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CAPE COD COMMISSION

Cape Cod 208 -Wide Water Quality Planning
Panel on Technologies

Monday, October 28, 2013
Innovation Room, Cape Cod Commission
1pm

Meeting Agenda

1:00	Welcome, Update on 208 Plan
1:10	Response to comments on Fact Sheets, Matrix
1:40	Green Infrastructure Screening Criteria
2:00	Watershed Approaches: Traditional and Alternative examples
2:45	Break
3:00	Adaptive Management and Monitoring
3:45	Next meeting agenda
3:50	Public Comments
4:00	Adjourn

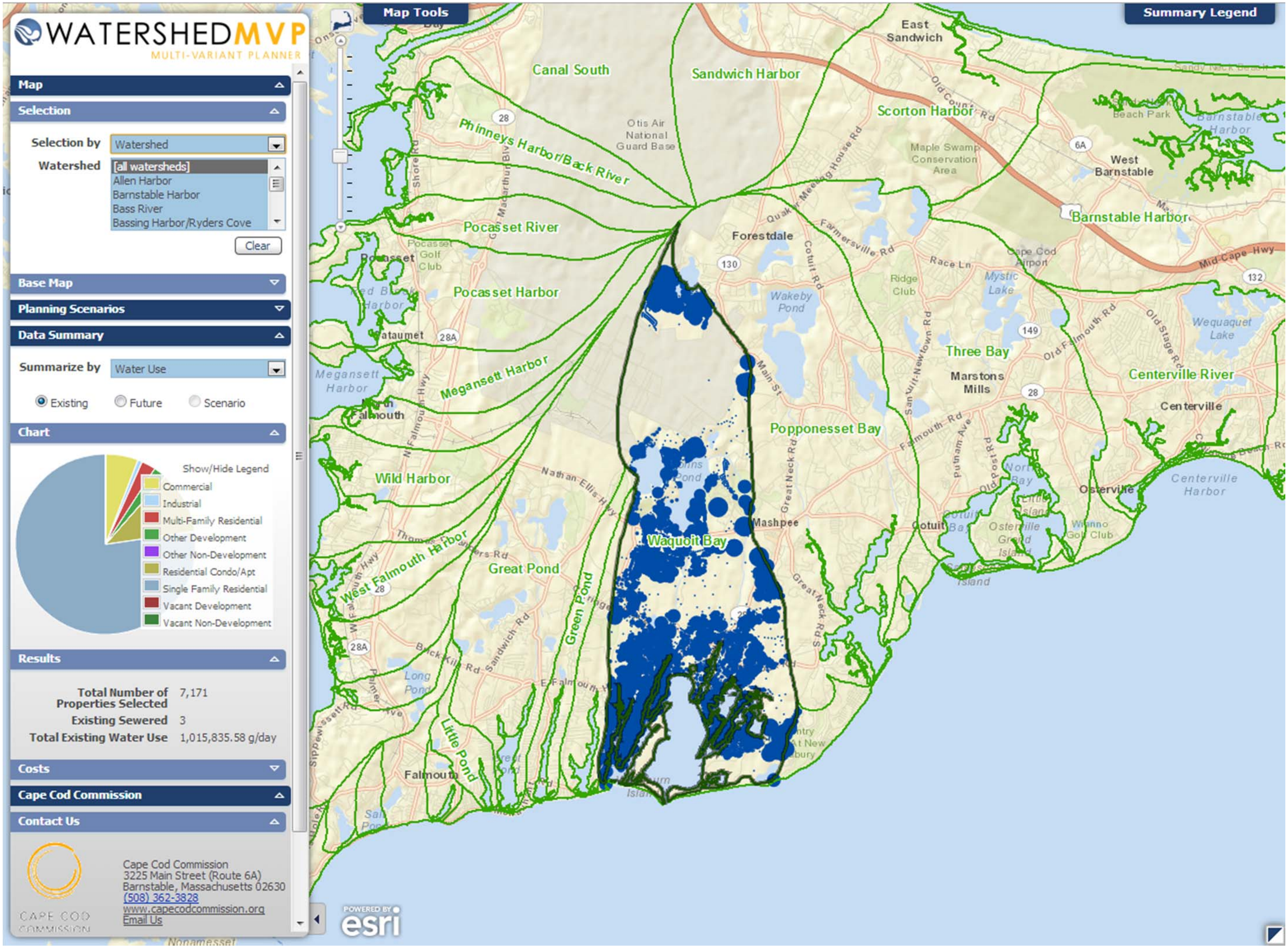
Tech Panel

October 25, 2013

Approaches

Conventional


Photo credit: Waquoit Bay Reserve


WATERSHEDMVP
MULTI-VARIANT PLANNER
Map
Selection
Selection by Watershed
Watershed
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Allen Harbor
Barnstable Harbor
Bass River
Bassing Harbor/Ryders Cove
Clear
Base Map
Planning Scenarios
Data Summary
Summarize by Water Use
Existing
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Scenario
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Show/Hide Legend
Commercial
Industrial
Multi-Family Residential
Other Development
