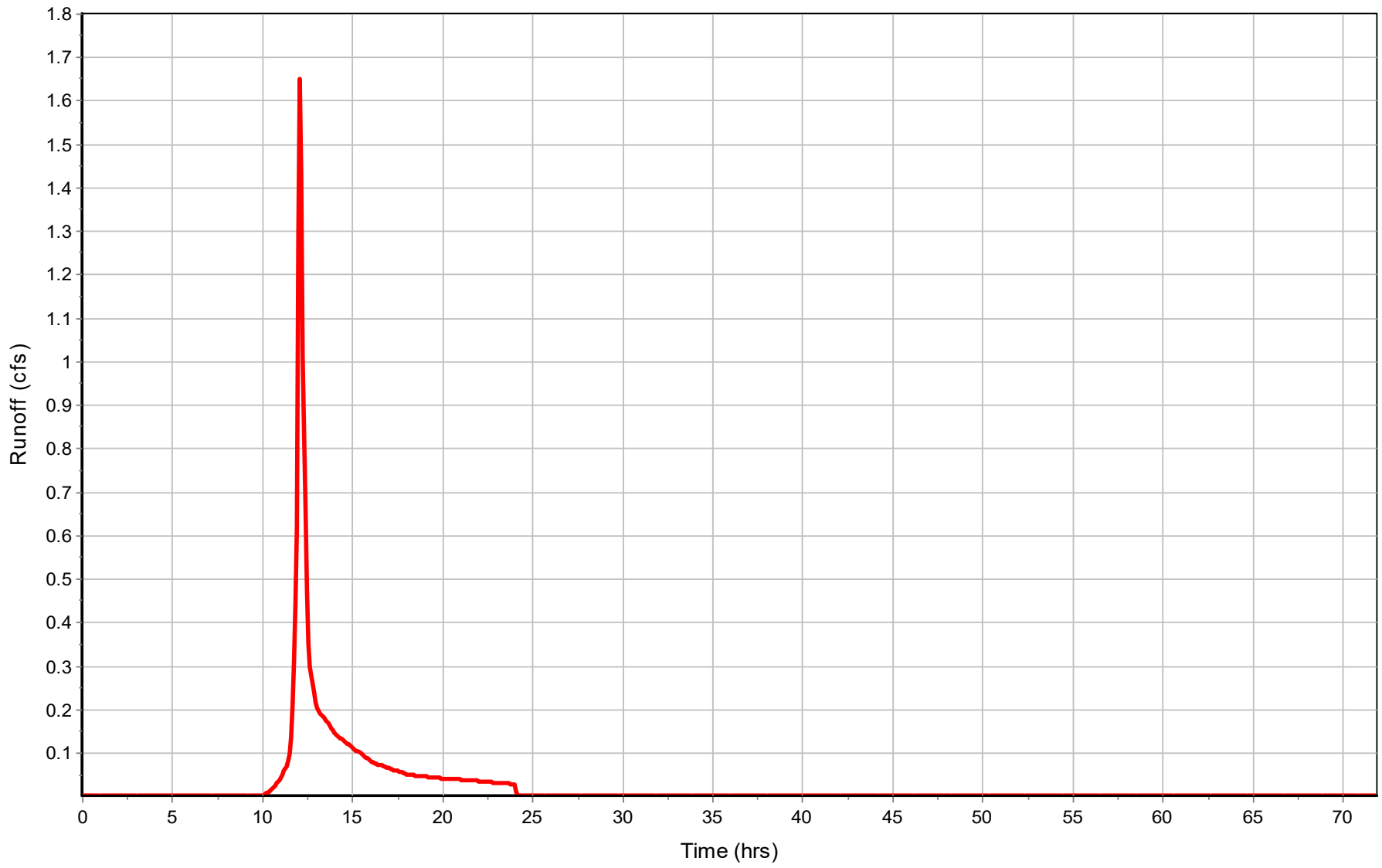
Total Rainfall (in) 3.41
Total Runoff (in) 1.3
Peak Runoff (cfs) 1.73
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:02:10

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

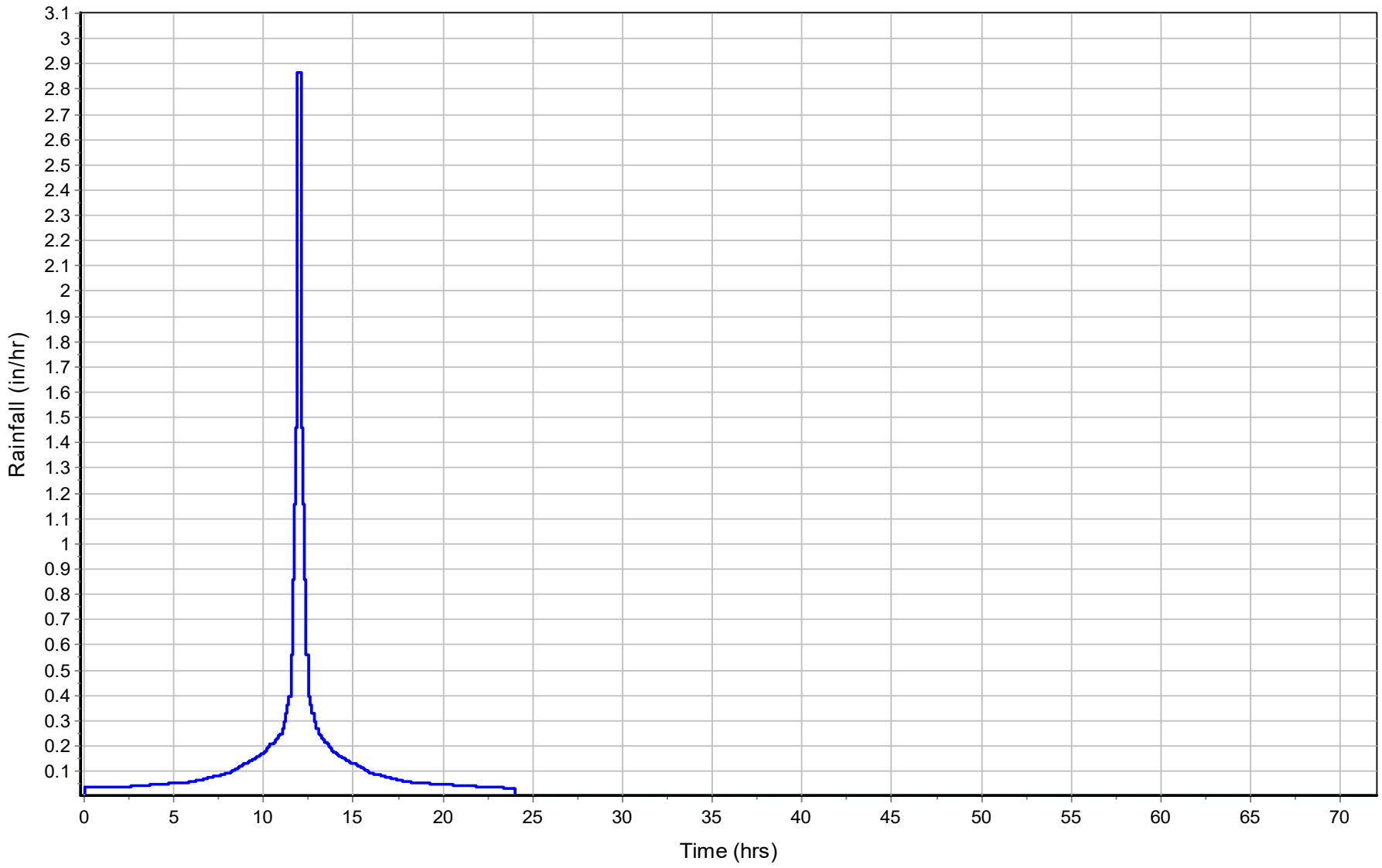
Total TOC (min) 4.13

Subbasin Runoff Results

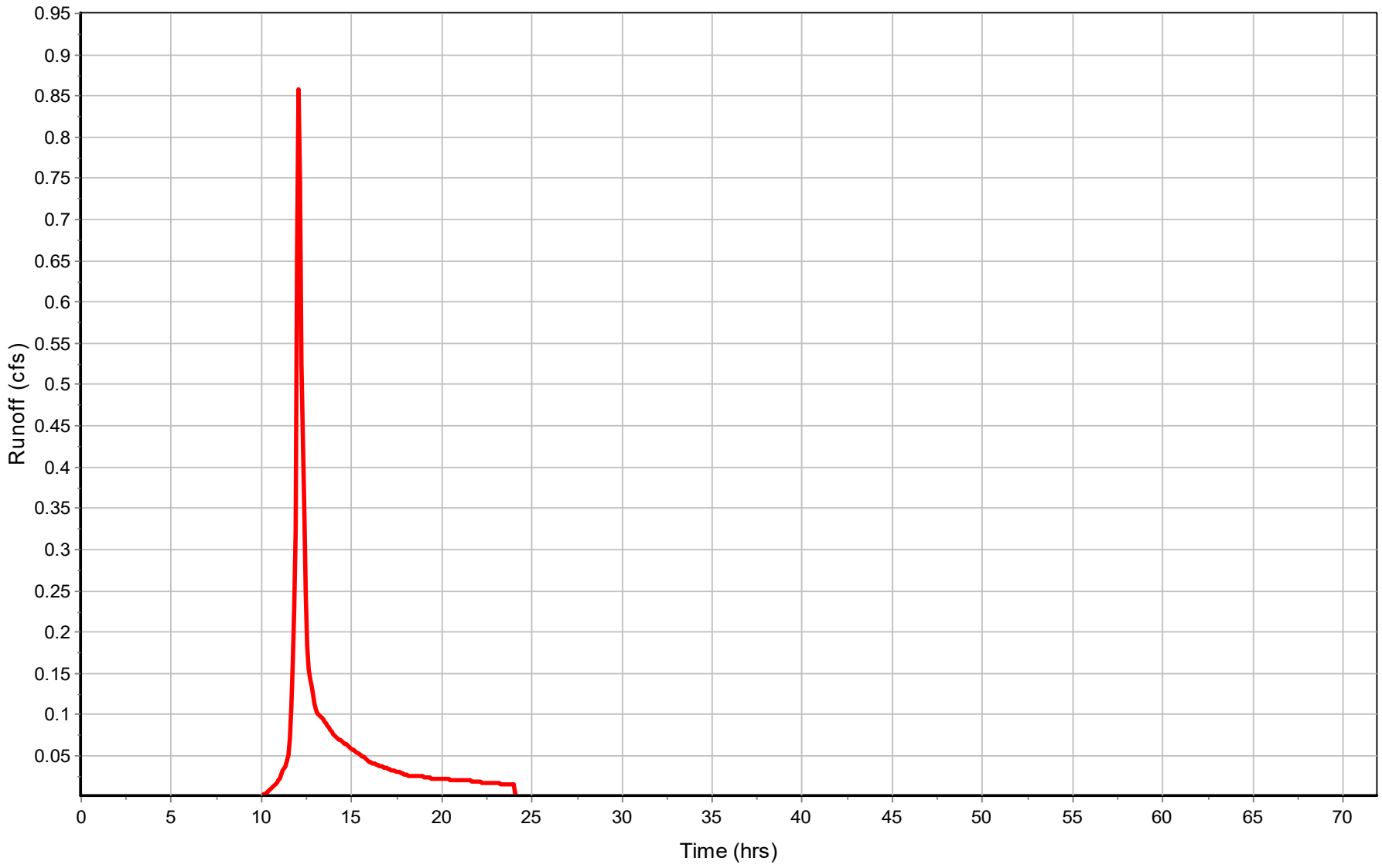
Total Rainfall (in)	3.41
Total Runoff (in)	1.3
Peak Runoff (cfs)	0.9
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:04:08

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

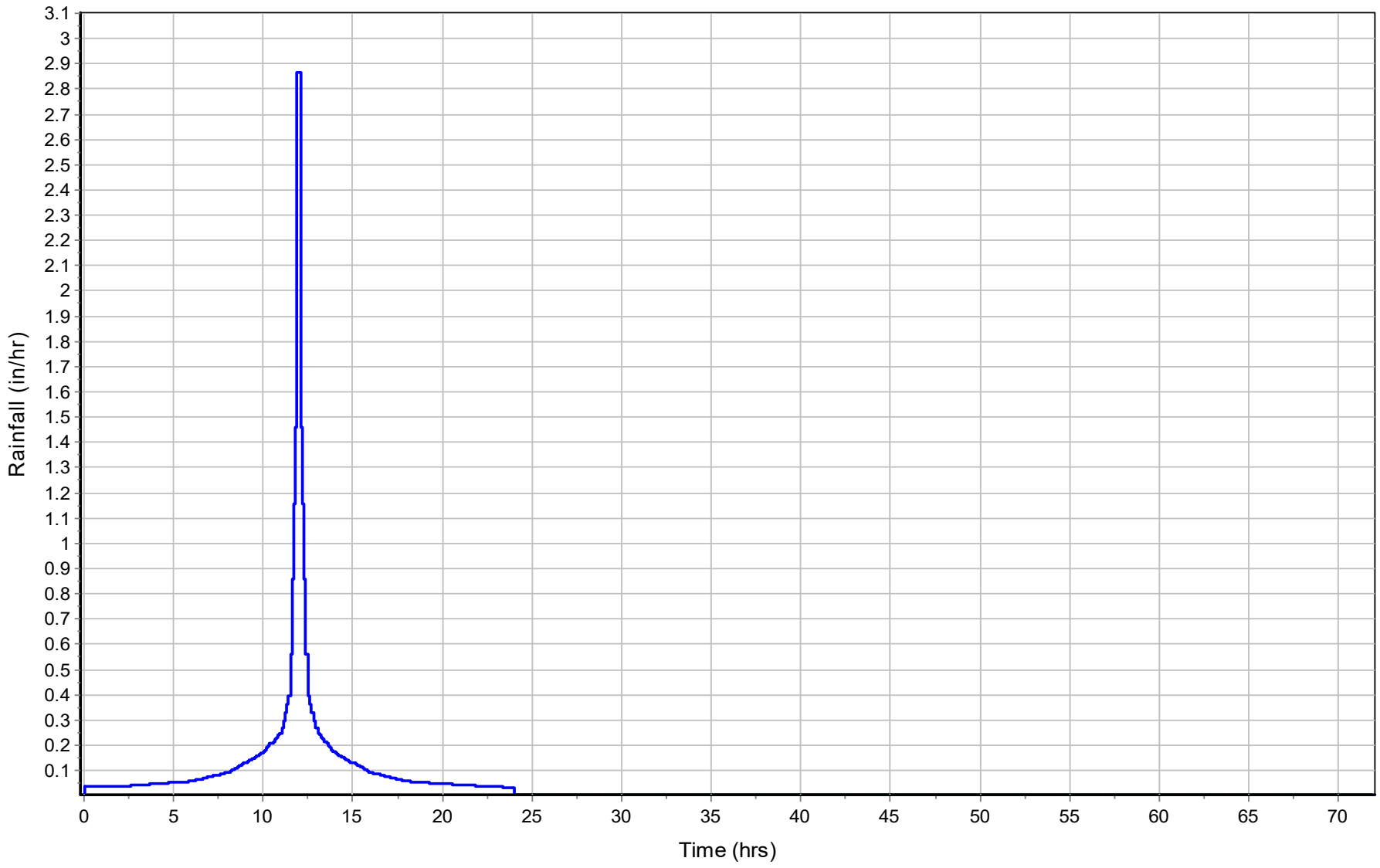
Total TOC (min) 34.83

Subbasin Runoff Results

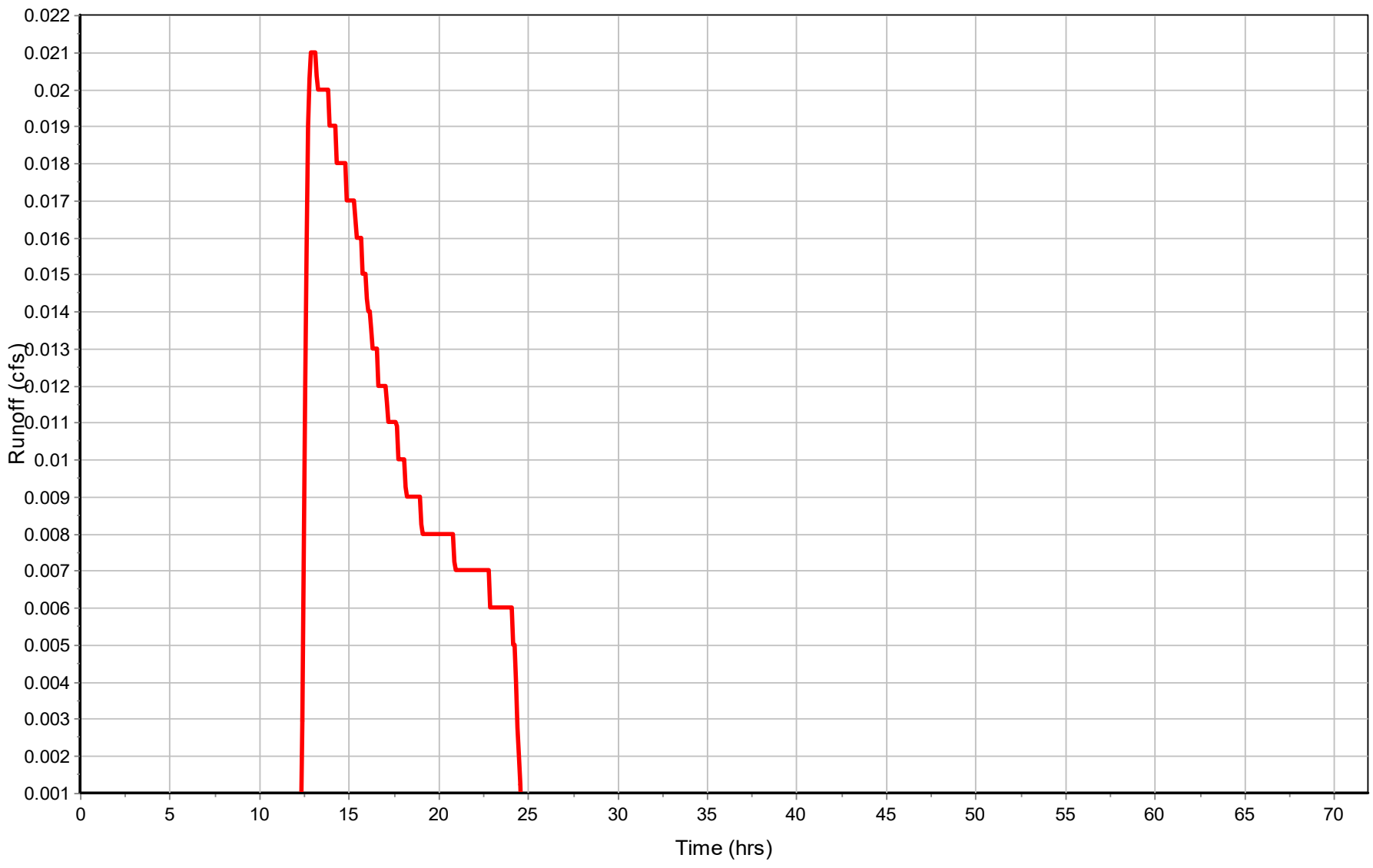
Total Rainfall (in)	3.41
Total Runoff (in)	0.15
Peak Runoff (cfs)	0.02
Weighted Curve Number	49
Time of Concentration (days hh:mm:ss)	0 00:34:50

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

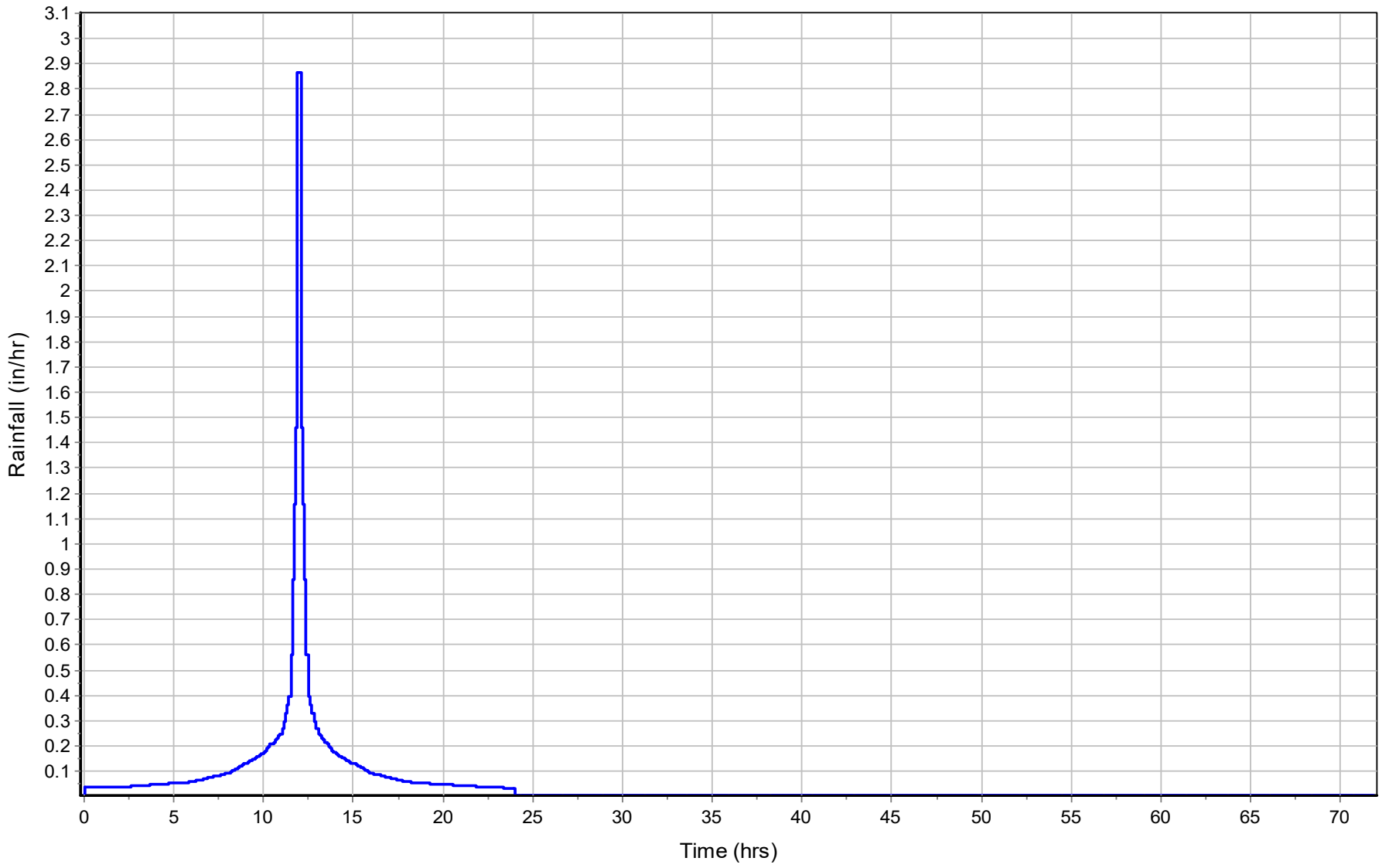
Total TOC (min) 36.49

Subbasin Runoff Results

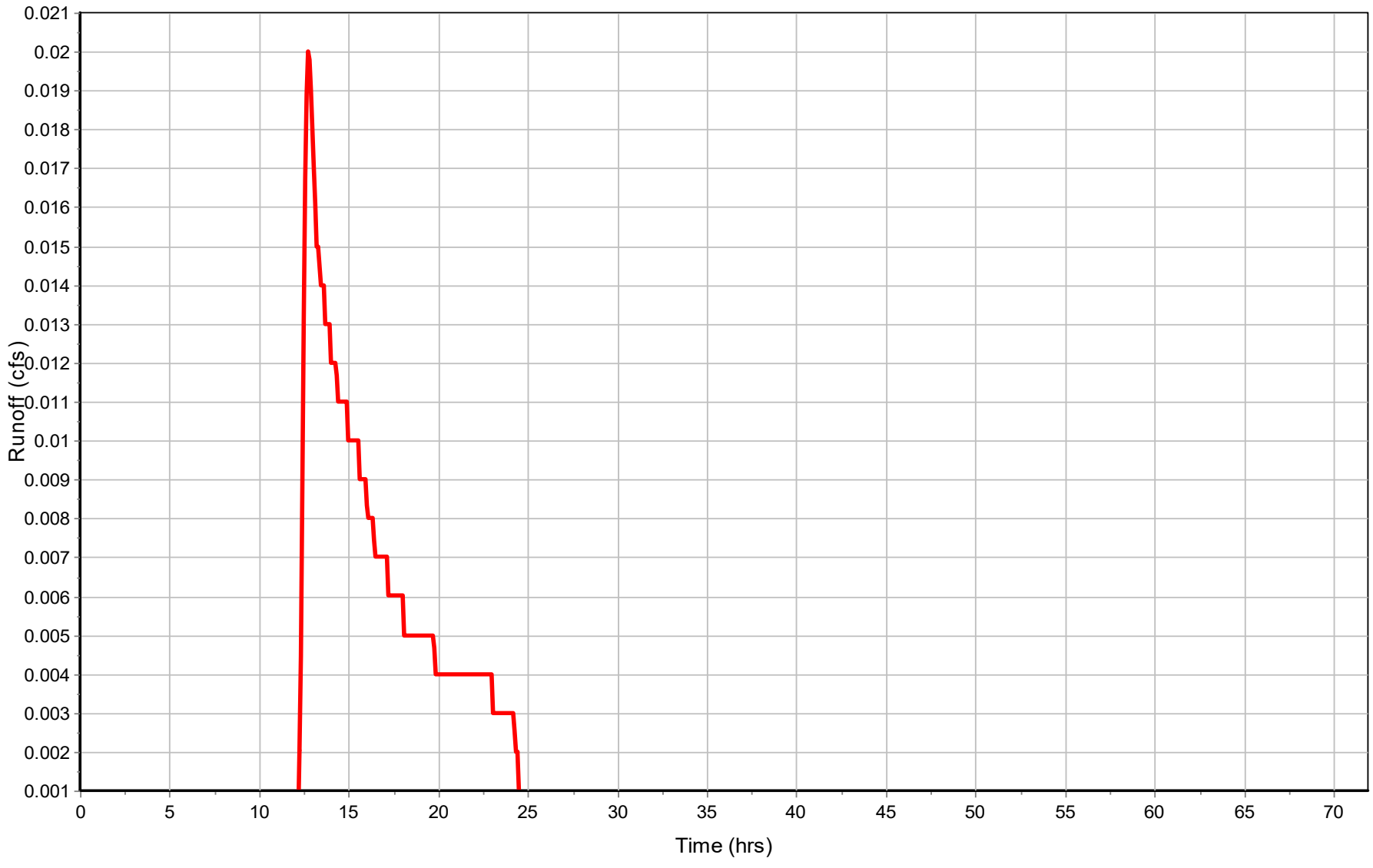
Total Rainfall (in)	3.41
Total Runoff (in)	0.22
Peak Runoff (cfs)	0.02
Weighted Curve Number	51.7
Time of Concentration (days hh:mm:ss)	0 00:36:29

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

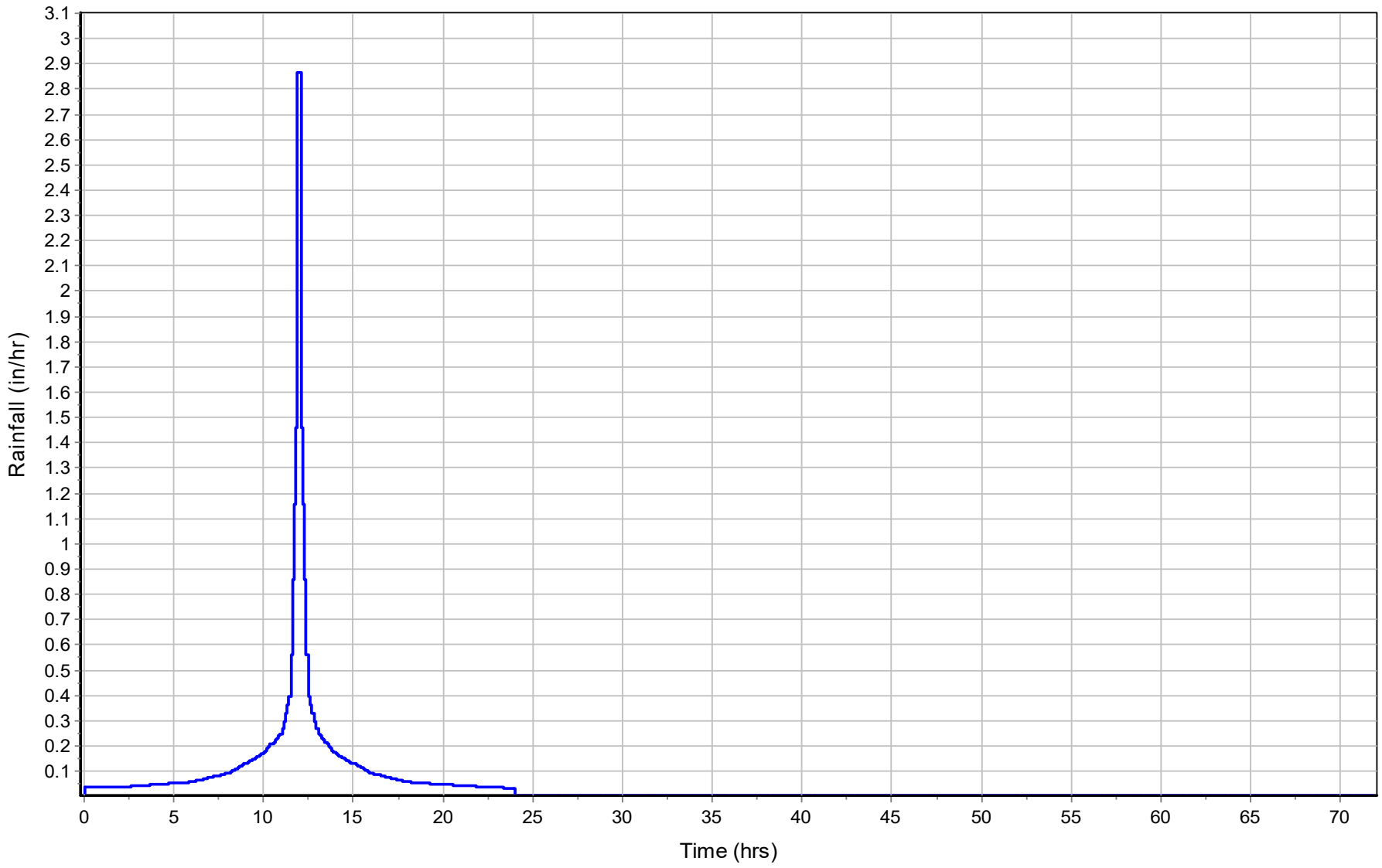
Total TOC (min) 42.87

Subbasin Runoff Results

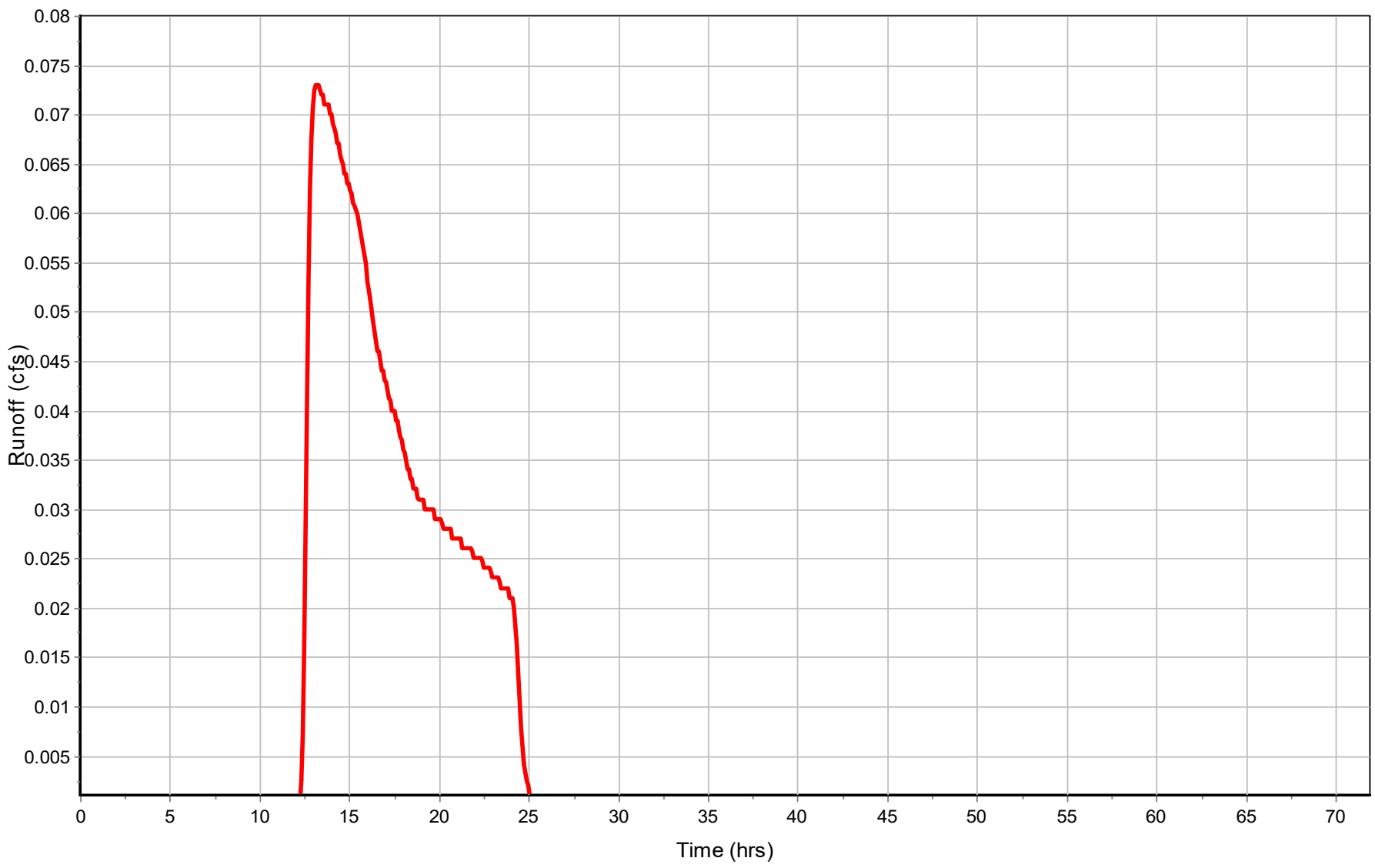
Total Rainfall (in)	3.41
Total Runoff (in)	0.15
Peak Runoff (cfs)	0.07
Weighted Curve Number	49
Time of Concentration (days hh:mm:ss)	0 00:42:52

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

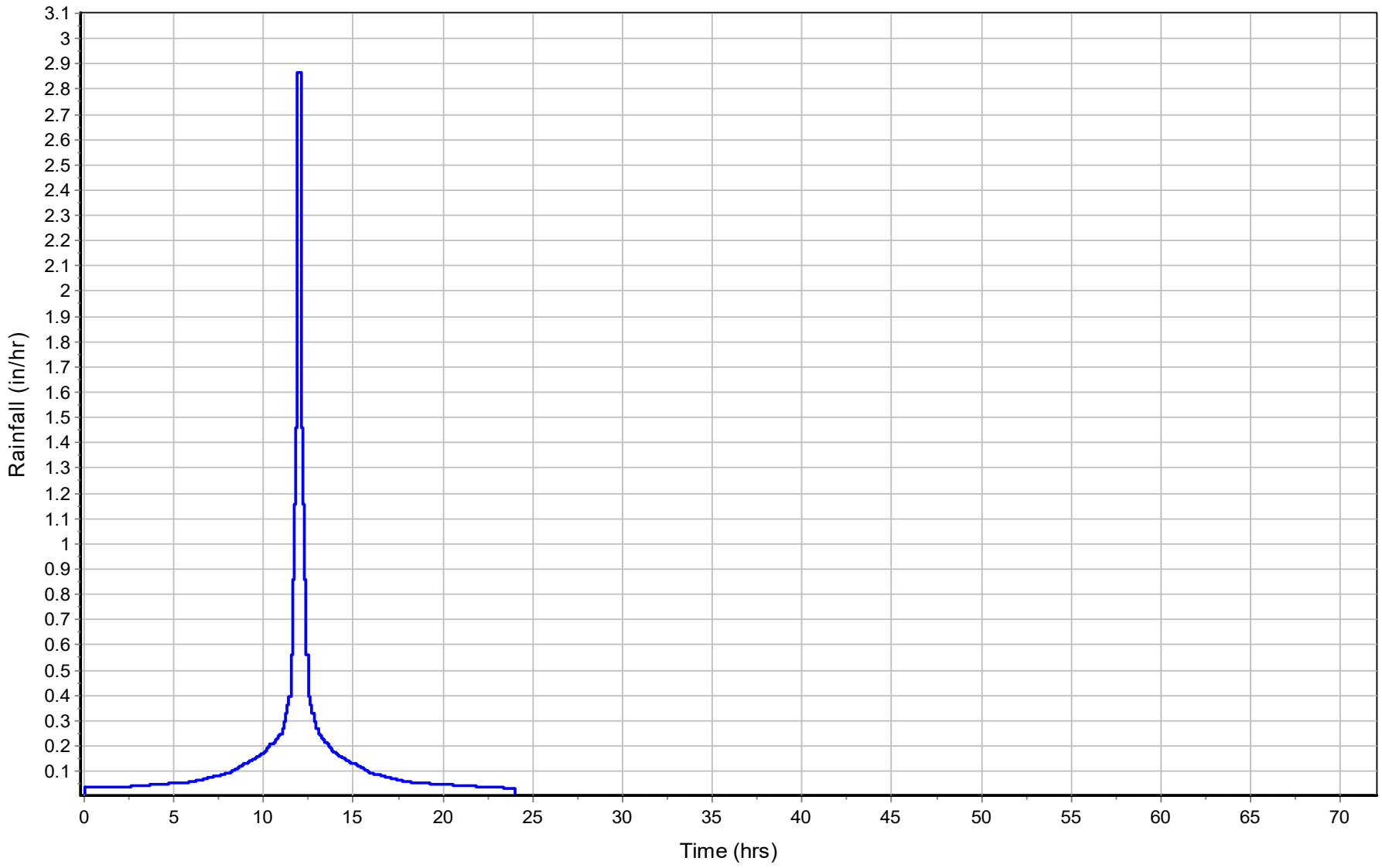
Total TOC (min) 14.50

Subbasin Runoff Results

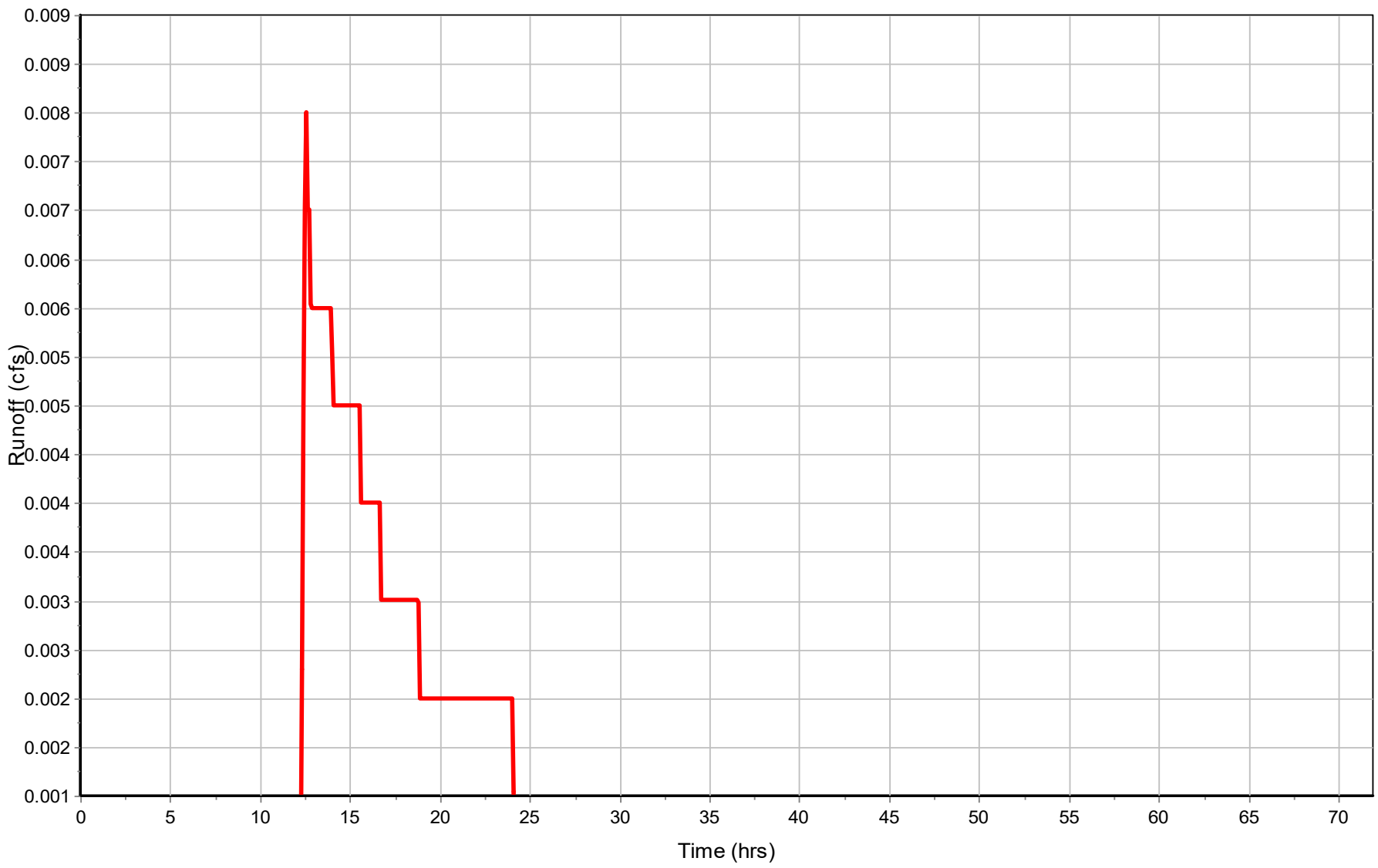
Total Rainfall (in)	3.41
Total Runoff (in)	0.15
Peak Runoff (cfs)	0.01
Weighted Curve Number	49
Time of Concentration (days hh:mm:ss)	0 00:14:30

Subbasin : Existing-E5.1_A2

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : A1-1-BASIN

Input Data

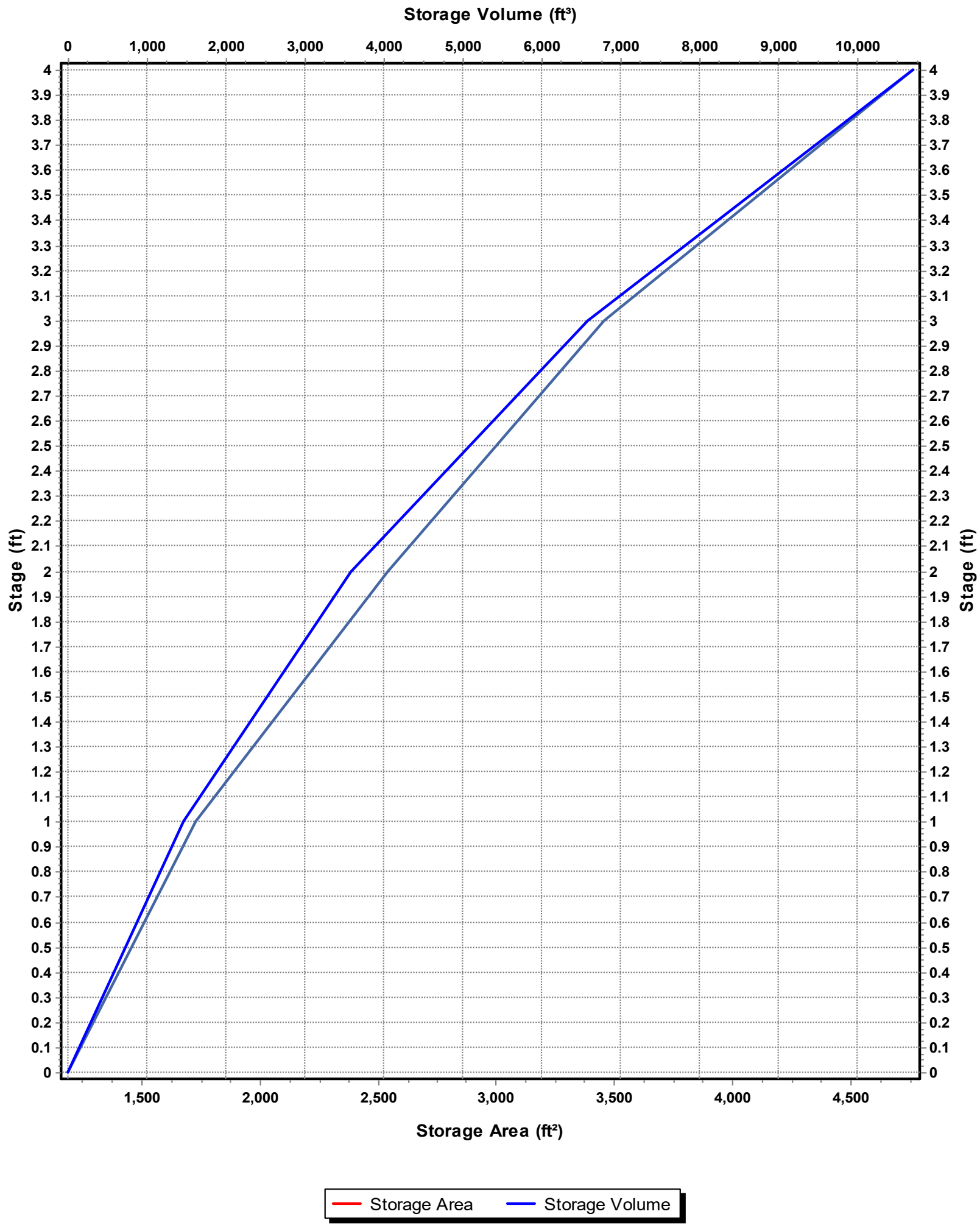
Invert Elevation (ft)	66.00
Max (Rim) Elevation (ft)	69.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	66.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

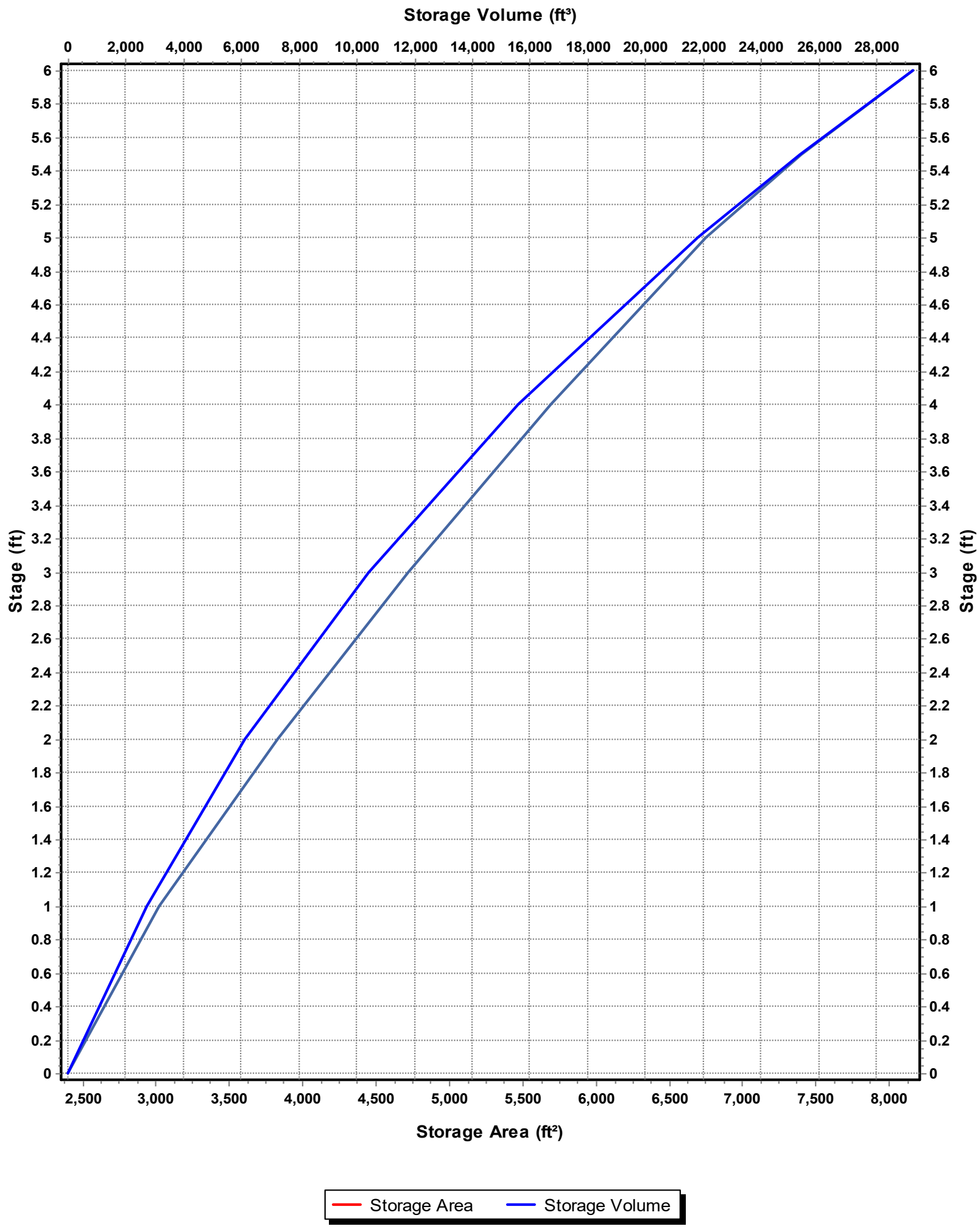
Invert Elevation (ft)	63.00
Max (Rim) Elevation (ft)	69.00
Max (Rim) Offset (ft)	6.00
Initial Water Elevation (ft)	63.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

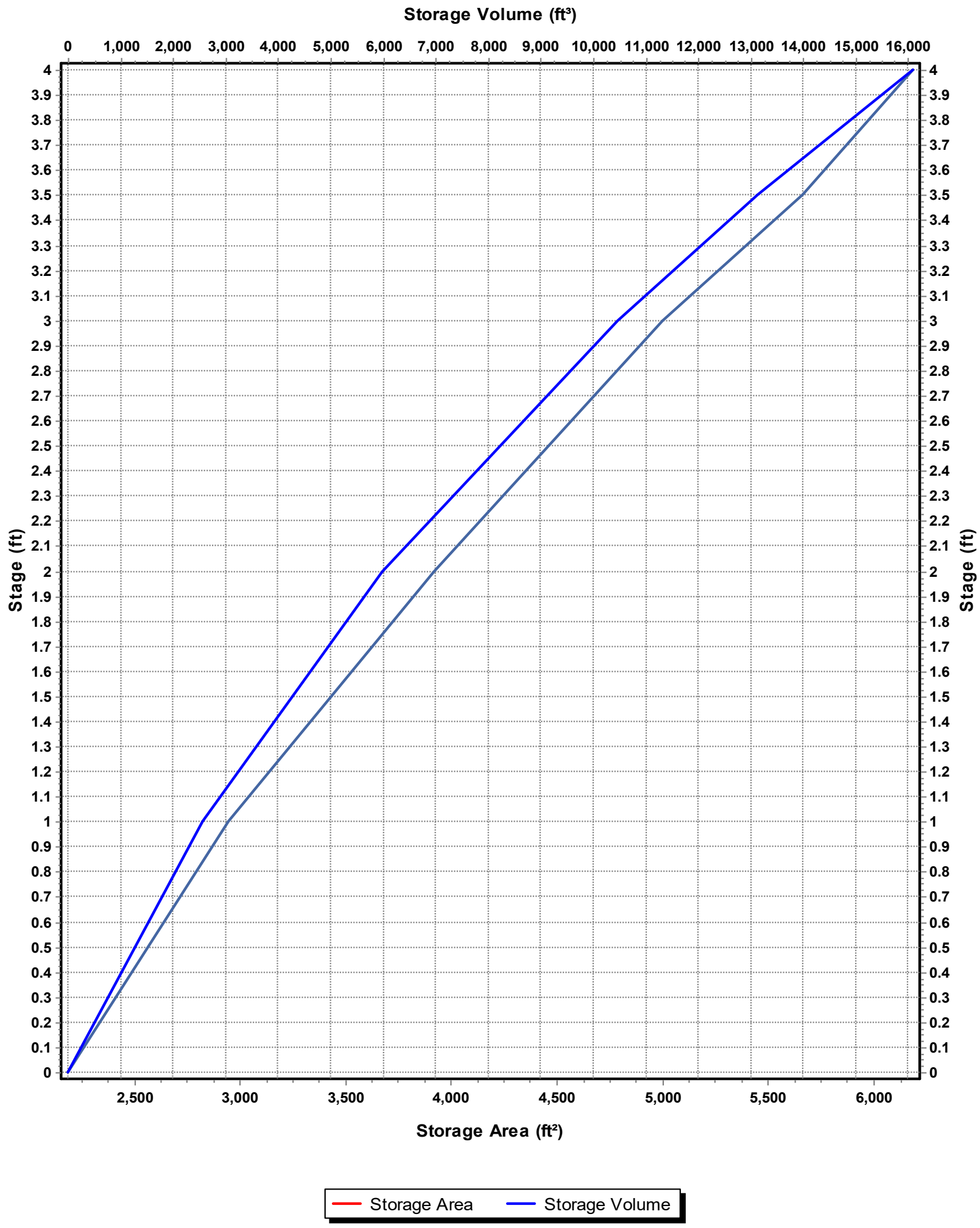
Invert Elevation (ft)	63.00
Max (Rim) Elevation (ft)	67.00
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	63.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

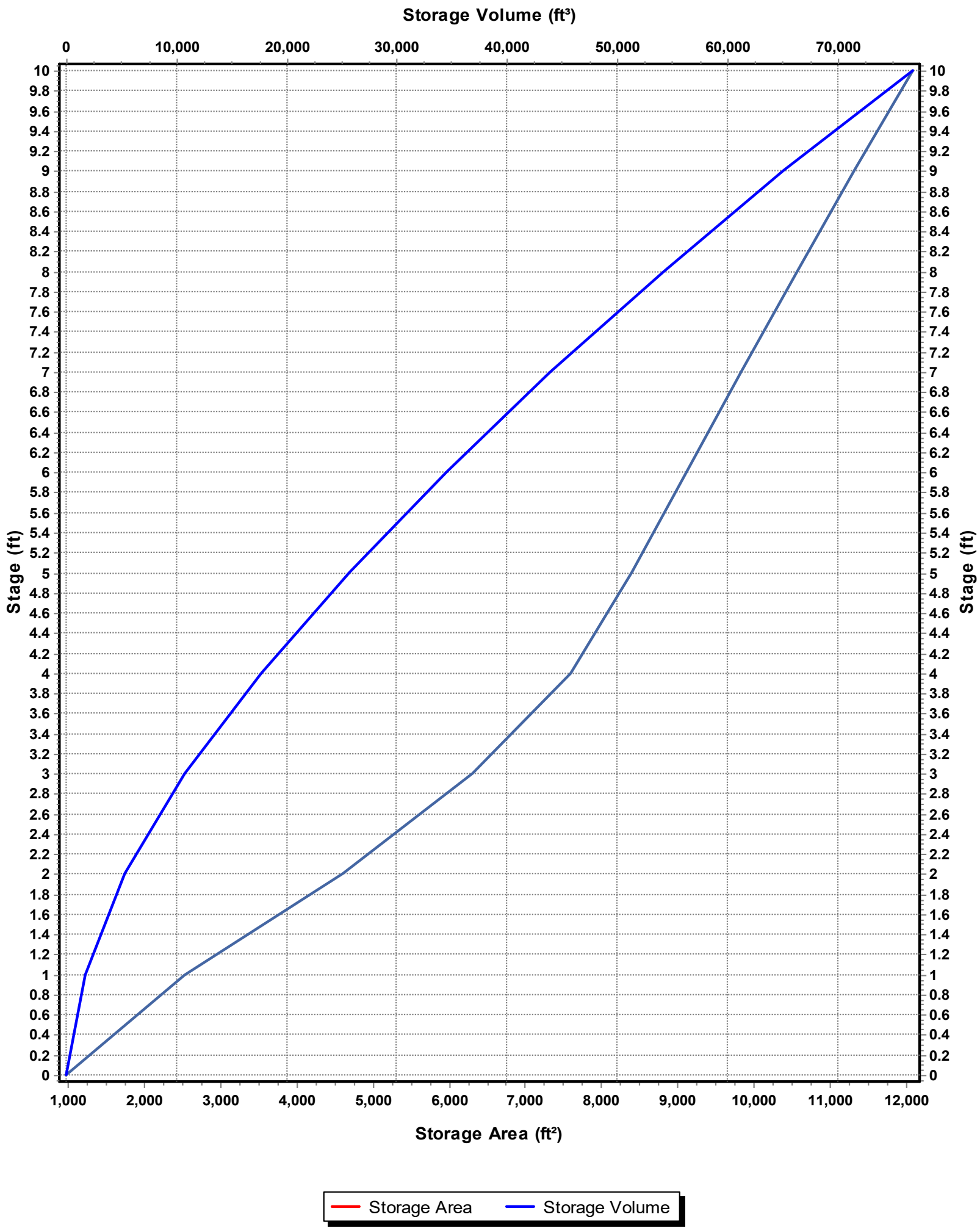
Invert Elevation (ft)	43.00
Max (Rim) Elevation (ft)	53.00
Max (Rim) Offset (ft)	10.00
Initial Water Elevation (ft)	43.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

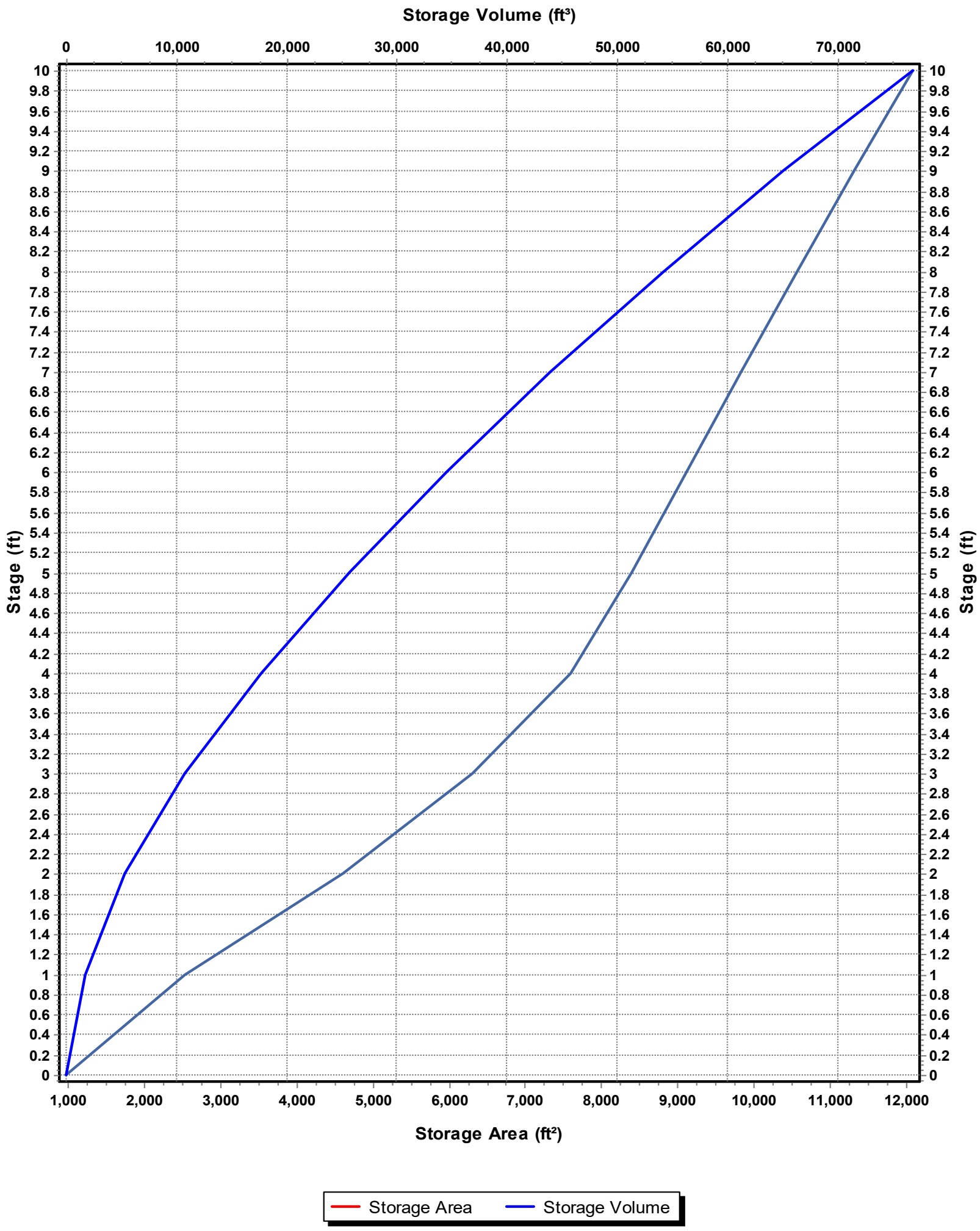
Invert Elevation (ft)	43.00
Max (Rim) Elevation (ft)	53.00
Max (Rim) Offset (ft)	10.00
Initial Water Elevation (ft)	43.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

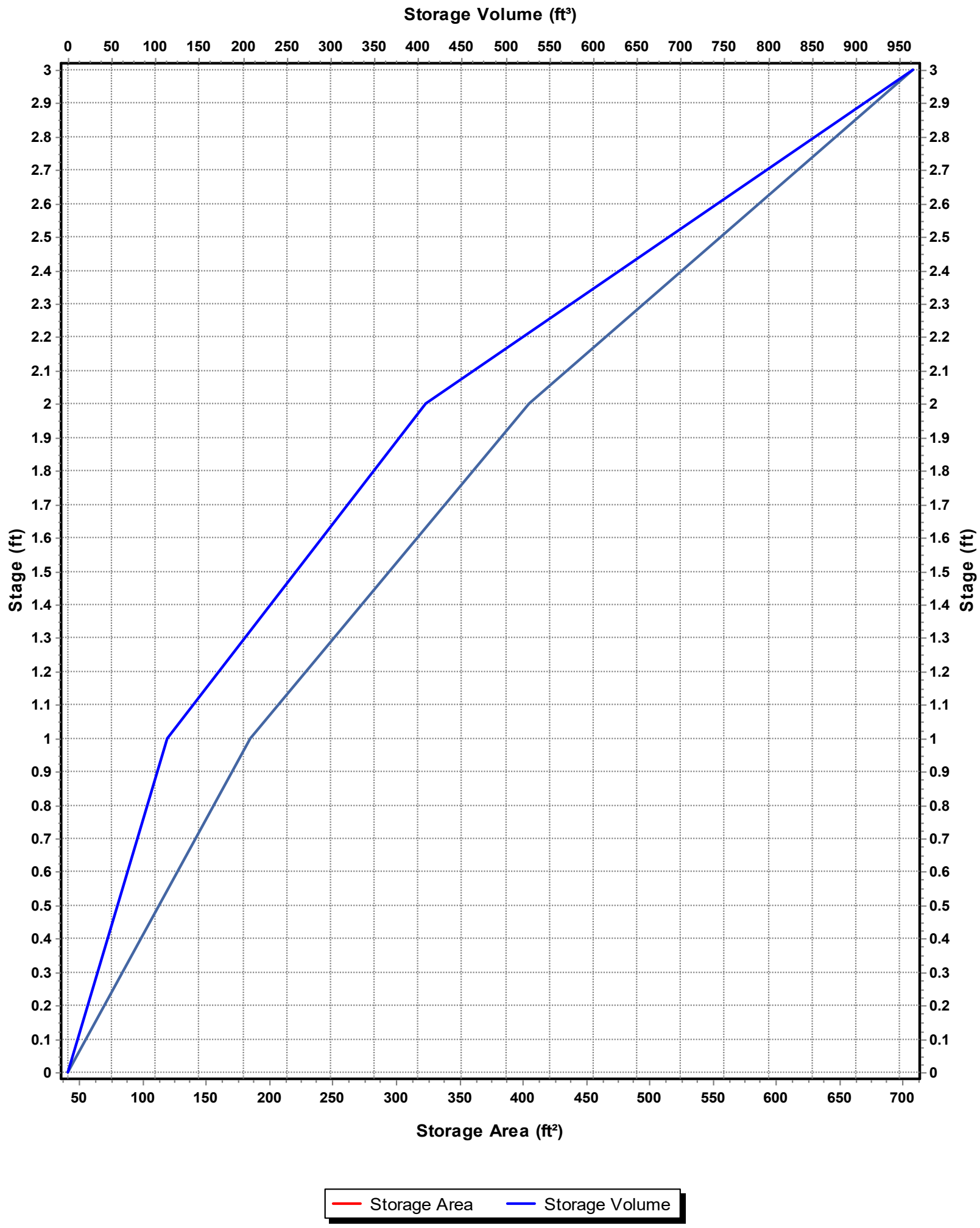
Invert Elevation (ft)	66.00
Max (Rim) Elevation (ft)	70.00
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	66.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

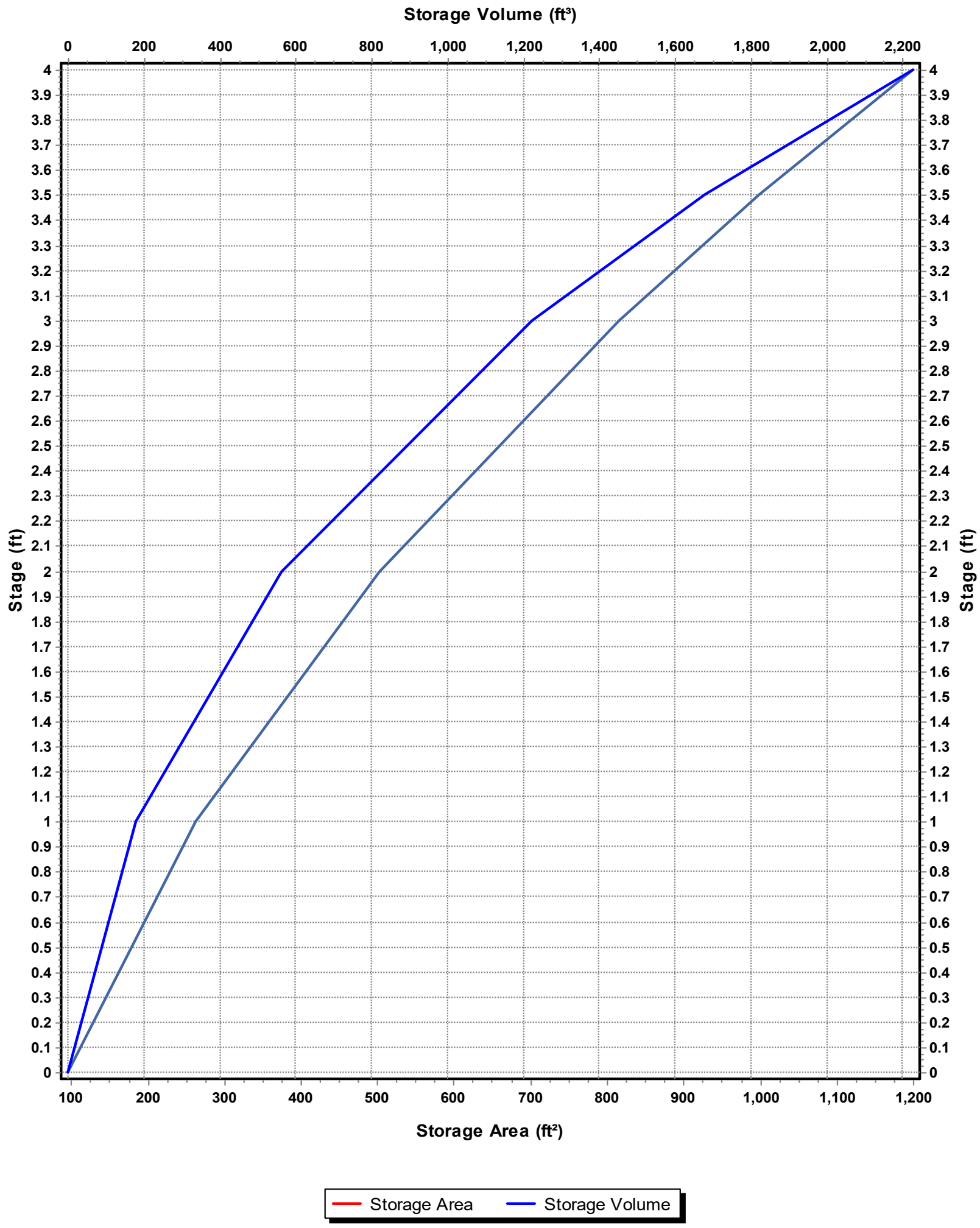
Invert Elevation (ft)	62.00
Max (Rim) Elevation (ft)	66.00
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	62.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

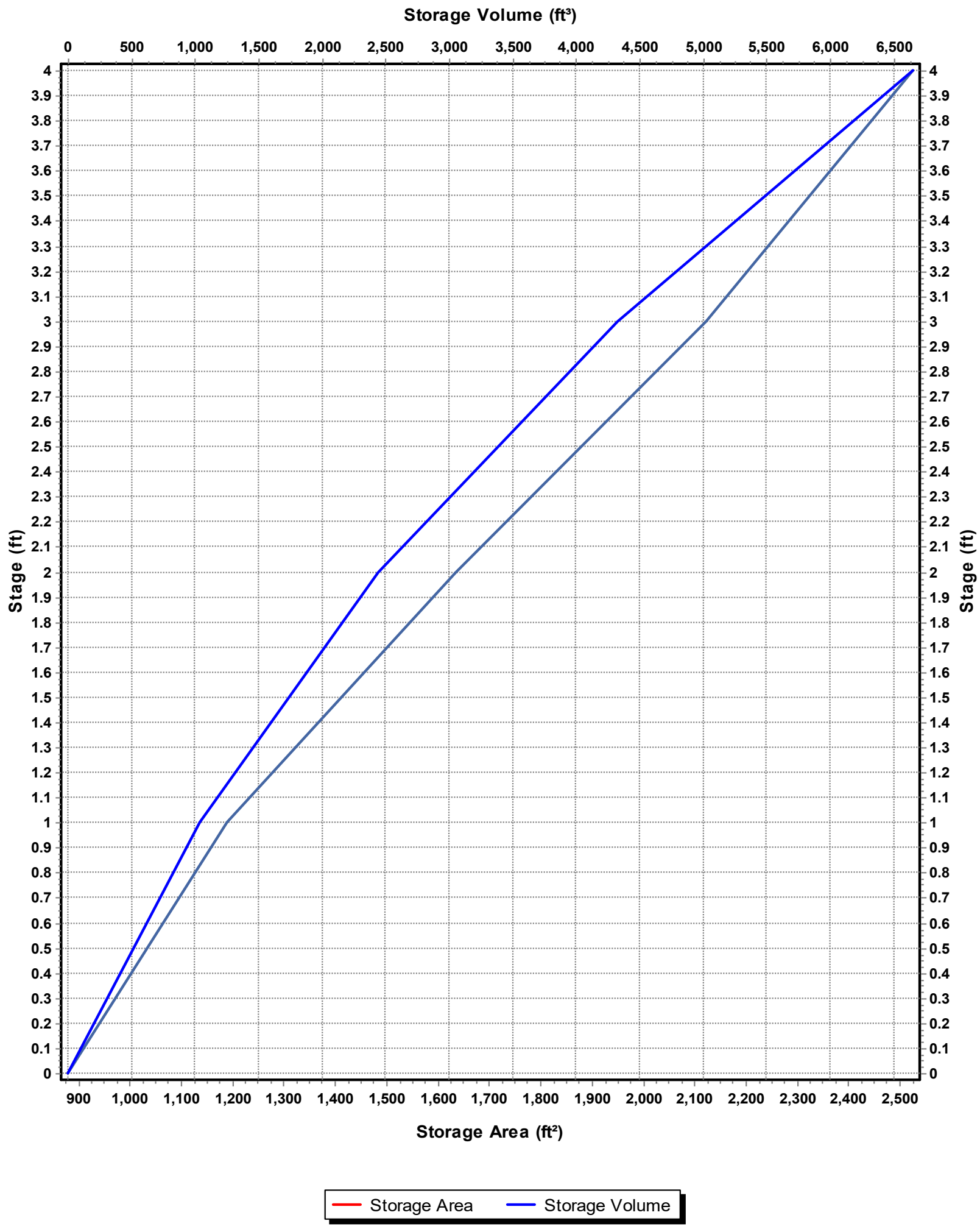
Invert Elevation (ft)	65.00
Max (Rim) Elevation (ft)	69.00
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	65.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

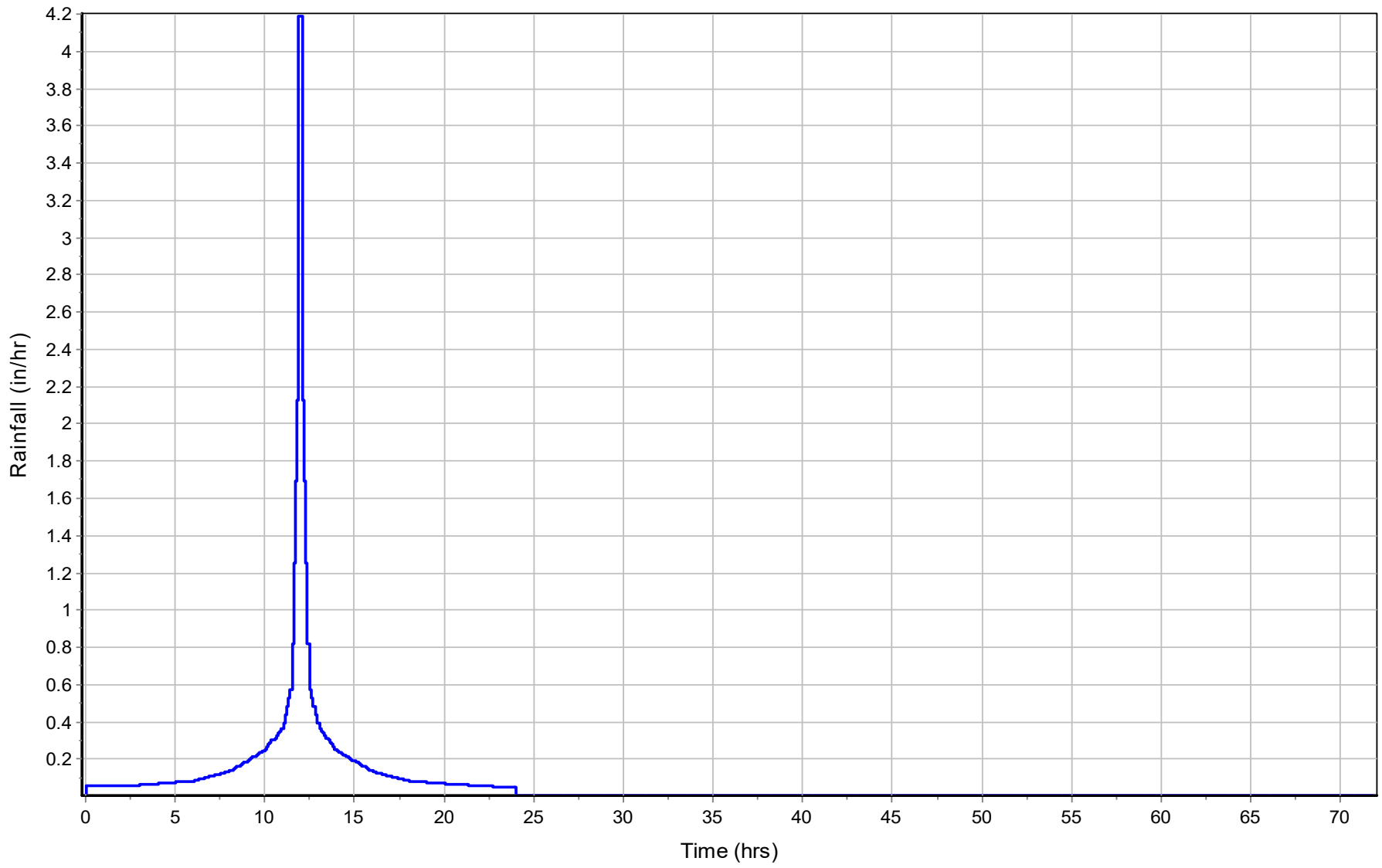
Total TOC (min) 4.58

Subbasin Runoff Results

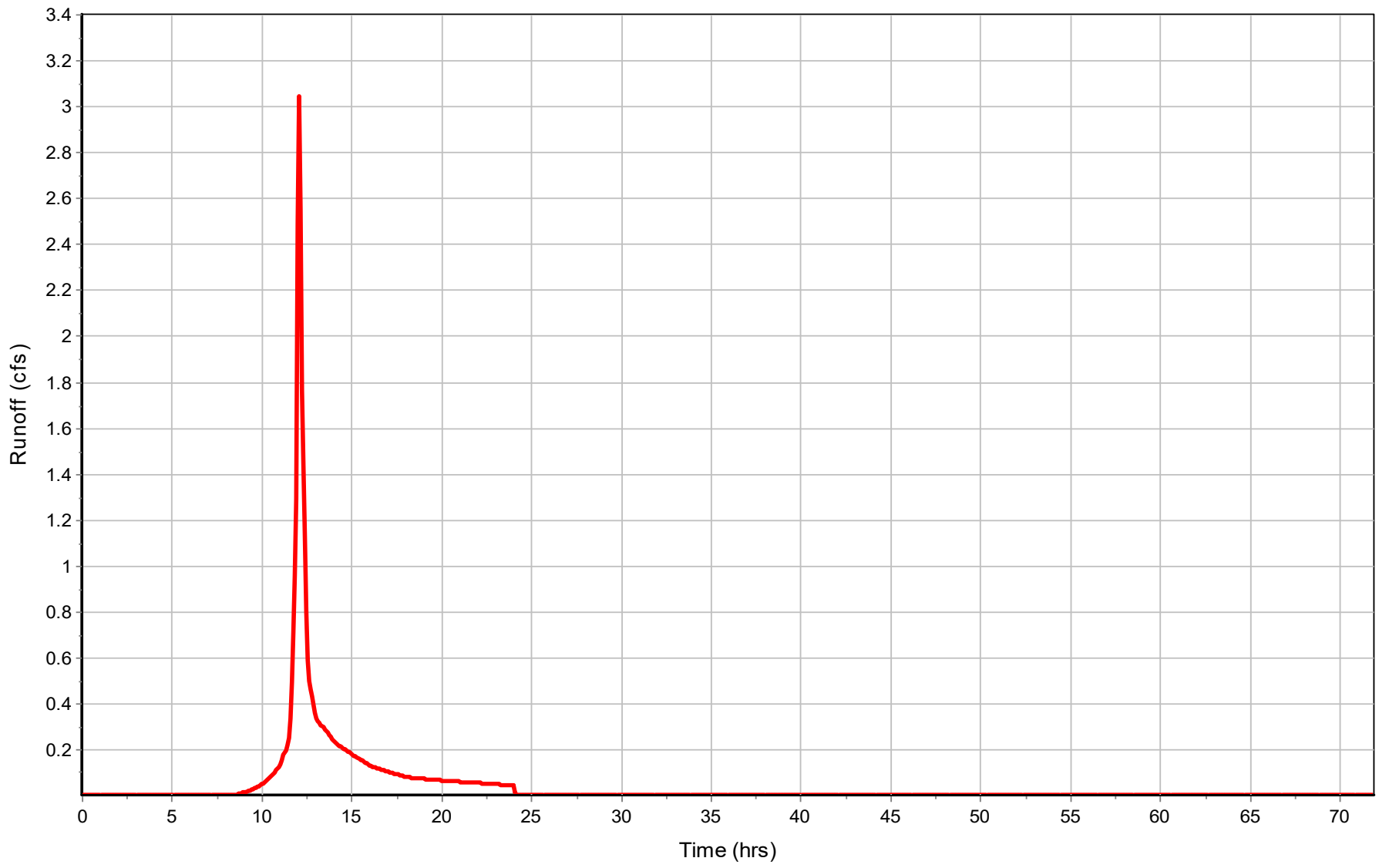
Total Rainfall (in) 4.98
Total Runoff (in) 2.52
Peak Runoff (cfs) 3.13
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:04:35

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

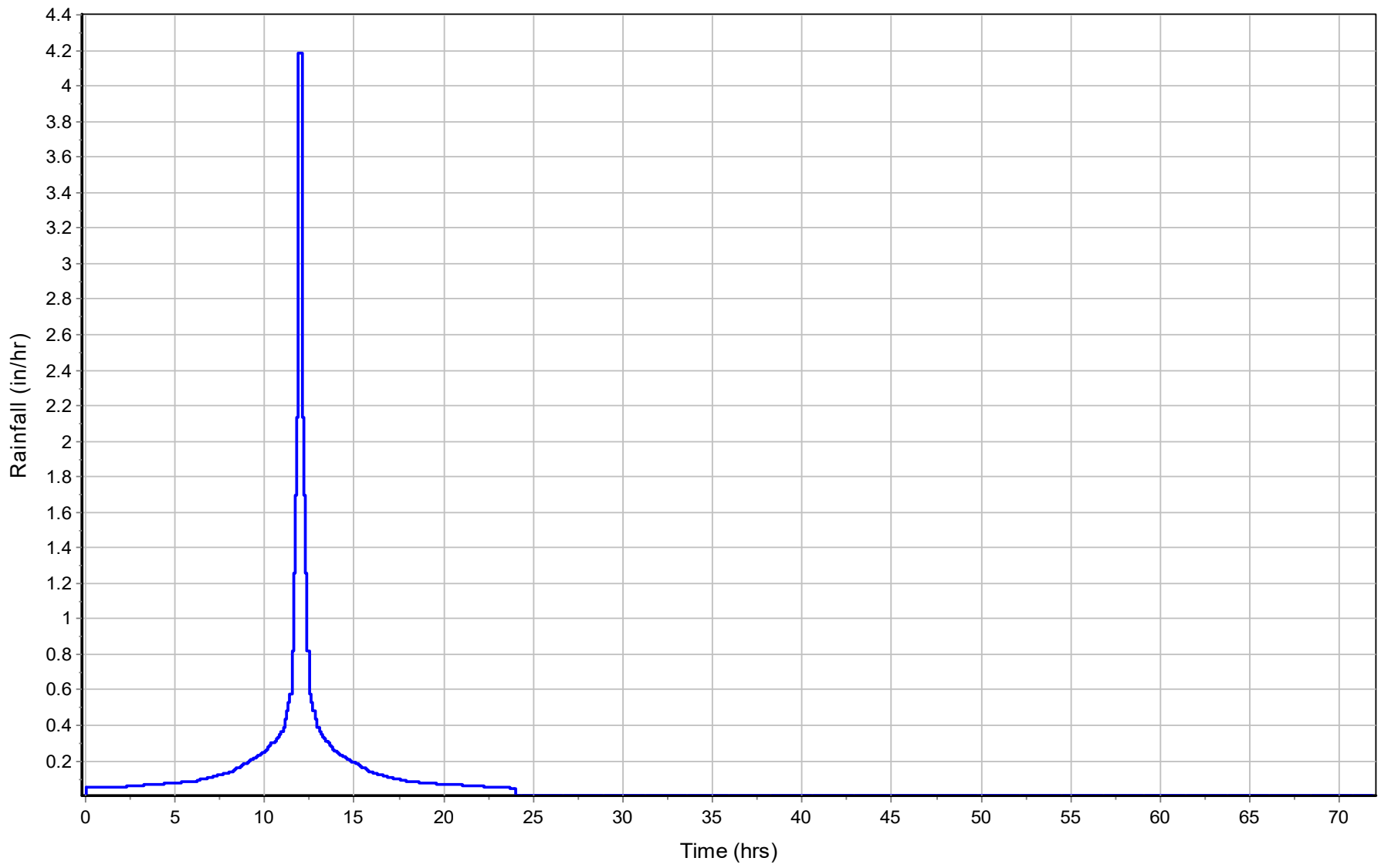
Total TOC (min) 10.92

Subbasin Runoff Results

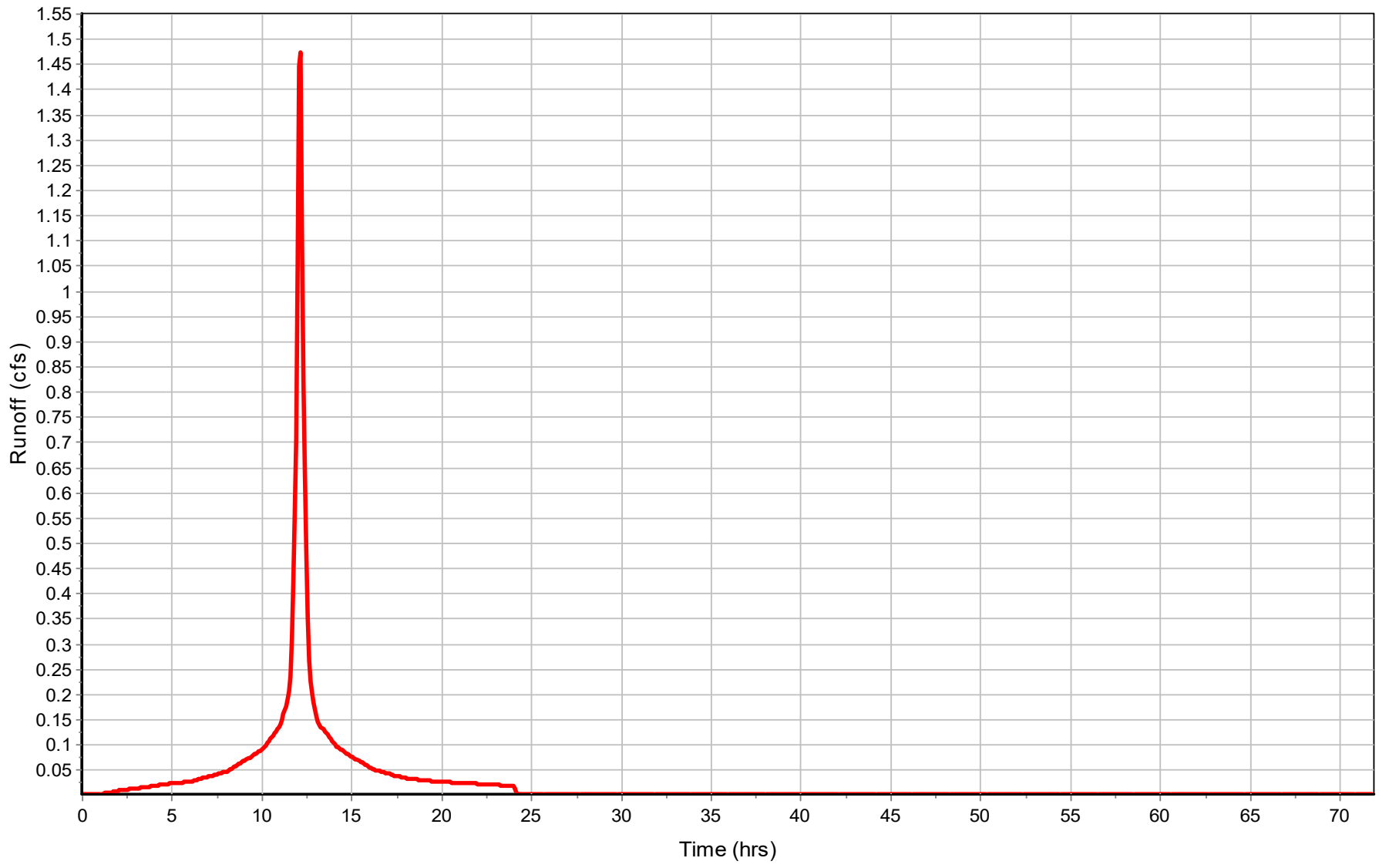
Total Rainfall (in) 4.98
Total Runoff (in) 4.74
Peak Runoff (cfs) 1.52
Weighted Curve Number 98
Time of Concentration (days hh:mm:ss) 0 00:10:55

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

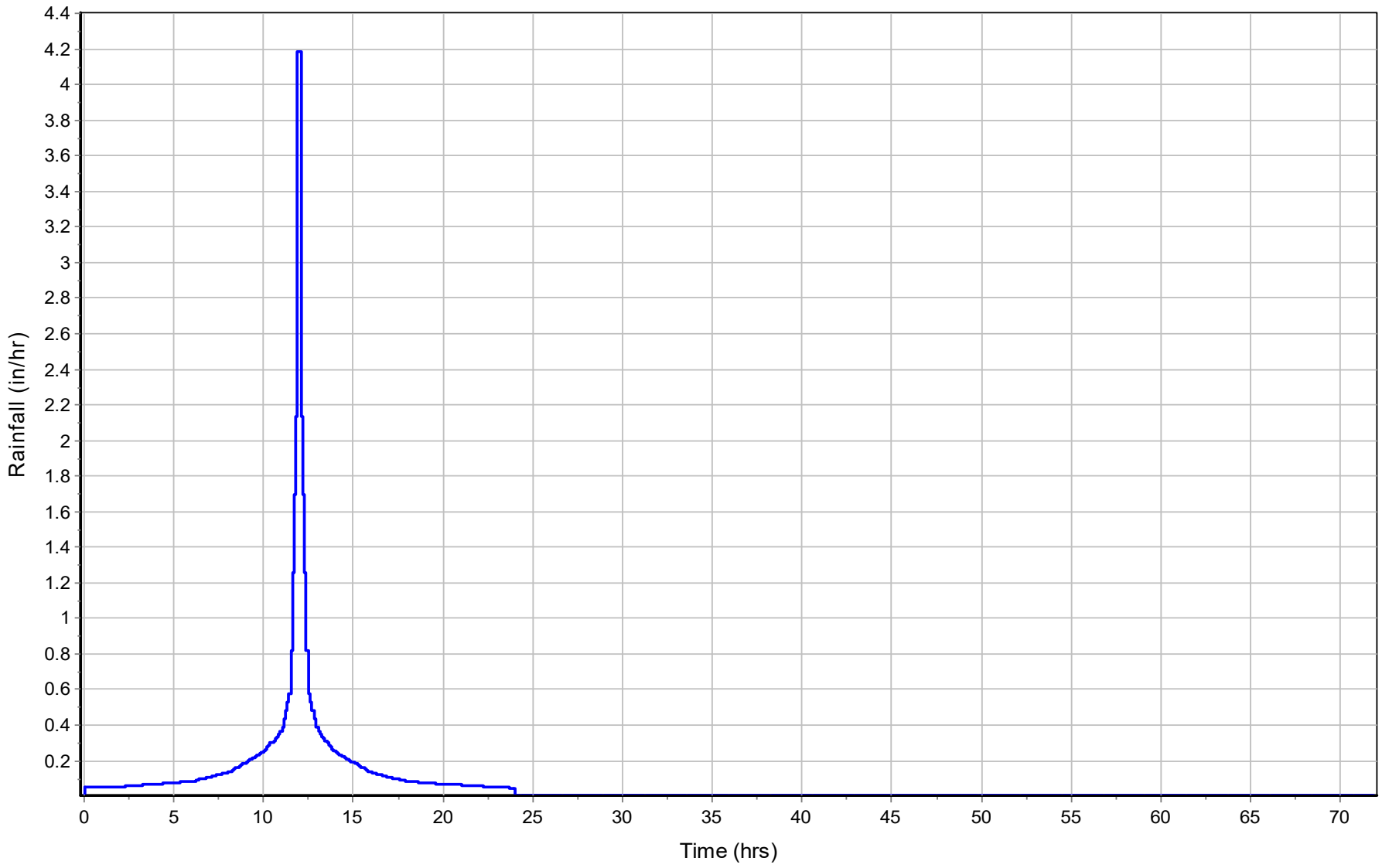
Total TOC (min) 3.41

Subbasin Runoff Results

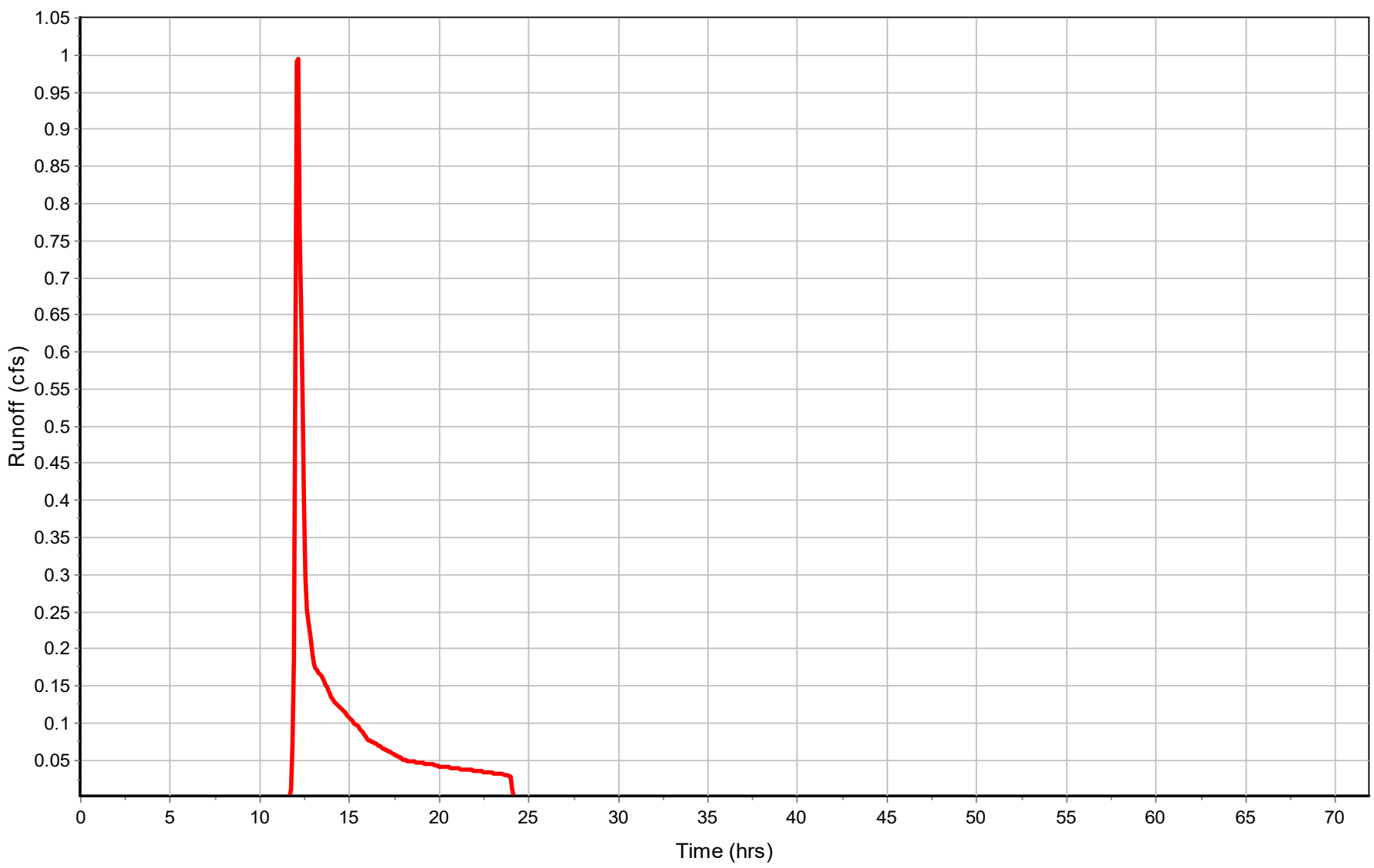
Total Rainfall (in) 4.98
Total Runoff (in) 0.95
Peak Runoff (cfs) 1.13
Weighted Curve Number 54.63
Time of Concentration (days hh:mm:ss) 0 00:03:25

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

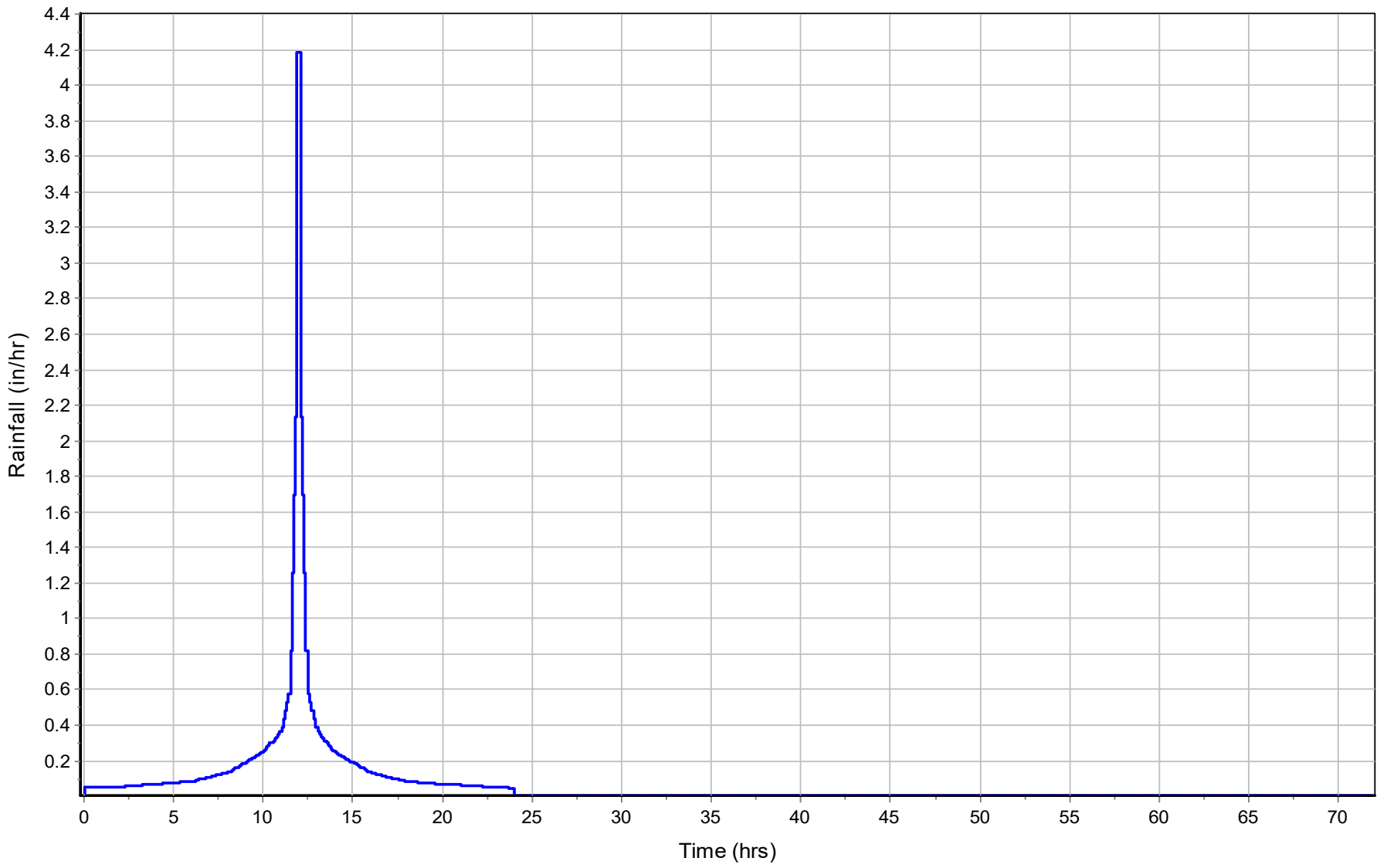
Total TOC (min) 40.27

Subbasin Runoff Results

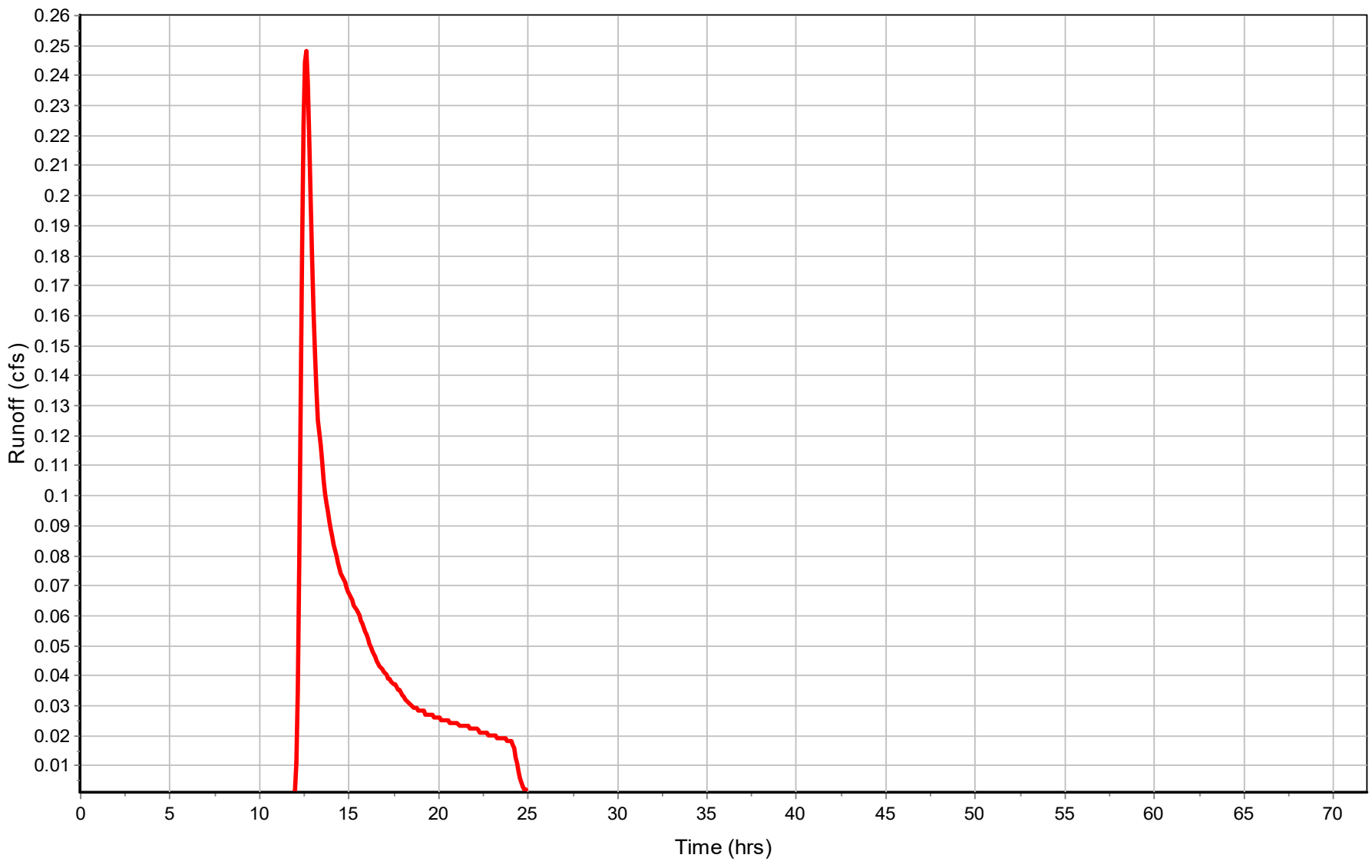
Total Rainfall (in) 4.98
Total Runoff (in) 0.63
Peak Runoff (cfs) 0.25
Weighted Curve Number 49
Time of Concentration (days hh:mm:ss) 0 00:40:16