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Residential Condo/Apt
Single Family Residential
Vacant Development
Vacant Non-Development
Results
Total Number of Properties Selected 7,171
Existing Sewered 3
Total Existing Water Use 1,015,835.58 g/day
Costs
Cape Cod Commission
Contact Us
Cape Cod Commission
3225 Main Street (Route 6A)
Barnstable, Massachusetts 02630
(508) 362-3828
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Email Us
Map Tools
Summary Legend
Canal South
Sandwich Harbor
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Barnstable Harbor
Pocasset River
Pocasset Harbor
Meganset Harbor
Three Bay
Centerville River
Popponesset Bay
Wild Harbor
Waquoit Bay
Great Pond
Green Pond
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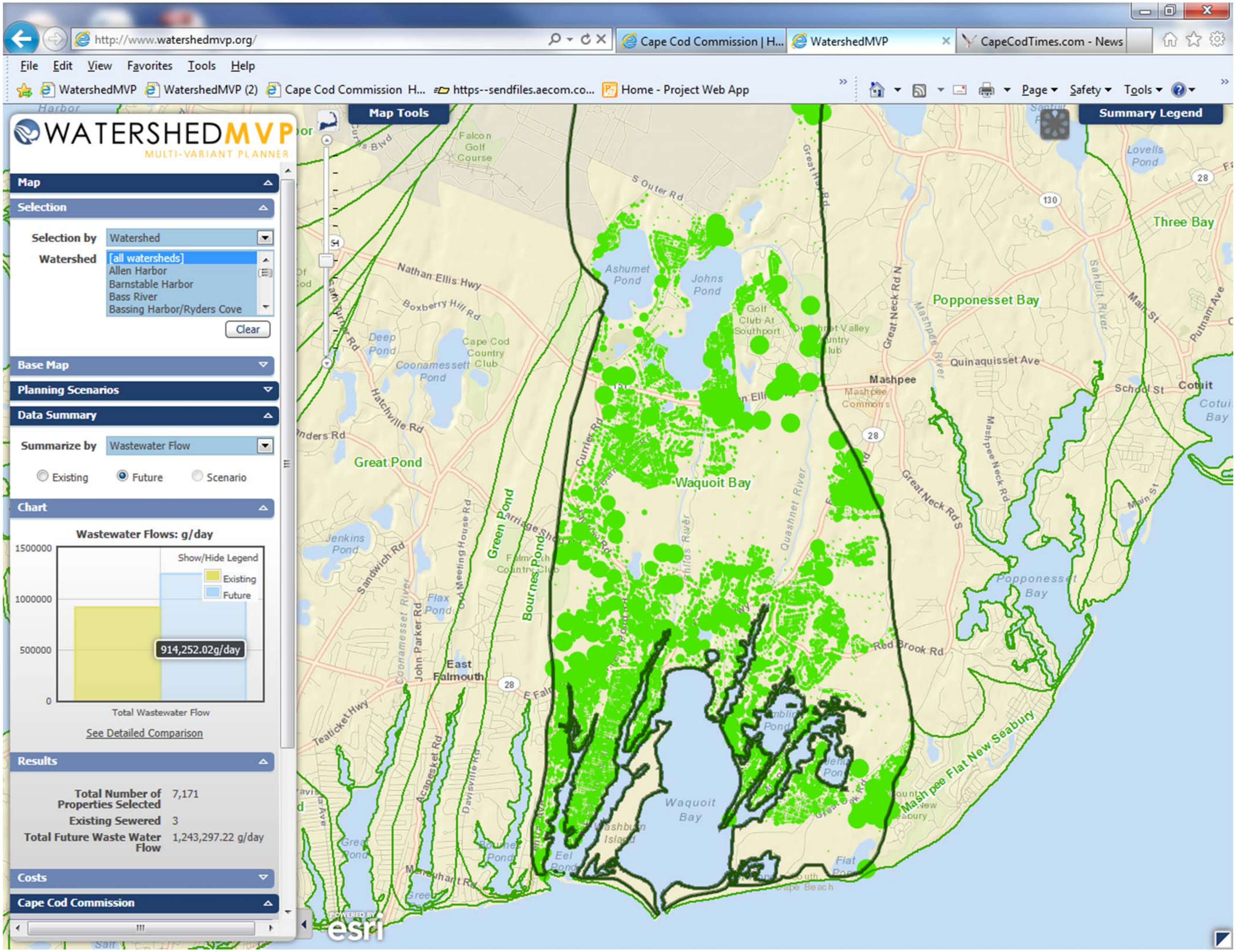
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Allen Harbor
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Base Map
Planning Scenarios
Data Summary
Summarize by Wastewater Flow
Existing Future Scenario
Chart
Wastewater Flows: g/day
1500000
1000000
500000
0
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Existing
Future
914,252.02g/day
Total Wastewater Flow
See Detailed Comparison
Results
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Johns Pond
Nathan Ellis Hwy
Quinaquisset Ave
Red Brook Rd
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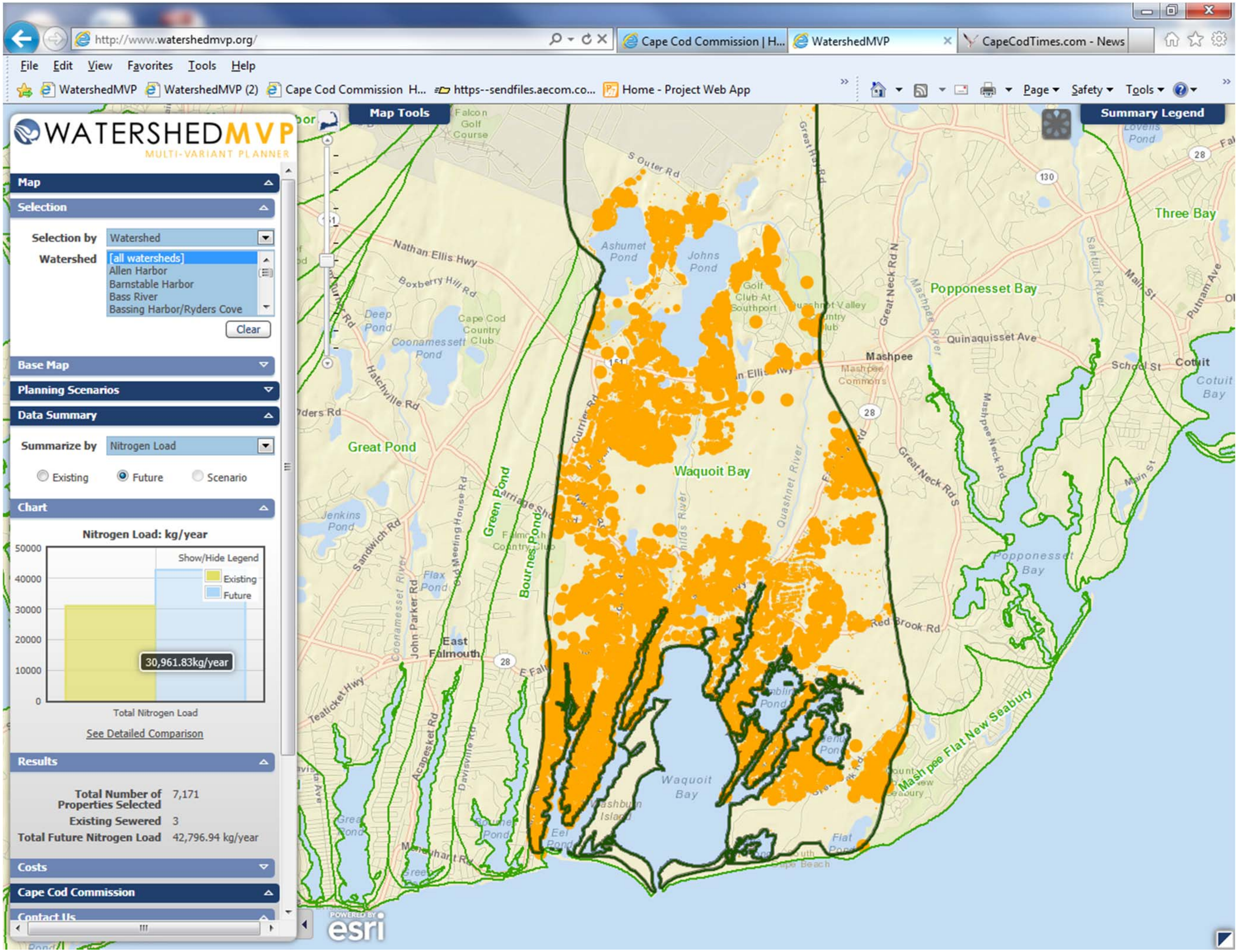
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Barnstable Harbor
Bass River
Bassing Harbor/Ryders Cove
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Base Map
Planning Scenarios
Data Summary
Summarize by Nitrogen Load
Existing
Future
Scenario
Chart
Nitrogen Load: kg/year
50000
40000
30000
20000
10000
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Existing
Future
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See Detailed Comparison
Results
Total Number of Properties Selected 7,171
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Deep Pond
Coonamessett Pond
Cape Cod Country Club
Hatchville Rd
Jenkins Pond
Sandwich Rd
Flax Pond
Green Pond
Bournes Pond
Quinaquisset Ave
Great Neck Rd N
Great Neck Rd S
Red Brook Rd
S Outer Rd
Falcon Golf Course
Golf Club At Southport
Quashnet Valley Country Club
Mashpee Commons
Teaticket Hwy
Acapesket Rd
Waquoit Bay
Washburn Island
Eel Pond
Flat Pond