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

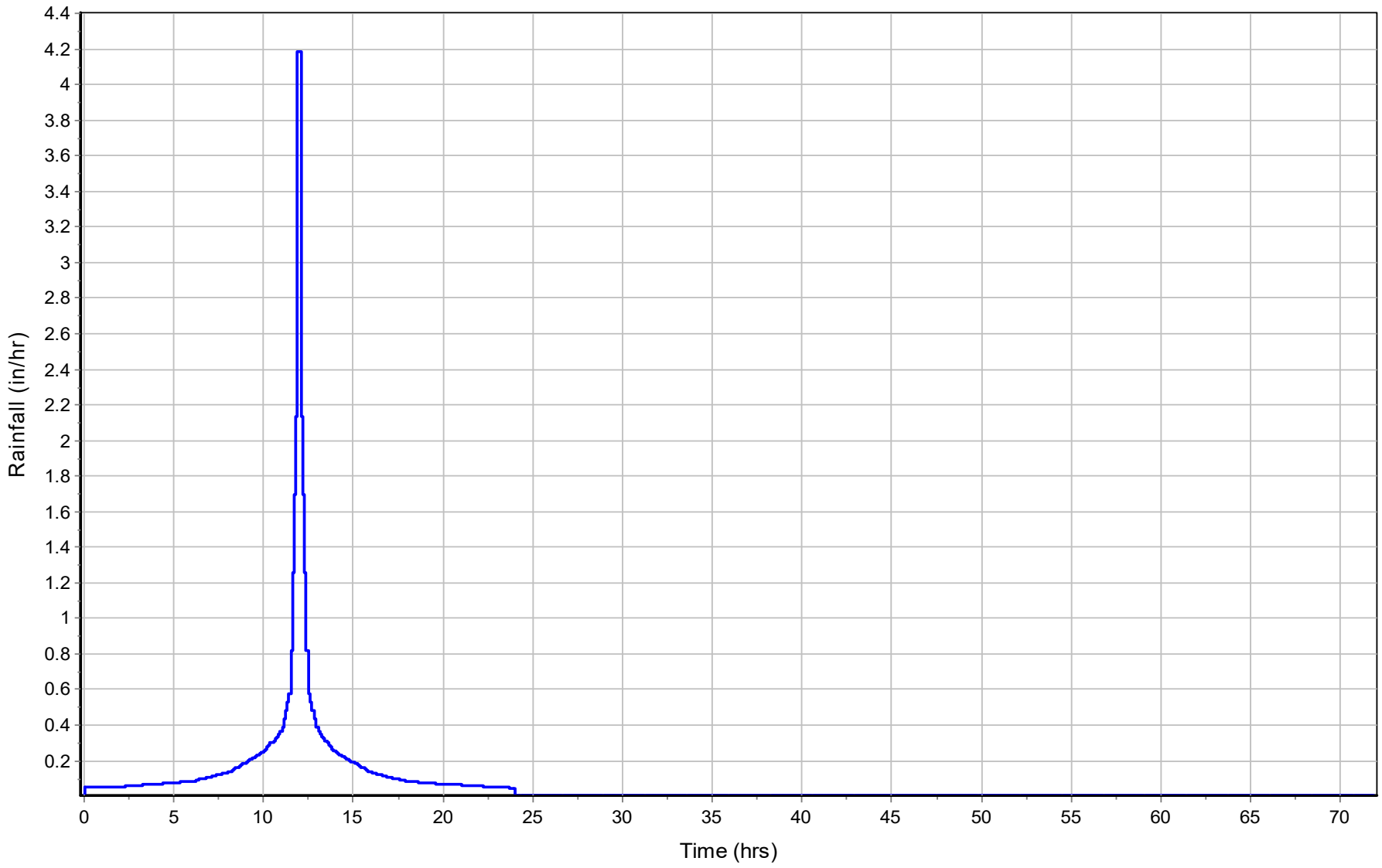
Total TOC (min) 3.51

Subbasin Runoff Results

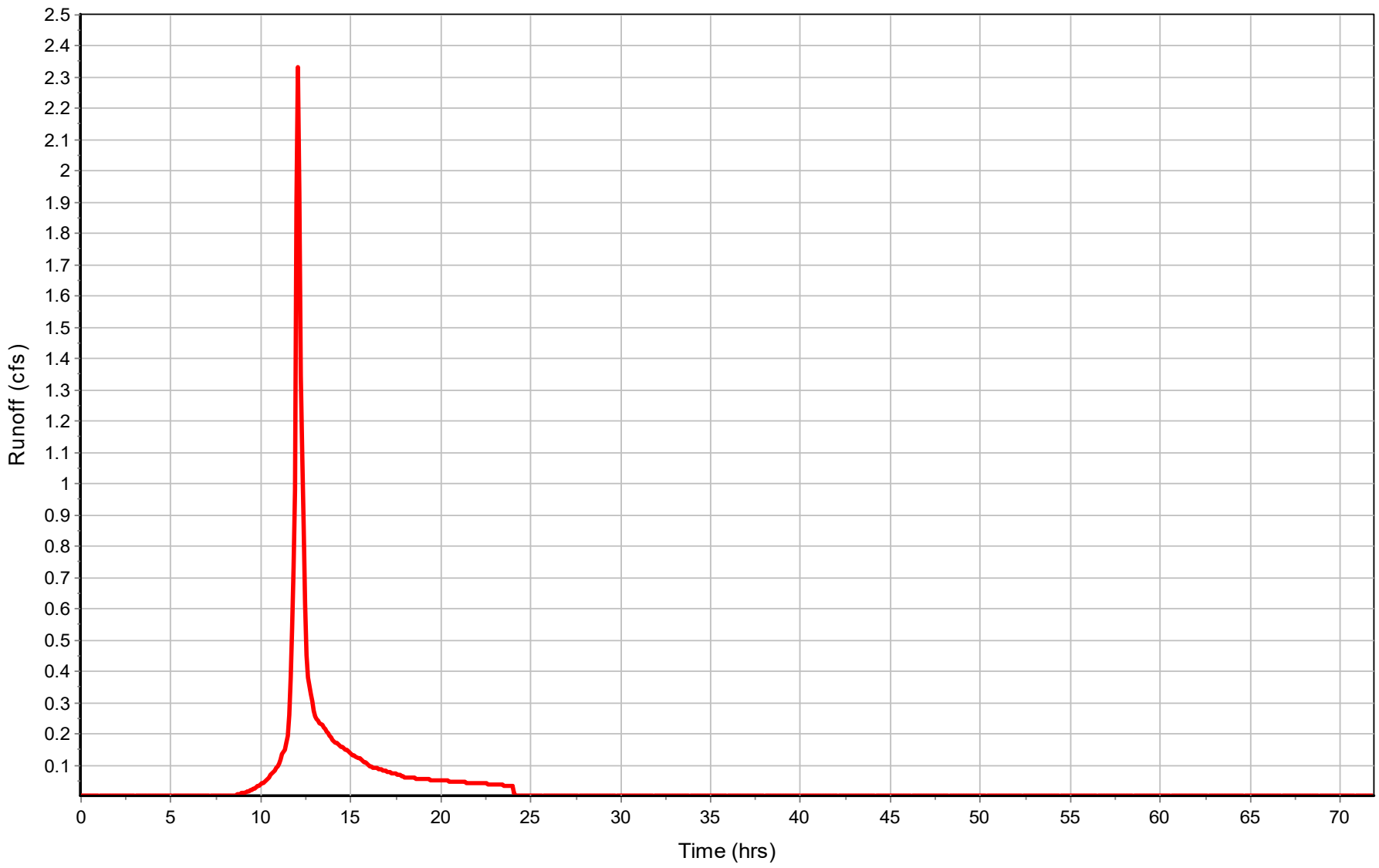
Total Rainfall (in) 4.98
Total Runoff (in) 2.52
Peak Runoff (cfs) 2.4
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:03:31

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

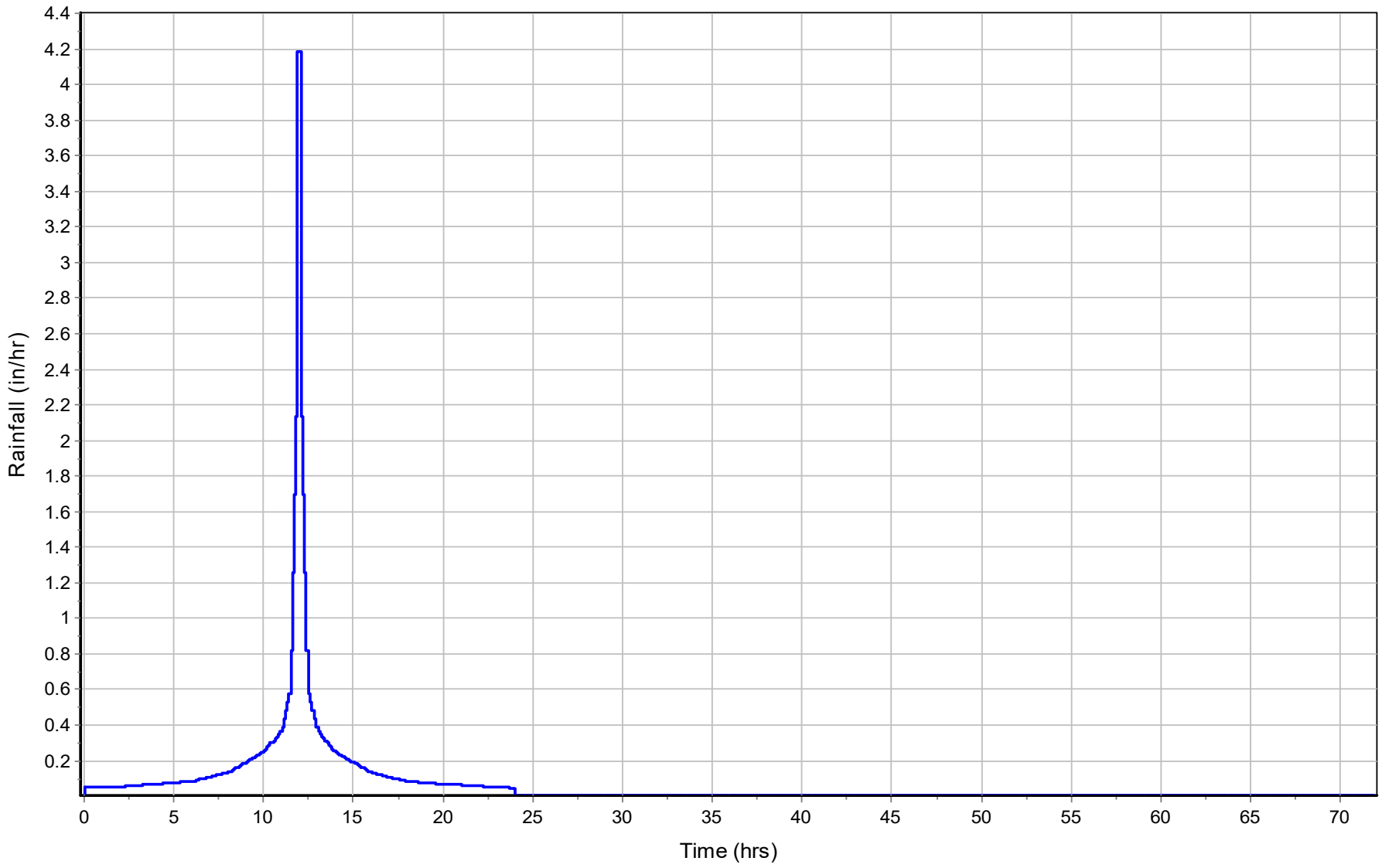
Total TOC (min) 36.12

Subbasin Runoff Results

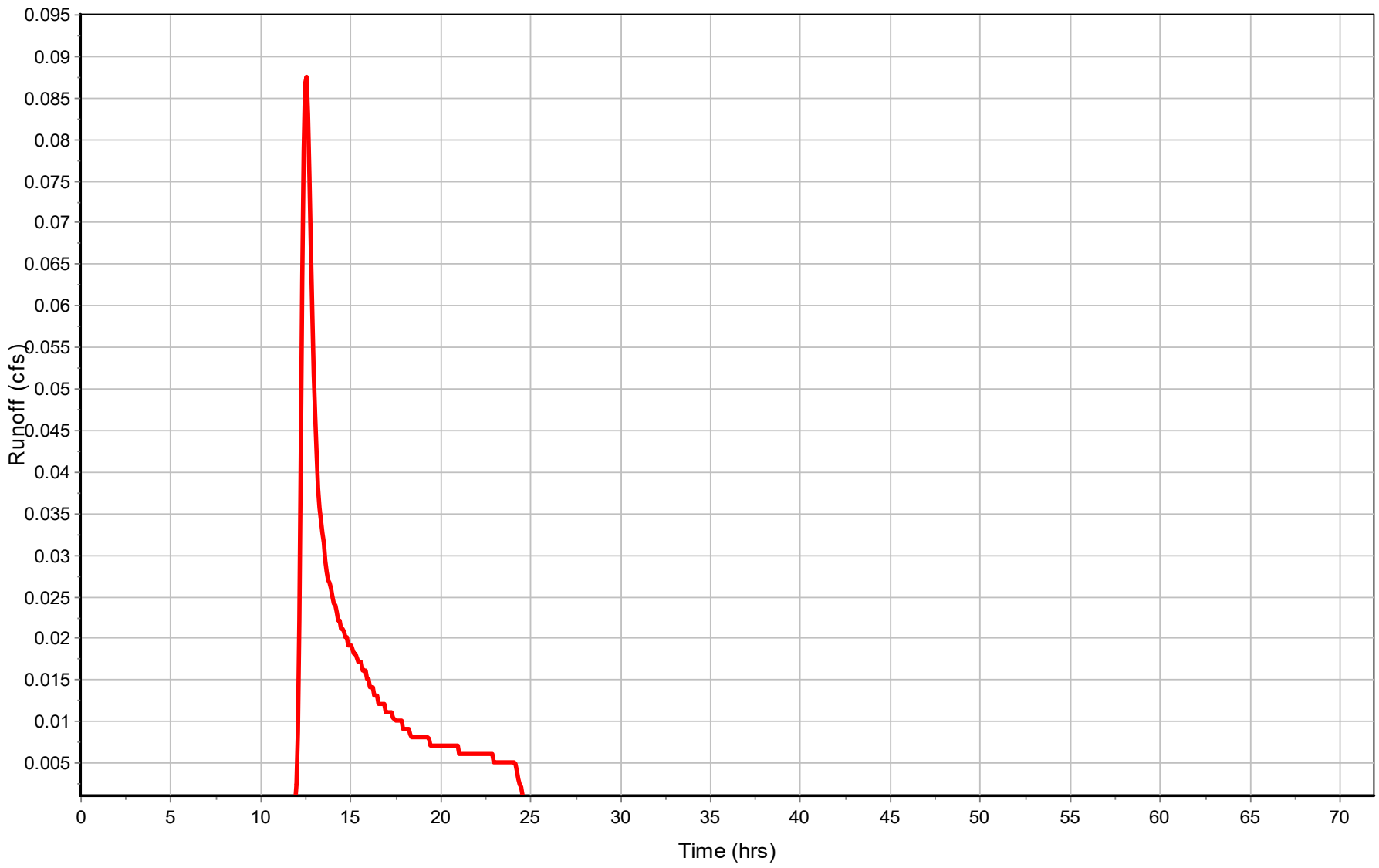
Total Rainfall (in)	4.98
Total Runoff (in)	0.78
Peak Runoff (cfs)	0.09
Weighted Curve Number	51.7
Time of Concentration (days hh:mm:ss)	0 00:36:07

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

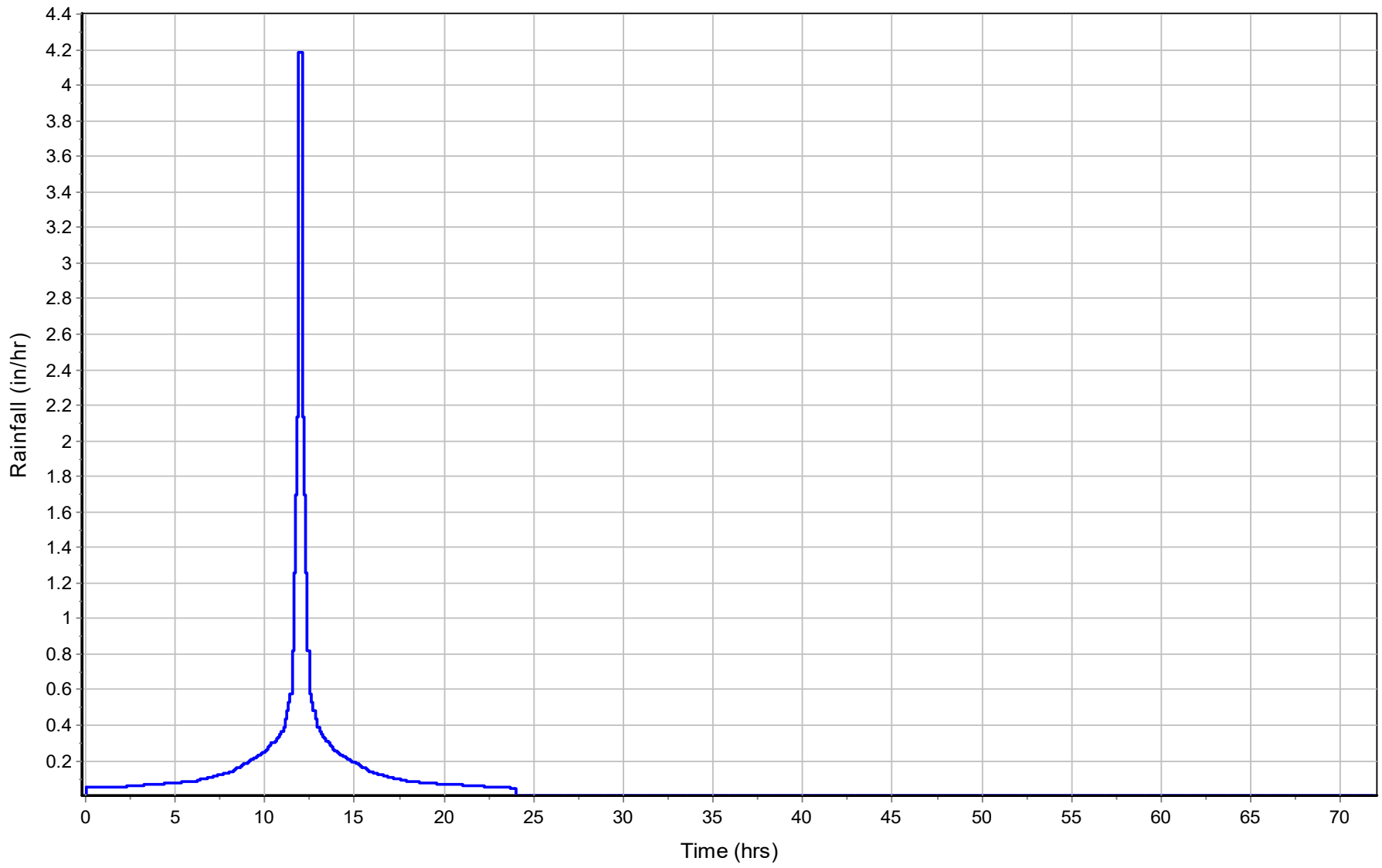
Total TOC (min) 3.14

Subbasin Runoff Results

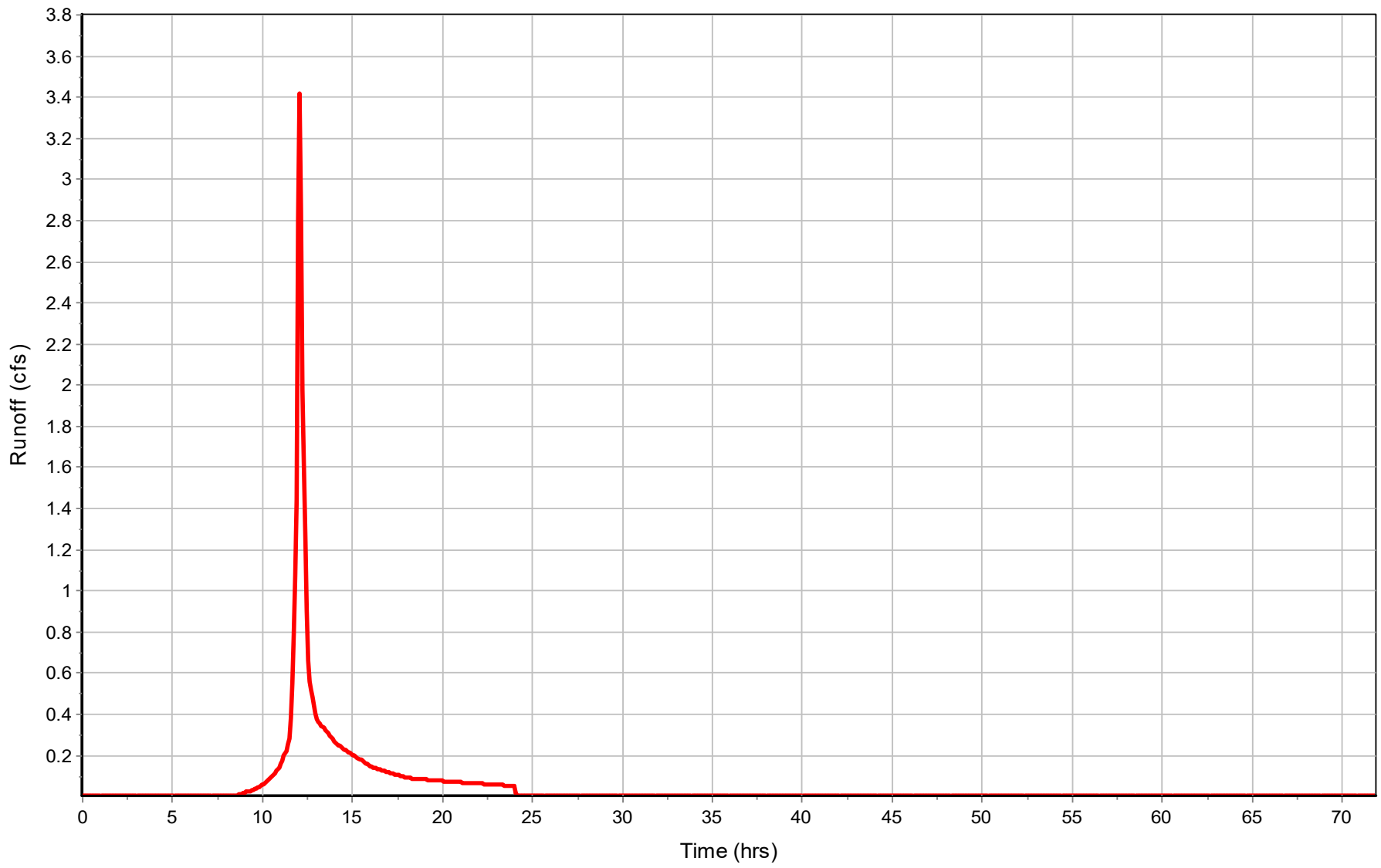
Total Rainfall (in) 4.98
Total Runoff (in) 2.52
Peak Runoff (cfs) 3.52
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:03:08

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

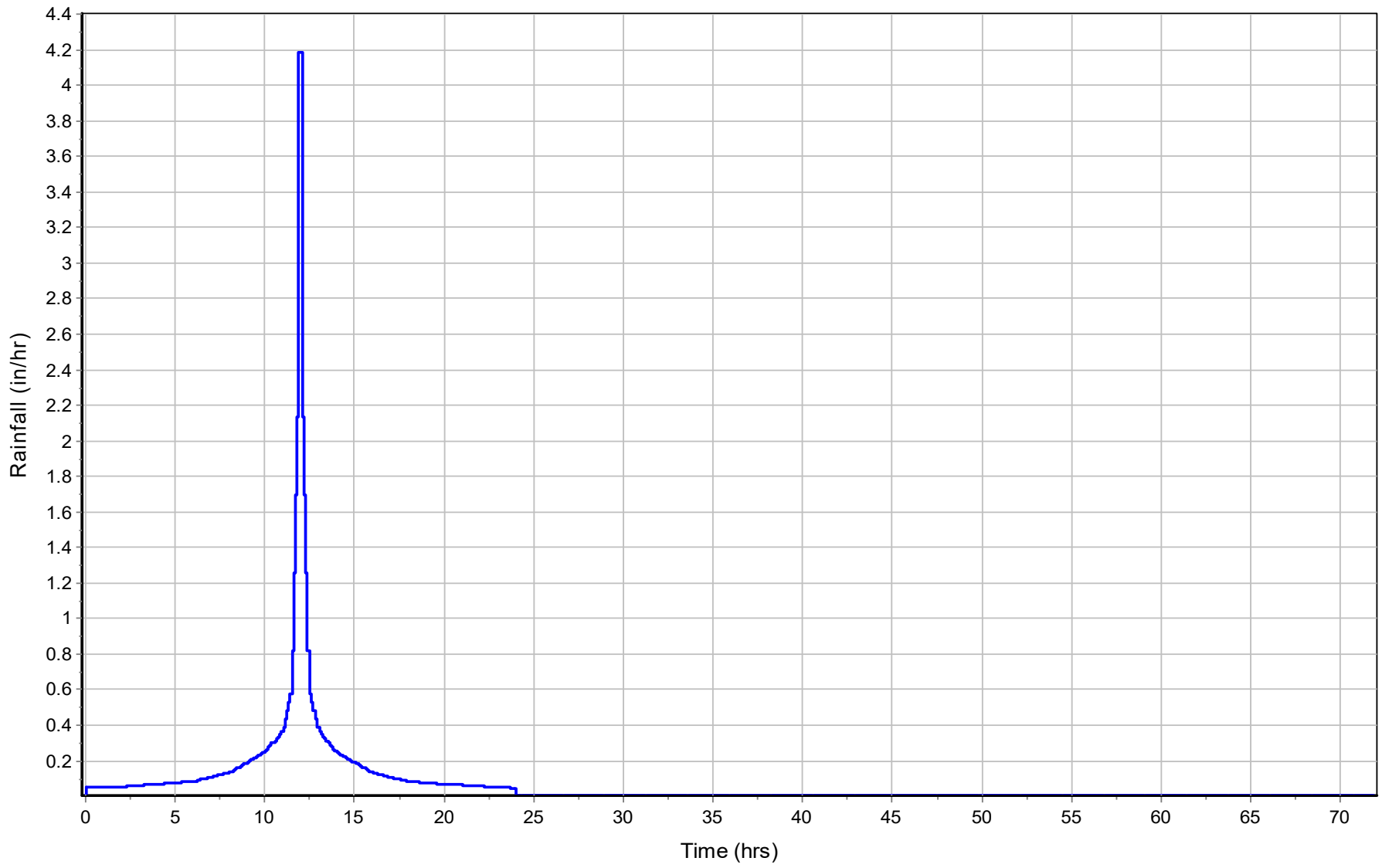
Total TOC (min) 2.17

Subbasin Runoff Results

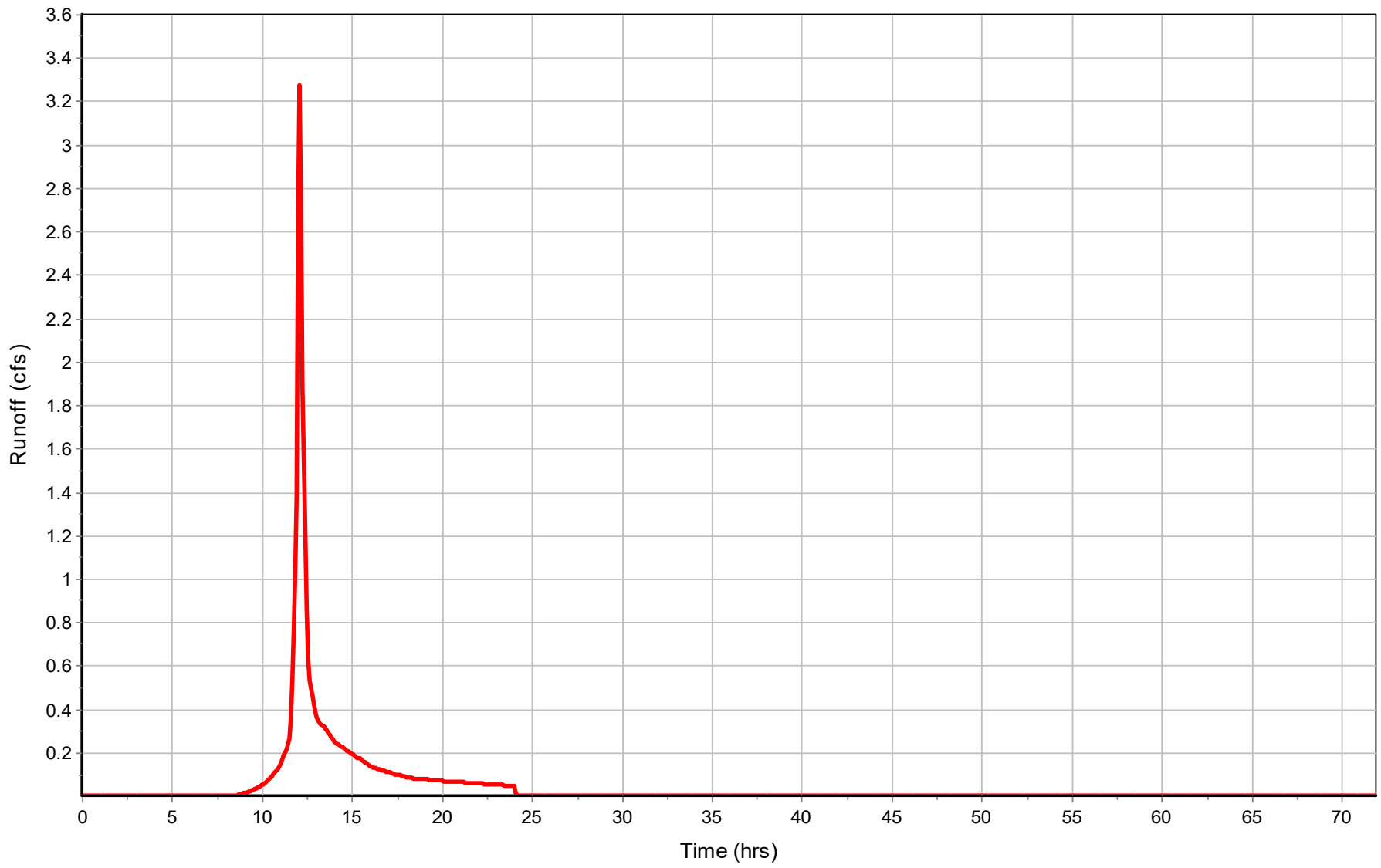
Total Rainfall (in) 4.98
Total Runoff (in) 2.52
Peak Runoff (cfs) 3.37
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:02:10

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

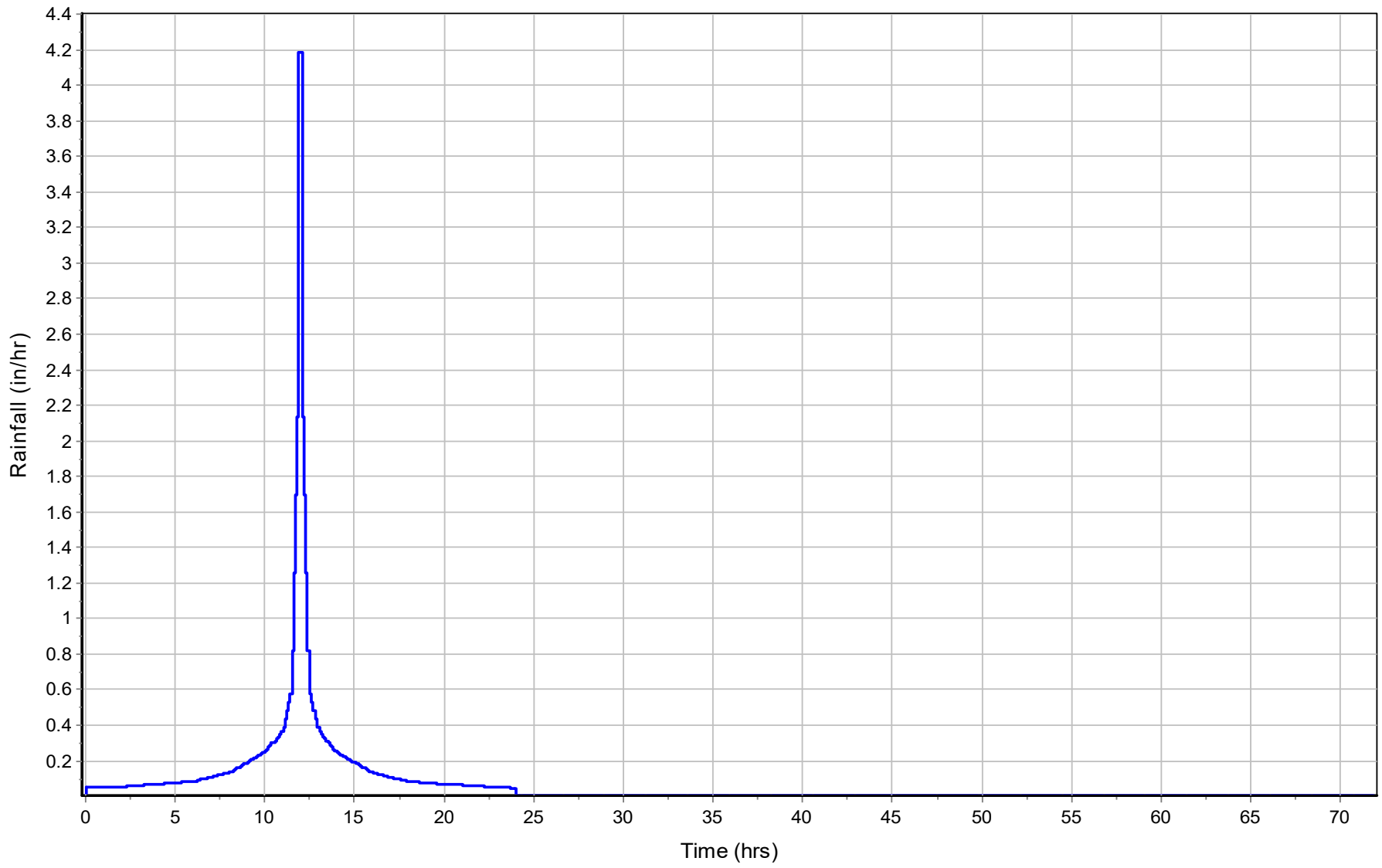
Total TOC (min) 4.13

Subbasin Runoff Results

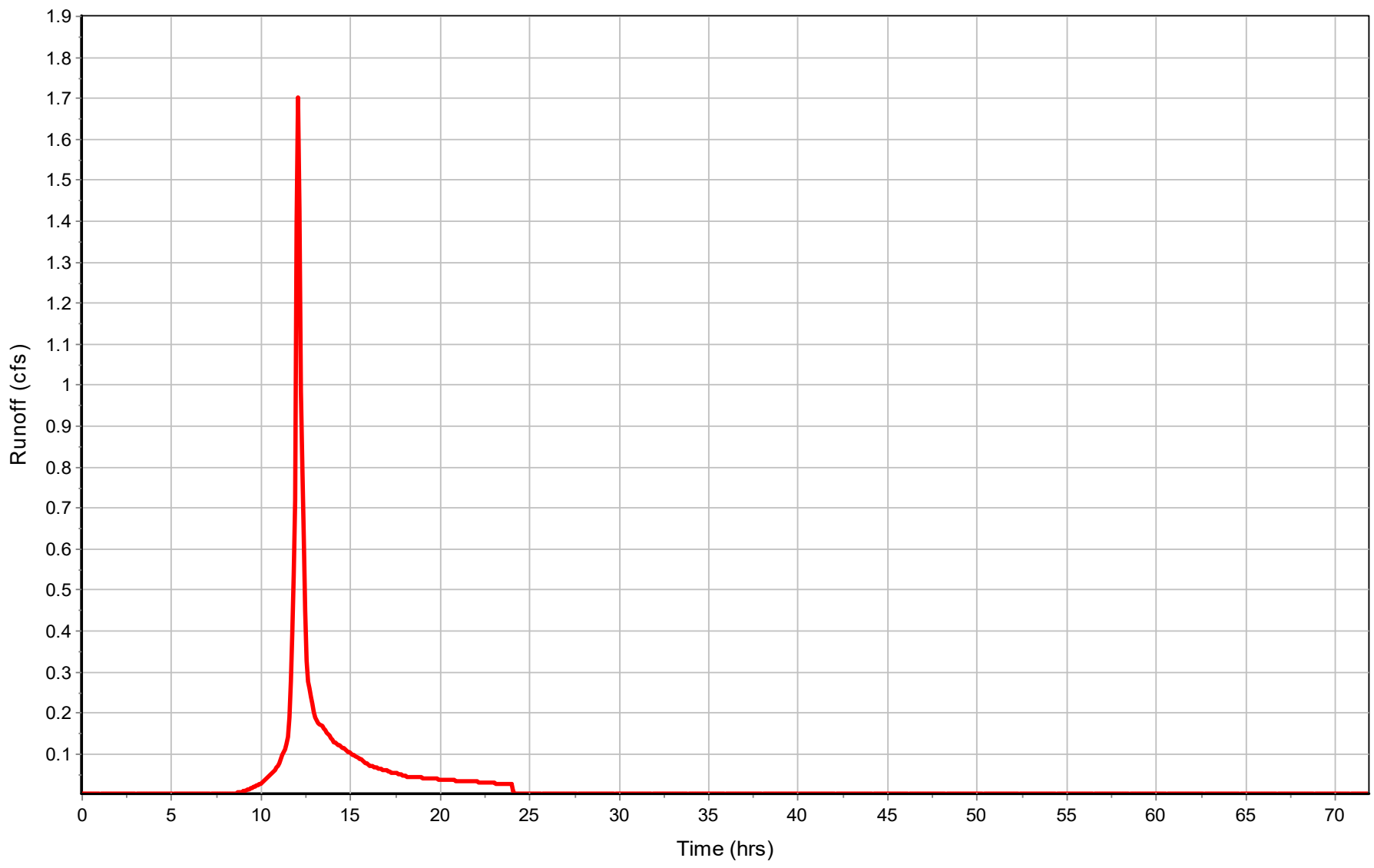
Total Rainfall (in)	4.98
Total Runoff (in)	2.52
Peak Runoff (cfs)	1.75
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:04:08

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

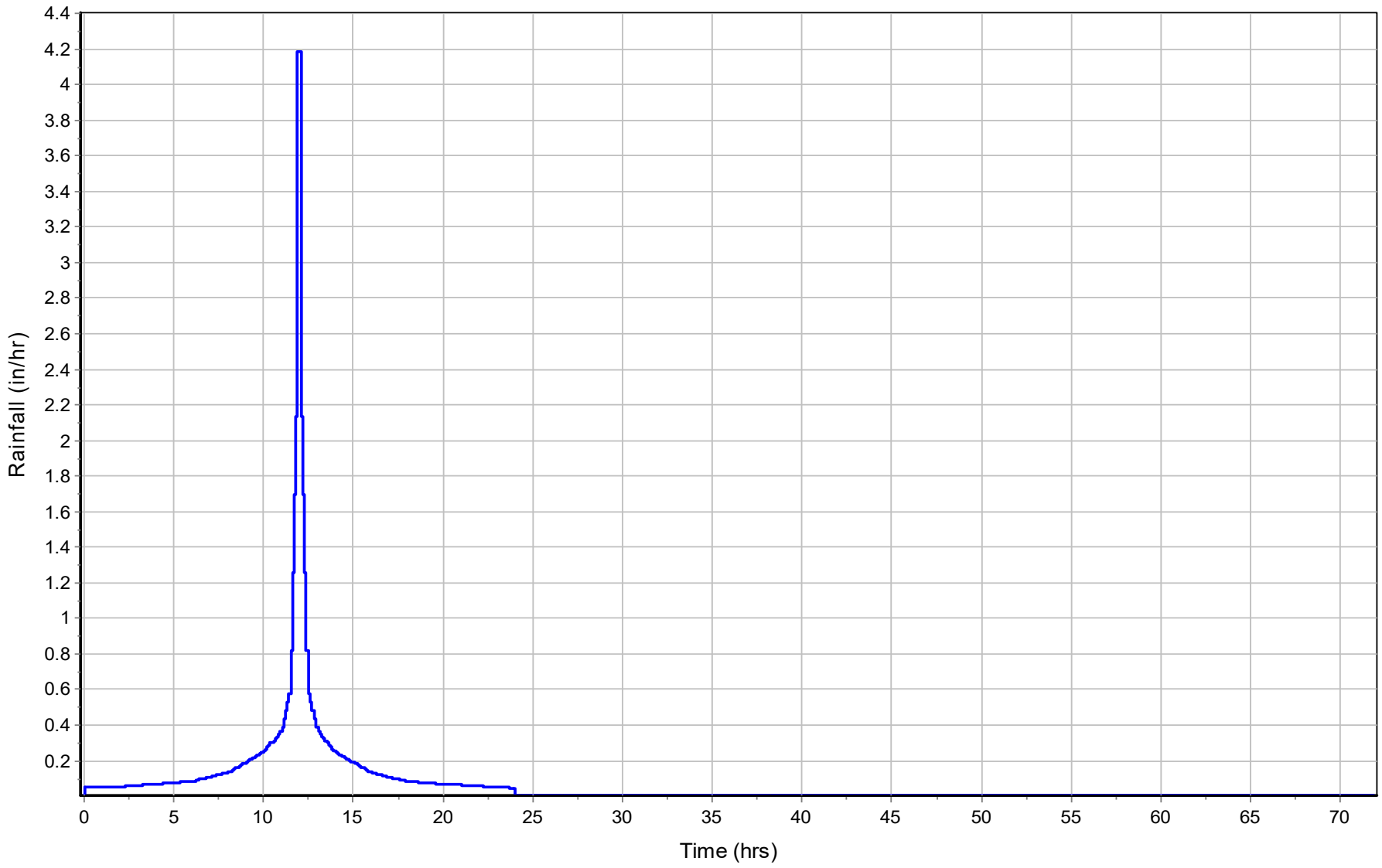
Total TOC (min) 34.83

Subbasin Runoff Results

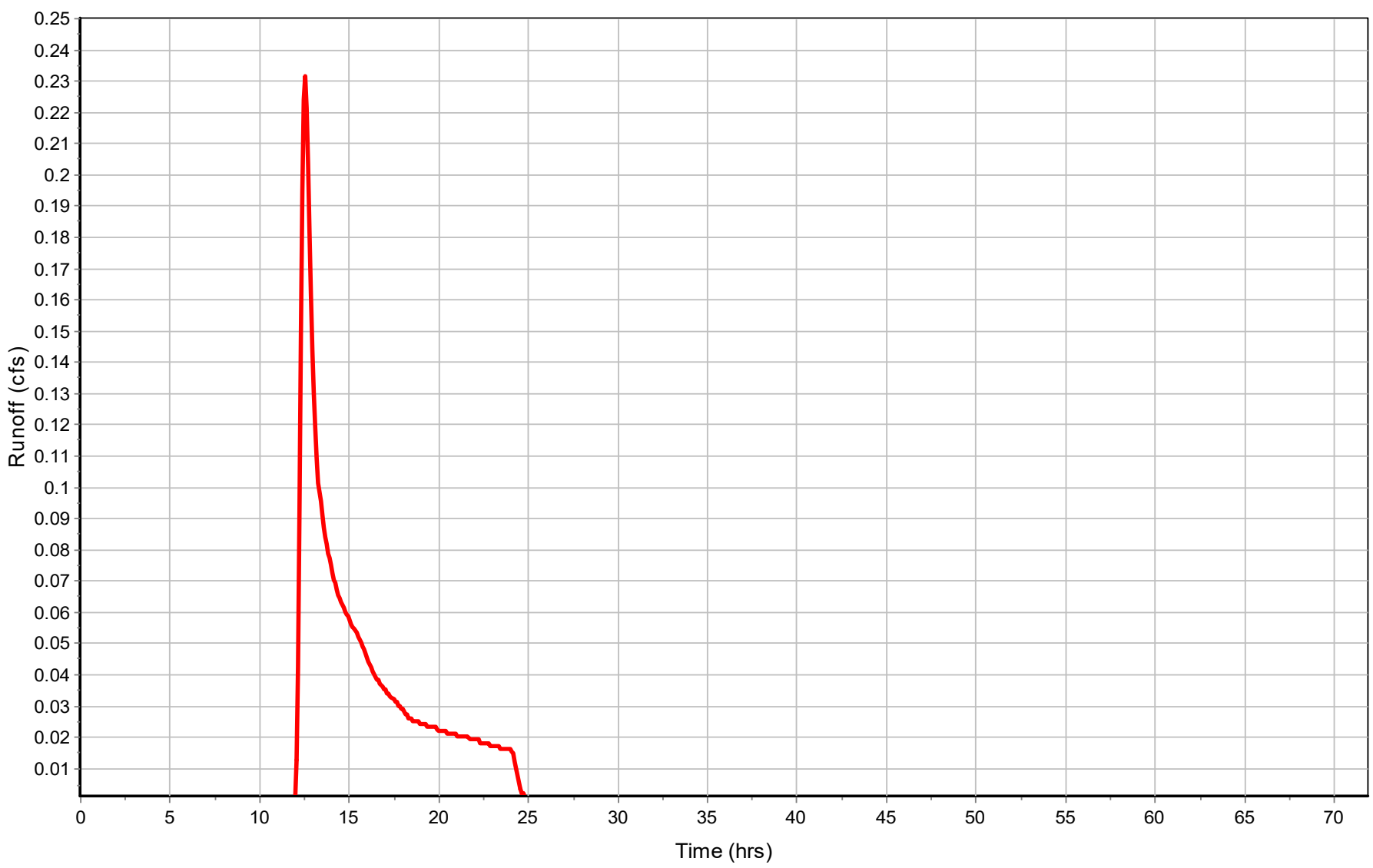
Total Rainfall (in)	4.98
Total Runoff (in)	0.63
Peak Runoff (cfs)	0.23
Weighted Curve Number	49
Time of Concentration (days hh:mm:ss)	0 00:34:50

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

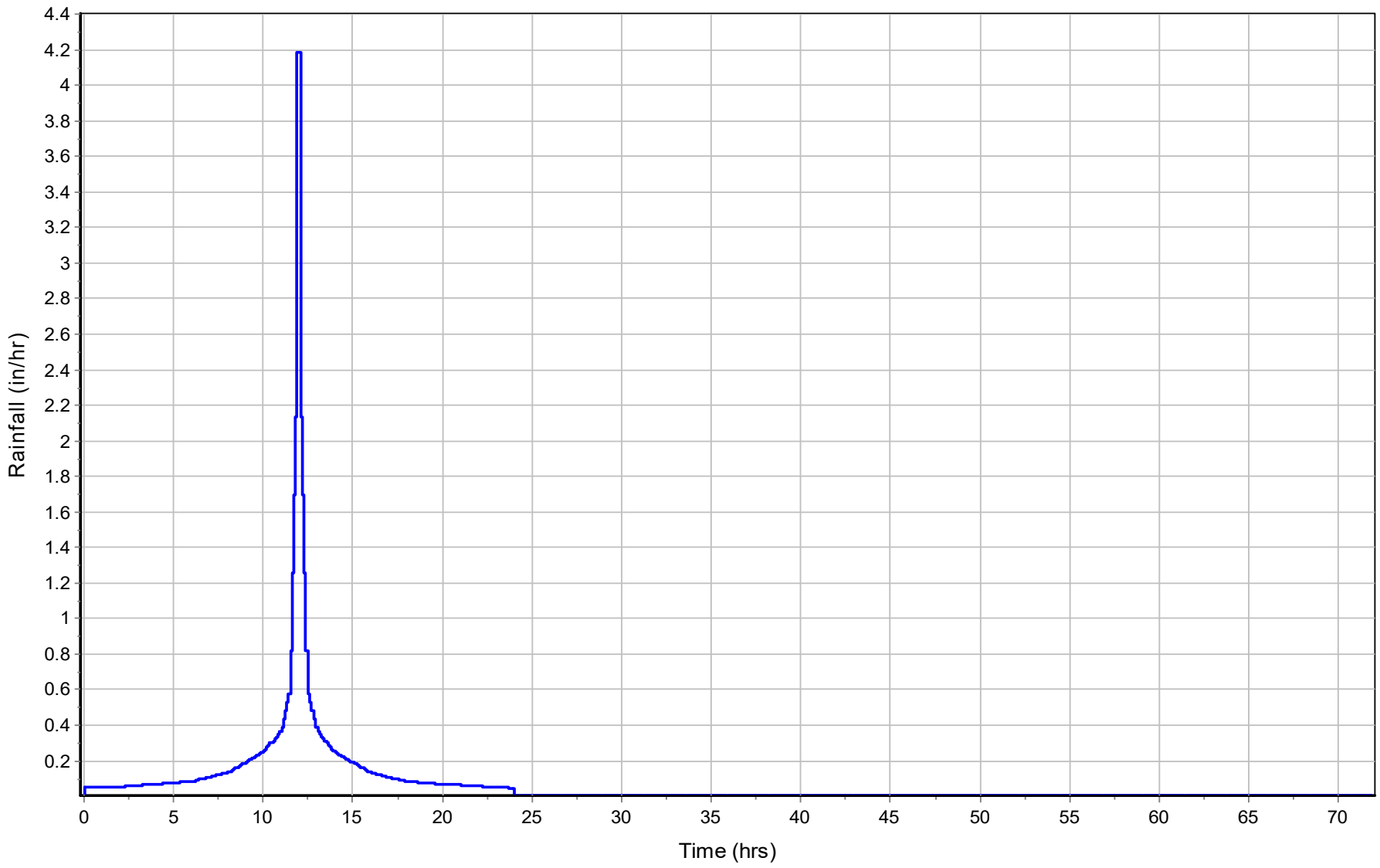
Total TOC (min) 36.49

Subbasin Runoff Results

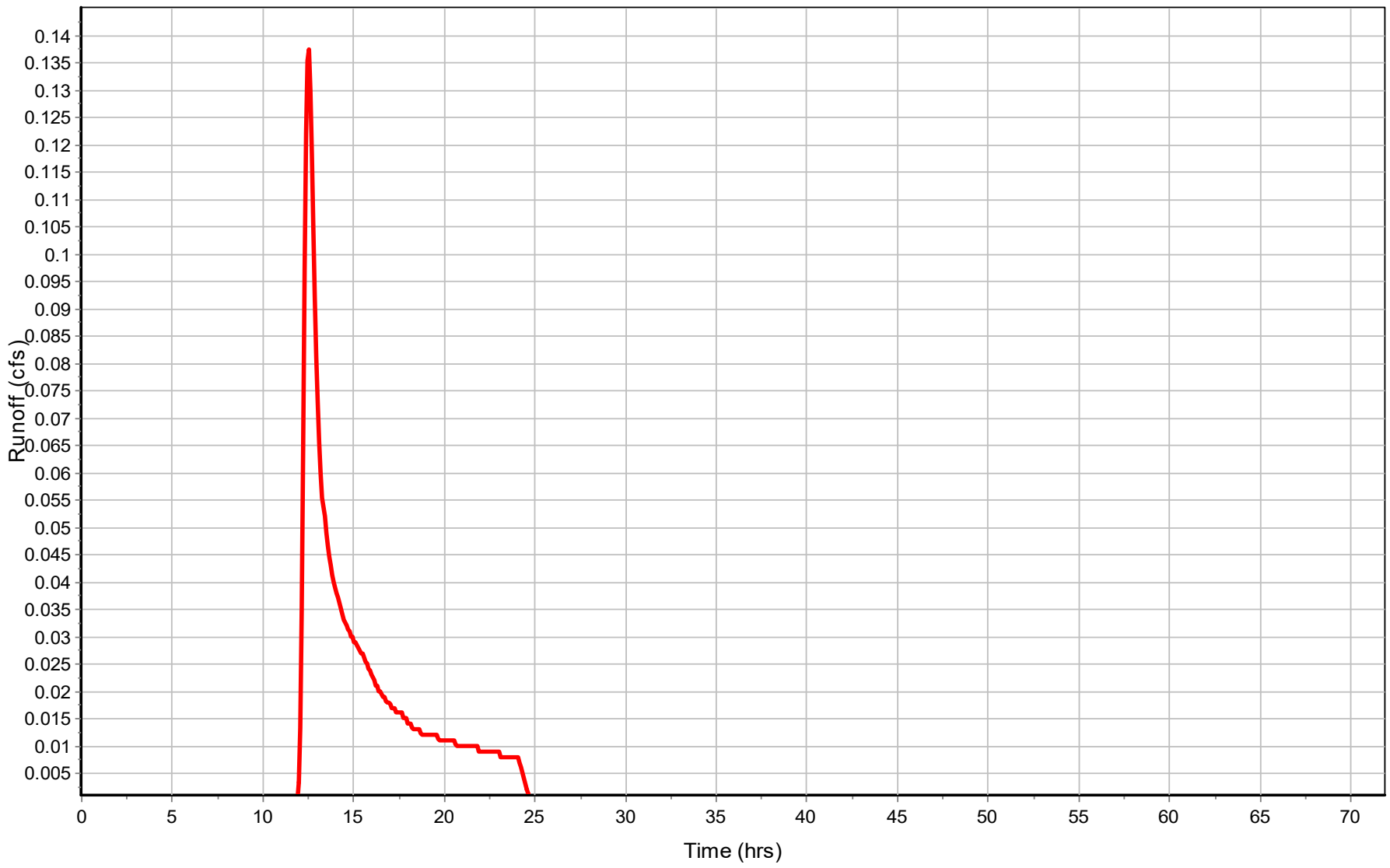
Total Rainfall (in)	4.98
Total Runoff (in)	0.78
Peak Runoff (cfs)	0.14
Weighted Curve Number	51.7
Time of Concentration (days hh:mm:ss)	0 00:36:29

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

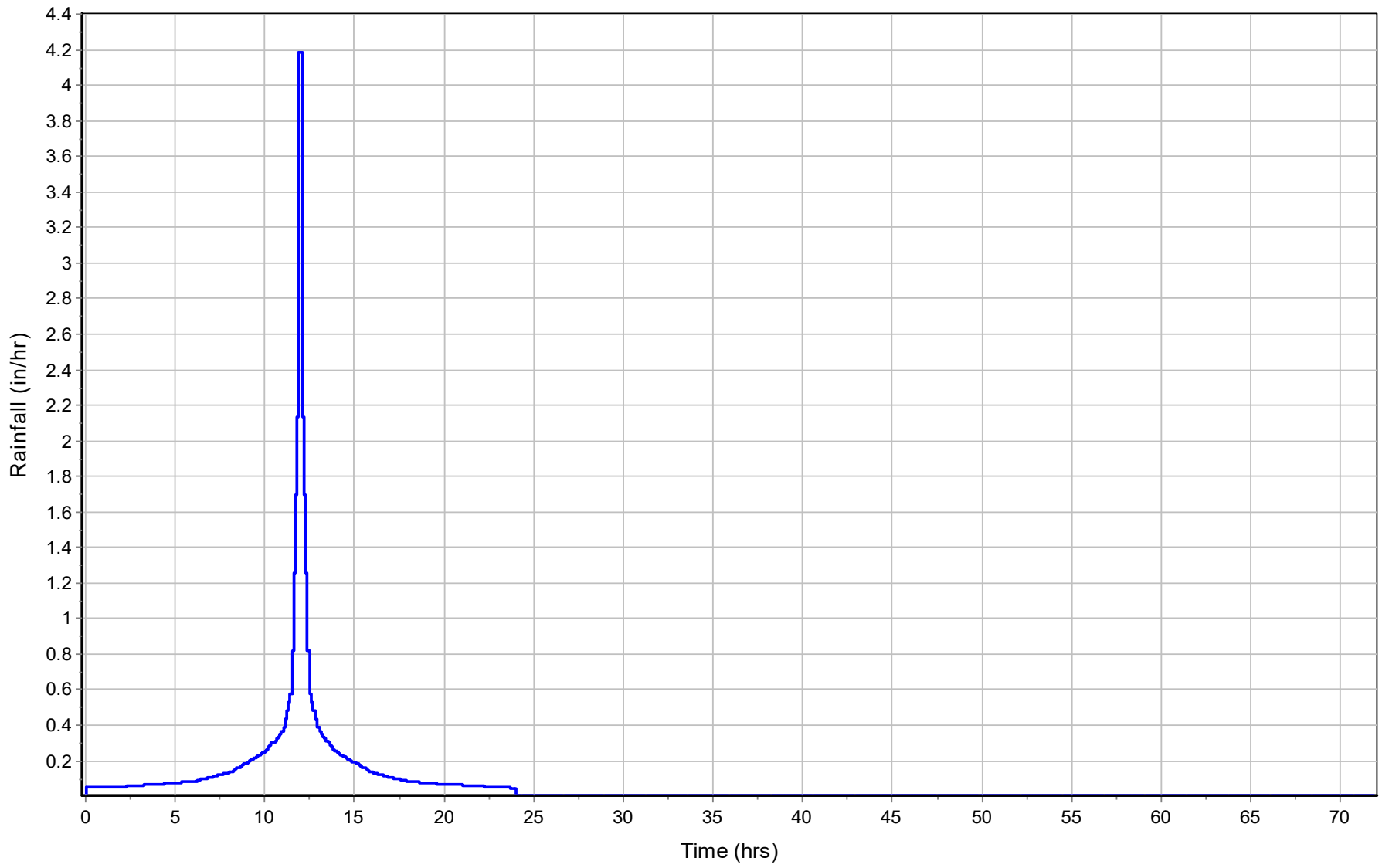
Total TOC (min) 42.87

Subbasin Runoff Results

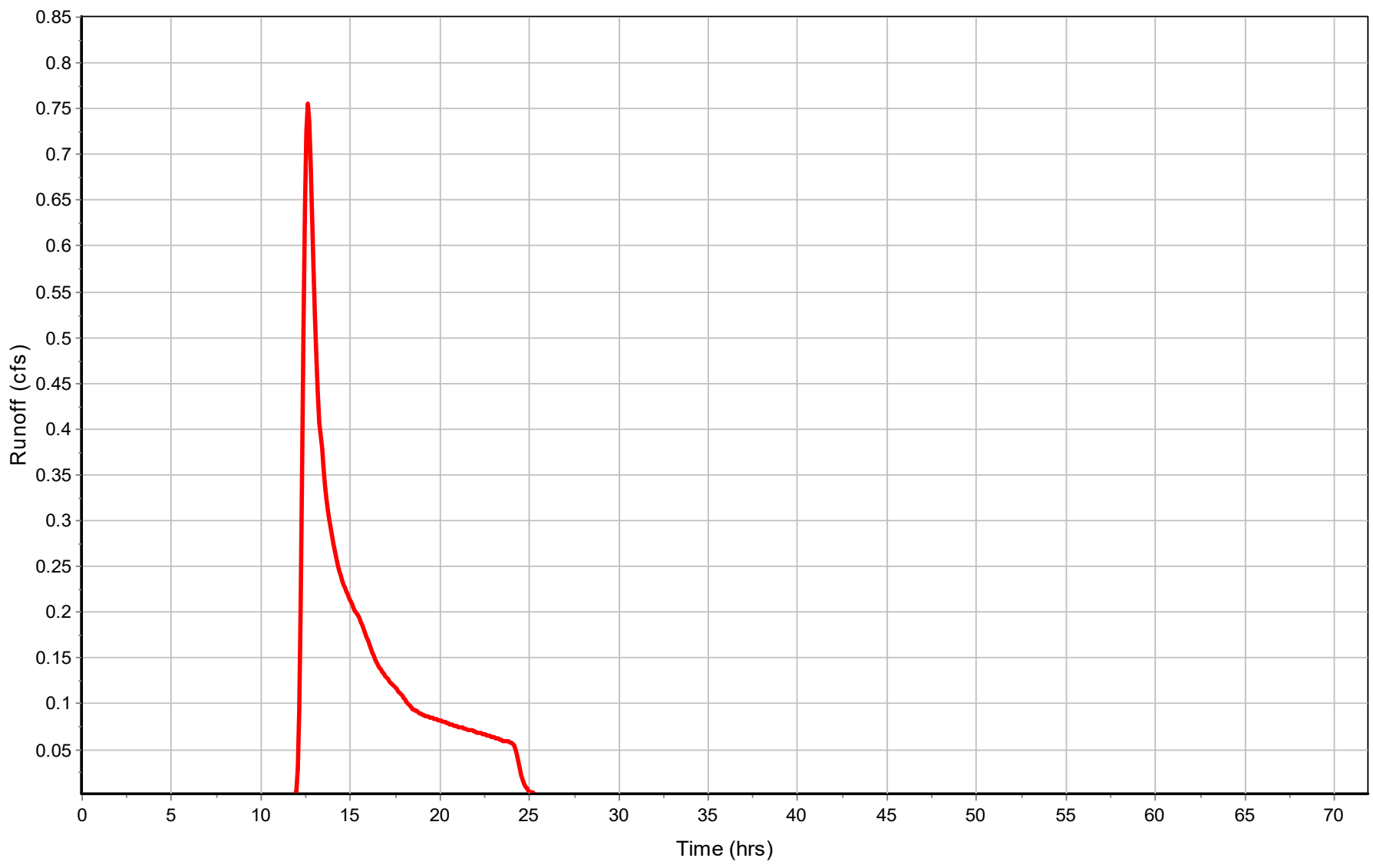
Total Rainfall (in)	4.98
Total Runoff (in)	0.63
Peak Runoff (cfs)	0.76
Weighted Curve Number	49
Time of Concentration (days hh:mm:ss)	0 00:42:52

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

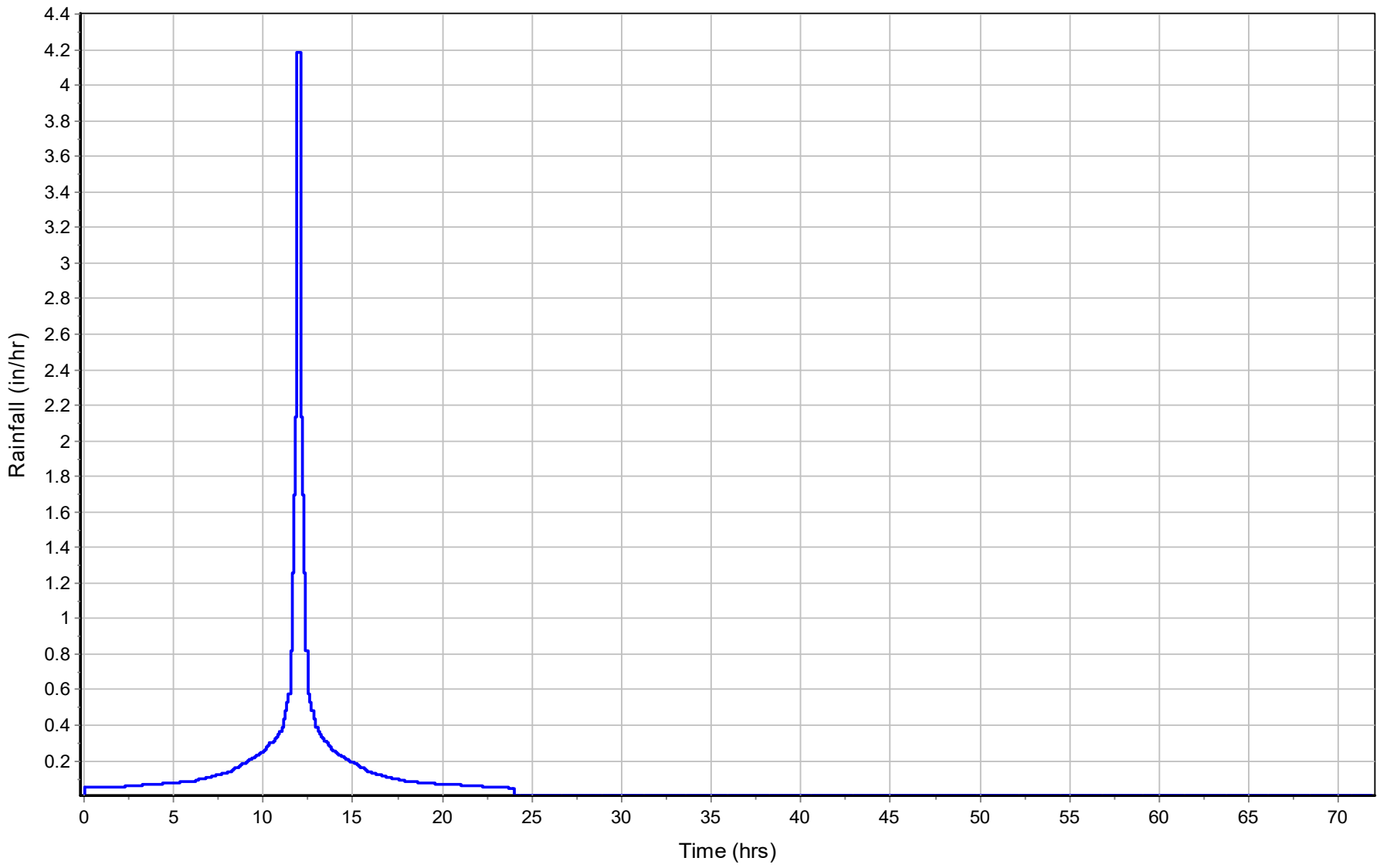
Total TOC (min) 14.50

Subbasin Runoff Results

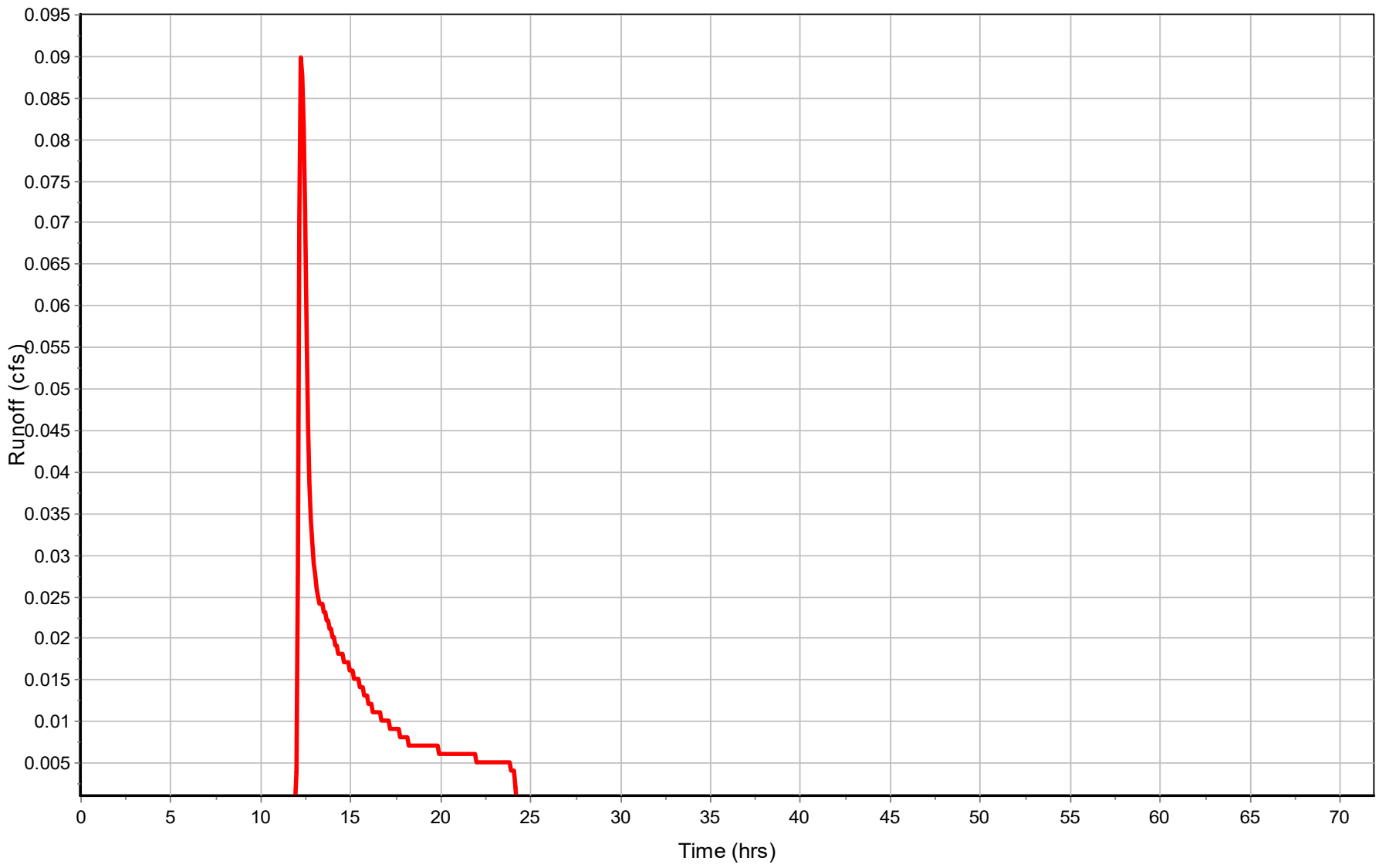
Total Rainfall (in)	4.98
Total Runoff (in)	0.63
Peak Runoff (cfs)	0.09
Weighted Curve Number	49
Time of Concentration (days hh:mm:ss)	0 00:14:30

Subbasin : Existing-E5.1_A2

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : A1-1-BASIN

Input Data

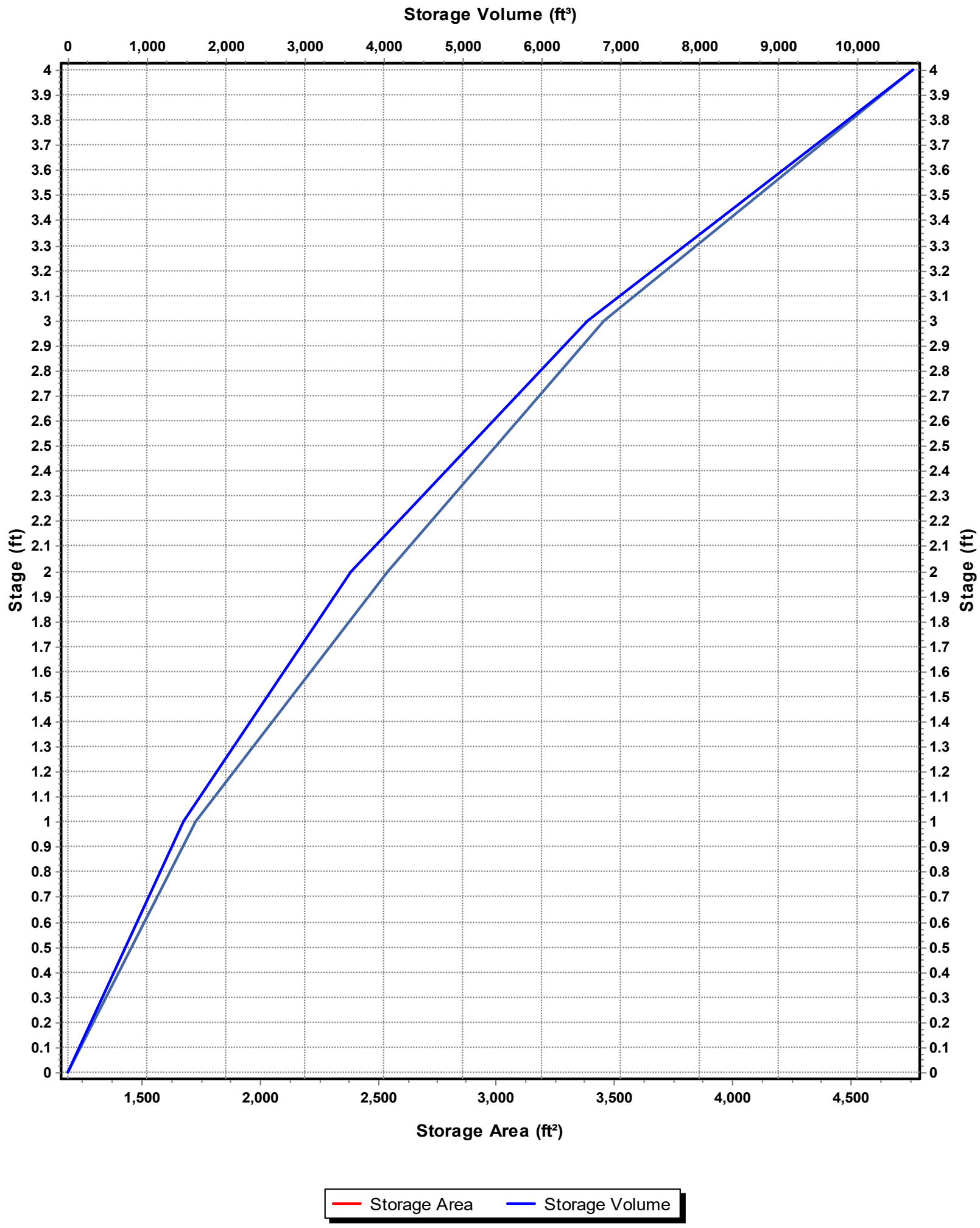
Invert Elevation (ft)	66.00
Max (Rim) Elevation (ft)	69.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	66.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

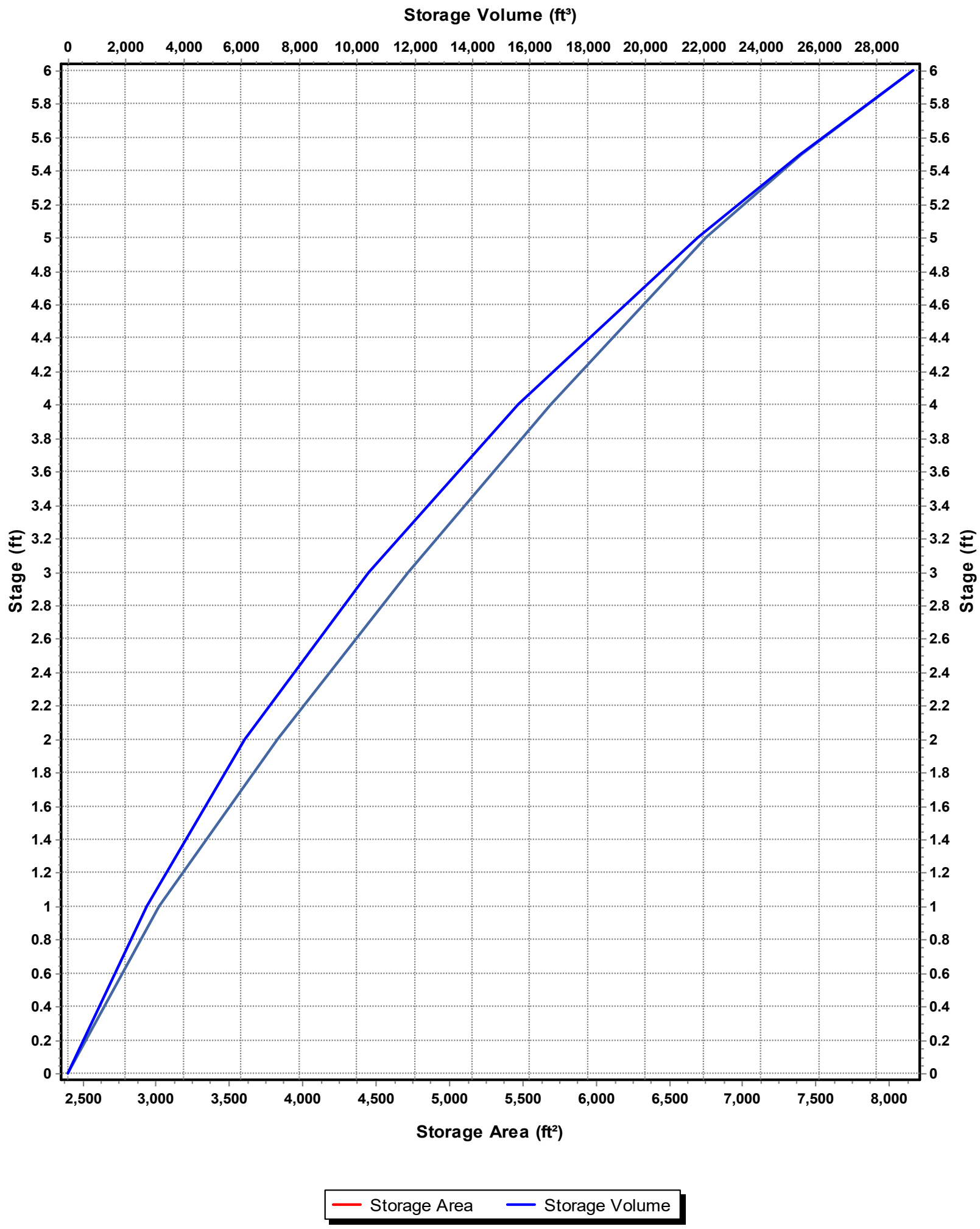
Invert Elevation (ft)	63.00
Max (Rim) Elevation (ft)	69.00
Max (Rim) Offset (ft)	6.00
Initial Water Elevation (ft)	63.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

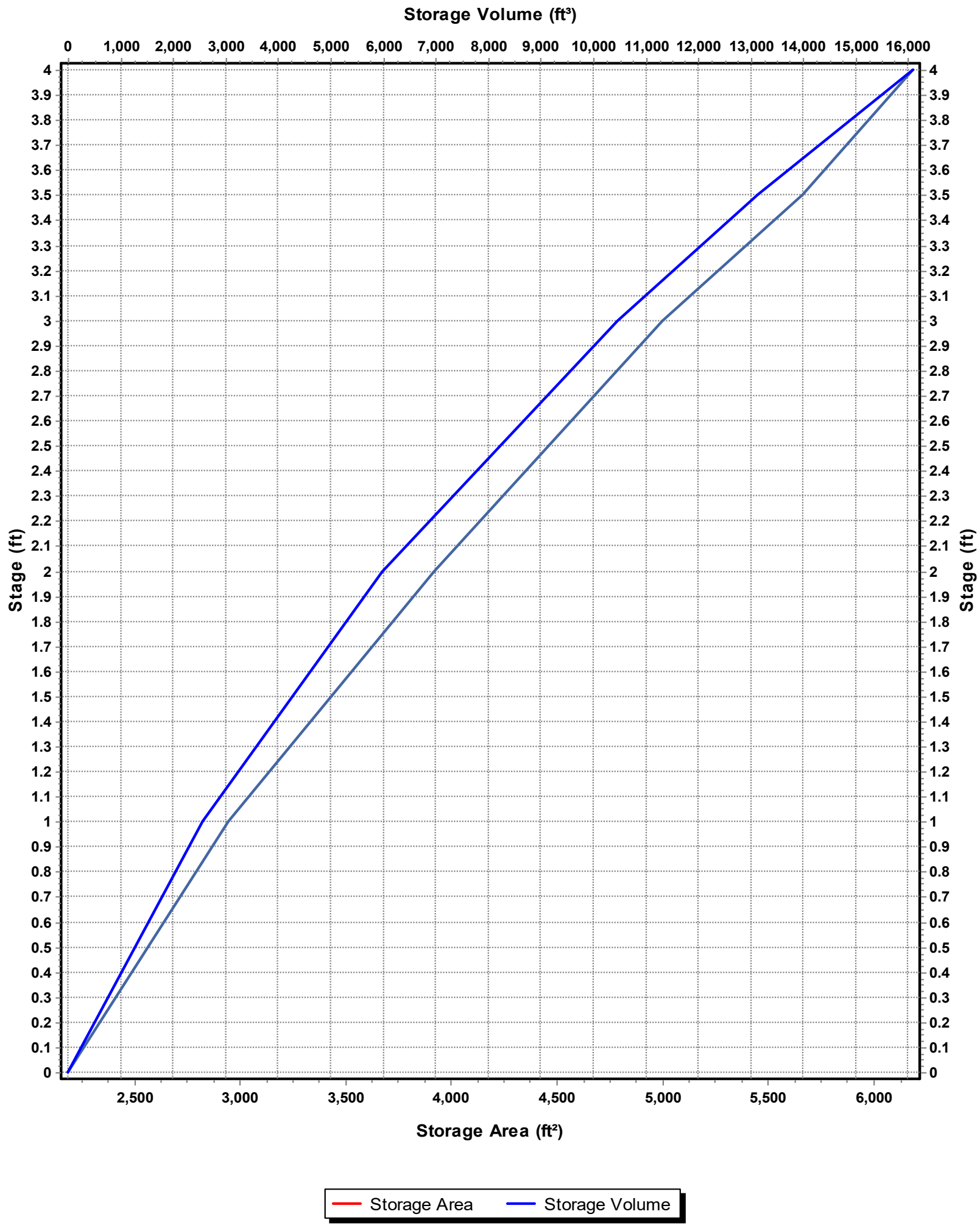
Invert Elevation (ft)	63.00
Max (Rim) Elevation (ft)	67.00
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	63.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

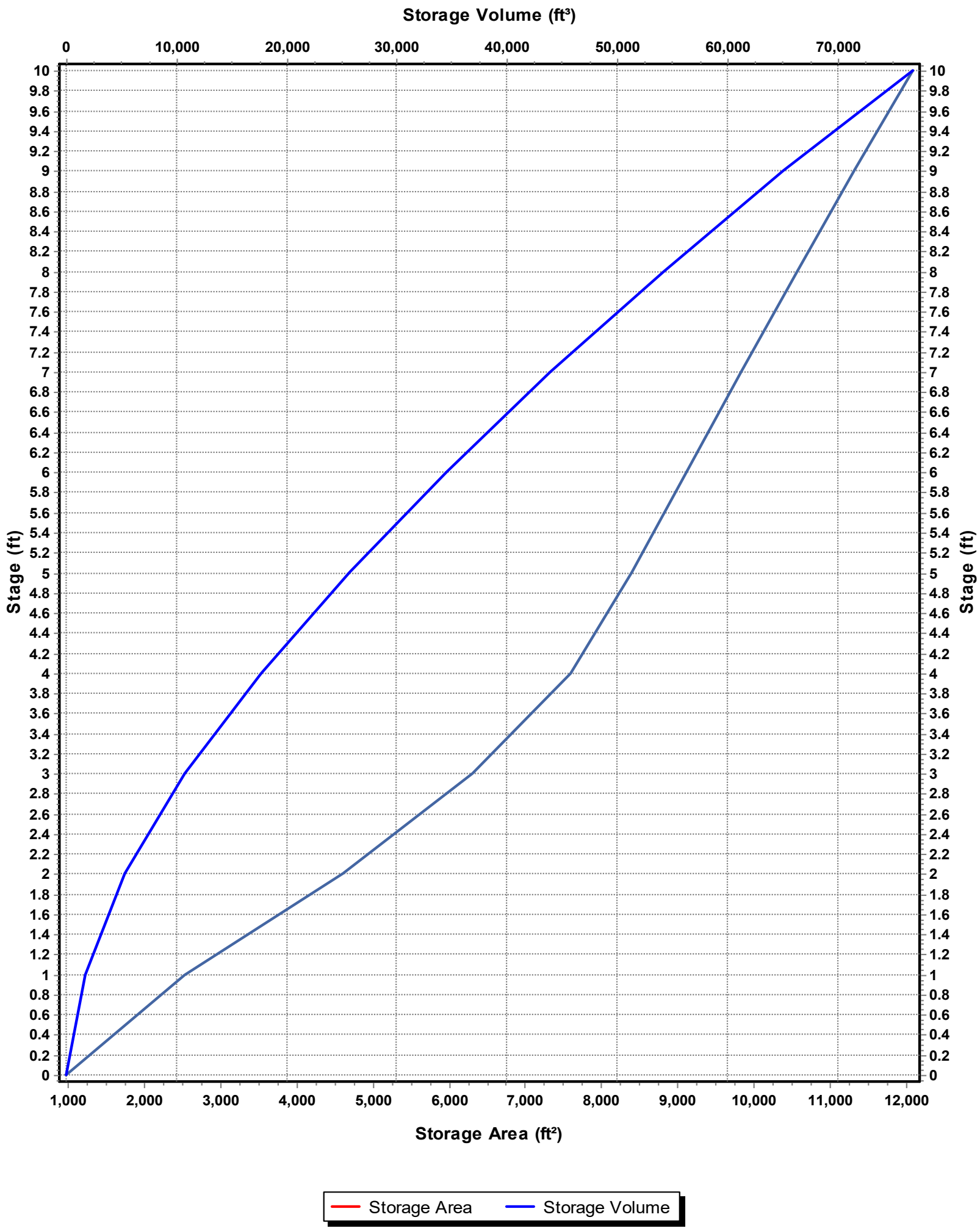
Invert Elevation (ft)	43.00
Max (Rim) Elevation (ft)	53.00
Max (Rim) Offset (ft)	10.00
Initial Water Elevation (ft)	43.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

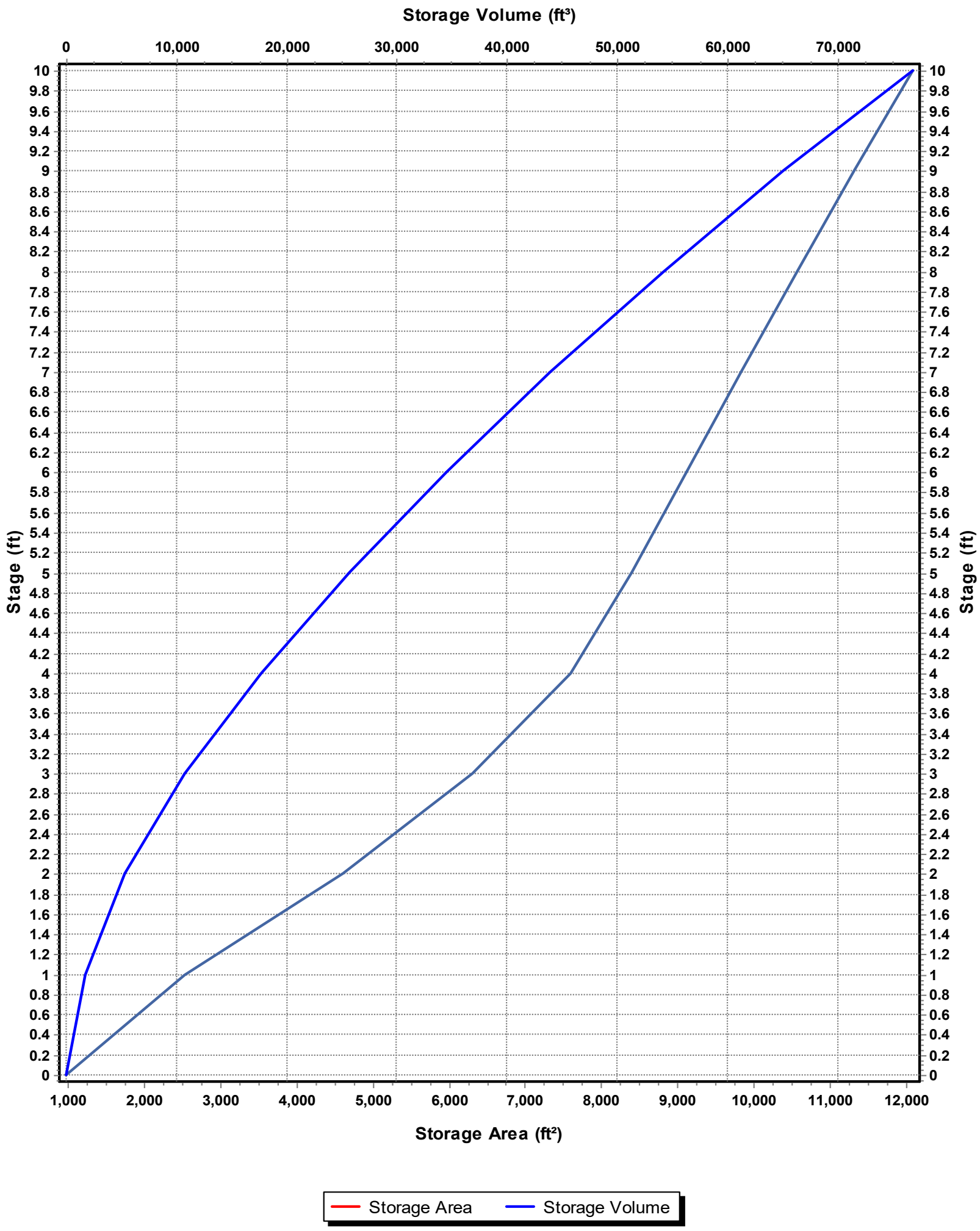
Invert Elevation (ft)	43.00
Max (Rim) Elevation (ft)	53.00
Max (Rim) Offset (ft)	10.00
Initial Water Elevation (ft)	43.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

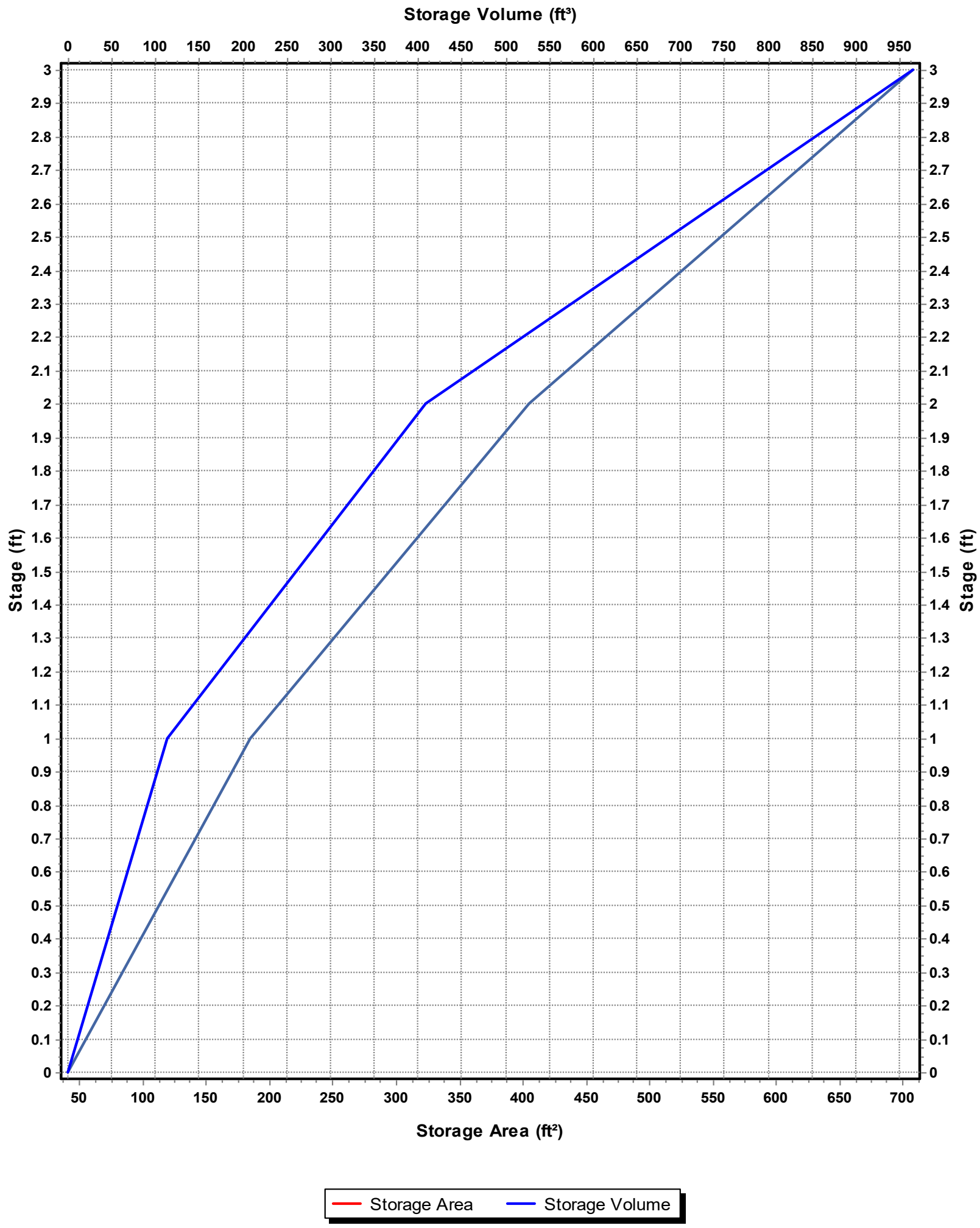
Invert Elevation (ft)	66.00
Max (Rim) Elevation (ft)	70.00
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	66.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

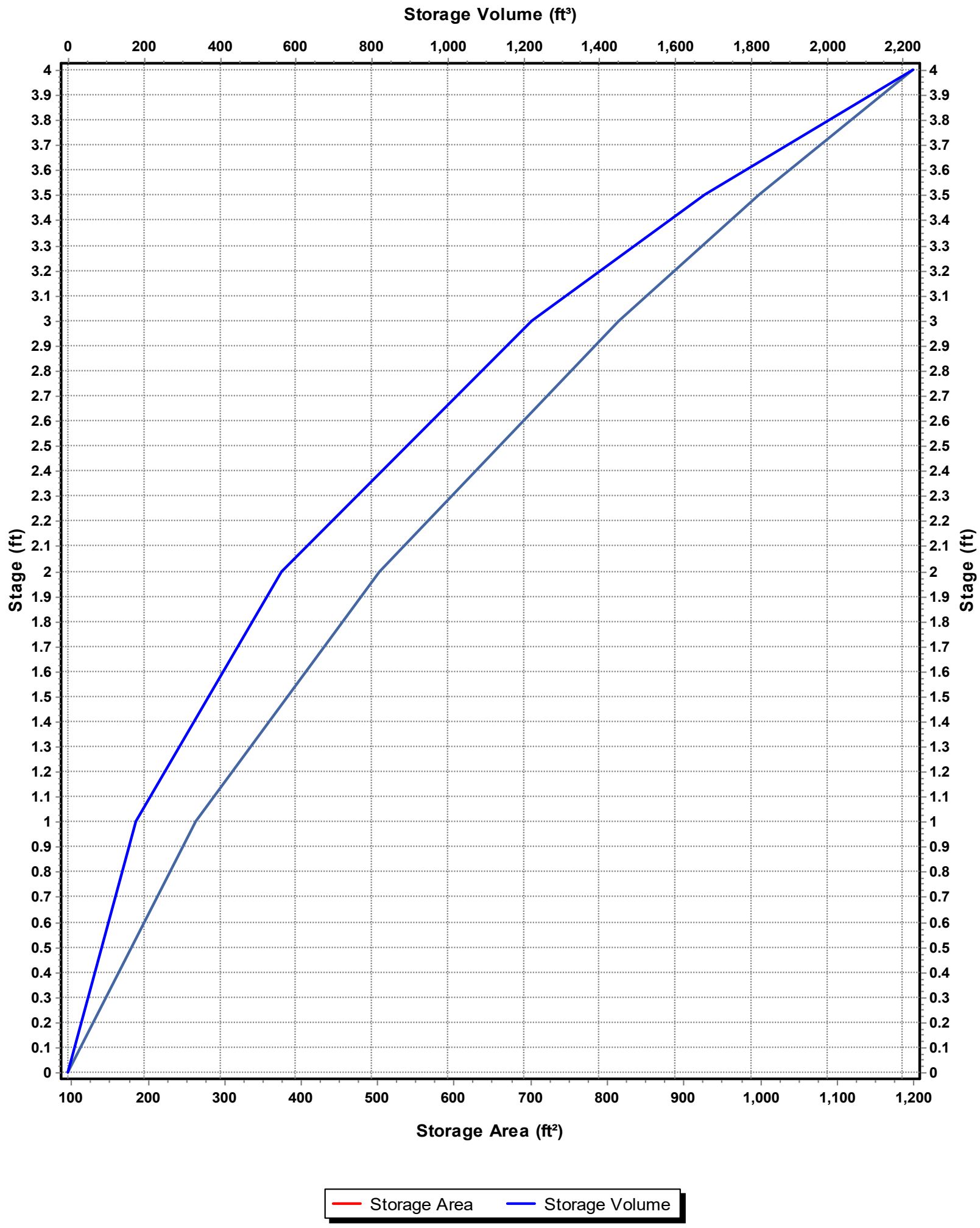
Invert Elevation (ft)	62.00
Max (Rim) Elevation (ft)	66.00
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	62.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

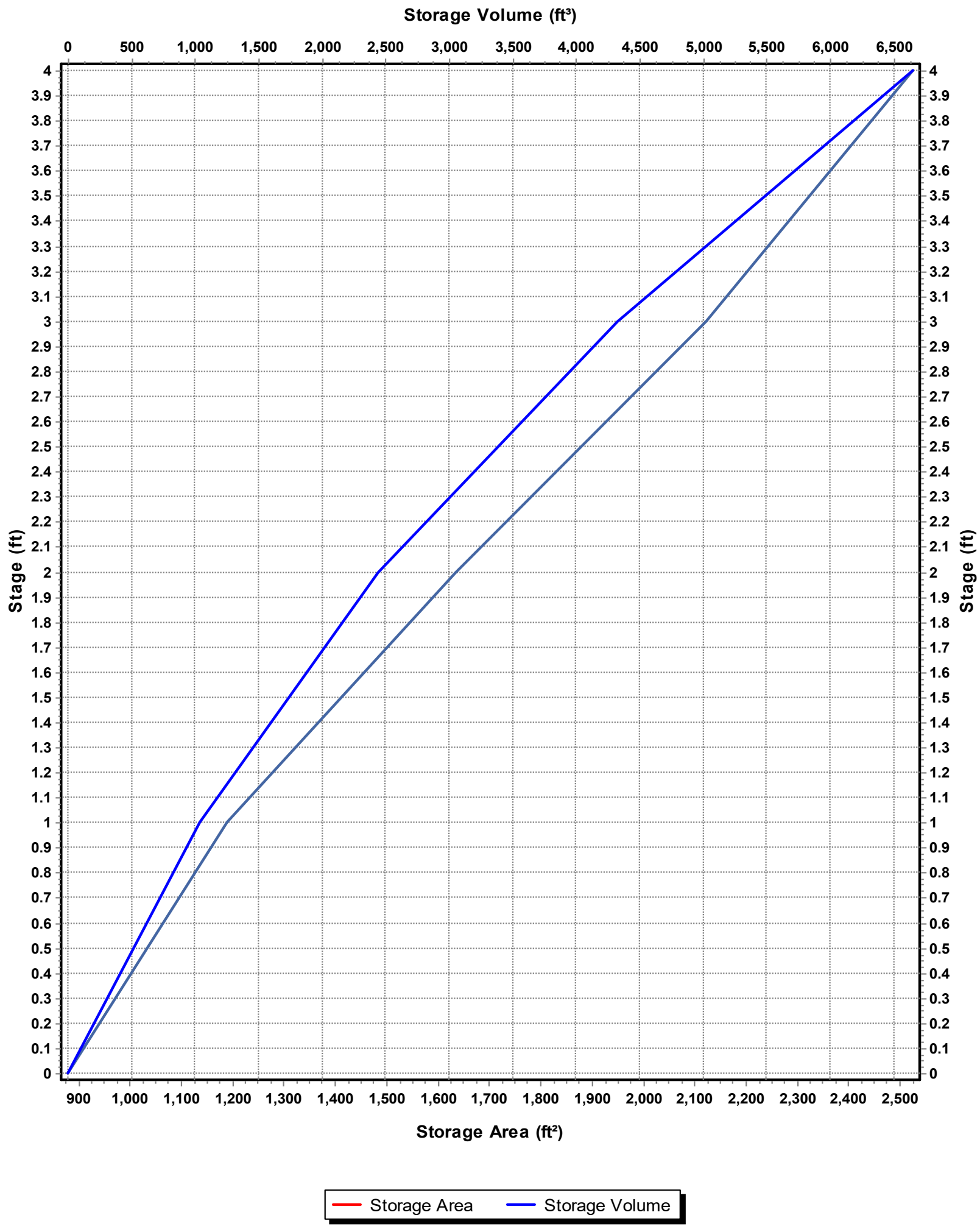
Invert Elevation (ft)	65.00
Max (Rim) Elevation (ft)	69.00
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	65.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

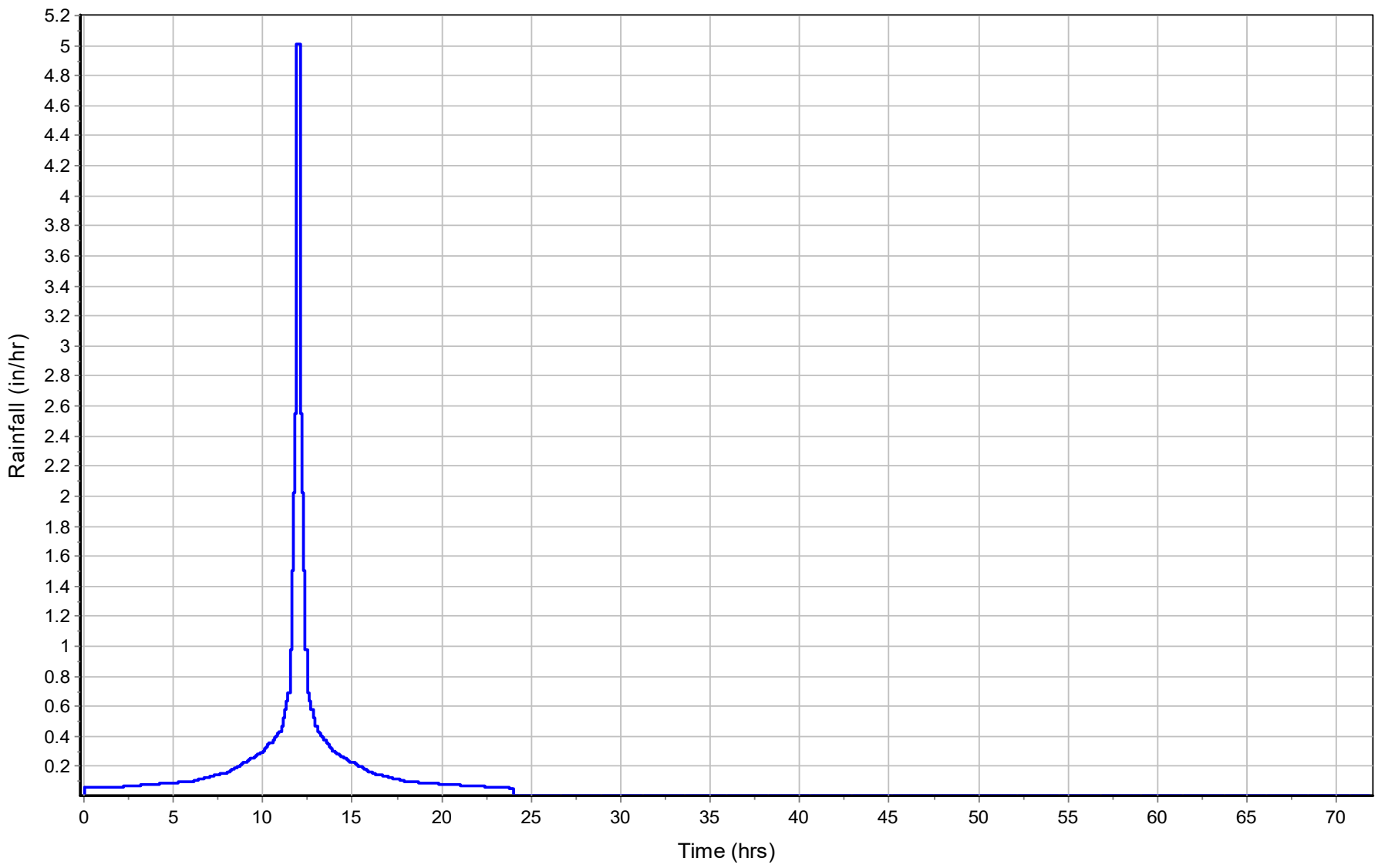
Total TOC (min) 4.58

Subbasin Runoff Results

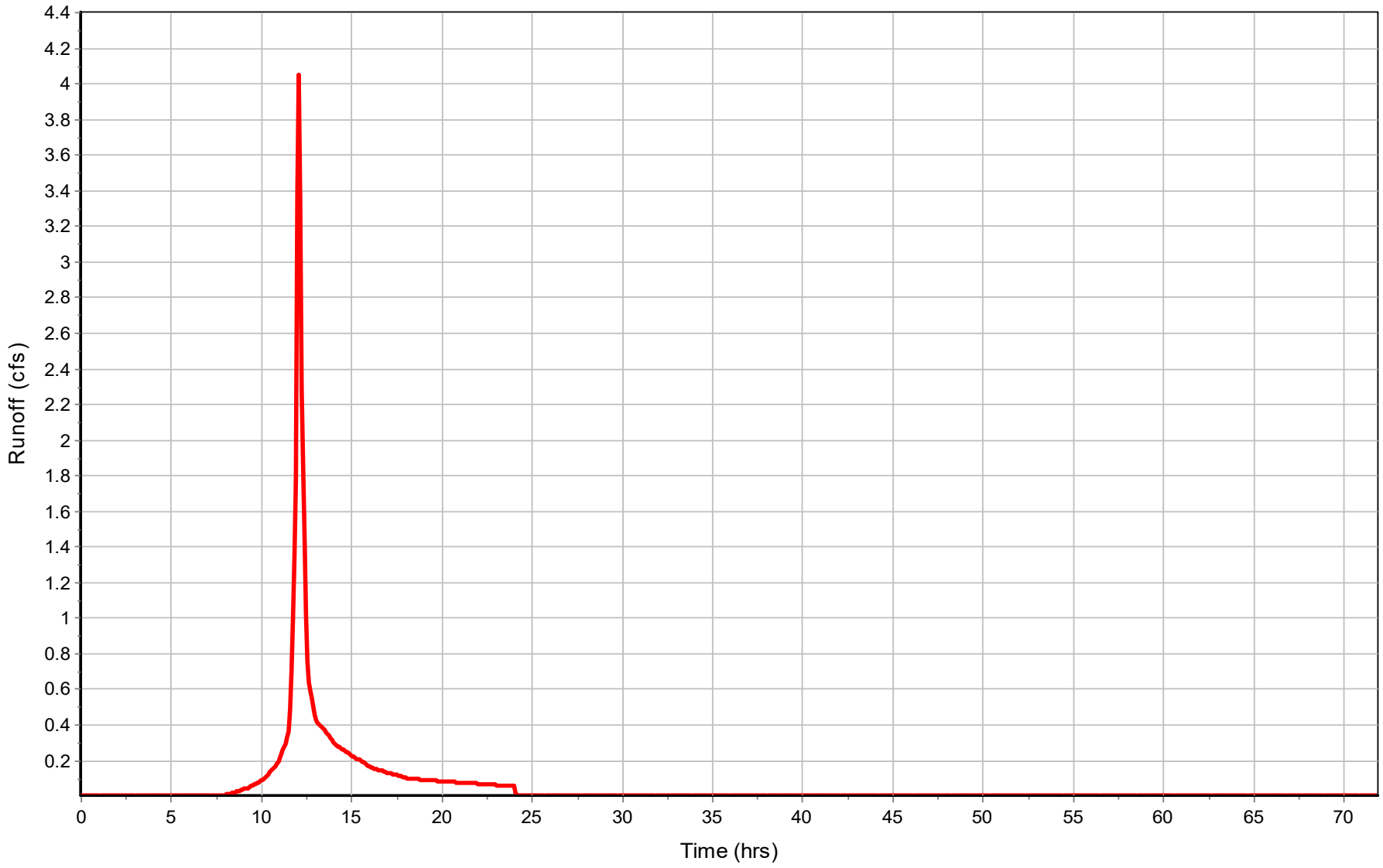
Total Rainfall (in) 5.96
Total Runoff (in) 3.35
Peak Runoff (cfs) 4.14
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:04:35

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

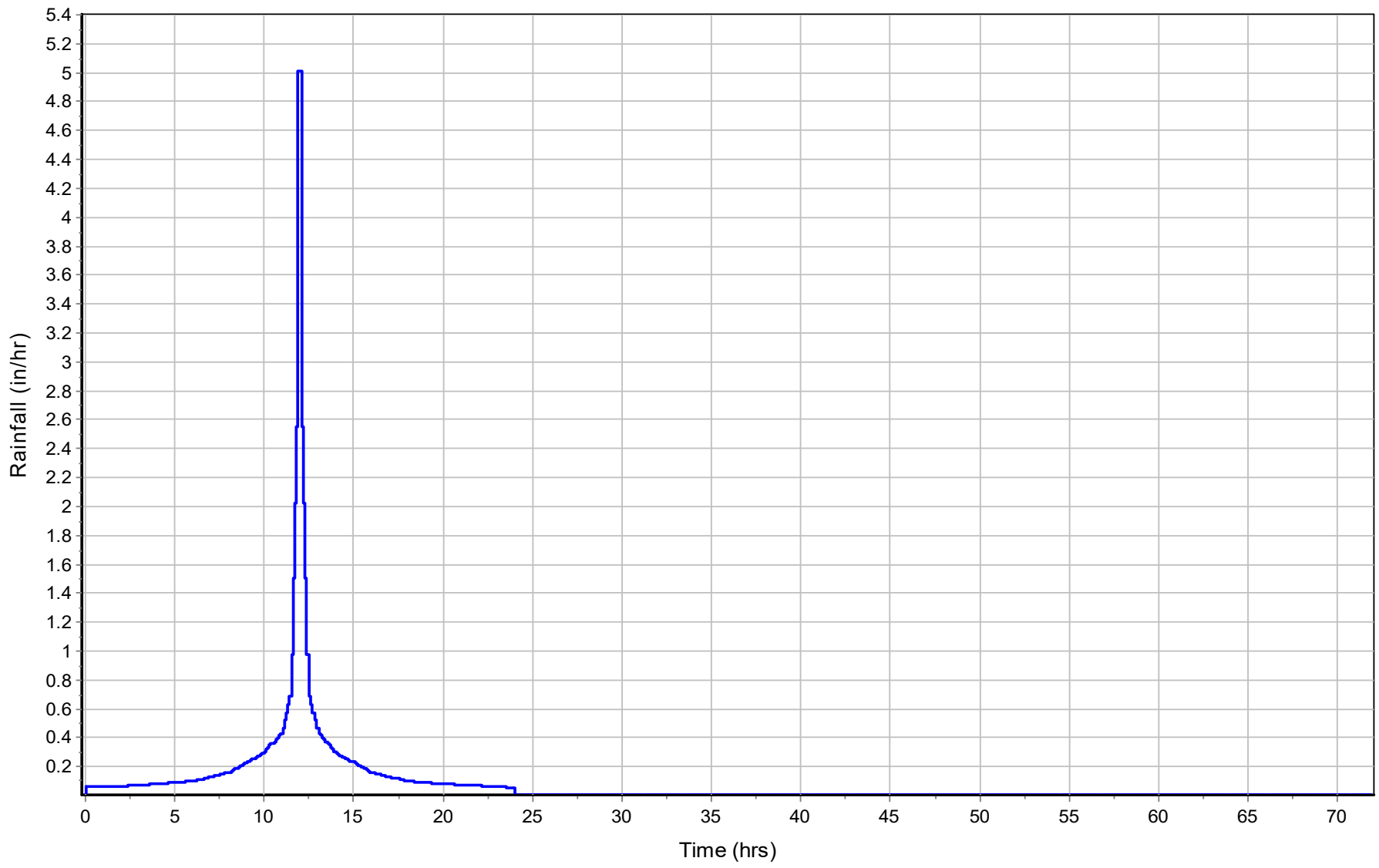
Total TOC (min) 10.92

Subbasin Runoff Results

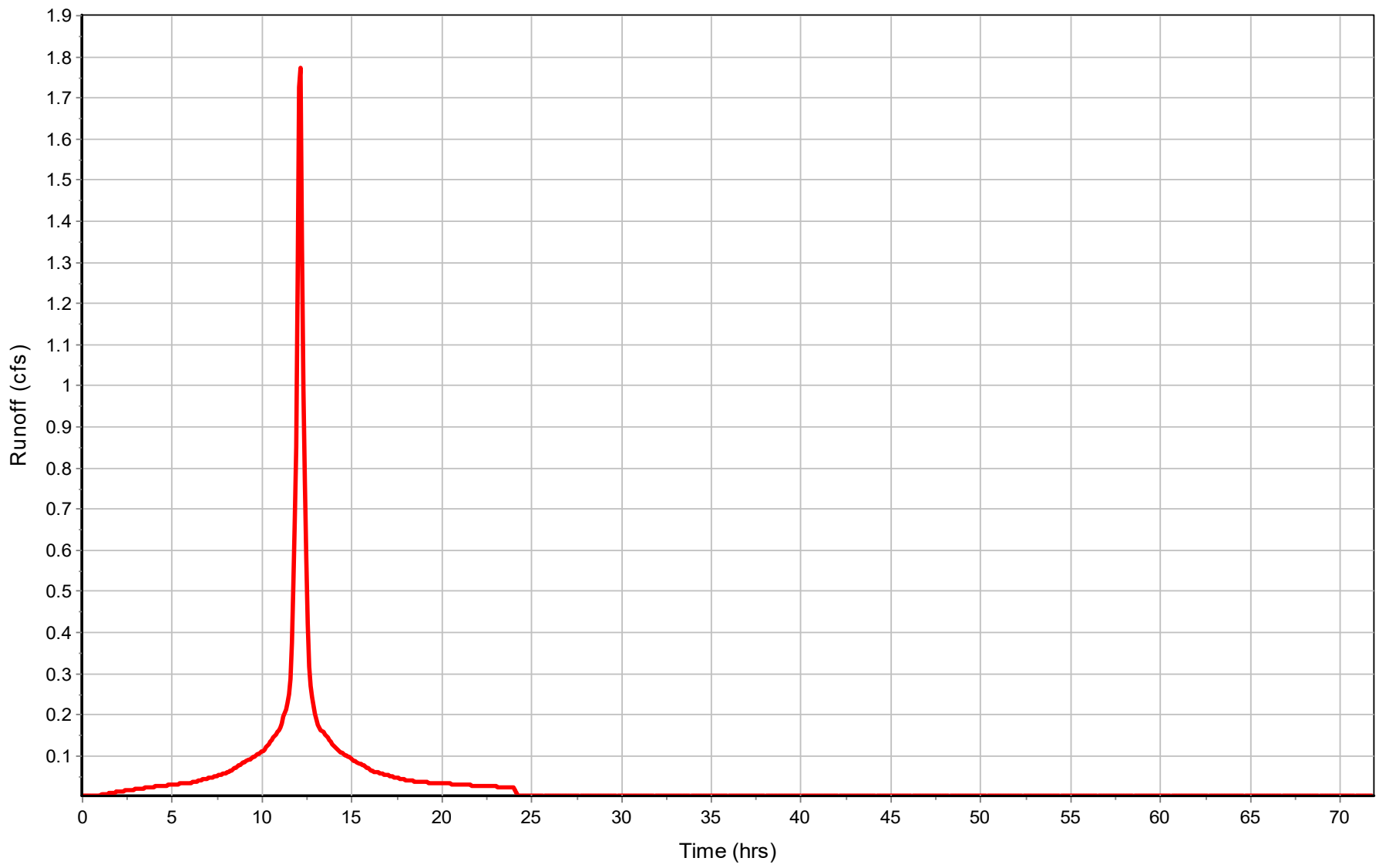
Total Rainfall (in) 5.96
Total Runoff (in) 5.72
Peak Runoff (cfs) 1.82
Weighted Curve Number 98
Time of Concentration (days hh:mm:ss) 0 00:10:55

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

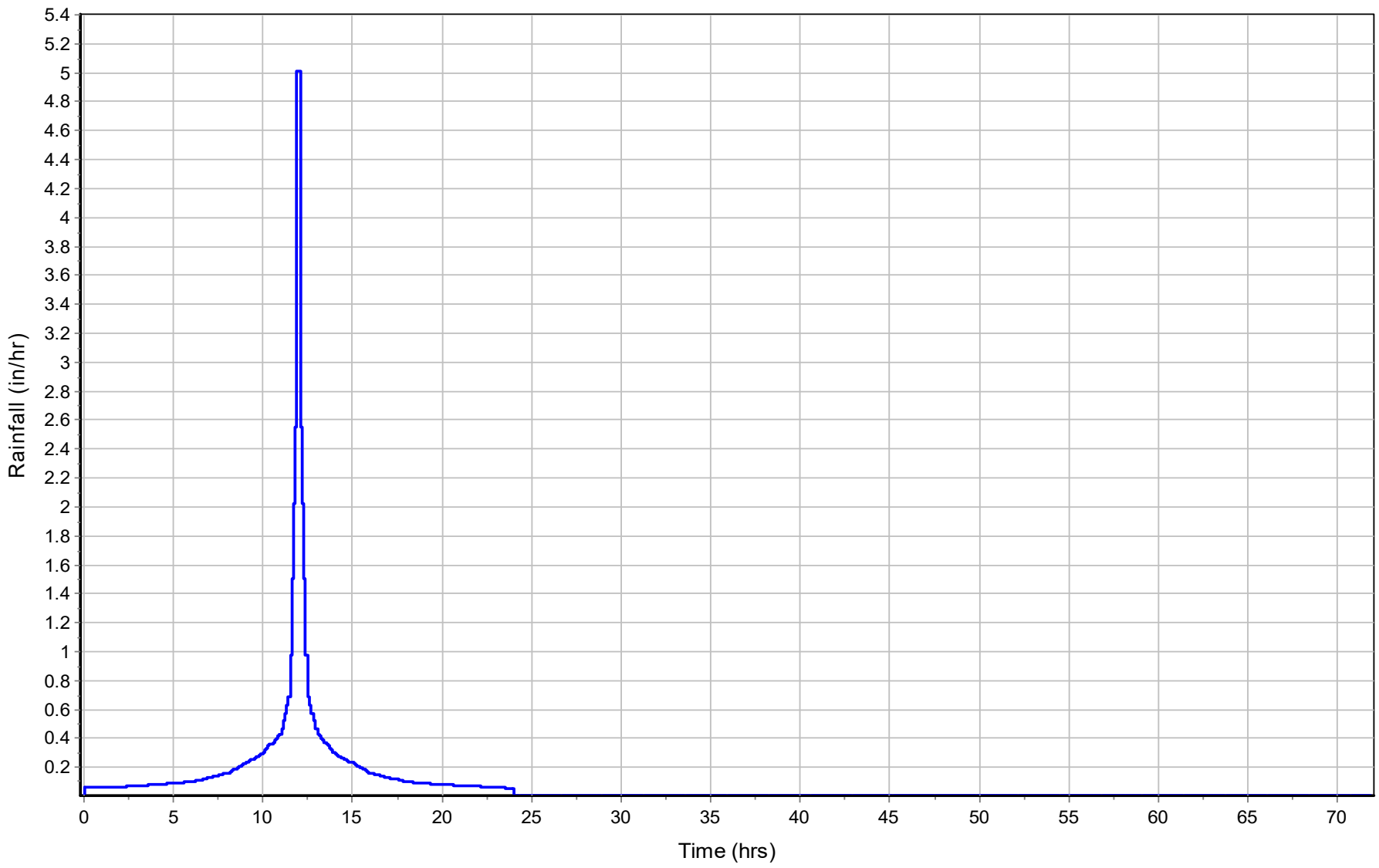
Total TOC (min) 3.41

Subbasin Runoff Results

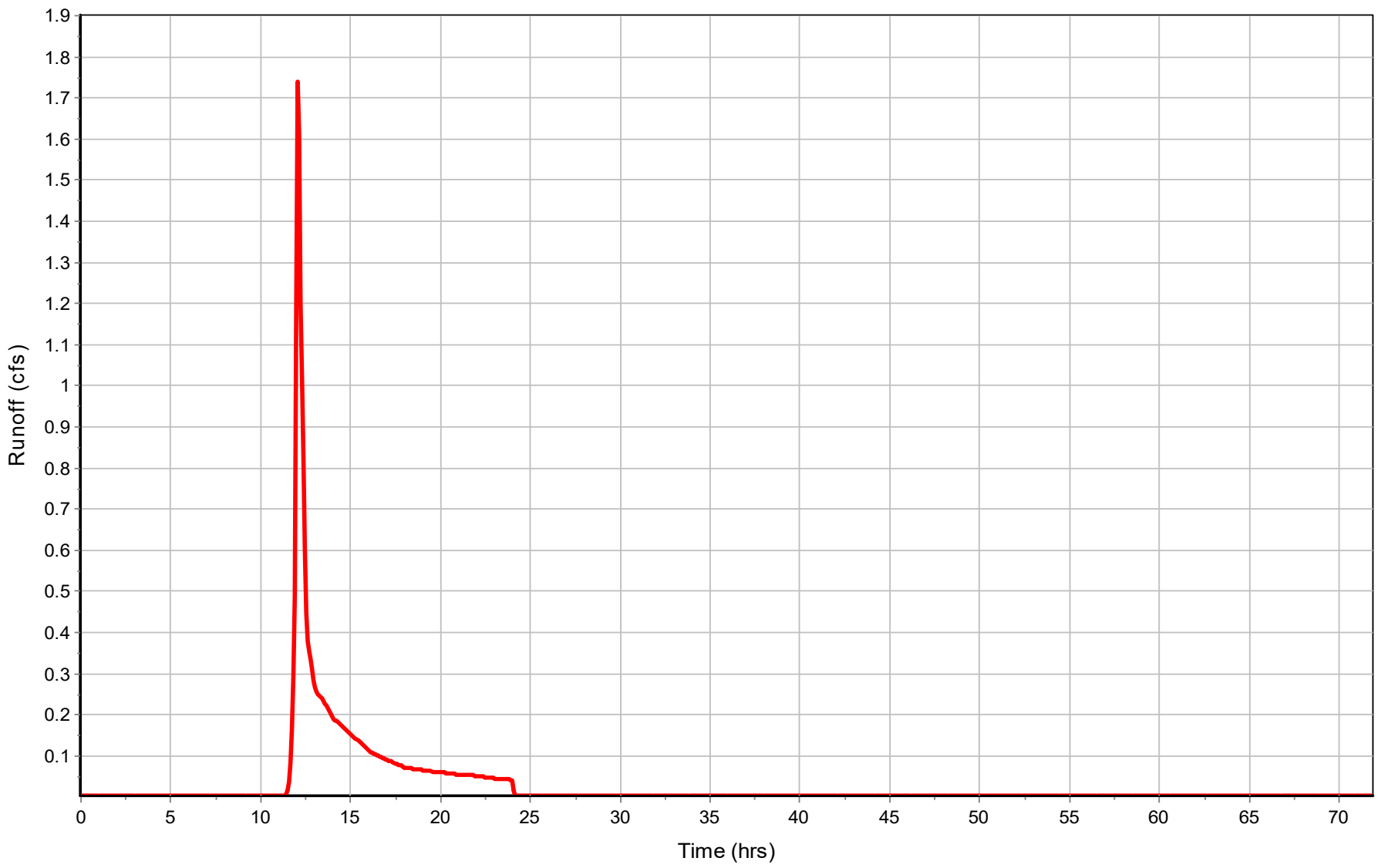
Total Rainfall (in) 5.96
Total Runoff (in) 1.47
Peak Runoff (cfs) 1.9
Weighted Curve Number 54.63
Time of Concentration (days hh:mm:ss) 0 00:03:25

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

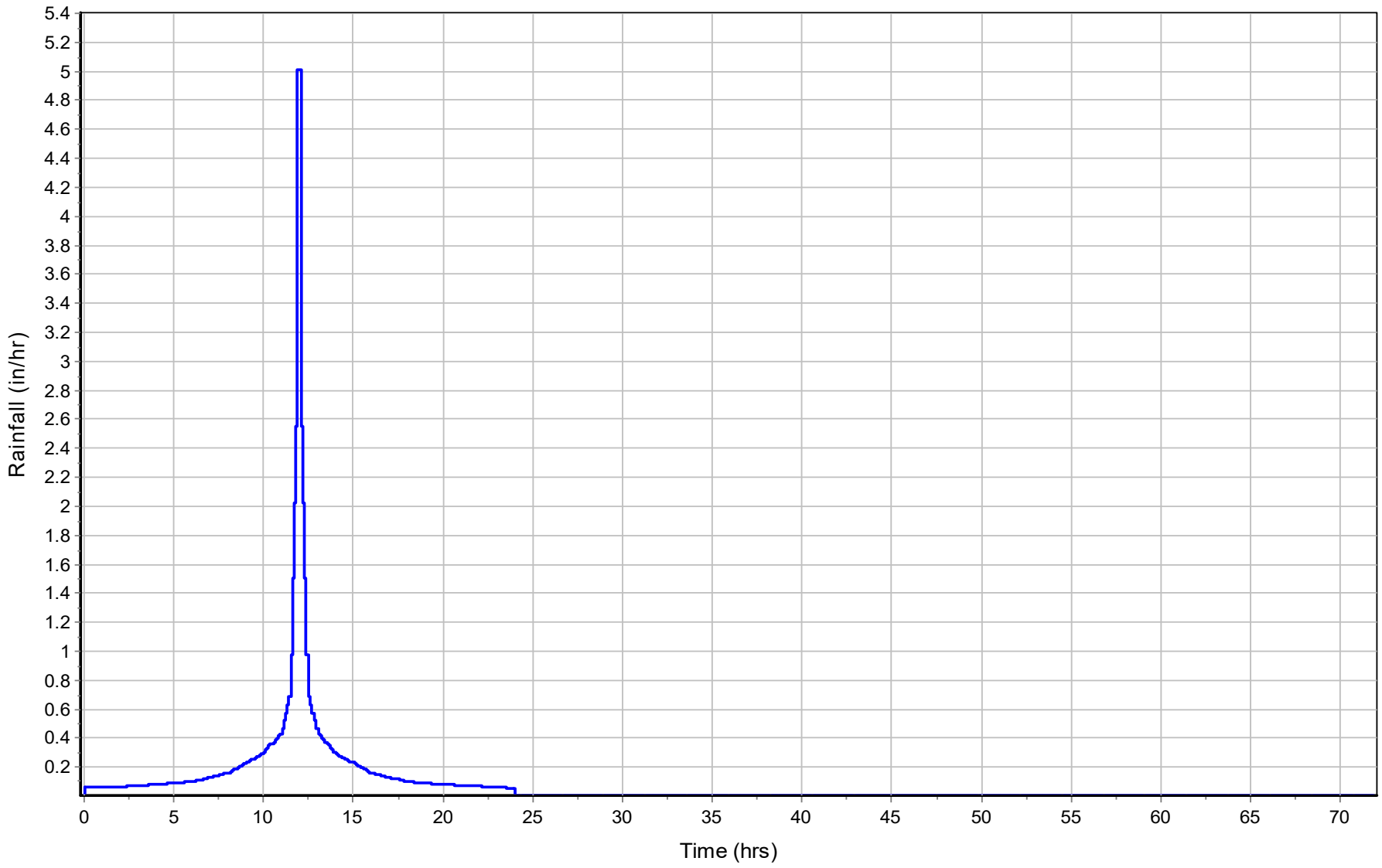
Total TOC (min) 40.27

Subbasin Runoff Results

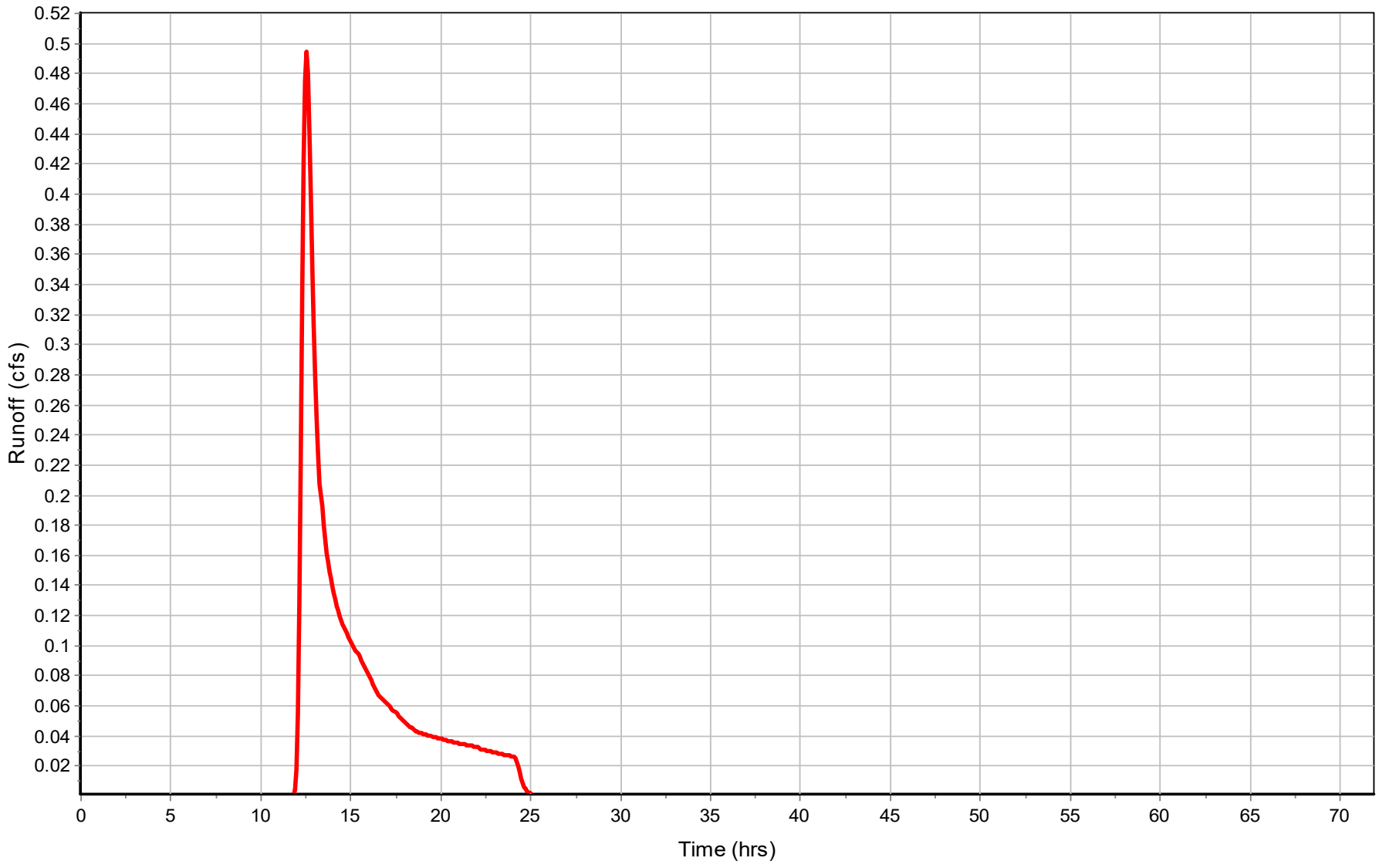
Total Rainfall (in) 5.96
Total Runoff (in) 1.05
Peak Runoff (cfs) 0.5
Weighted Curve Number 49
Time of Concentration (days hh:mm:ss) 0 00:40:16

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

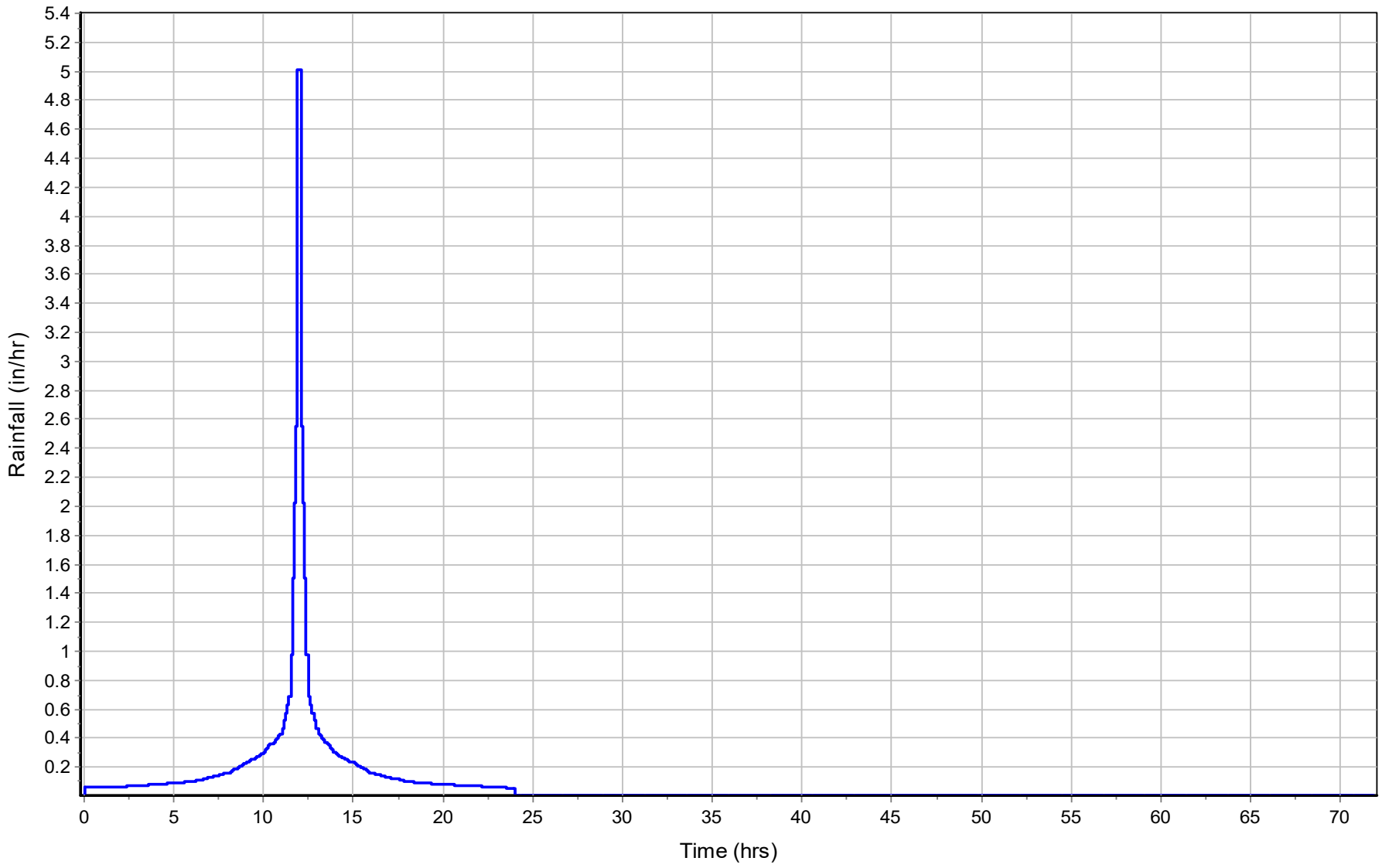
Total TOC (min) 3.51

Subbasin Runoff Results

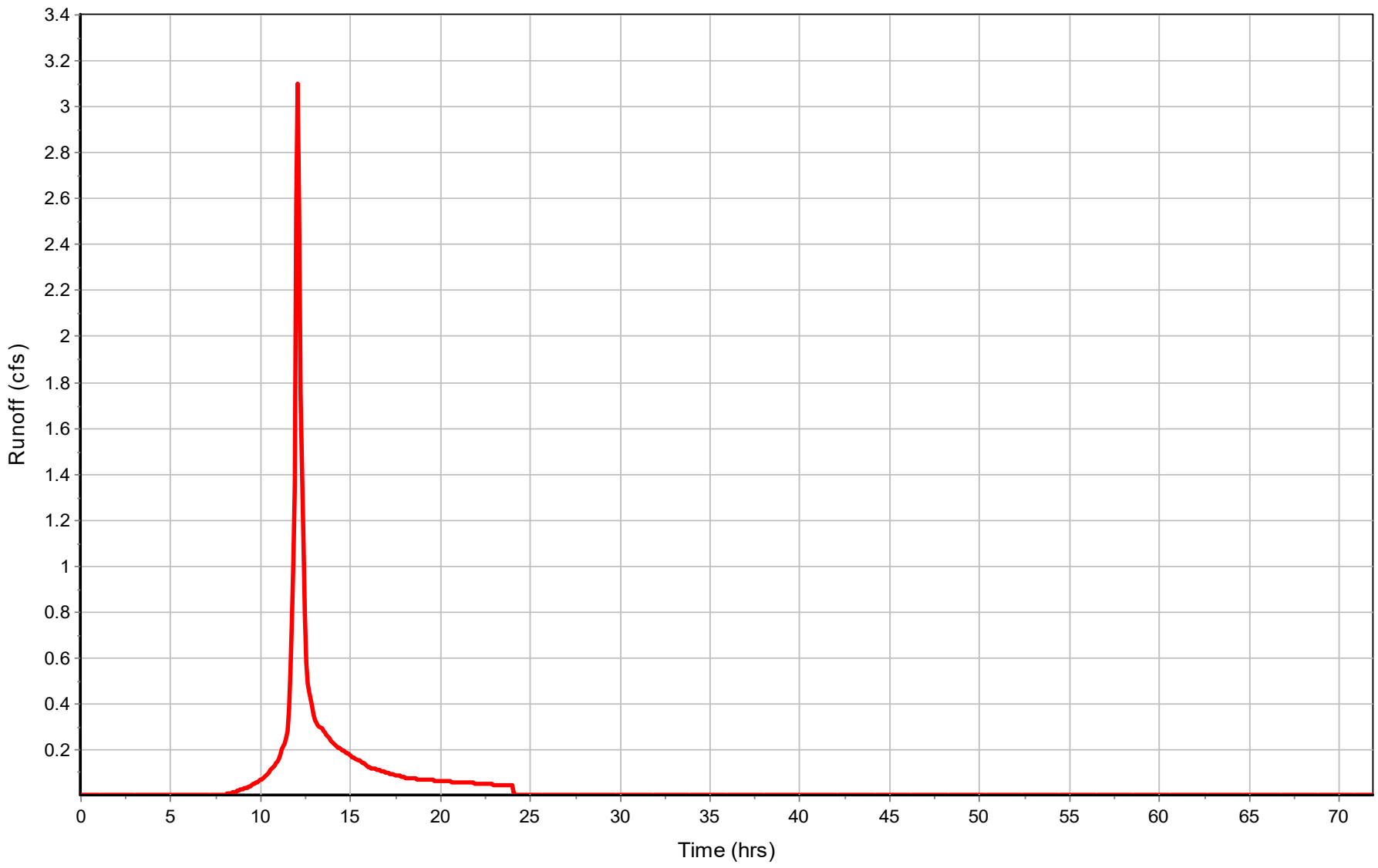
Total Rainfall (in) 5.96
Total Runoff (in) 3.35
Peak Runoff (cfs) 3.17
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:03:31

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

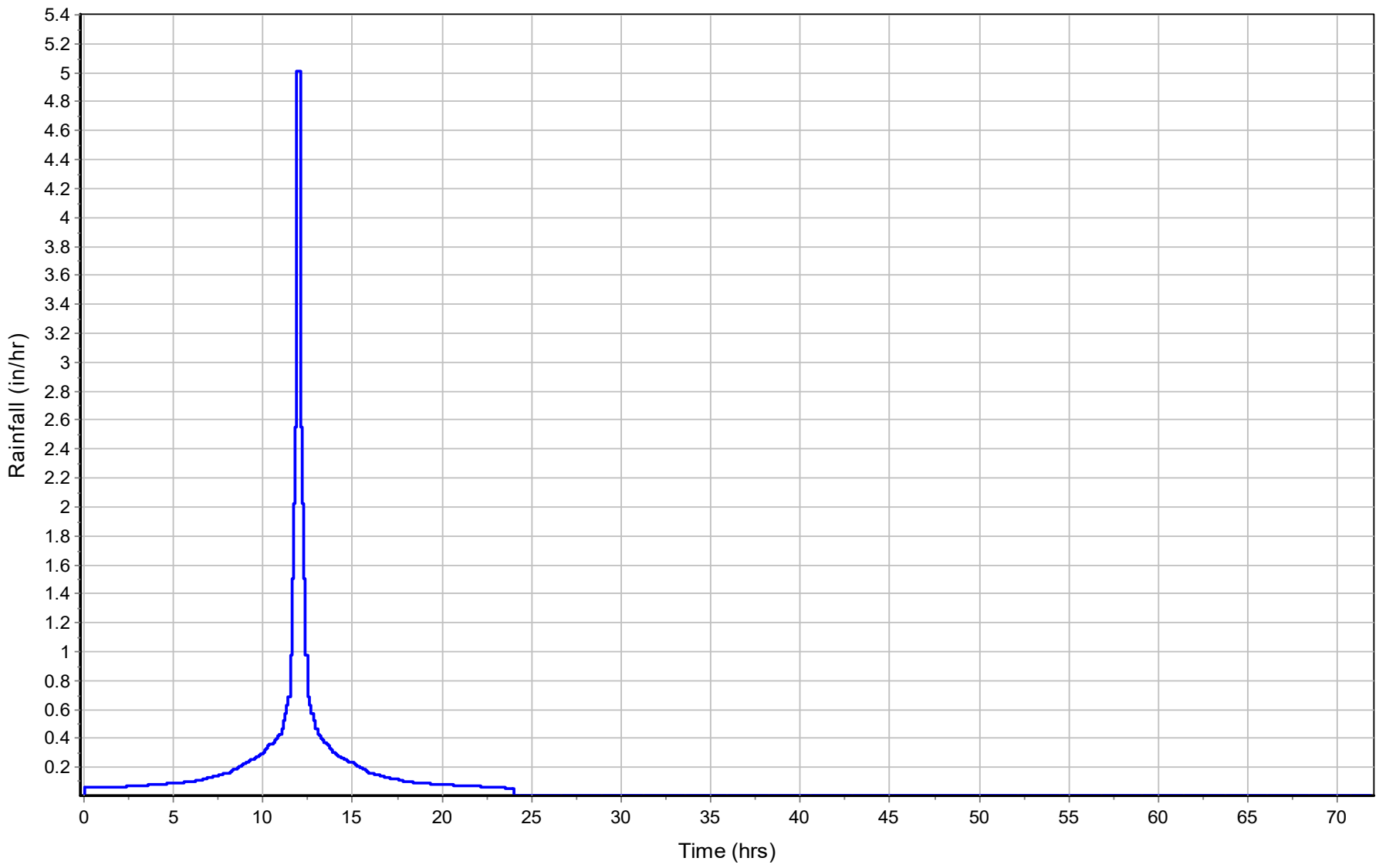
Total TOC (min) 36.12

Subbasin Runoff Results

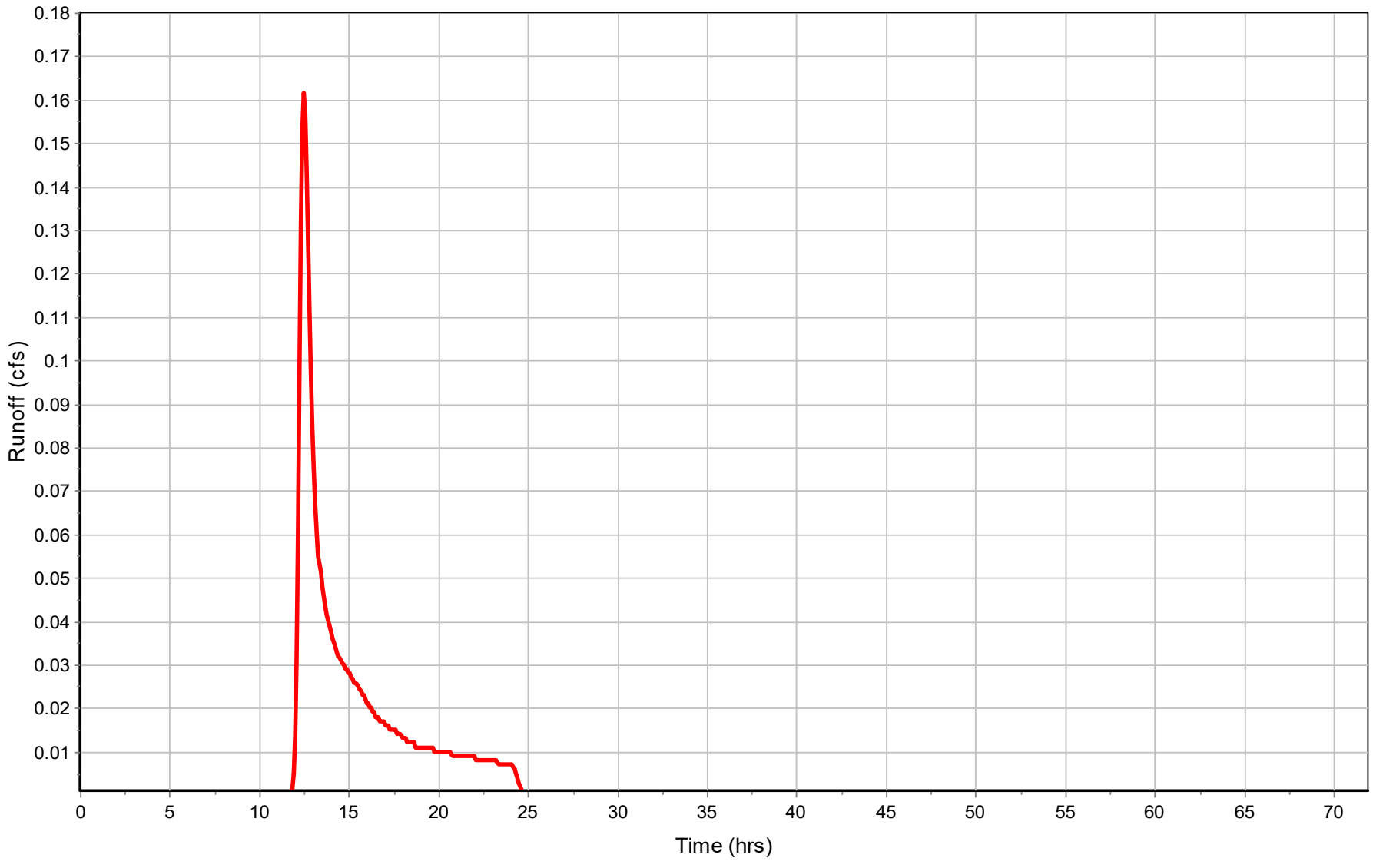
Total Rainfall (in)	5.96
Total Runoff (in)	1.25
Peak Runoff (cfs)	0.16
Weighted Curve Number	51.7
Time of Concentration (days hh:mm:ss)	0 00:36:07

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

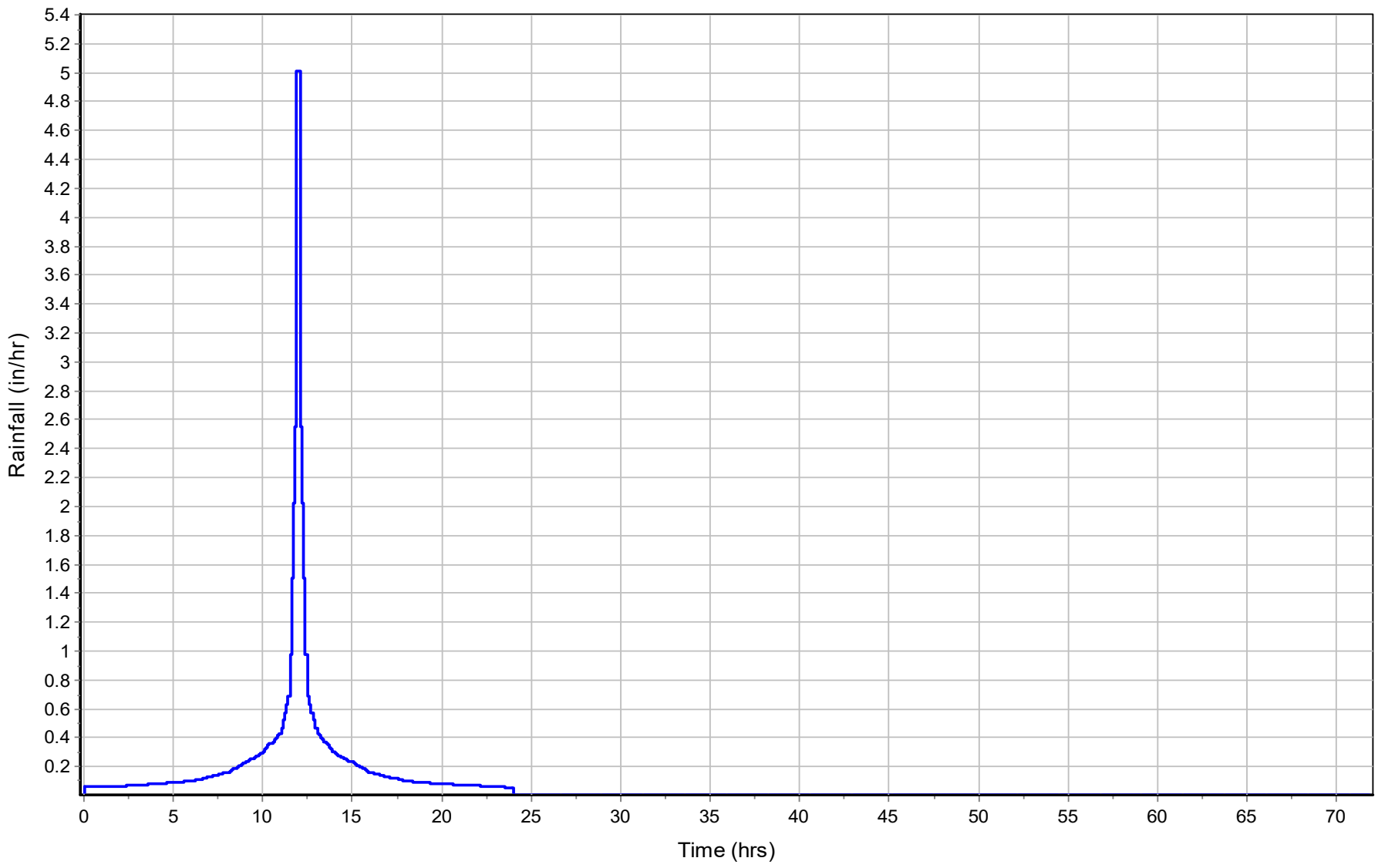
Total TOC (min) 3.14

Subbasin Runoff Results

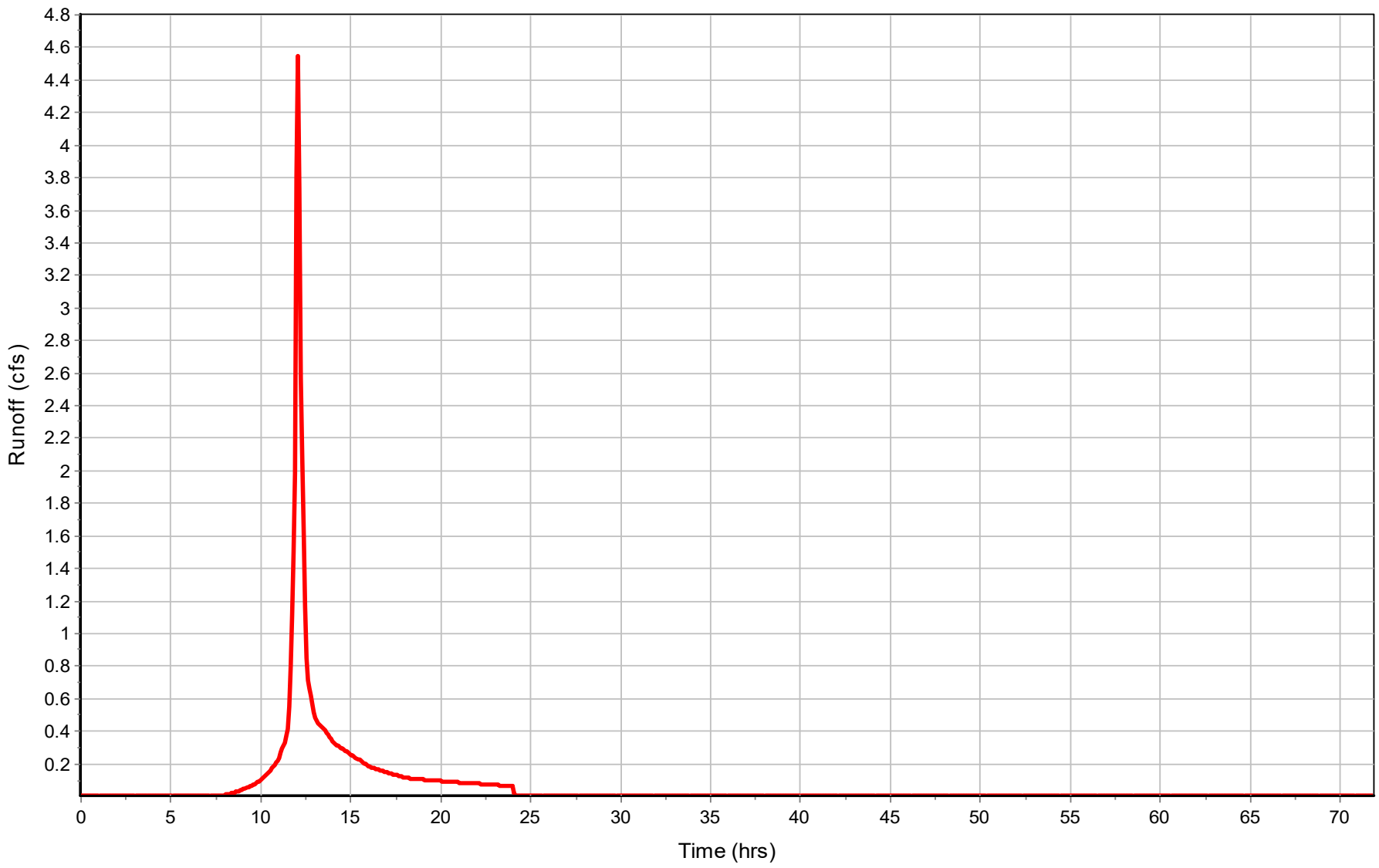
Total Rainfall (in) 5.96
Total Runoff (in) 3.35
Peak Runoff (cfs) 4.65
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:03:08

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

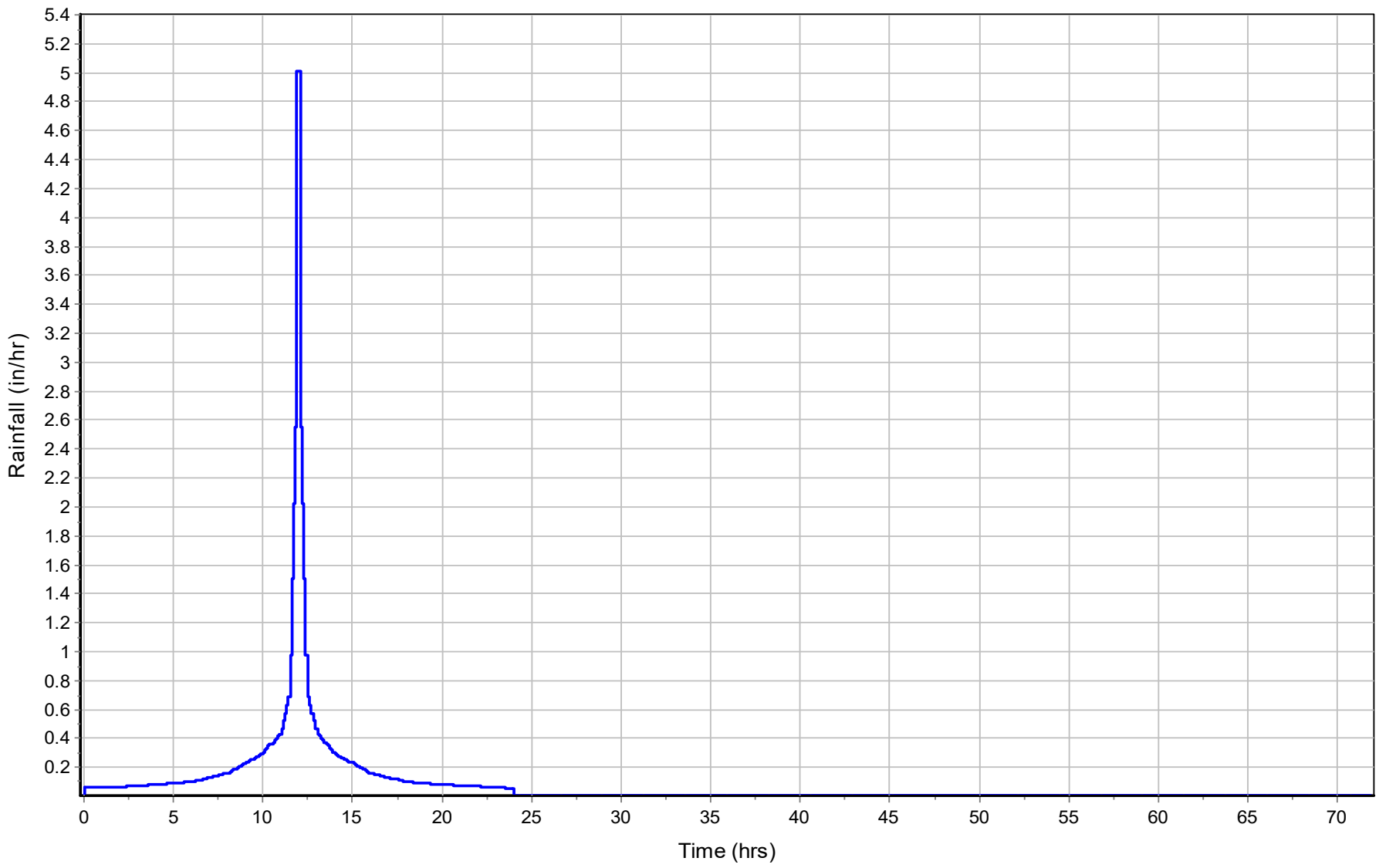
Total TOC (min) 2.17

Subbasin Runoff Results

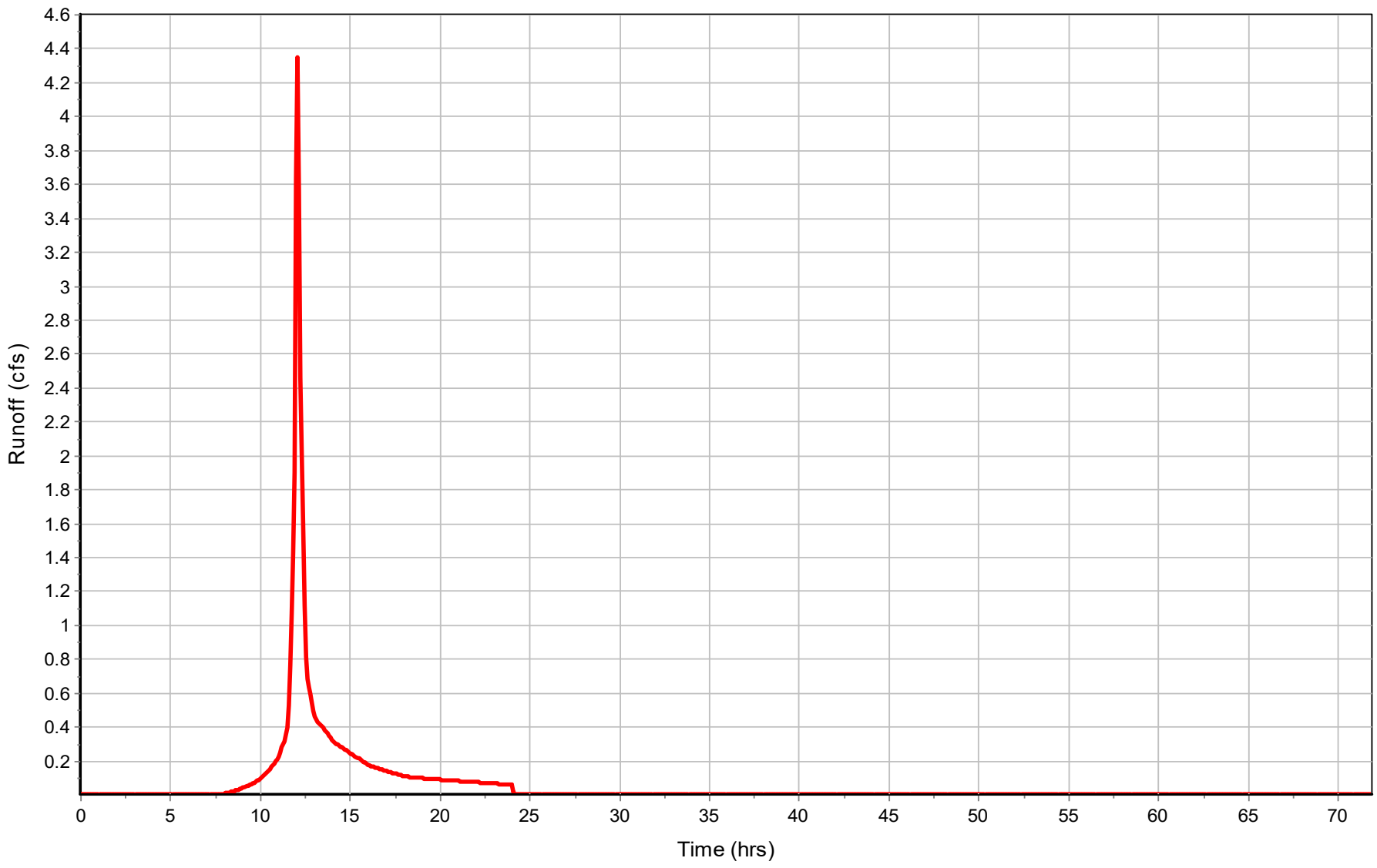
Total Rainfall (in) 5.96
Total Runoff (in) 3.35
Peak Runoff (cfs) 4.45
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:02:10

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

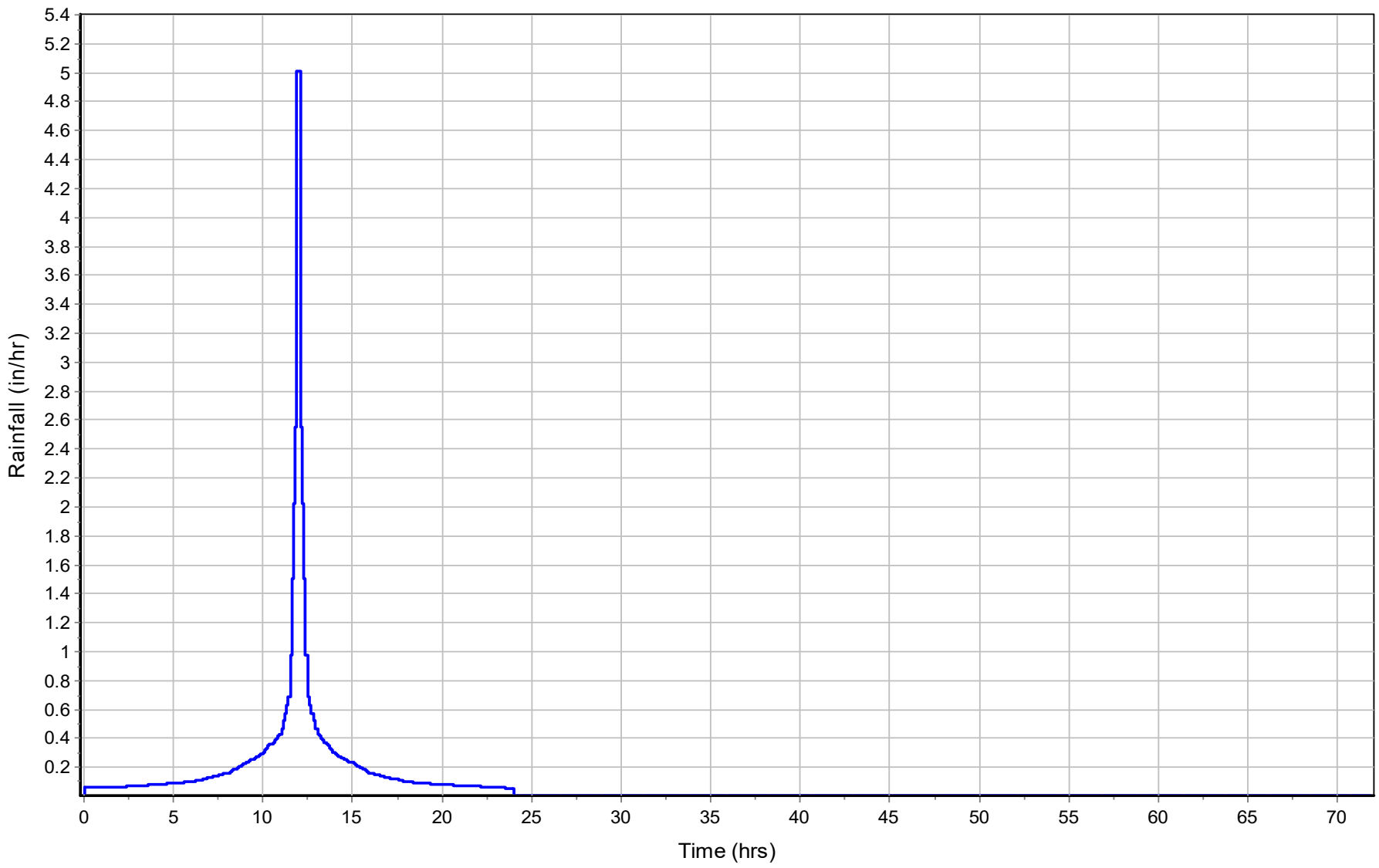
Total TOC (min) 4.13

Subbasin Runoff Results

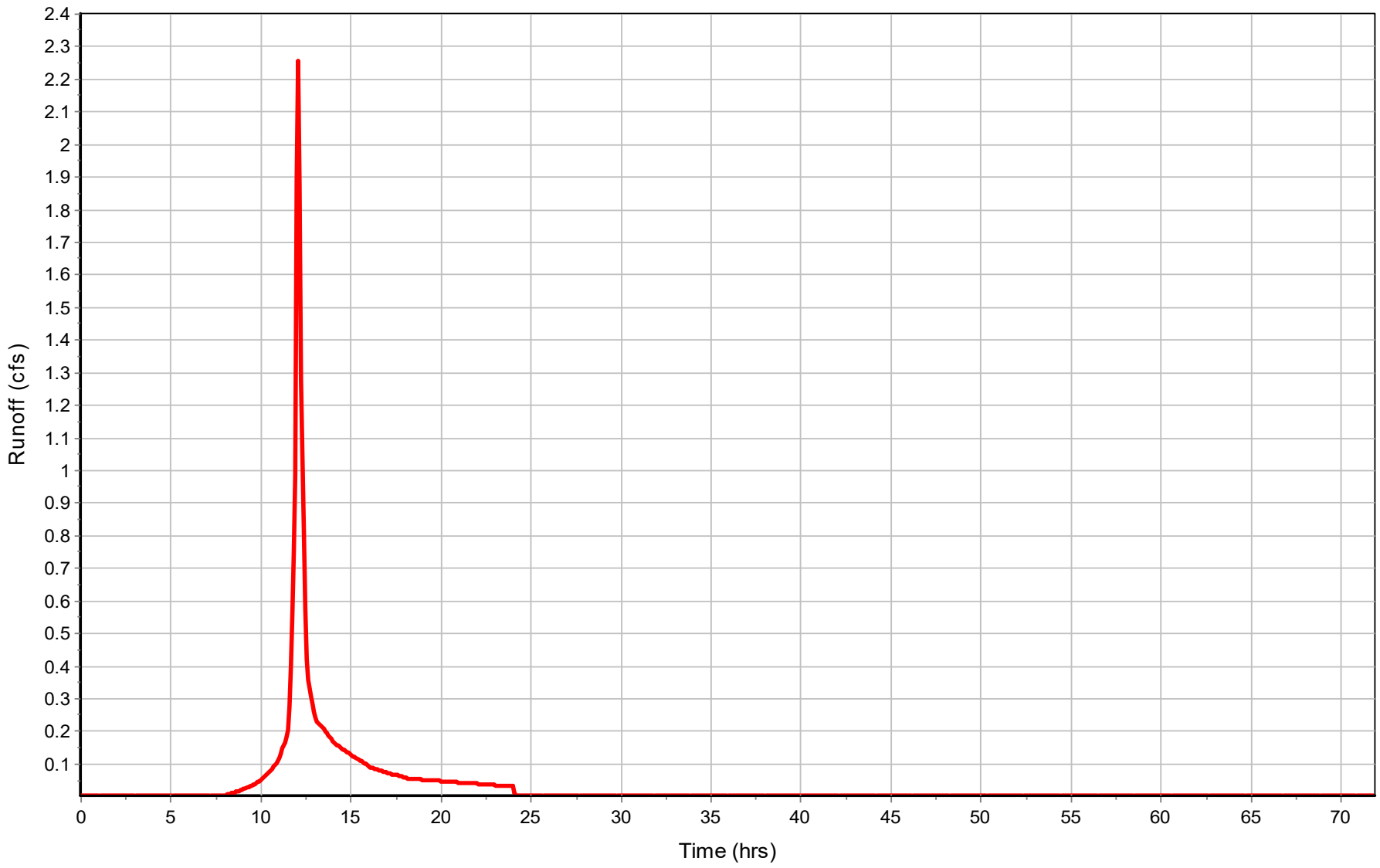
Total Rainfall (in)	5.96
Total Runoff (in)	3.35
Peak Runoff (cfs)	2.31
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:04:08

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

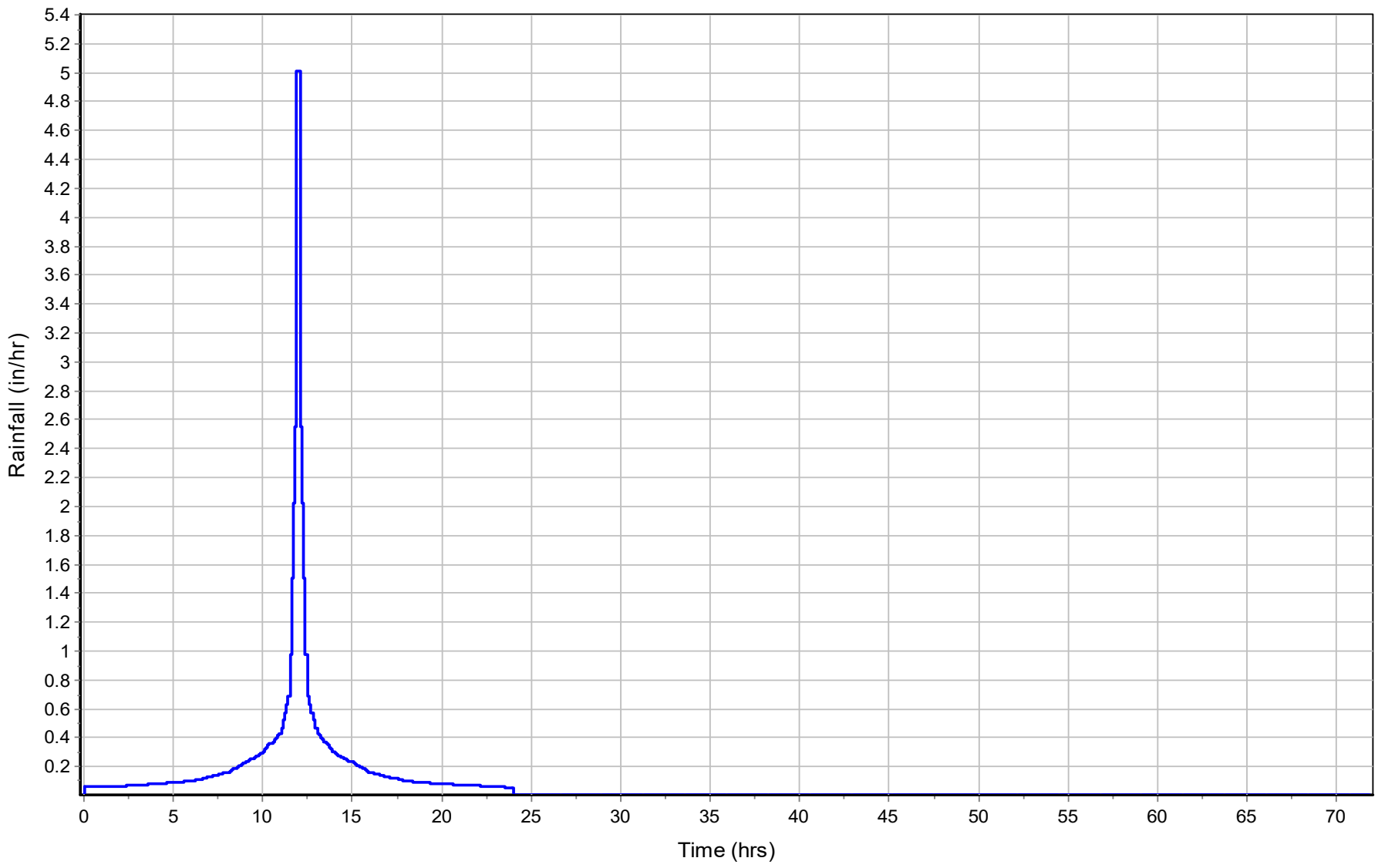
Total TOC (min) 34.83

Subbasin Runoff Results

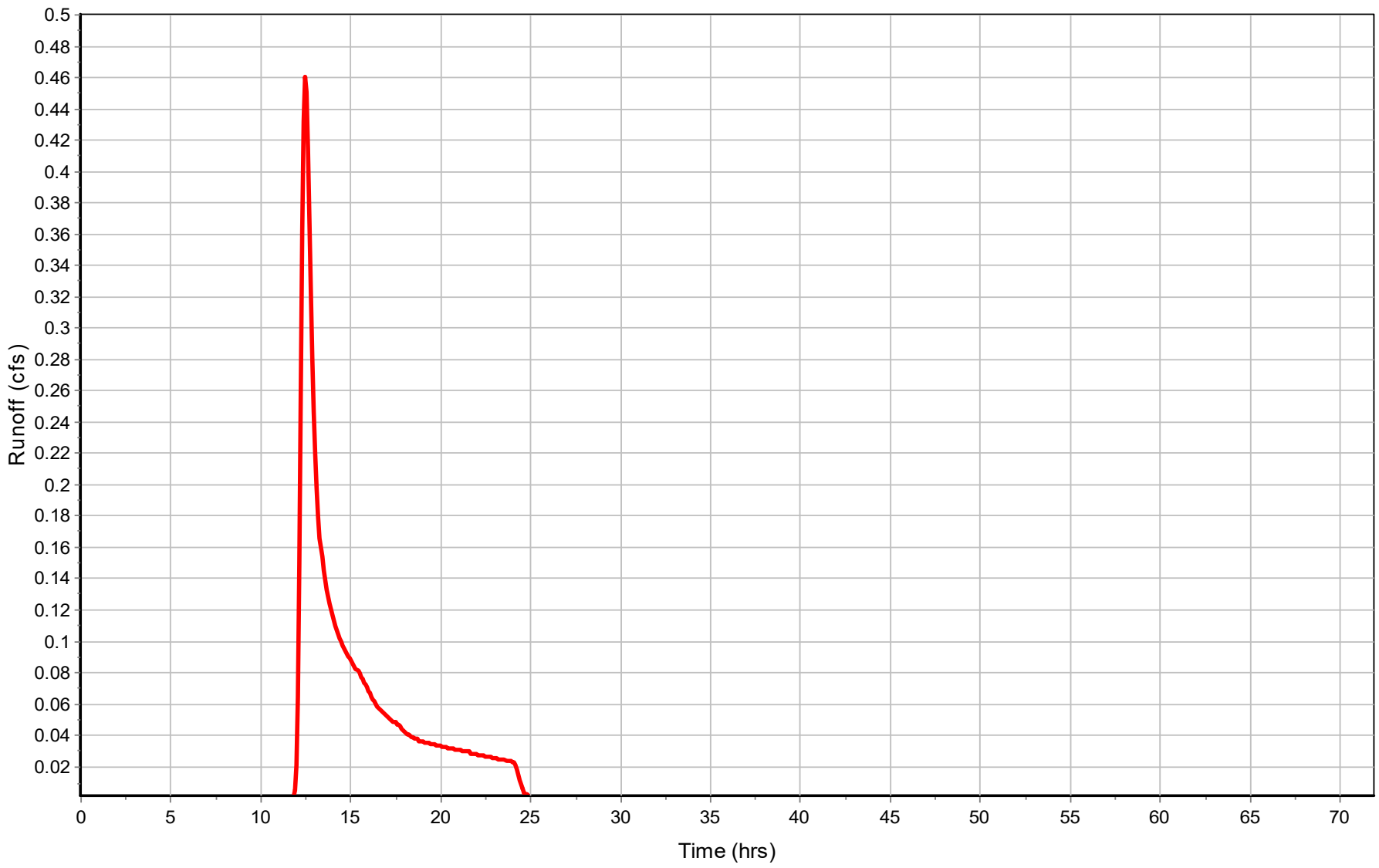
Total Rainfall (in)	5.96
Total Runoff (in)	1.05
Peak Runoff (cfs)	0.46
Weighted Curve Number	49
Time of Concentration (days hh:mm:ss)	0 00:34:50

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

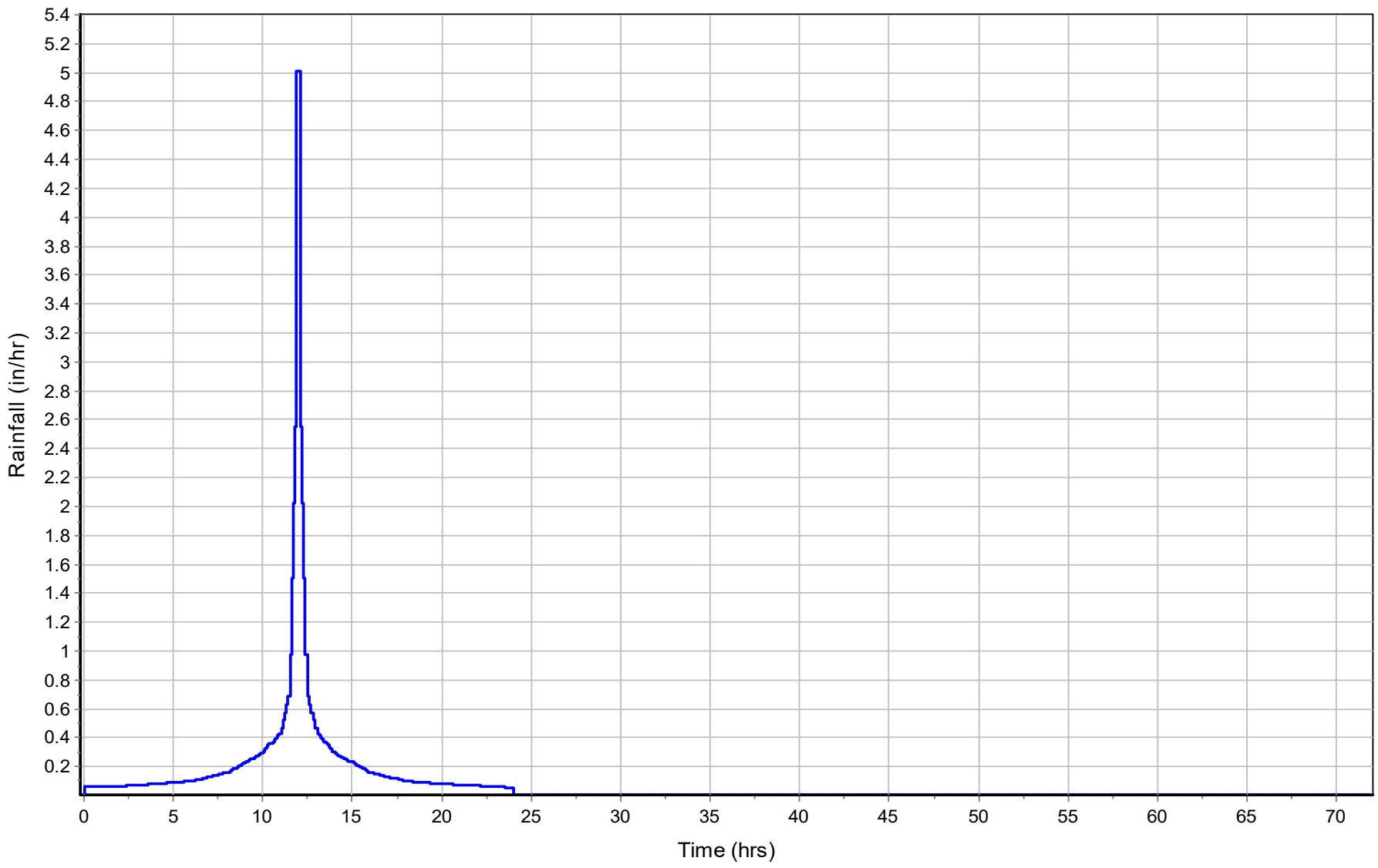
Total TOC (min) 36.49

Subbasin Runoff Results

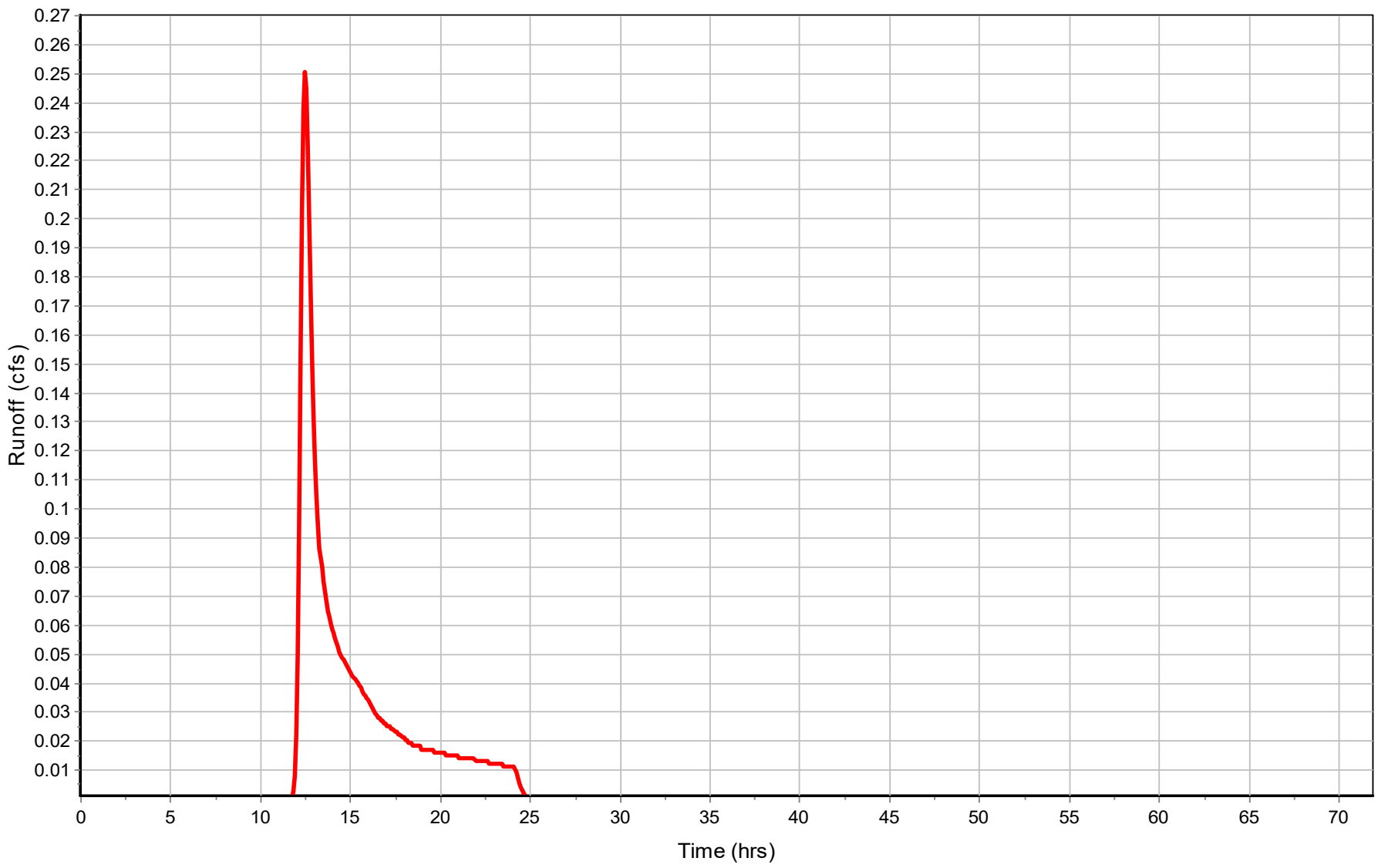
Total Rainfall (in)	5.96
Total Runoff (in)	1.25
Peak Runoff (cfs)	0.25
Weighted Curve Number	51.7
Time of Concentration (days hh:mm:ss)	0 00:36:29

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

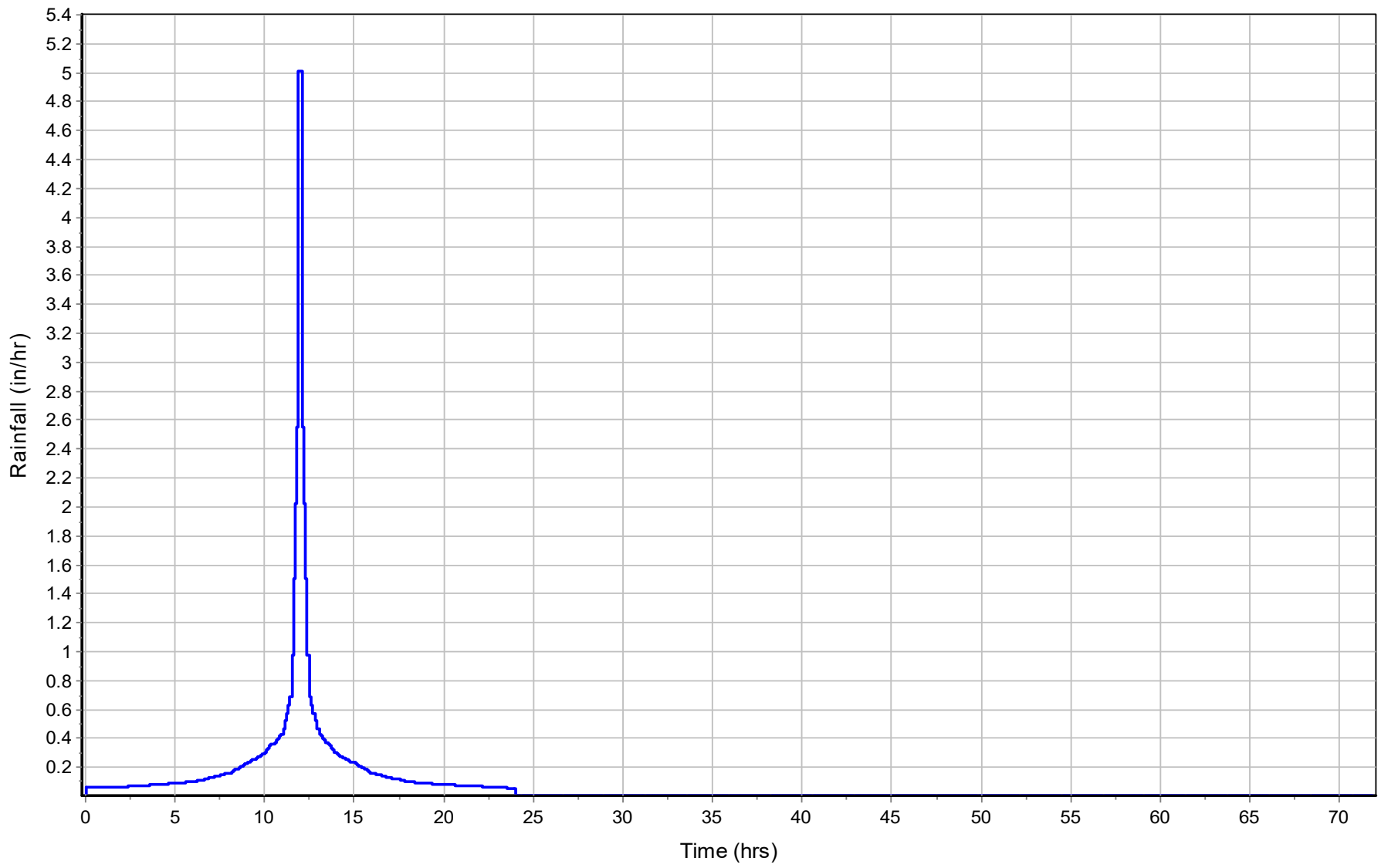
Total TOC (min) 42.87

Subbasin Runoff Results

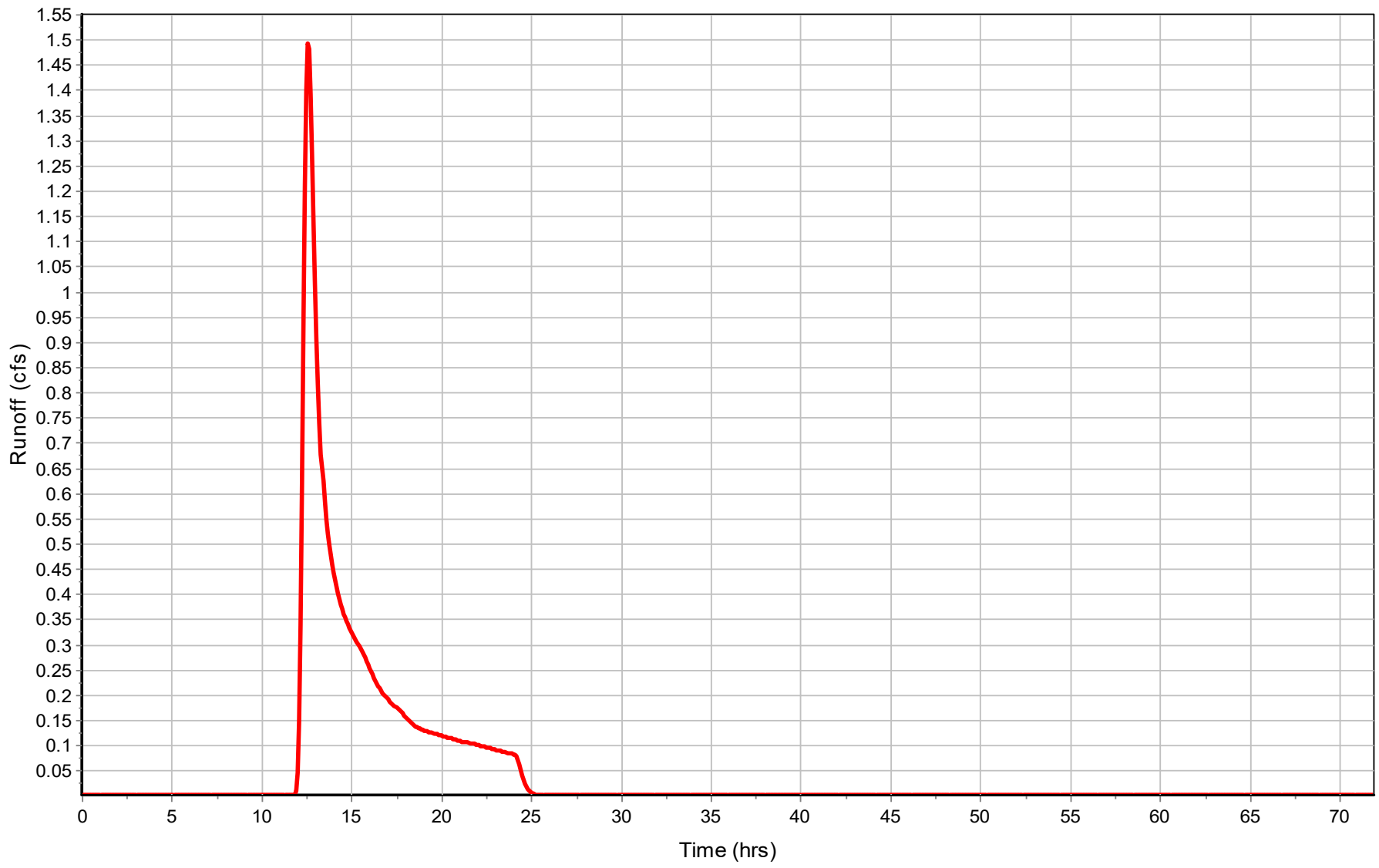
Total Rainfall (in)	5.96
Total Runoff (in)	1.05
Peak Runoff (cfs)	1.5
Weighted Curve Number	49
Time of Concentration (days hh:mm:ss)	0 00:42:52

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

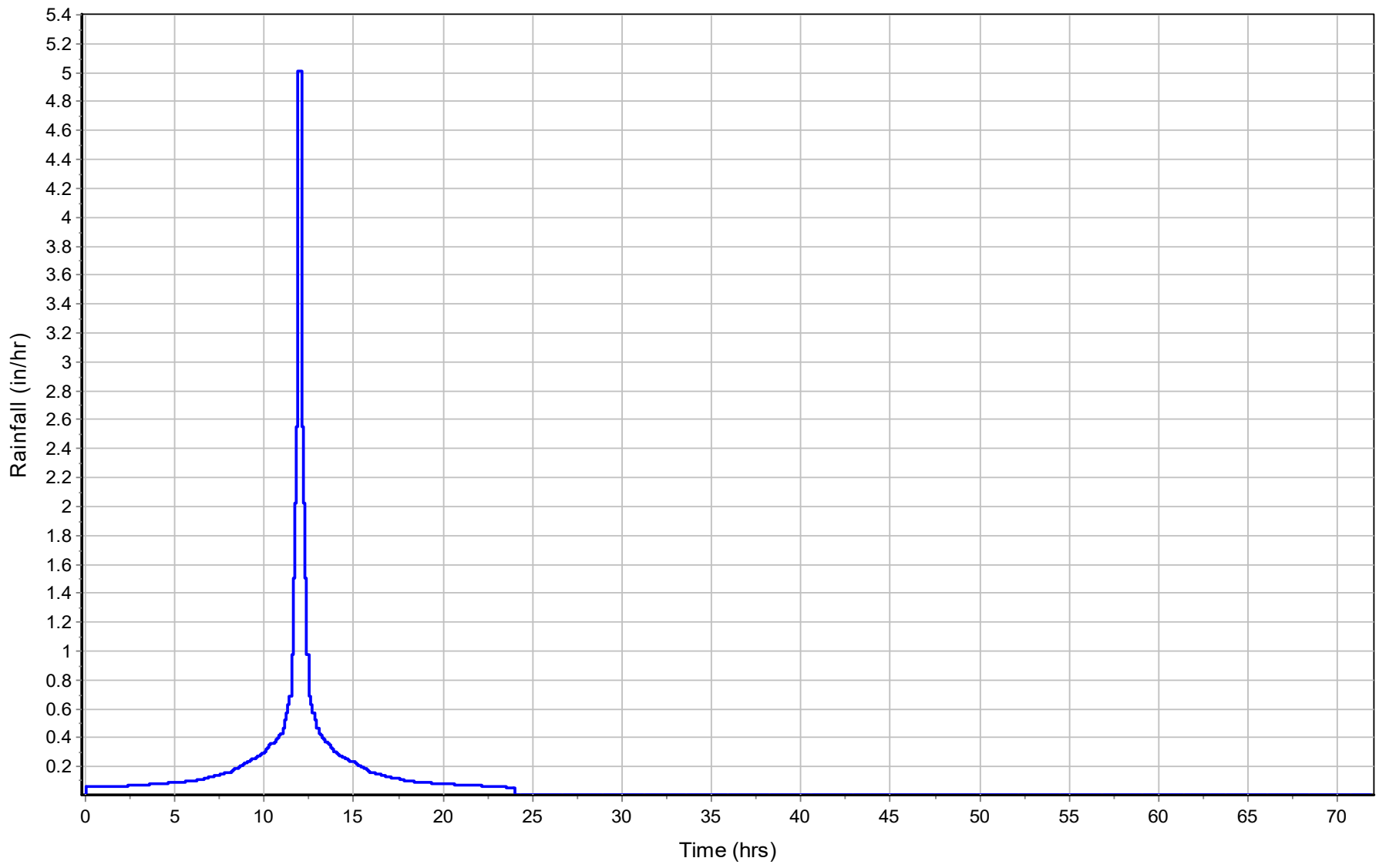
Total TOC (min) 14.50

Subbasin Runoff Results

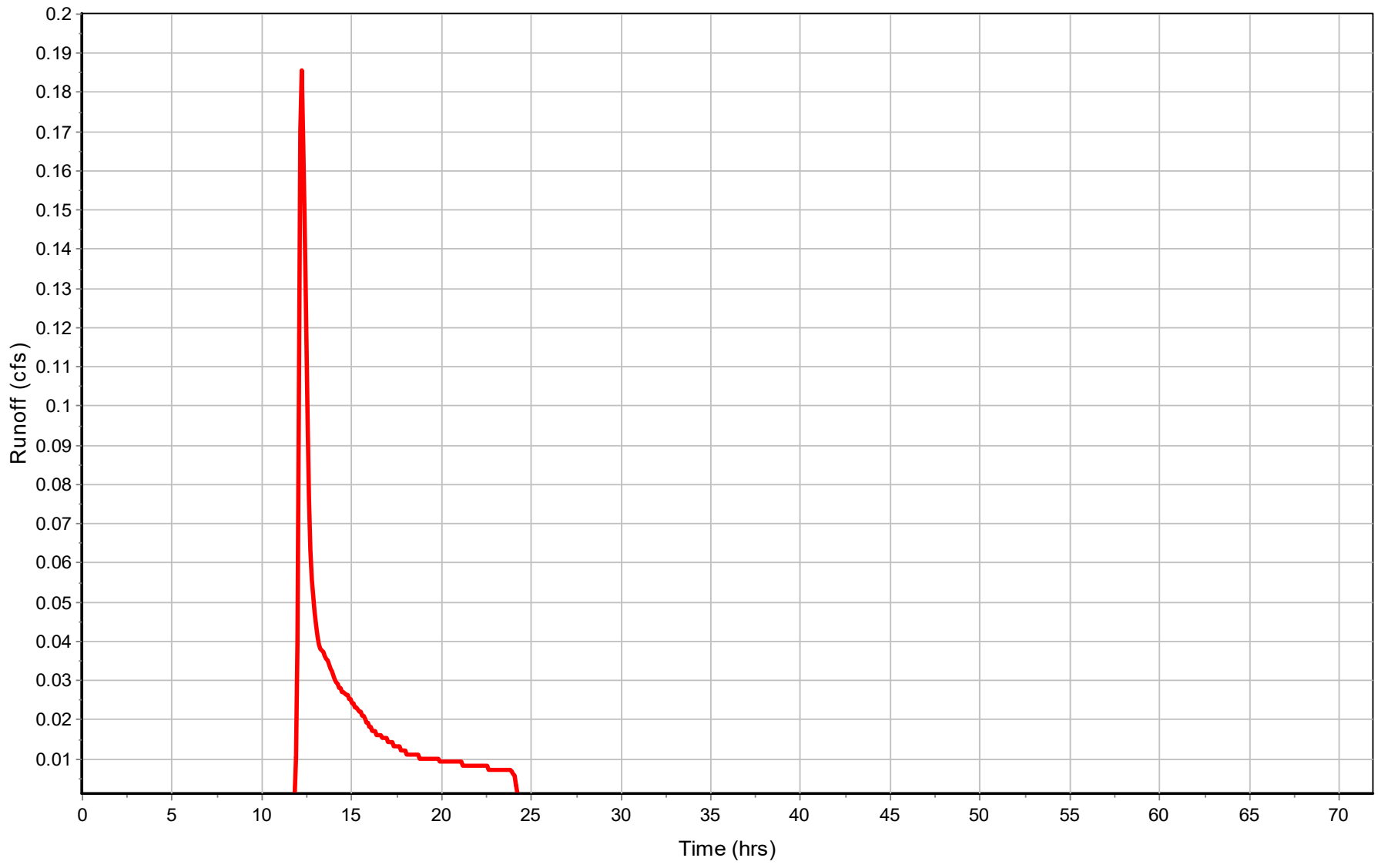
Total Rainfall (in)	5.96
Total Runoff (in)	1.05
Peak Runoff (cfs)	0.19
Weighted Curve Number	49
Time of Concentration (days hh:mm:ss)	0 00:14:30

Subbasin : Existing-E5.1_A2

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : A1-1-BASIN

Input Data

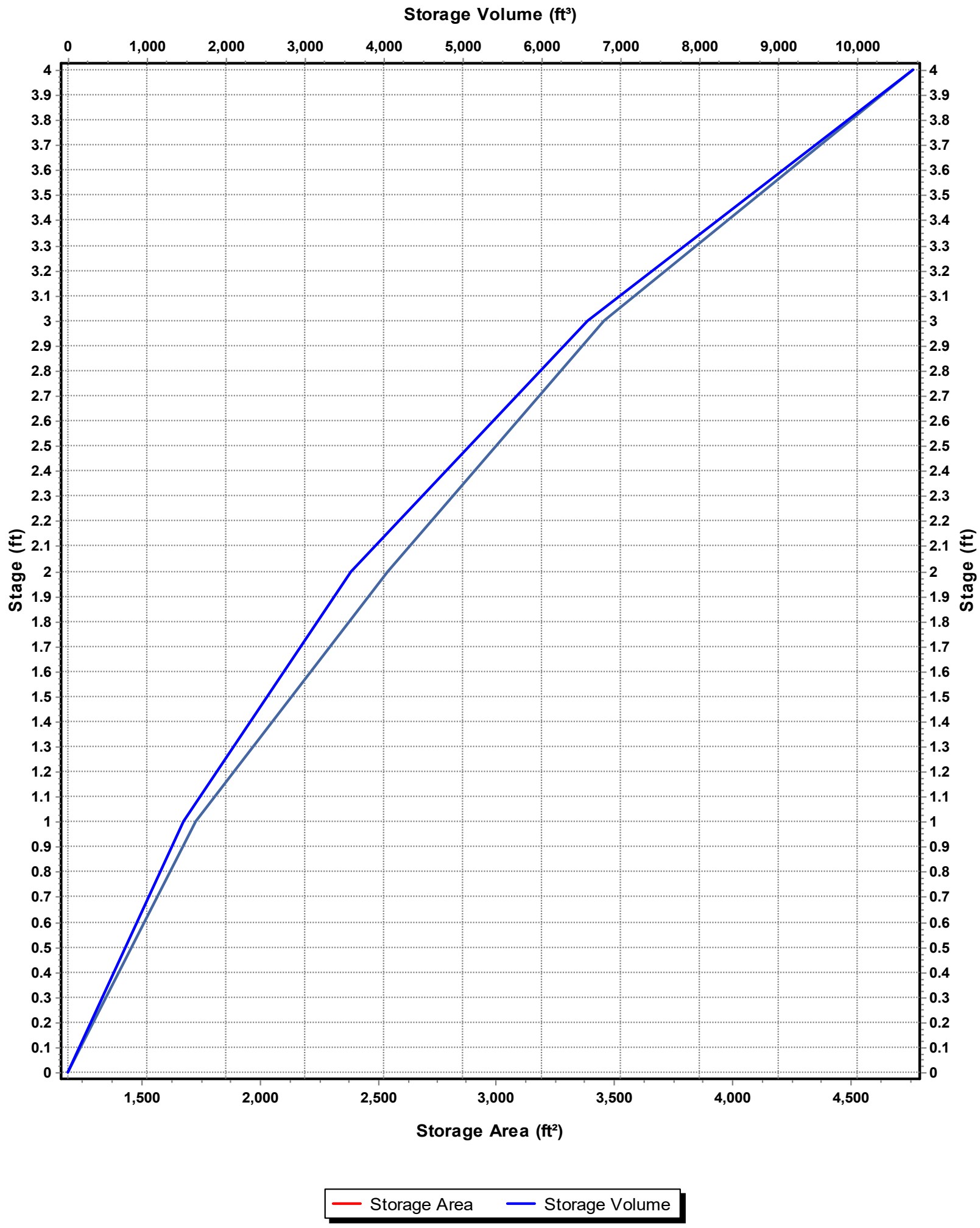
Invert Elevation (ft)	66.00
Max (Rim) Elevation (ft)	69.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	66.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

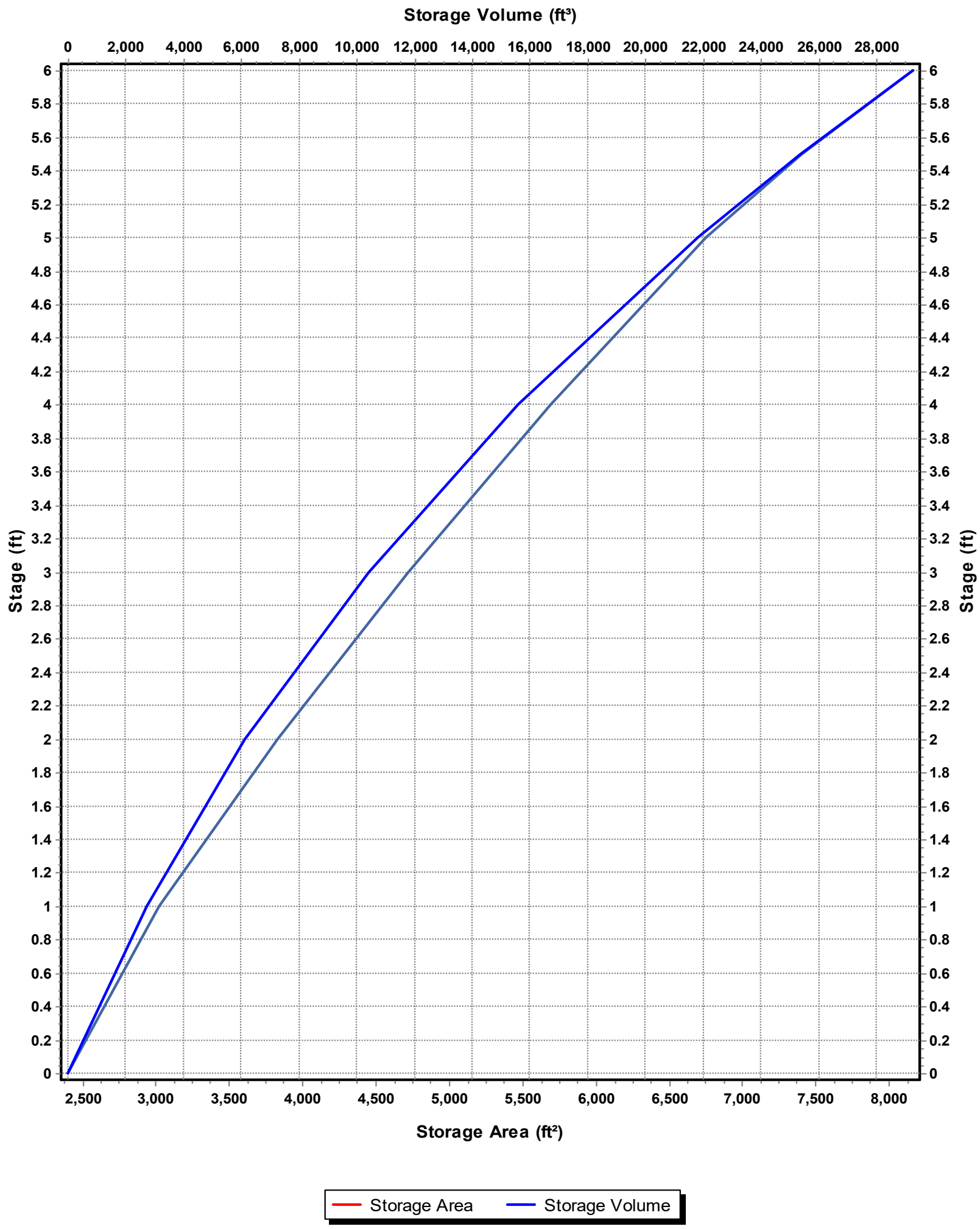
Invert Elevation (ft)	63.00
Max (Rim) Elevation (ft)	69.00
Max (Rim) Offset (ft)	6.00
Initial Water Elevation (ft)	63.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