South Cape Beach
Mashpee Flat New Seabury
Popponesset Bay
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Main St
Putnam Ave
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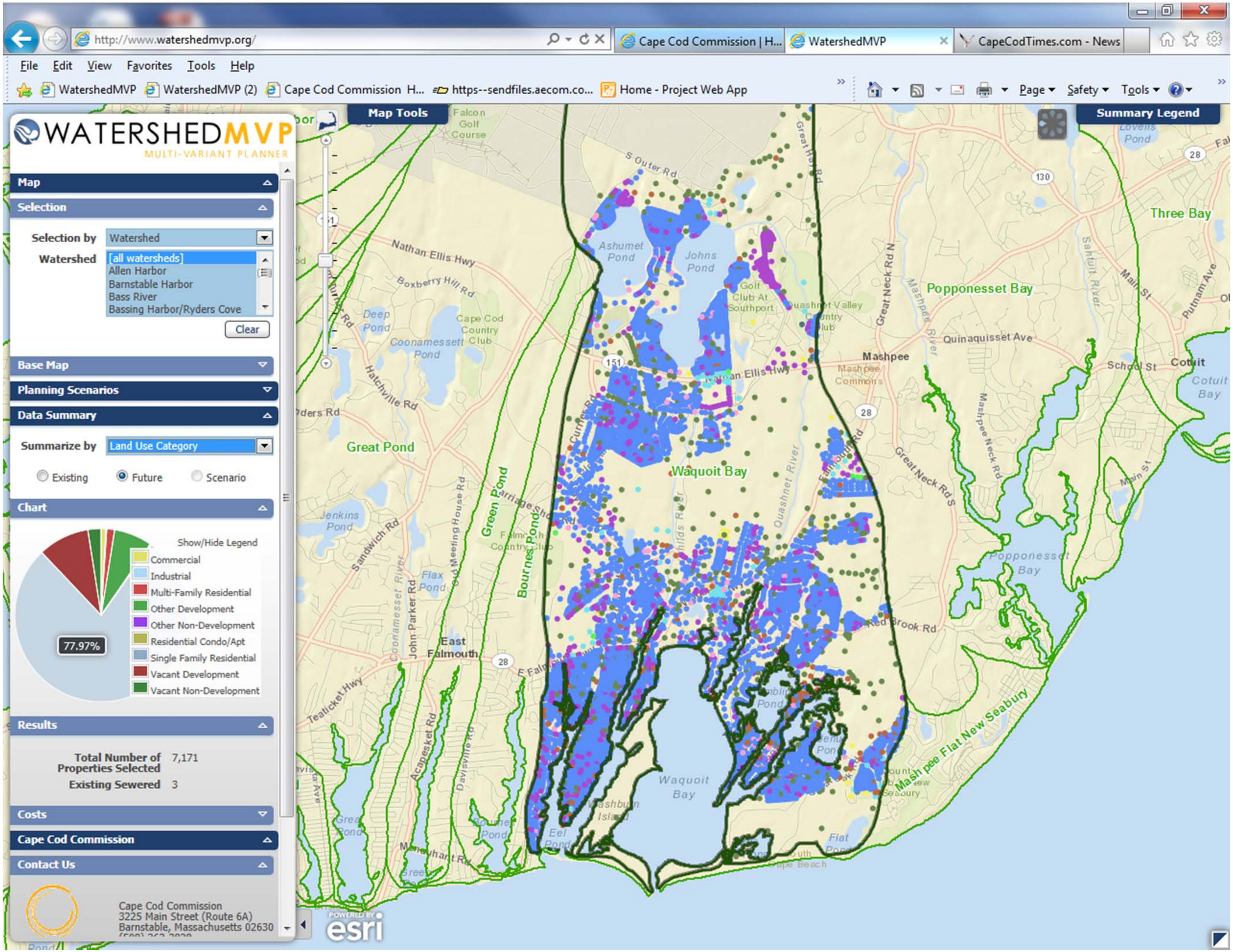
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Industrial
Multi-Family Residential
Other Development
Other Non-Development
Residential Condo/Apt
Single Family Residential
Vacant Development
Vacant Non-Development
77.97%
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Total Number of Properties Selected 7,171
Existing Sewered 3
Costs
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Map Tools
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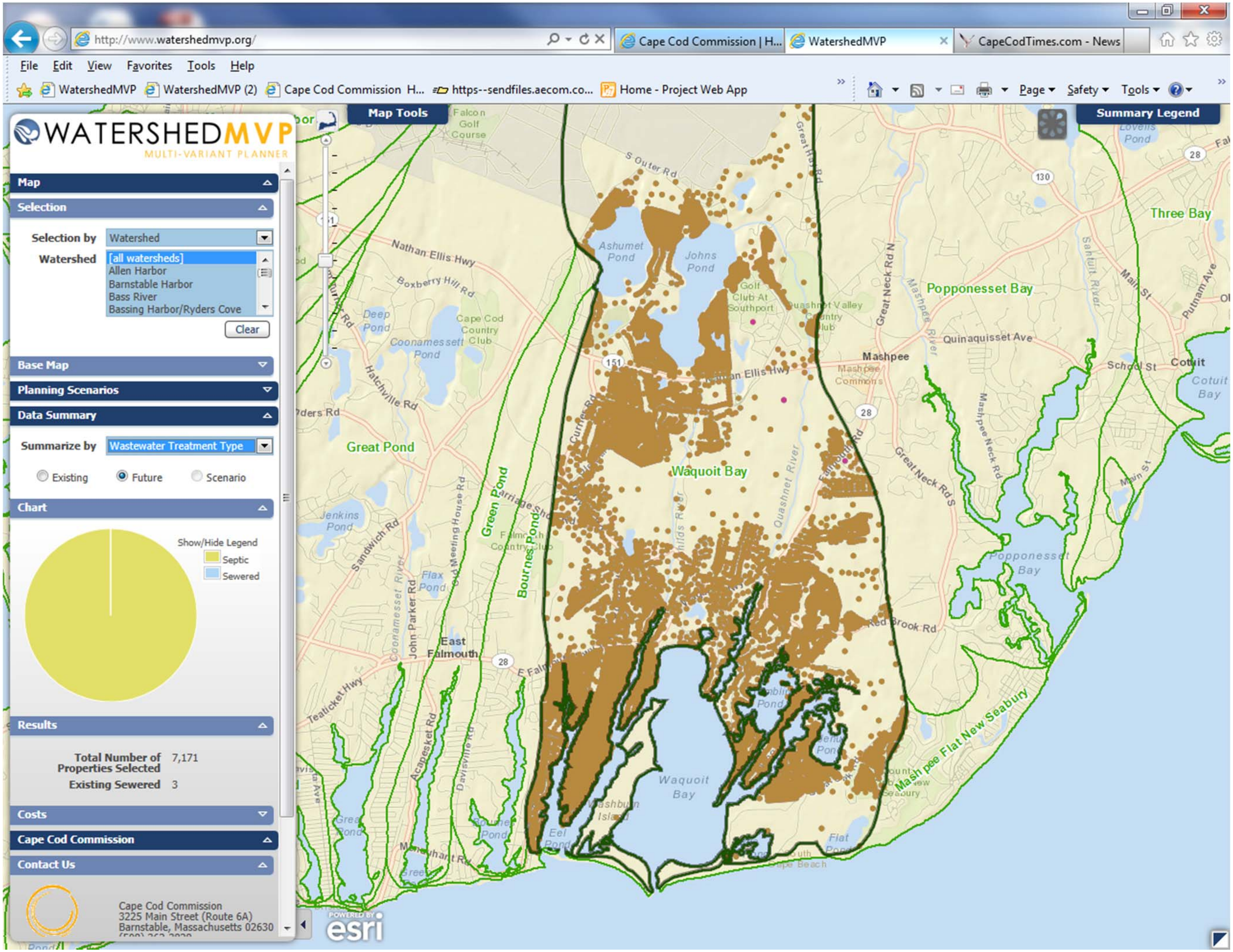
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Wastewater Treatment Type
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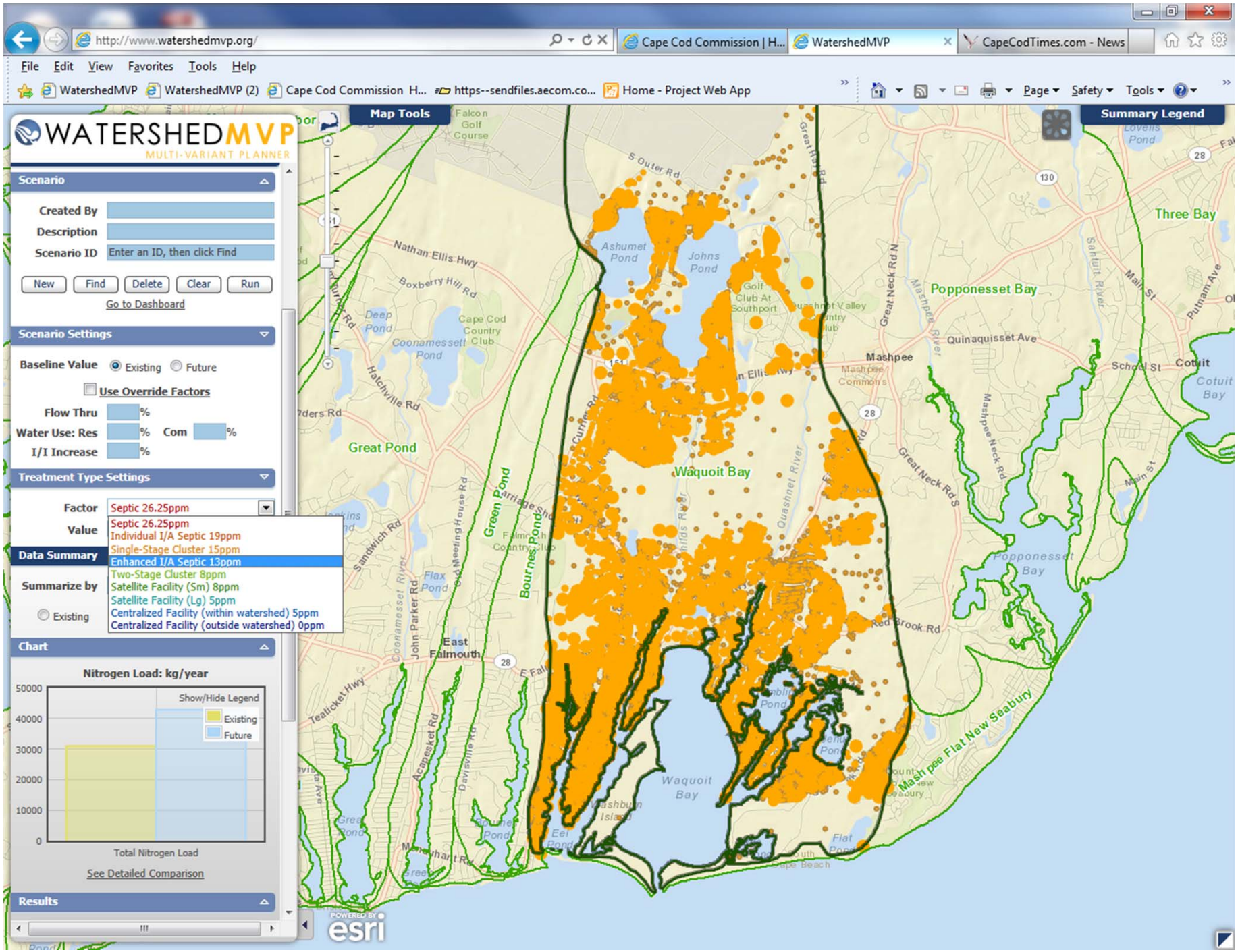
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Description
Scenario ID
Enter an ID, then click Find
New Find Delete Clear Run
Go to Dashboard
Scenario Settings
Baseline Value
Existing
Future
Use Override Factors
Flow Thru %
Water Use: Res % Com %
I/I Increase %