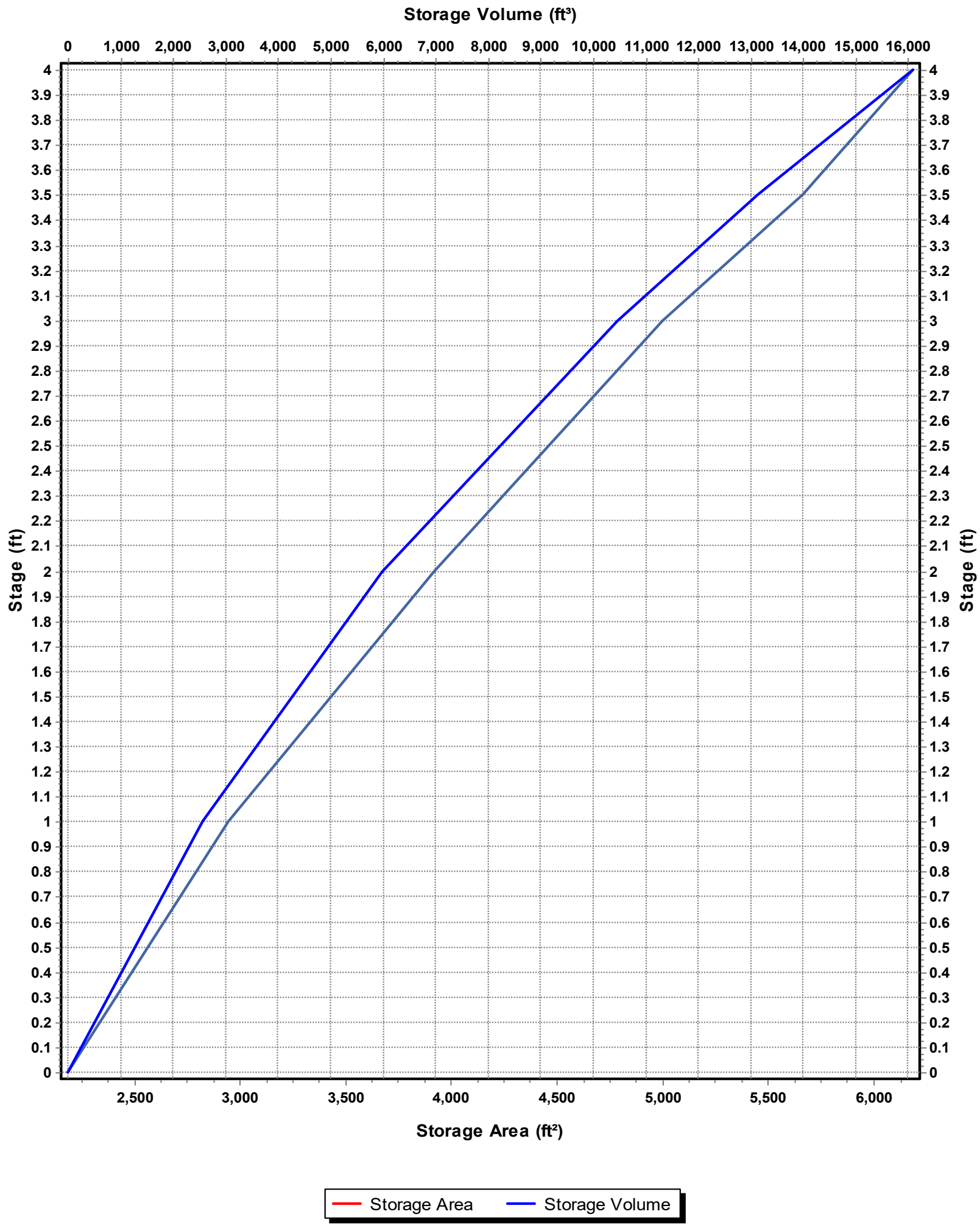
Invert Elevation (ft)	63.00
Max (Rim) Elevation (ft)	67.00
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	63.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

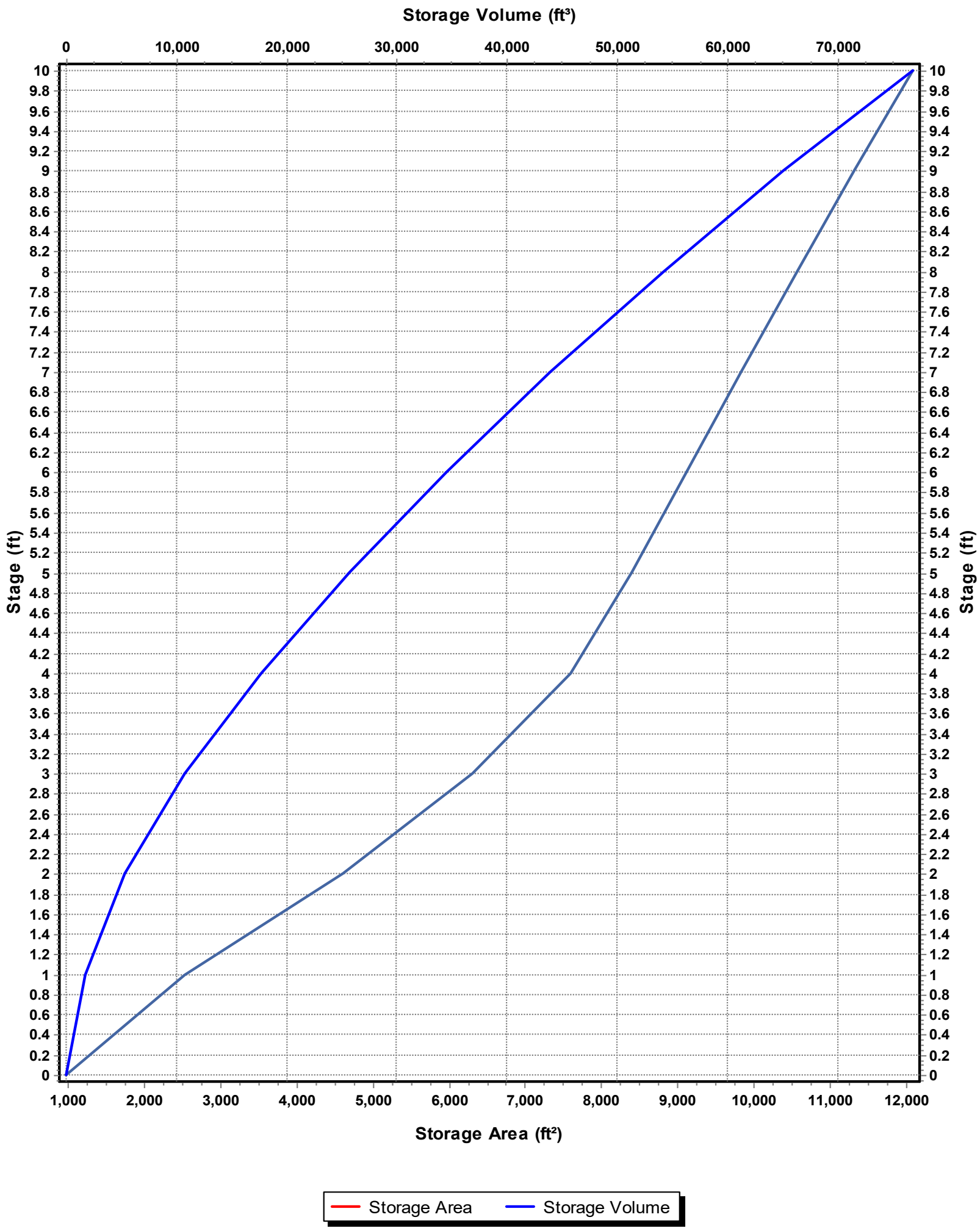
Invert Elevation (ft)	43.00
Max (Rim) Elevation (ft)	53.00
Max (Rim) Offset (ft)	10.00
Initial Water Elevation (ft)	43.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

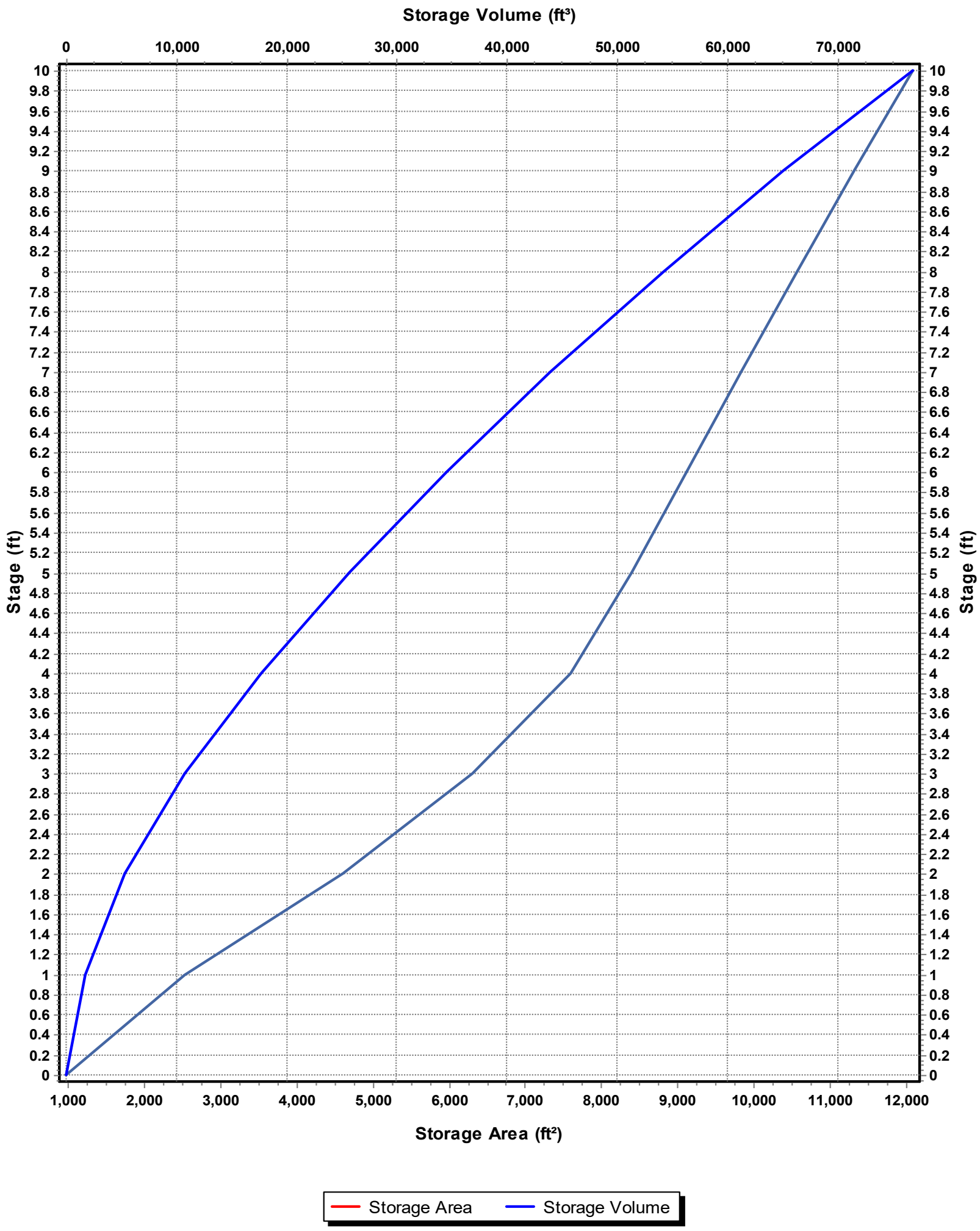
Invert Elevation (ft)	43.00
Max (Rim) Elevation (ft)	53.00
Max (Rim) Offset (ft)	10.00
Initial Water Elevation (ft)	43.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

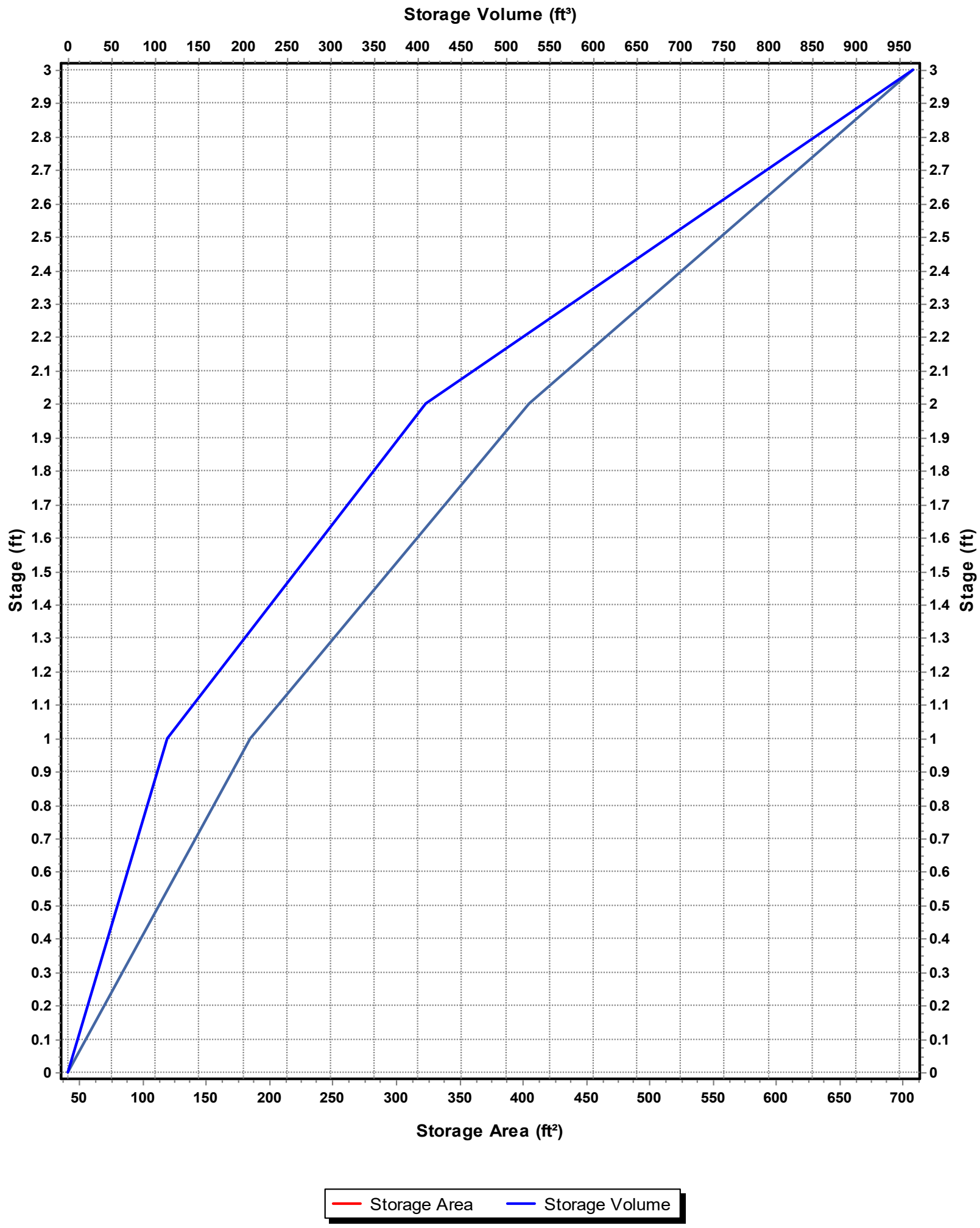
Invert Elevation (ft)	66.00
Max (Rim) Elevation (ft)	70.00
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	66.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

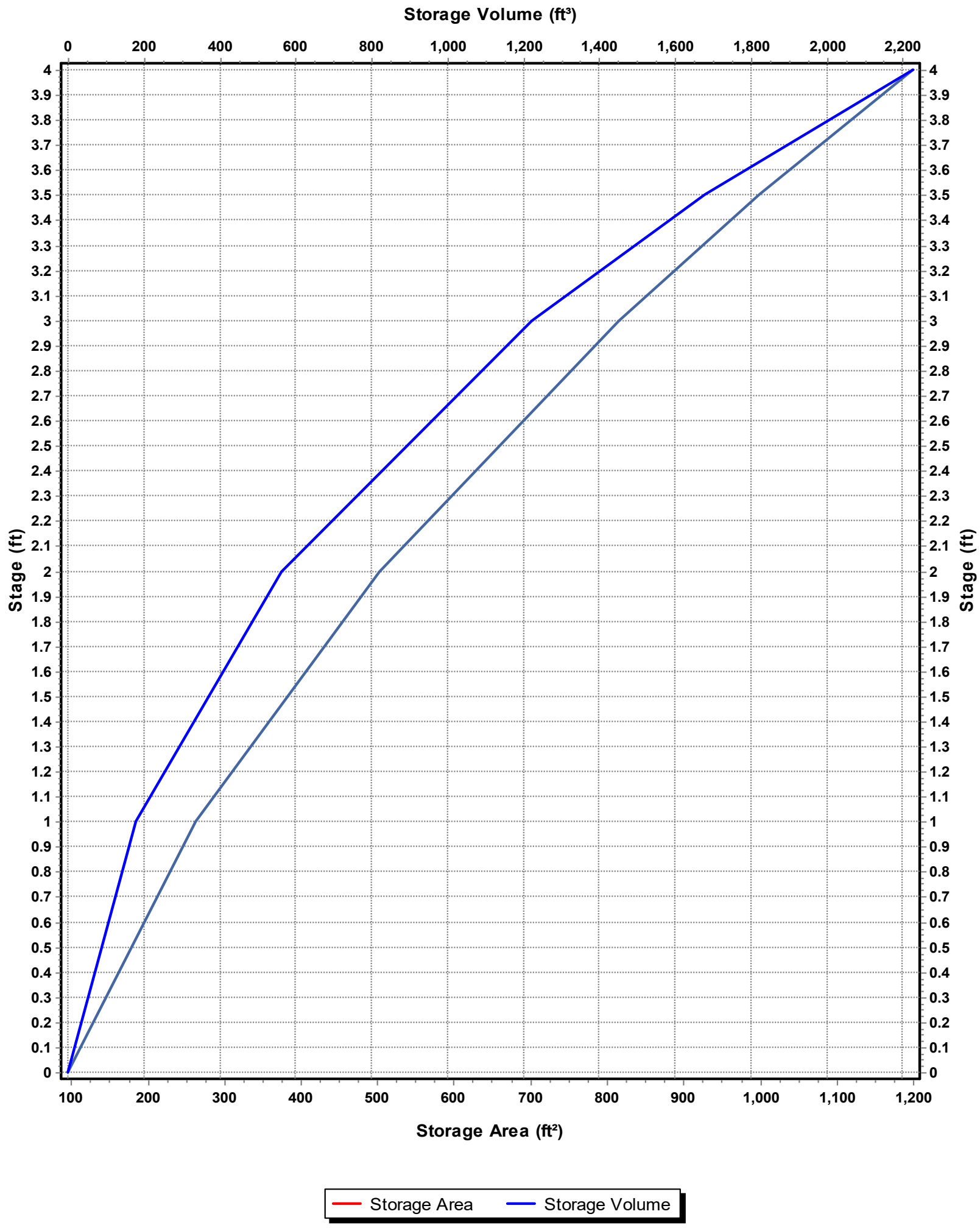
Invert Elevation (ft)	62.00
Max (Rim) Elevation (ft)	66.00
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	62.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

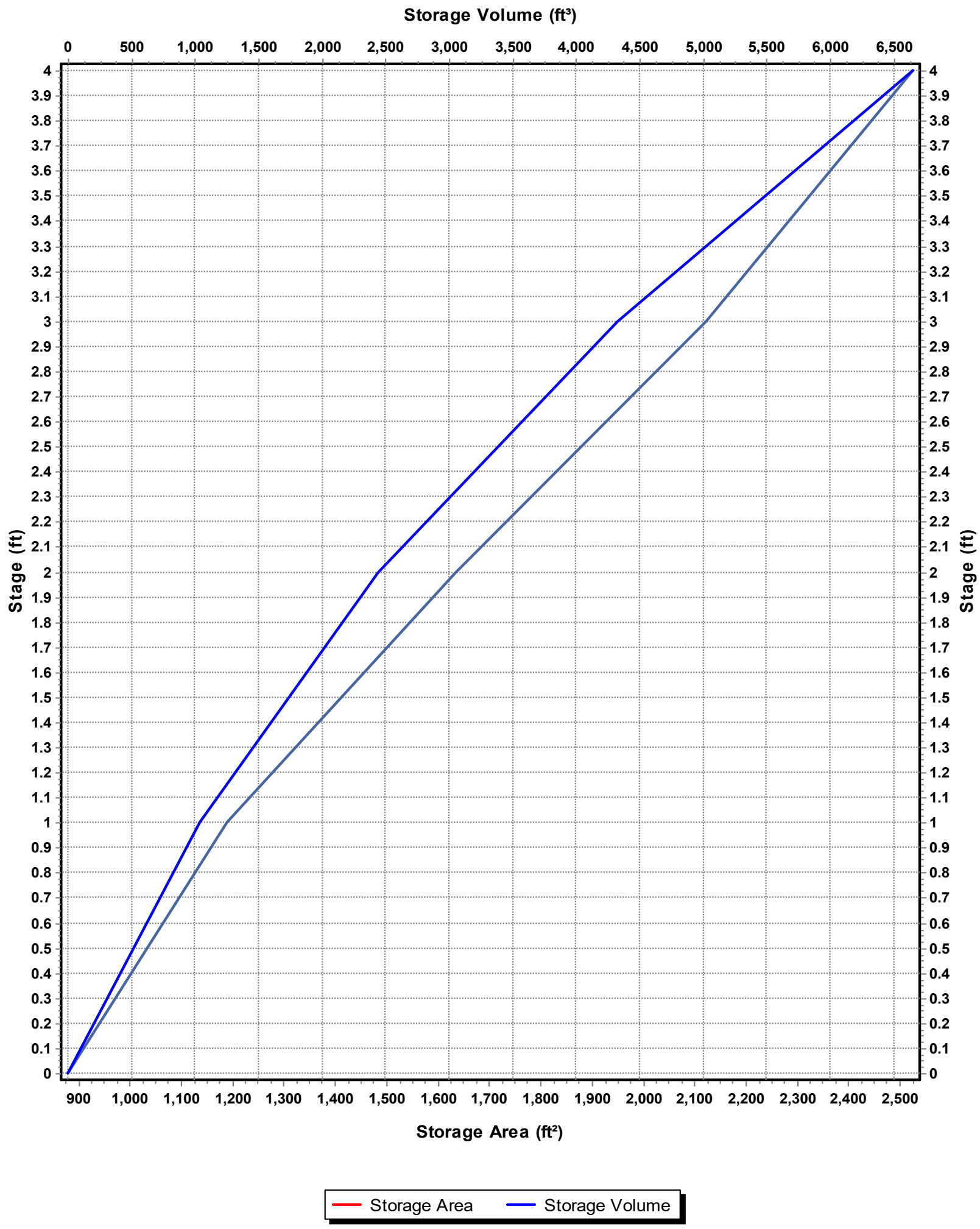
Invert Elevation (ft)	65.00
Max (Rim) Elevation (ft)	69.00
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	65.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

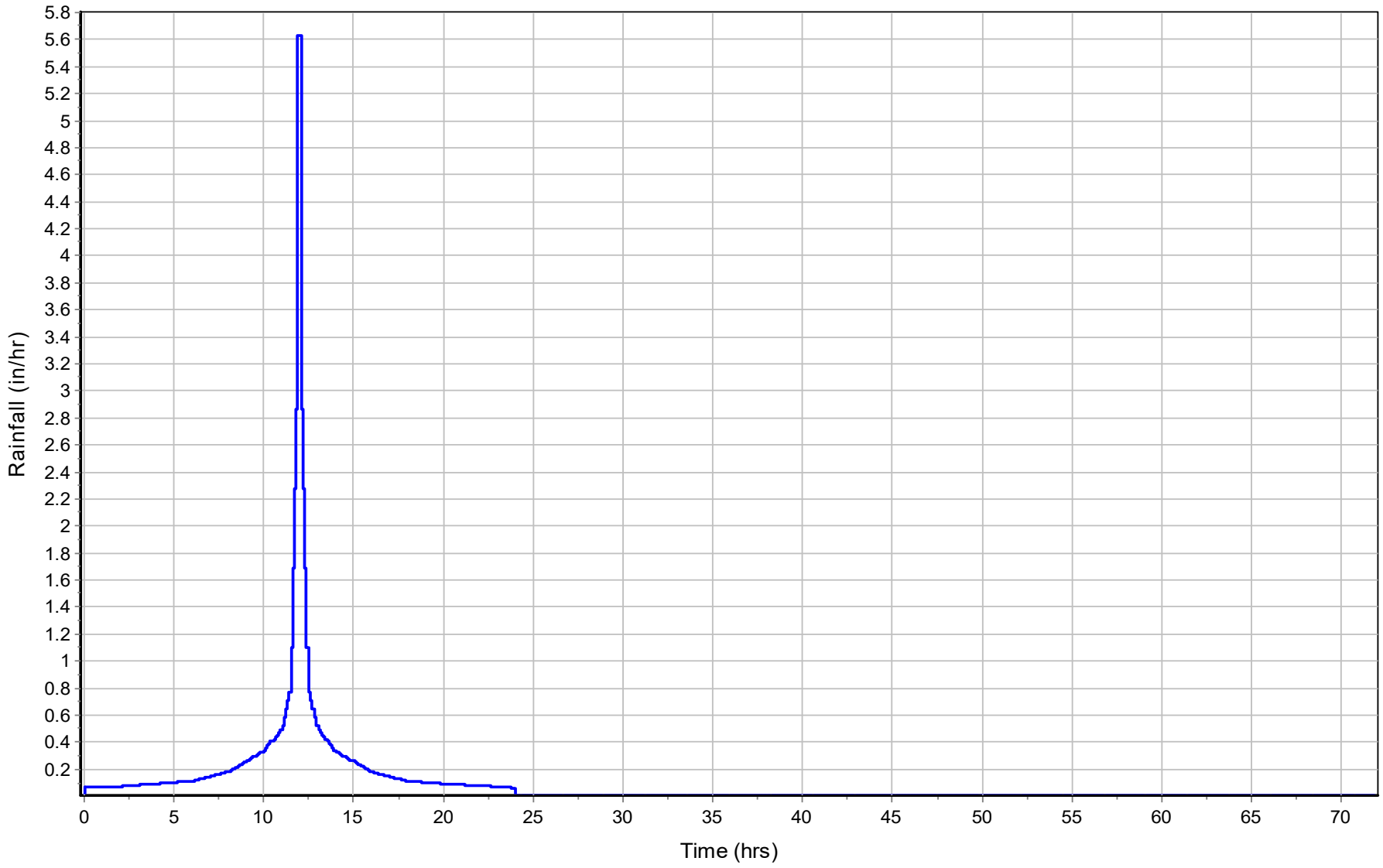
Total TOC (min) 4.58

Subbasin Runoff Results

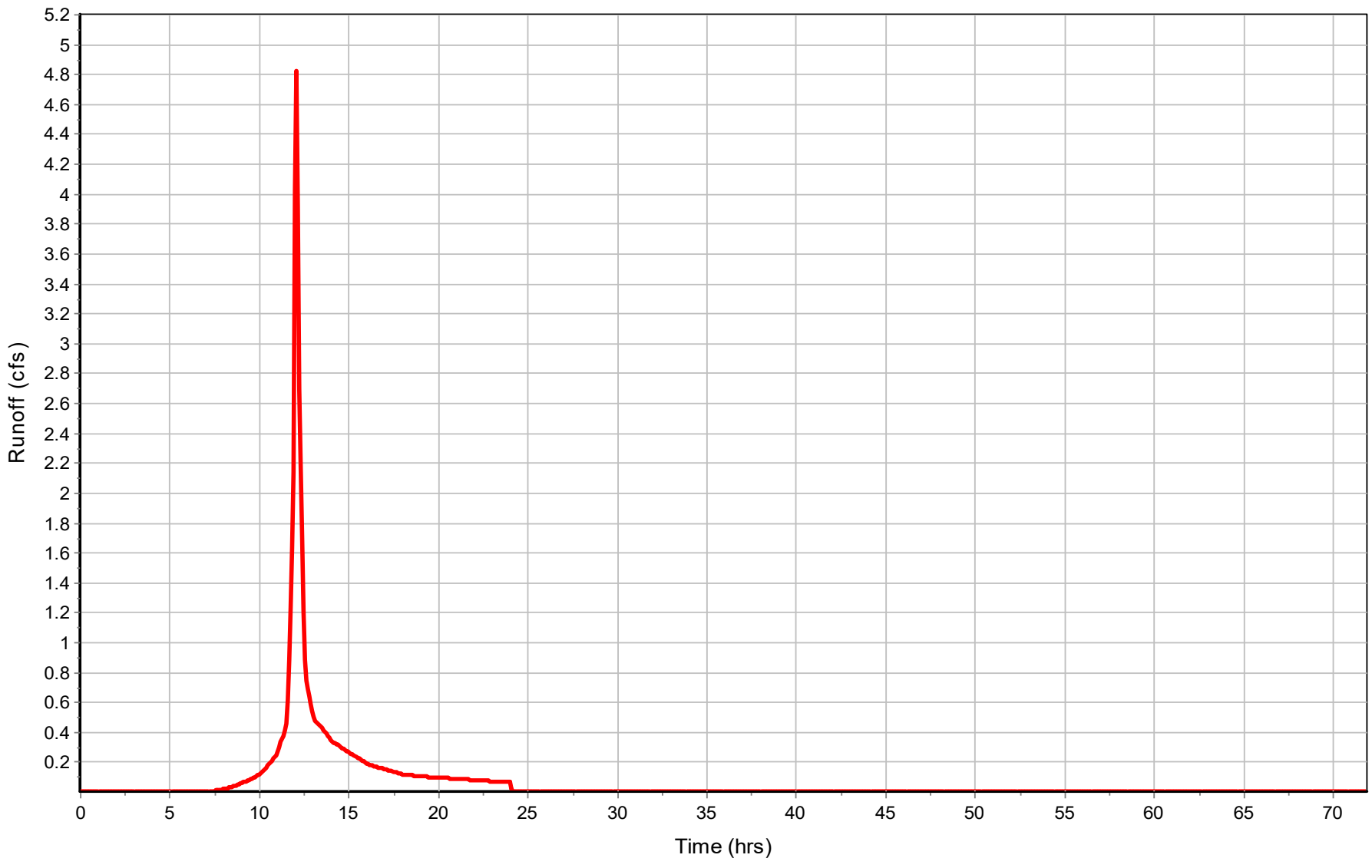
Total Rainfall (in) 6.7
Total Runoff (in) 3.99
Peak Runoff (cfs) 4.92
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:04:35

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

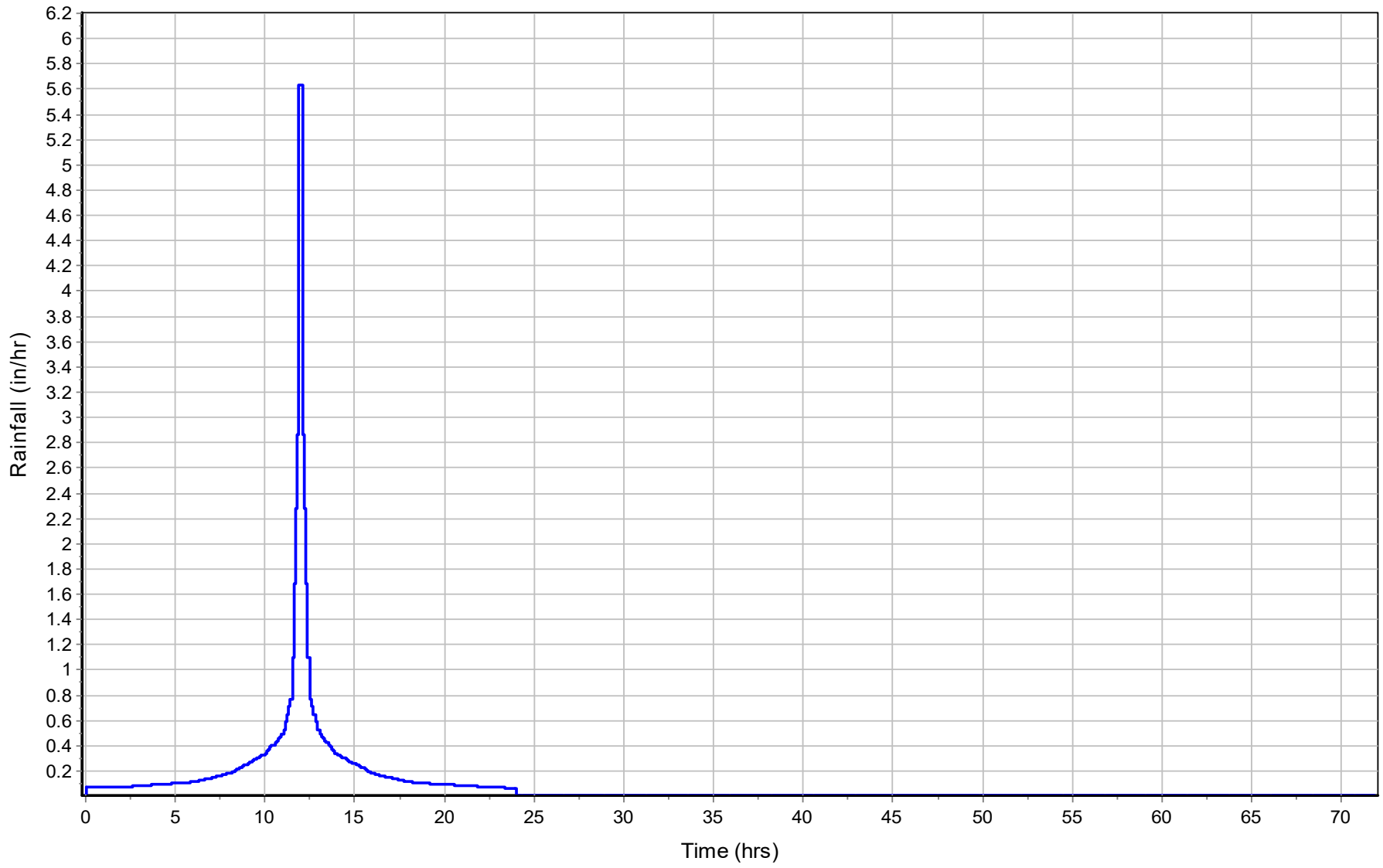
Total TOC (min) 10.92

Subbasin Runoff Results

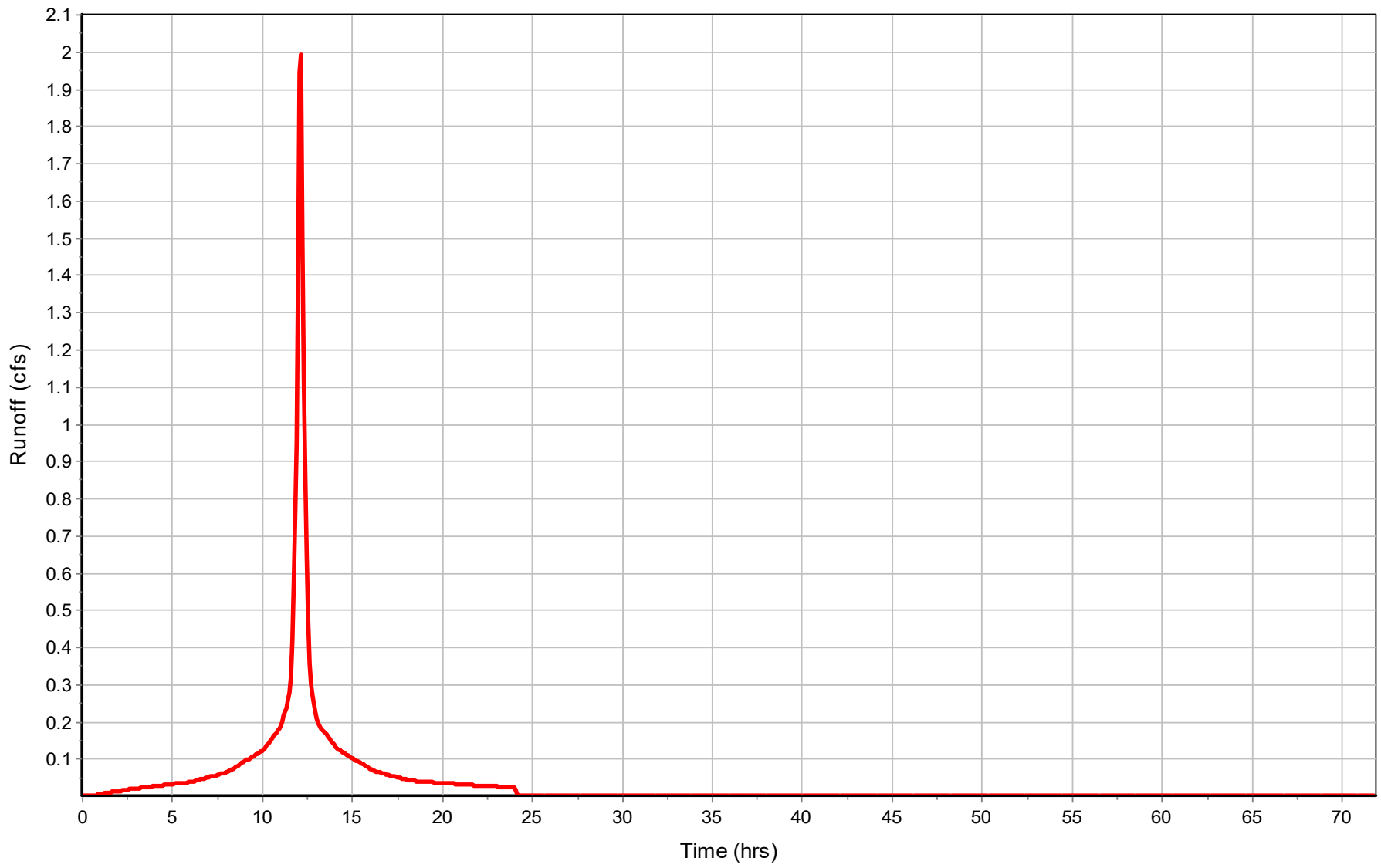
Total Rainfall (in) 6.7
Total Runoff (in) 6.46
Peak Runoff (cfs) 2.05
Weighted Curve Number 98
Time of Concentration (days hh:mm:ss) 0 00:10:55

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

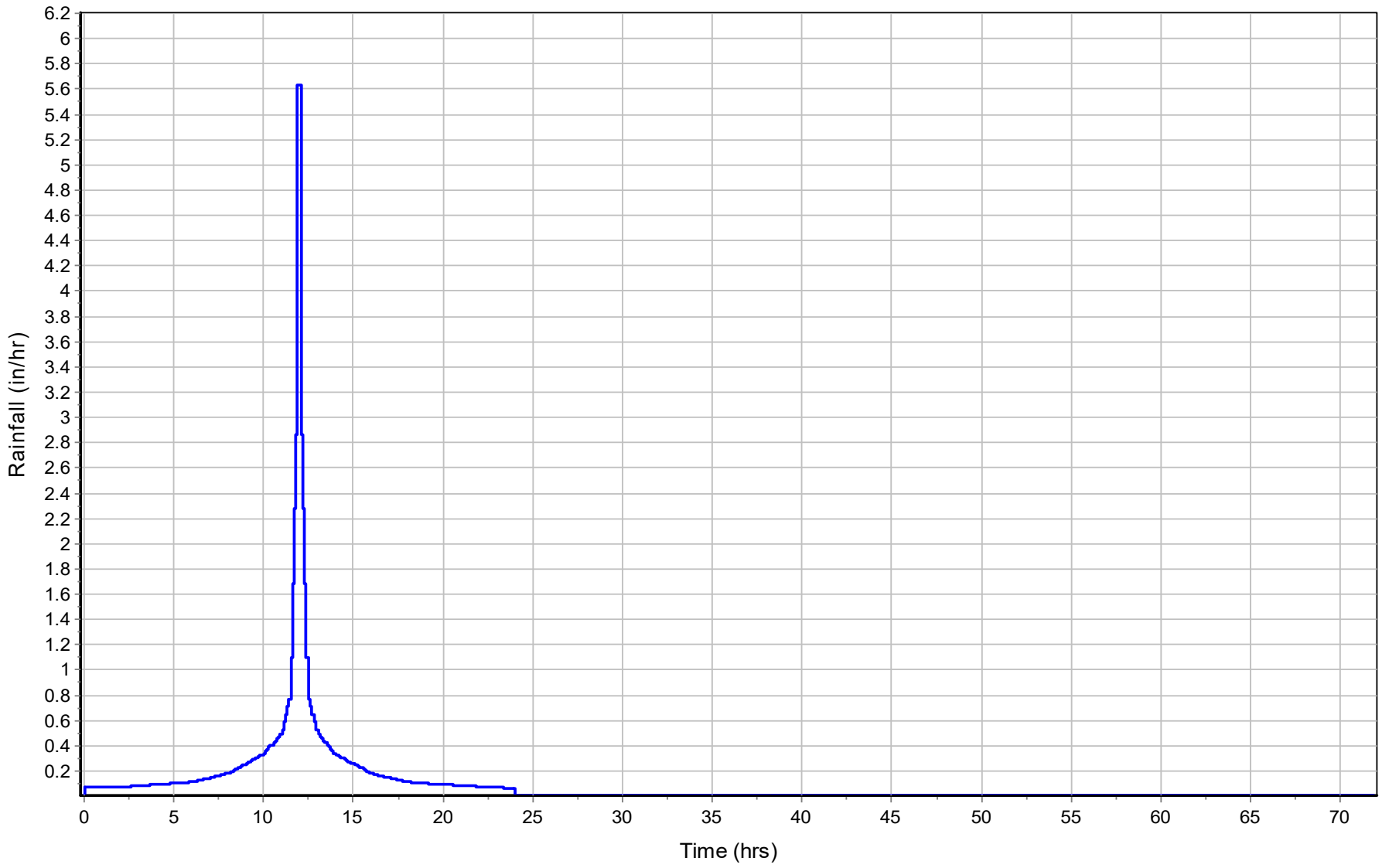
Total TOC (min) 3.41

Subbasin Runoff Results

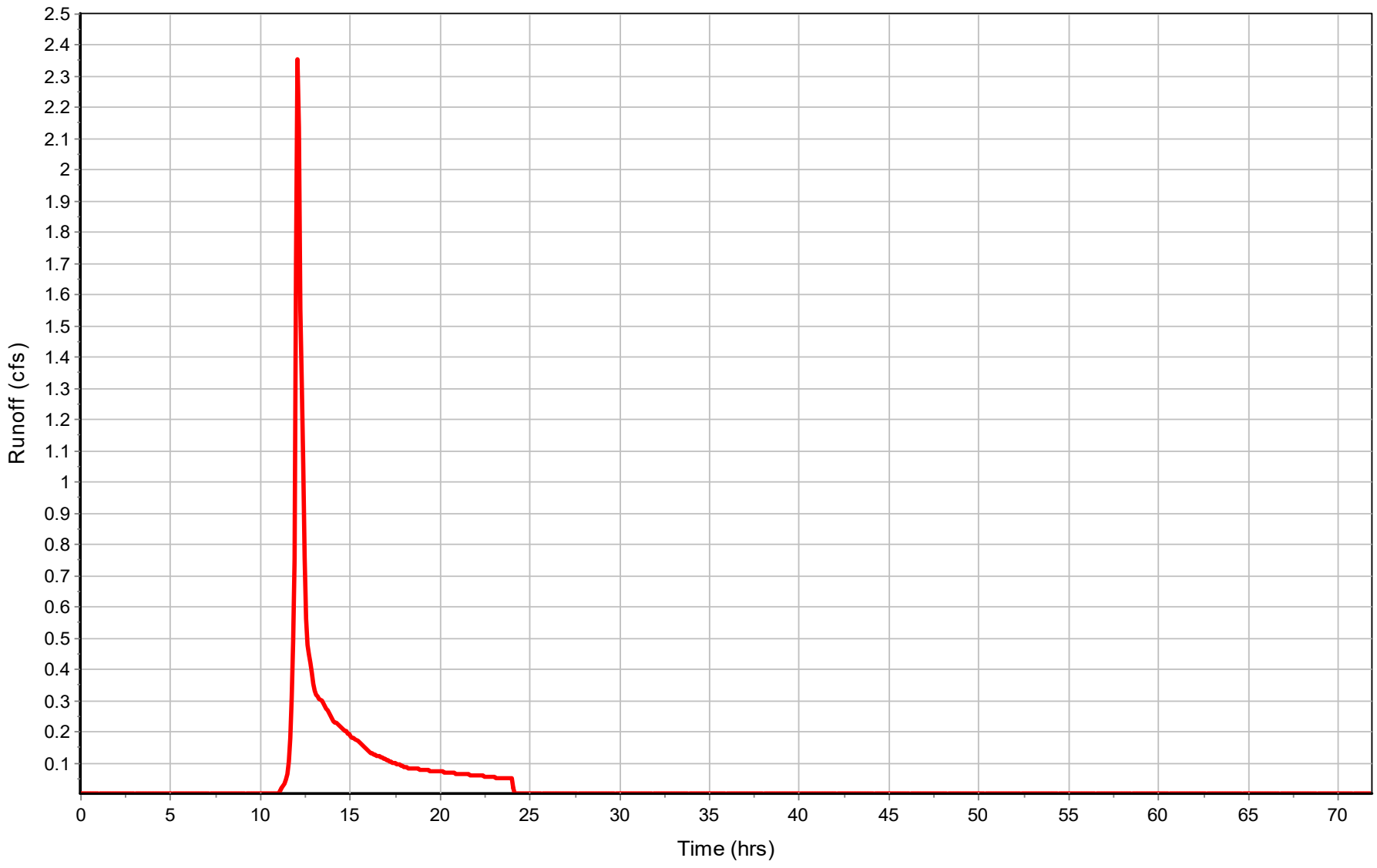
Total Rainfall (in) 6.7
Total Runoff (in) 1.9
Peak Runoff (cfs) 2.53
Weighted Curve Number 54.63
Time of Concentration (days hh:mm:ss) 0 00:03:25

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

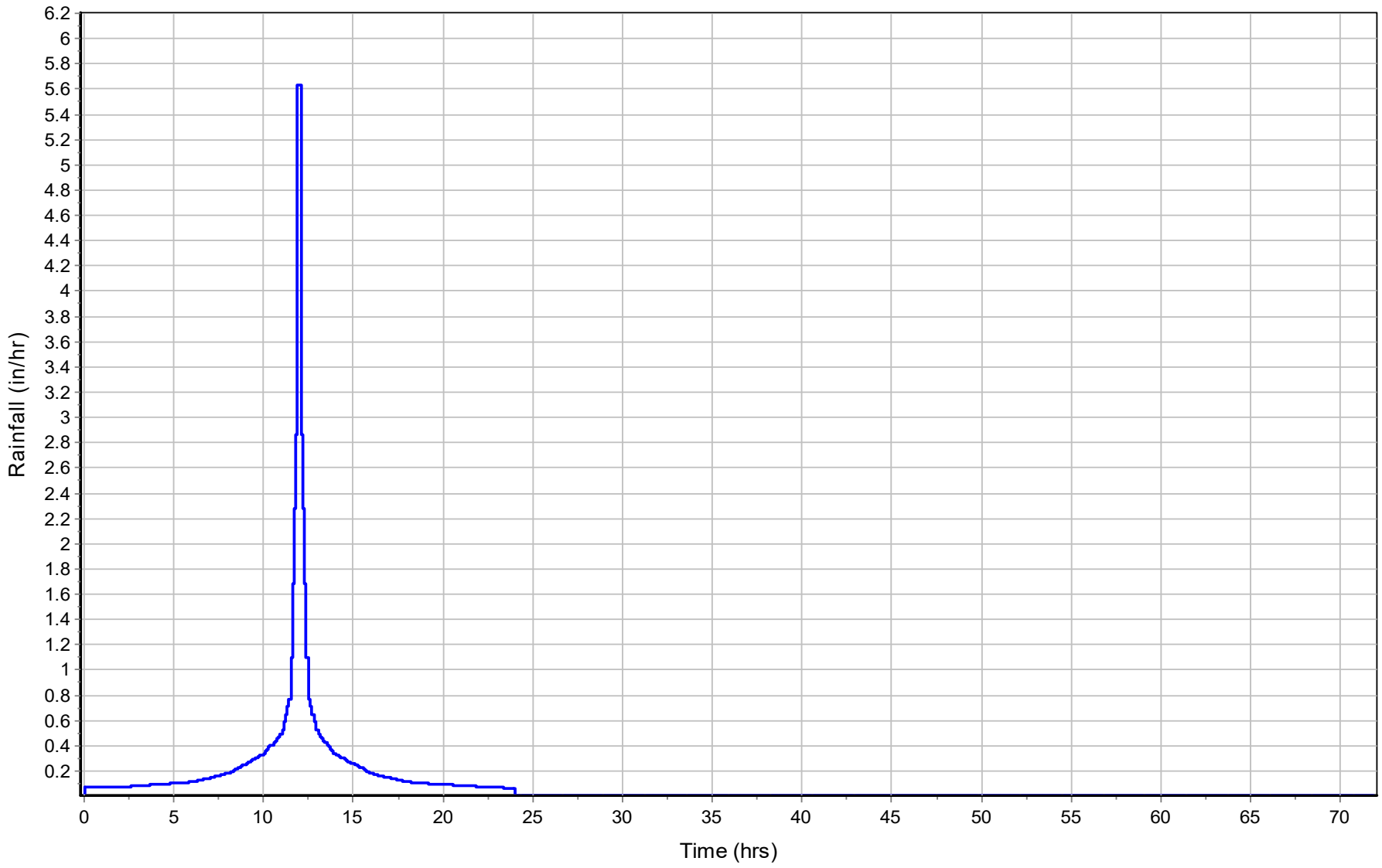
Total TOC (min) 40.27

Subbasin Runoff Results

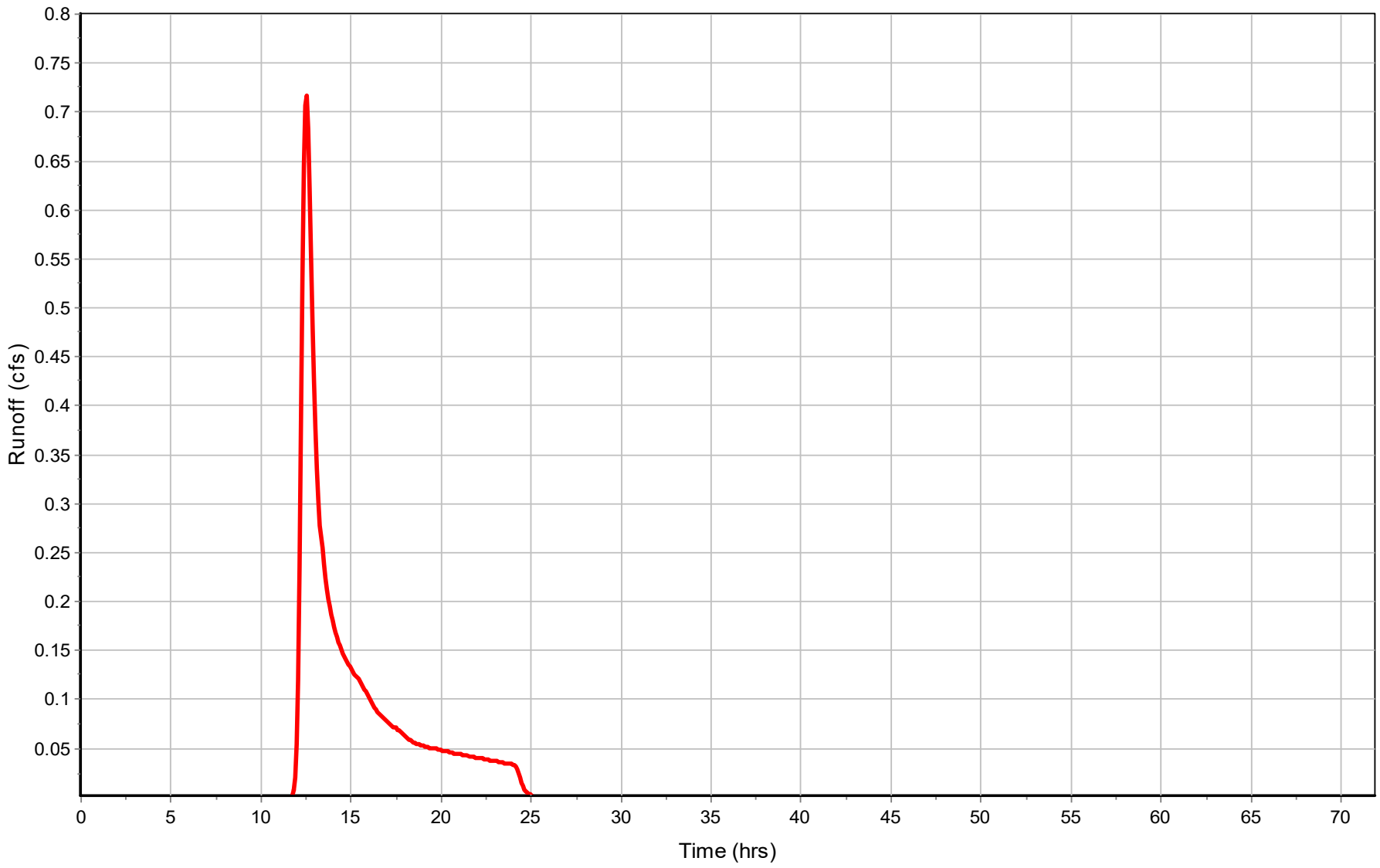
Total Rainfall (in) 6.7
Total Runoff (in) 1.42
Peak Runoff (cfs) 0.72
Weighted Curve Number 49
Time of Concentration (days hh:mm:ss) 0 00:40:16

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

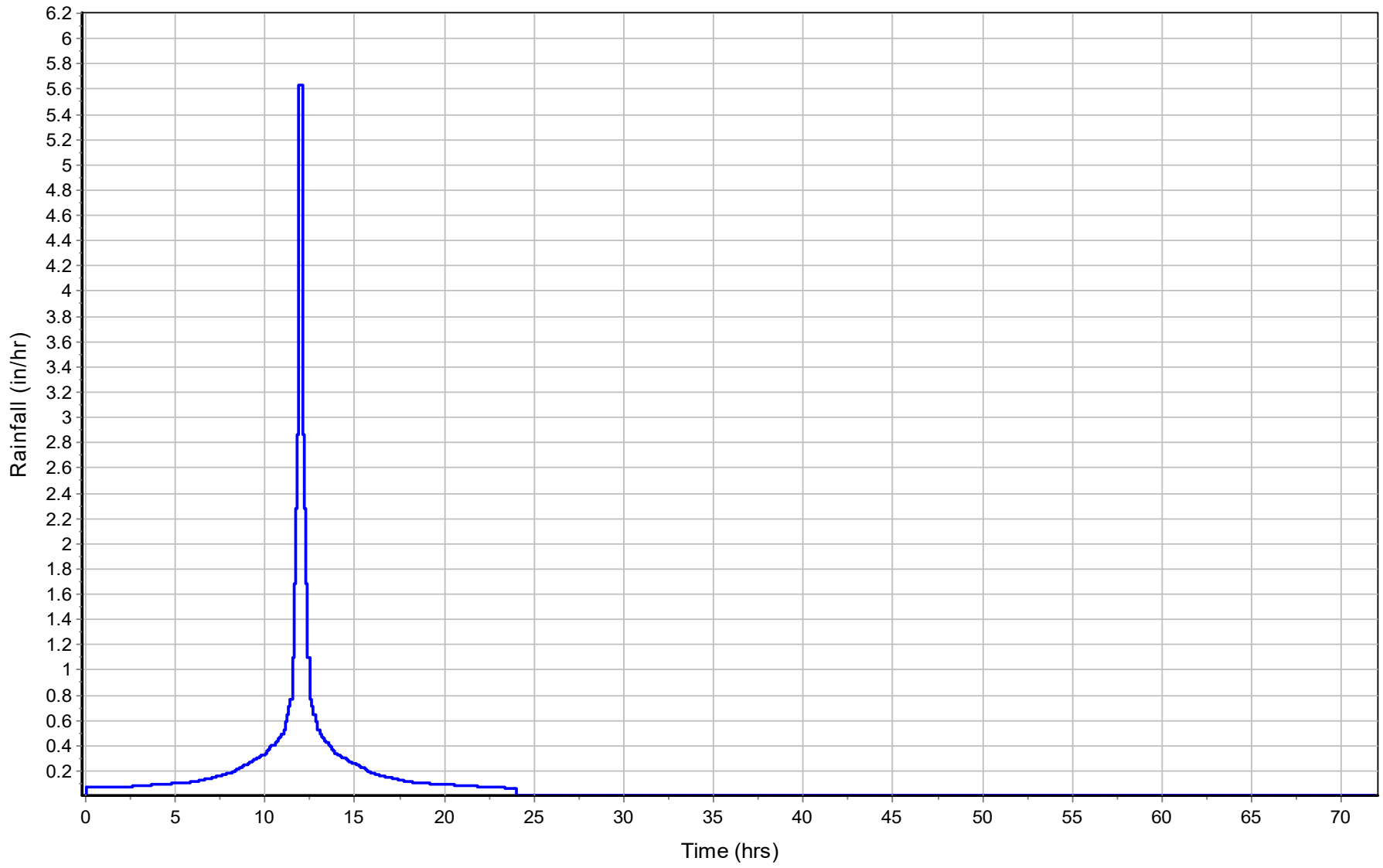
Total TOC (min) 3.51

Subbasin Runoff Results

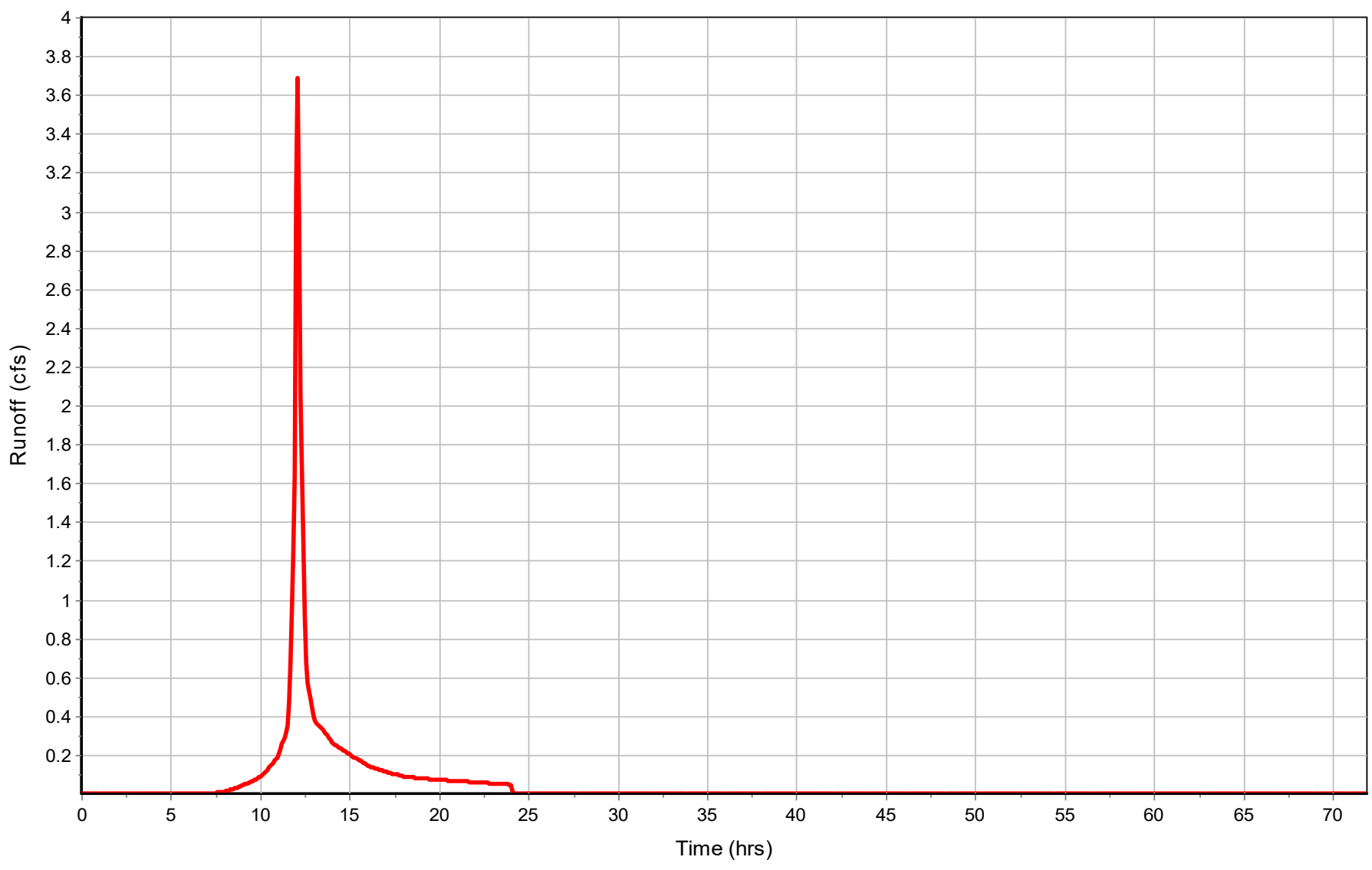
Total Rainfall (in) 6.7
Total Runoff (in) 3.99
Peak Runoff (cfs) 3.77
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:03:31

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

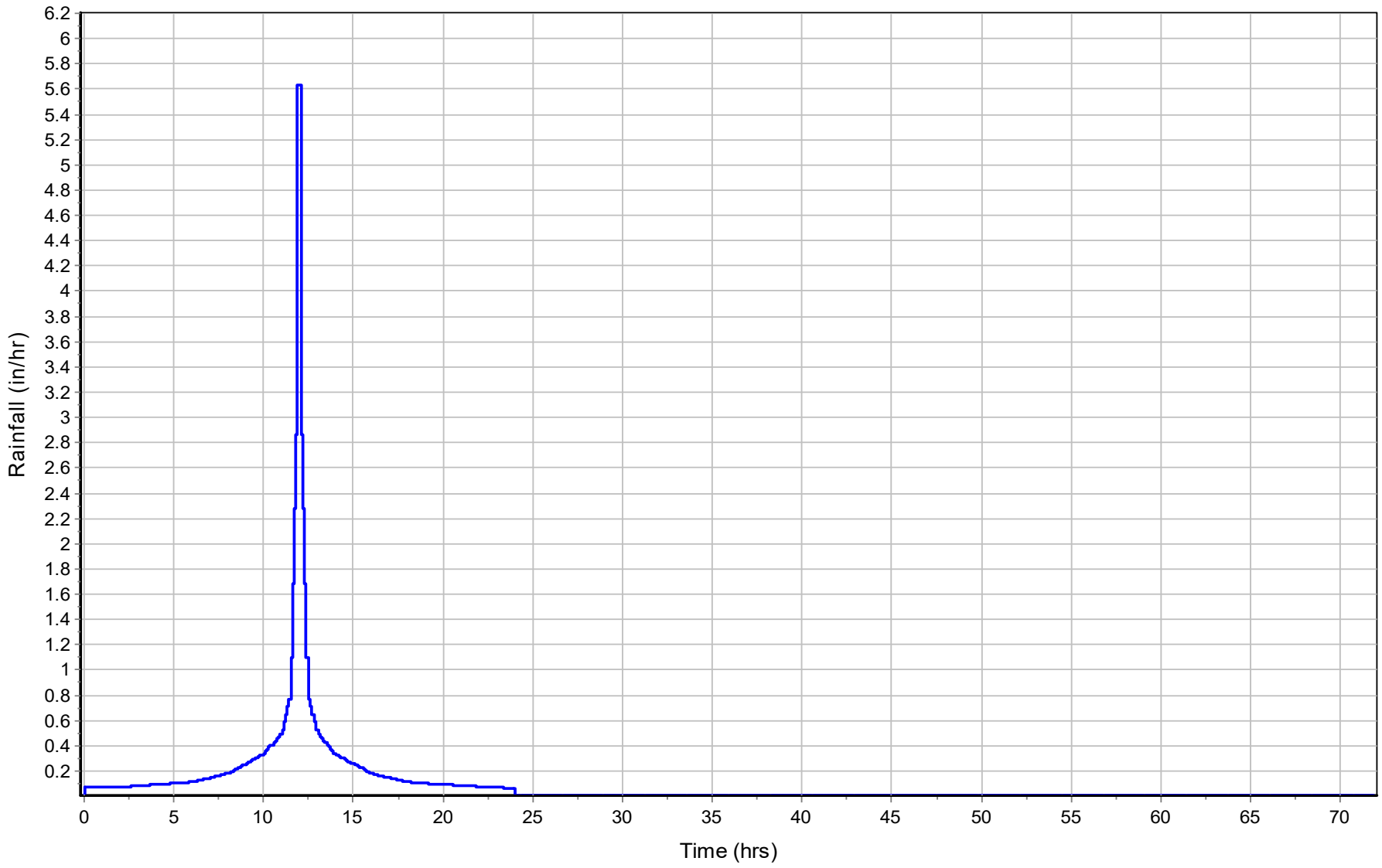
Total TOC (min) 36.12

Subbasin Runoff Results

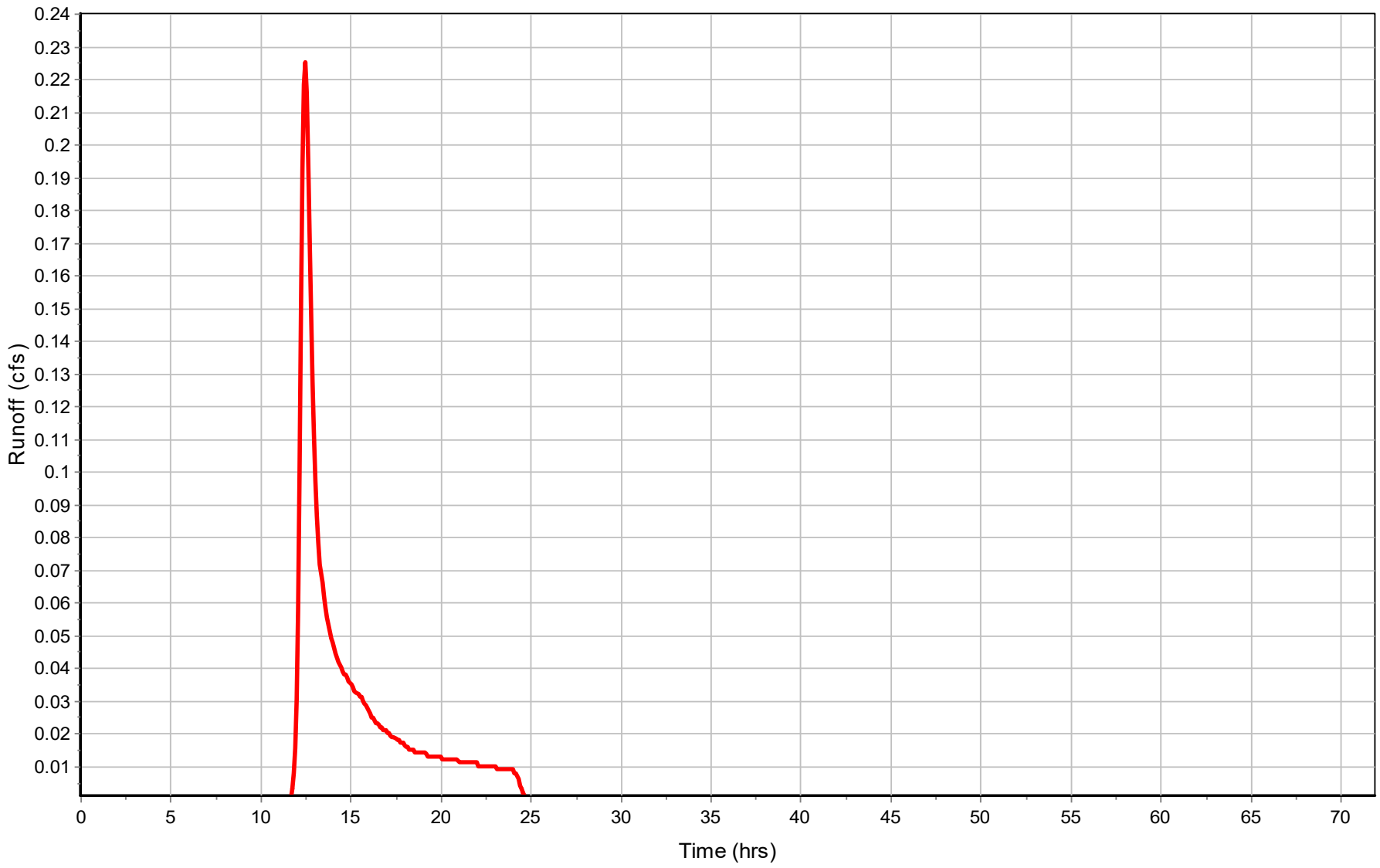
Total Rainfall (in) 6.7
Total Runoff (in) 1.65
Peak Runoff (cfs) 0.23
Weighted Curve Number 51.7
Time of Concentration (days hh:mm:ss) 0 00:36:07

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

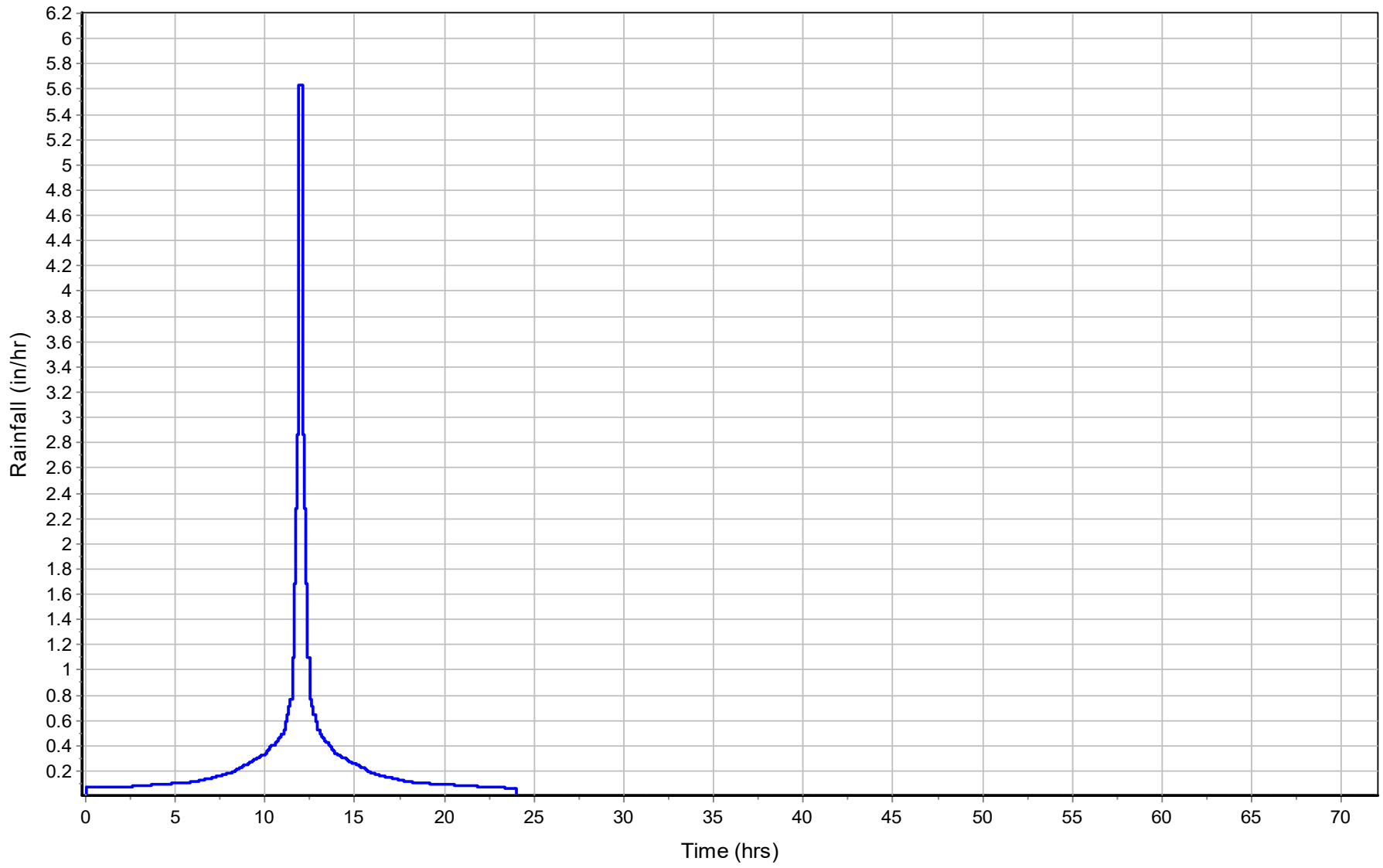
Total TOC (min) 3.14

Subbasin Runoff Results

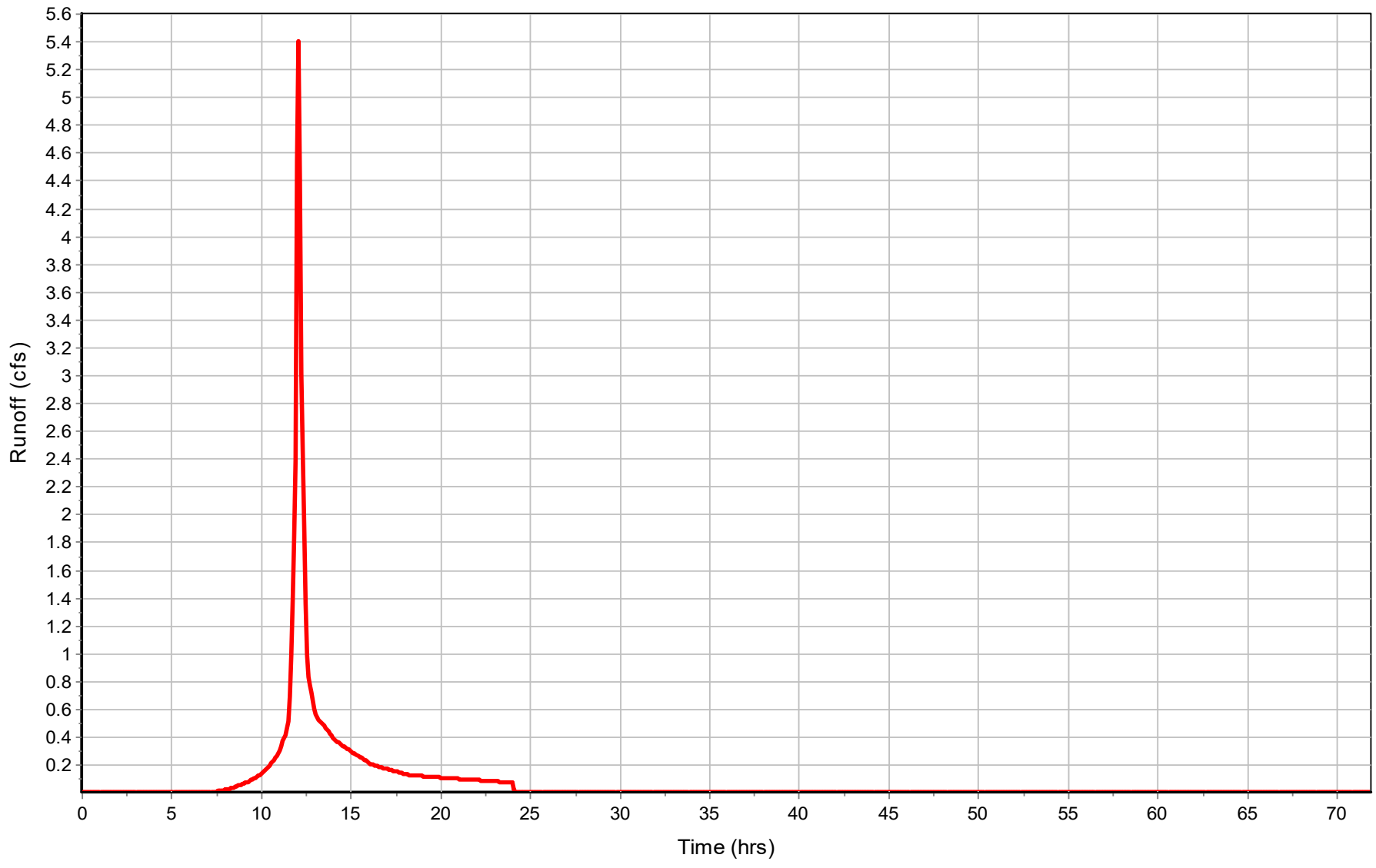
Total Rainfall (in) 6.7
Total Runoff (in) 3.99
Peak Runoff (cfs) 5.52
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:03:08

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

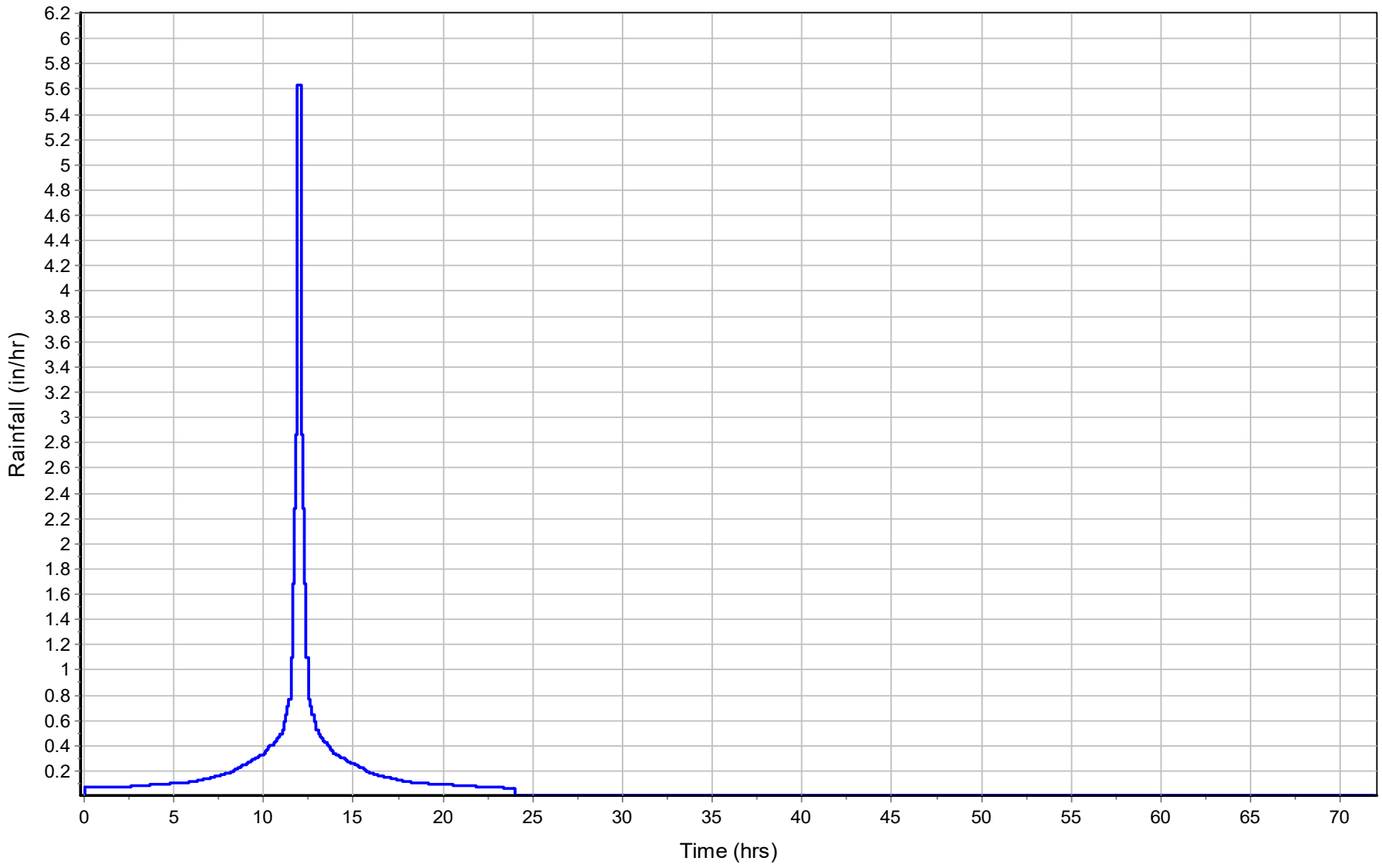
Total TOC (min) 2.17

Subbasin Runoff Results

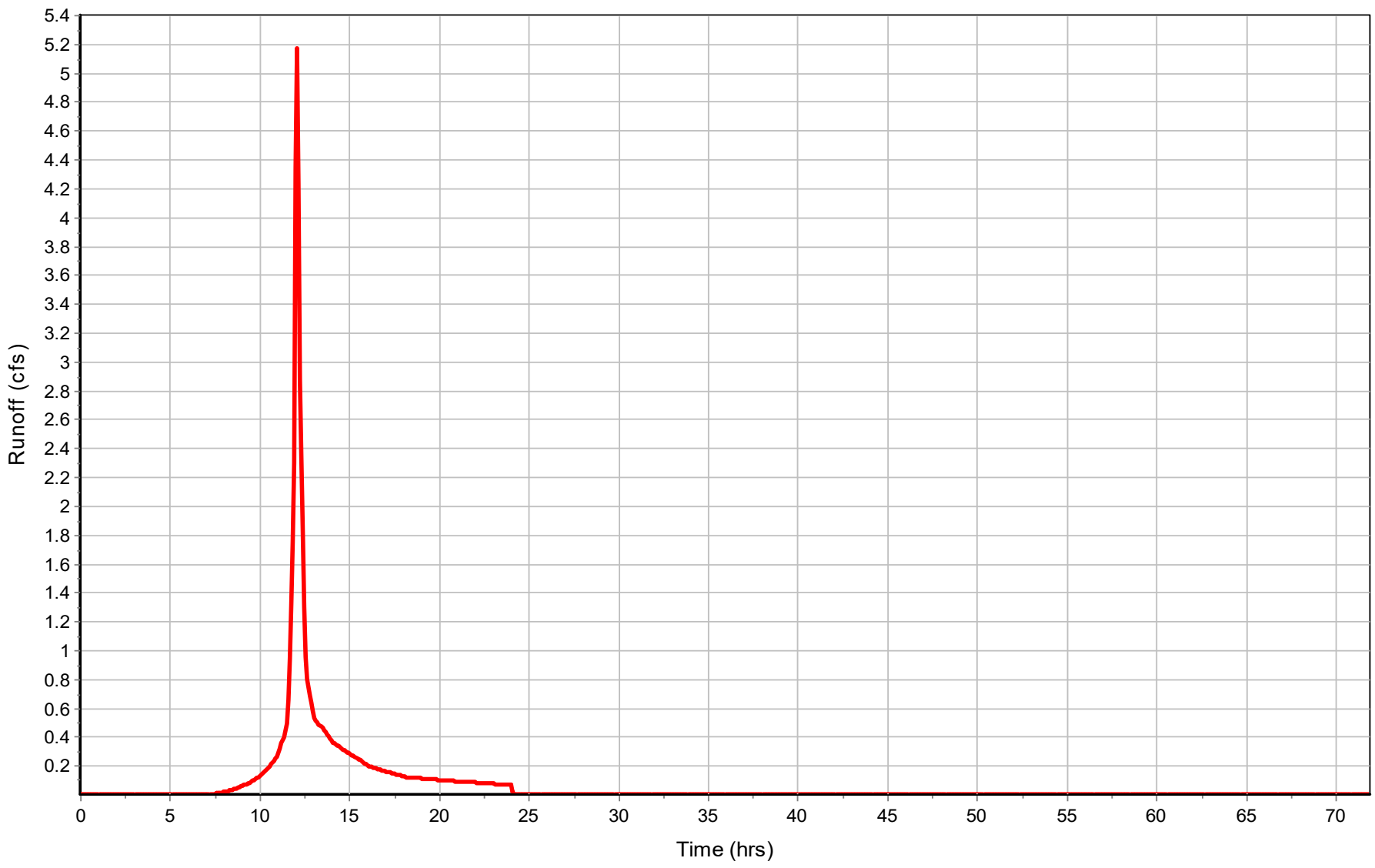
Total Rainfall (in) 6.7
Total Runoff (in) 3.99
Peak Runoff (cfs) 5.28
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:02:10

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

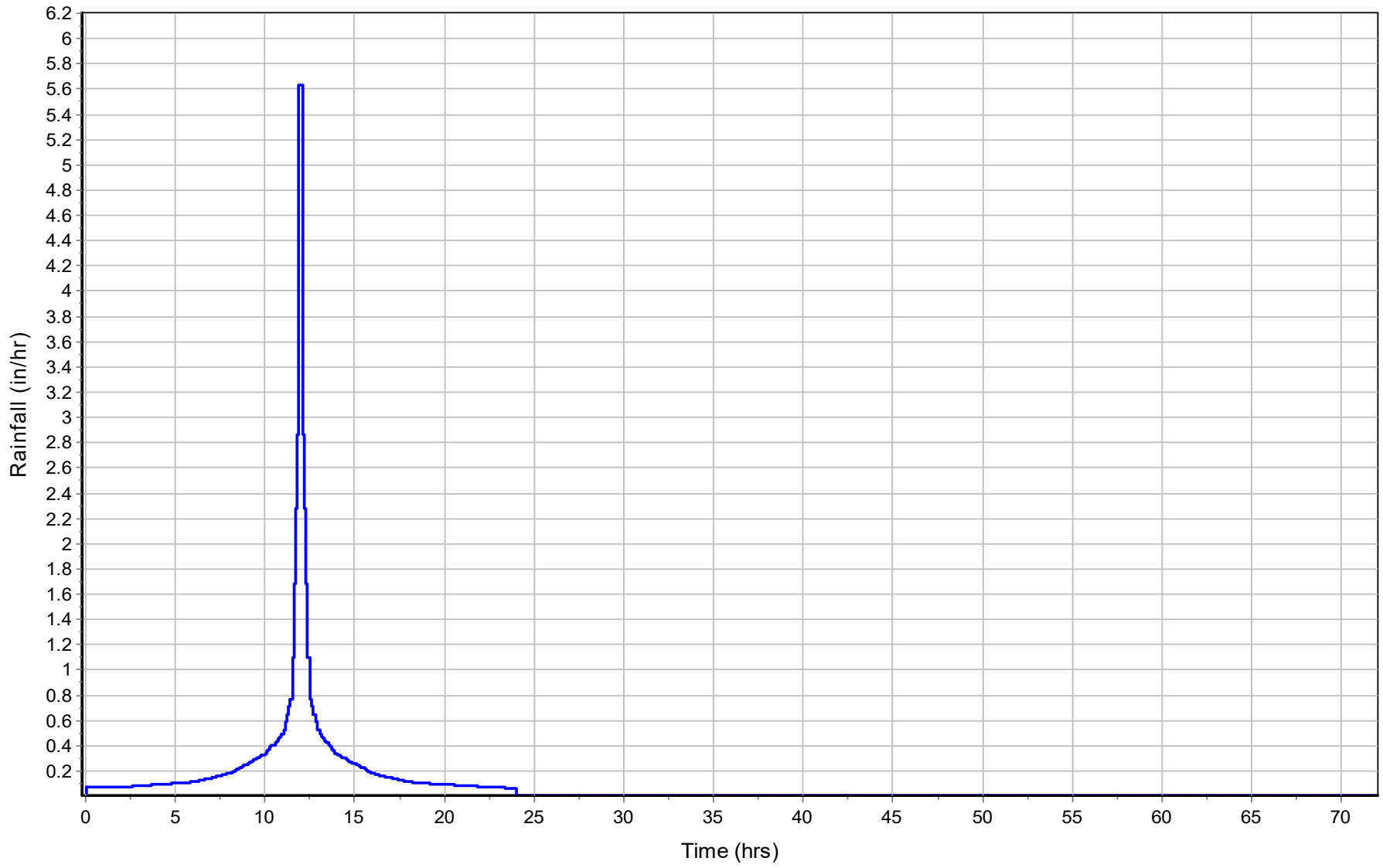
Total TOC (min) 4.13

Subbasin Runoff Results

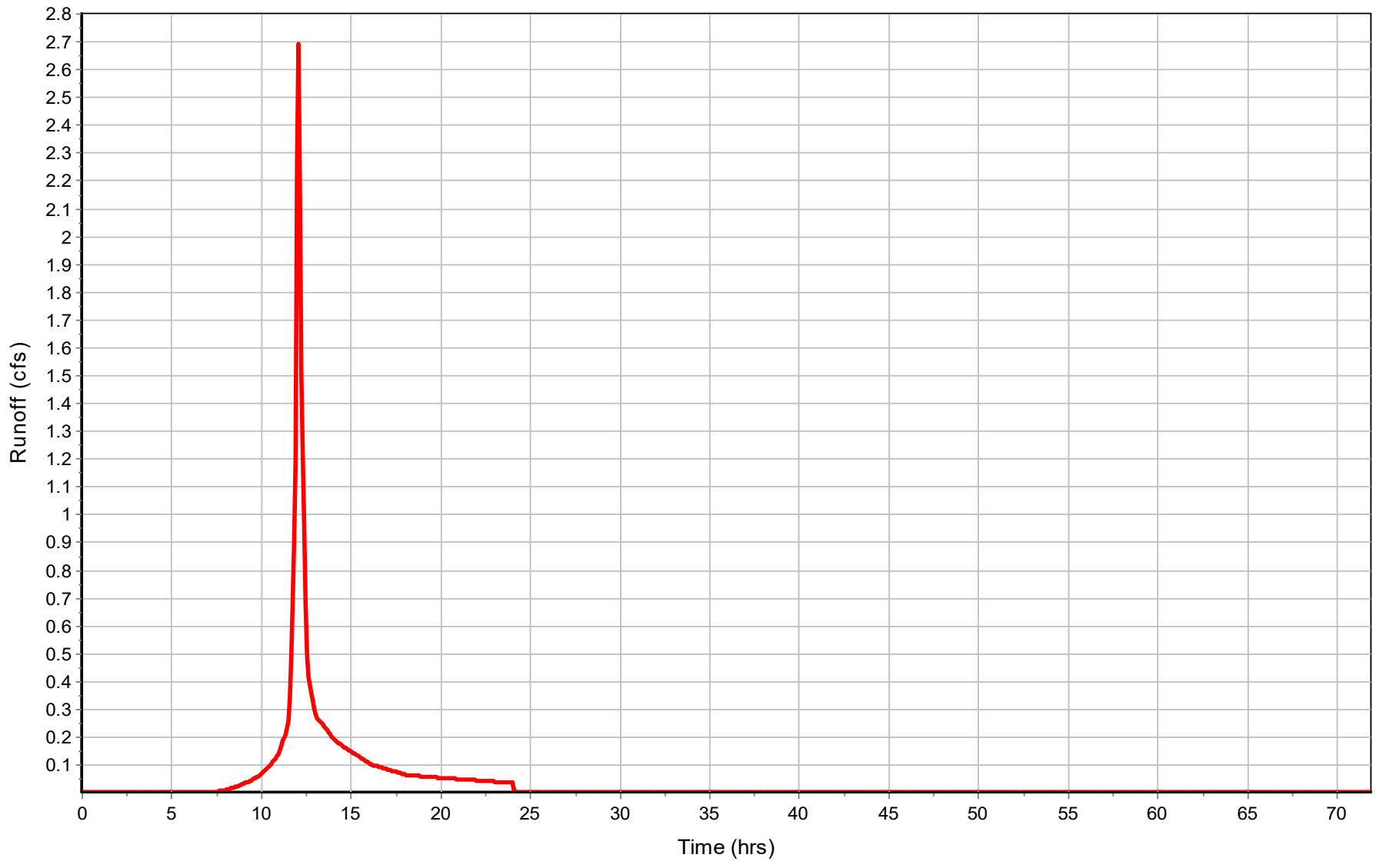
Total Rainfall (in)	6.7
Total Runoff (in)	3.99
Peak Runoff (cfs)	2.75
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:04:08

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

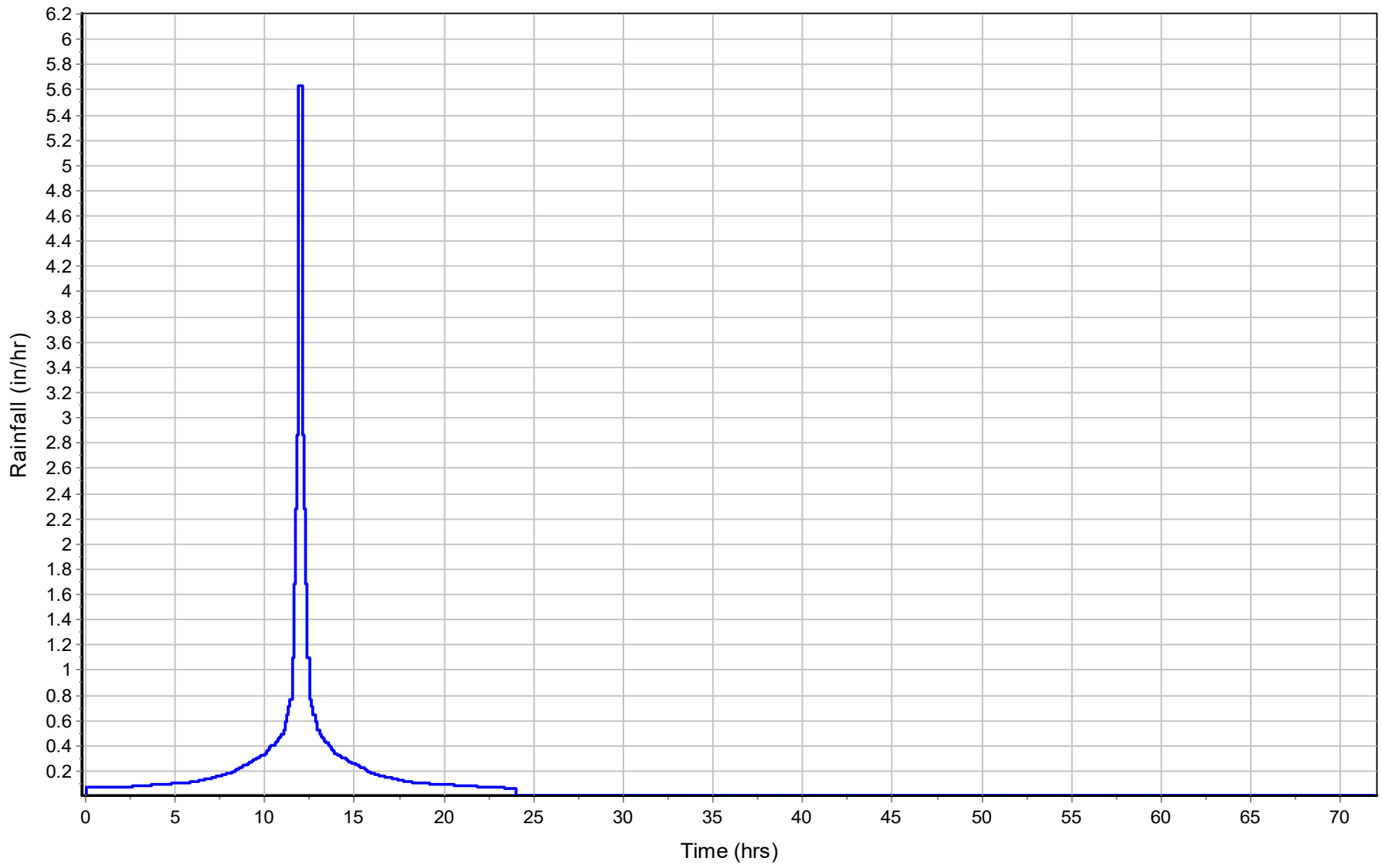
Total TOC (min) 34.83

Subbasin Runoff Results

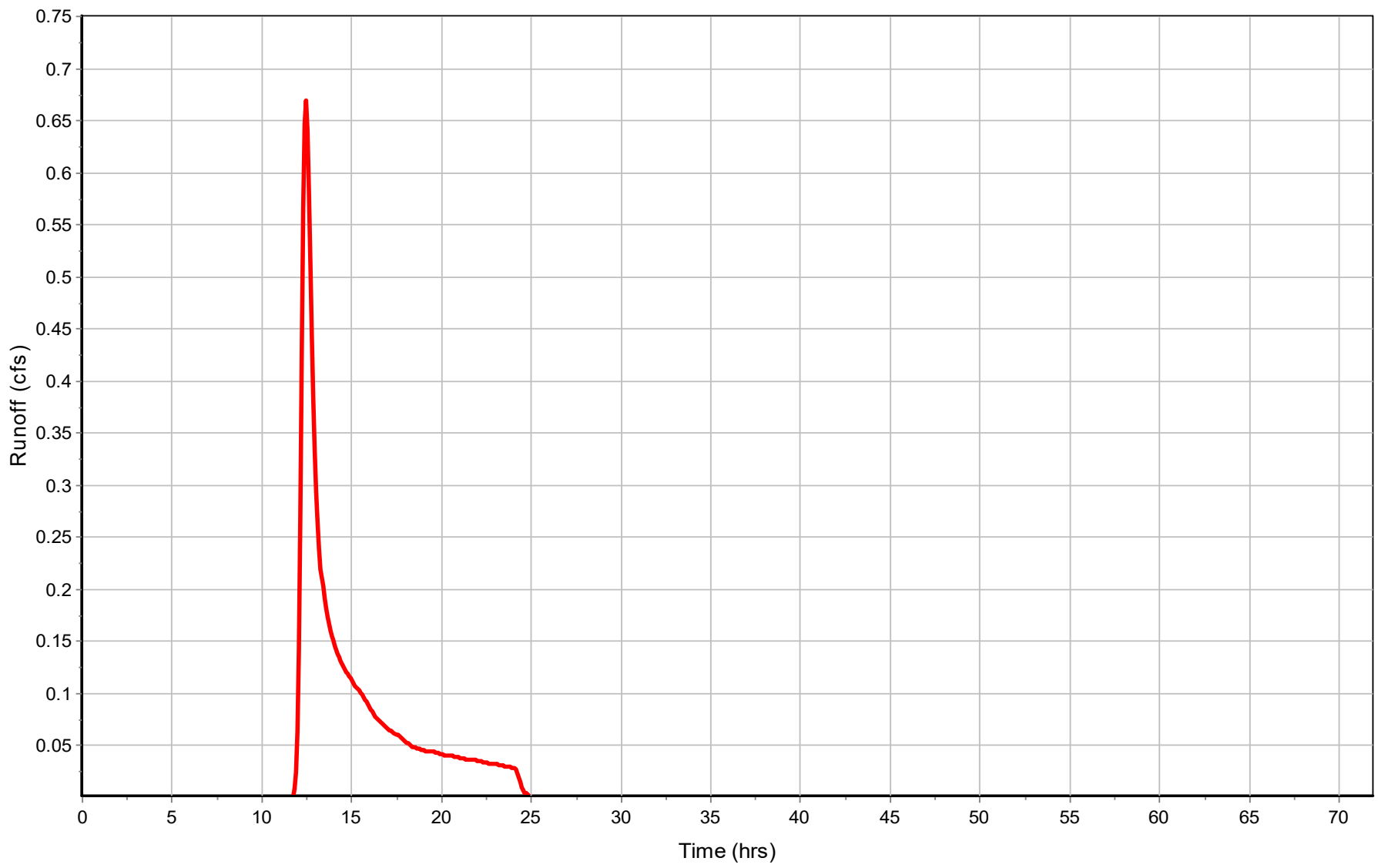
Total Rainfall (in)	6.7
Total Runoff (in)	1.42
Peak Runoff (cfs)	0.67
Weighted Curve Number	49
Time of Concentration (days hh:mm:ss)	0 00:34:50

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

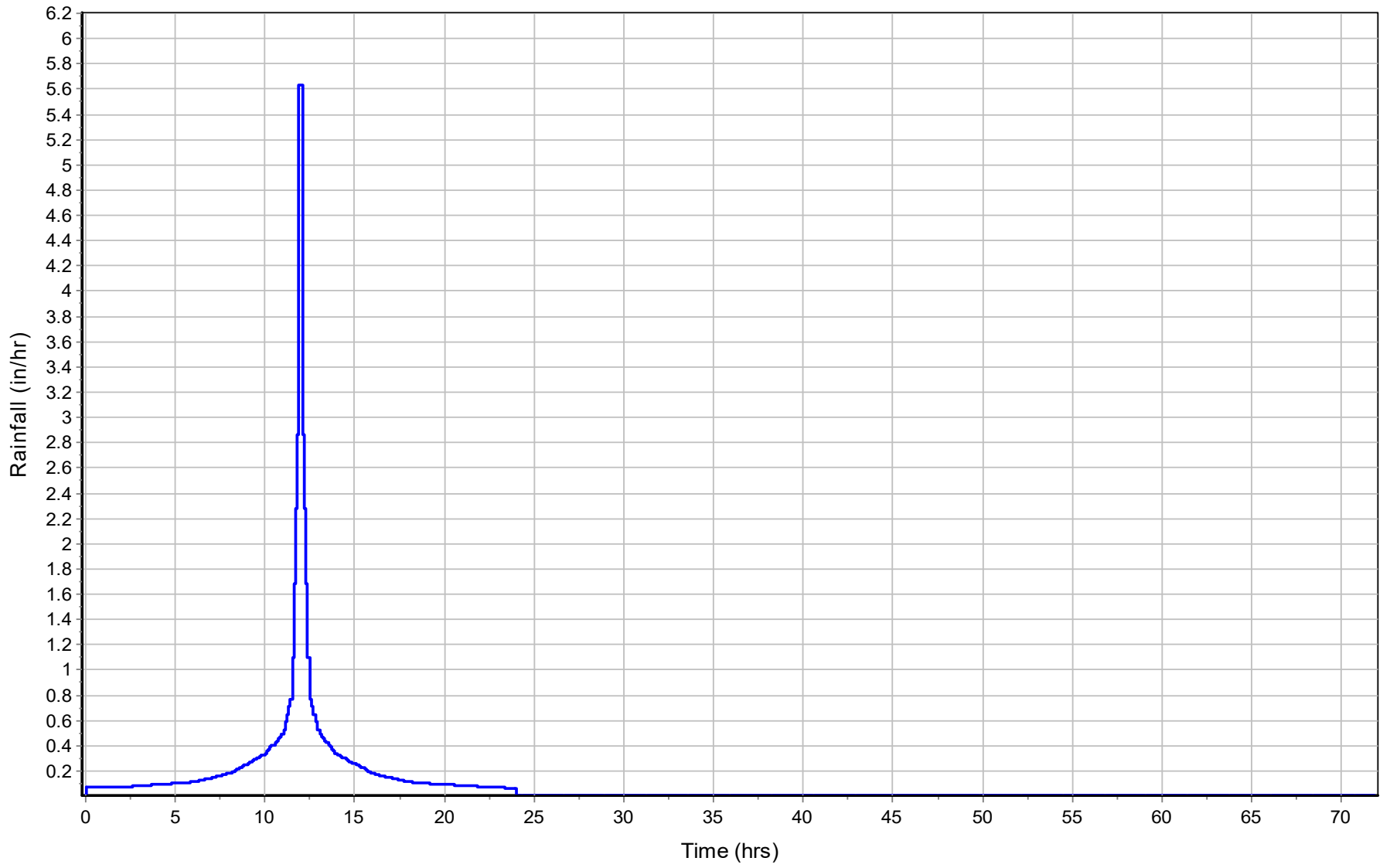
Total TOC (min) 36.49

Subbasin Runoff Results

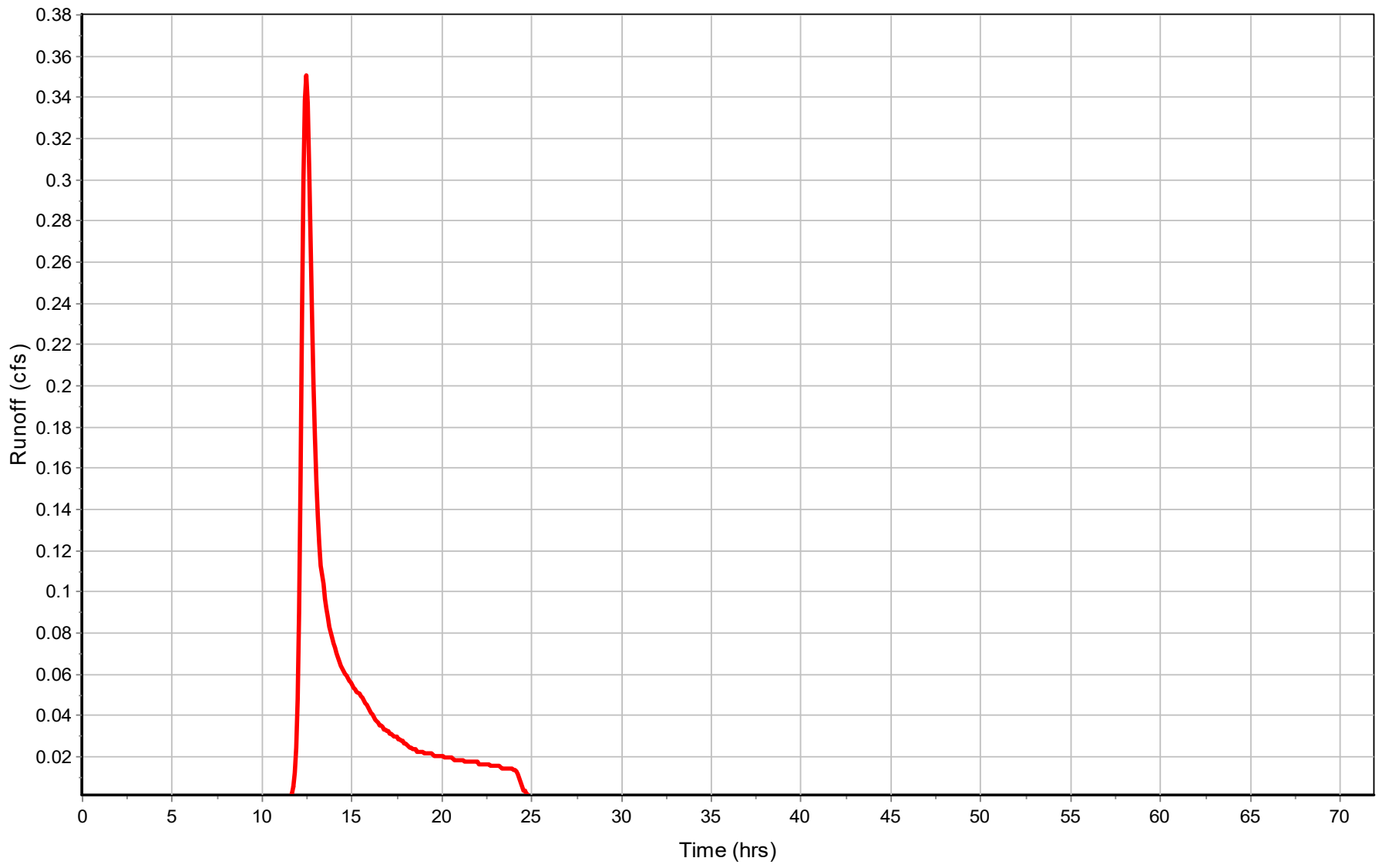
Total Rainfall (in)	6.7
Total Runoff (in)	1.65
Peak Runoff (cfs)	0.35
Weighted Curve Number	51.7
Time of Concentration (days hh:mm:ss)	0 00:36:29

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

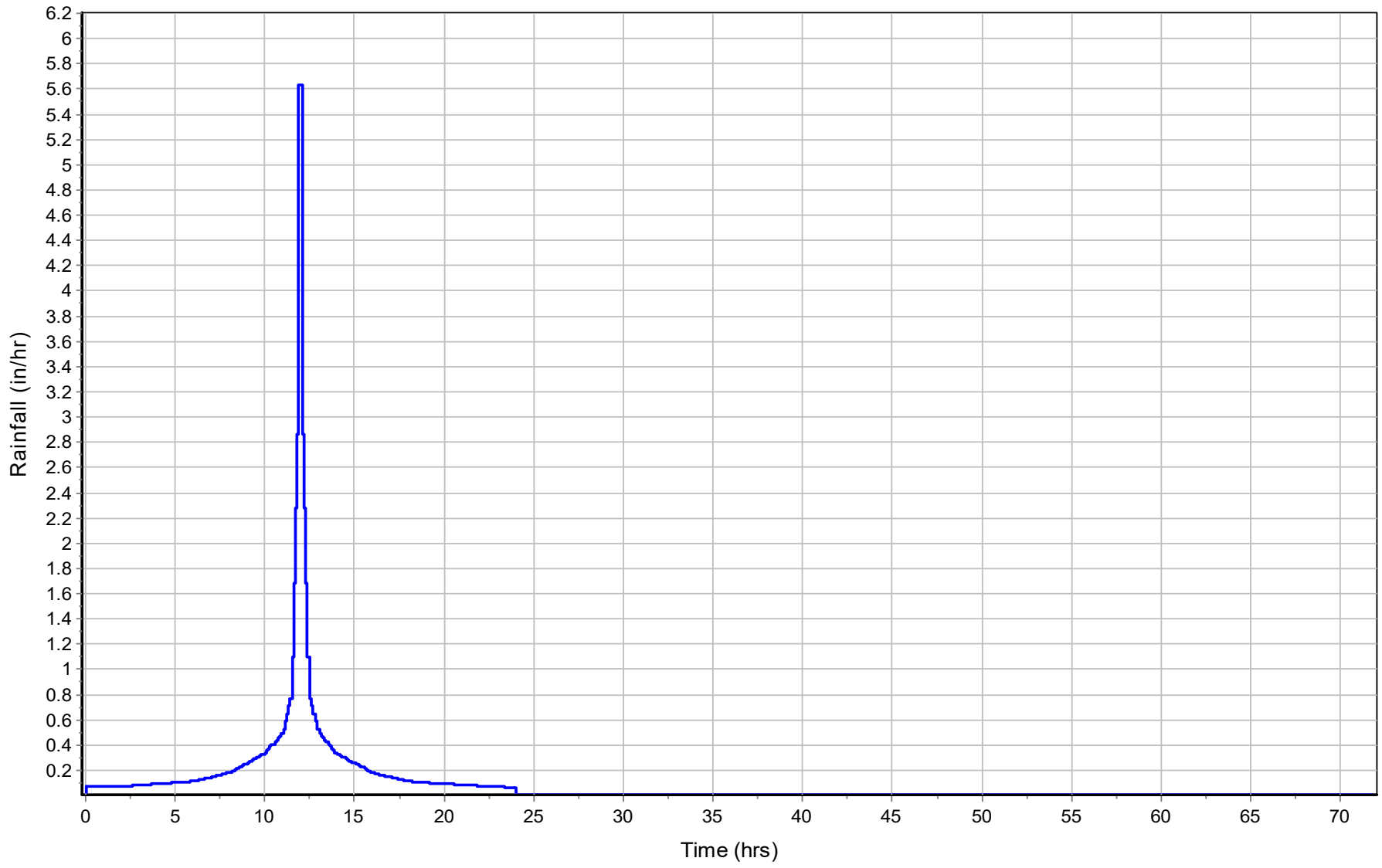
Total TOC (min) 42.87

Subbasin Runoff Results

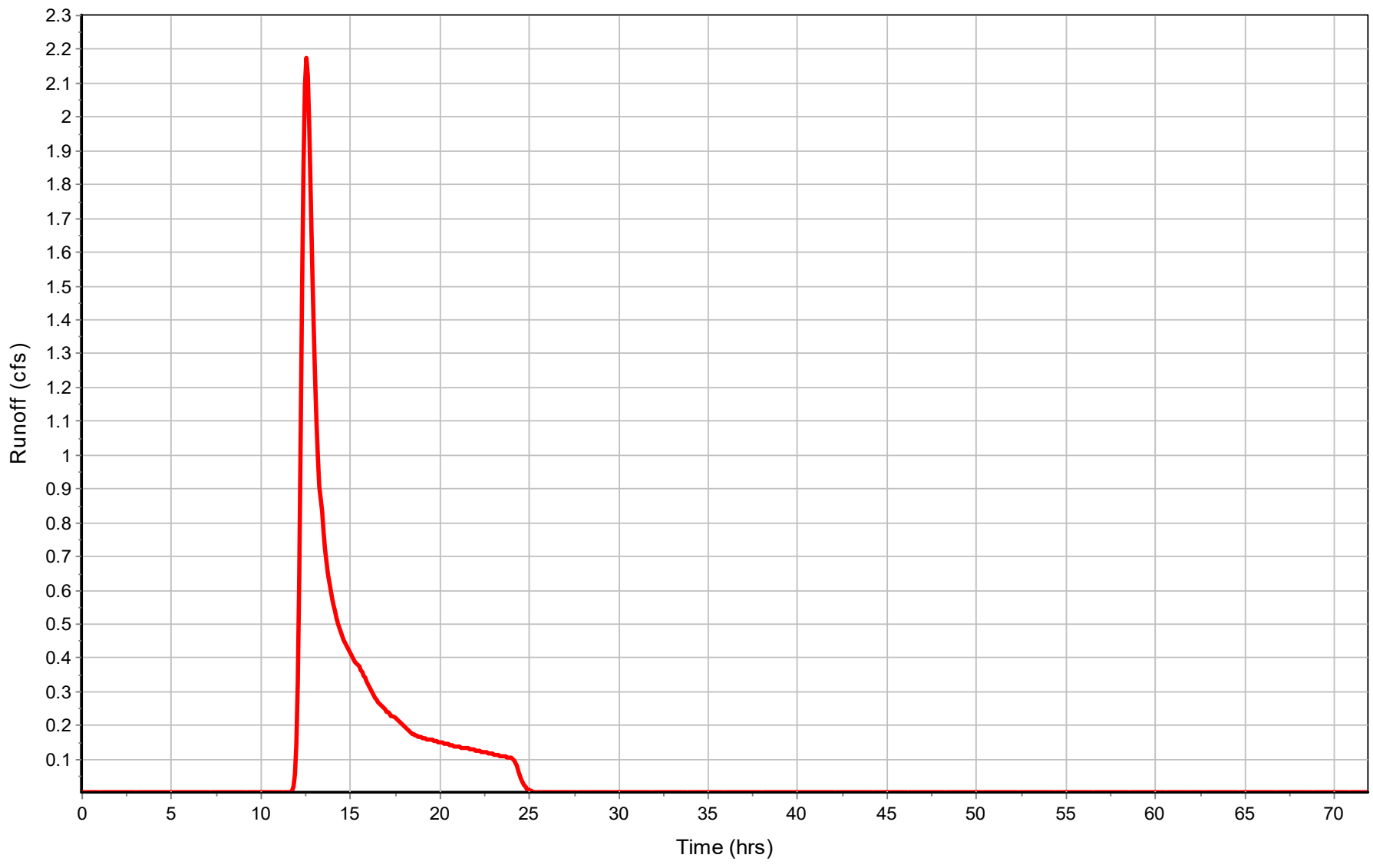
Total Rainfall (in)	6.7
Total Runoff (in)	1.42
Peak Runoff (cfs)	2.18
Weighted Curve Number	49
Time of Concentration (days hh:mm:ss)	0 00:42:52

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

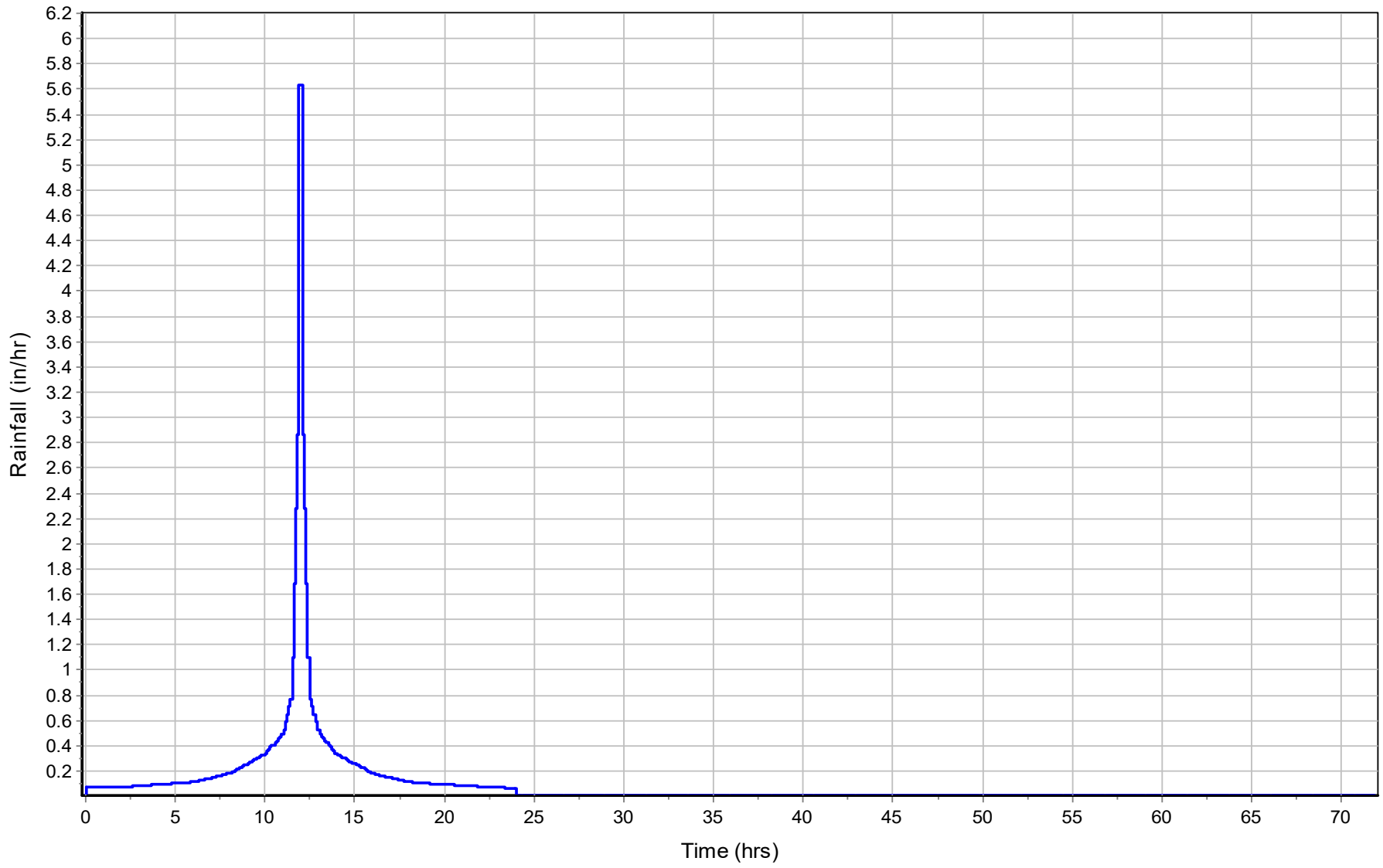
Total TOC (min) 14.50

Subbasin Runoff Results

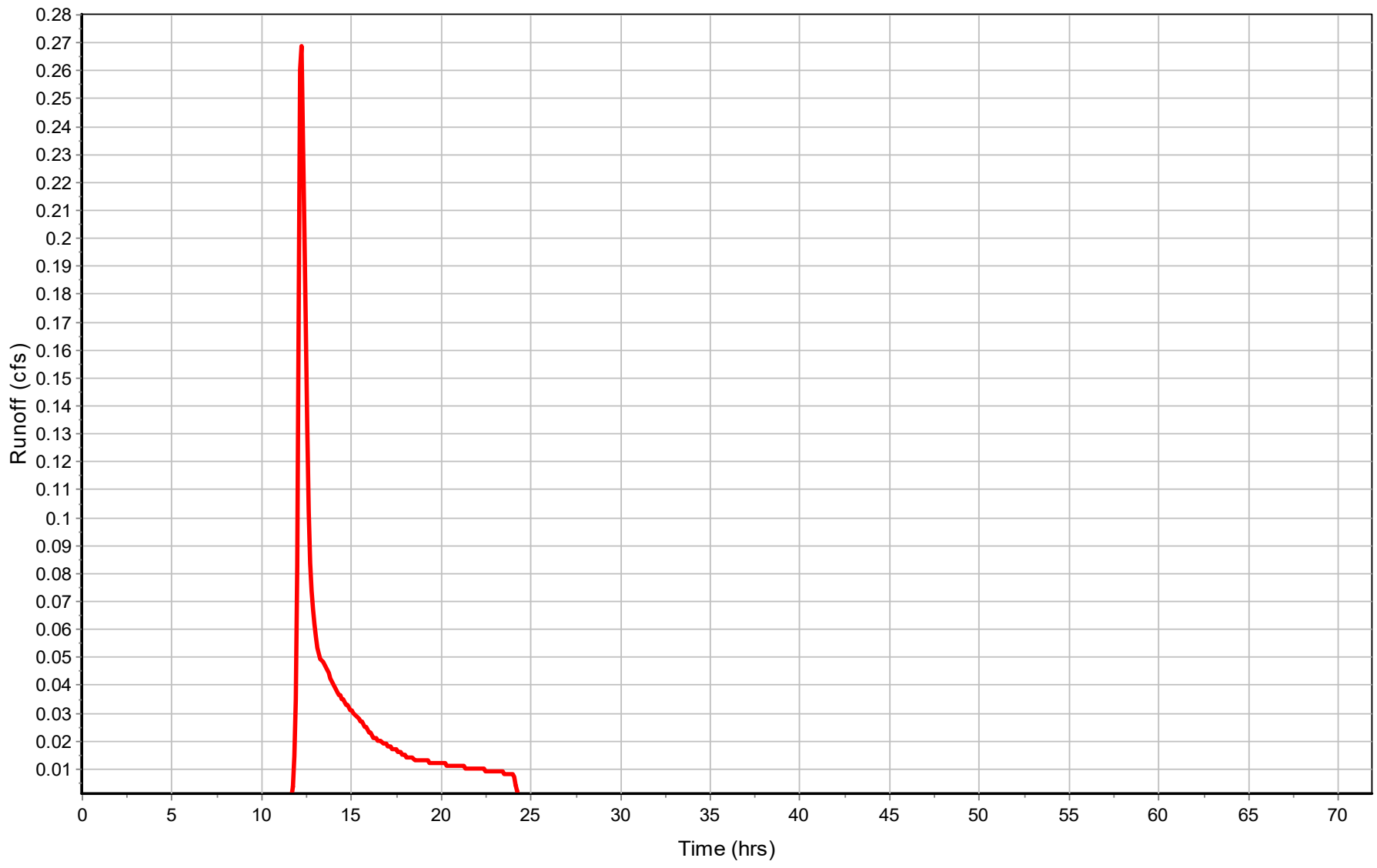
Total Rainfall (in)	6.7
Total Runoff (in)	1.42
Peak Runoff (cfs)	0.27
Weighted Curve Number	49
Time of Concentration (days hh:mm:ss)	0 00:14:30

Subbasin : Existing-E5.1_A2

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : A1-1-BASIN

Input Data

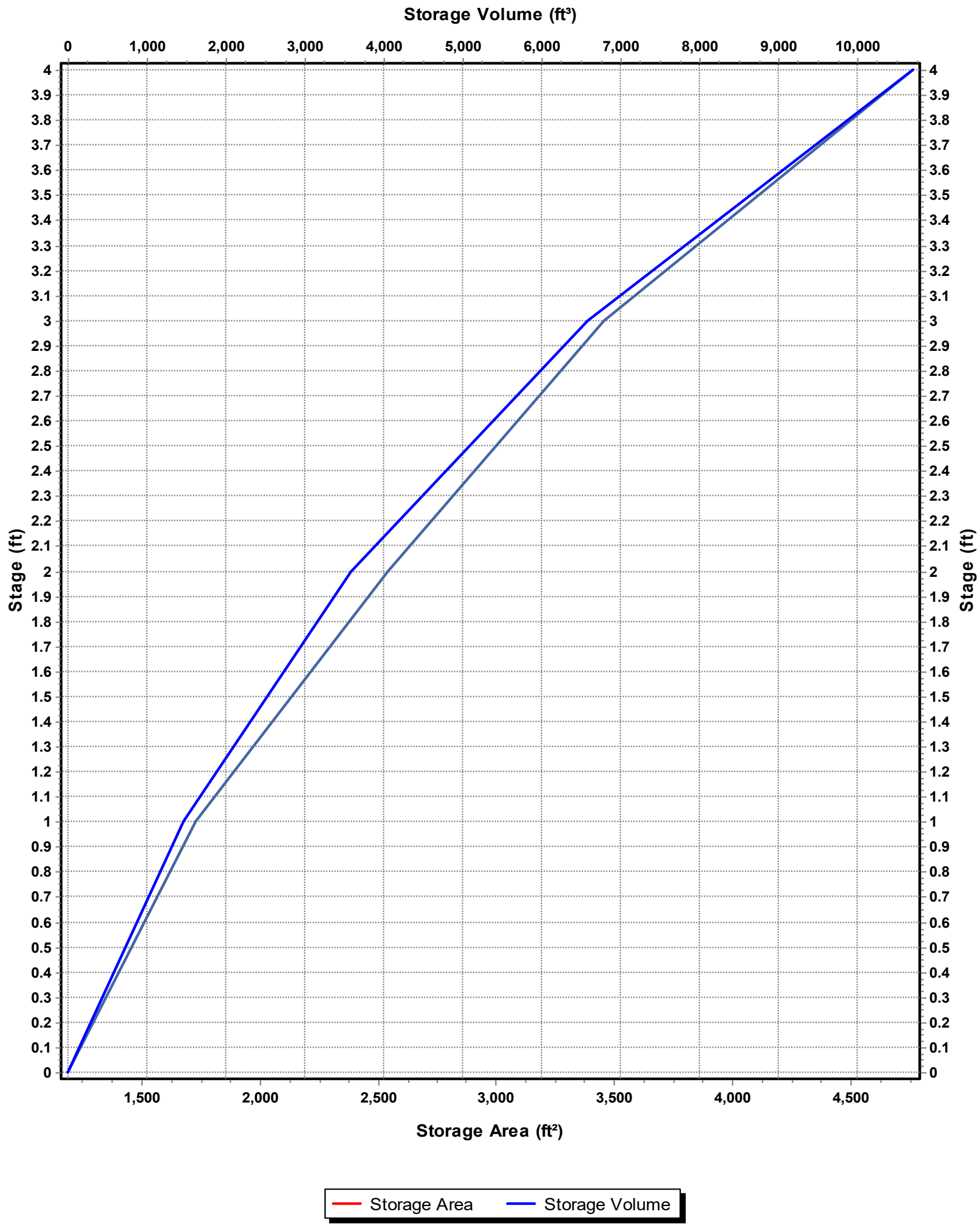
Invert Elevation (ft)	66.00
Max (Rim) Elevation (ft)	69.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	66.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

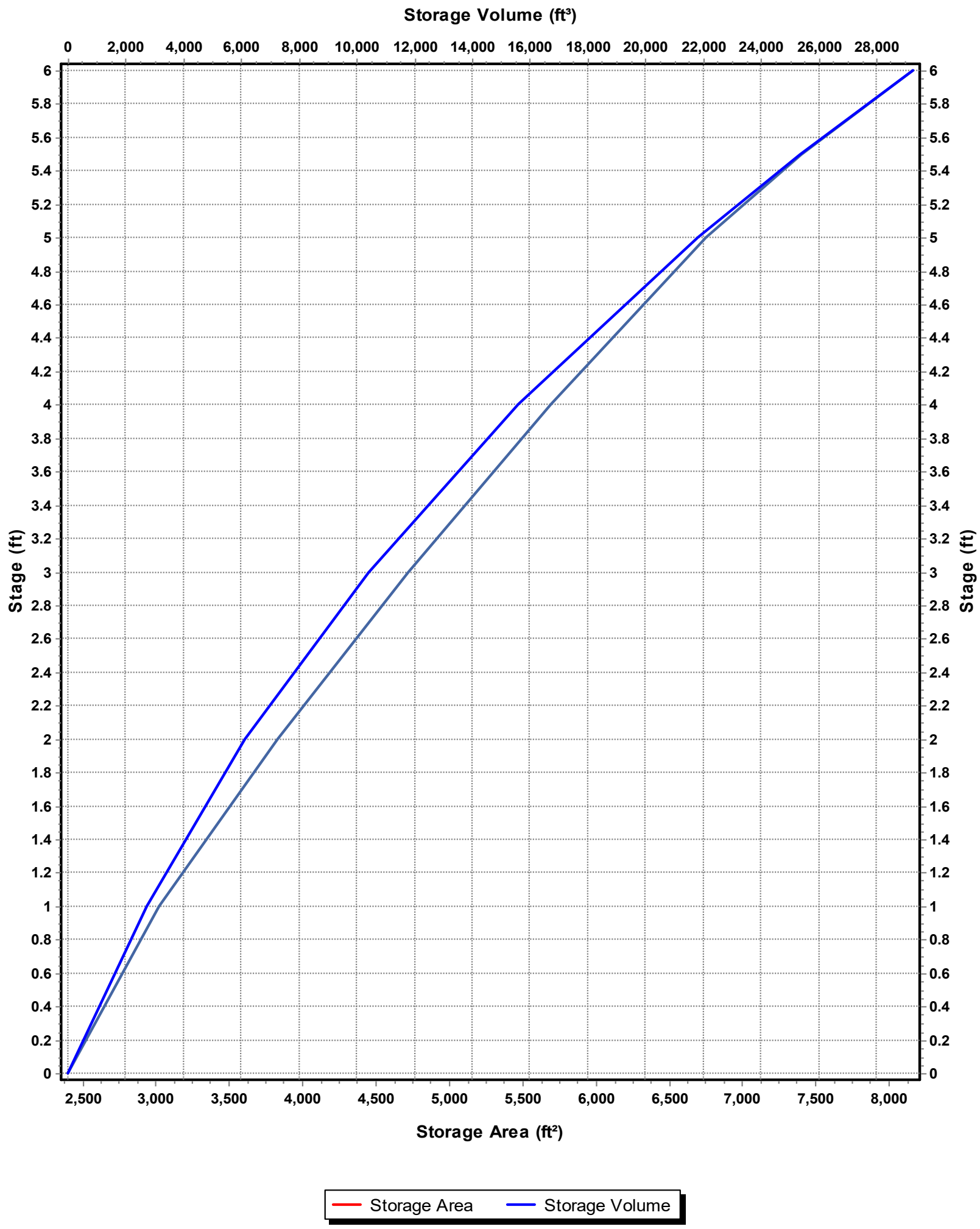
Invert Elevation (ft)	63.00
Max (Rim) Elevation (ft)	69.00
Max (Rim) Offset (ft)	6.00
Initial Water Elevation (ft)	63.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

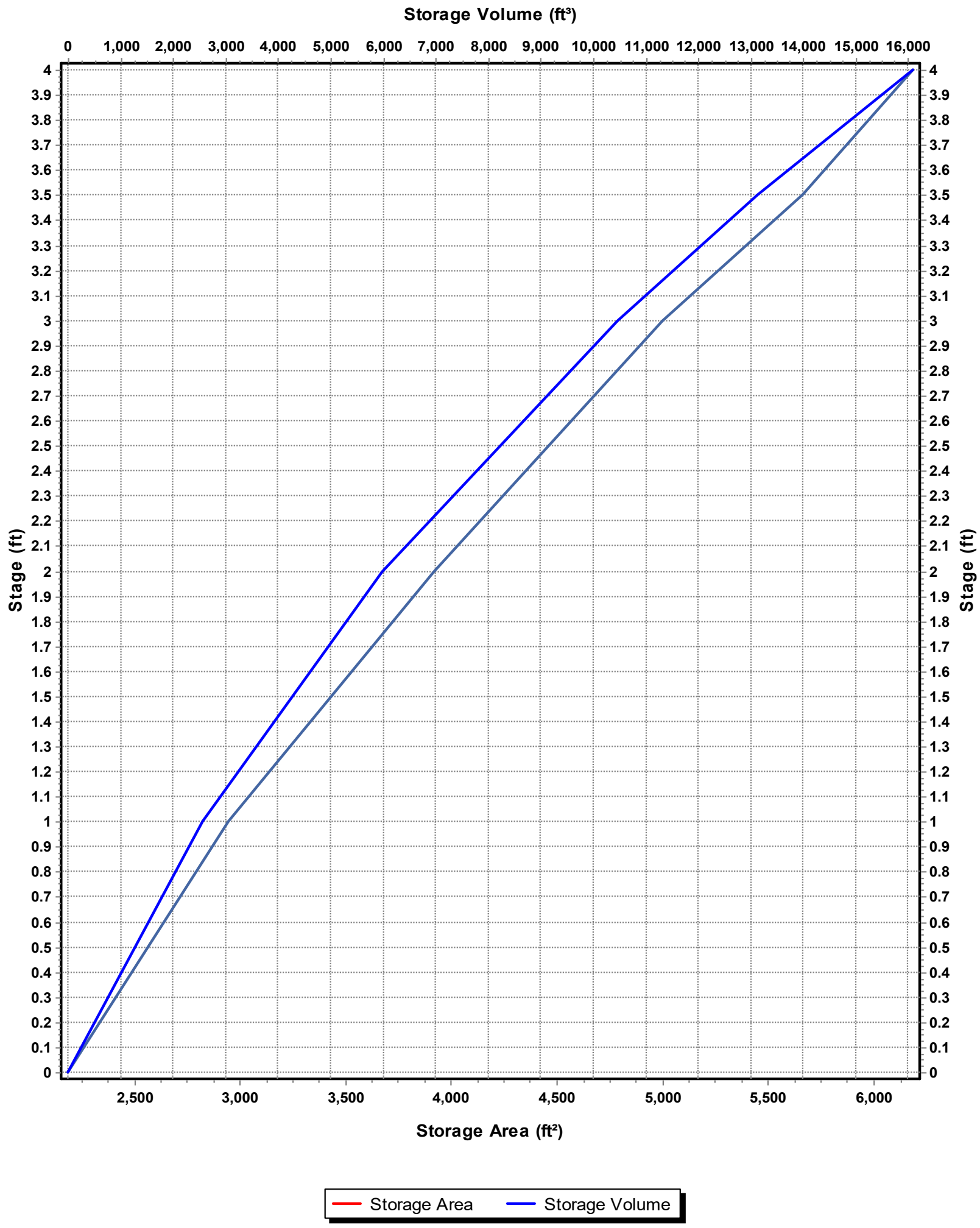
Invert Elevation (ft)	63.00
Max (Rim) Elevation (ft)	67.00
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	63.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

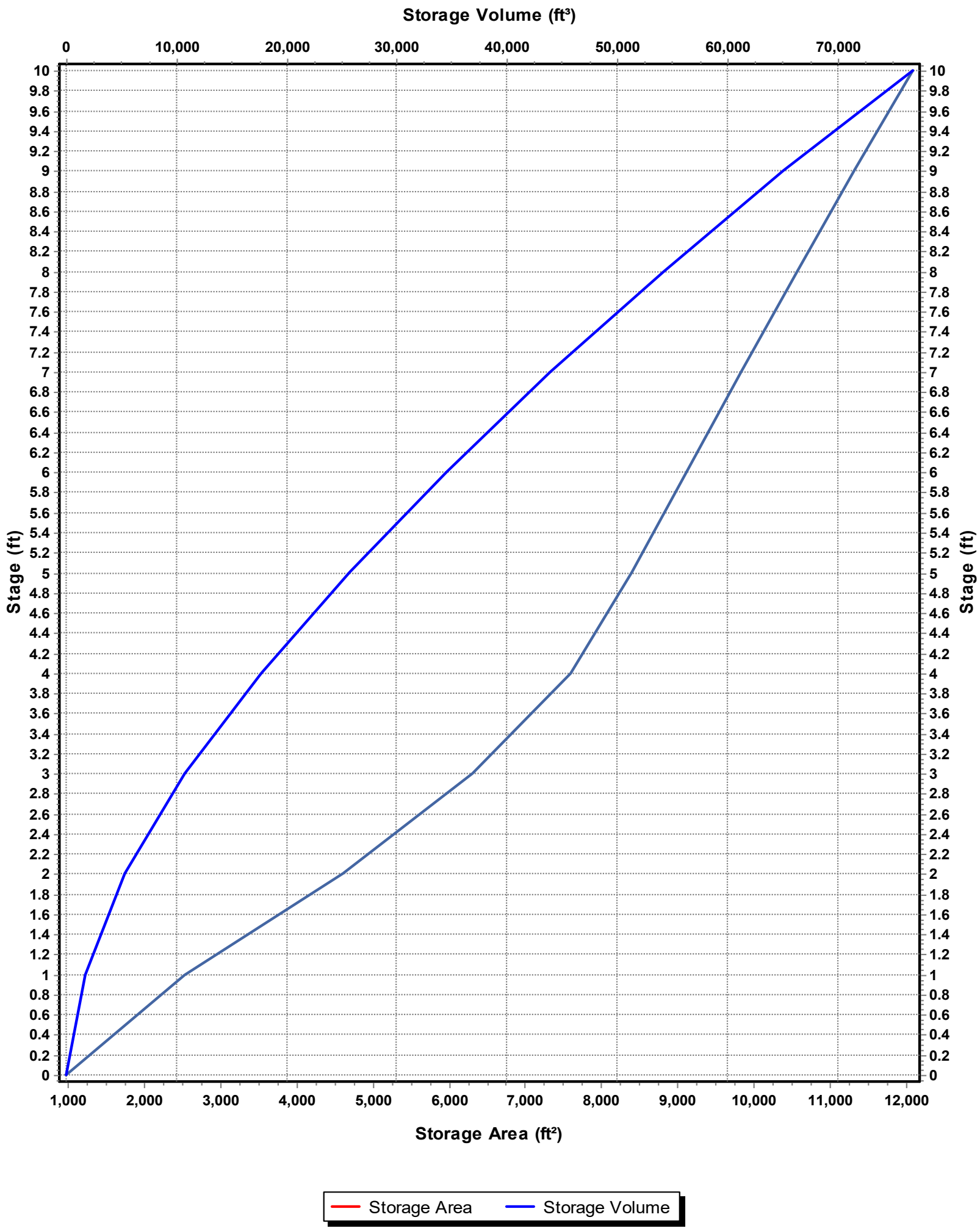
Invert Elevation (ft)	43.00
Max (Rim) Elevation (ft)	53.00
Max (Rim) Offset (ft)	10.00
Initial Water Elevation (ft)	43.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

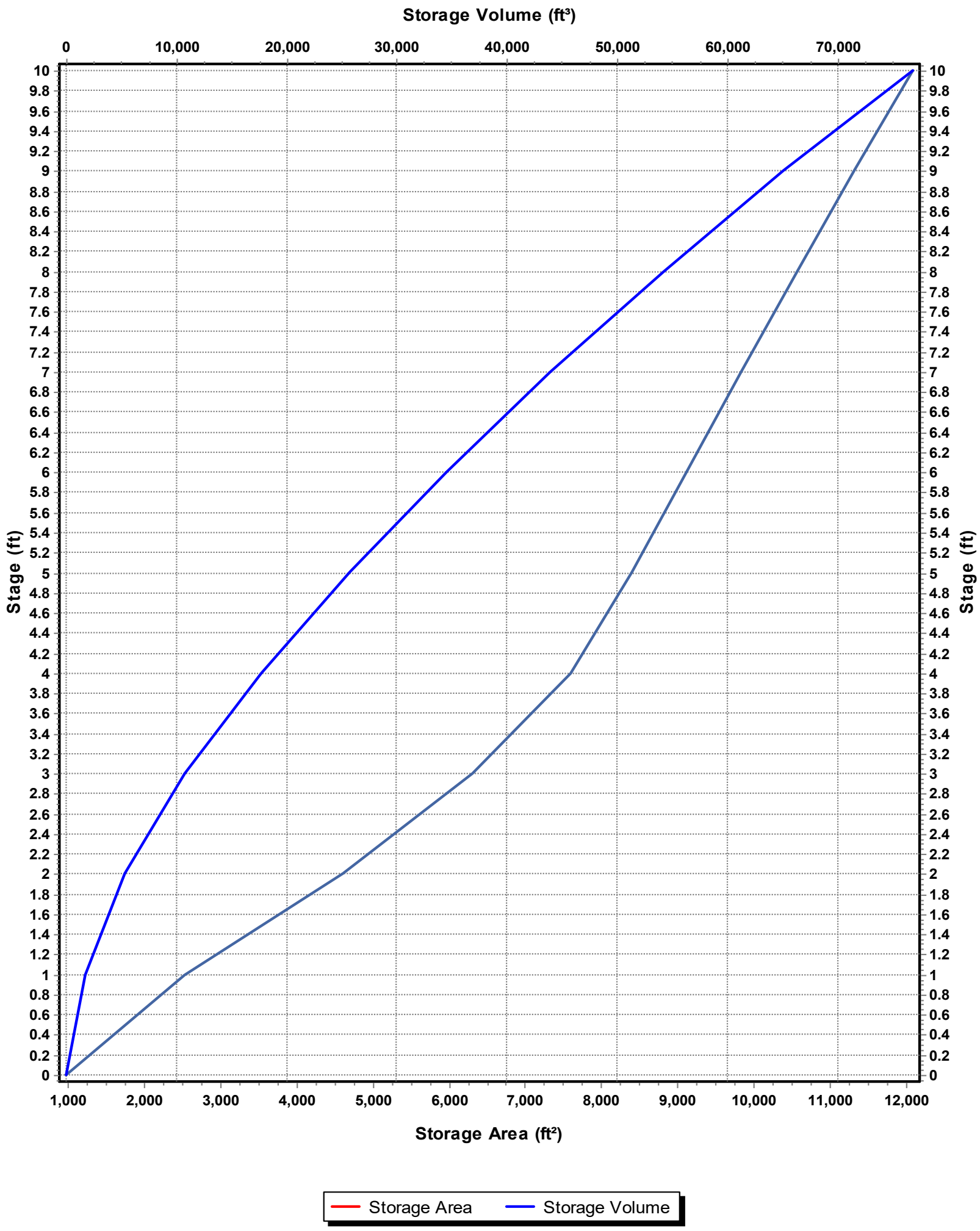
Invert Elevation (ft)	43.00
Max (Rim) Elevation (ft)	53.00
Max (Rim) Offset (ft)	10.00
Initial Water Elevation (ft)	43.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

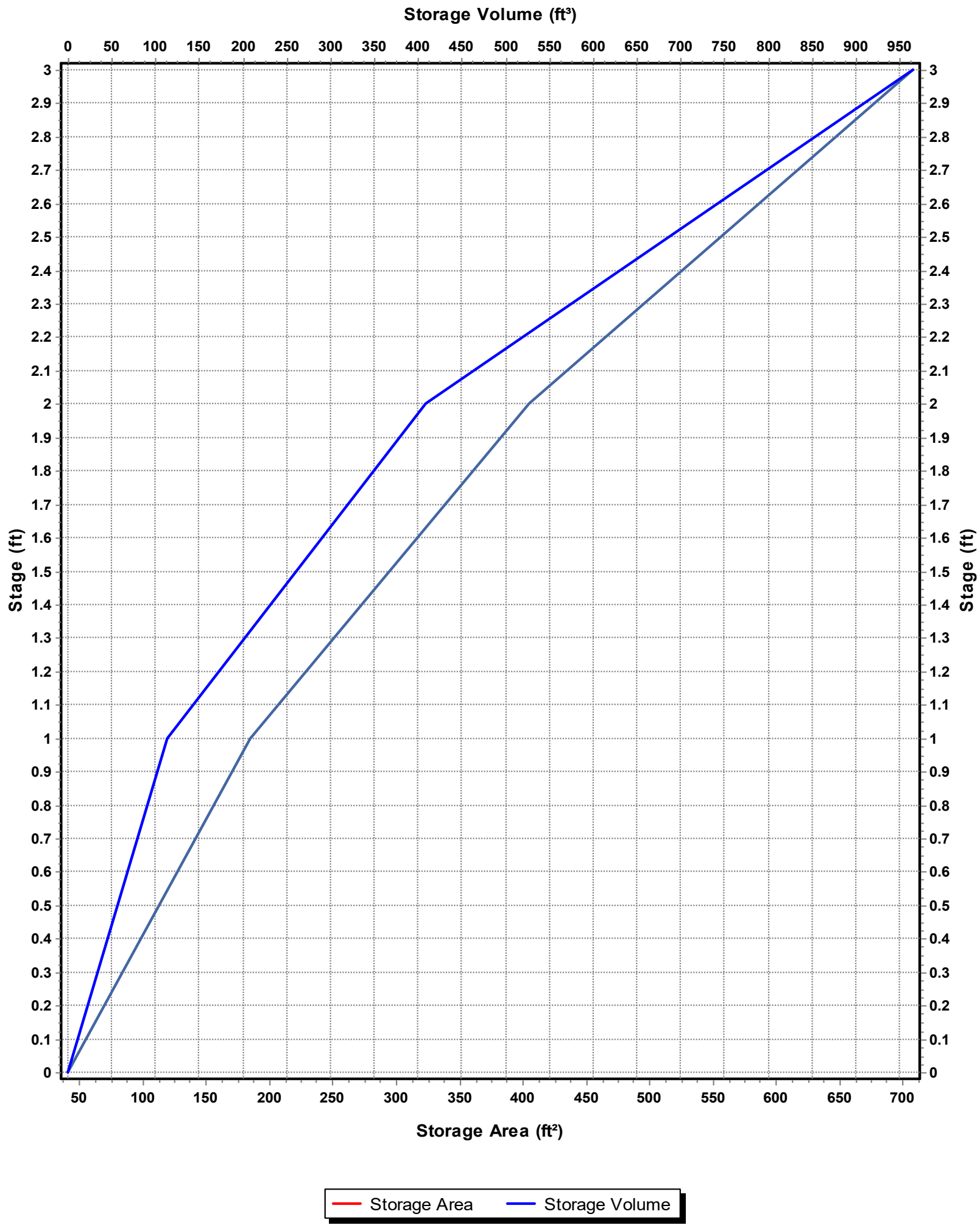
Invert Elevation (ft)	66.00
Max (Rim) Elevation (ft)	70.00
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	66.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

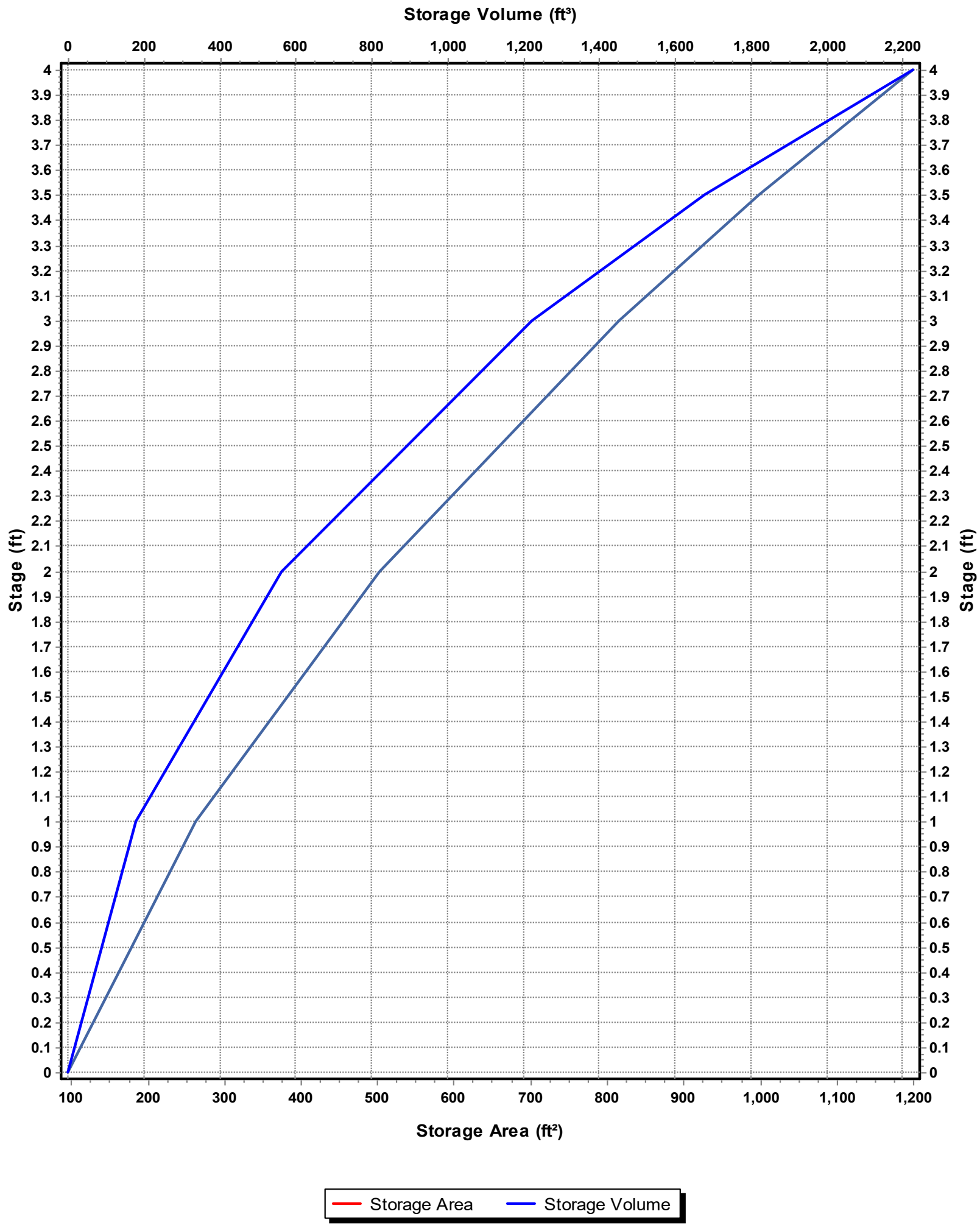
Invert Elevation (ft)	62.00
Max (Rim) Elevation (ft)	66.00
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	62.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

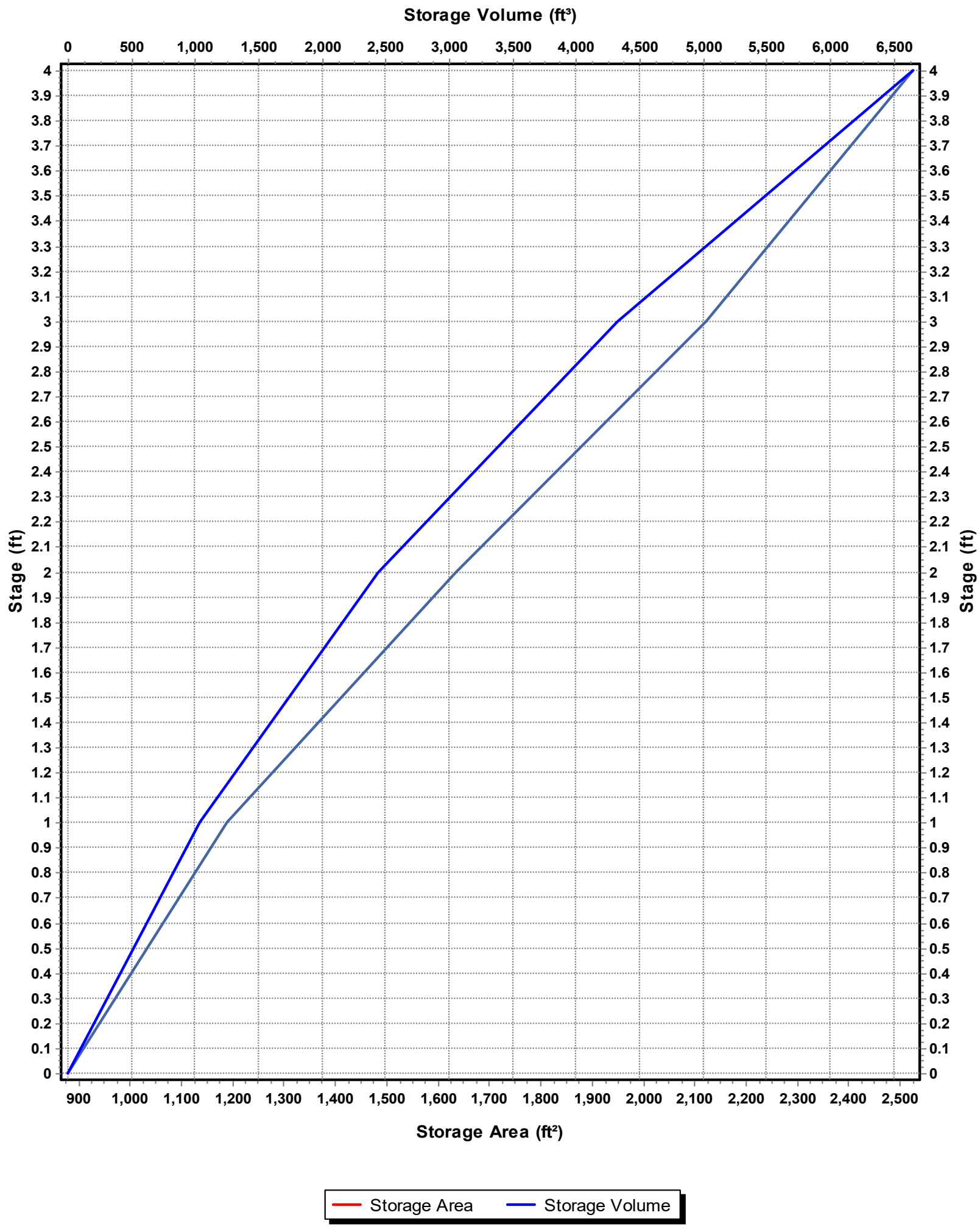
Invert Elevation (ft)	65.00
Max (Rim) Elevation (ft)	69.00
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	65.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

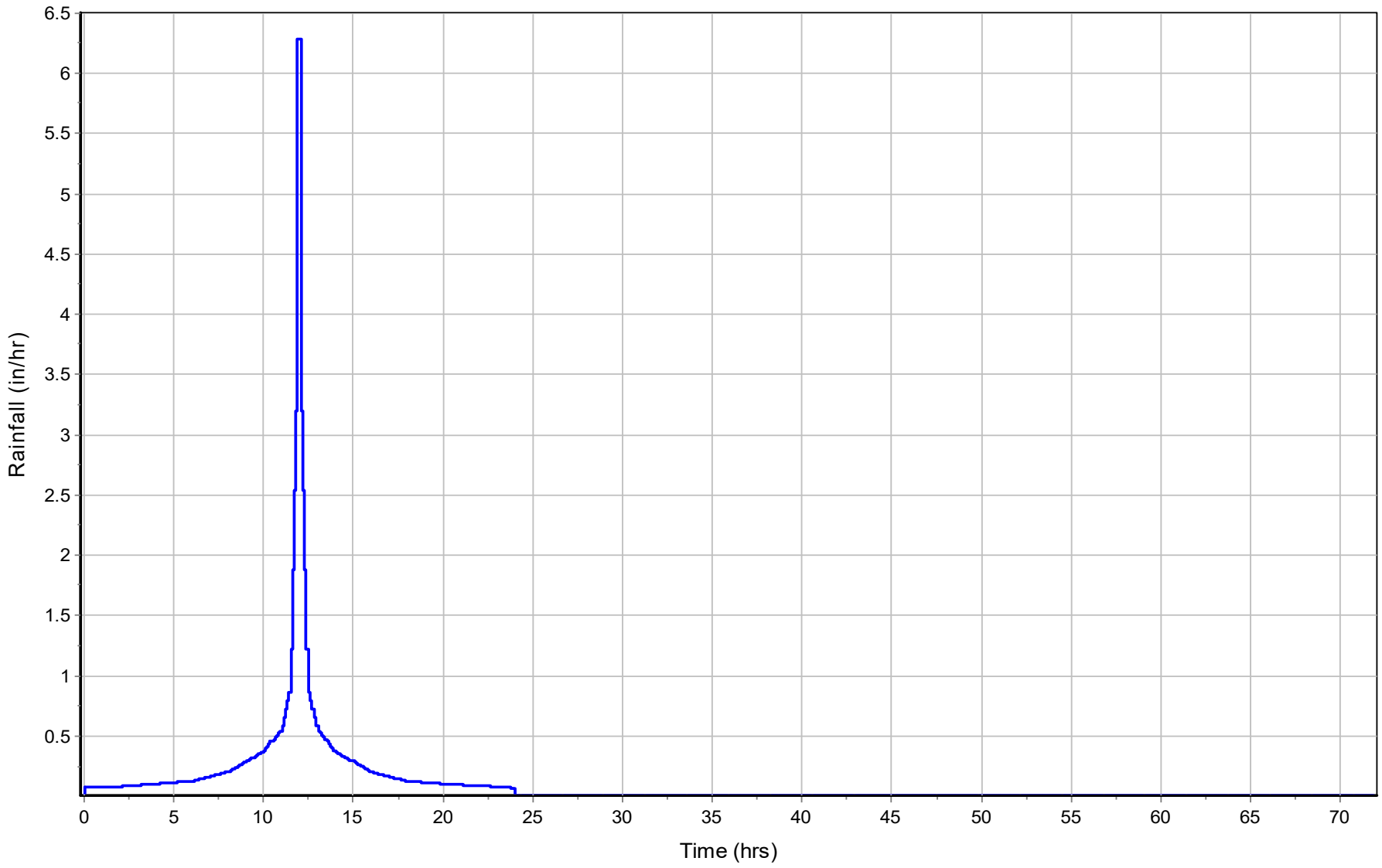
Total TOC (min) 4.58

Subbasin Runoff Results

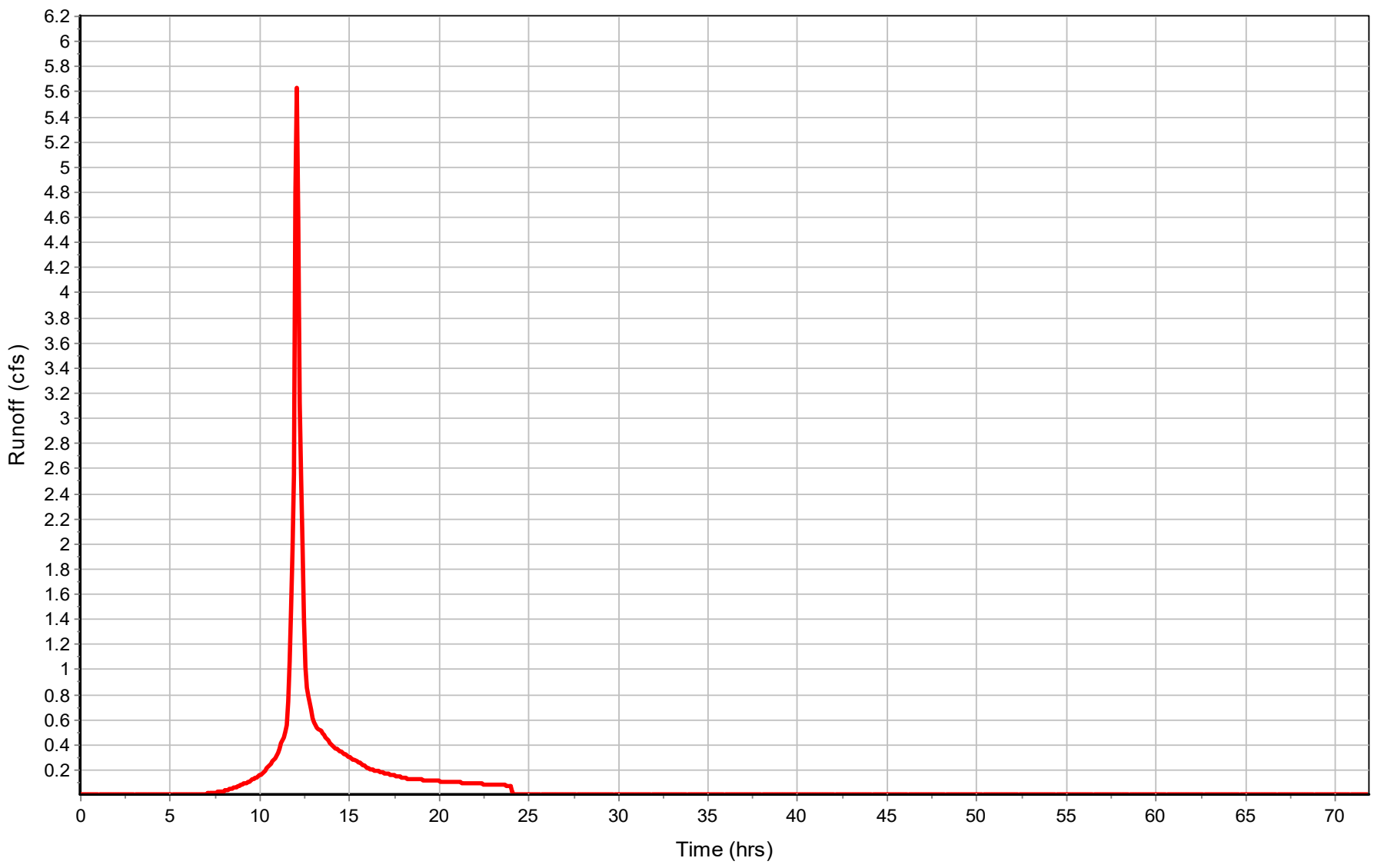
Total Rainfall (in) 7.47
Total Runoff (in) 4.68
Peak Runoff (cfs) 5.73
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:04:35

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

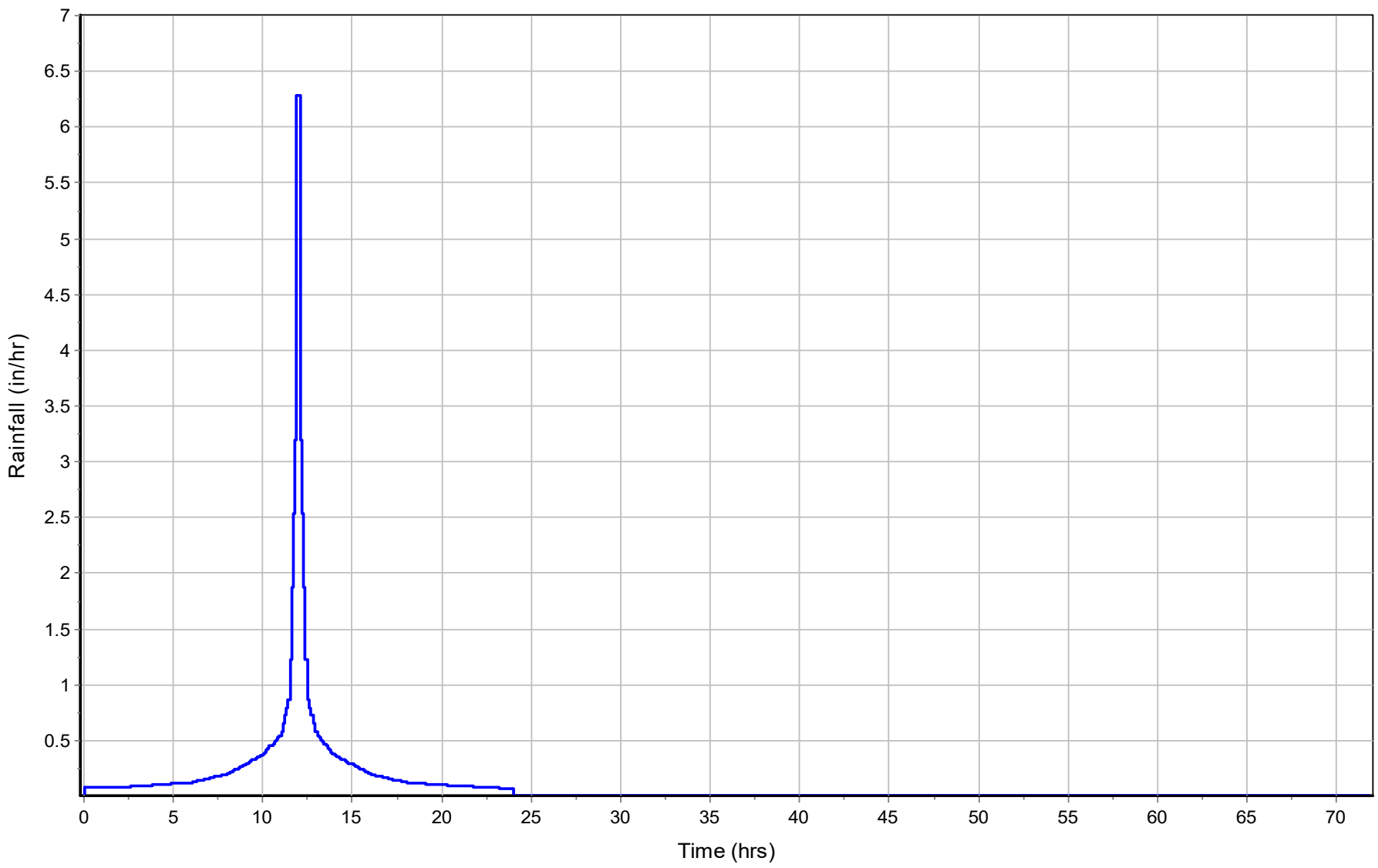
Total TOC (min) 10.92

Subbasin Runoff Results

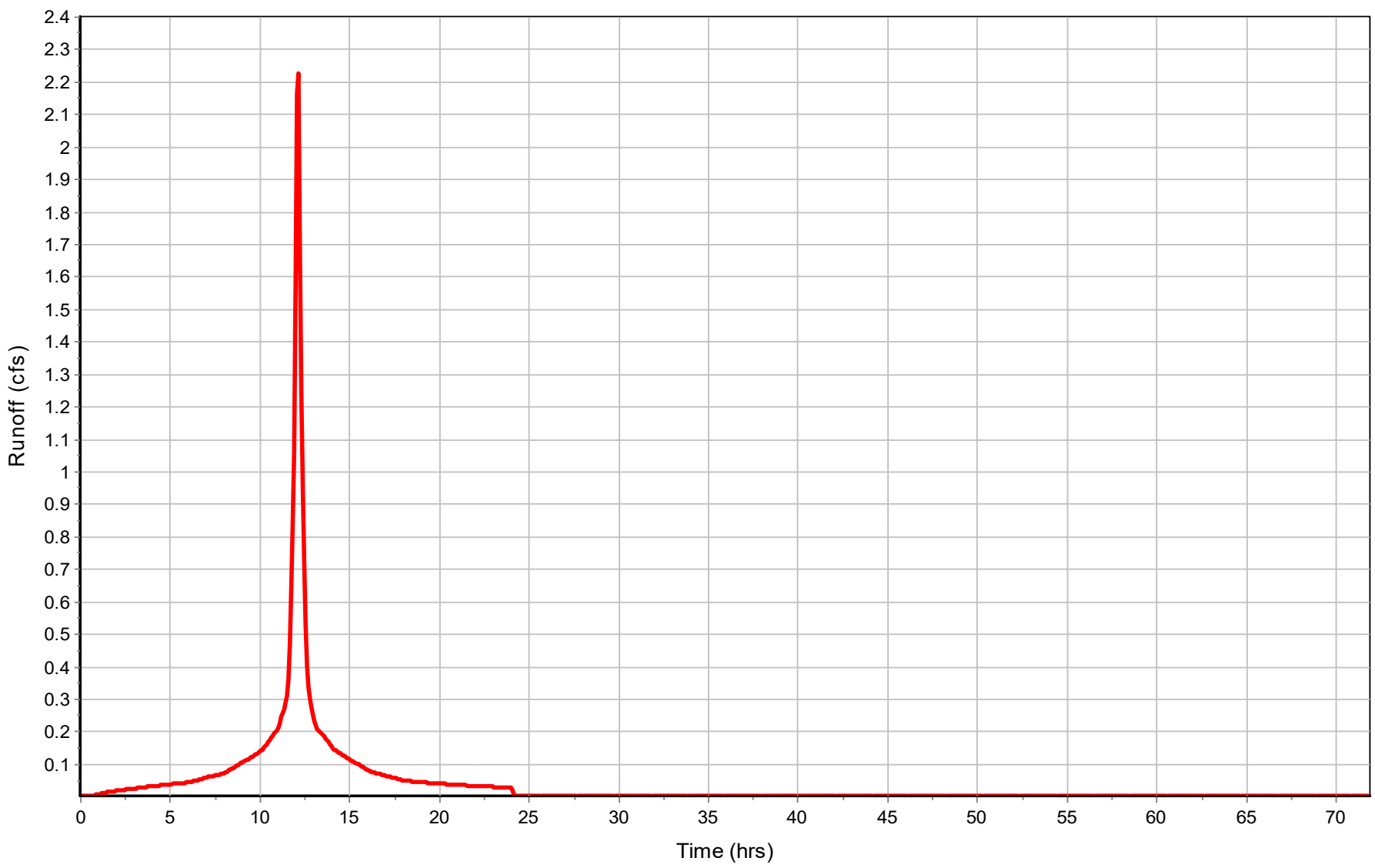
Total Rainfall (in) 7.47
Total Runoff (in) 7.23
Peak Runoff (cfs) 2.29
Weighted Curve Number 98
Time of Concentration (days hh:mm:ss) 0 00:10:55

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

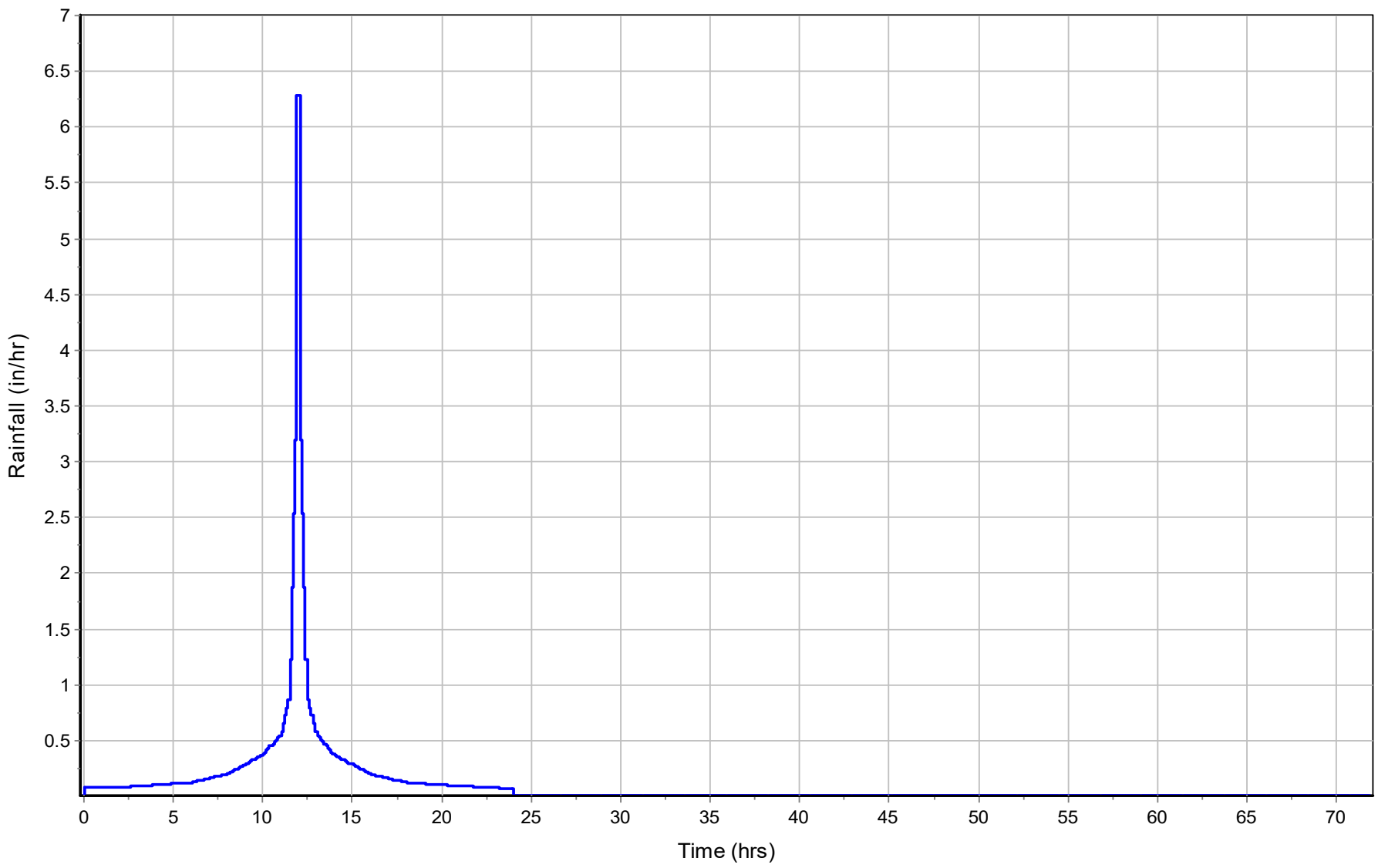
Total TOC (min) 3.41

Subbasin Runoff Results

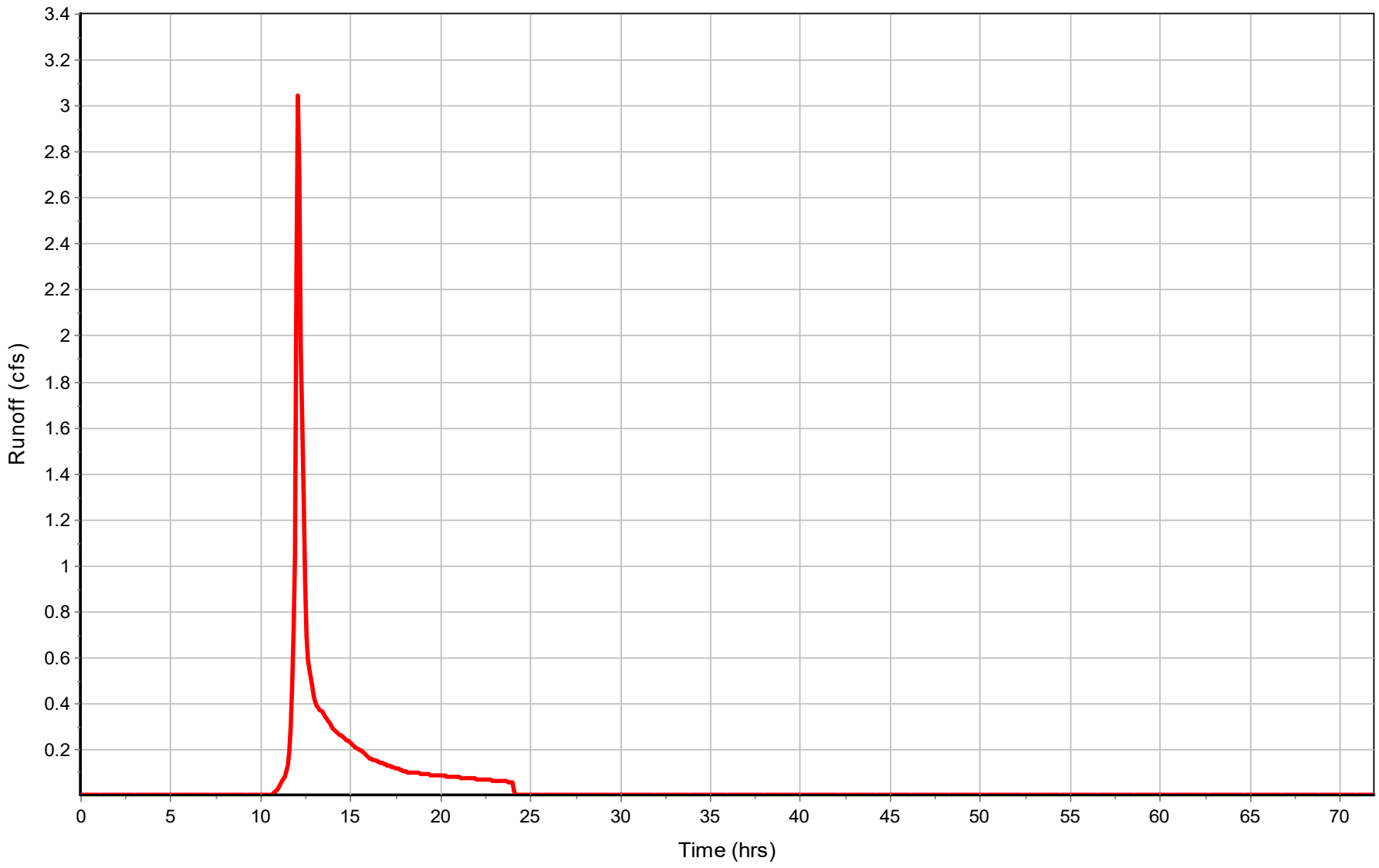
Total Rainfall (in) 7.47
Total Runoff (in) 2.39
Peak Runoff (cfs) 3.24
Weighted Curve Number 54.63
Time of Concentration (days hh:mm:ss) 0 00:03:25

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

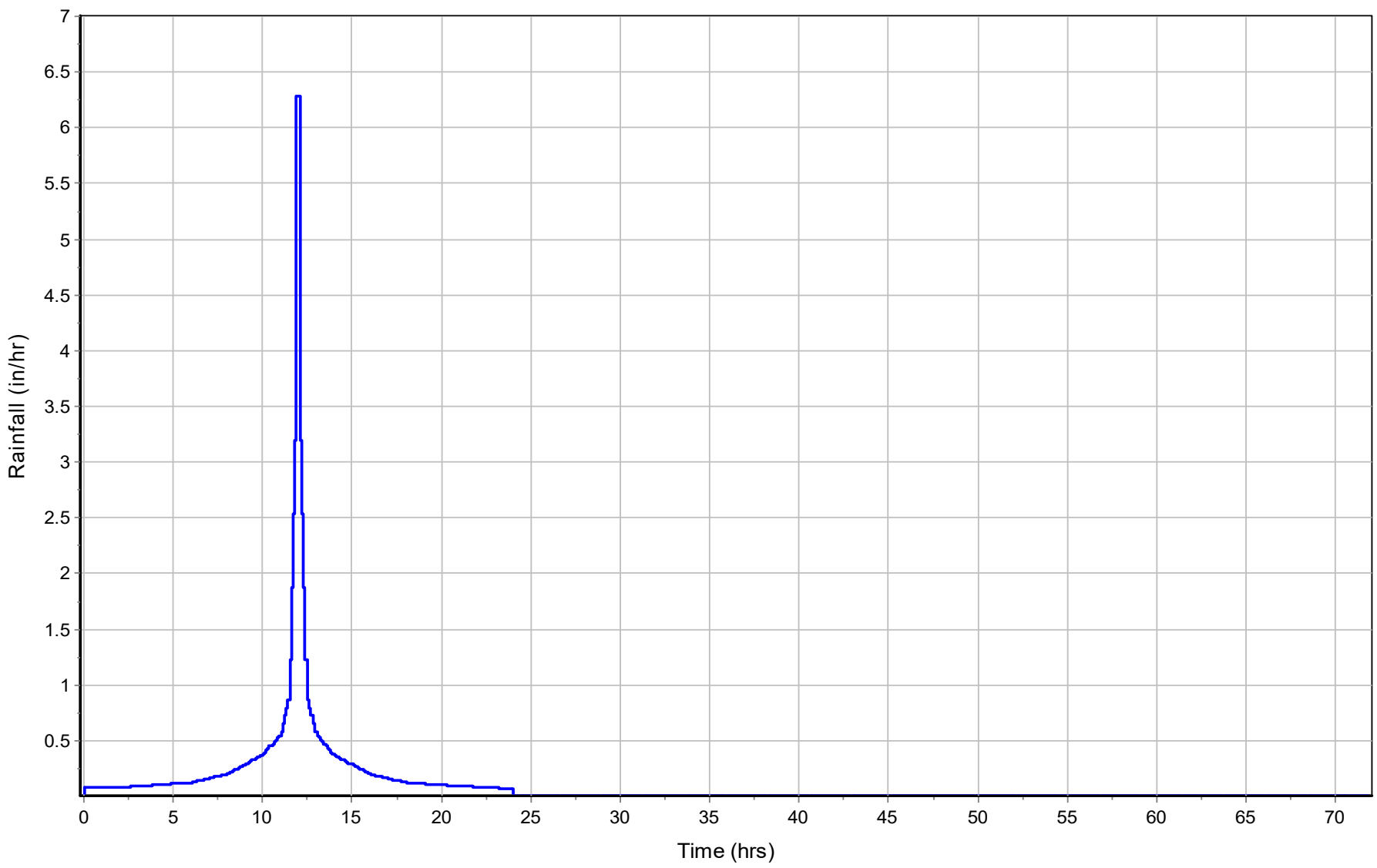
Total TOC (min) 40.27

Subbasin Runoff Results

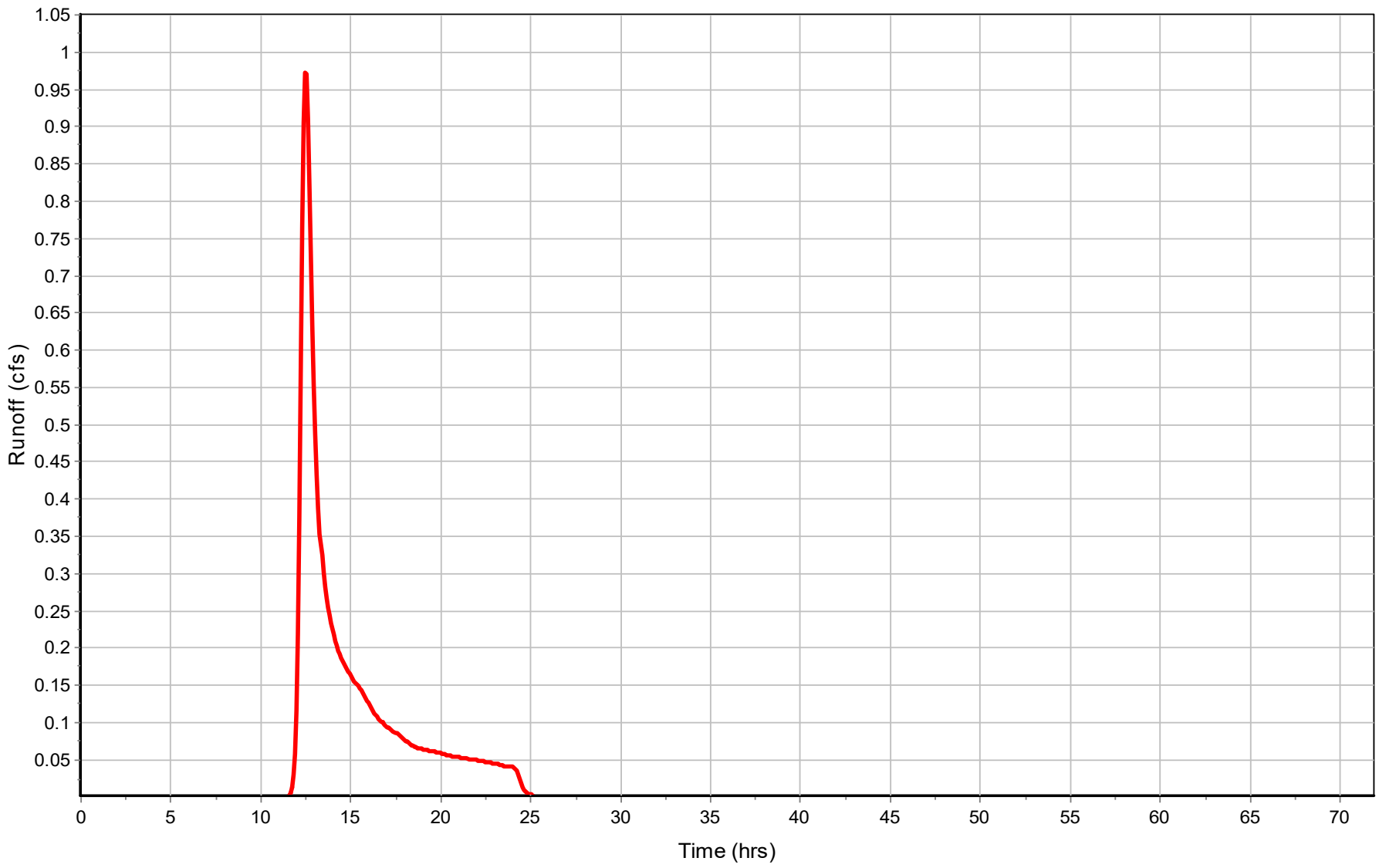
Total Rainfall (in) 7.47
Total Runoff (in) 1.84
Peak Runoff (cfs) 0.98
Weighted Curve Number 49
Time of Concentration (days hh:mm:ss) 0 00:40:16

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

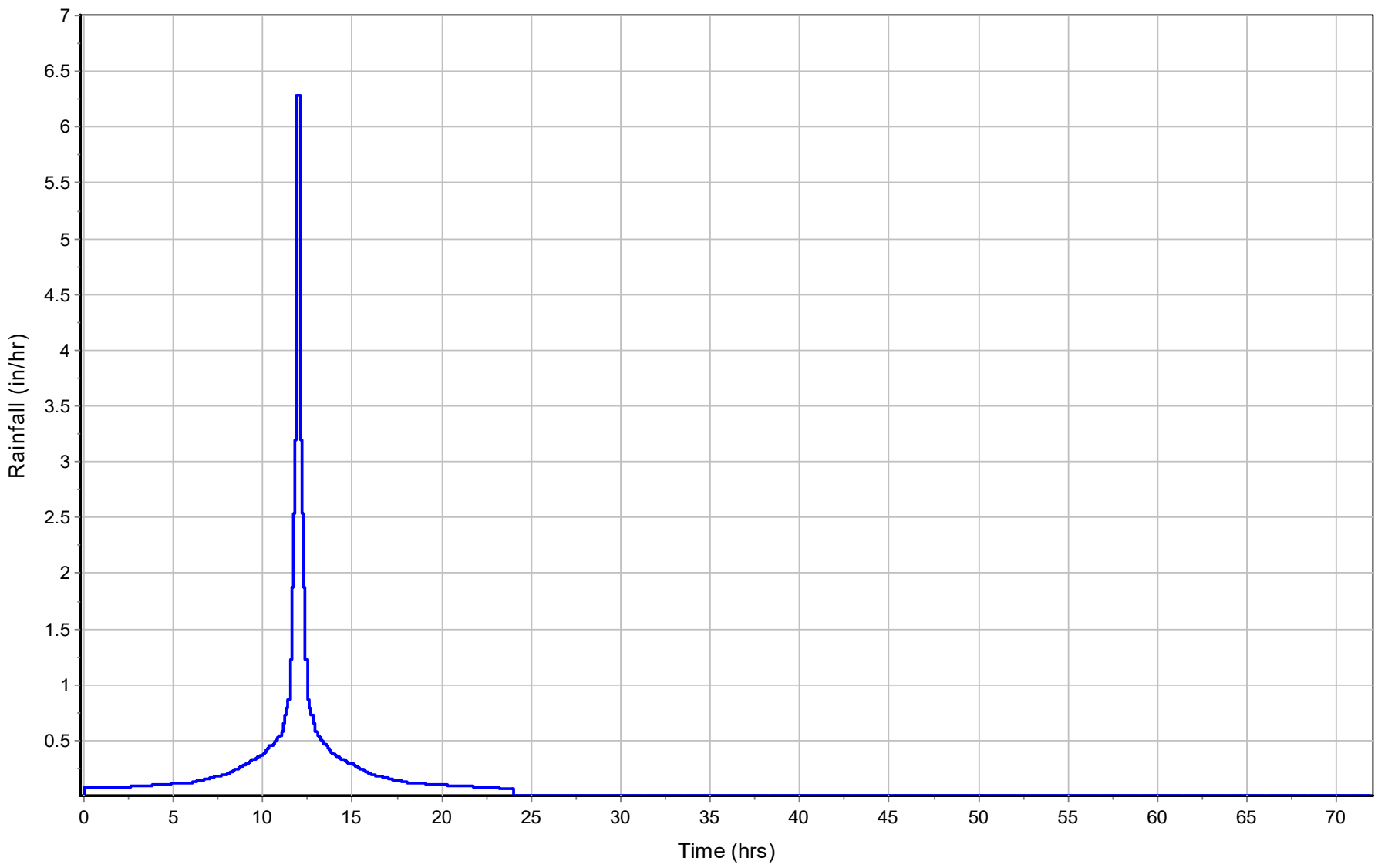
Total TOC (min) 3.51

Subbasin Runoff Results

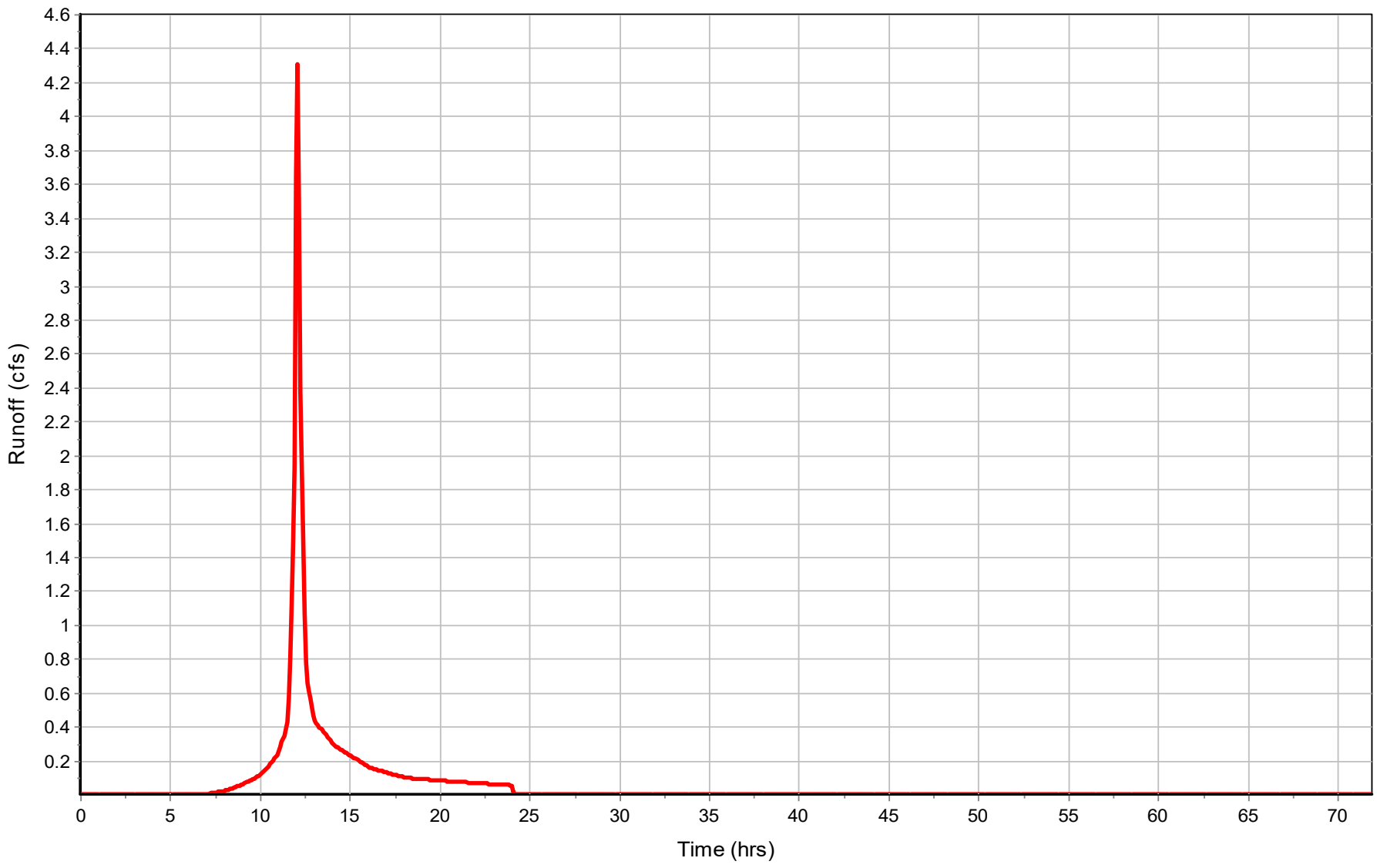
Total Rainfall (in) 7.47
Total Runoff (in) 4.68
Peak Runoff (cfs) 4.39
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:03:31

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

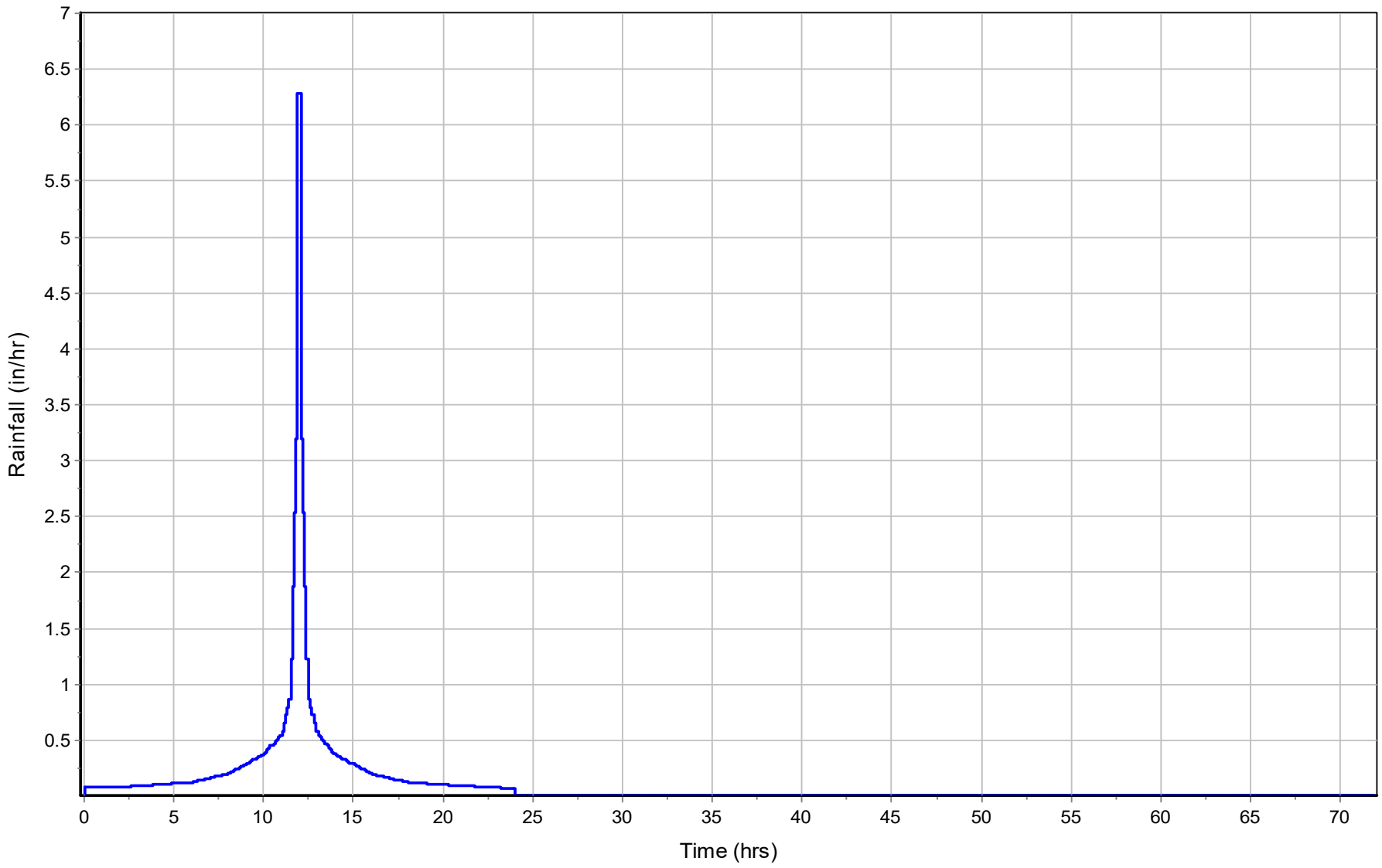
Total TOC (min) 36.12

Subbasin Runoff Results

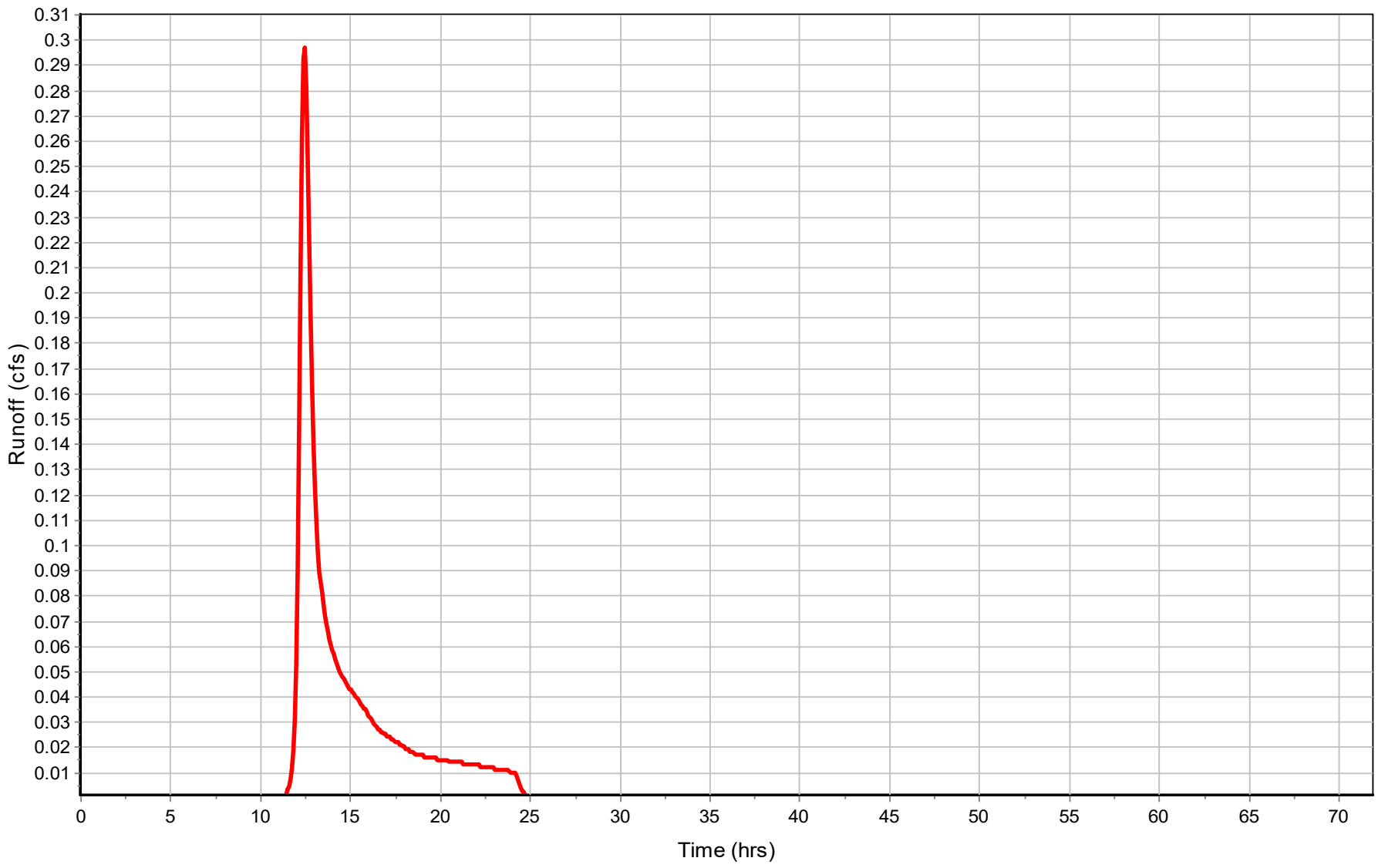
Total Rainfall (in) 7.47
Total Runoff (in) 2.1
Peak Runoff (cfs) 0.3
Weighted Curve Number 51.7
Time of Concentration (days hh:mm:ss) 0 00:36:07

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

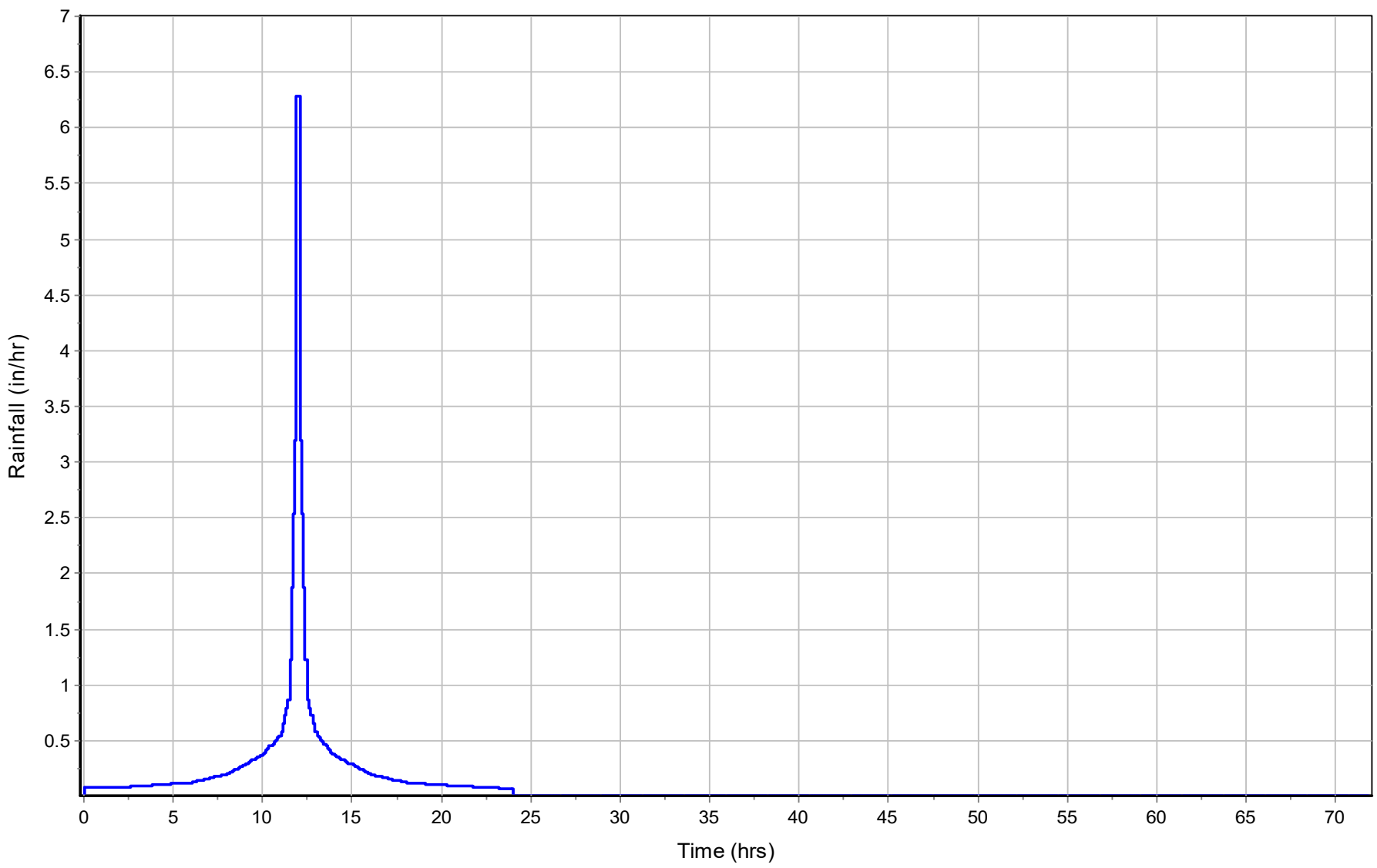
Total TOC (min) 3.14

Subbasin Runoff Results

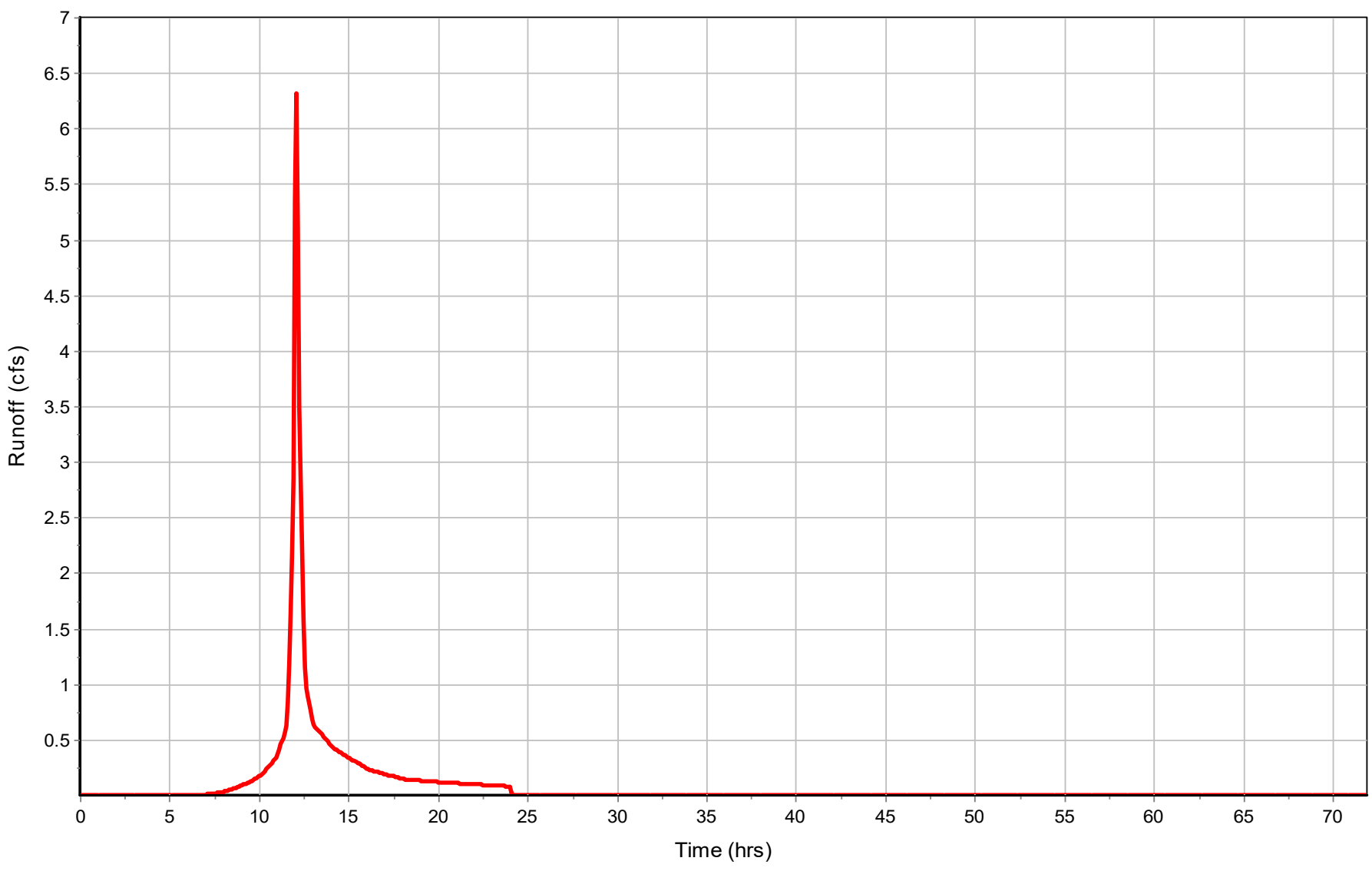
Total Rainfall (in) 7.47
Total Runoff (in) 4.68
Peak Runoff (cfs) 6.44
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:03:08