Treatment Type Settings
Factor
Septic 26.25ppm
Value
Septic 26.25ppm
Individual I/A Septic 19ppm
Single-Stage Cluster 15ppm
Enhanced I/A Septic 13ppm
Two-Stage Cluster 8ppm
Satellite Facility (Sm) 8ppm
Satellite Facility (Lg) 5ppm
Centralized Facility (within watershed) 5ppm
Centralized Facility (outside watershed) 0ppm
Data Summary
Summarize by
Existing
Chart
Nitrogen Load: kg/year
50000
40000
30000
20000
10000
0
Show/Hide Legend
Existing
Future
Total Nitrogen Load
See Detailed Comparison
Results
Great Pond
Waquoit Bay
East Falmouth
Popponesset Bay
Mashpee
Three Bay
Cotuit
Cotuit Bay
Quinaquisset Ave
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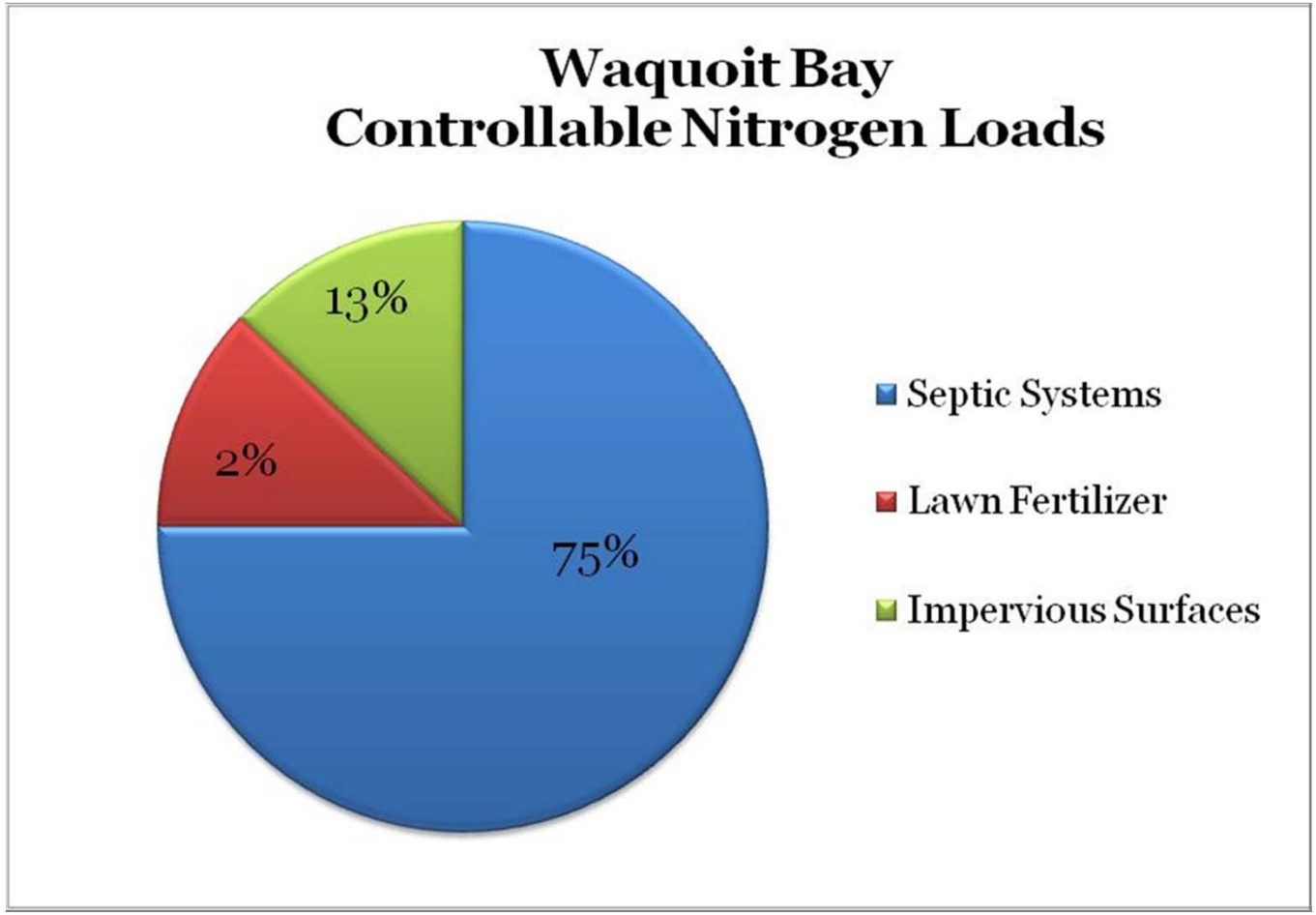
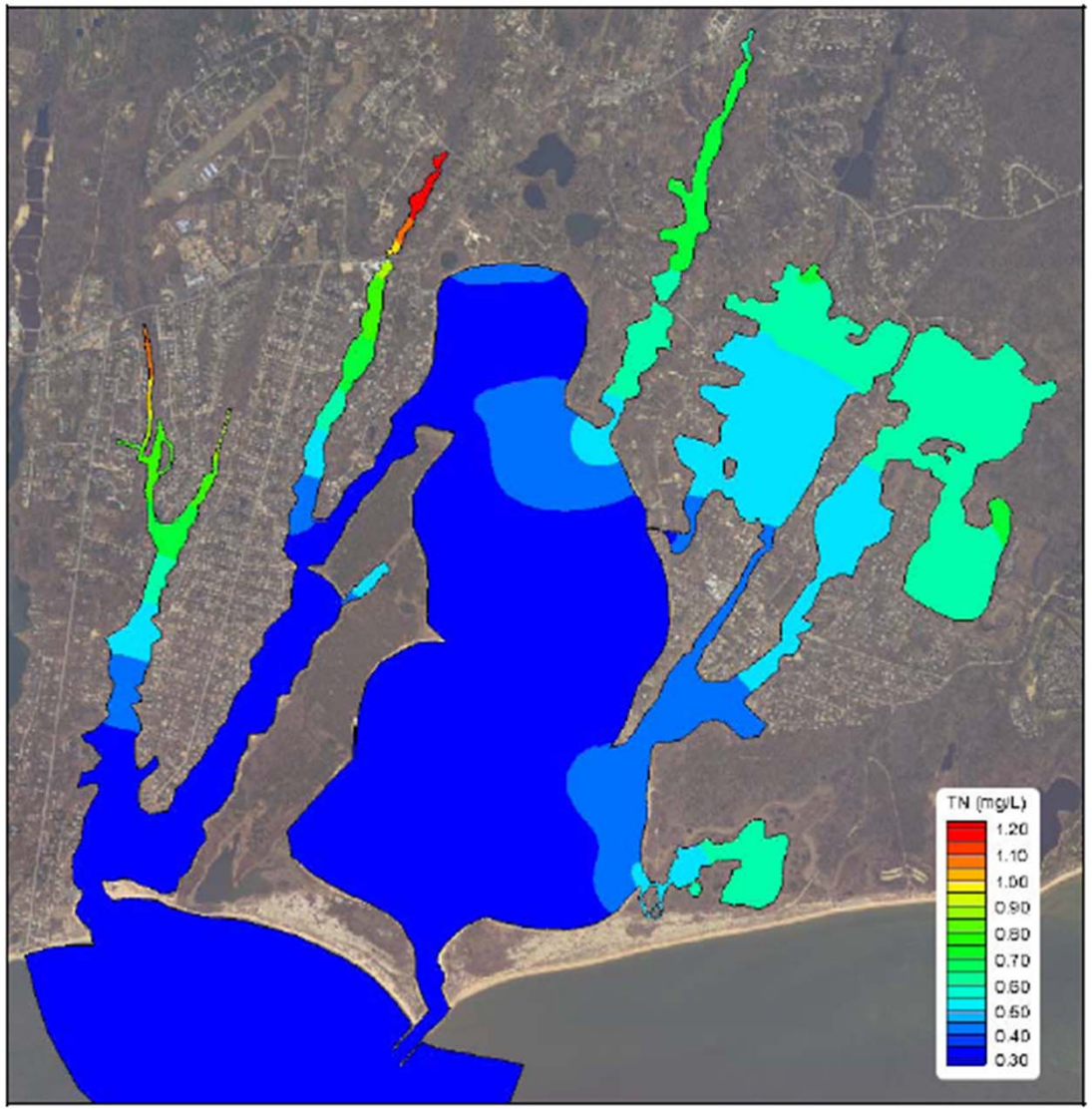
Mashpee Neck Rd
Mashpee Commons
School St
Main St
Putnam Ave
Sahuit River
Lovells Pond
S Outer Rd
Great Hill Rd
Curtis Rd
Old Meeting House Rd
Parrage Shores
Falmouth Country Club
Flax Pond
John Parker Rd
Coonamessett River
Teaticket Hwy
Acapesket Rd
Davisville Rd
Red Brook Rd
Washburn Island
Eel Pond
Flat Pond
Mashpee Flat
New Seabury
Waquoit Bay
Popponesset Bay
Falcon Golf Course
130
28
151
POWERED BY esri