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

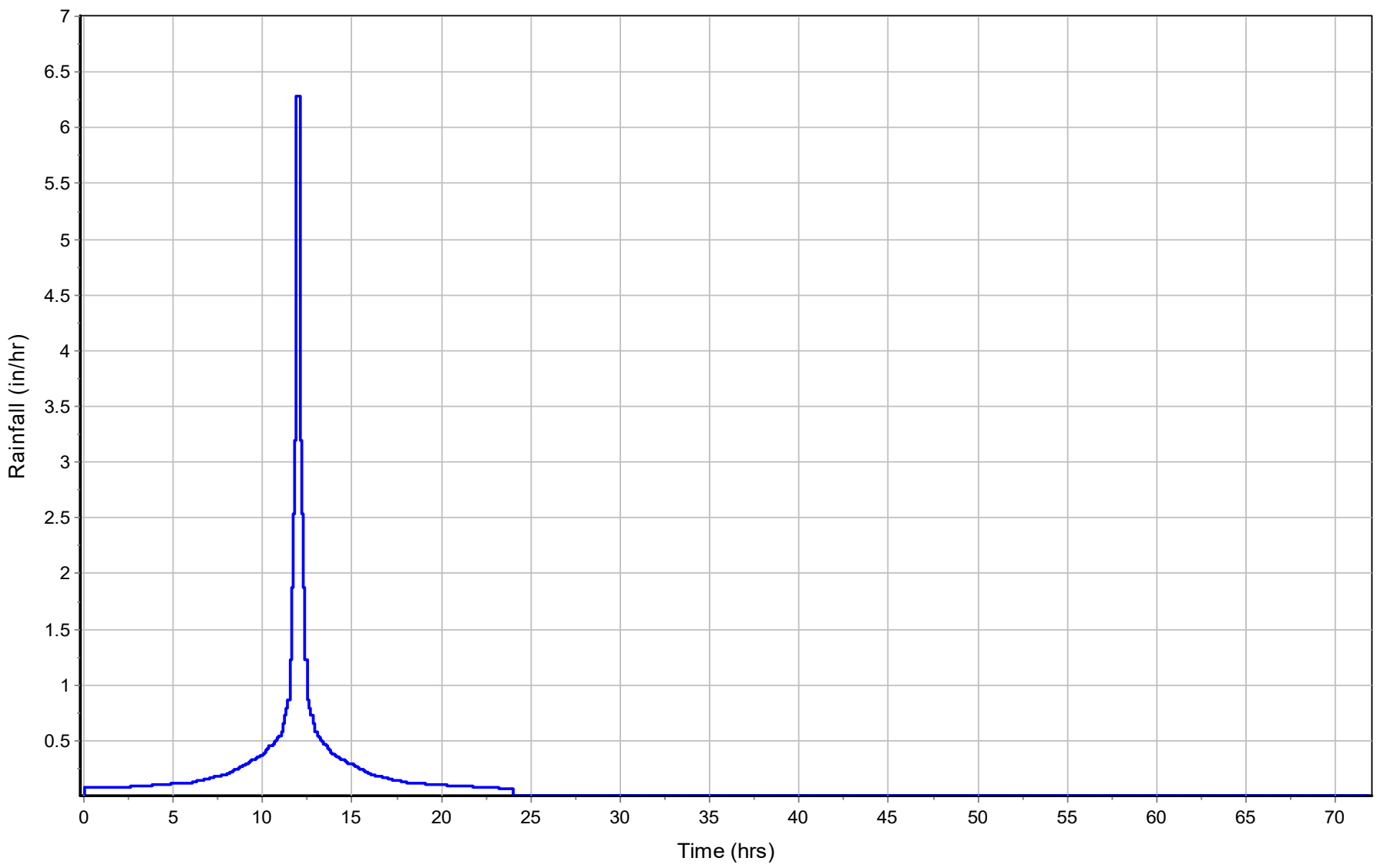
Total TOC (min) 2.17

Subbasin Runoff Results

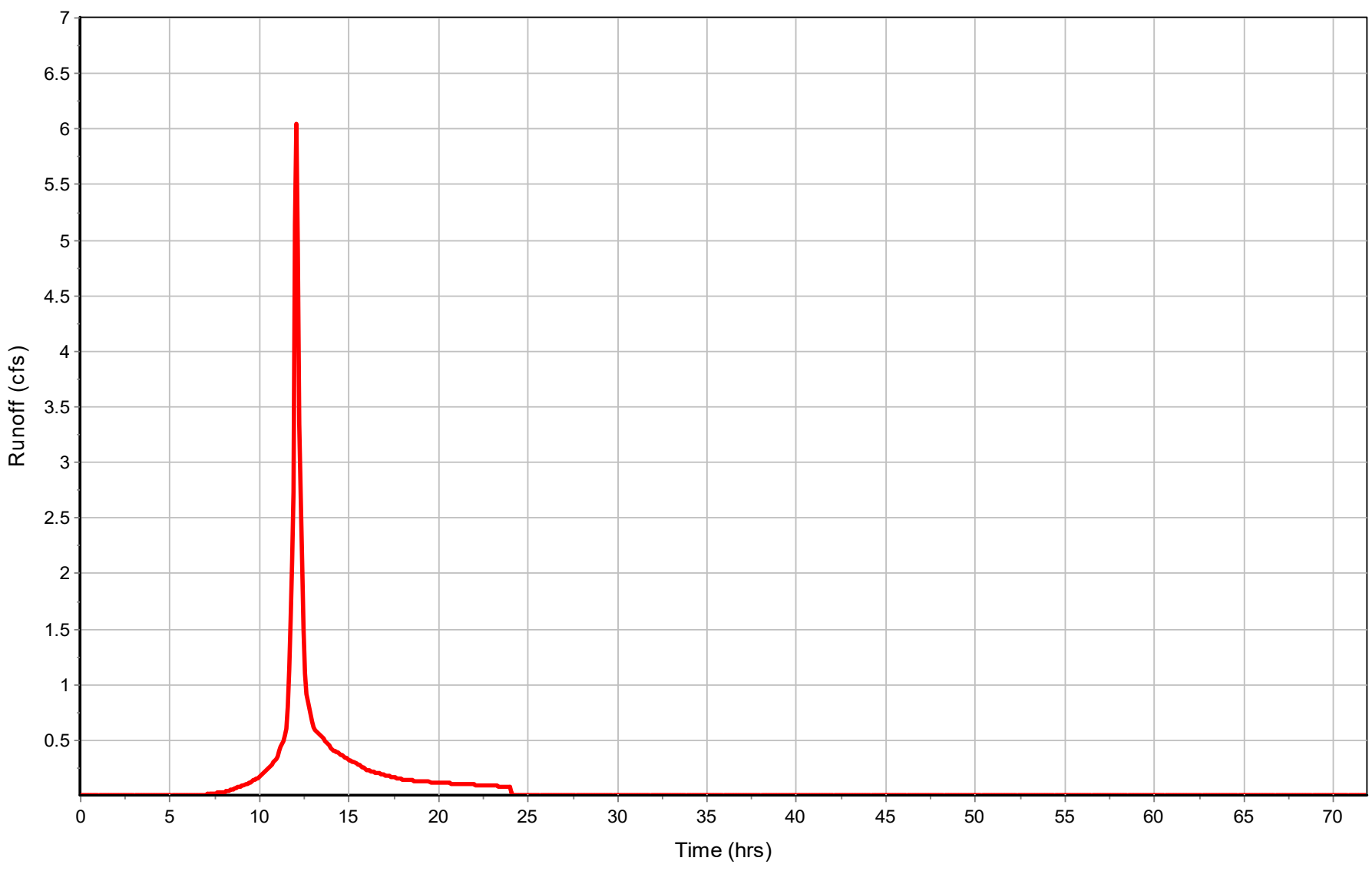
Total Rainfall (in) 7.47
Total Runoff (in) 4.68
Peak Runoff (cfs) 6.16
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:02:10

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

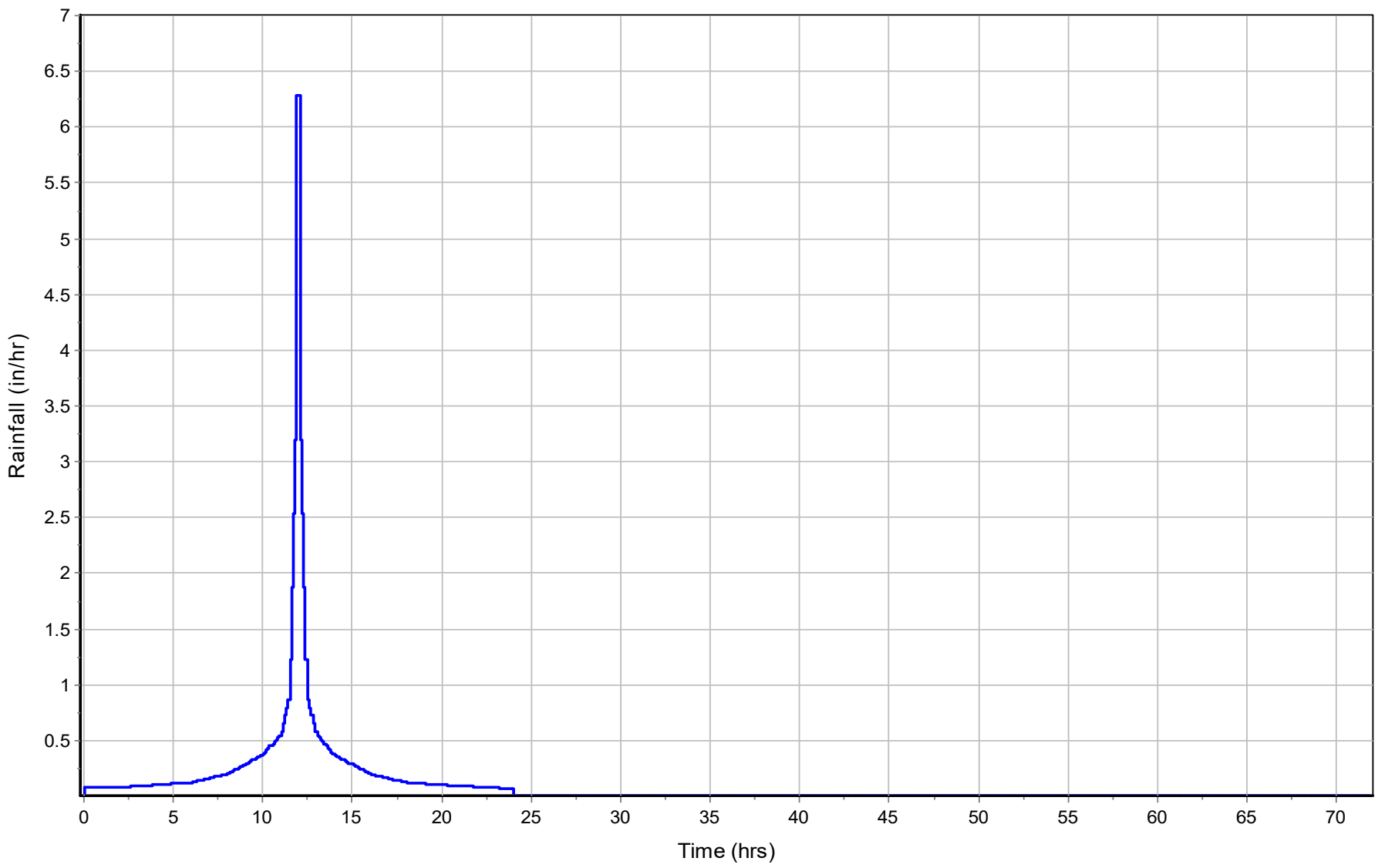
Total TOC (min) 4.13

Subbasin Runoff Results

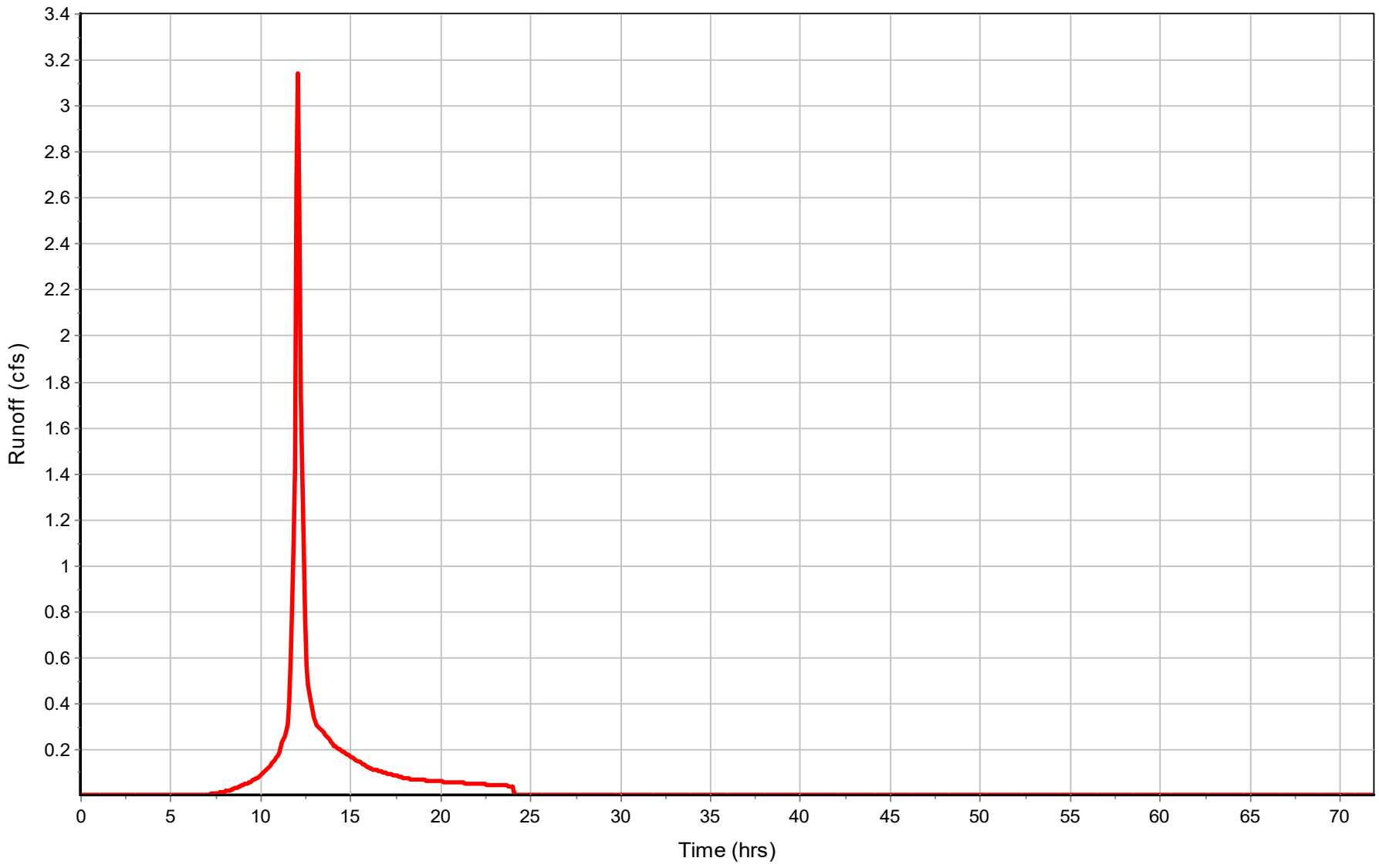
Total Rainfall (in)	7.47
Total Runoff (in)	4.68
Peak Runoff (cfs)	3.2
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:04:08

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

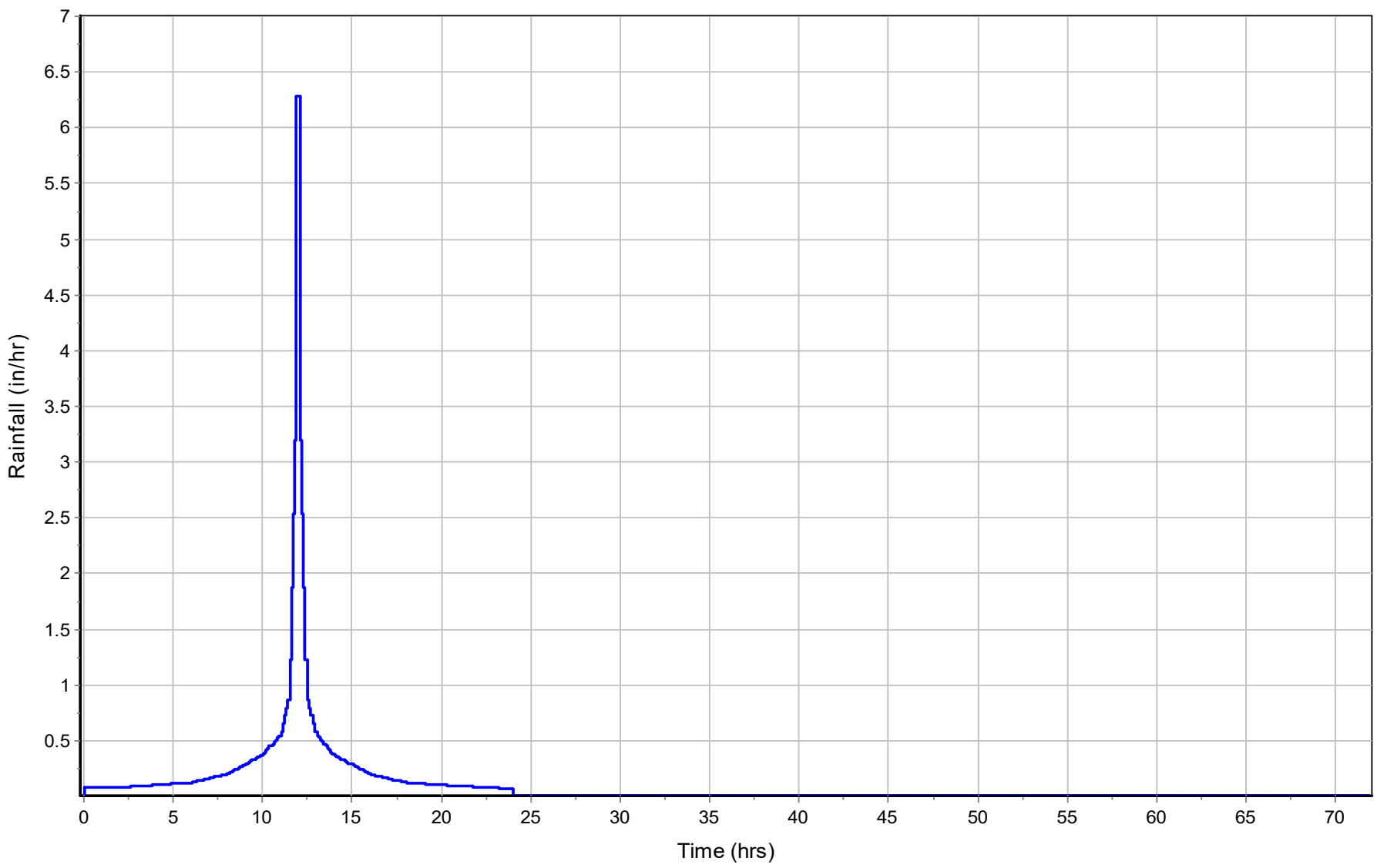
Total TOC (min) 34.83

Subbasin Runoff Results

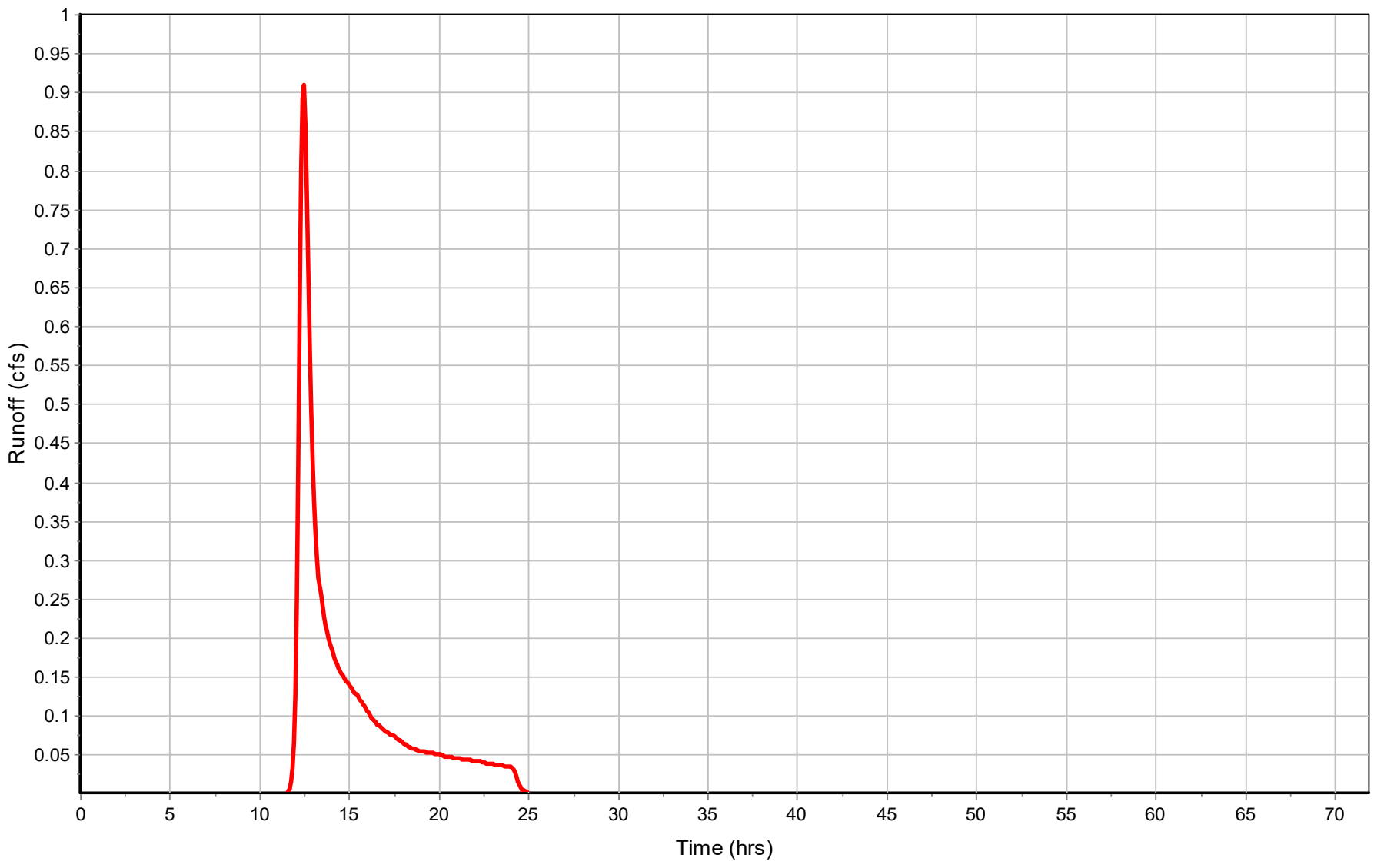
Total Rainfall (in)	7.47
Total Runoff (in)	1.84
Peak Runoff (cfs)	0.91
Weighted Curve Number	49
Time of Concentration (days hh:mm:ss)	0 00:34:50

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

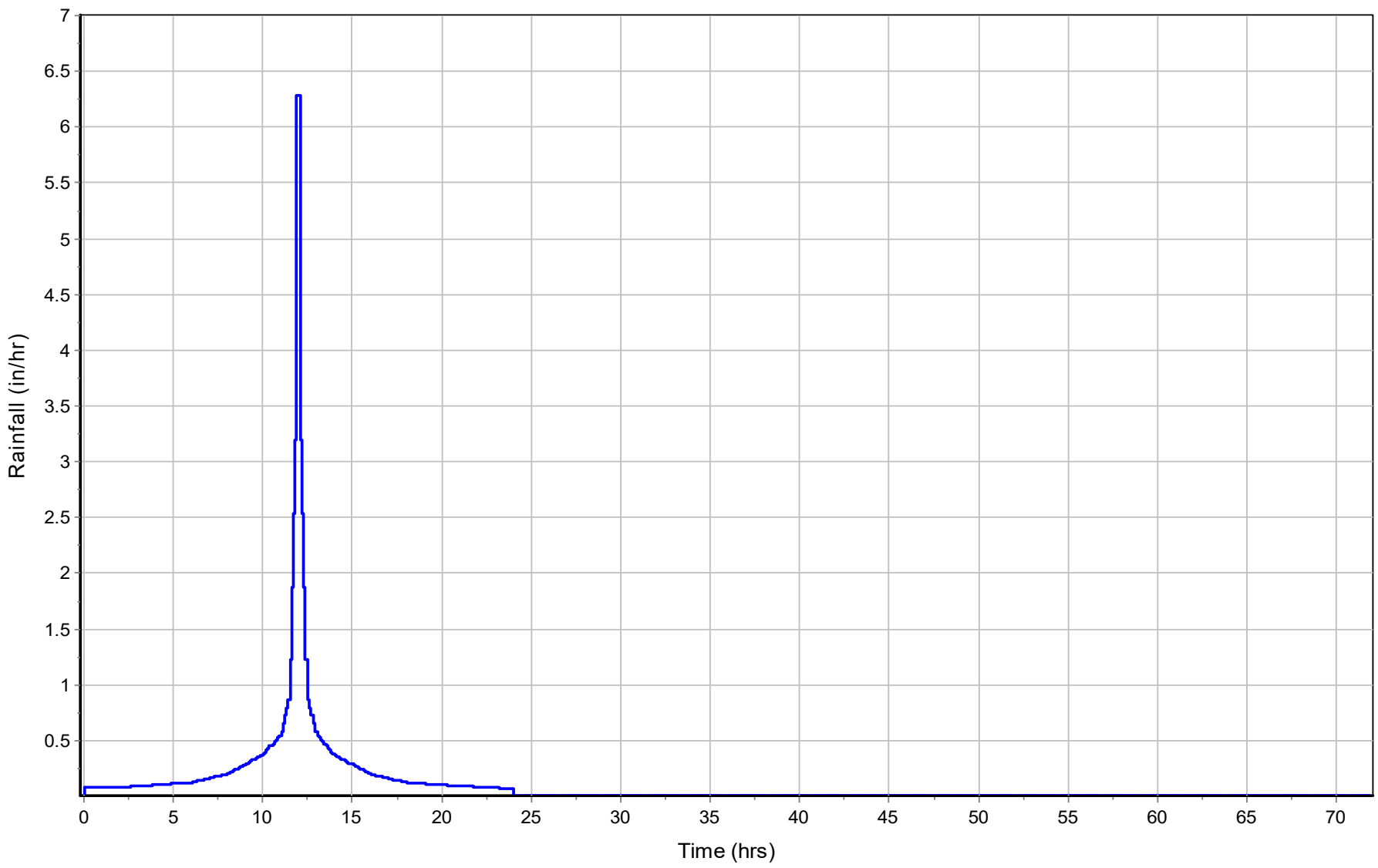
Total TOC (min) 36.49

Subbasin Runoff Results

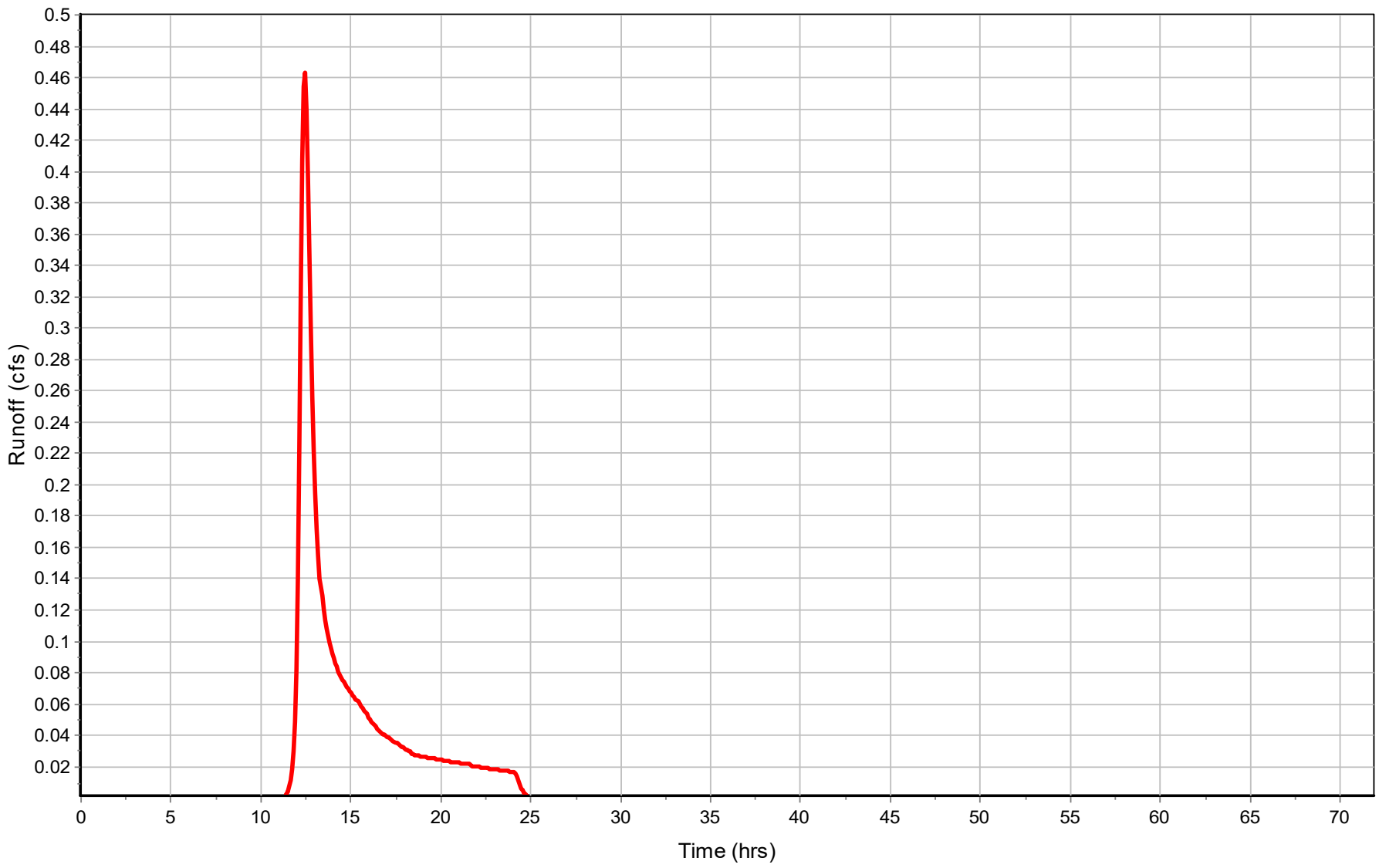
Total Rainfall (in)	7.47
Total Runoff (in)	2.1
Peak Runoff (cfs)	0.46
Weighted Curve Number	51.7
Time of Concentration (days hh:mm:ss)	0 00:36:29

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

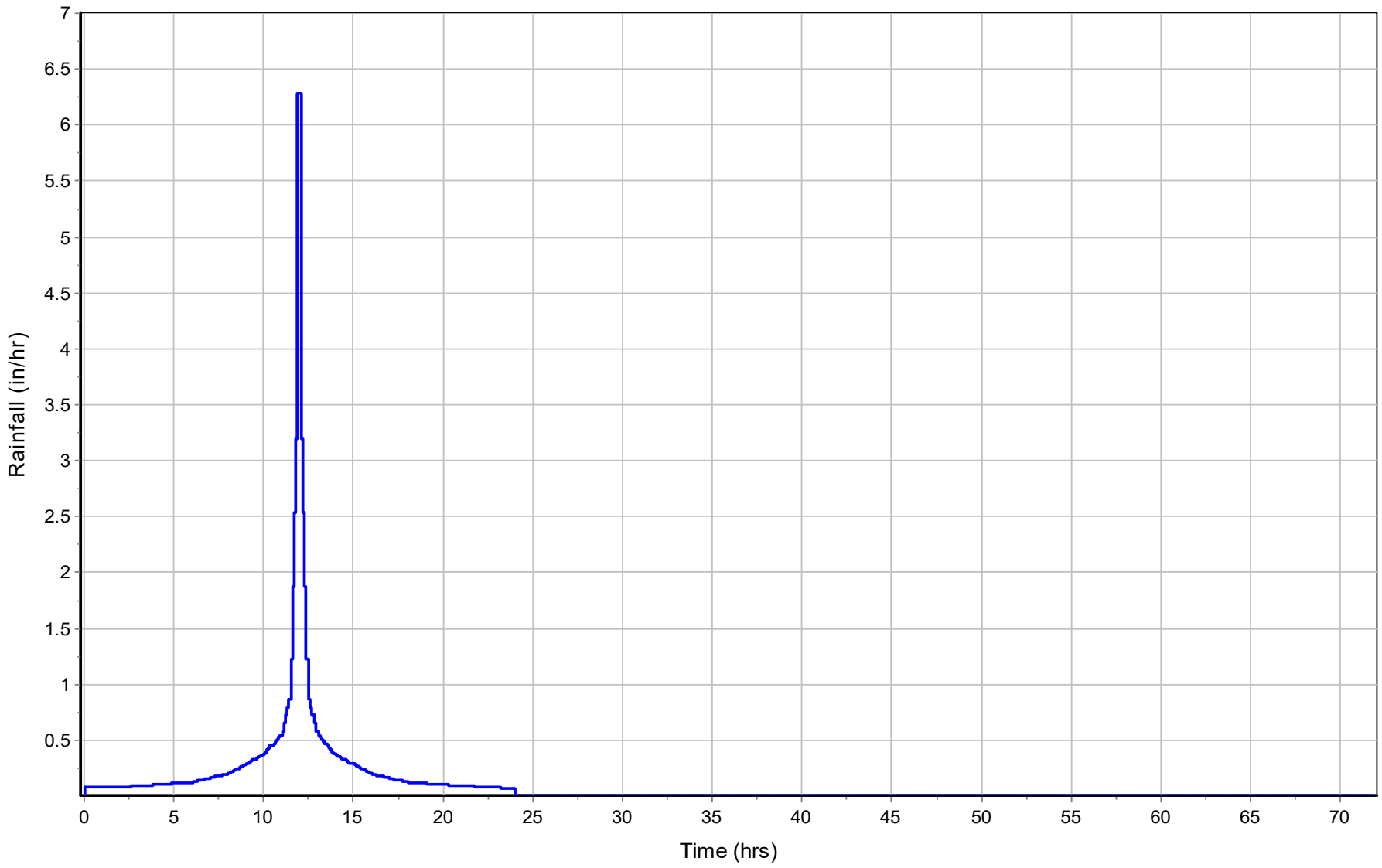
Total TOC (min) 42.87

Subbasin Runoff Results

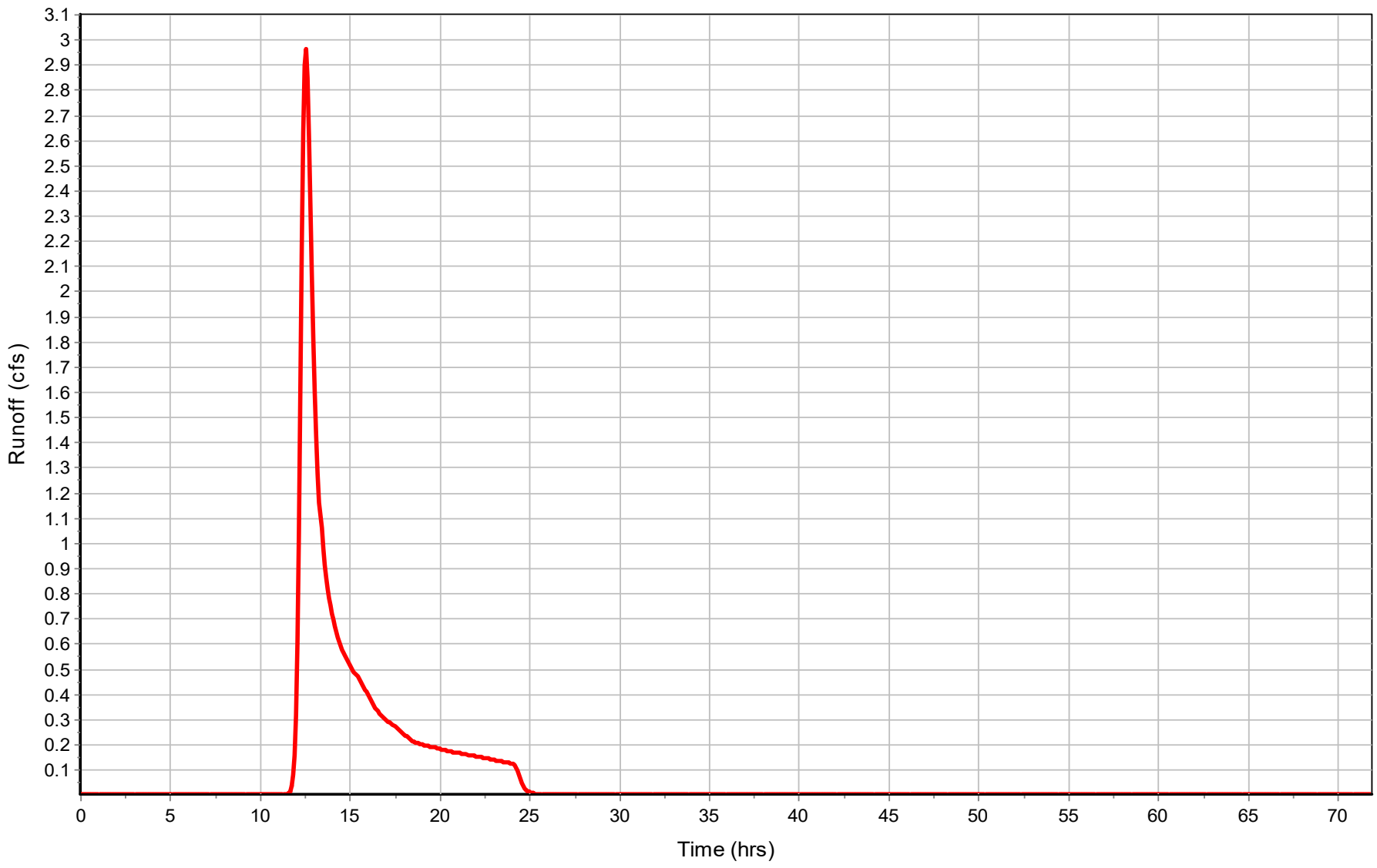
Total Rainfall (in)	7.47
Total Runoff (in)	1.84
Peak Runoff (cfs)	2.96
Weighted Curve Number	49
Time of Concentration (days hh:mm:ss)	0 00:42:52

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

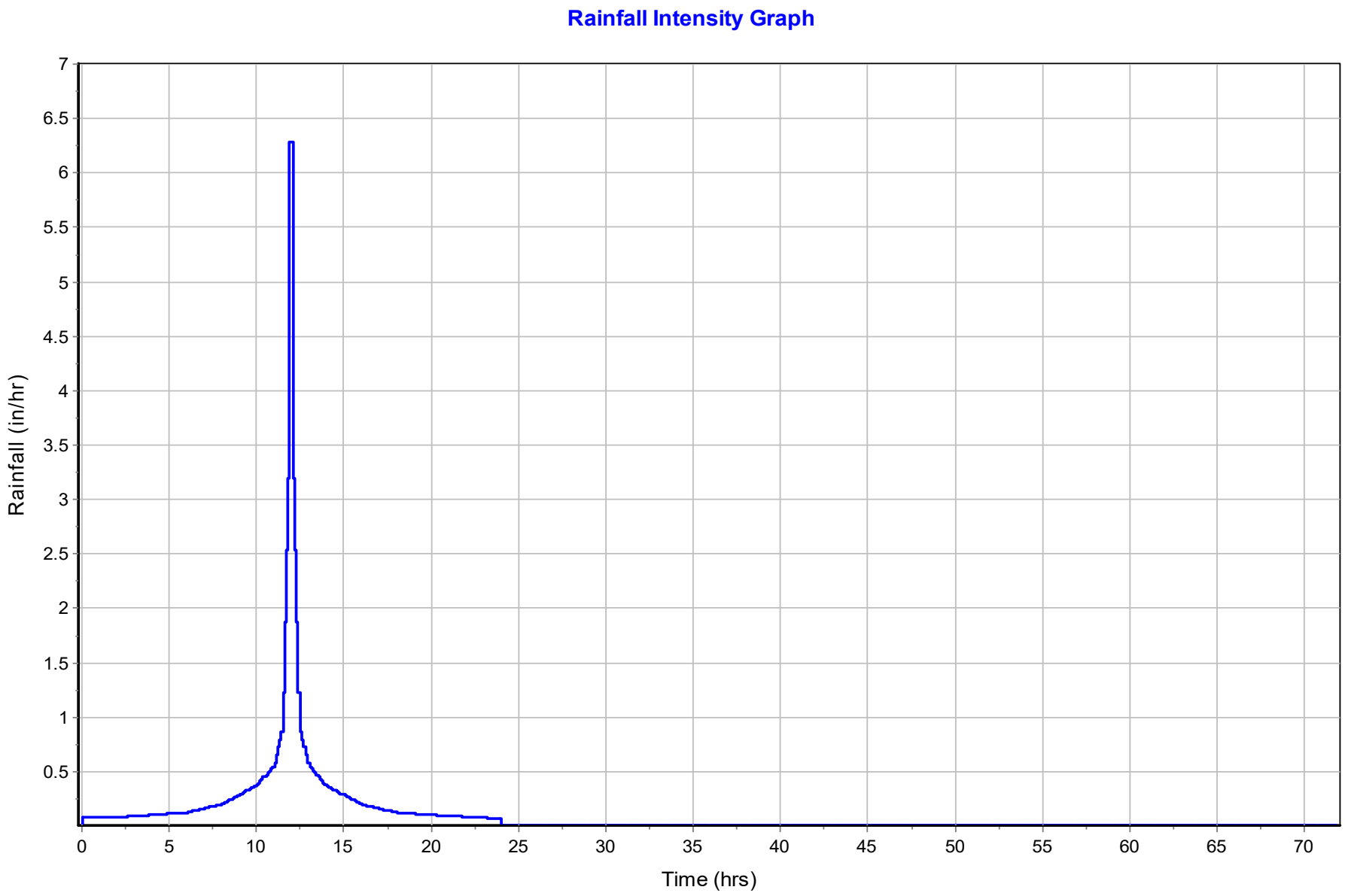
Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.4	0	0
Flow Length (ft) :	142.47	0	0
Slope (%) :	10	0	0
2 yr, 24 hr Rainfall (in) :	3.41	0	0
Velocity (ft/sec) :	0.16	0	0
Computed Flow Time (min) :	14.5	0	0

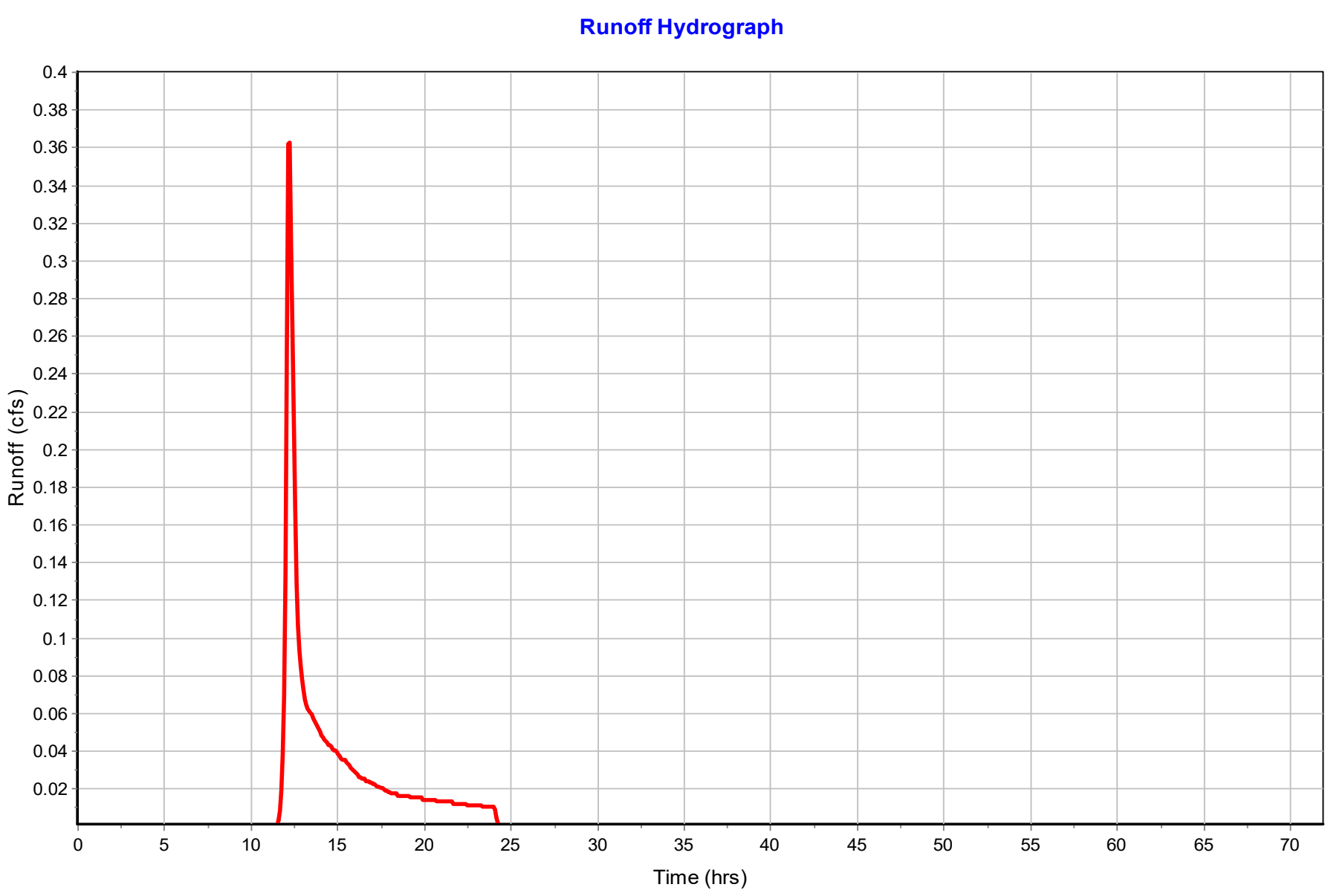
Total TOC (min) 14.50

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

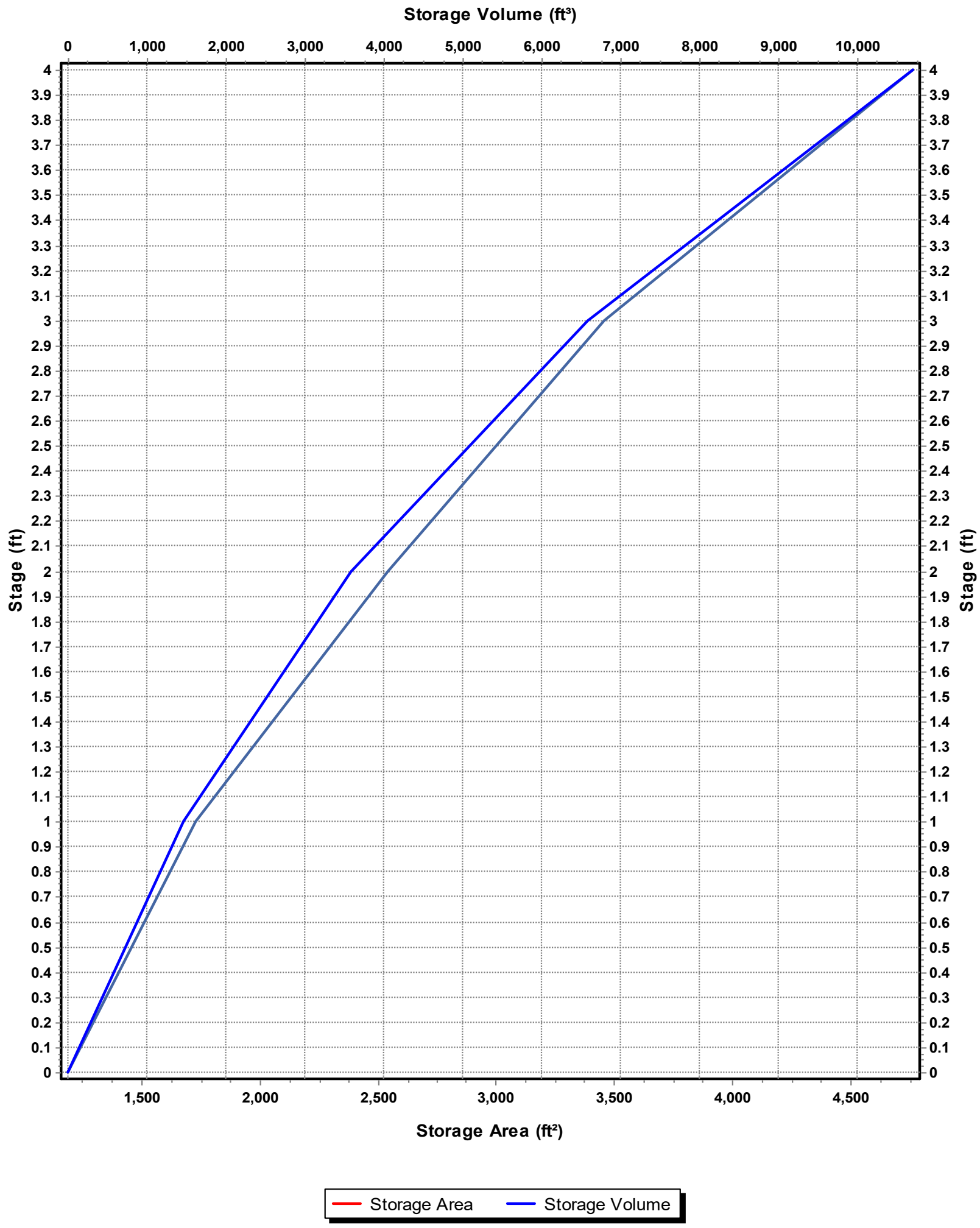
Invert Elevation (ft)	66.00
Max (Rim) Elevation (ft)	69.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	66.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

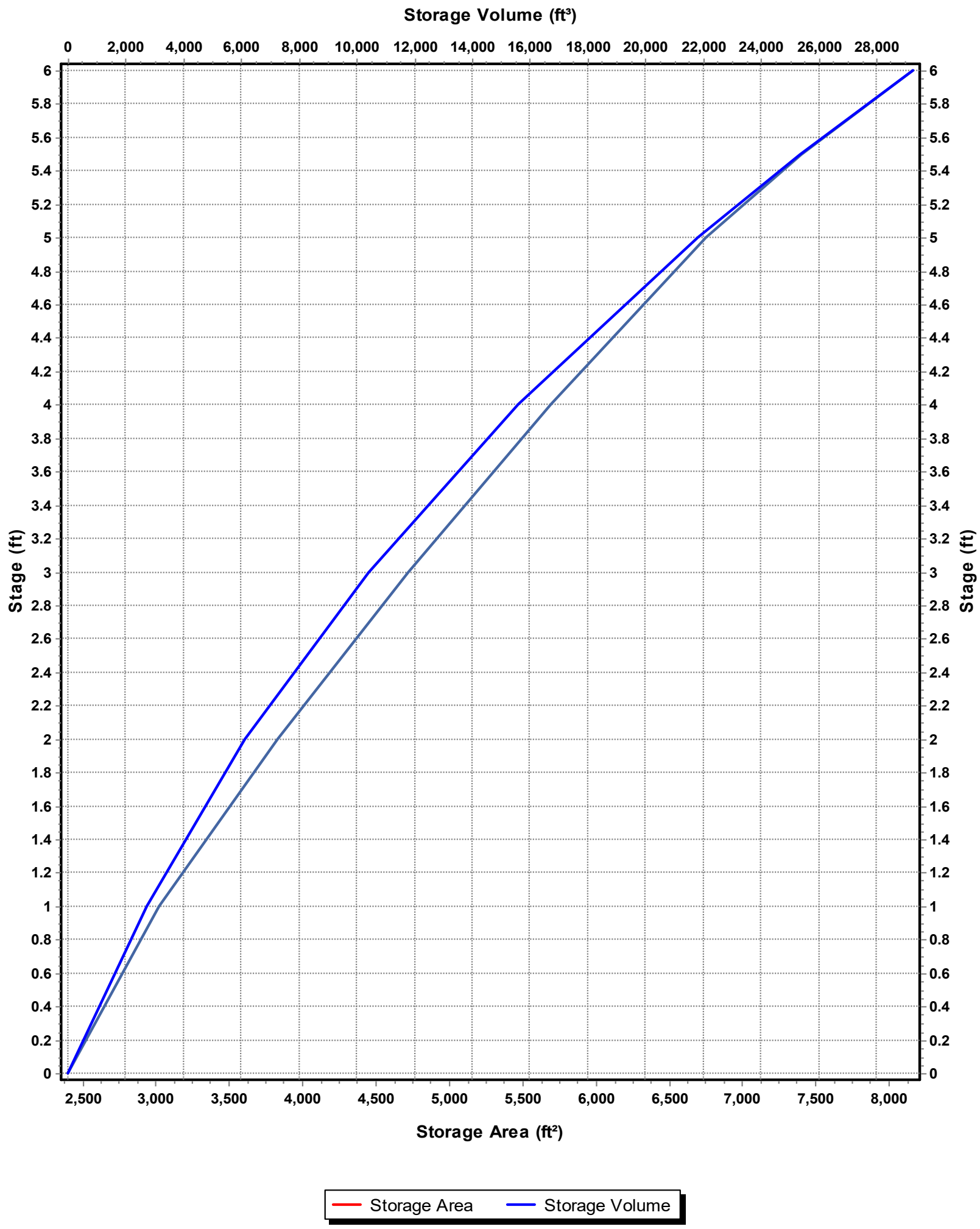
Invert Elevation (ft)	63.00
Max (Rim) Elevation (ft)	69.00
Max (Rim) Offset (ft)	6.00
Initial Water Elevation (ft)	63.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

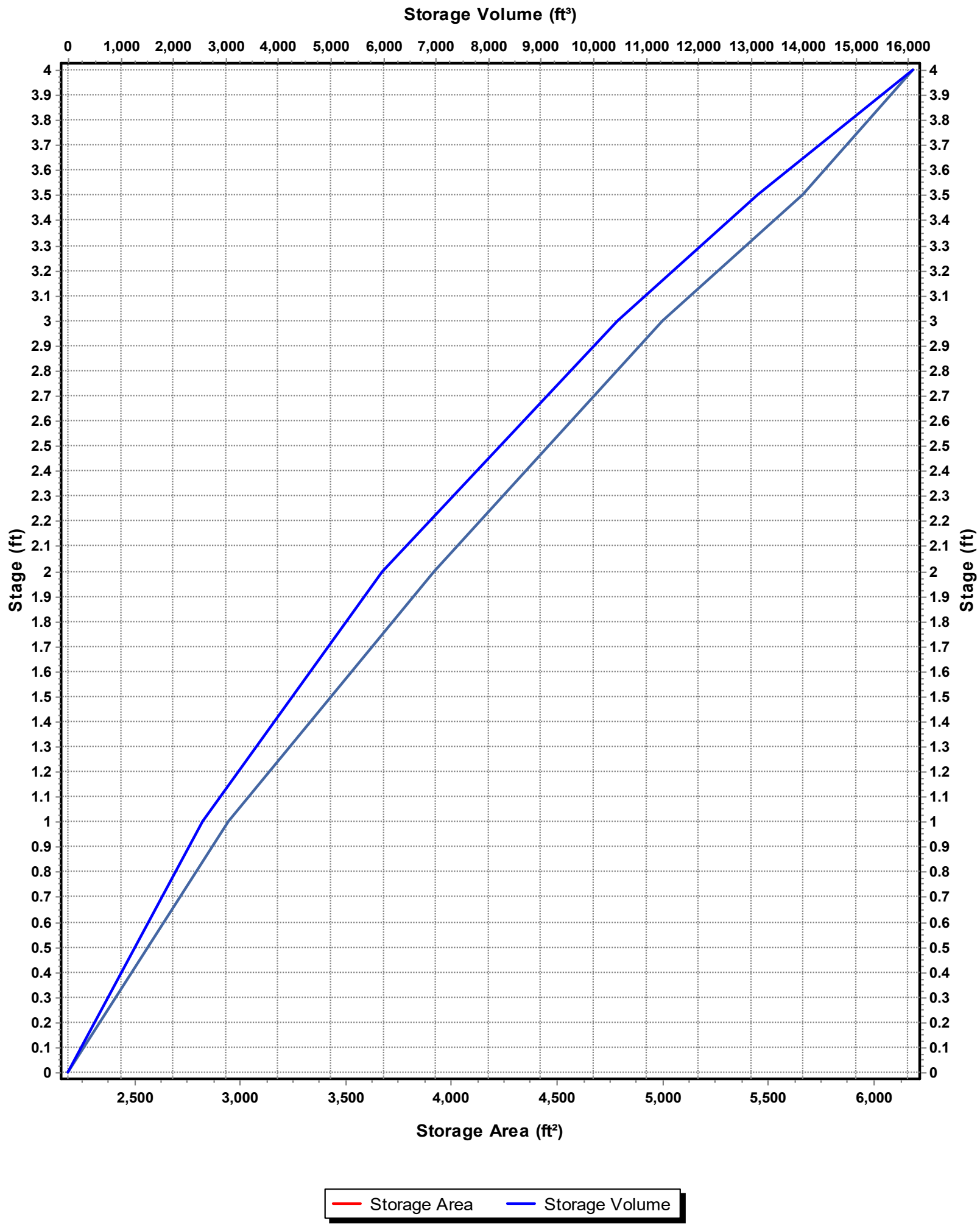
Invert Elevation (ft)	63.00
Max (Rim) Elevation (ft)	67.00
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	63.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

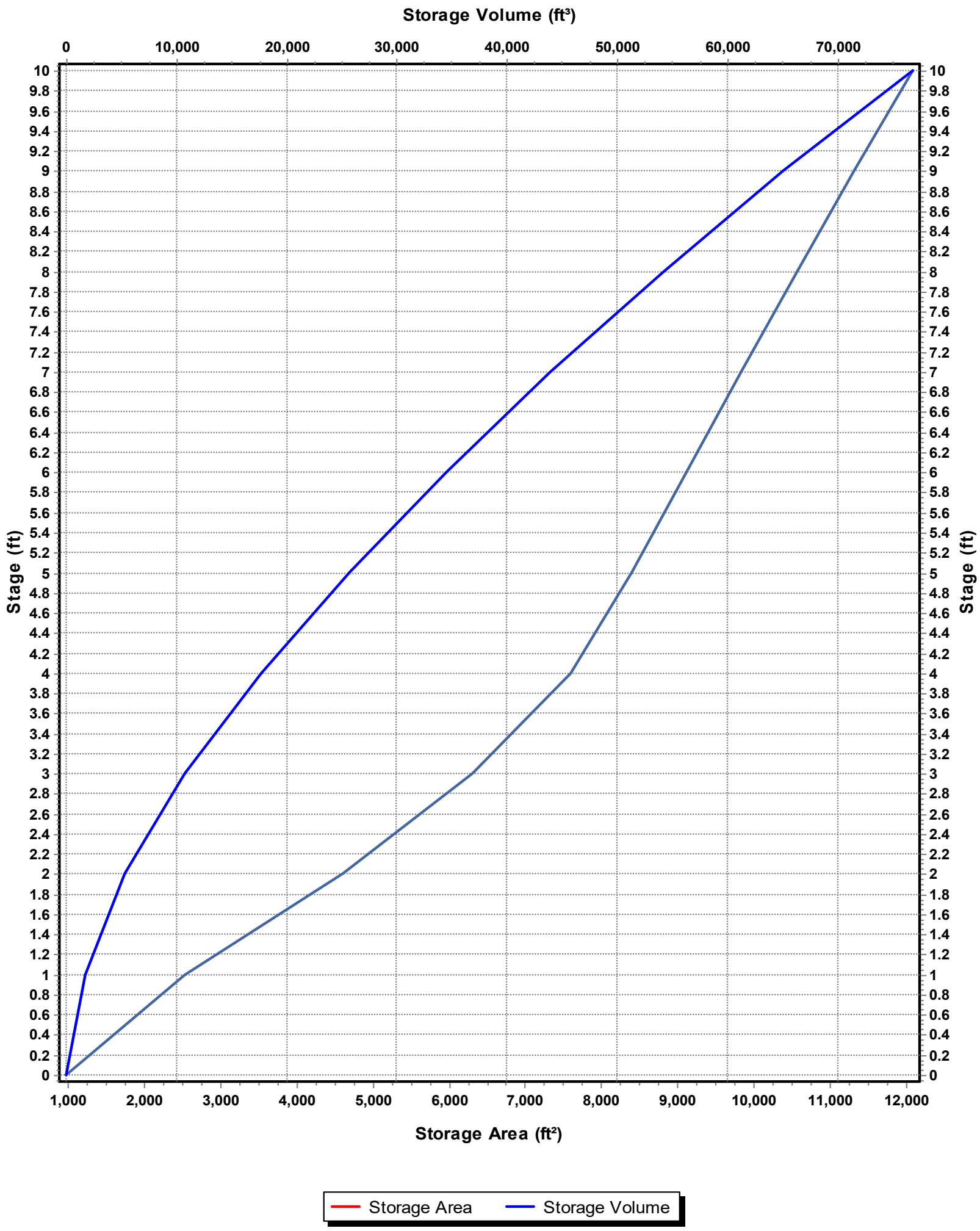
Invert Elevation (ft)	43.00
Max (Rim) Elevation (ft)	53.00
Max (Rim) Offset (ft)	10.00
Initial Water Elevation (ft)	43.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

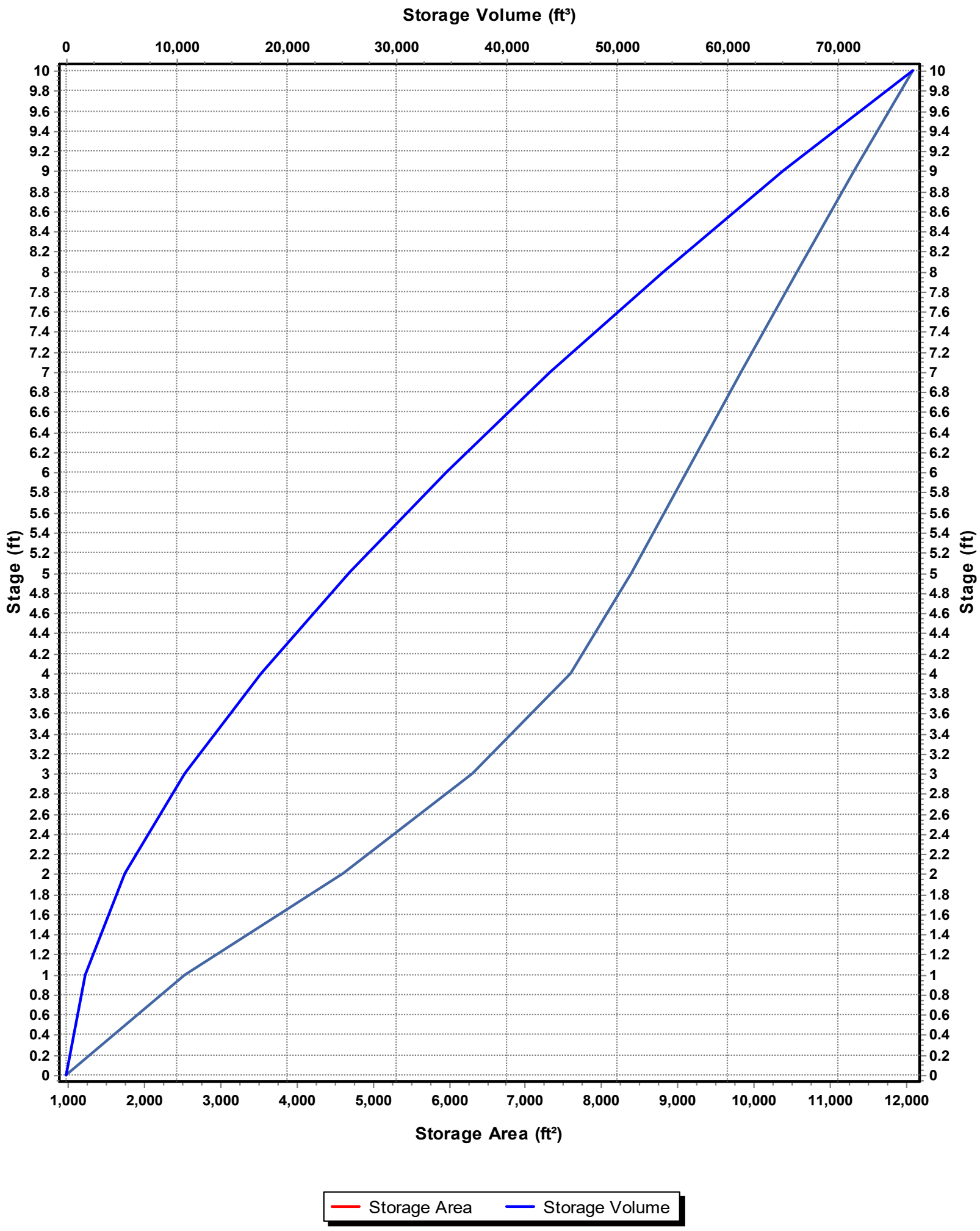
Invert Elevation (ft)	43.00
Max (Rim) Elevation (ft)	53.00
Max (Rim) Offset (ft)	10.00
Initial Water Elevation (ft)	43.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

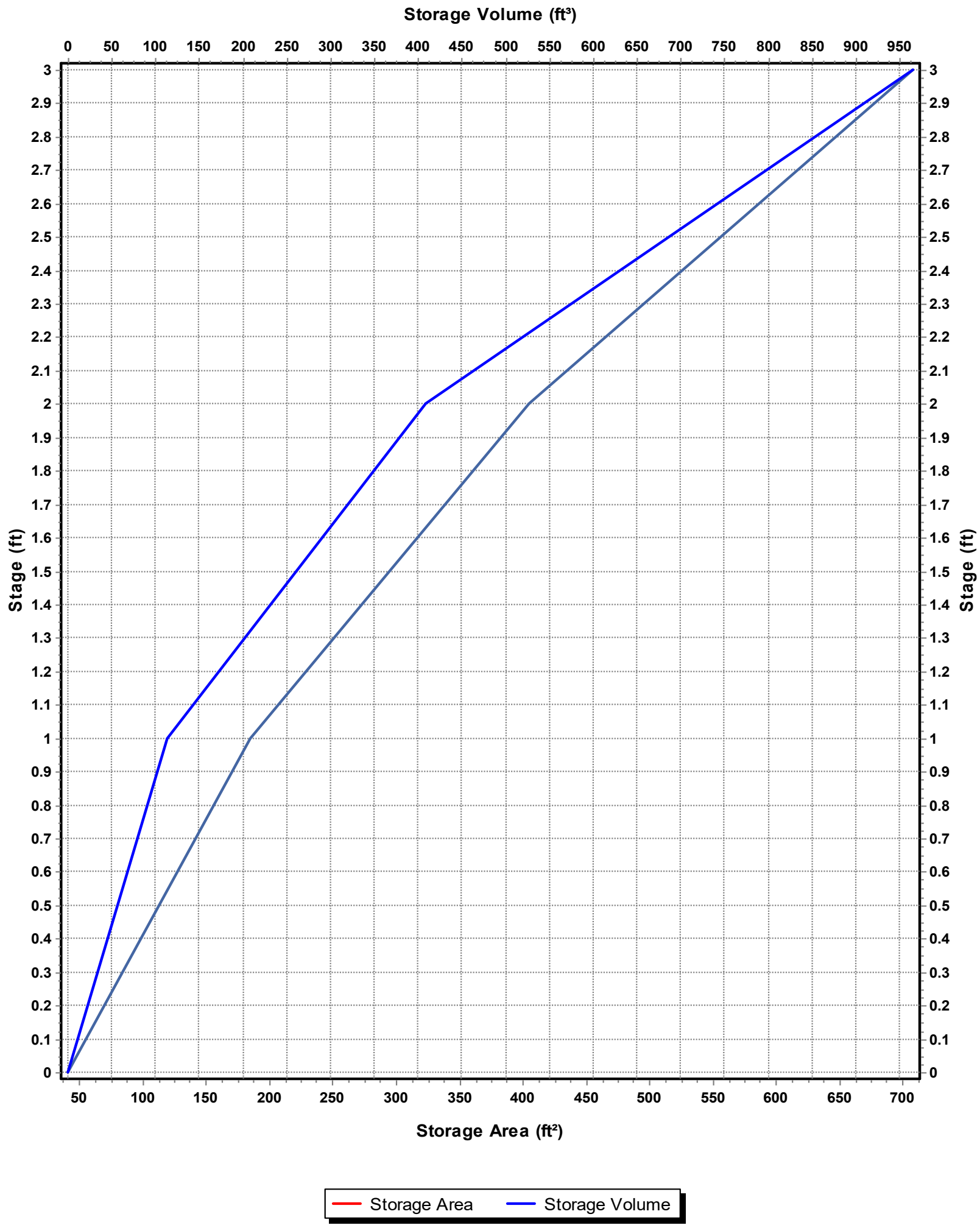
Invert Elevation (ft)	66.00
Max (Rim) Elevation (ft)	70.00
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	66.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

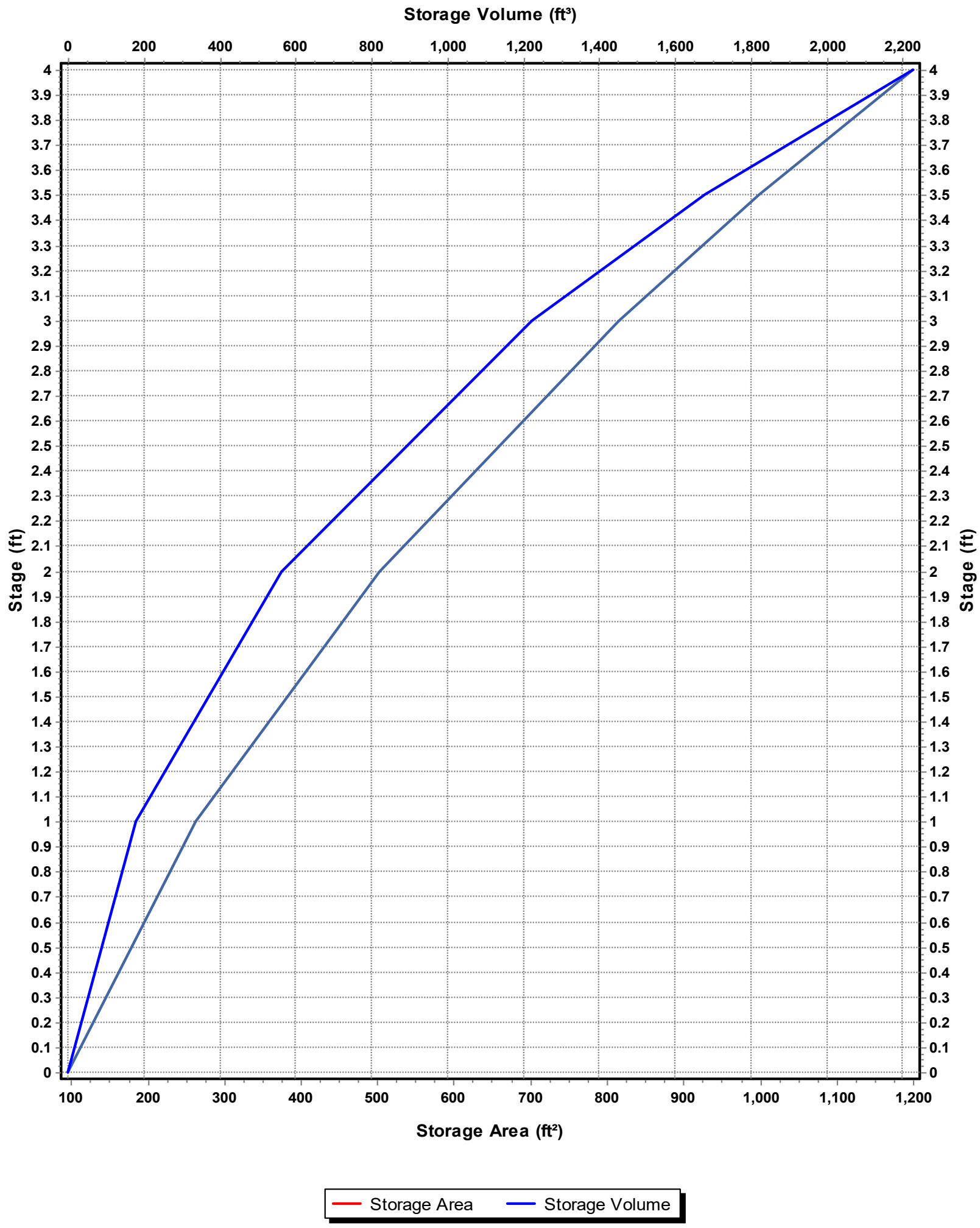
Invert Elevation (ft)	62.00
Max (Rim) Elevation (ft)	66.00
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	62.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

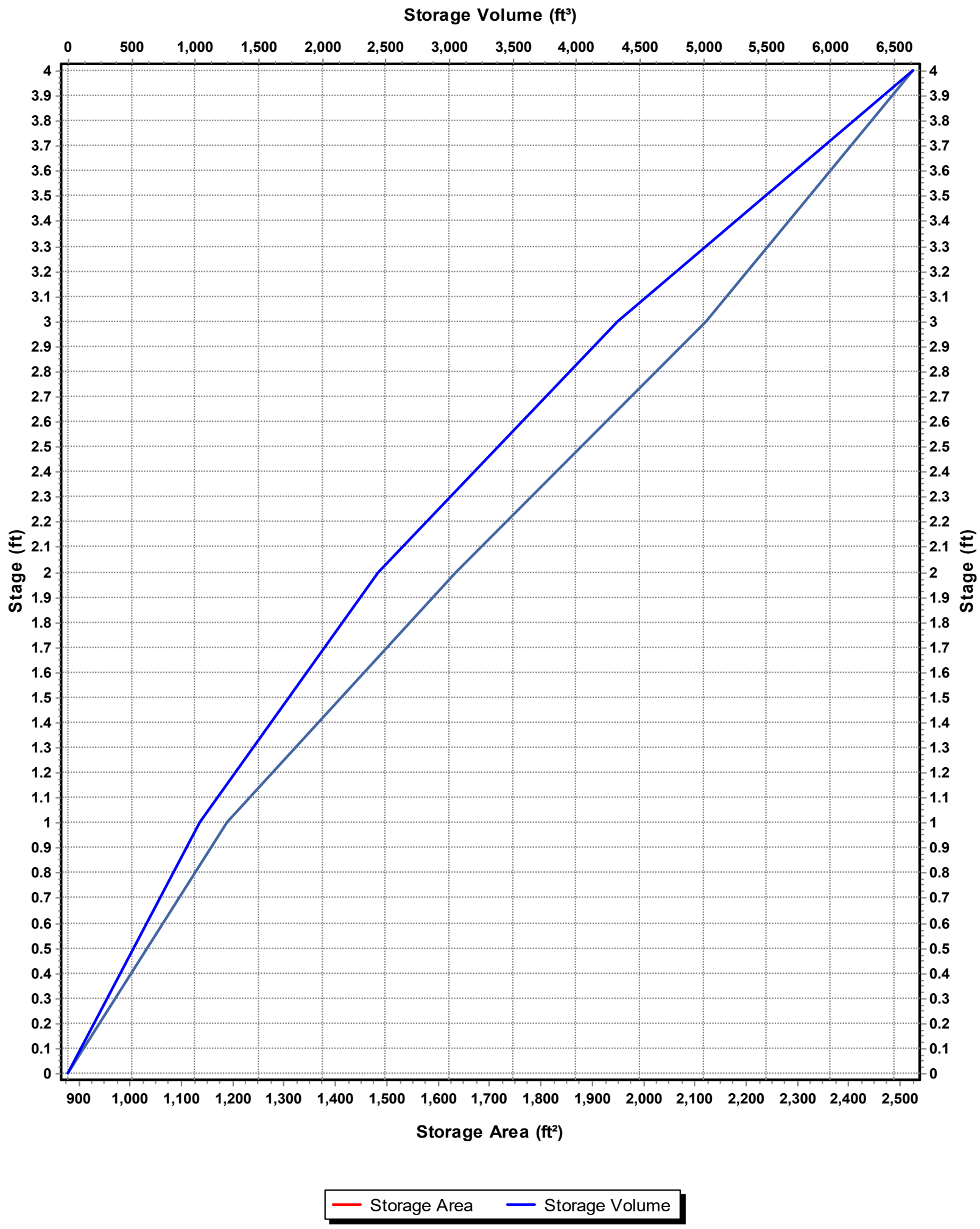
Invert Elevation (ft)	65.00
Max (Rim) Elevation (ft)	69.00
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	65.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

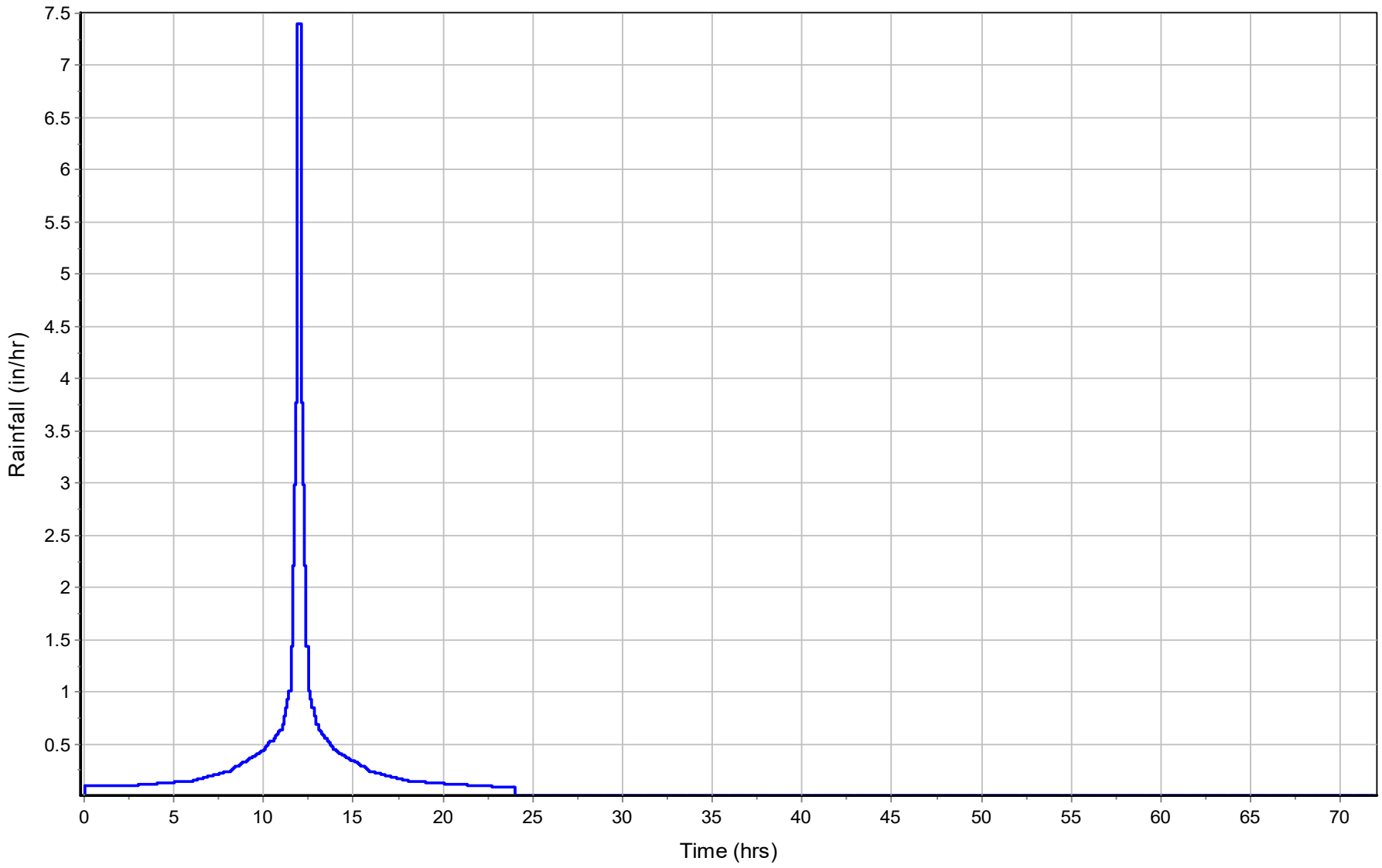
Total TOC (min) 4.58

Subbasin Runoff Results

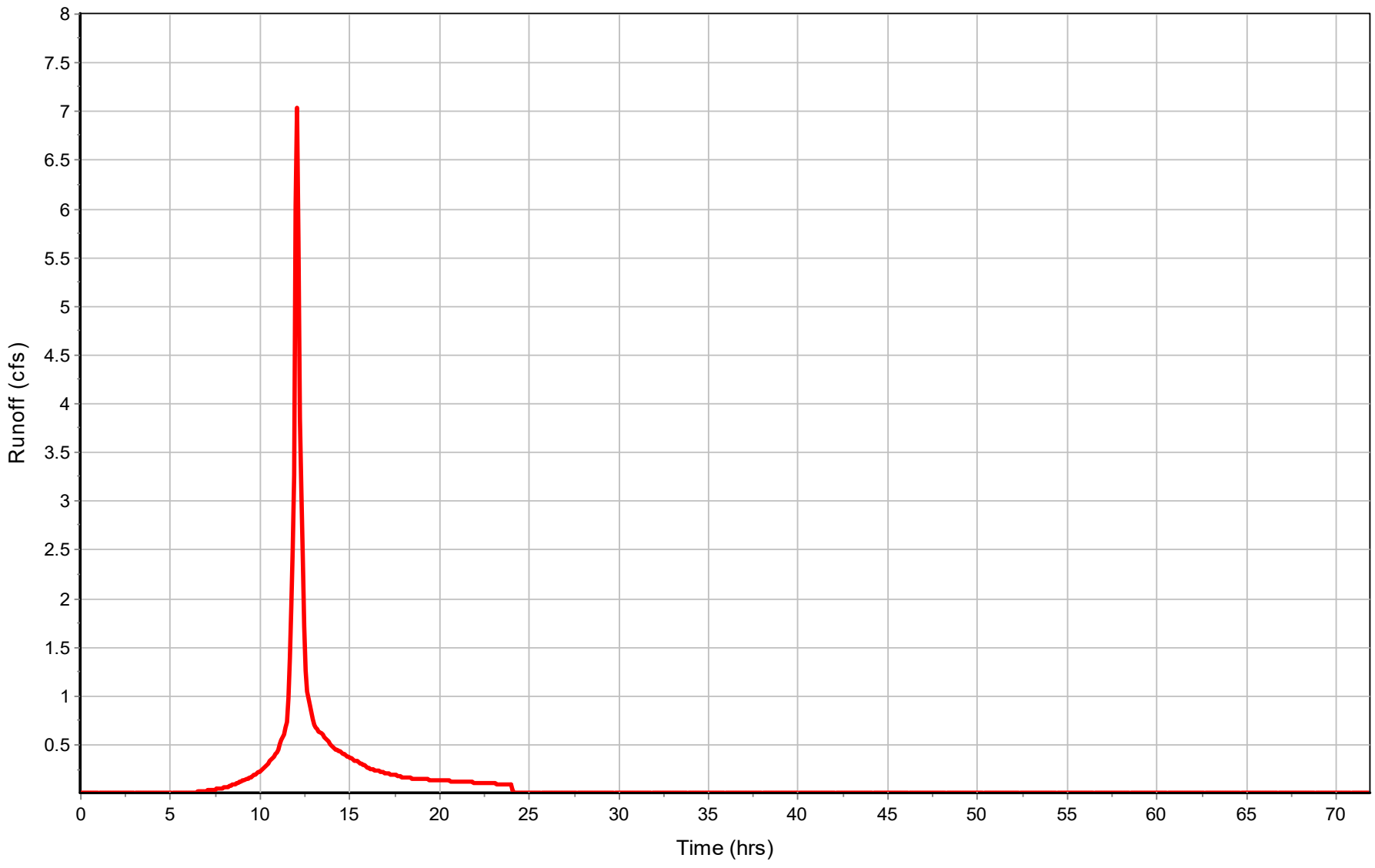
Total Rainfall (in) 8.8
Total Runoff (in) 5.89
Peak Runoff (cfs) 7.15
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:04:35

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

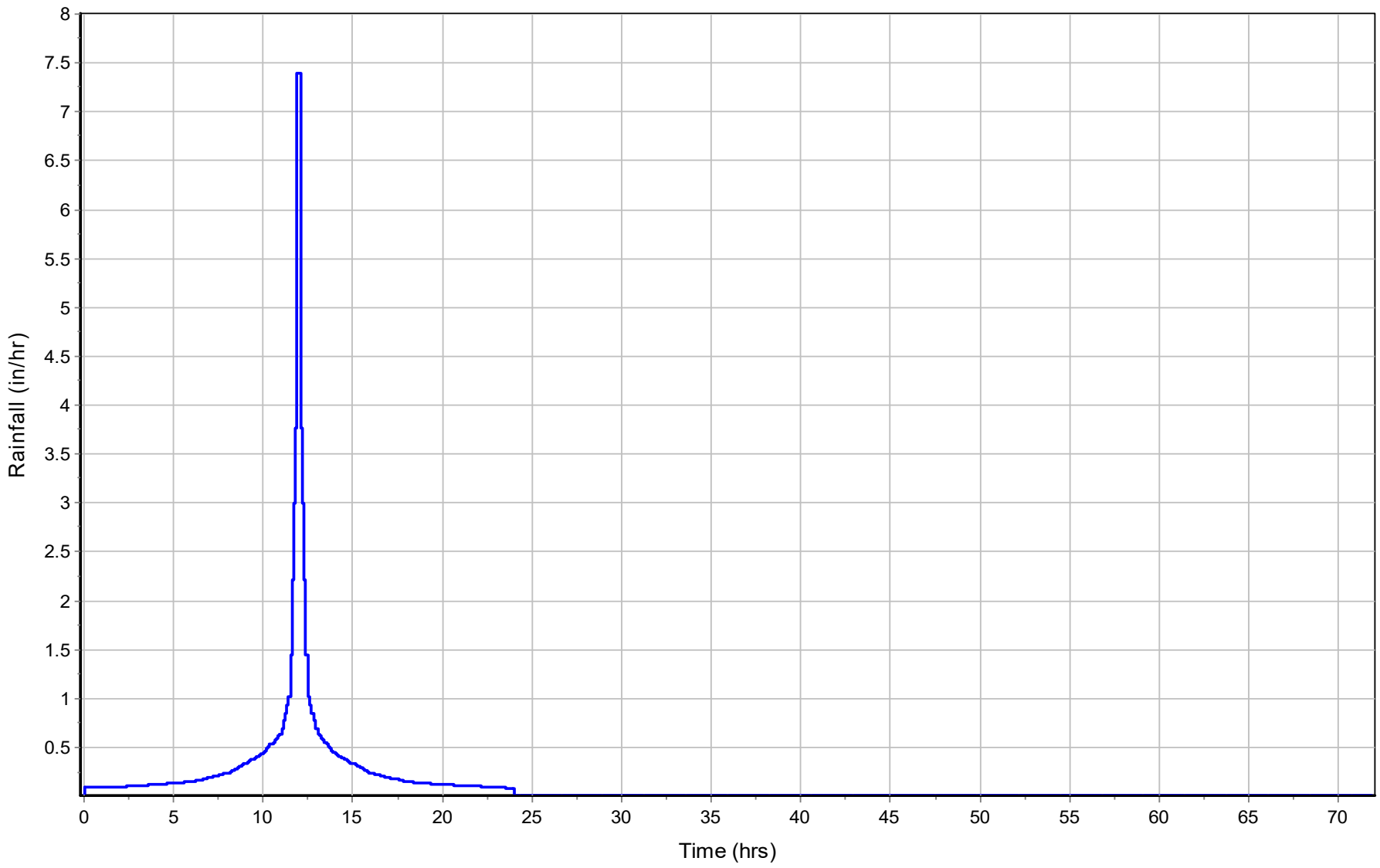
Total TOC (min) 10.92

Subbasin Runoff Results

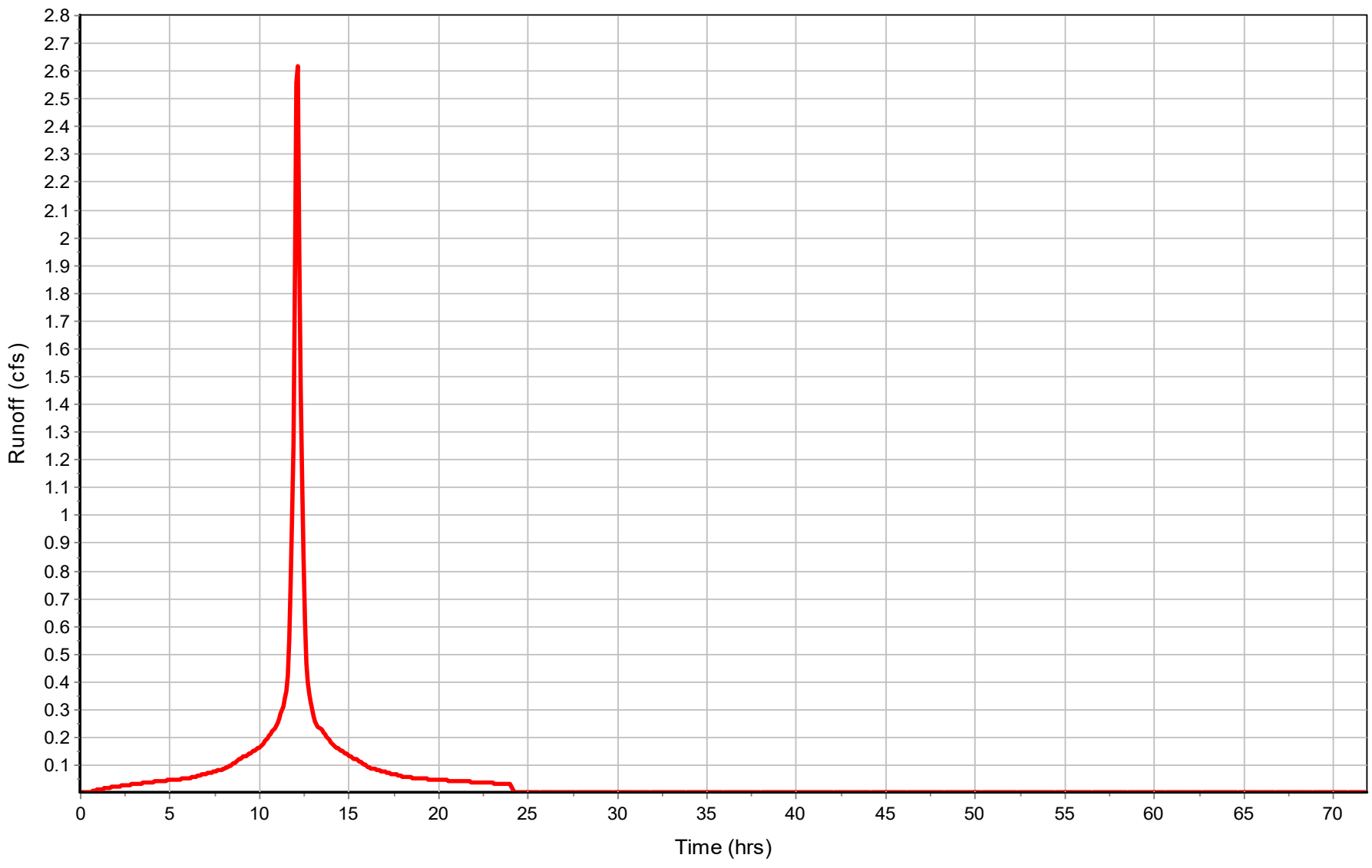
Total Rainfall (in) 8.8
Total Runoff (in) 8.56
Peak Runoff (cfs) 2.7
Weighted Curve Number 98
Time of Concentration (days hh:mm:ss) 0 00:10:55

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

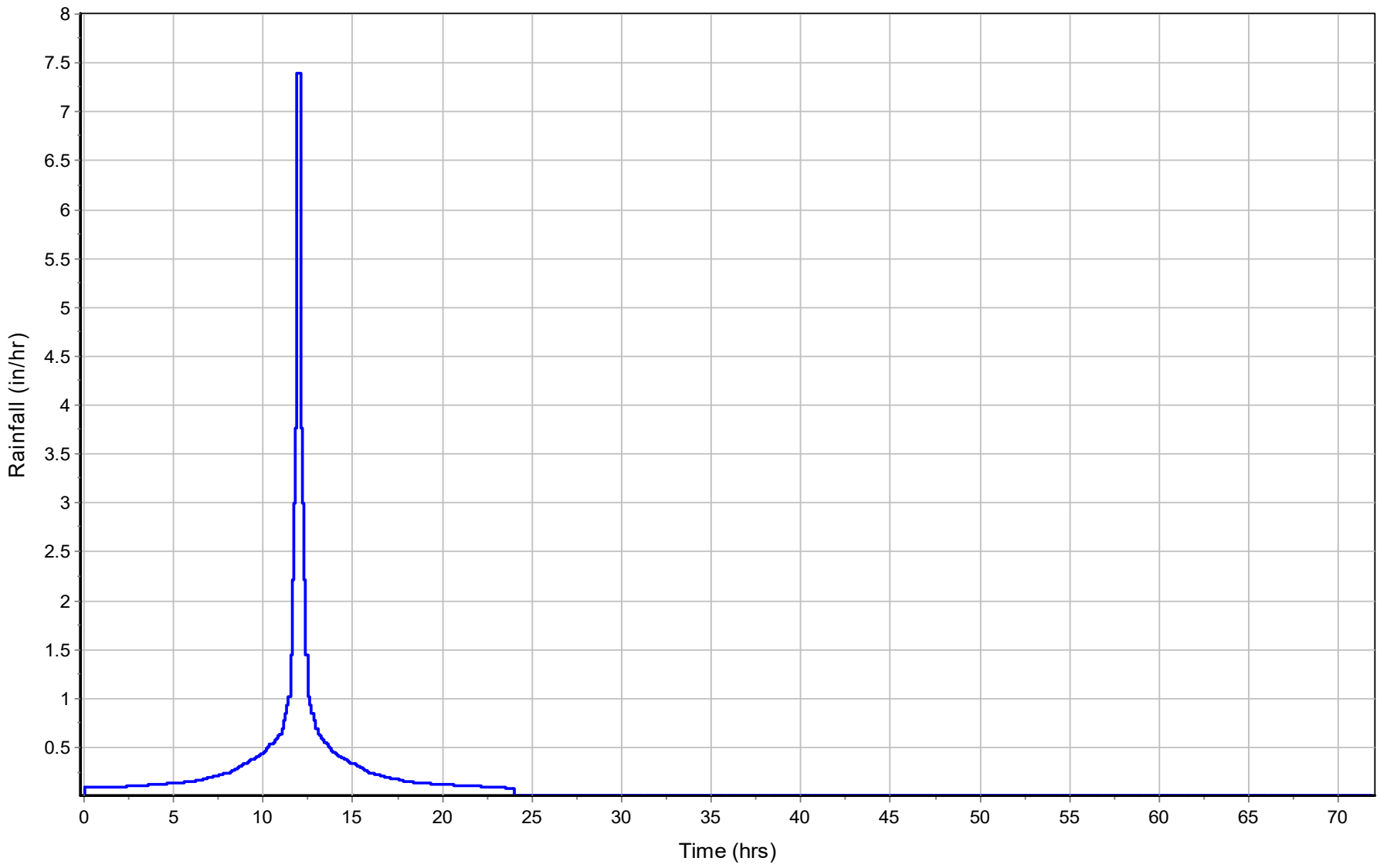
Total TOC (min) 3.41

Subbasin Runoff Results

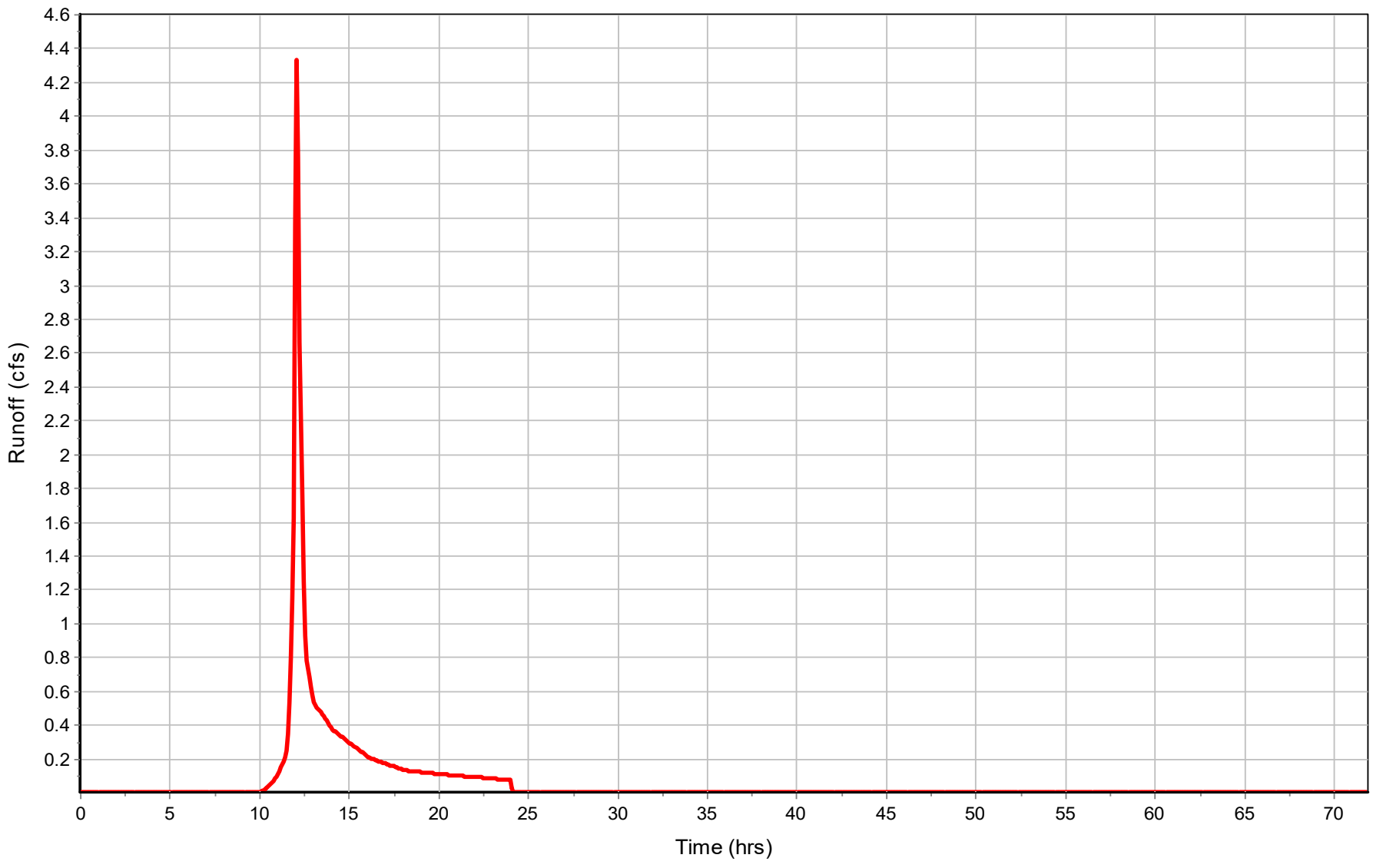
Total Rainfall (in) 8.8
Total Runoff (in) 3.3
Peak Runoff (cfs) 4.54
Weighted Curve Number 54.63
Time of Concentration (days hh:mm:ss) 0 00:03:25