Waquoit Bay
Controllable Nitrogen Loads
13%
2%
75%
Septic Systems
Lawn Fertilizer
Impervious Surfaces



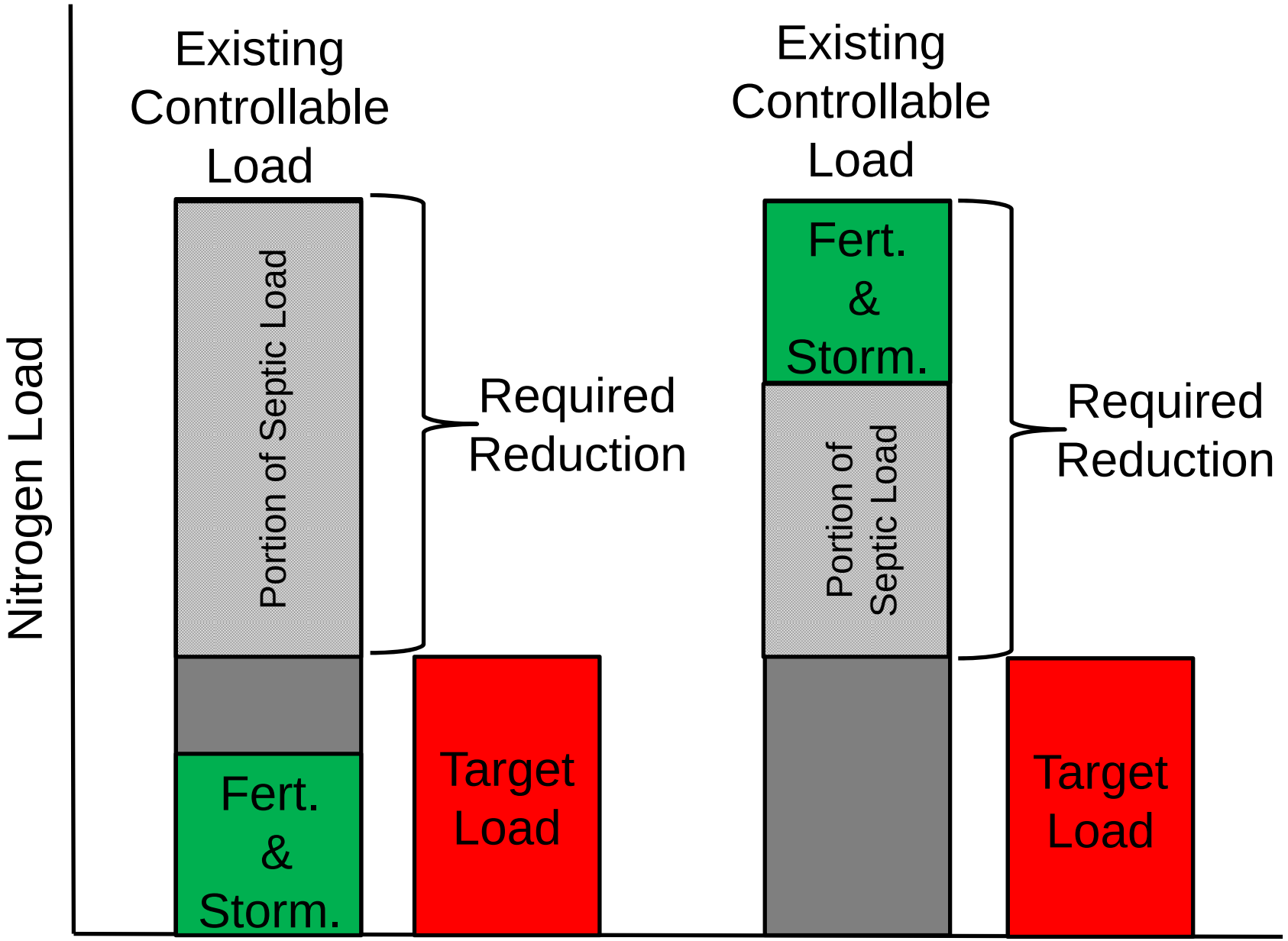
Contour plots of **average total nitrogen concentrations** from results of the present conditions loading scenario, for the Waquoit Bay system.