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

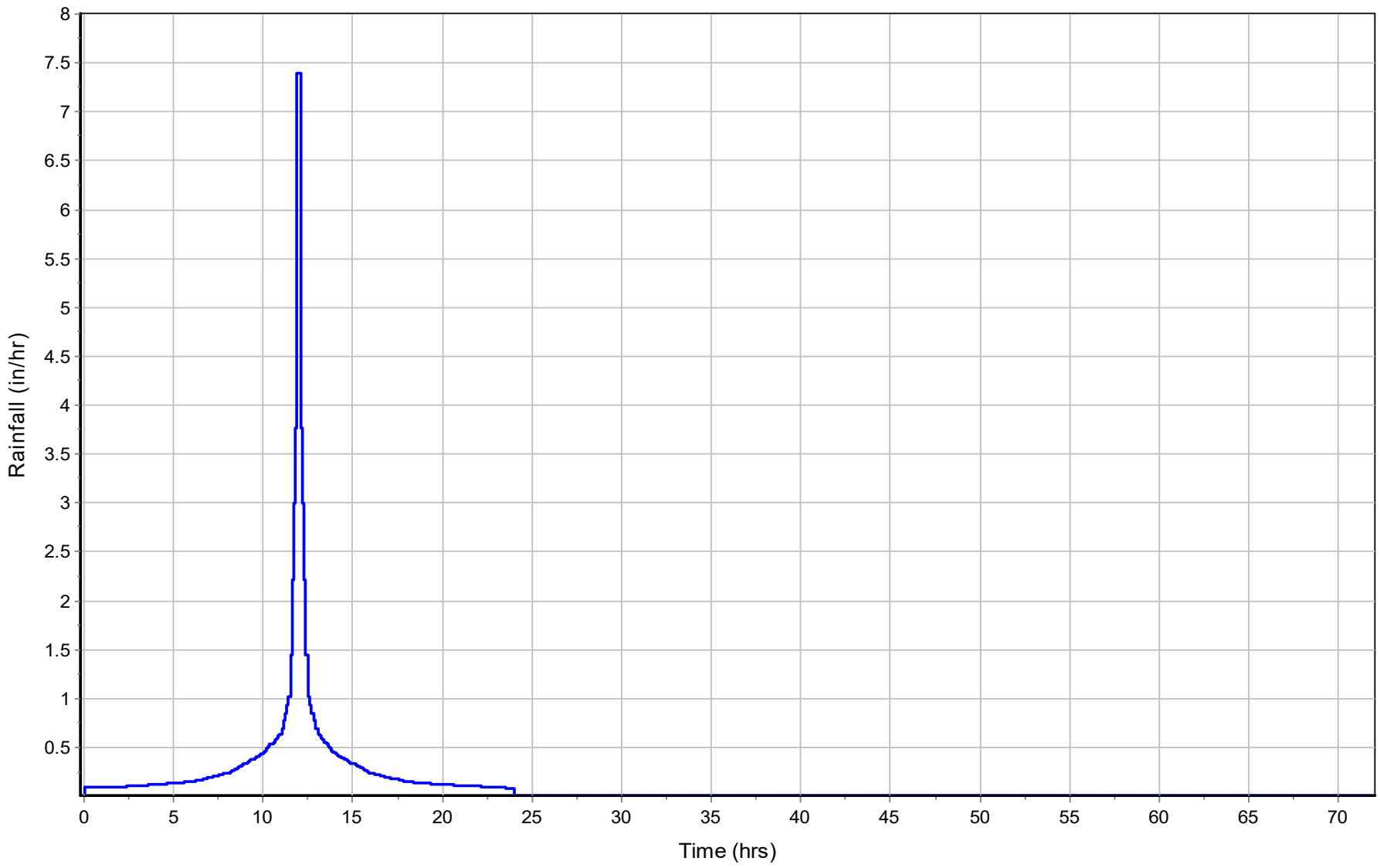
Total TOC (min) 40.27

Subbasin Runoff Results

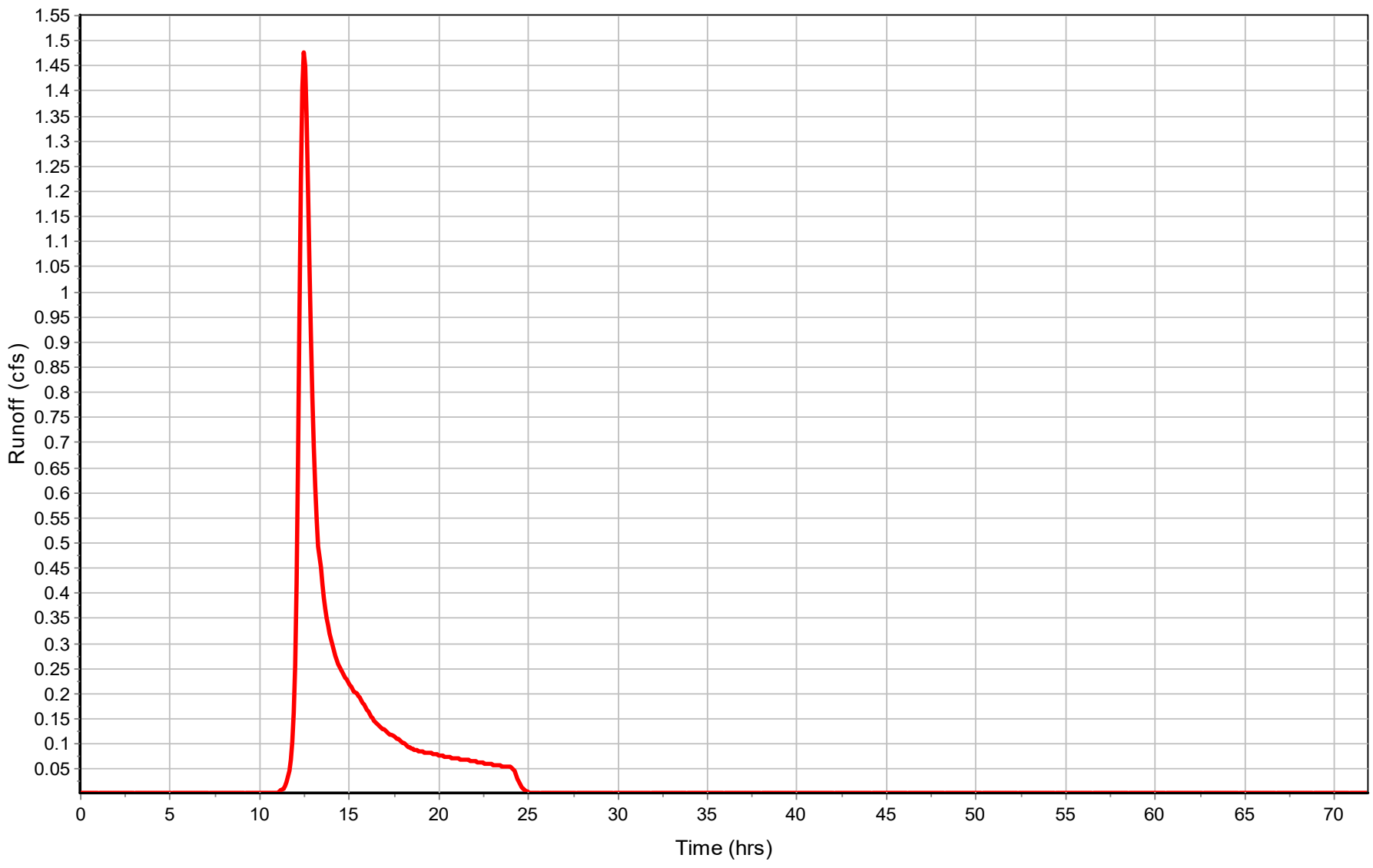
Total Rainfall (in) 8.8
Total Runoff (in) 2.64
Peak Runoff (cfs) 1.48
Weighted Curve Number 49
Time of Concentration (days hh:mm:ss) 0 00:40:16

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

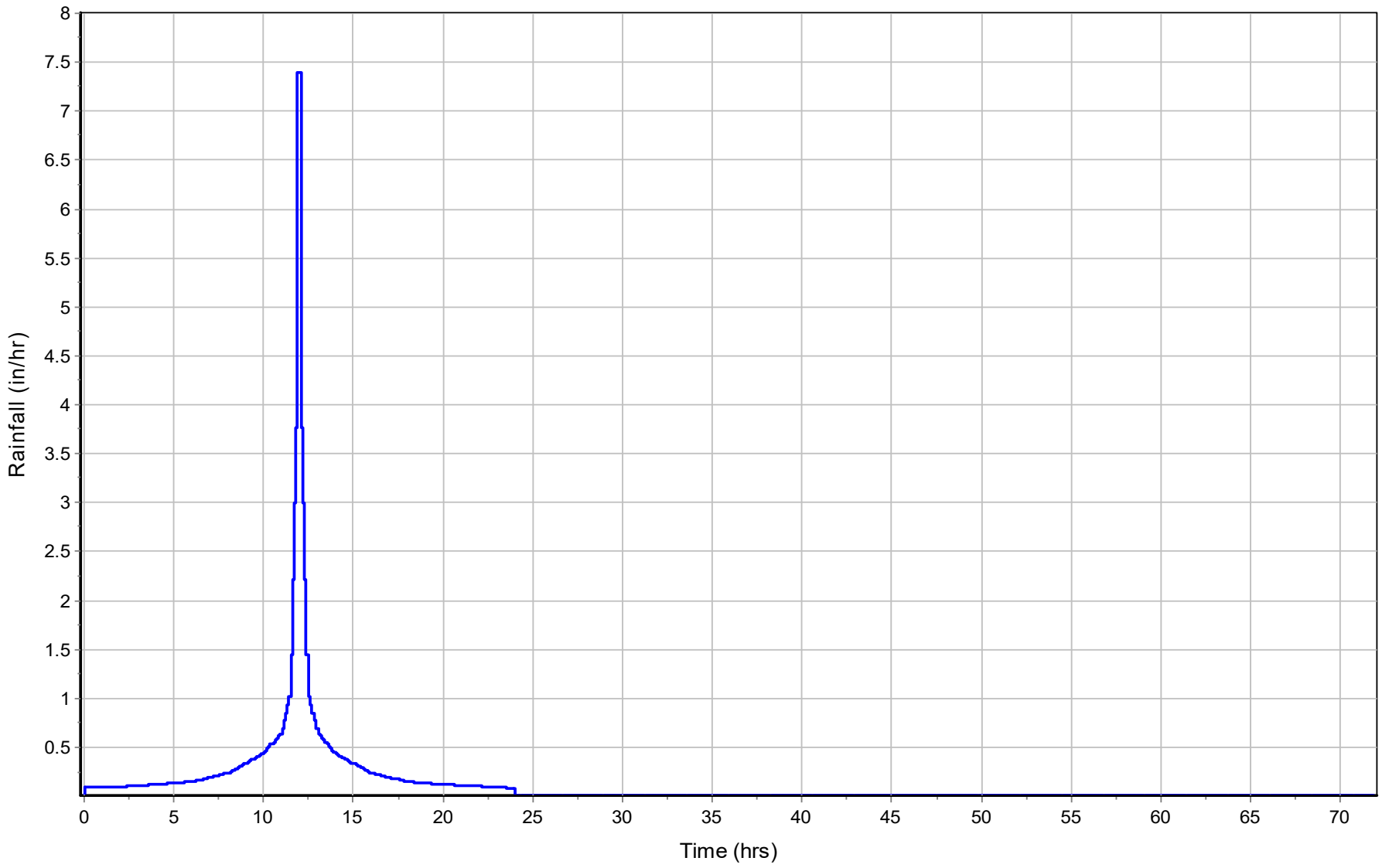
Total TOC (min) 3.51

Subbasin Runoff Results

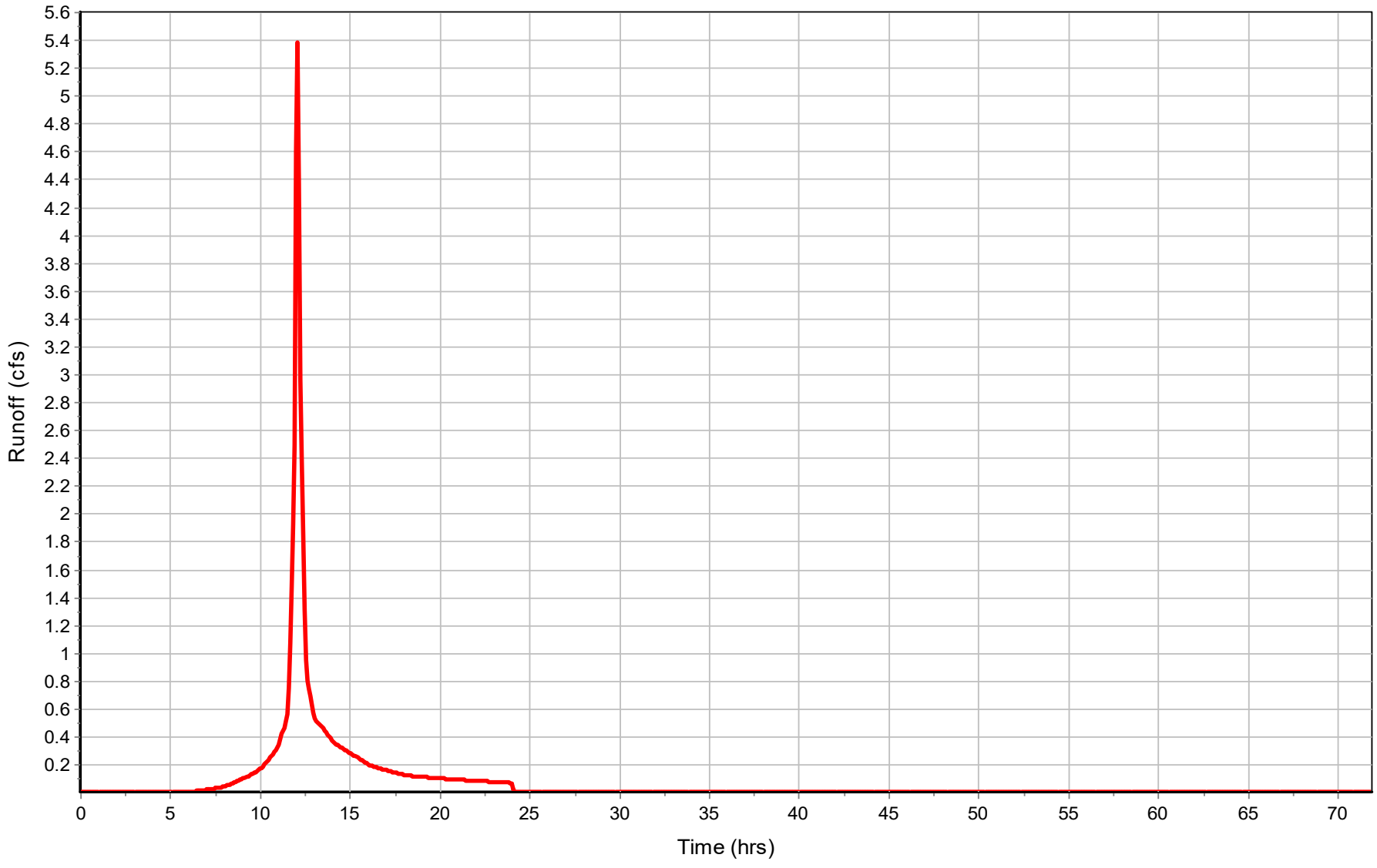
Total Rainfall (in) 8.8
Total Runoff (in) 5.89
Peak Runoff (cfs) 5.48
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:03:31

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

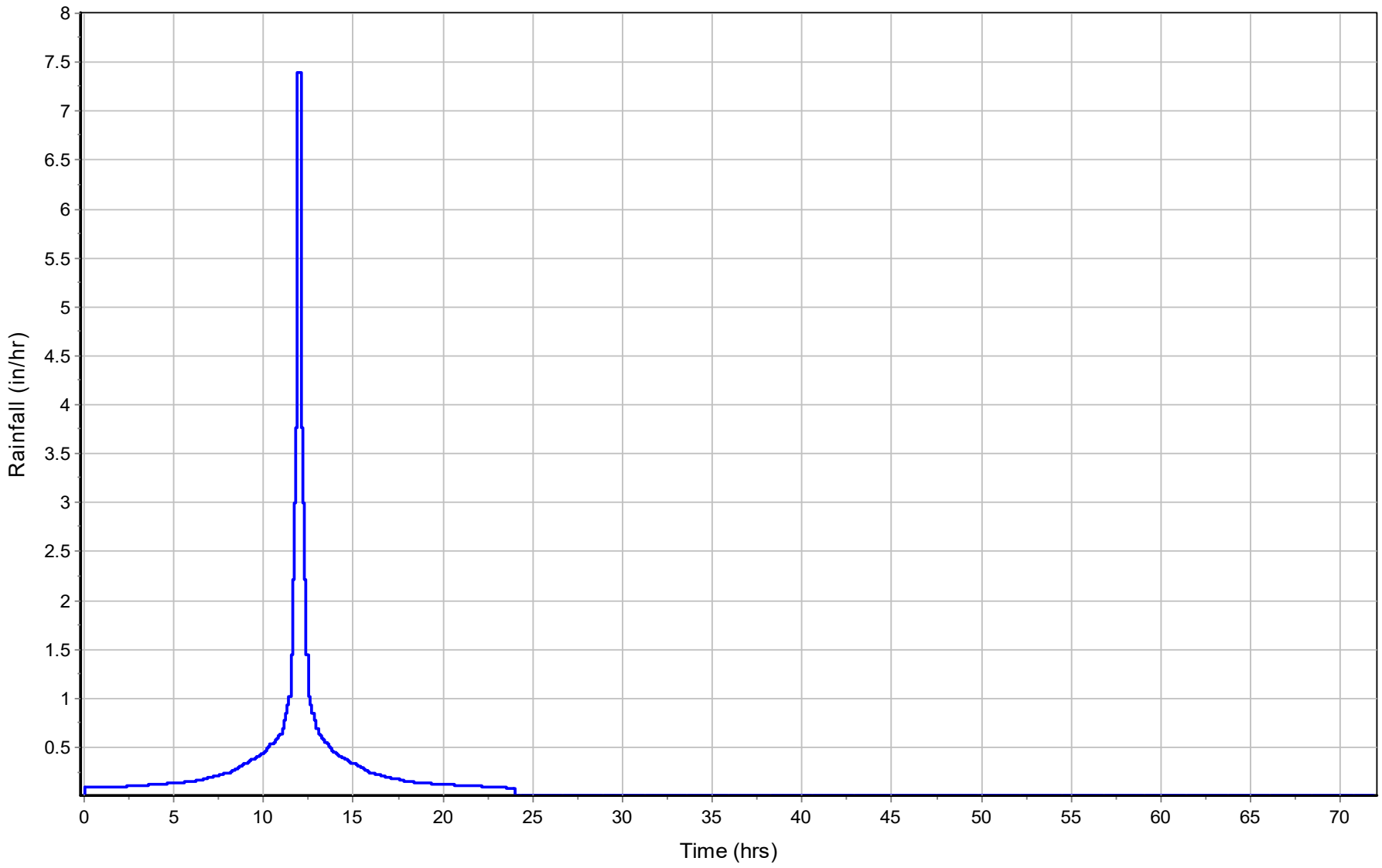
Total TOC (min) 36.12

Subbasin Runoff Results

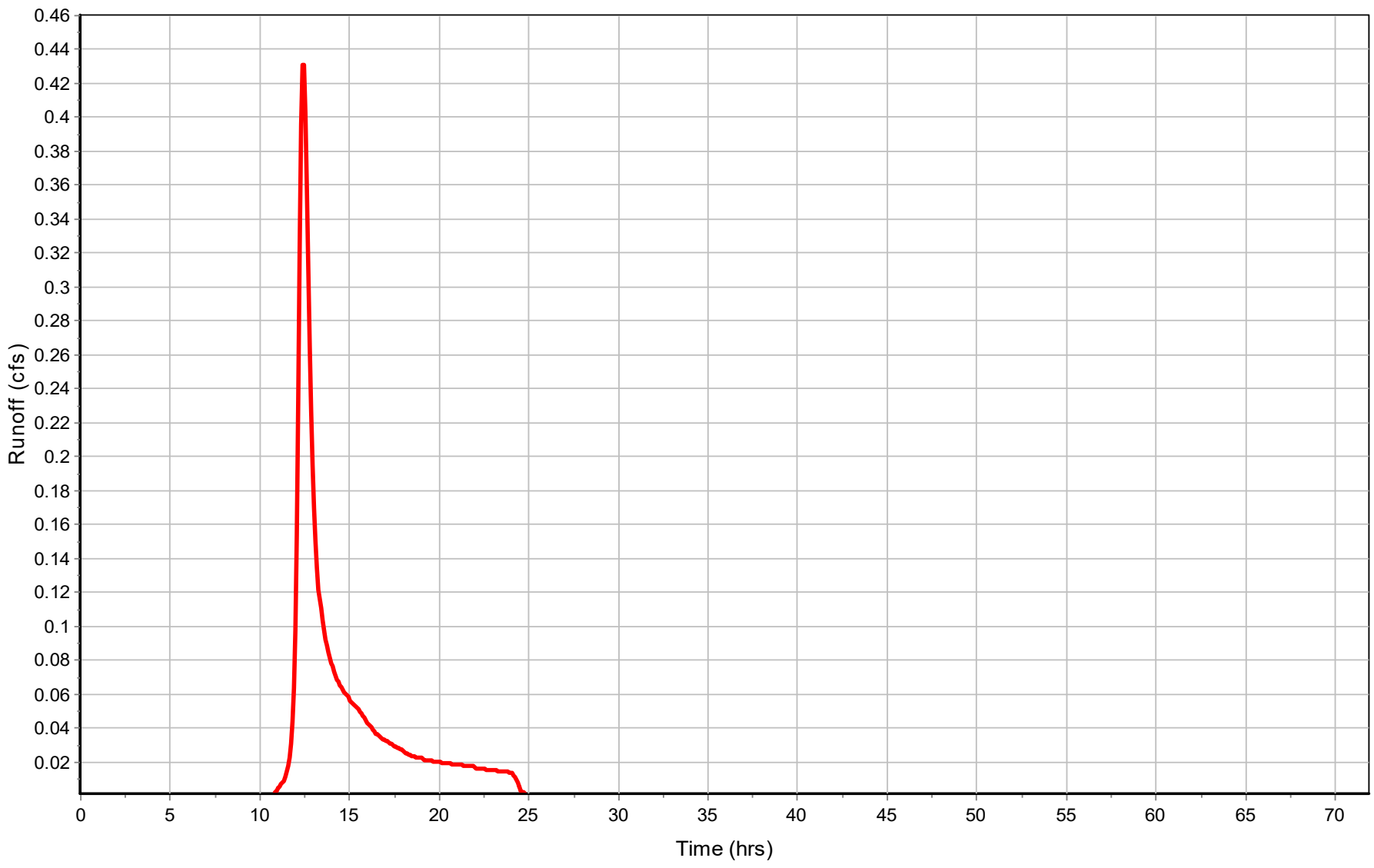
Total Rainfall (in)	8.8
Total Runoff (in)	2.95
Peak Runoff (cfs)	0.43
Weighted Curve Number	51.7
Time of Concentration (days hh:mm:ss)	0 00:36:07

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

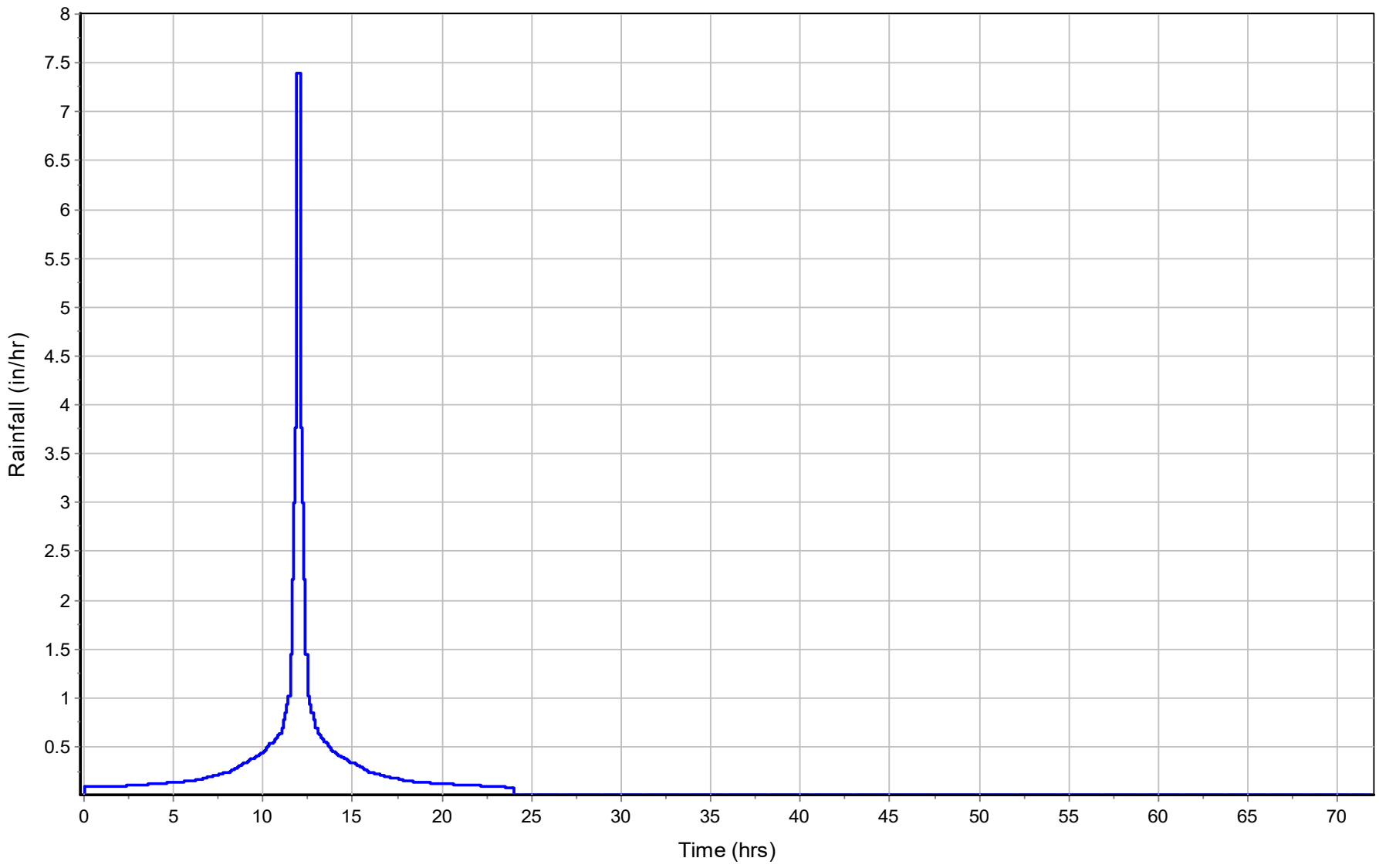
Total TOC (min) 3.14

Subbasin Runoff Results

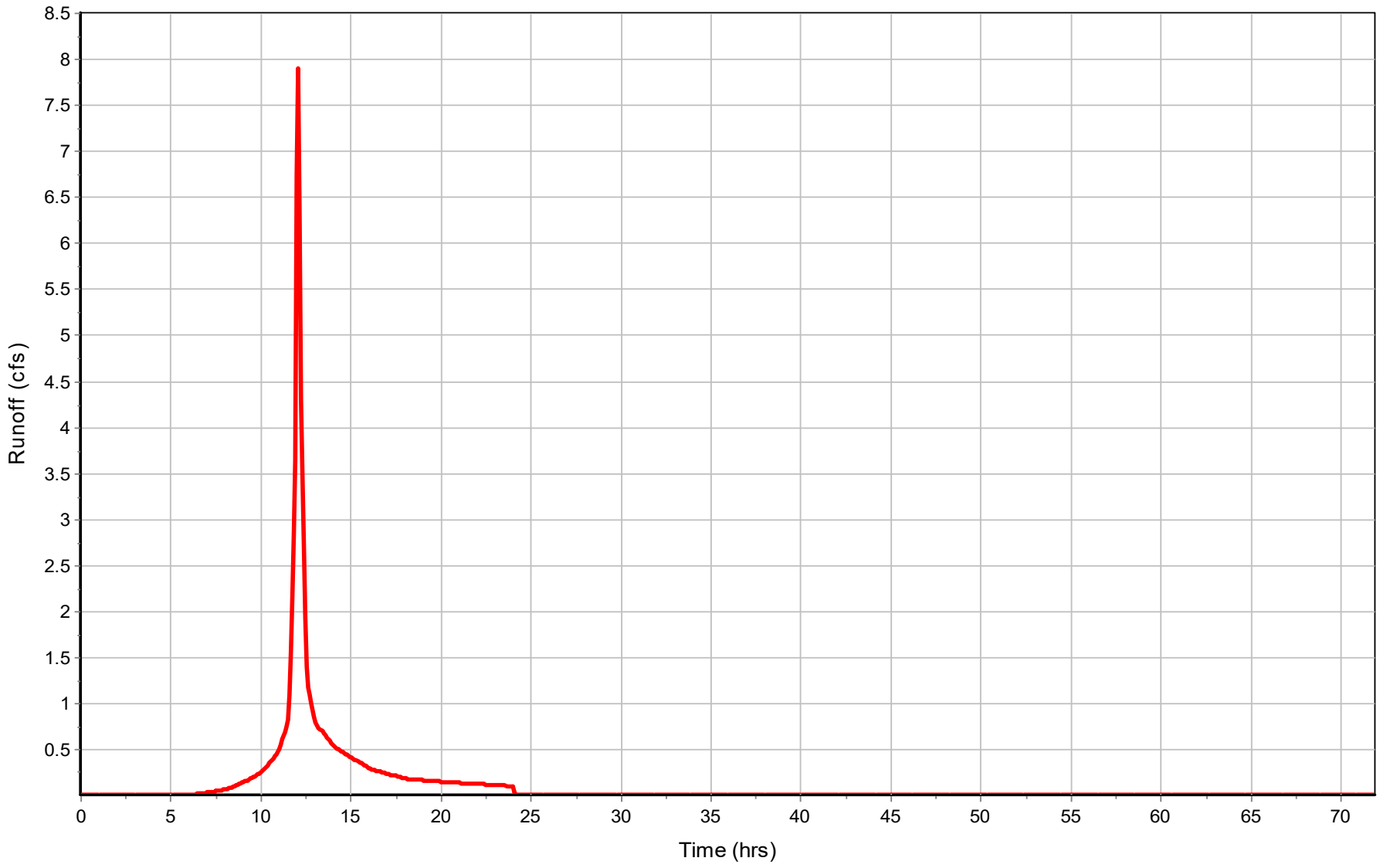
Total Rainfall (in) 8.8
Total Runoff (in) 5.89
Peak Runoff (cfs) 8.02
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:03:08

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

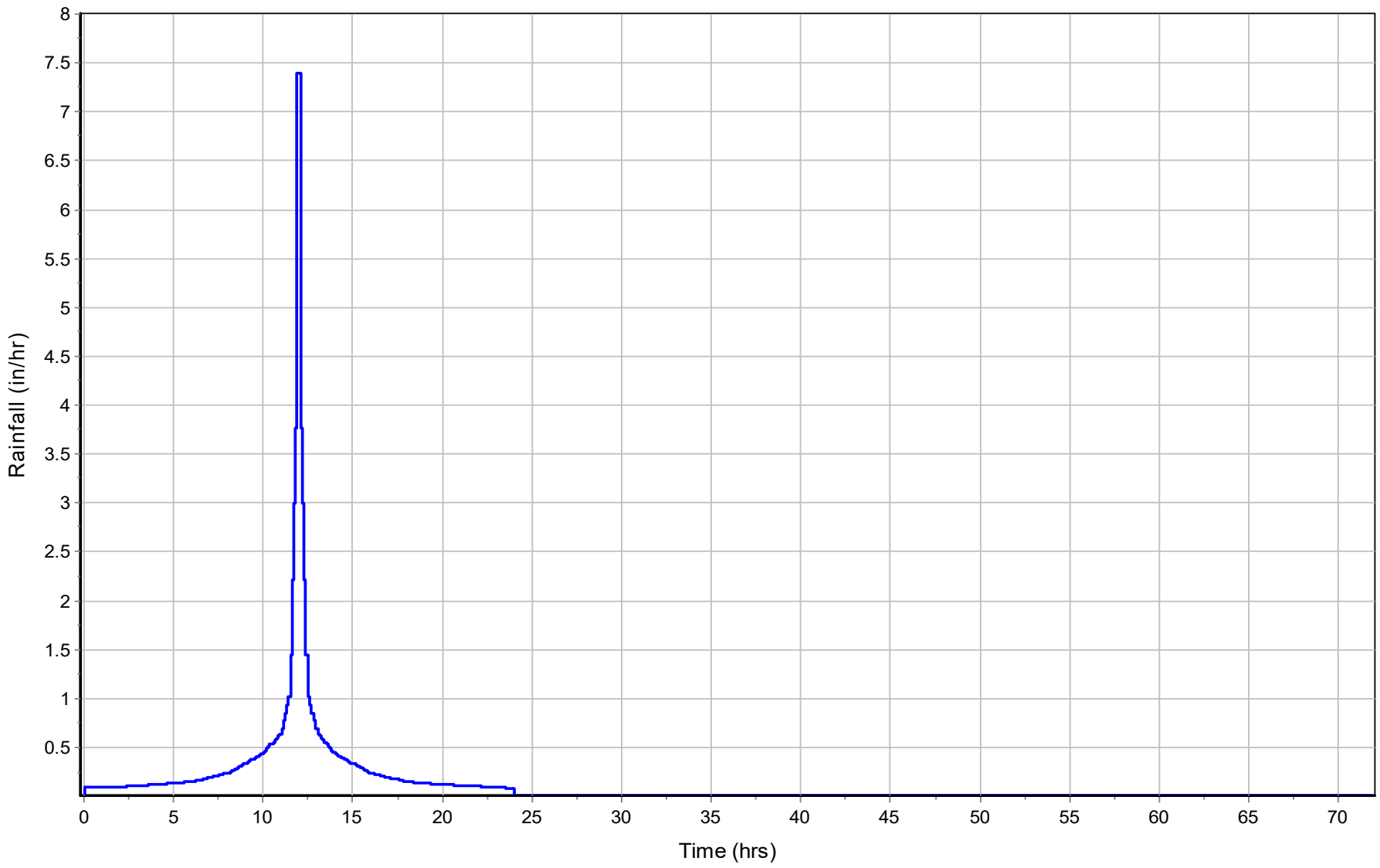
Total TOC (min) 2.17

Subbasin Runoff Results

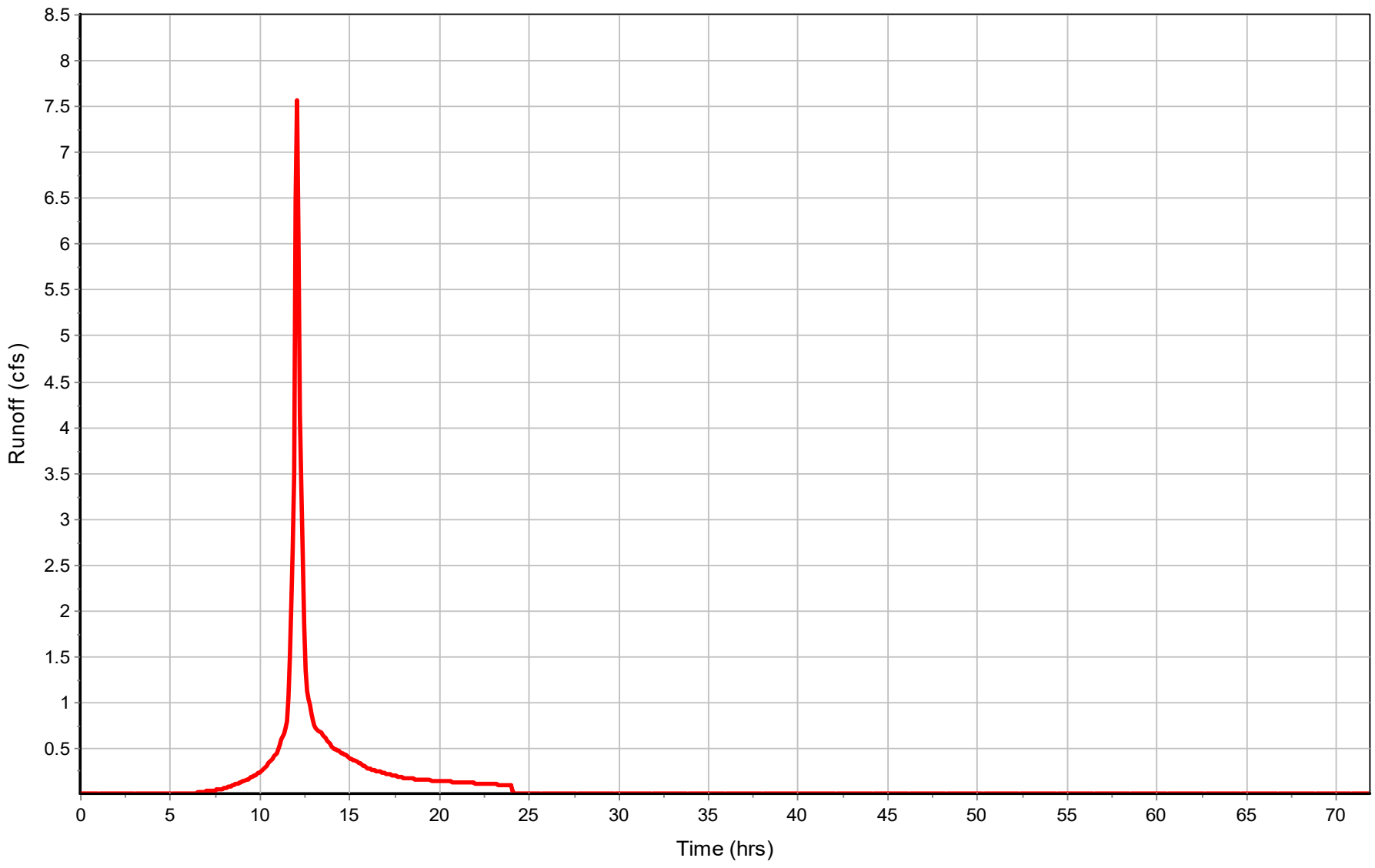
Total Rainfall (in) 8.8
Total Runoff (in) 5.89
Peak Runoff (cfs) 7.68
Weighted Curve Number 76
Time of Concentration (days hh:mm:ss) 0 00:02:10

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

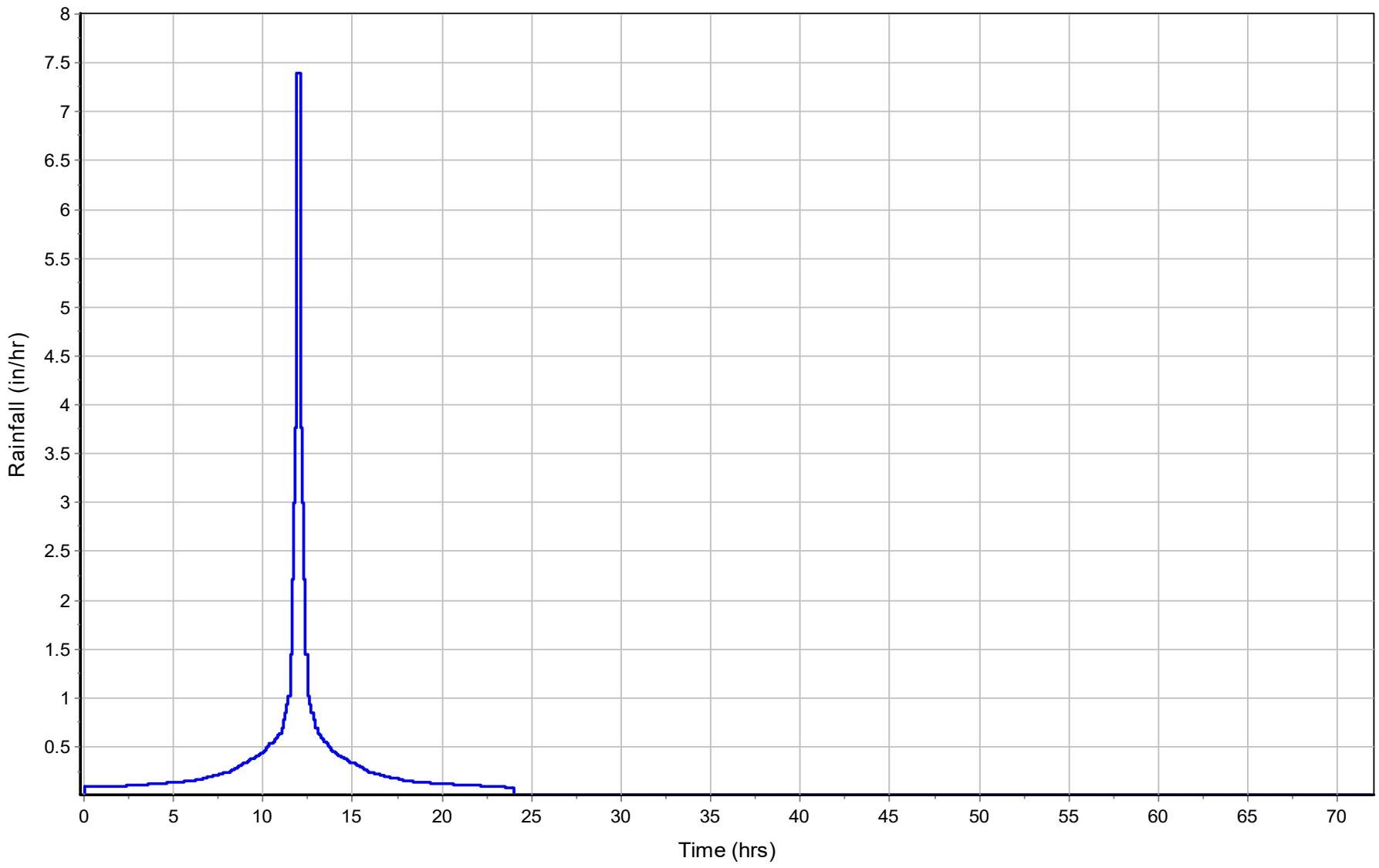
Total TOC (min) 4.13

Subbasin Runoff Results

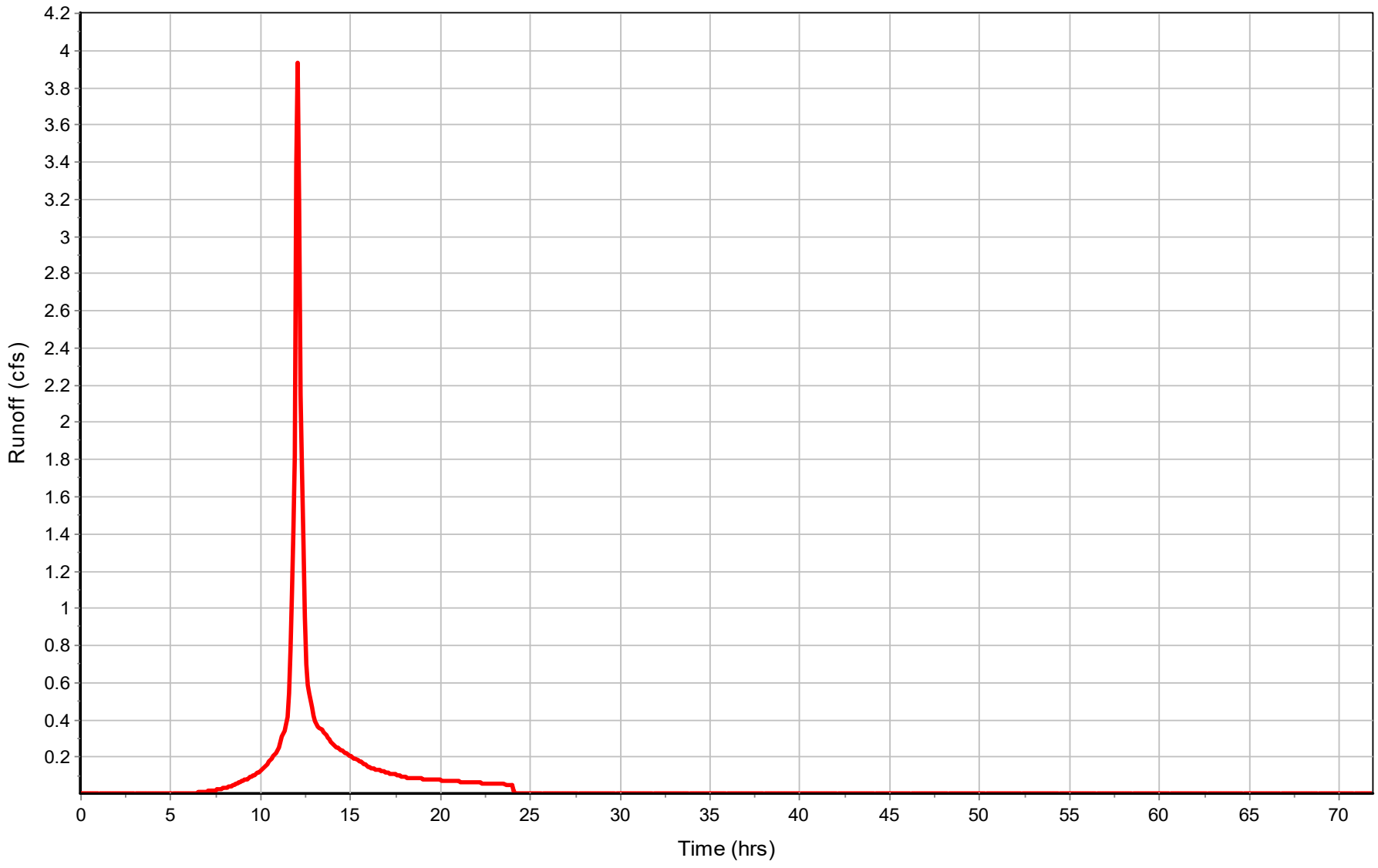
Total Rainfall (in)	8.8
Total Runoff (in)	5.89
Peak Runoff (cfs)	3.99
Weighted Curve Number	76
Time of Concentration (days hh:mm:ss)	0 00:04:08

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

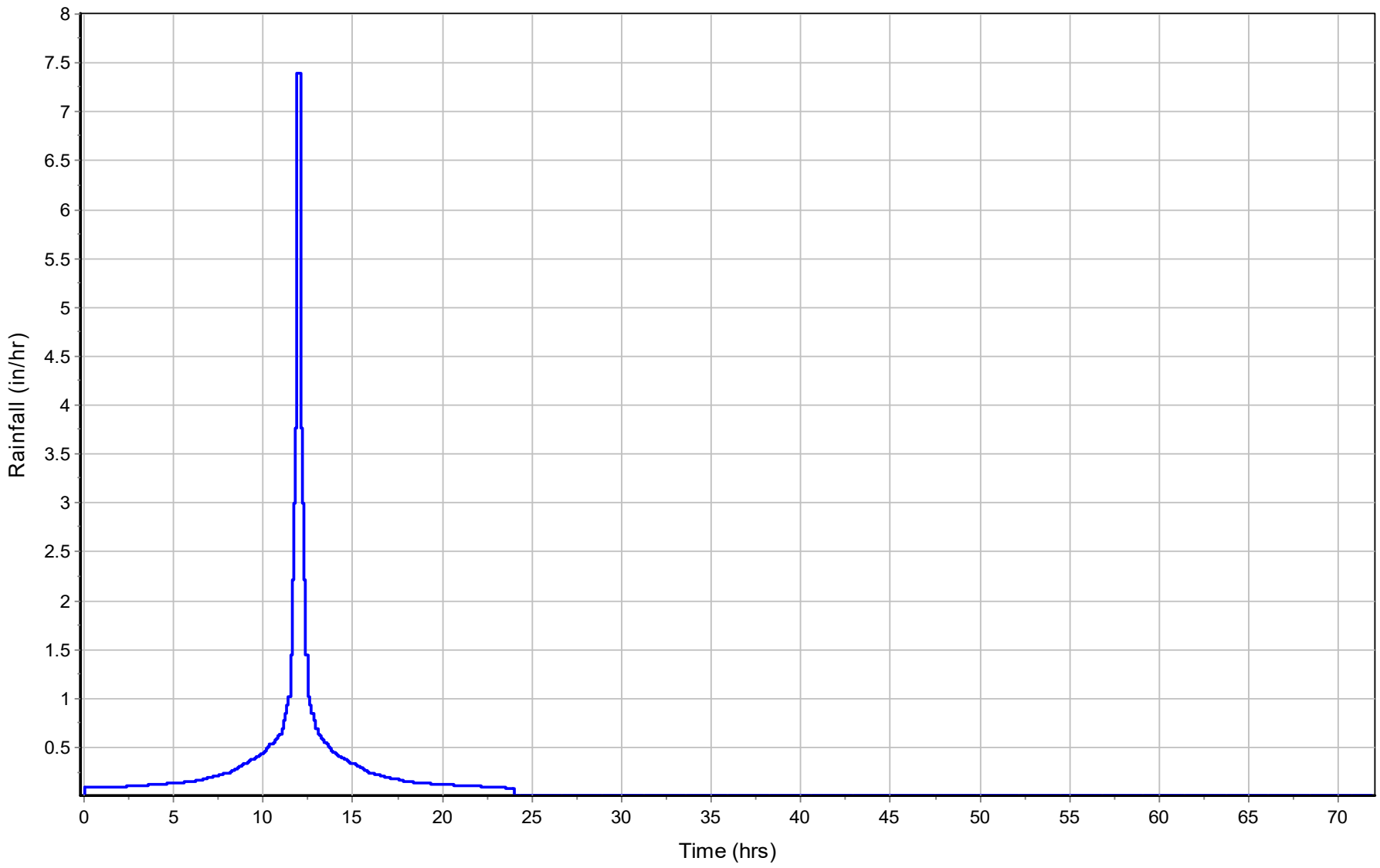
Total TOC (min) 34.83

Subbasin Runoff Results

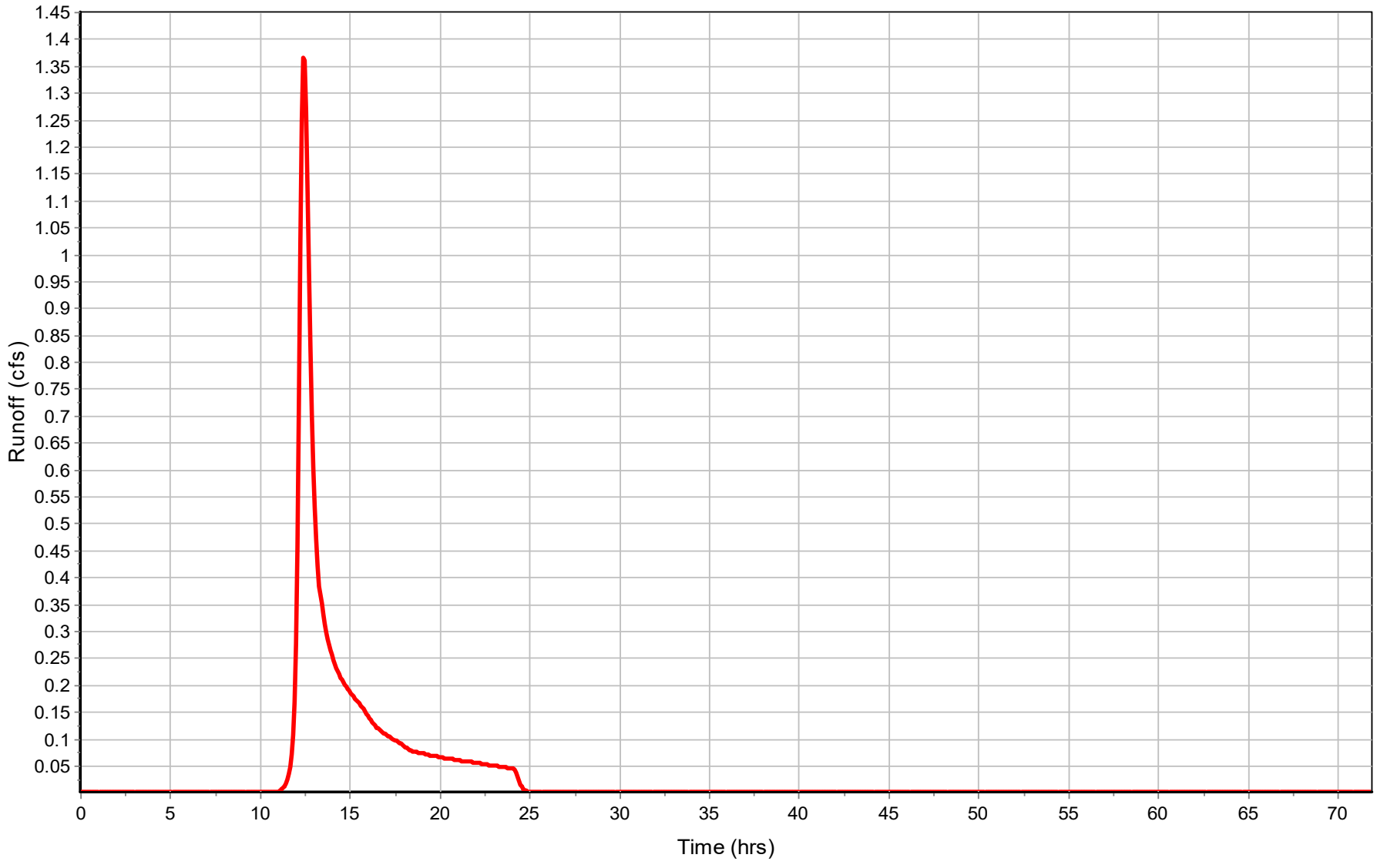
Total Rainfall (in)	8.8
Total Runoff (in)	2.64
Peak Runoff (cfs)	1.38
Weighted Curve Number	49
Time of Concentration (days hh:mm:ss)	0 00:34:50

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

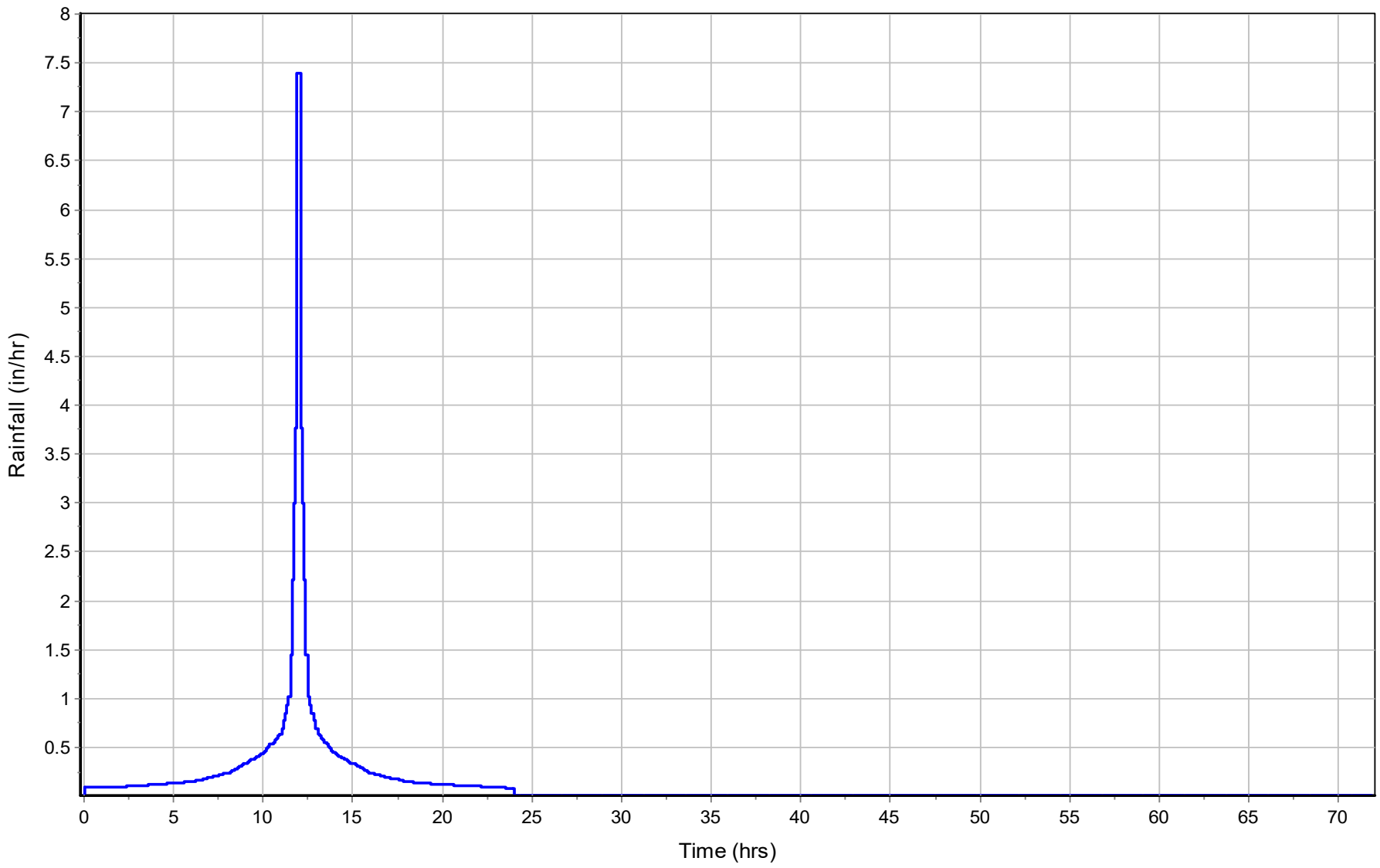
Total TOC (min) 36.49

Subbasin Runoff Results

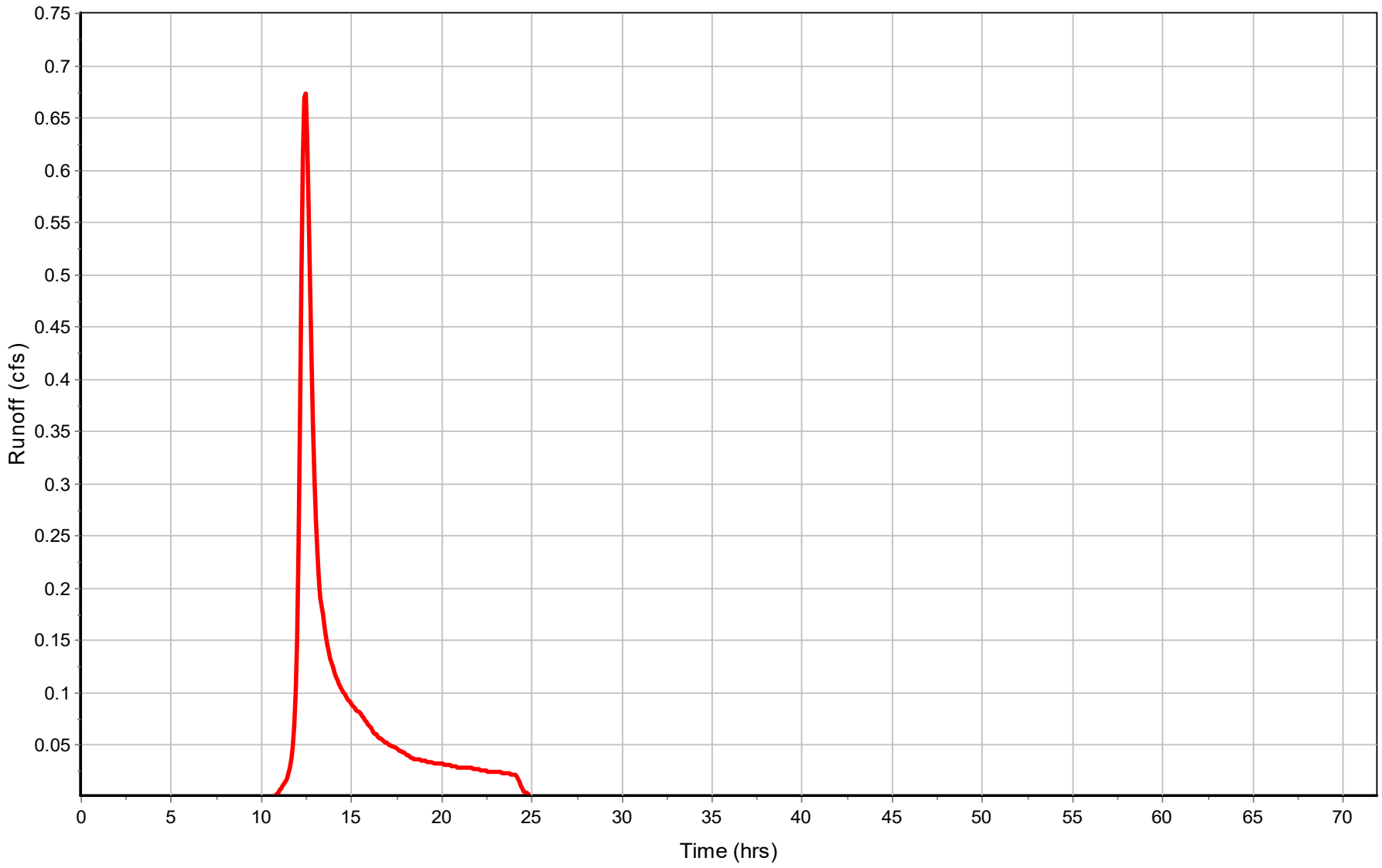
Total Rainfall (in)	8.8
Total Runoff (in)	2.95
Peak Runoff (cfs)	0.68
Weighted Curve Number	51.7
Time of Concentration (days hh:mm:ss)	0 00:36:29

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

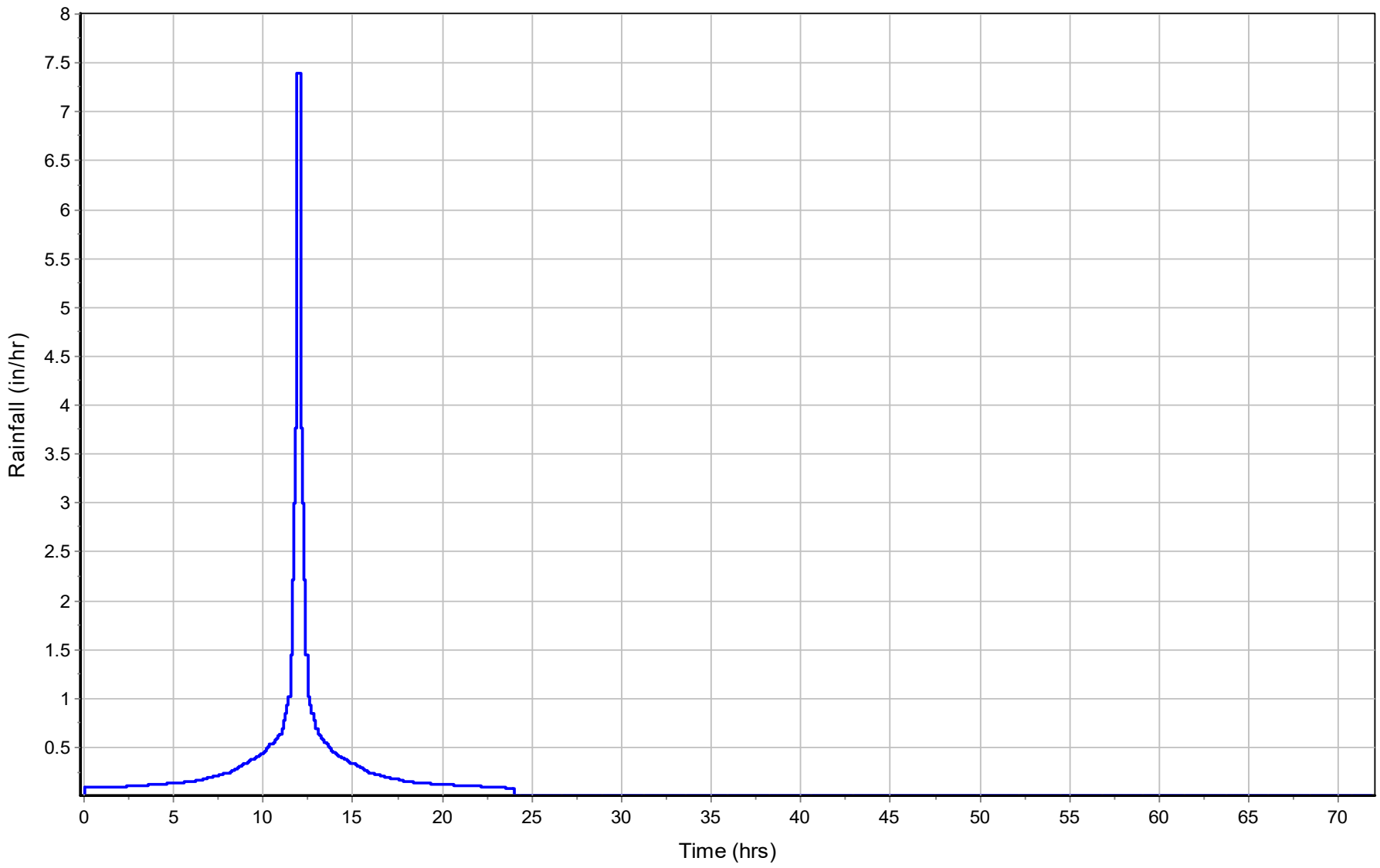
Total TOC (min) 42.87

Subbasin Runoff Results

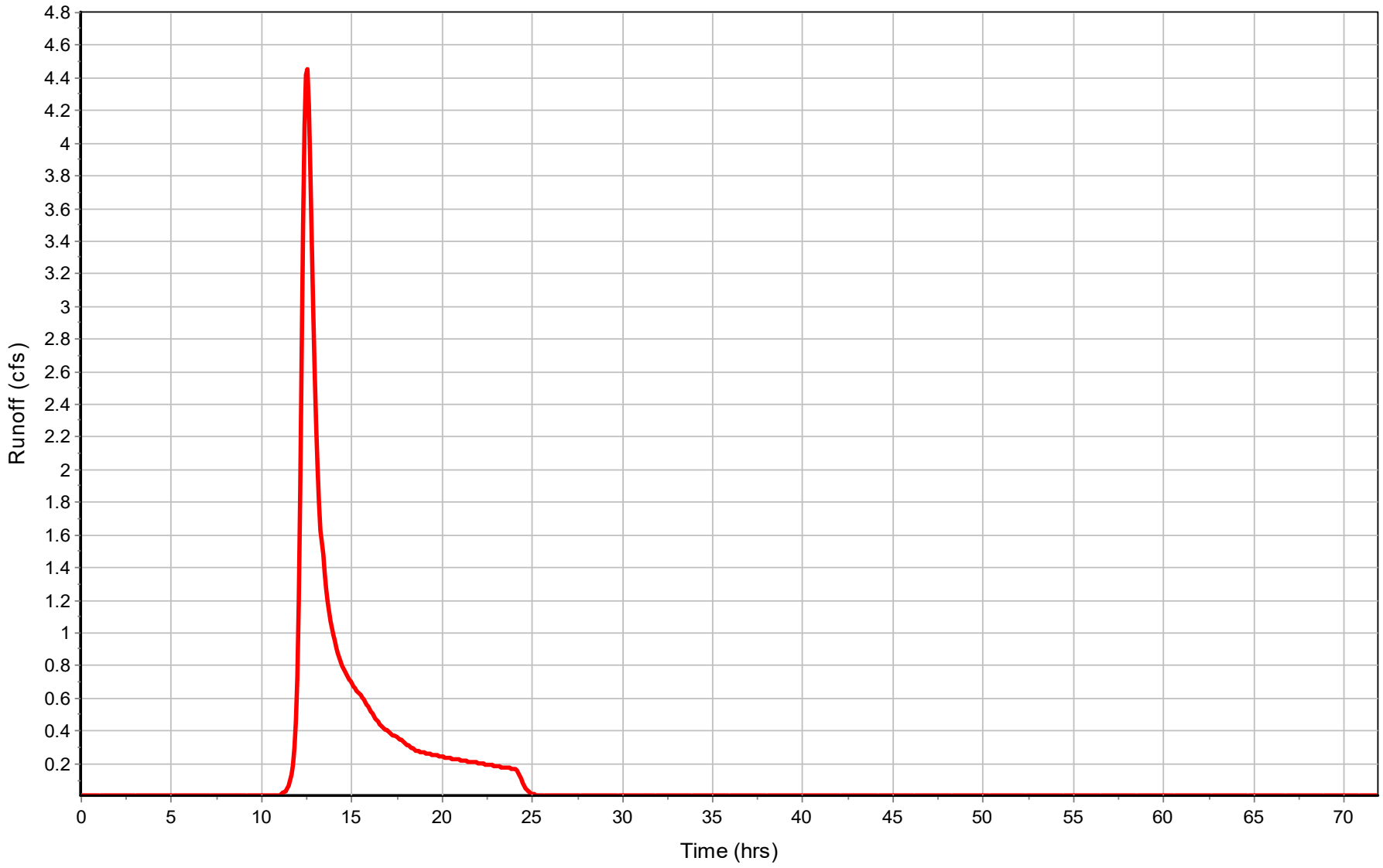
Total Rainfall (in)	8.8
Total Runoff (in)	2.64
Peak Runoff (cfs)	4.47
Weighted Curve Number	49
Time of Concentration (days hh:mm:ss)	0 00:42:52

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

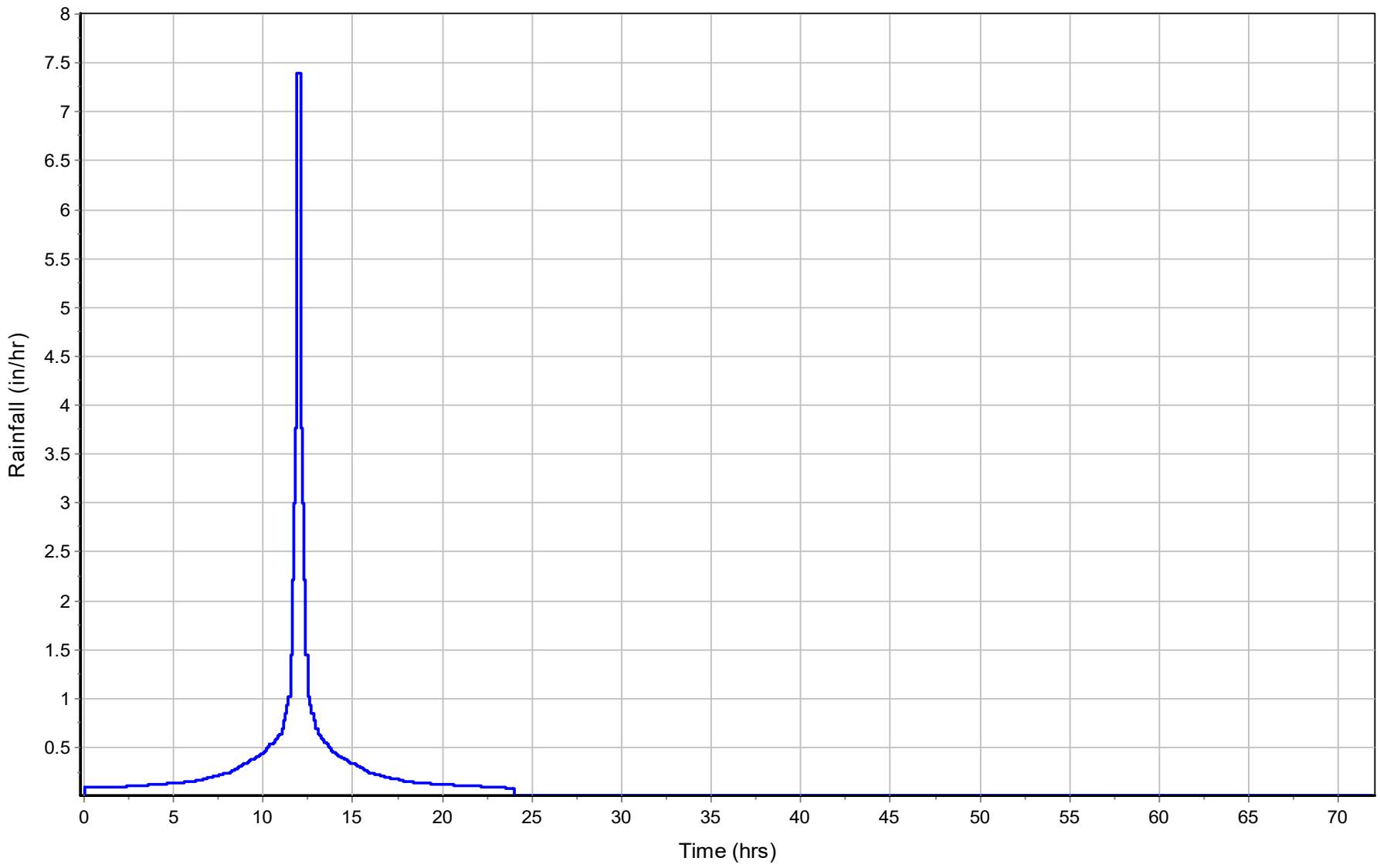
Total TOC (min) 14.50

Subbasin Runoff Results

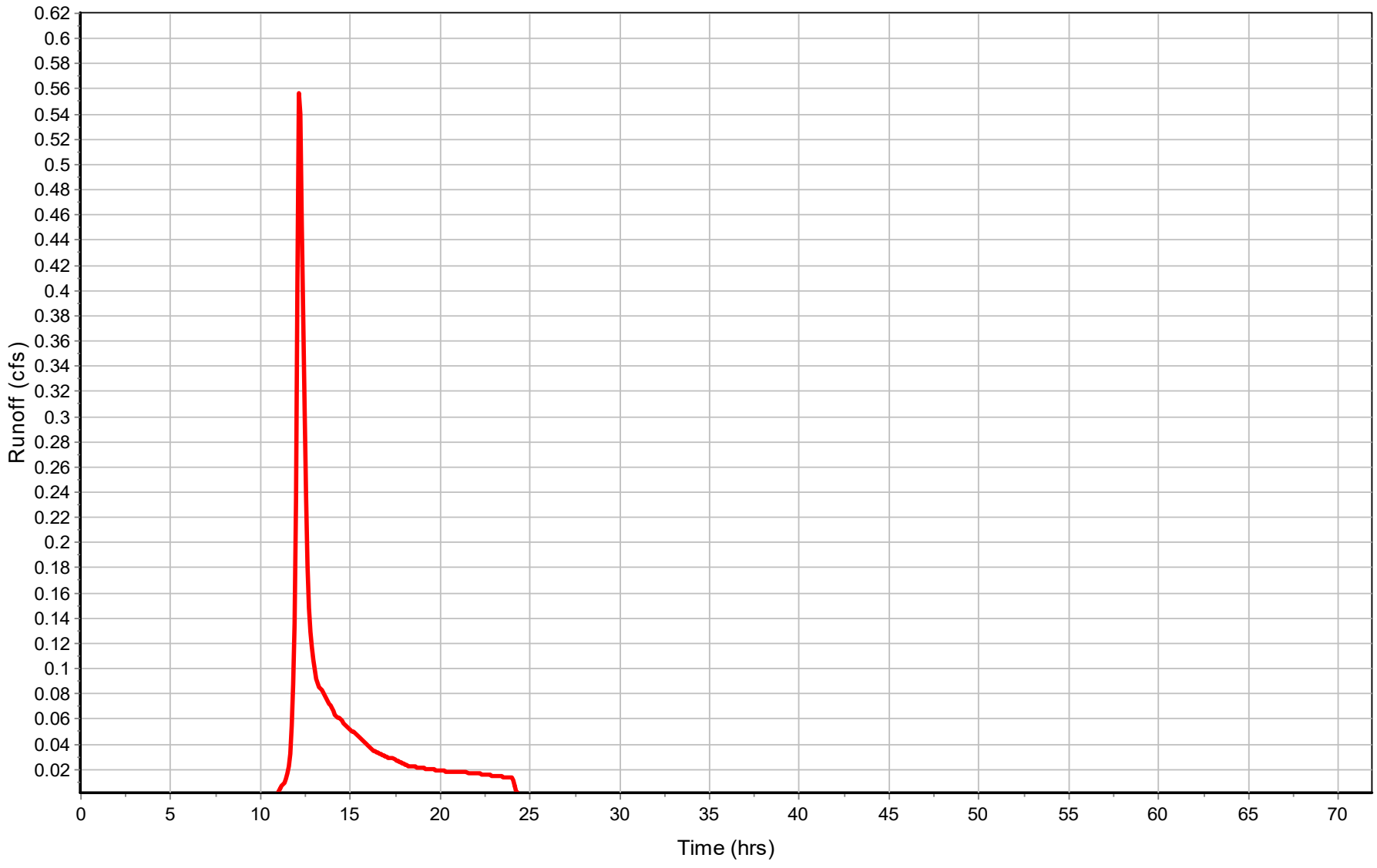
Total Rainfall (in)	8.8
Total Runoff (in)	2.64
Peak Runoff (cfs)	0.57
Weighted Curve Number	49
Time of Concentration (days hh:mm:ss)	0 00:14:30

Subbasin : Existing-E5.1_A2

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : A1-1-BASIN

Input Data

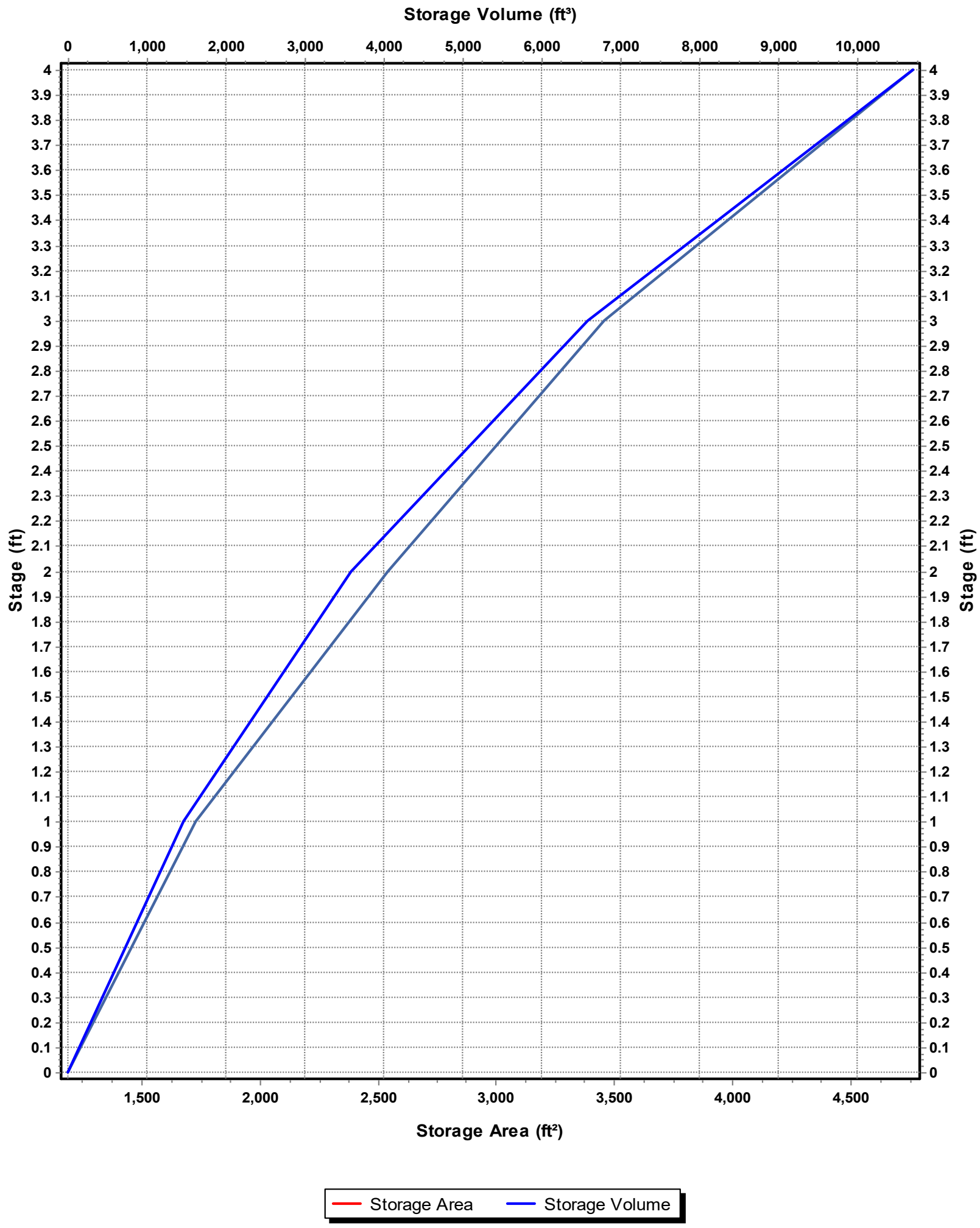
Invert Elevation (ft)	66.00
Max (Rim) Elevation (ft)	69.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	66.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

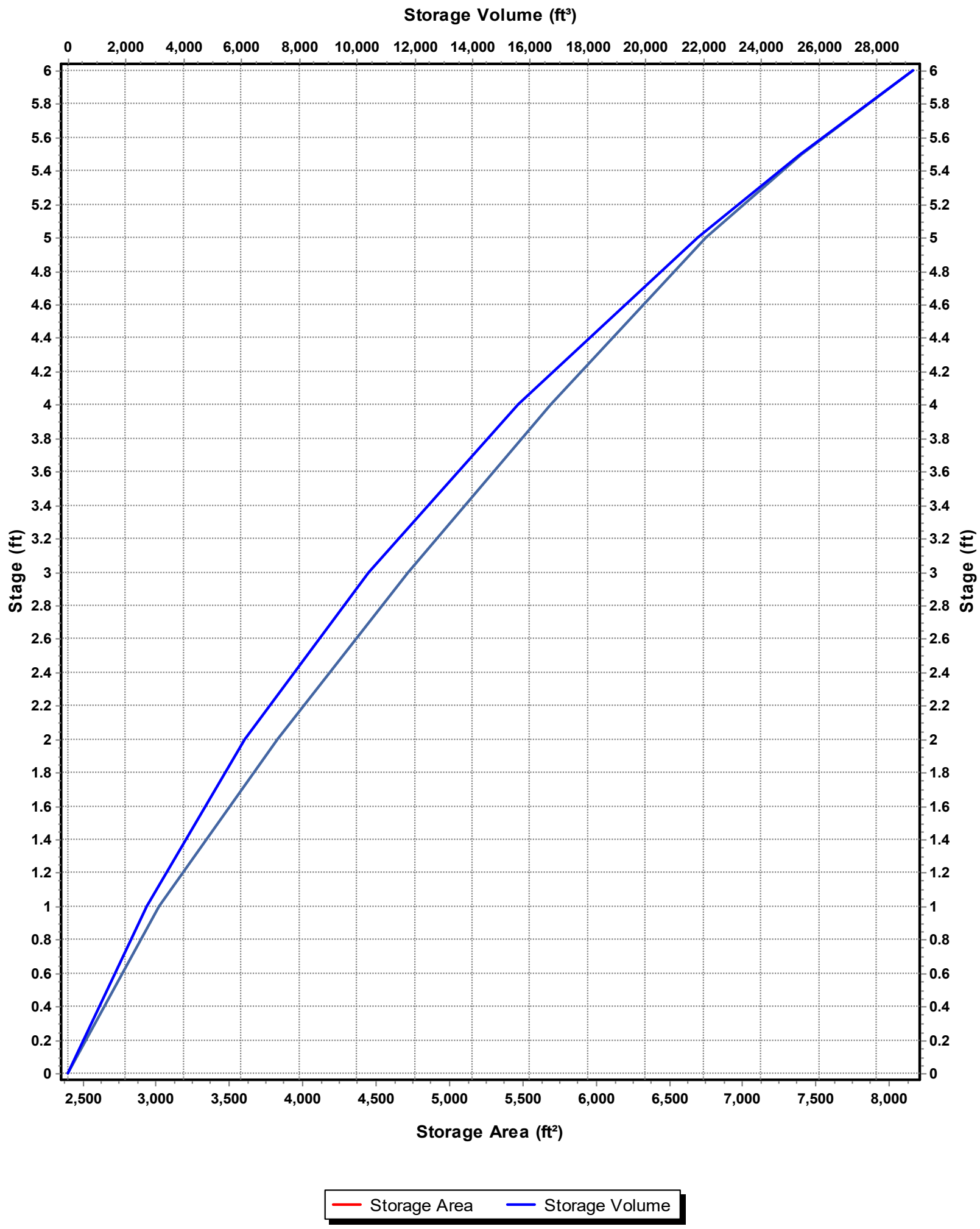
Invert Elevation (ft)	63.00
Max (Rim) Elevation (ft)	69.00
Max (Rim) Offset (ft)	6.00
Initial Water Elevation (ft)	63.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

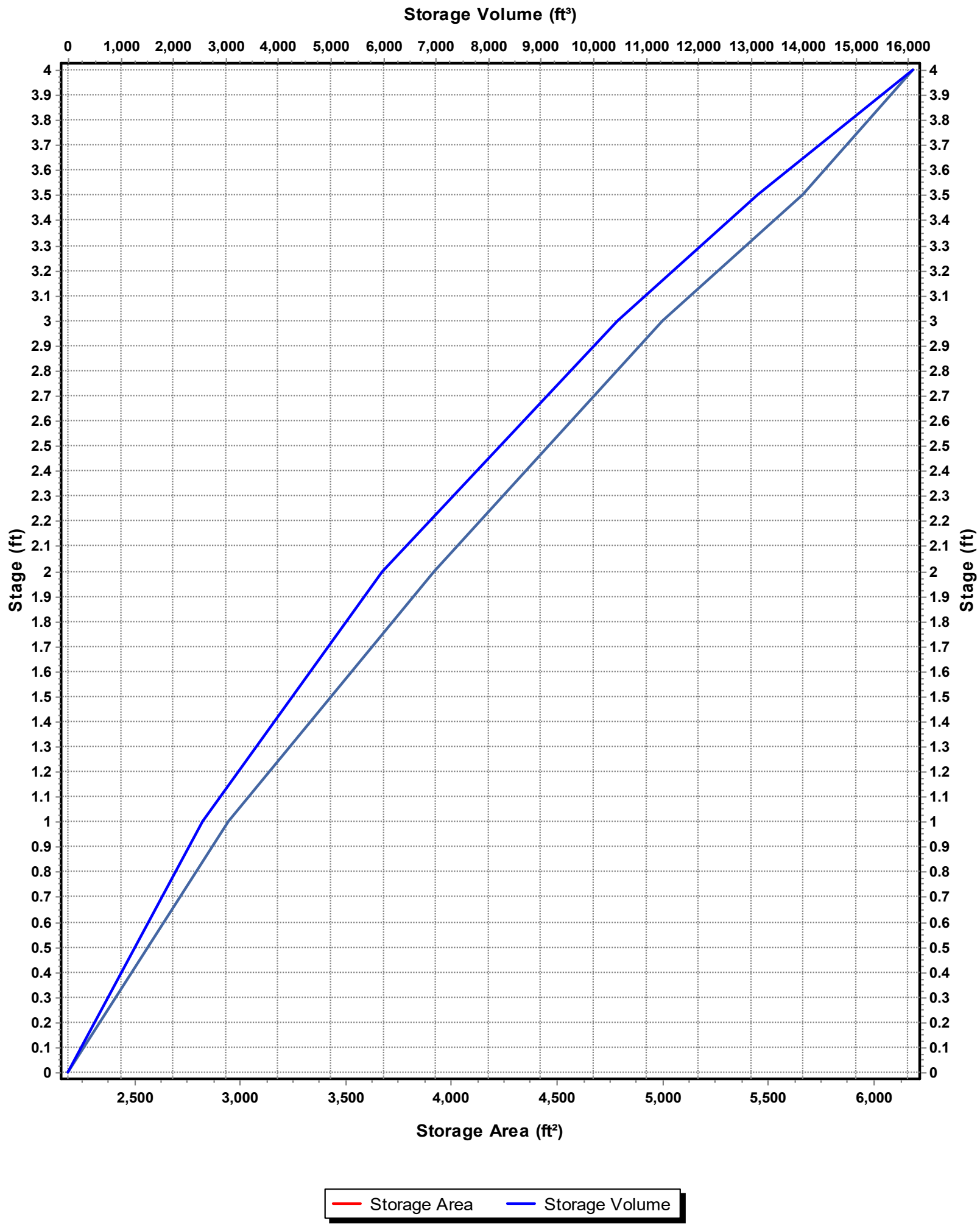
Invert Elevation (ft)	63.00
Max (Rim) Elevation (ft)	67.00
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	63.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

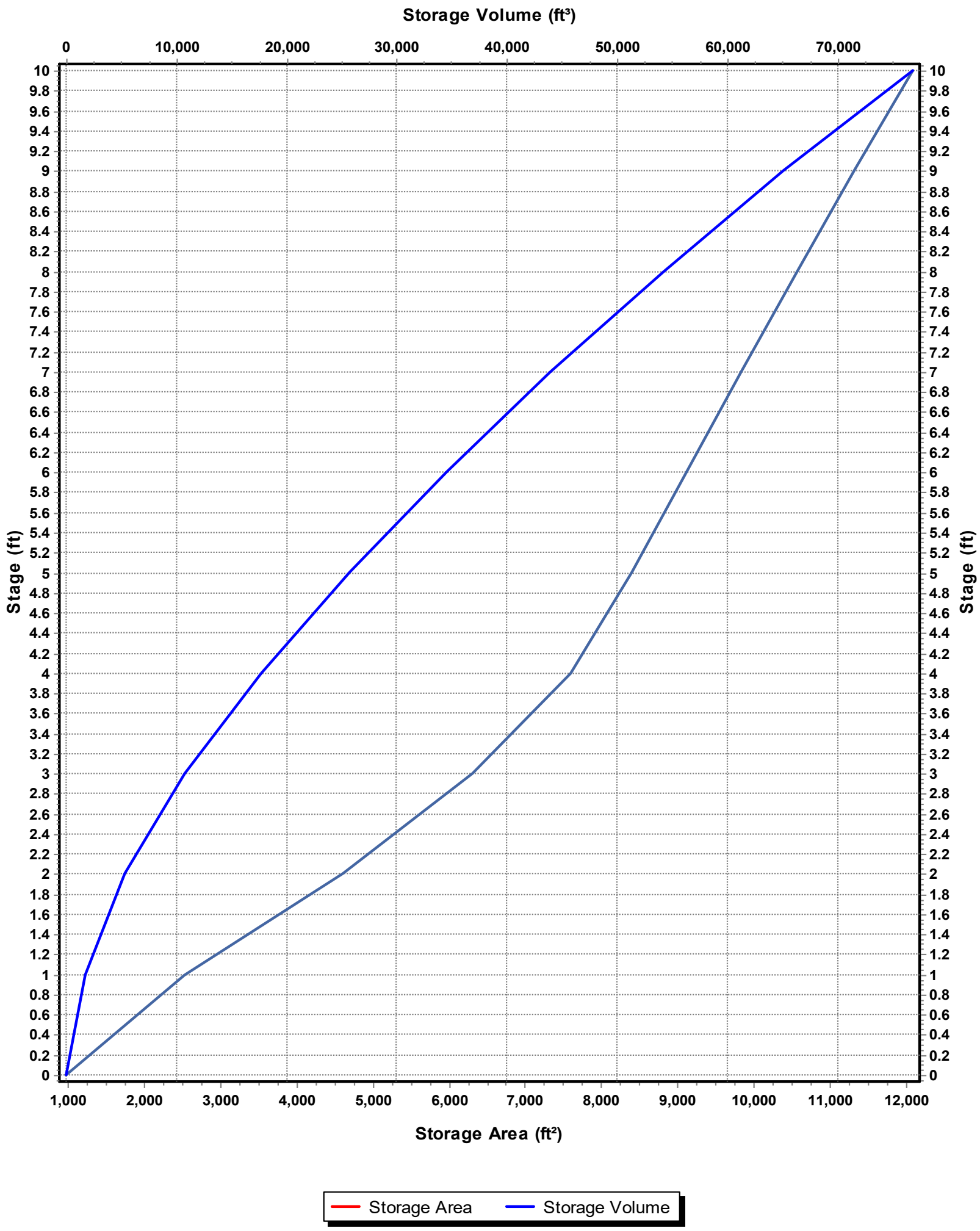
Invert Elevation (ft)	43.00
Max (Rim) Elevation (ft)	53.00
Max (Rim) Offset (ft)	10.00
Initial Water Elevation (ft)	43.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

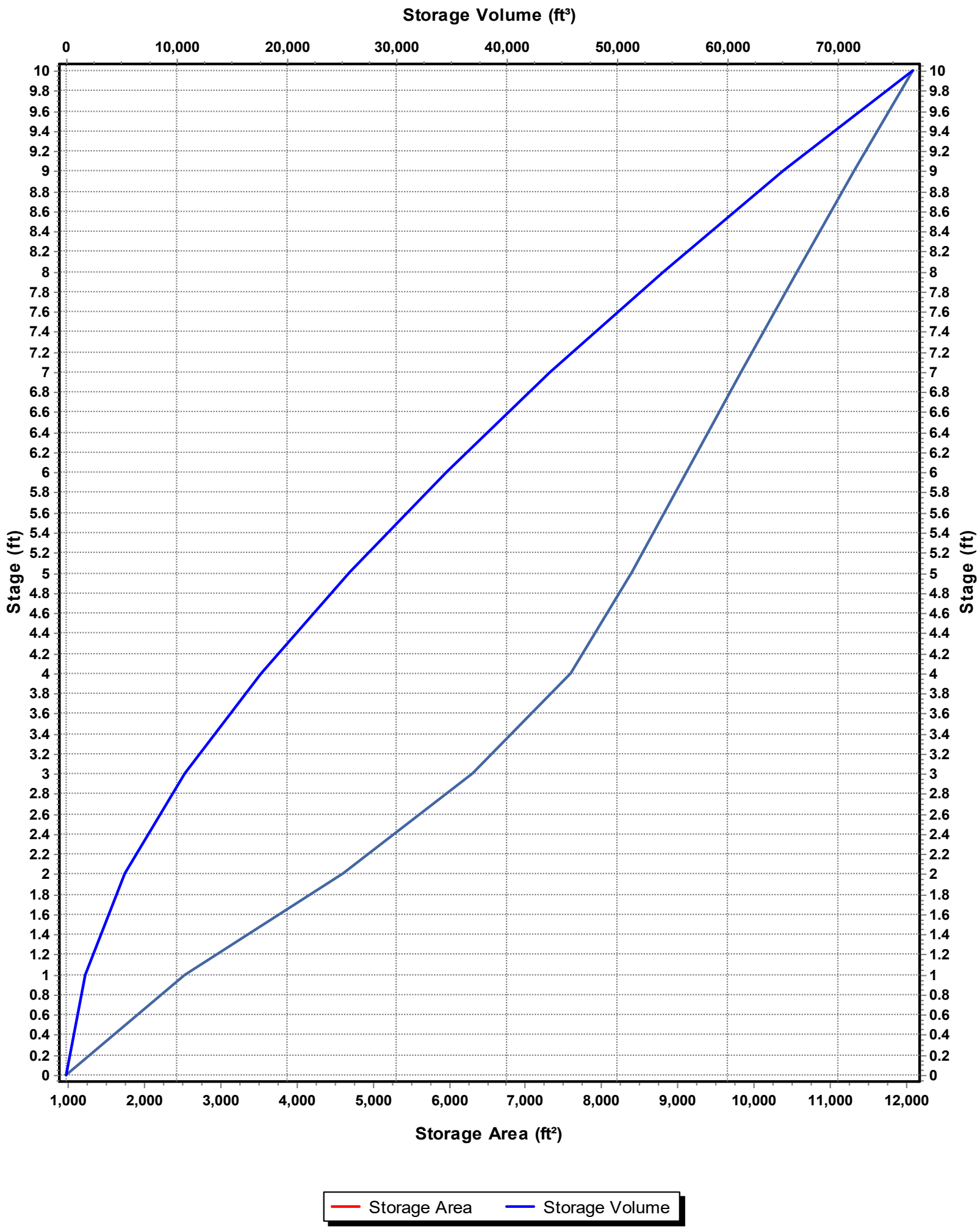
Invert Elevation (ft)	43.00
Max (Rim) Elevation (ft)	53.00
Max (Rim) Offset (ft)	10.00
Initial Water Elevation (ft)	43.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

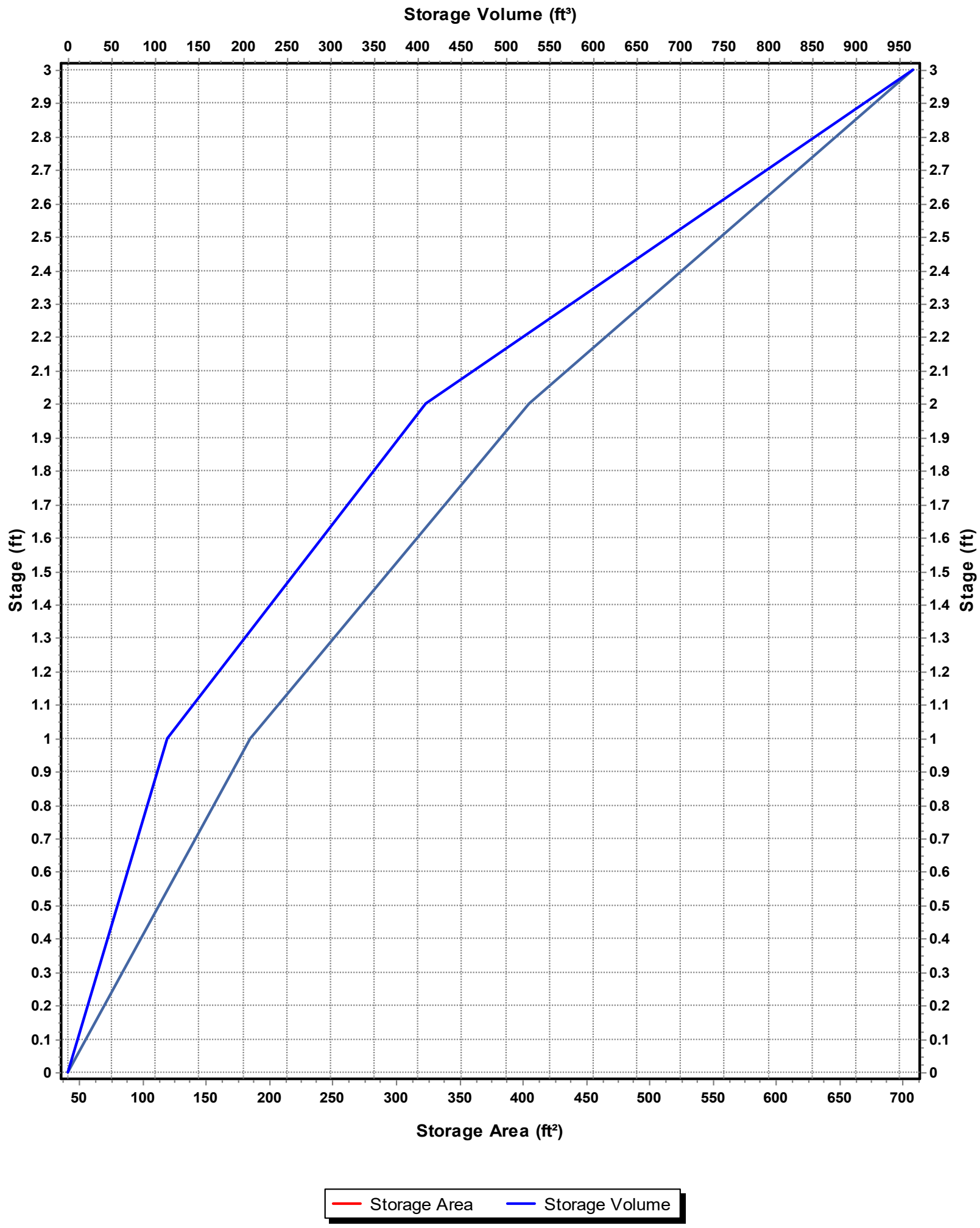
Invert Elevation (ft)	66.00
Max (Rim) Elevation (ft)	70.00
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	66.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

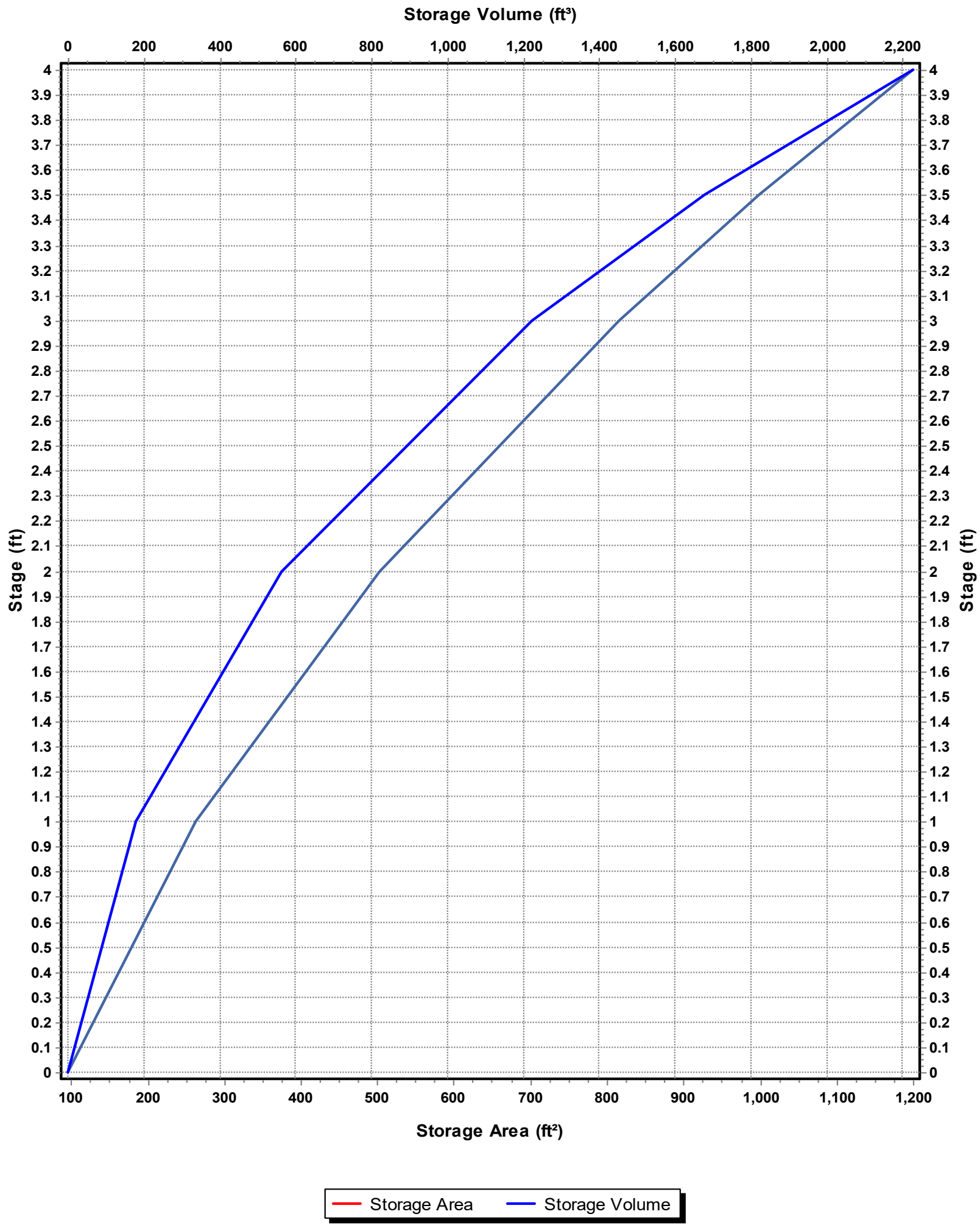
Invert Elevation (ft)	62.00
Max (Rim) Elevation (ft)	66.00
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	62.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

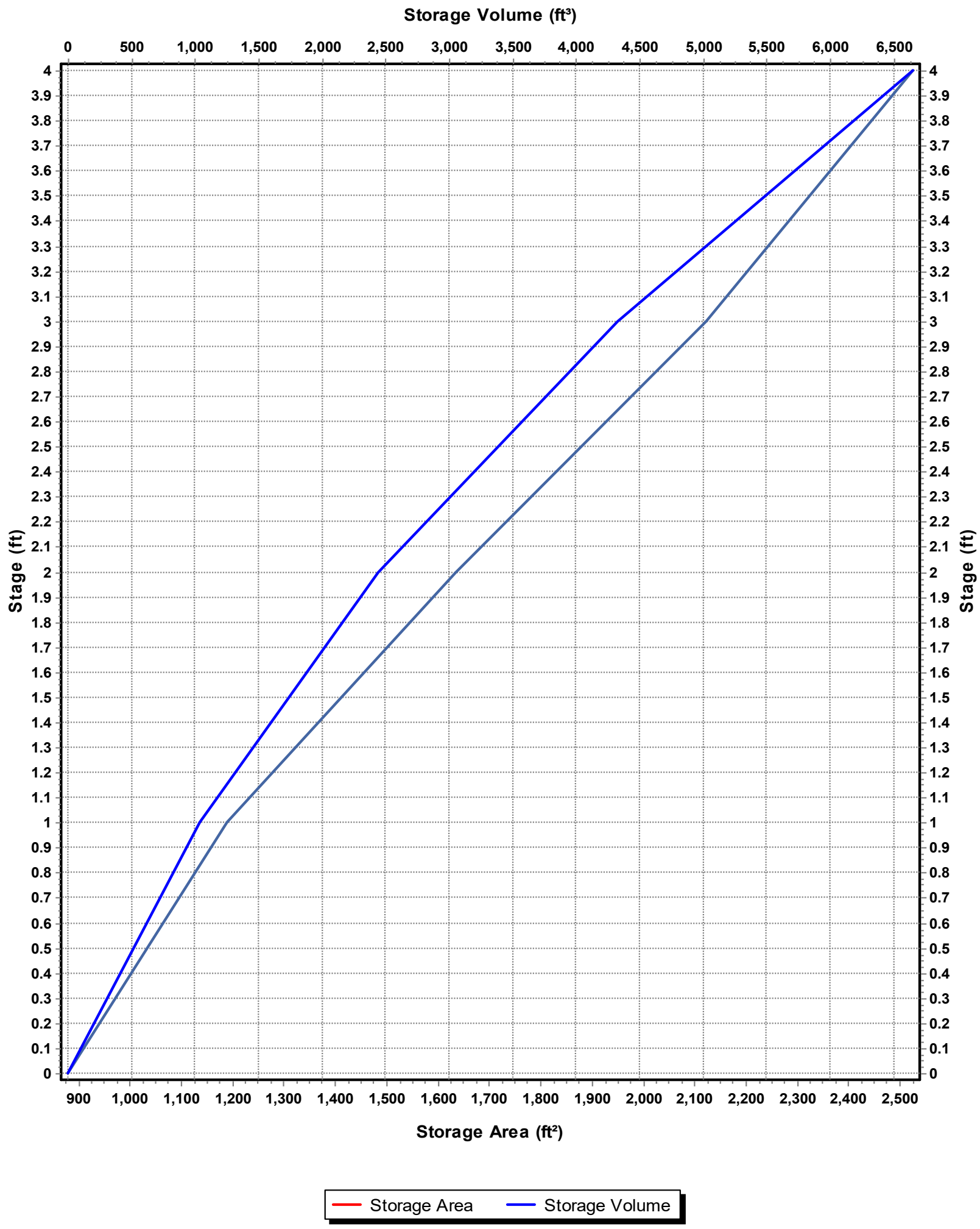
Invert Elevation (ft)	65.00
Max (Rim) Elevation (ft)	69.00
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	65.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

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

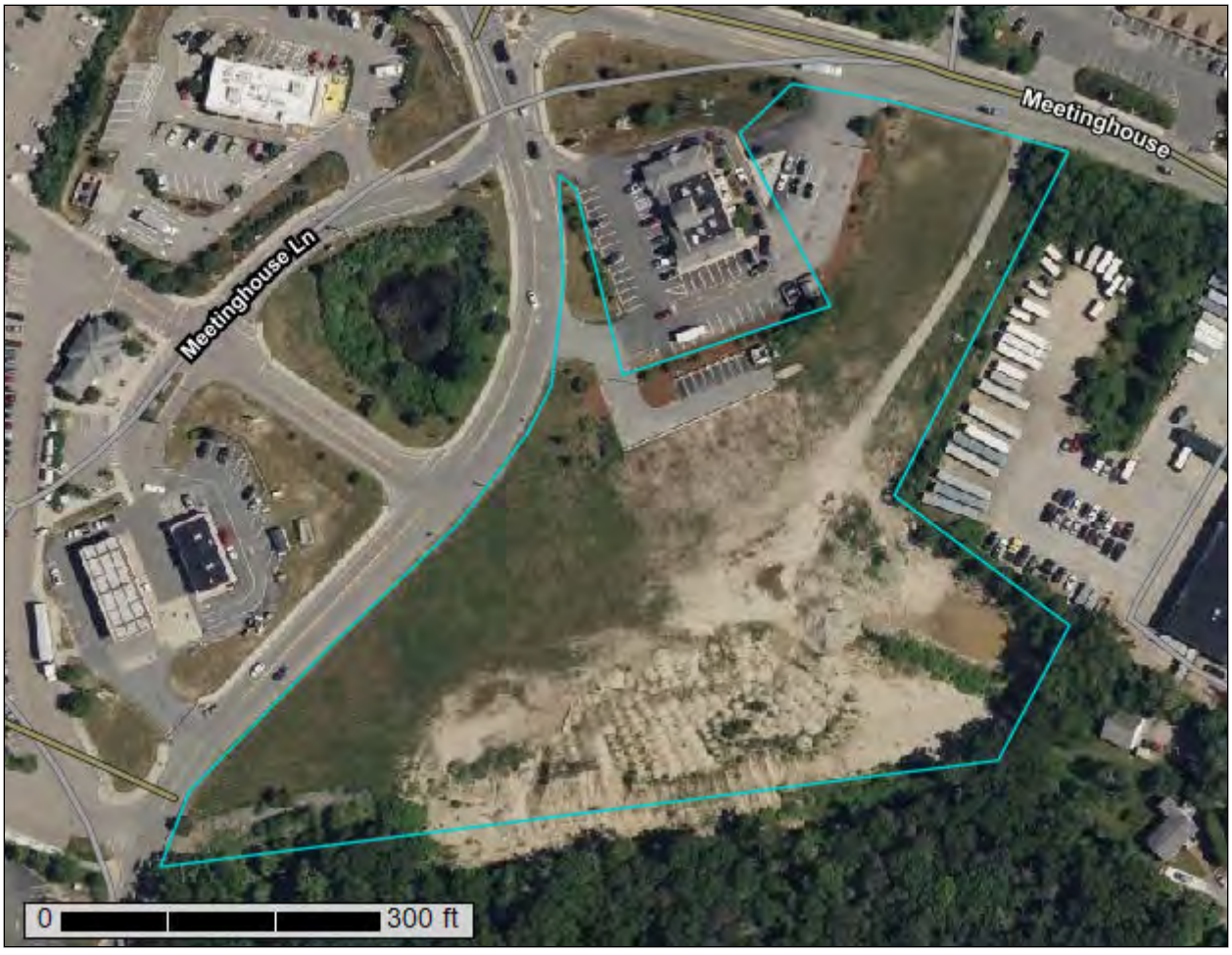
United States Department of Agriculture

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.