(Source: MEP 2012)

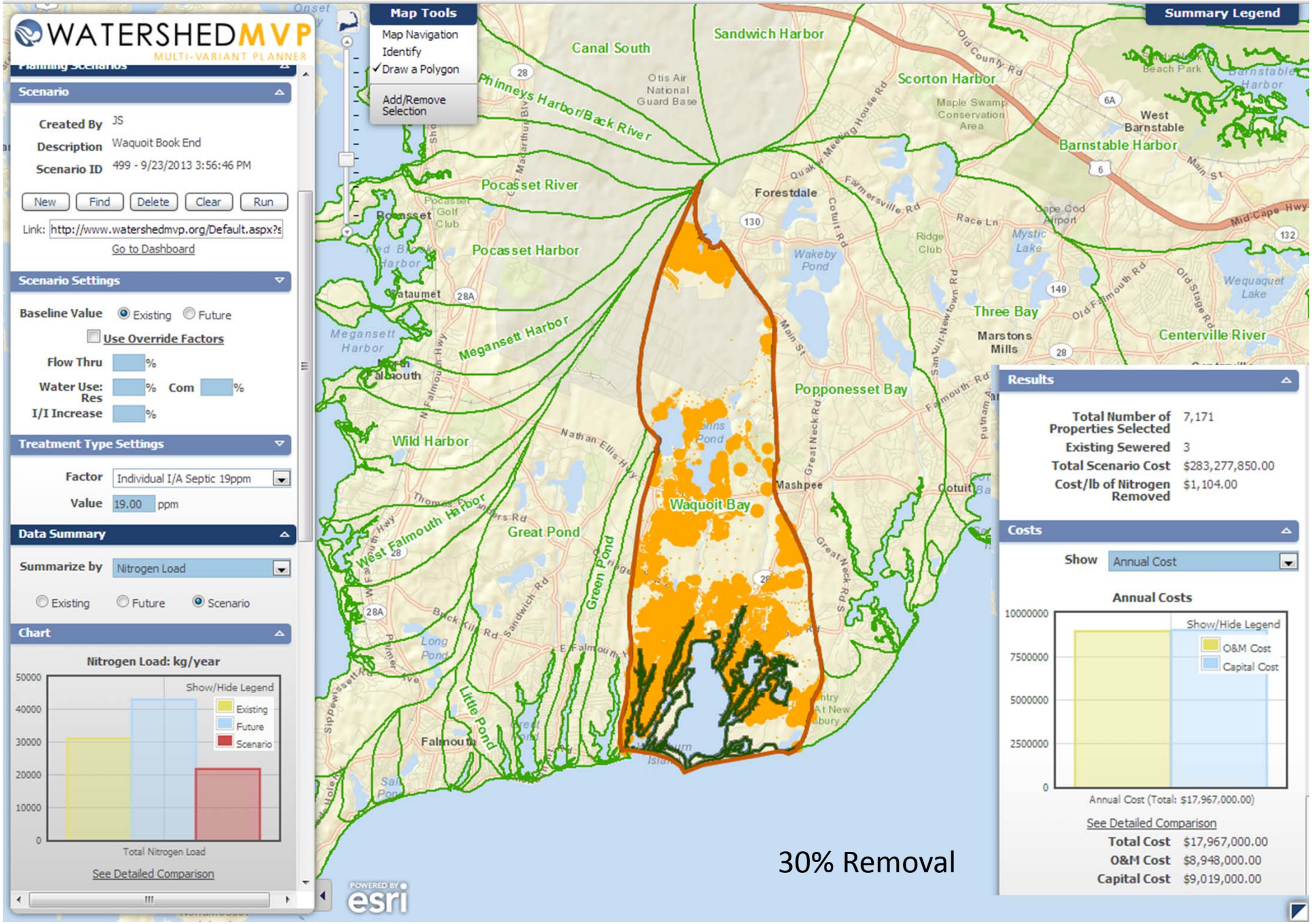
Present Conditions: Waquoit Bay

Aggregate Percent removals Septic and Total

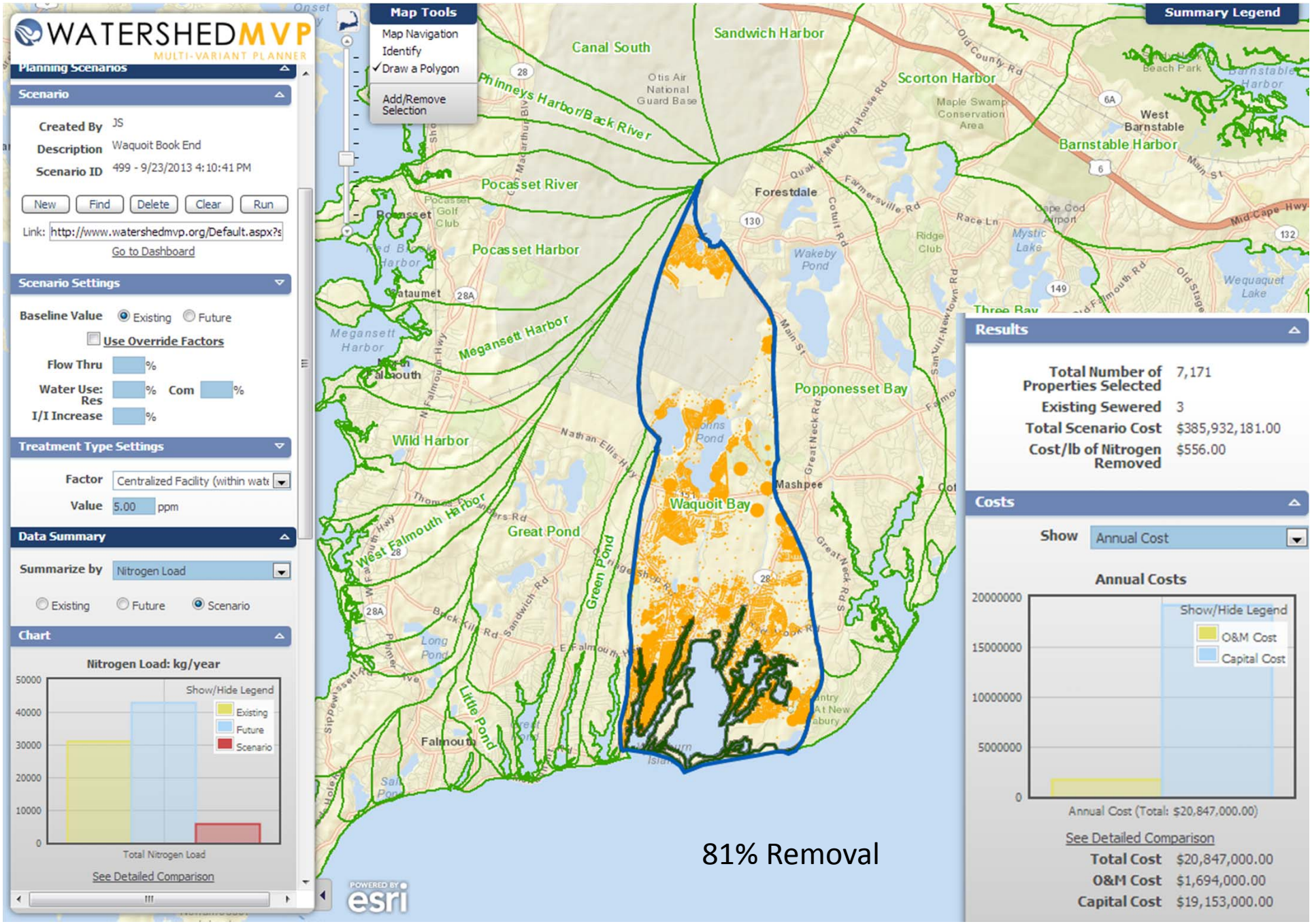
Total Nitrogen Removal Required	53.4%
Septic Nitrogen Removal Required	75%

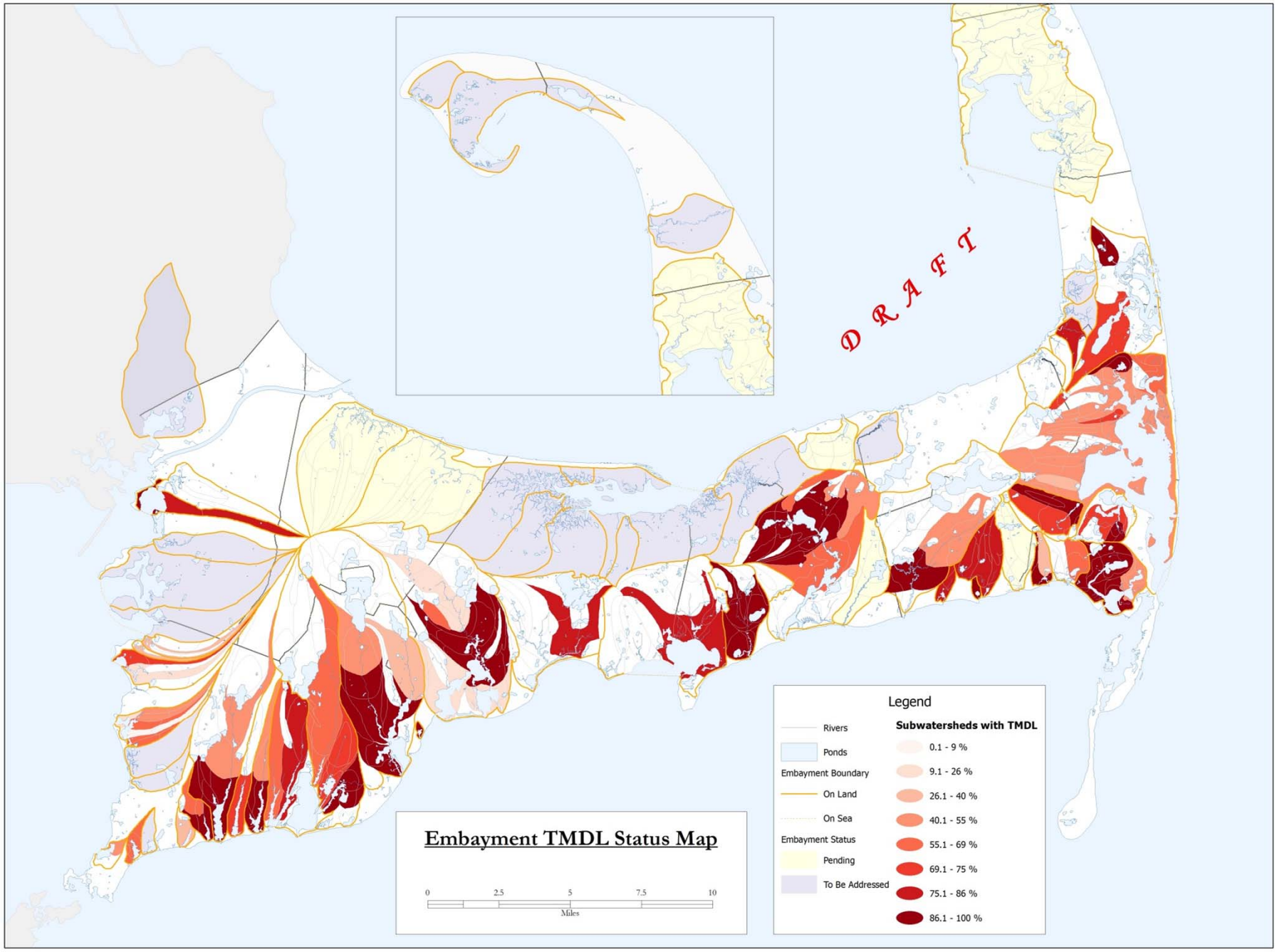

Nitrogen Load
Existing Controllable Load
Portion of Septic Load
Fert. & Storm.
Required Reduction
Target Load
Existing Controllable Load
Fert. & Storm.
Portion of Septic Load
Required Reduction
Target Load