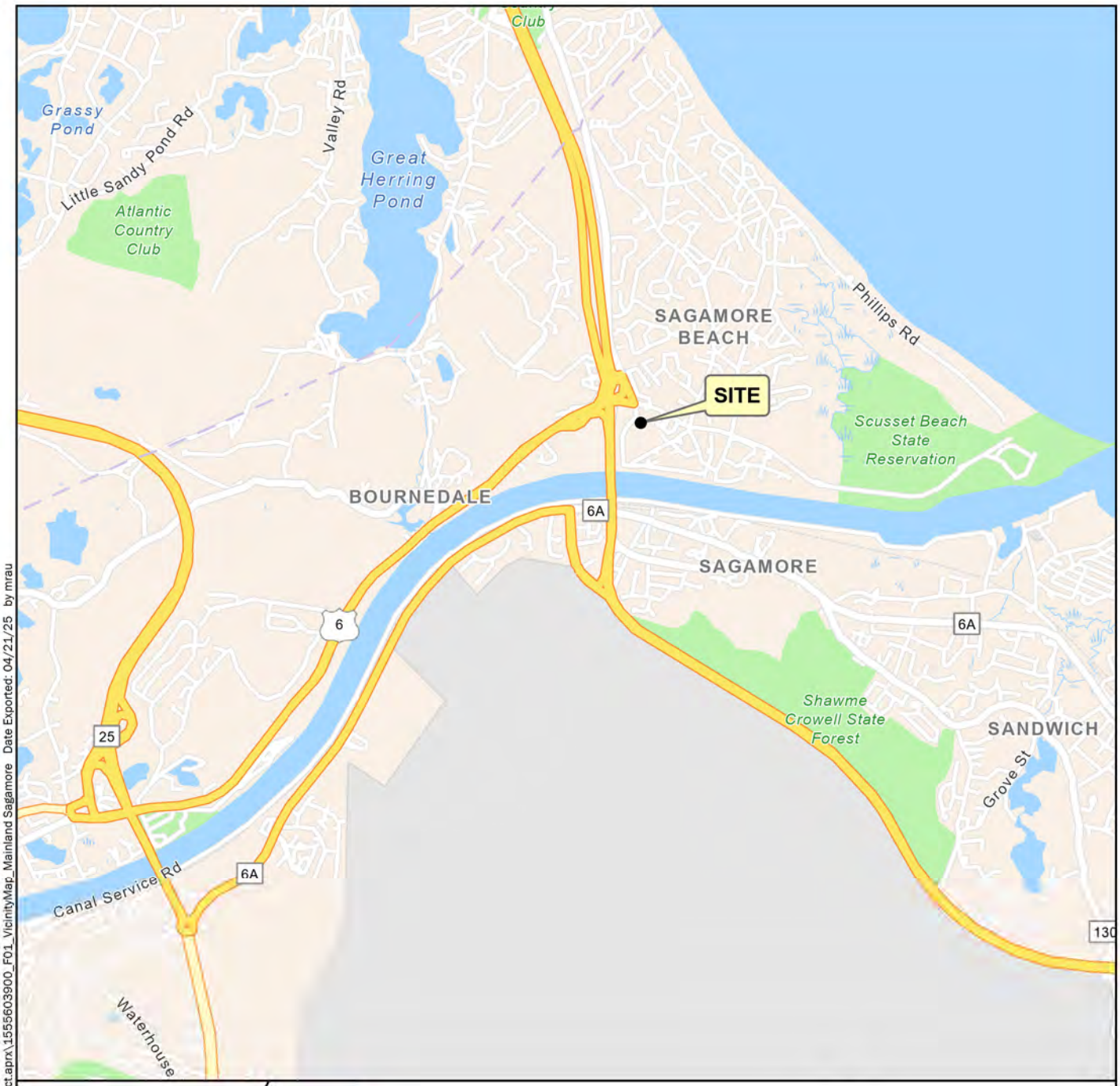
International Code Council, 2021, "International Building Code."

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.

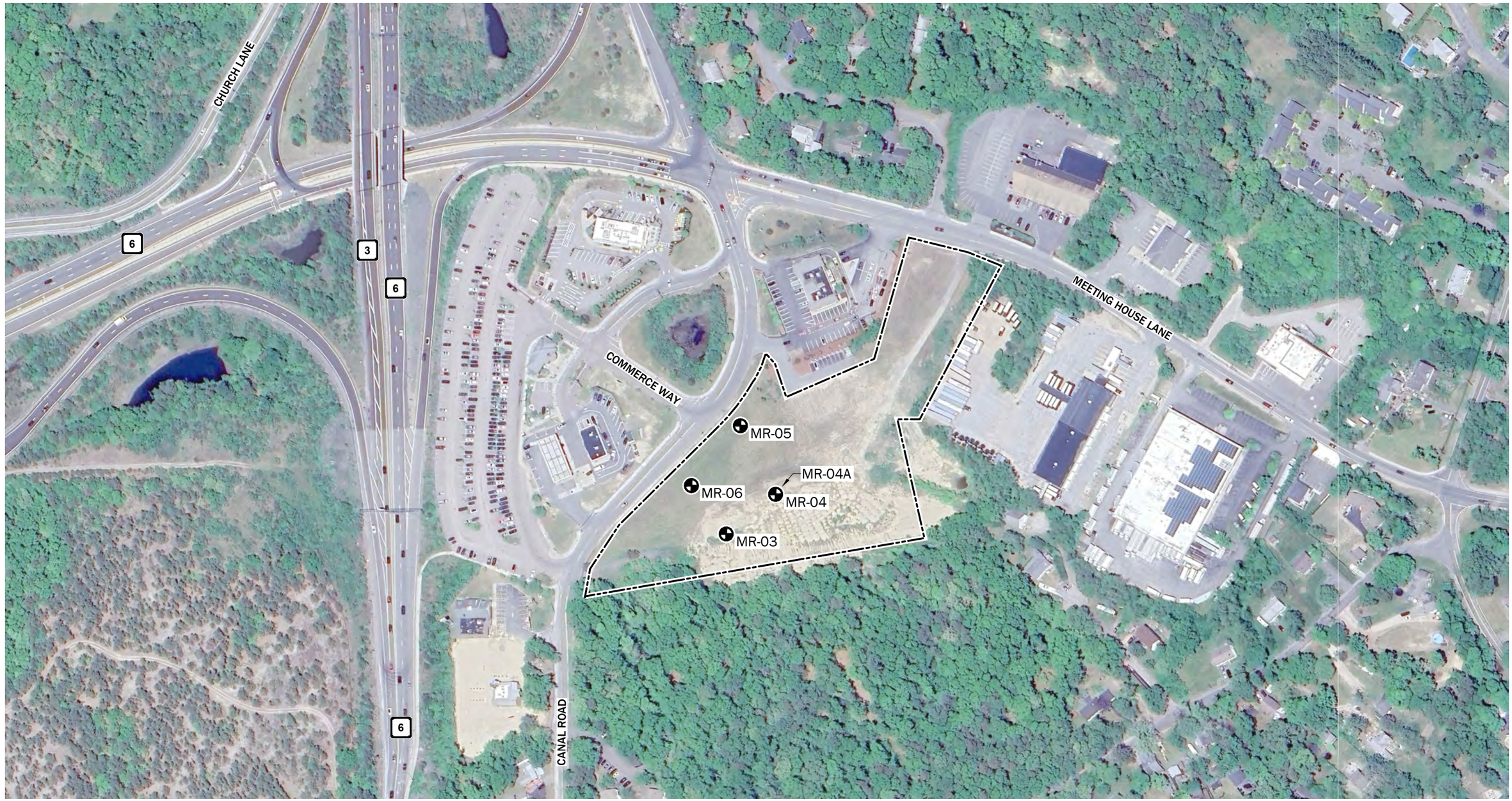
Vicinity Map

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)	---

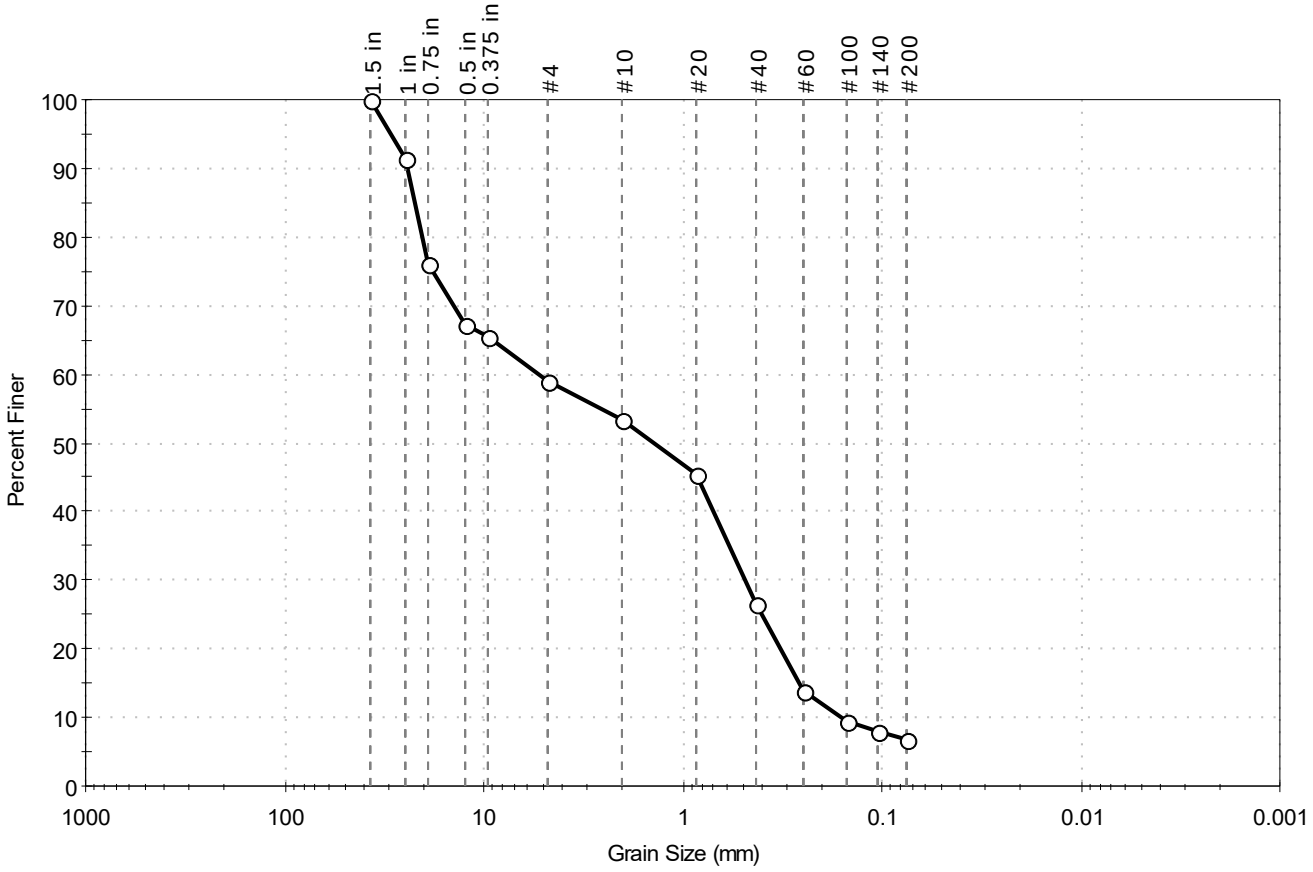
Client:	GeoEngineers, Inc.				
Project:	Cape Cod - En bridge				
Location:	MA			Project No:	GTX-320749
Boring ID:	MR-06	Sample Type:	Jar	Tested By:	ajl
Sample ID:	S-9	Test Date:	04/03/25	Checked By:	ank
Depth :	29-31	Test Id:	808049		
Test Comment:	---				
Visual Description:	Moist, brown sand with silt				
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))

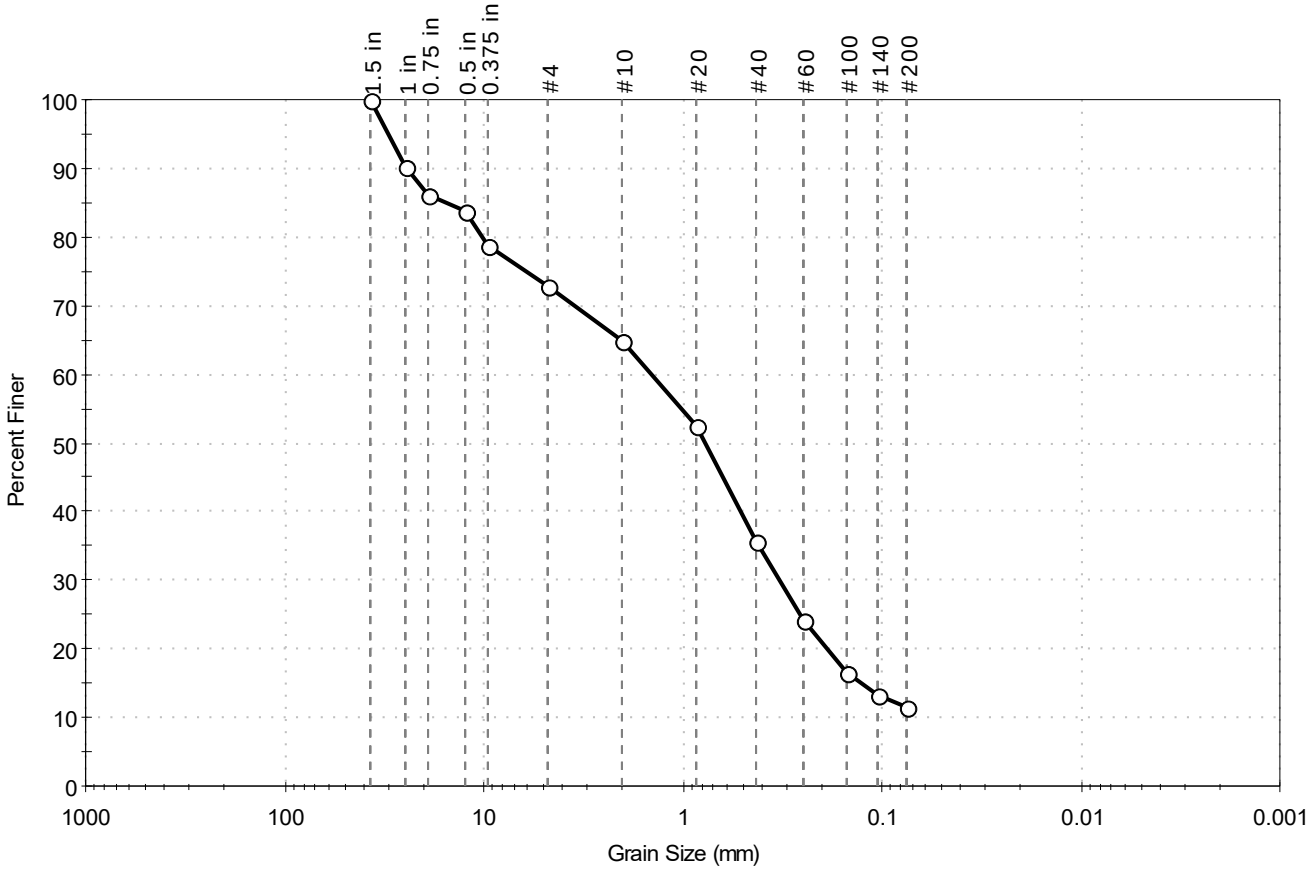
Sample / Test Description

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))

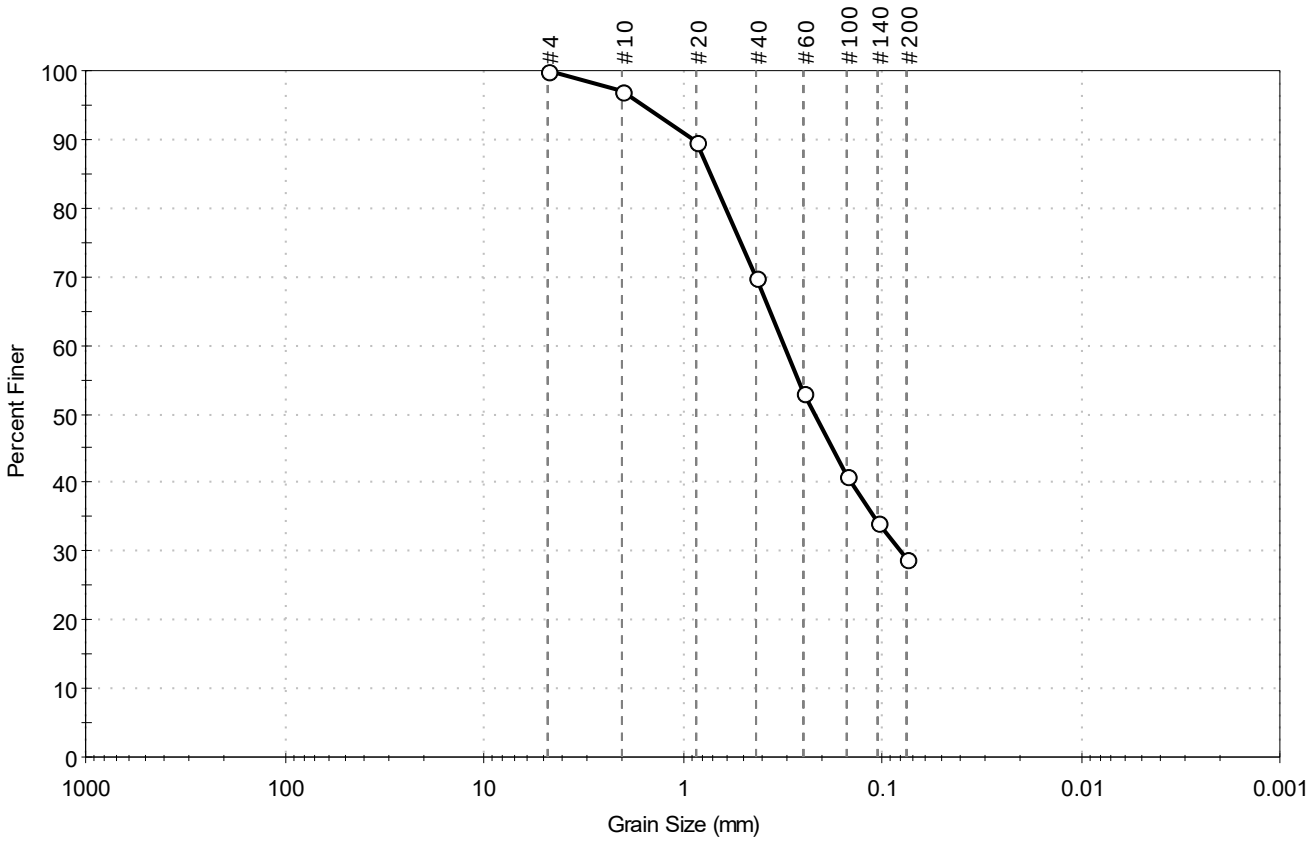
Sample / Test Description

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

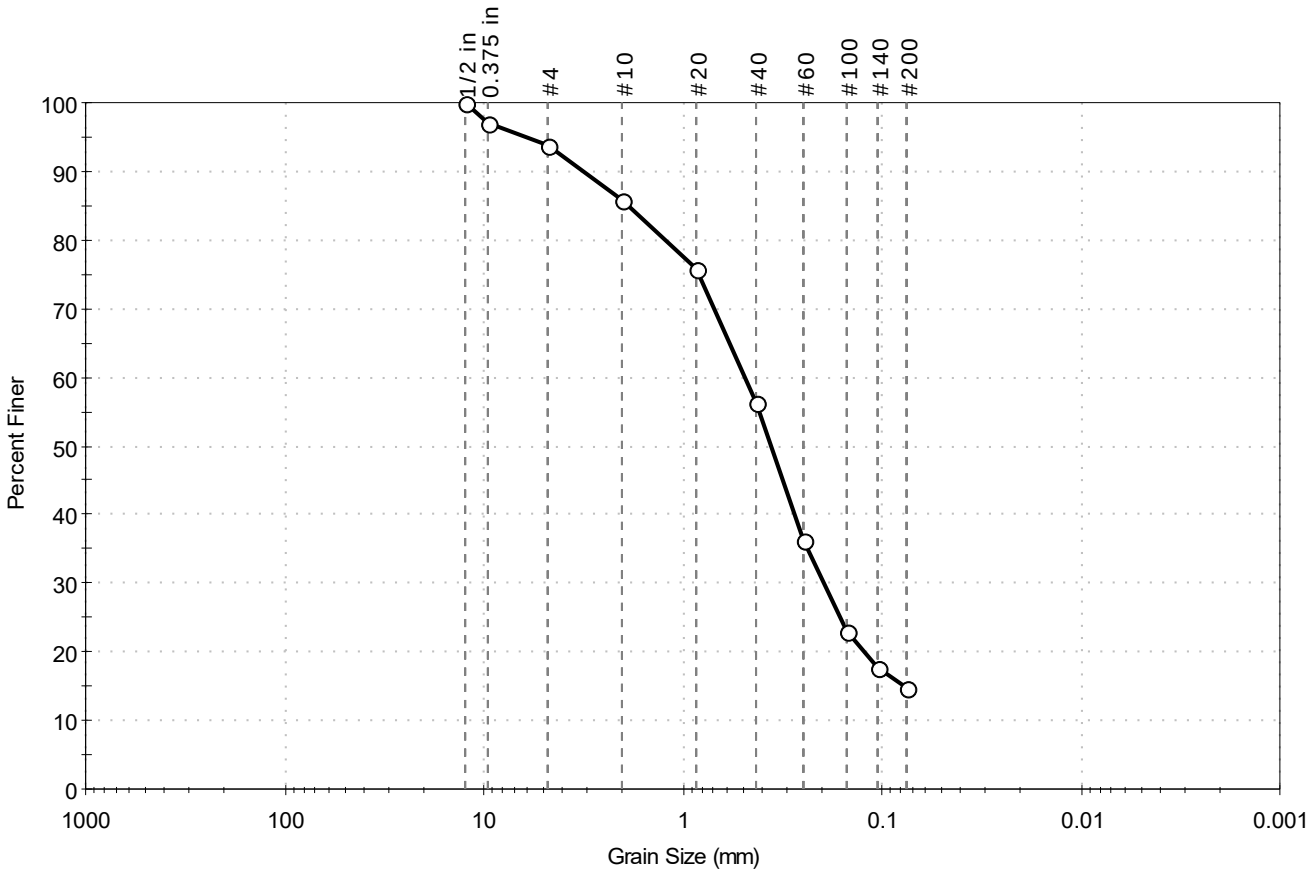
Sand/Gravel Particle Shape : ---

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))

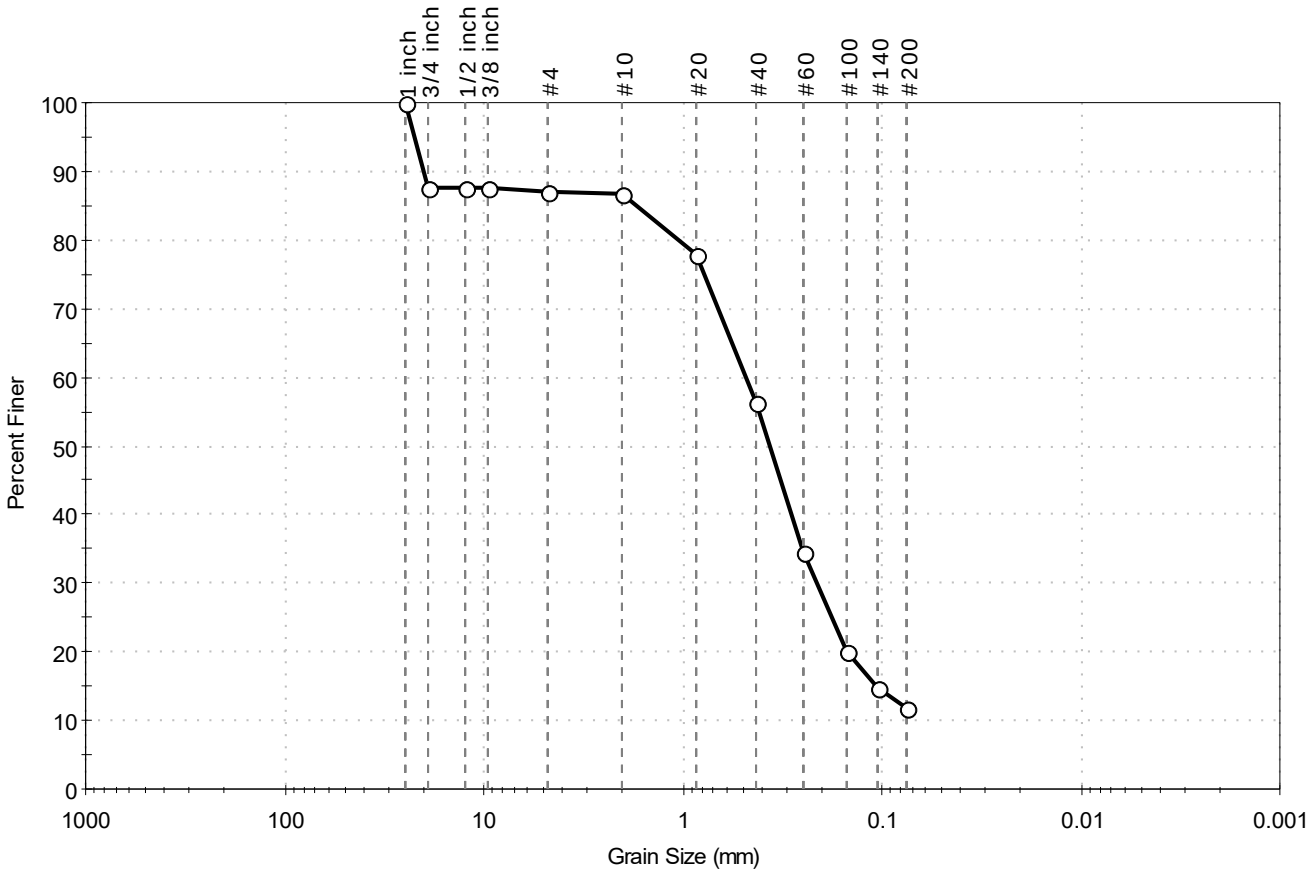
Sample / Test Description

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

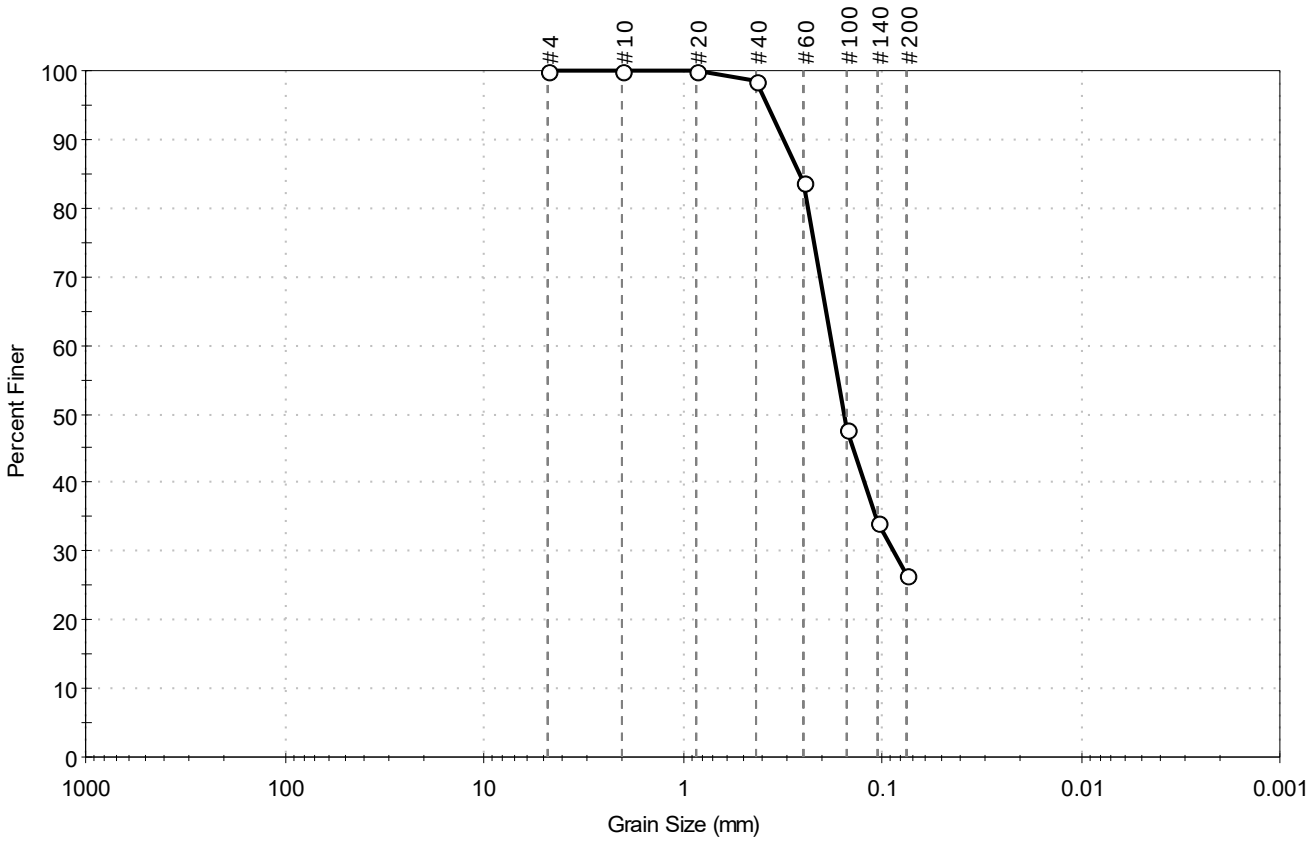
Sand/Gravel Particle Shape : ANGULAR

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))

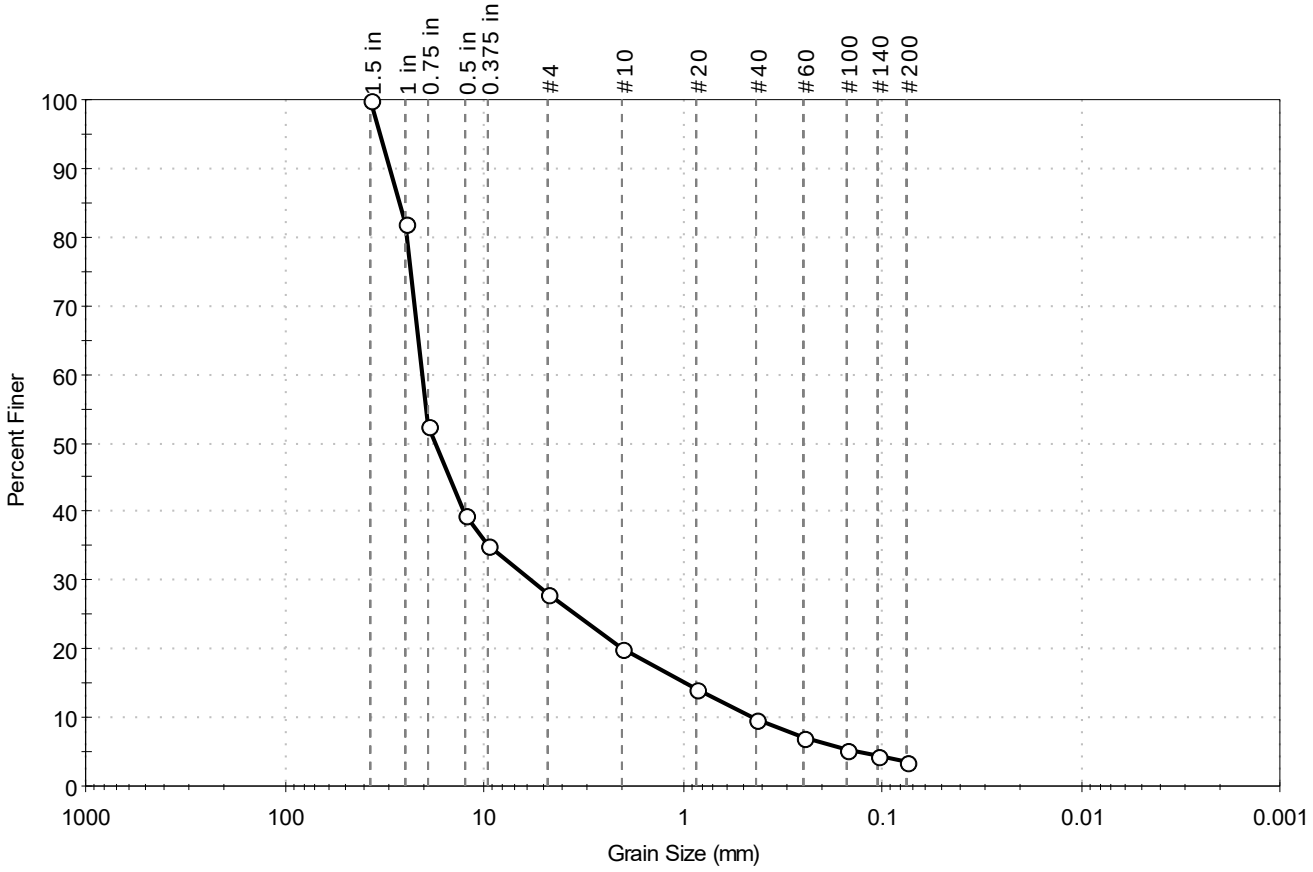
Sample / Test Description

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))

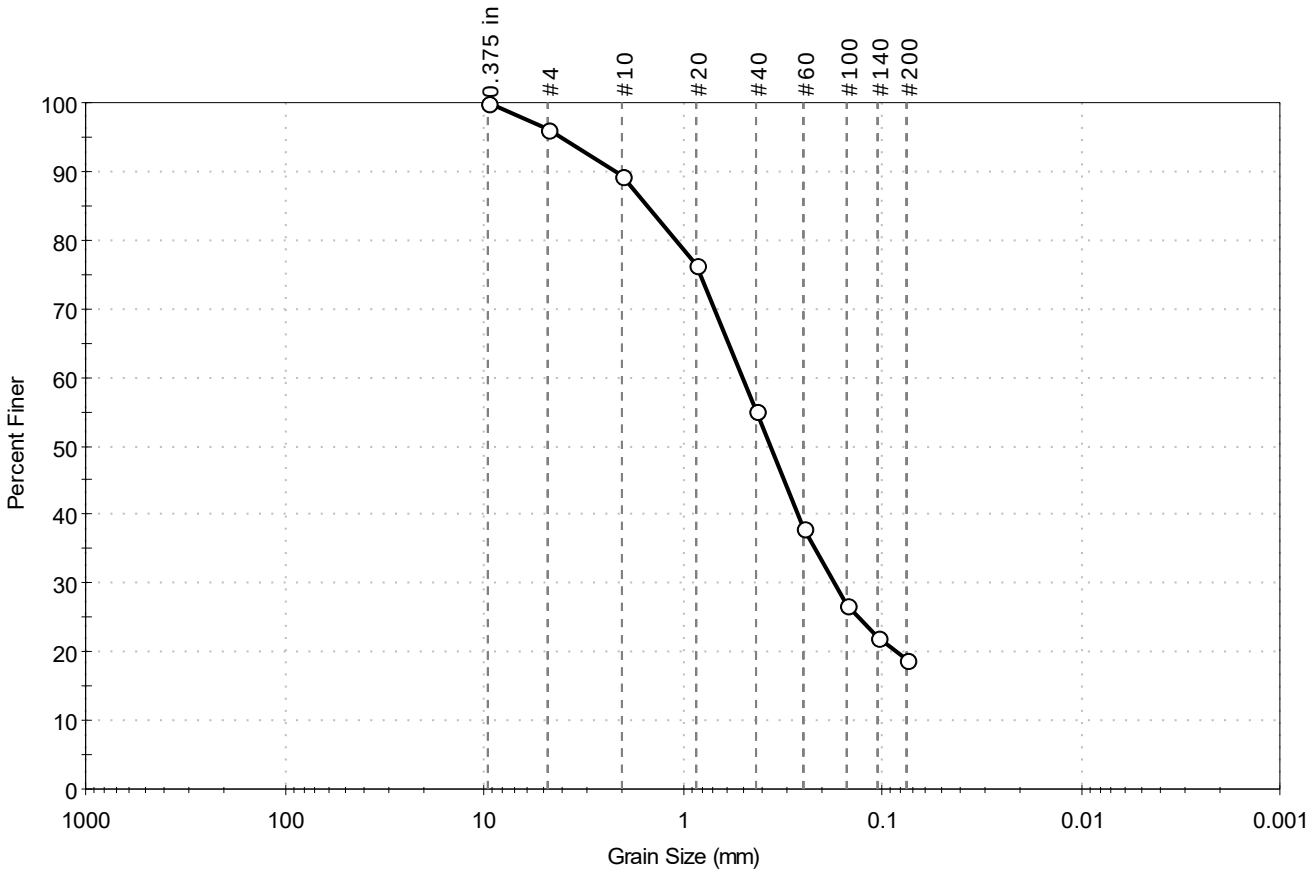
Sample / Test Description

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))

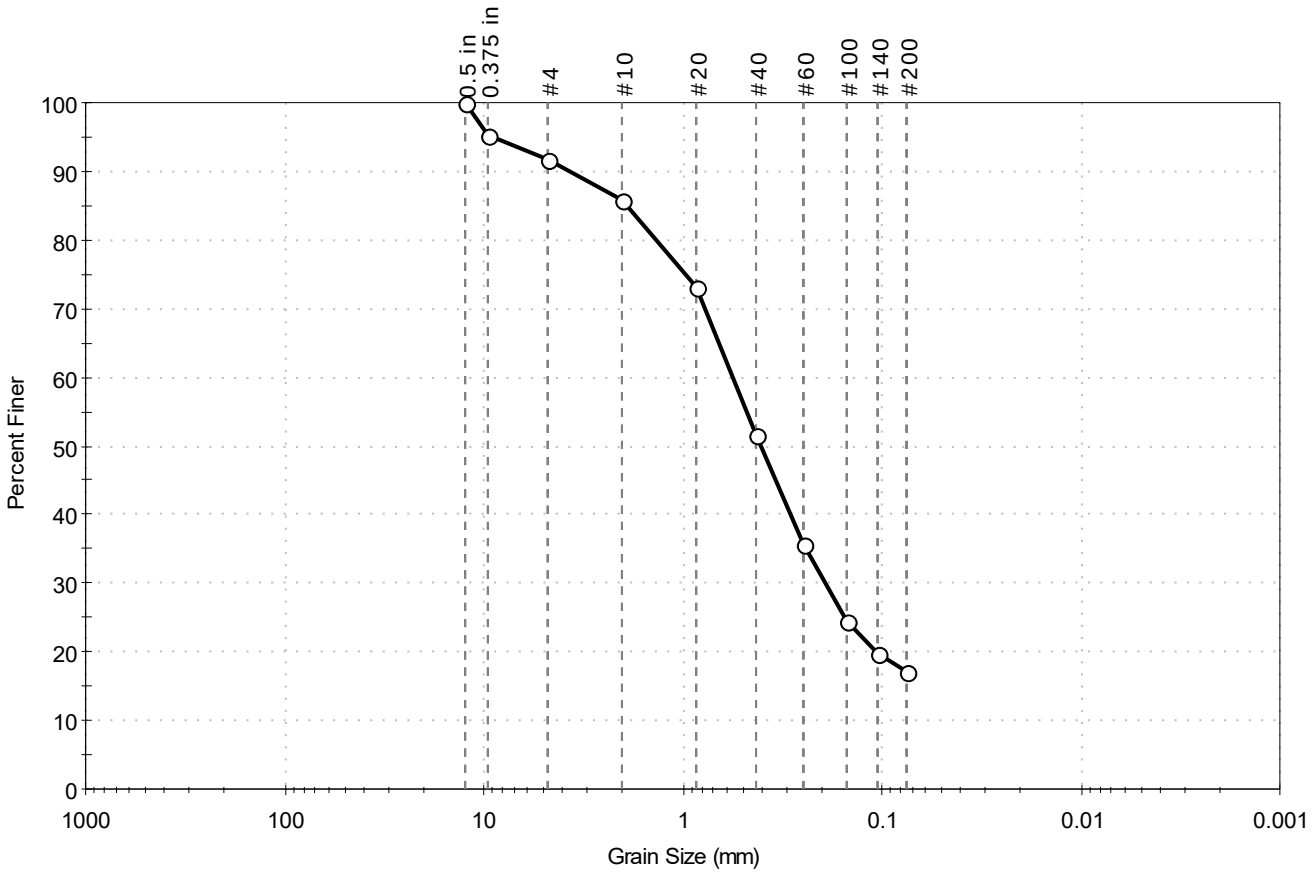
Sample / Test Description

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))

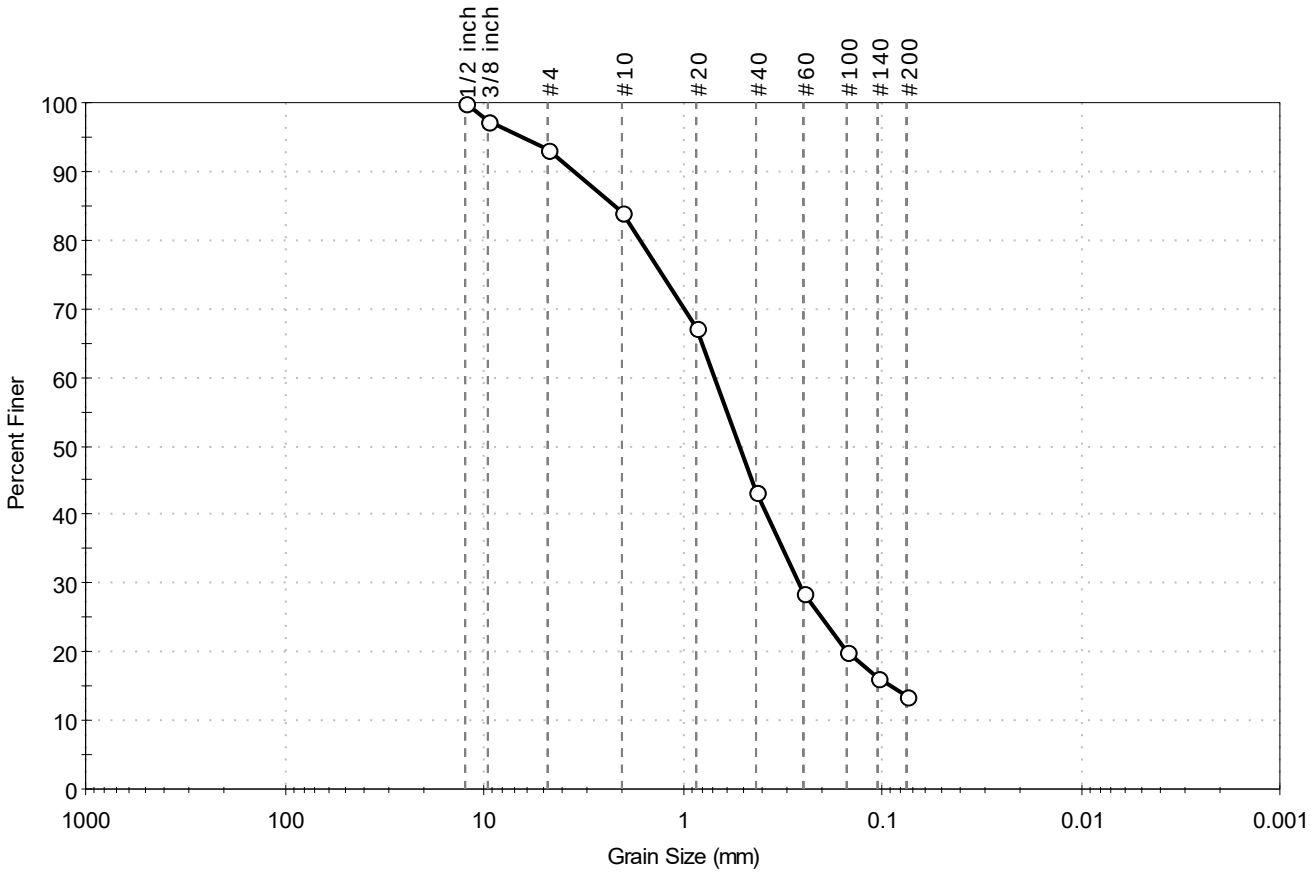
Sample / Test Description

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

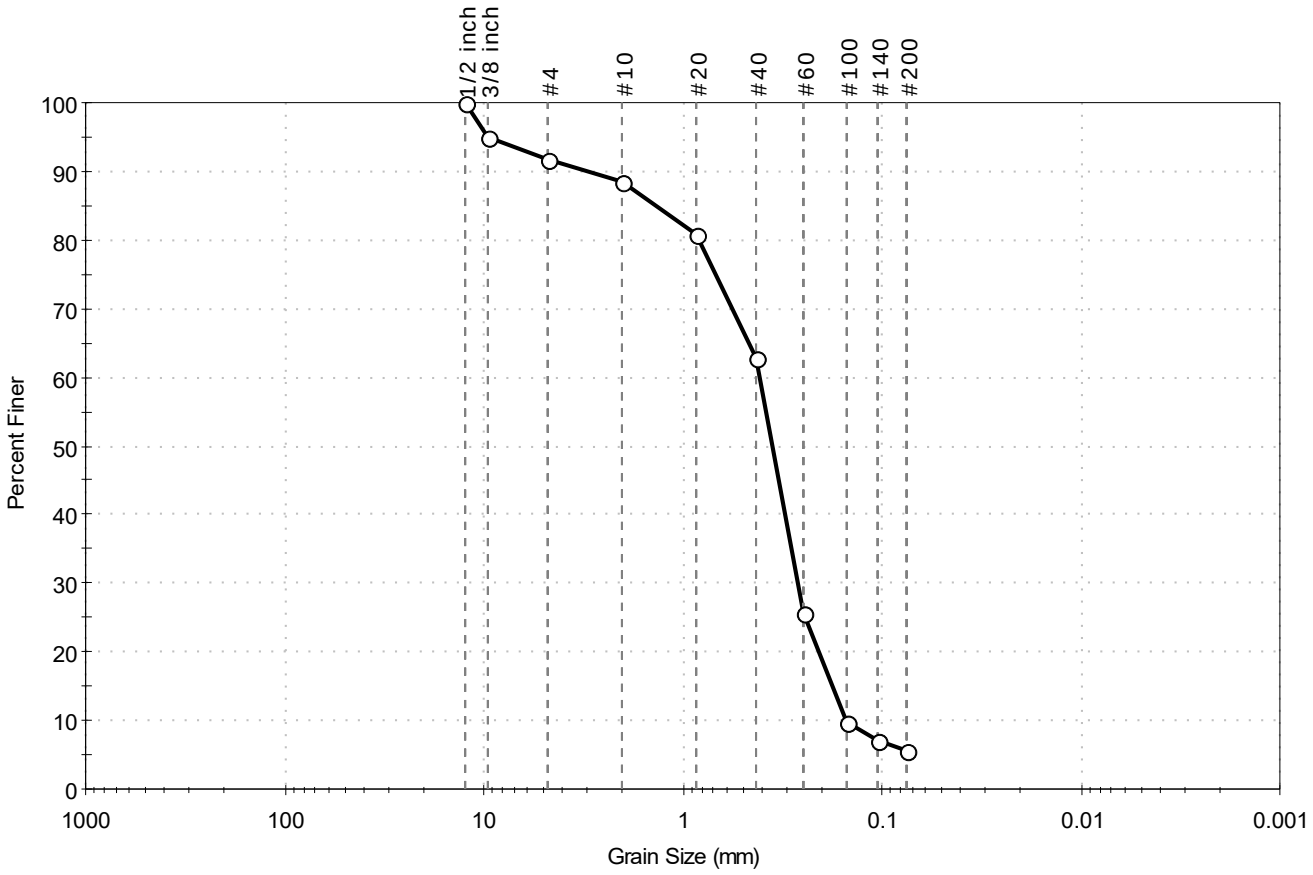
Sand/Gravel Particle Shape : ANGULAR

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

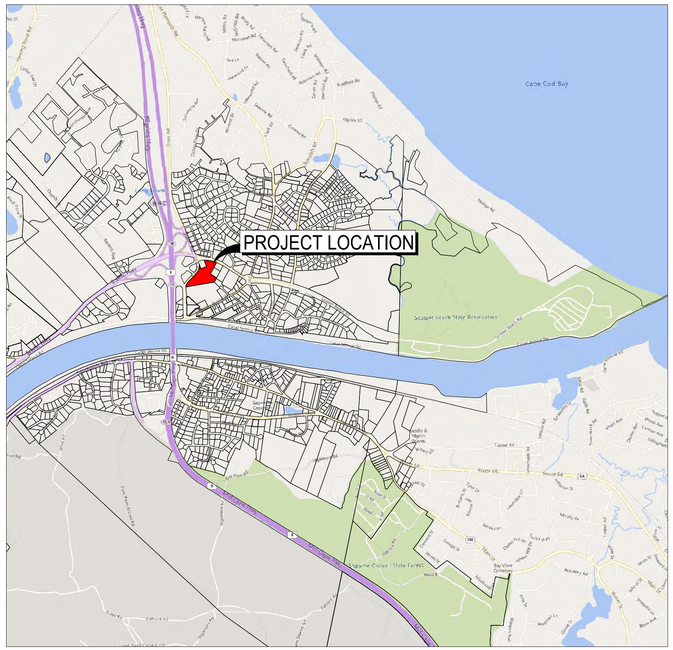
Best Management Practice	Inspection Frequency	Date Inspected	Inspector	Minimum Maintenance and Key Items to Check	Cleaning/Repair Needed ☐ yes ☐ no	Date of Cleaning/Repair	Performed by:
					☐ yes ☐ no		
					☐ yes ☐ no		
					☐ yes ☐ no		
					☐ yes ☐ no		
					☐ yes ☐ no		
					☐ yes ☐ no		
					☐ 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

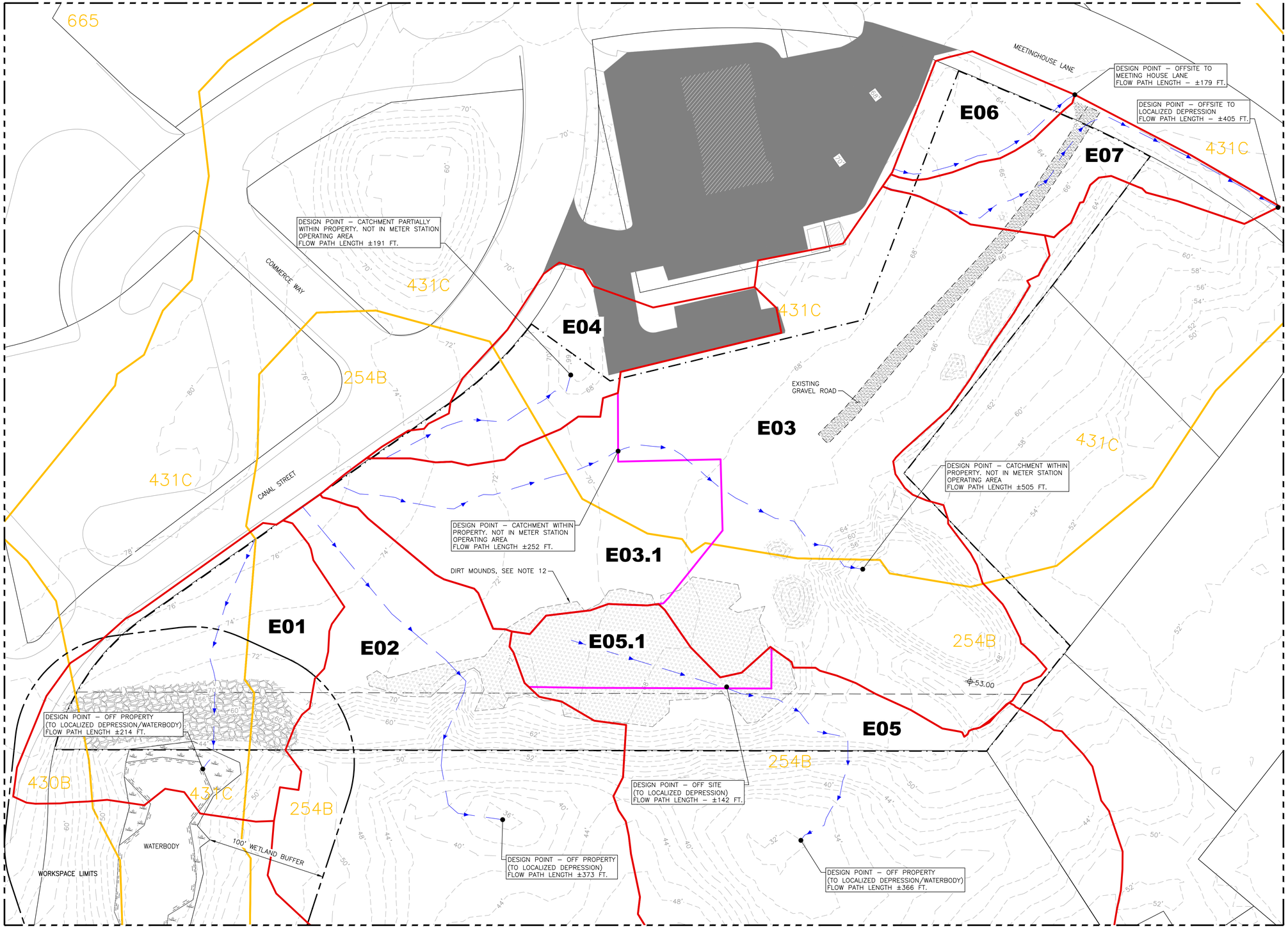
audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

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

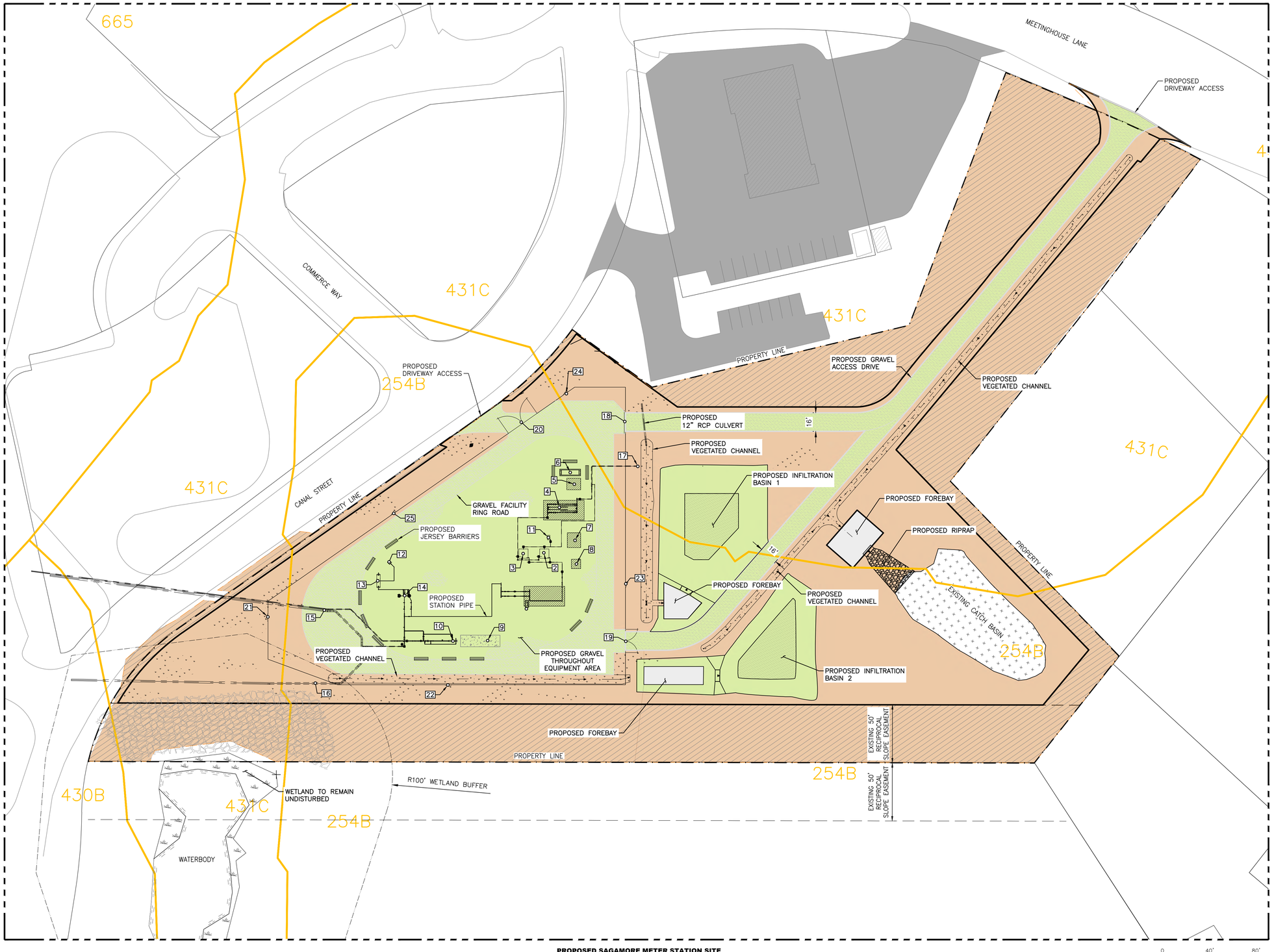
audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

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

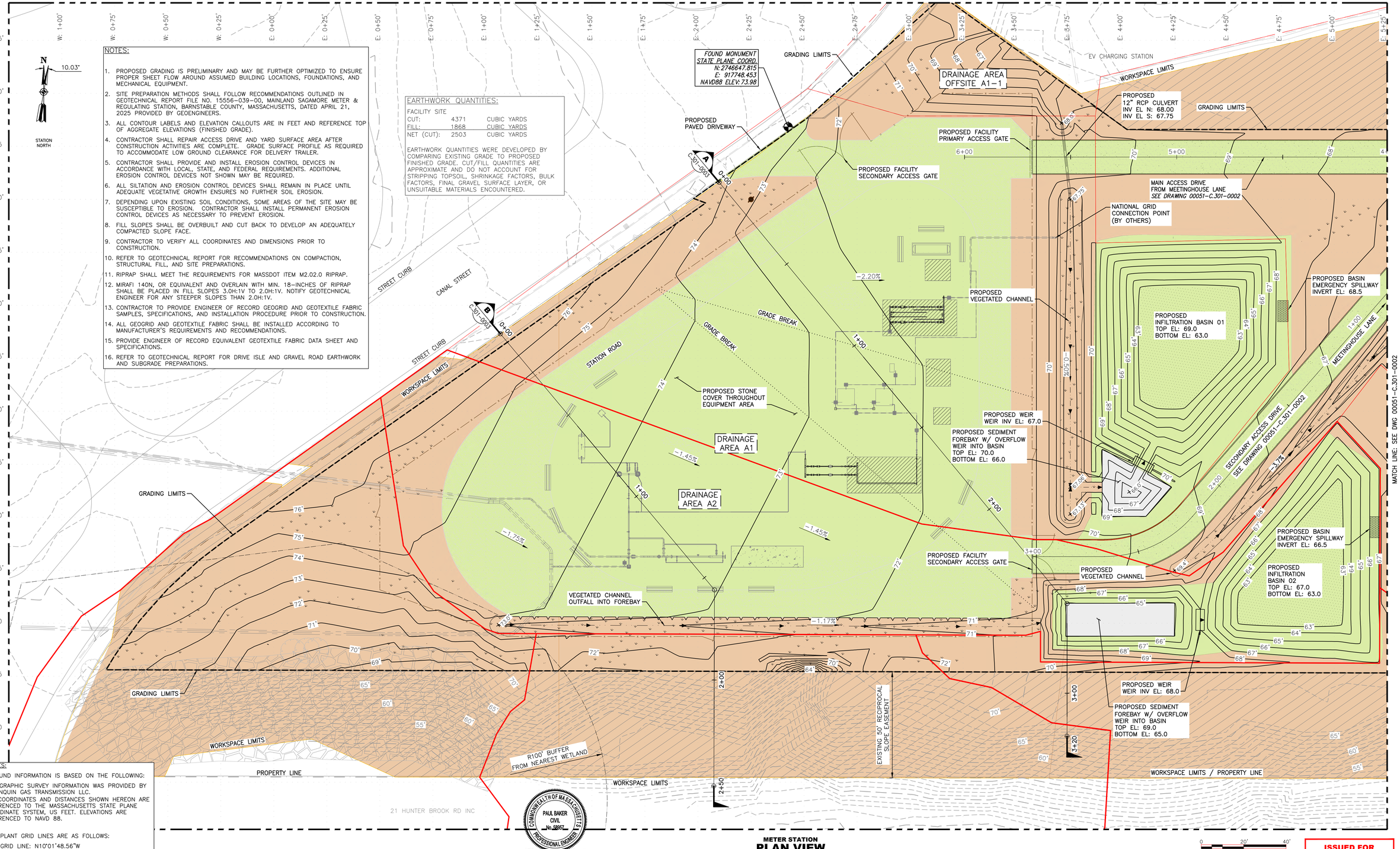
audubon
AUDUBON COMPANIES, LLC
3505 W. SAM HOUSTON PKWY. N.
SUITE 150
HOUSTON, TX 77043
PHONE: (281) 669-0590

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

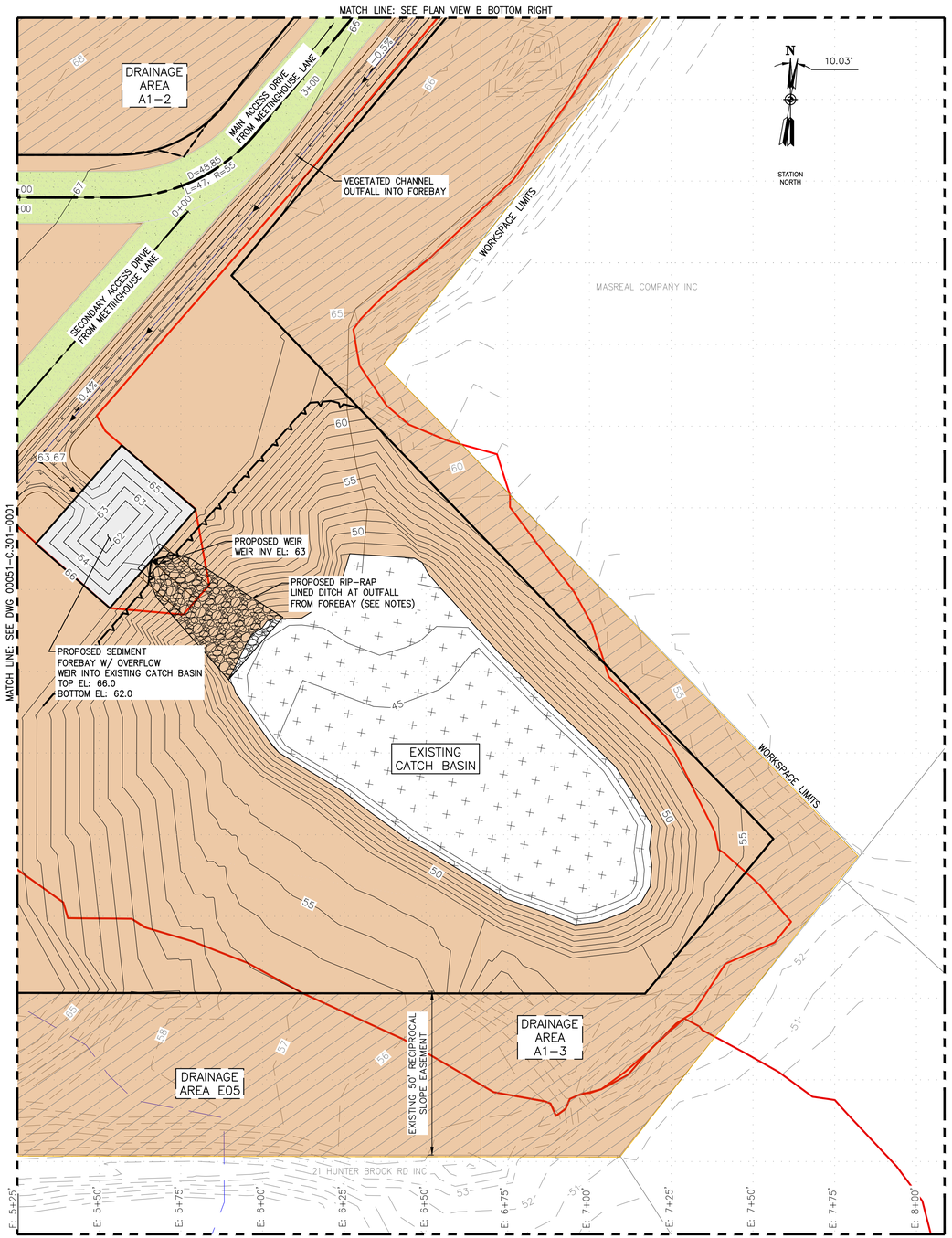
DRAWN BY:	CR	04/20/25	
DESIGN CHECKER:	AE	06/18/26	
DESIGN ENGINEER:	PB	06/18/26	
PROJECT MANAGER:	AC	06/18/26	
TITLE	INITIALS	DATE	

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

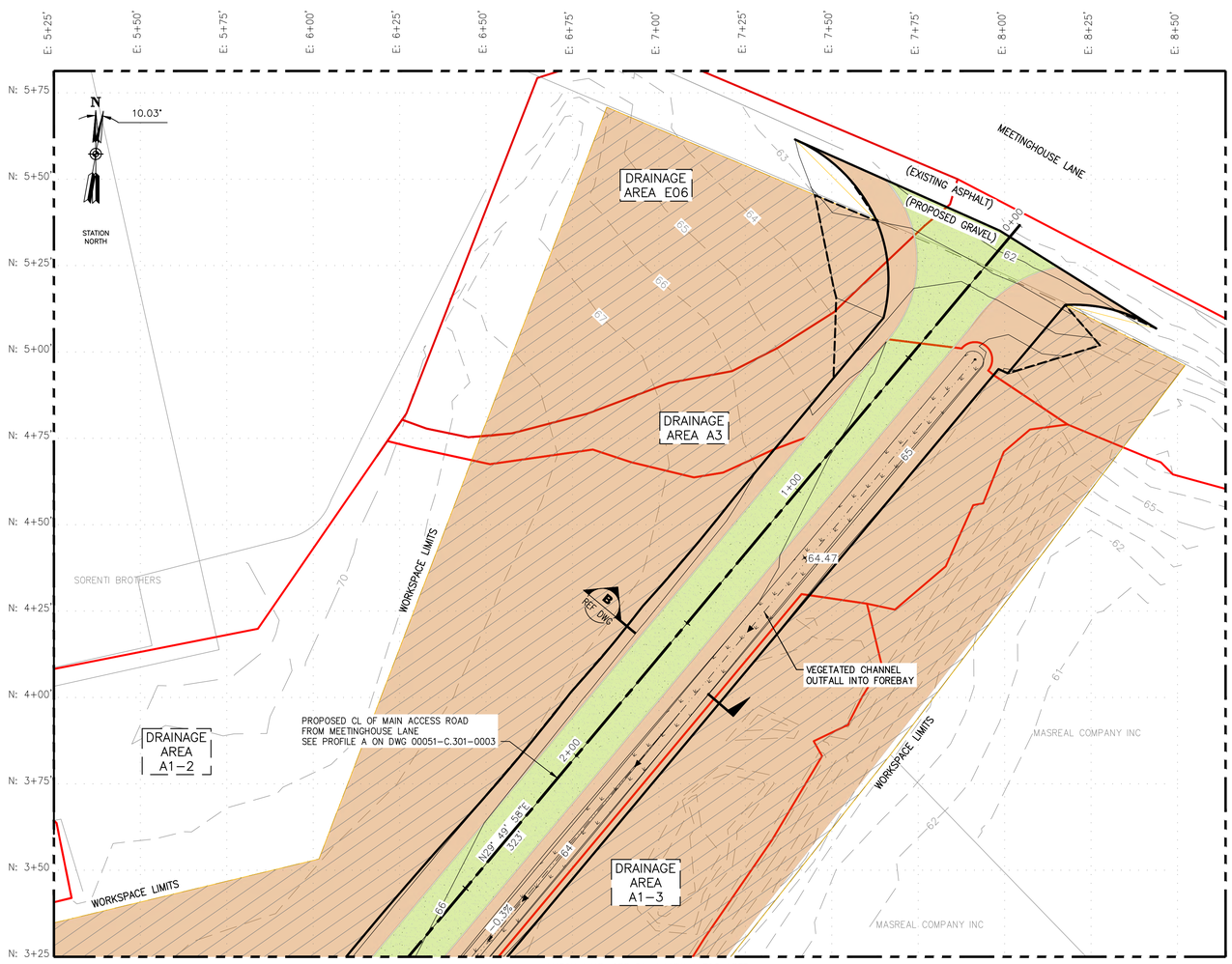
S:\AE\Projects\Enbridge\Mass\026356-001\200_Civil_Structural\170_Drawings\Grading\Mainland Sagamore\00051-C.301-0002.dwg — PLOT TIME: 6/24/2026 12:49 AM



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		

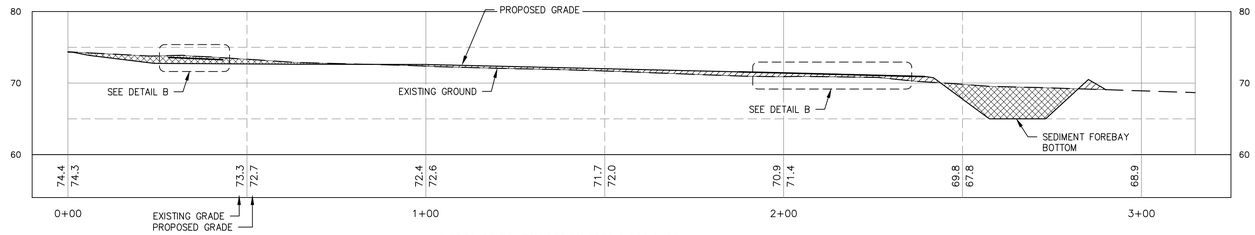
DWG. NO.	REFERENCE DWG.	REV	DATE	DSN	CK	DESCRIPTION
		E	06/18/26	CR	DT	ISSUED FOR PERMIT
		D	05/15/26	CR	DT	ISSUED FOR BID
		C	05/15/26	CR	DT	ISSUED FOR PERMIT
00051-C.301-0003	CIVIL GRADING SECTIONS AND DETAILS	B	03/03/26	CR	PB	ISSUED FOR REVIEW – 90% REVIEW
00051-C.301-0001	CIVIL GRADING PLAN	A	05/29/25	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

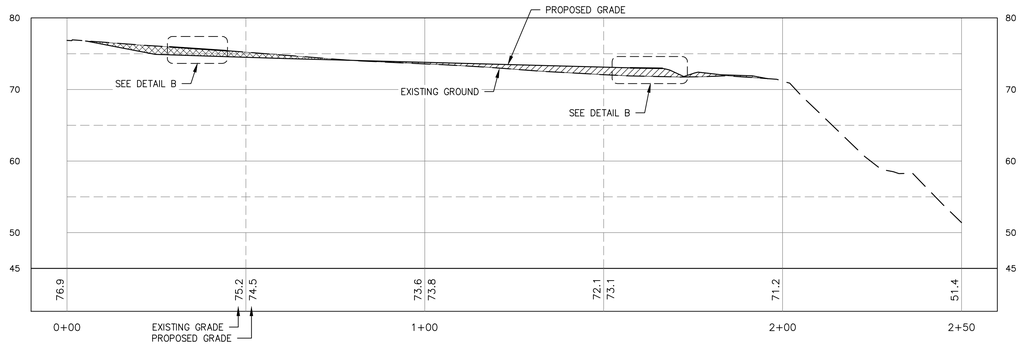
ENBRIDGE
Algonquin Gas Transmission, LLC
915 North Eldridge Parkway, Suite 1100, Houston, TX 77079 713.627.5400



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

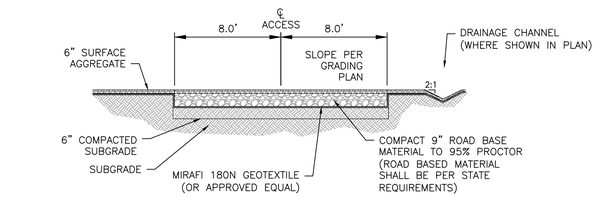
      DIRECTION BACK   S31° 01' 52.19"W
         RADIUS        55.000'
         DELTA         48°56'19"(RT)
         LENGTH        46.978'
         TANGENT       25.029'
         CHORD DIRECTION     S55° 30' 01.82"W   DISTANCE   45.563'
      DIRECTION AHEAD S79° 58' 11.44"W

   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)

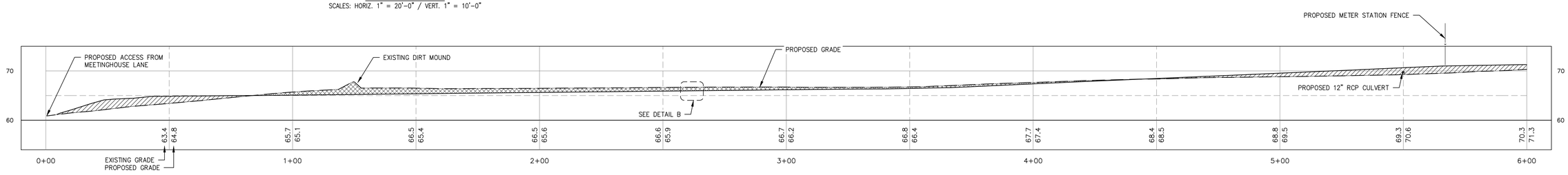
   N 2,746,468.2437   E 917,897.3850                    3+00.00
END SECONDARY DRIVEWAY
**********************************************************

ALIGNMENT LENGTH: 300.000'
```



DETAIL B – TYPICAL AGGREGATE ACCESS/FACILITY ROAD

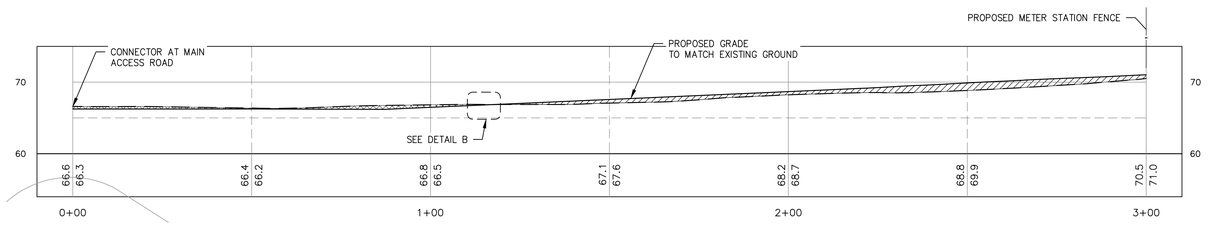
SCALE: NOT TO SCALE



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

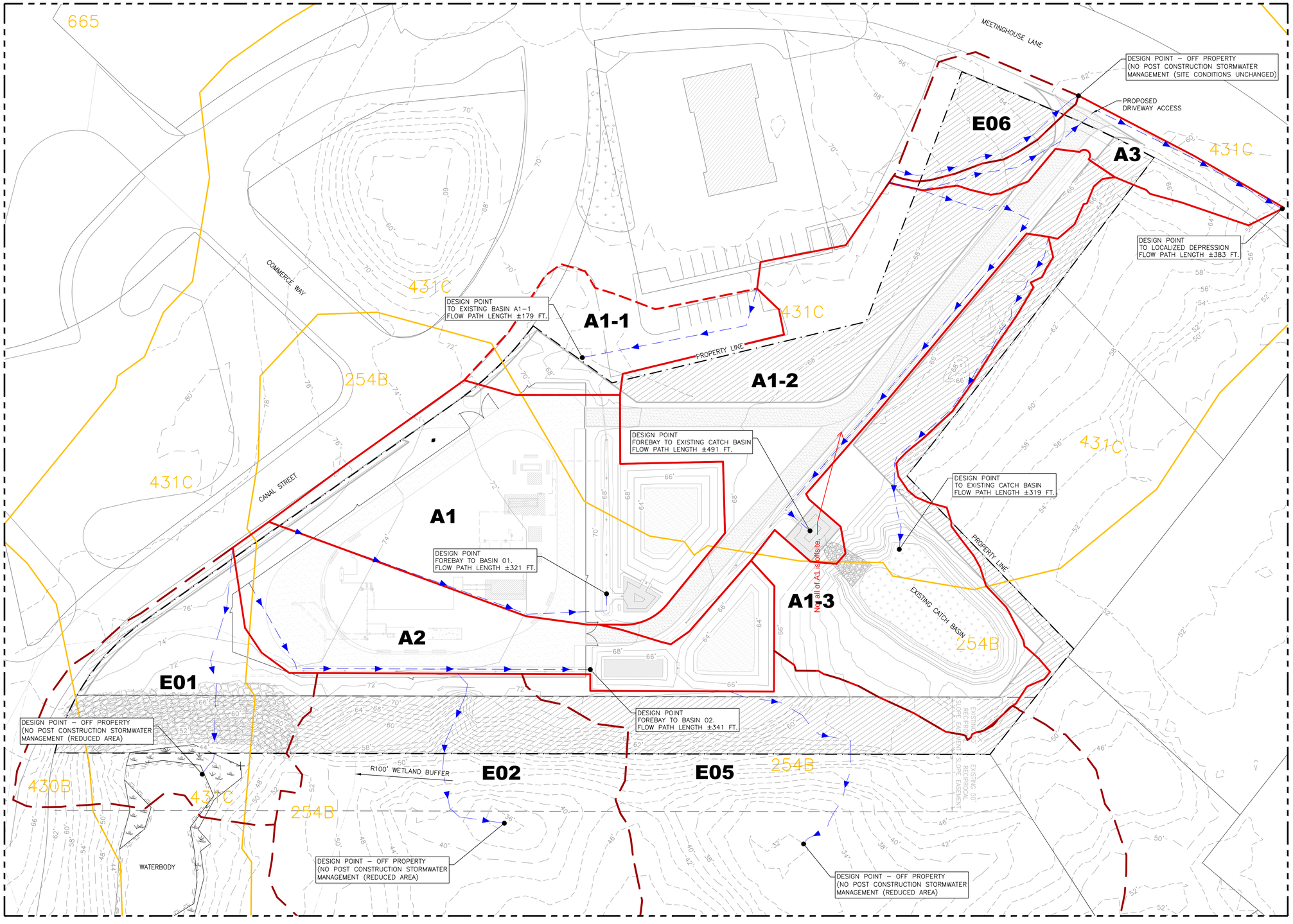
LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

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	

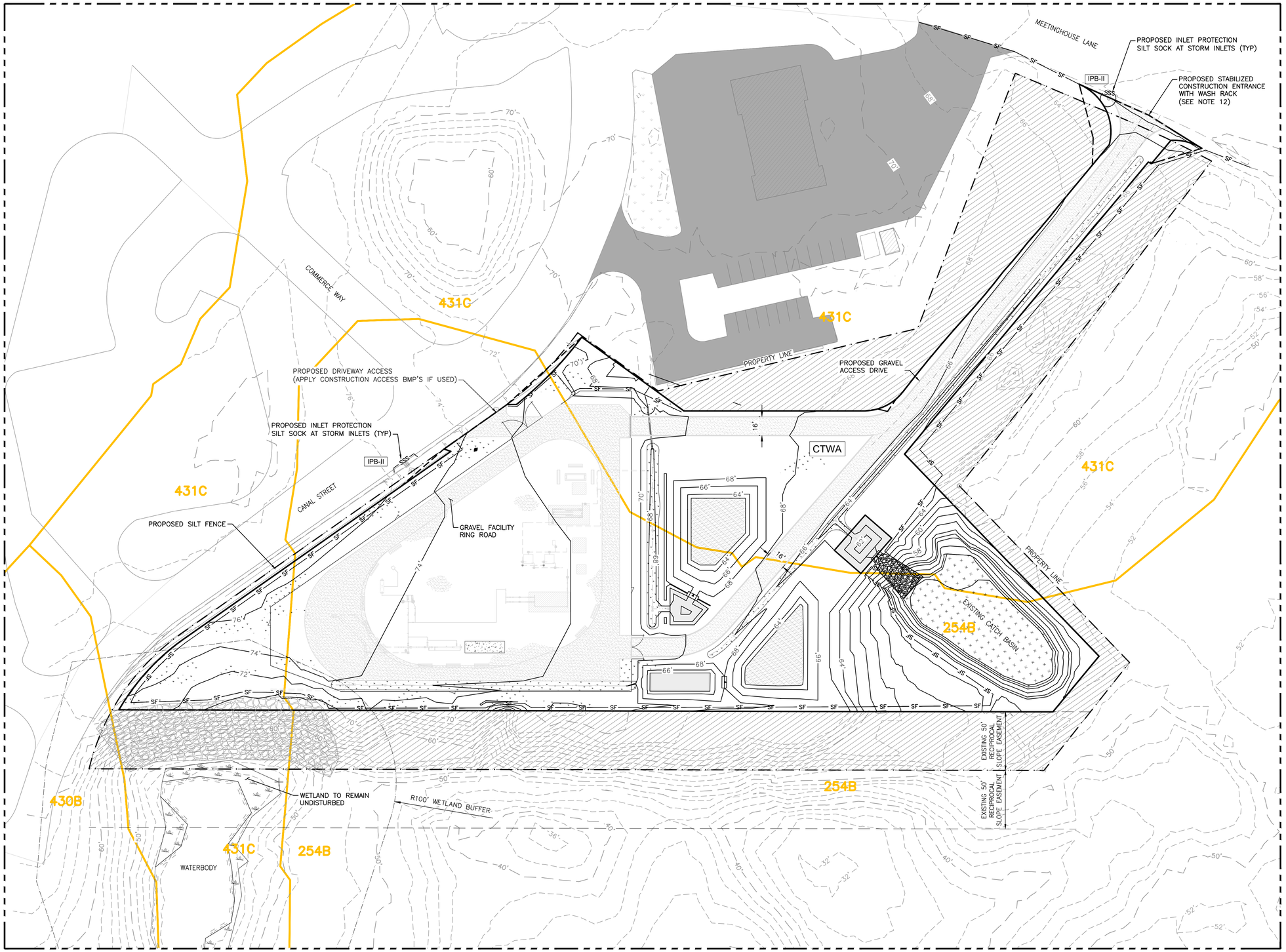
CAPE COD CANAL PIPELINE RELOCATION PROJECT
SAGAMORE M&R RELOCATION
M&R 00051
TITLE: PROPOSED SUBCATCHMENT AREAS PLAN

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

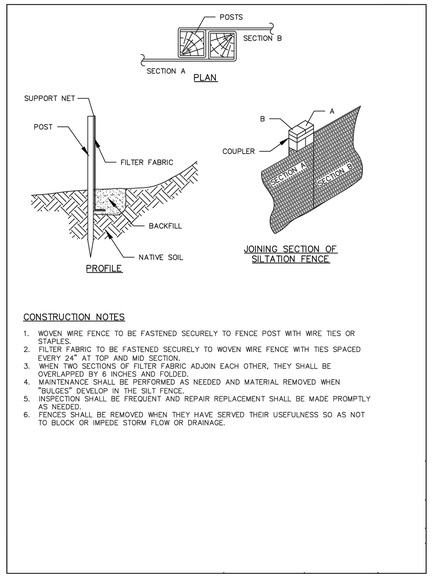
E&S CONSTRUCTION SEQUENCE AND MAINTENANCE

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:

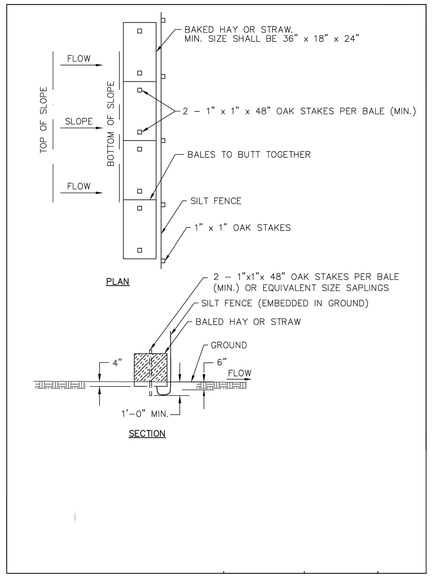
- INSPECT ALL EROSION AND SEDIMENTATION CONTROL MEASURES PERIODICALLY AND AFTER EACH RAINFALL EVENT. INSPECTION RECORDS SHALL BE MAINTAINED ONSITE BY THE CONTRACTOR.
- REPAIR OR REPLACE DAMAGED OR DETERIORATED EROSION CONTROL MEASURES IMMEDIATELY UPON IDENTIFICATION.
- REMOVE ACCUMULATED SEDIMENT FROM 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.



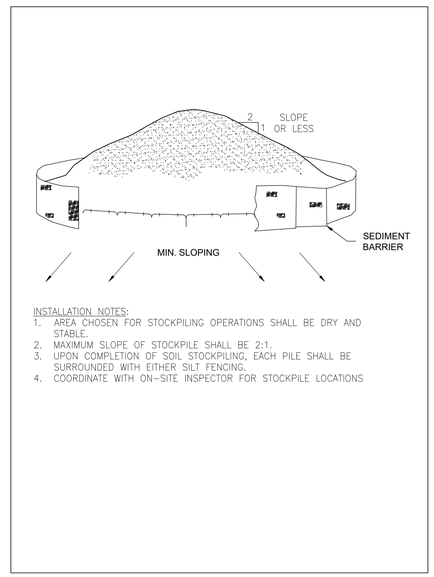
CONSTRUCTION NOTES

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



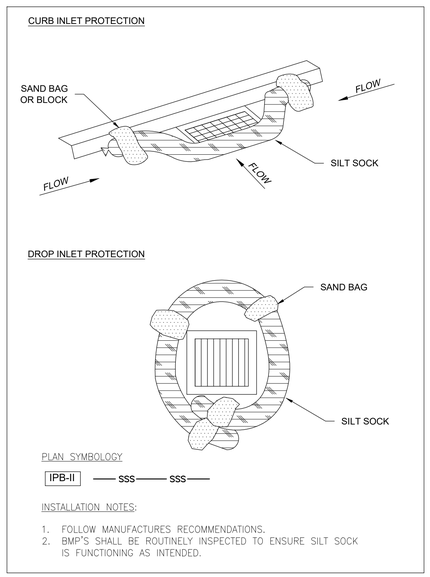
HAYBALES AND SILT FENCE



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



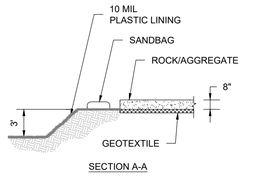
PLAN SYMBOLOGY

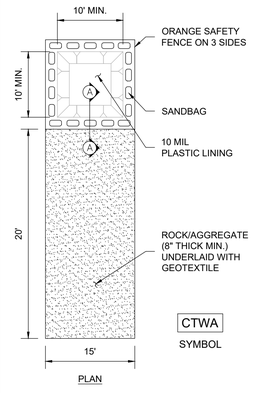
IPB-II — SSS — SSS

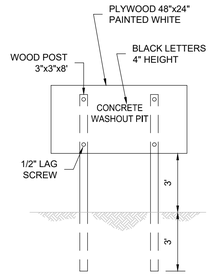
INSTALLATION NOTES:

1. FOLLOW MANUFACTURES RECOMMENDATIONS.
2. BMP'S SHALL BE ROUTINELY INSPECTED TO ENSURE SILT SOCK IS FUNCTIONING AS INTENDED.

SILT SOCK INLET PROTECTION





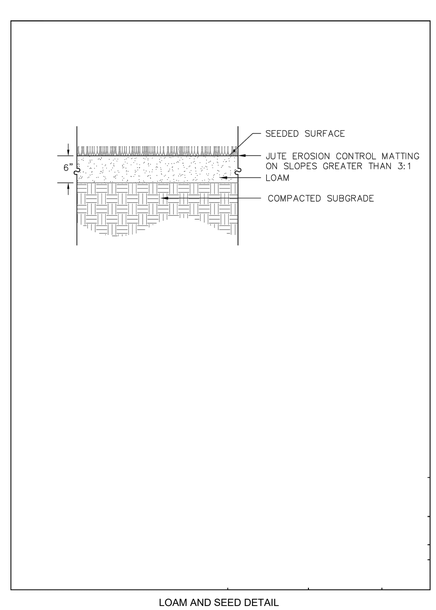


CTWA
SYMBOL

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

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

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: DETAILS

LOC.: BARNSTABLE COUNTY, MASSACHUSETTS

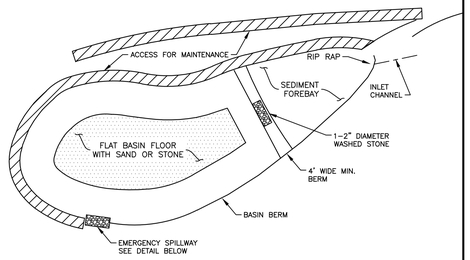
TITLE	INITIALS	DATE	YEAR:	W.O.:	SCALE:	DWG.:	REV.:
			2026		N.T.S.	00051-C.320-0006	C

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

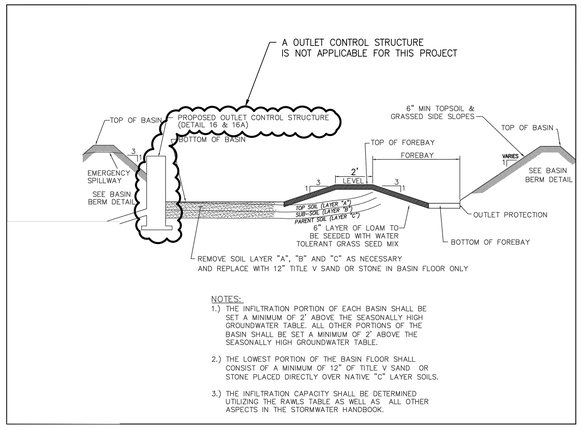
ISSUED FOR PERMIT
06/18/2026

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

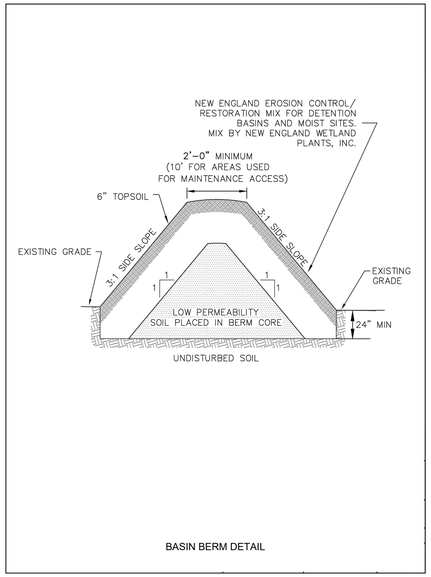


NOTES:
1.) THE INFILTRATION PORTION OF EACH BASIN SHALL BE SET A MINIMUM OF 2' ABOVE THE SEASONALLY HIGH GROUNDWATER TABLE. ALL OTHER PORTIONS OF THE BASIN SHALL BE SET A MINIMUM OF 2' ABOVE THE SEASONALLY HIGH GROUNDWATER TABLE.

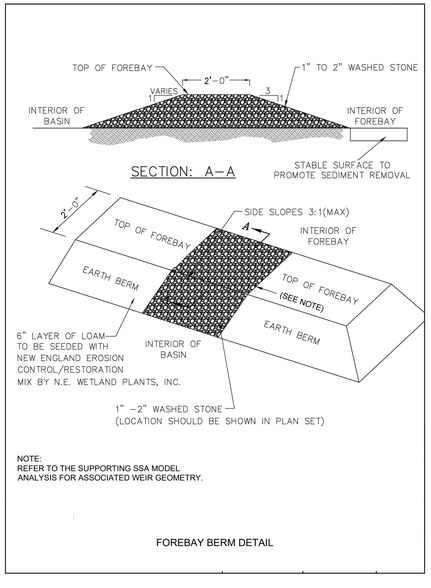
2.) THE LOWEST PORTION OF THE BASIN FLOOR SHALL CONSIST OF A MINIMUM OF 12" OF TITLE V SAND OR STONE PLACED DIRECTLY OVER NATIVE "C" LAYER SOILS.

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

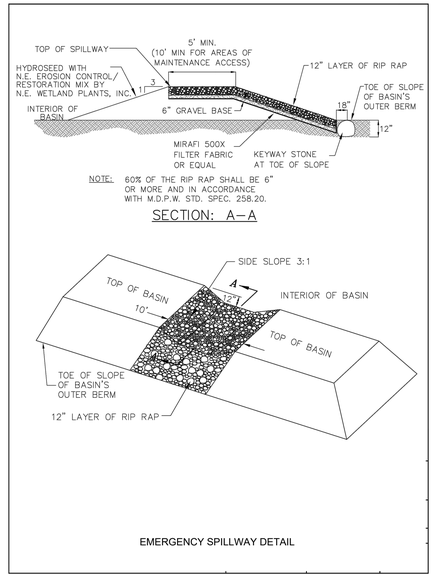


BASIN BERM DETAIL



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

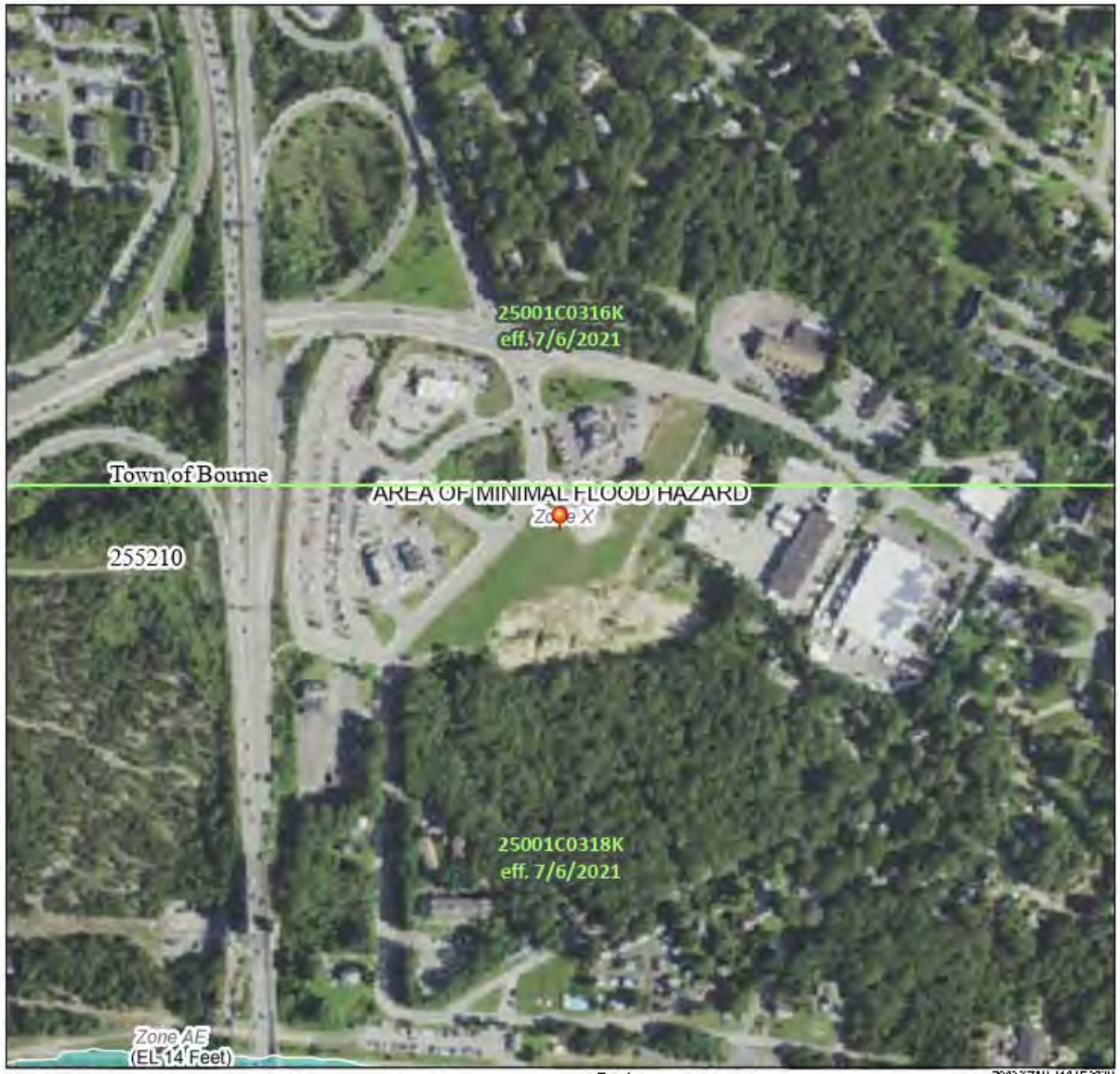
Attachment G – Standard 9 Supporting Documentation

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.