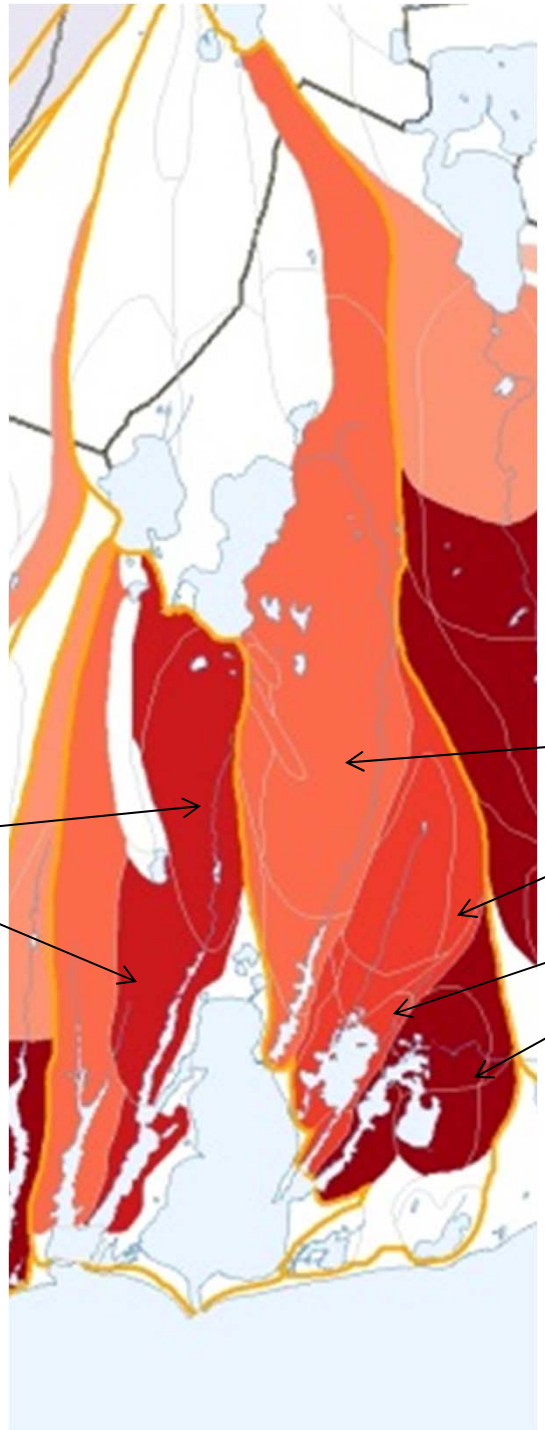
IA Entire Watershed



Centralized Treatment Inside Watershed




D R A F T
Embayment TMDL Status Map
0
2.5
5
7.5
10
Miles
Legend
Rivers
Ponds
Embayment Boundary
On Land
On Sea
Embayment Status
Pending
To Be Addressed
Subwatersheds with TMDL
0.1 - 9 %
9.1 - 26 %
26.1 - 40 %
40.1 - 55 %
55.1 - 69 %
69.1 - 75 %
75.1 - 86 %
86.1 - 100 %



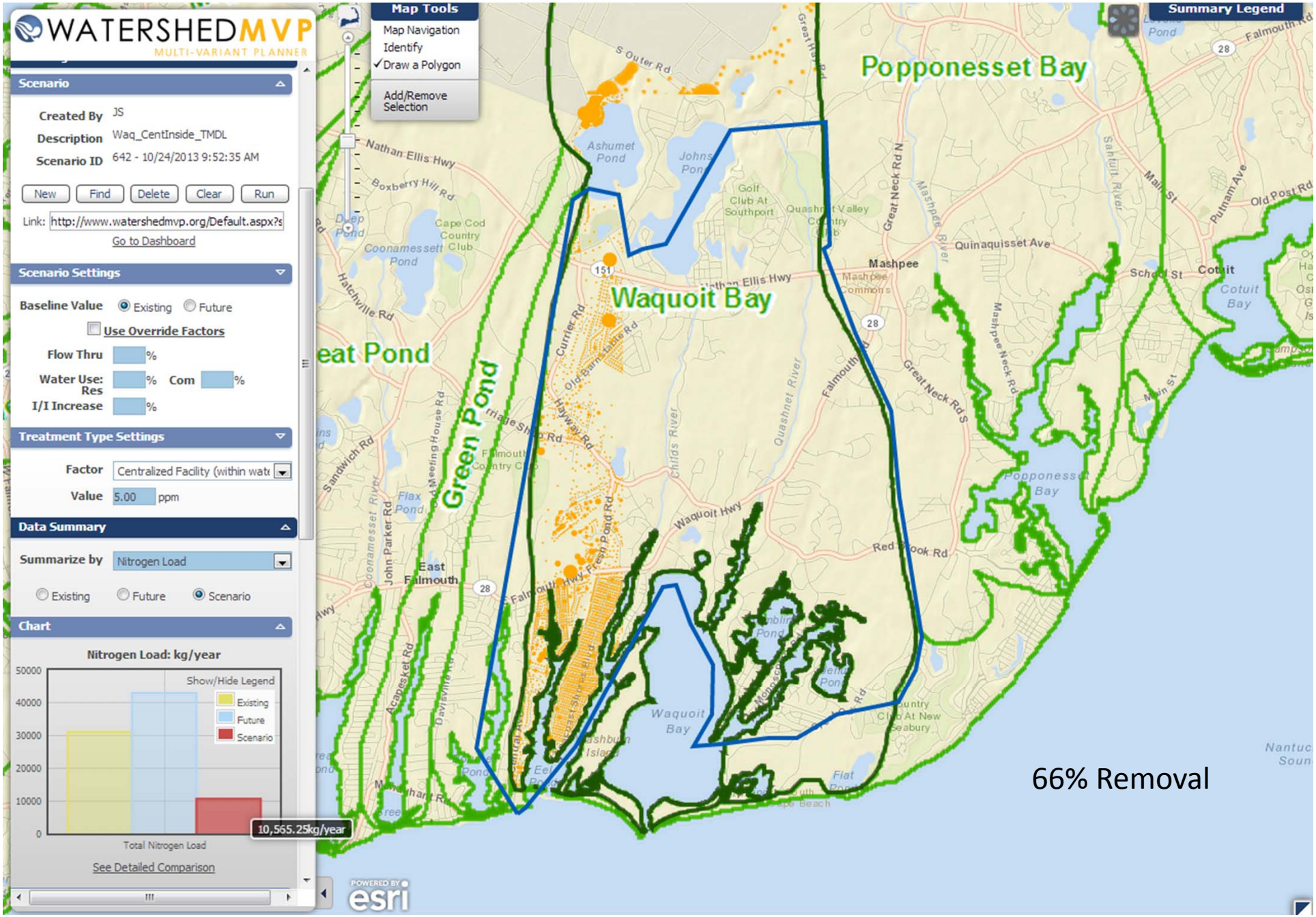
Targeted Septic Removal

80%

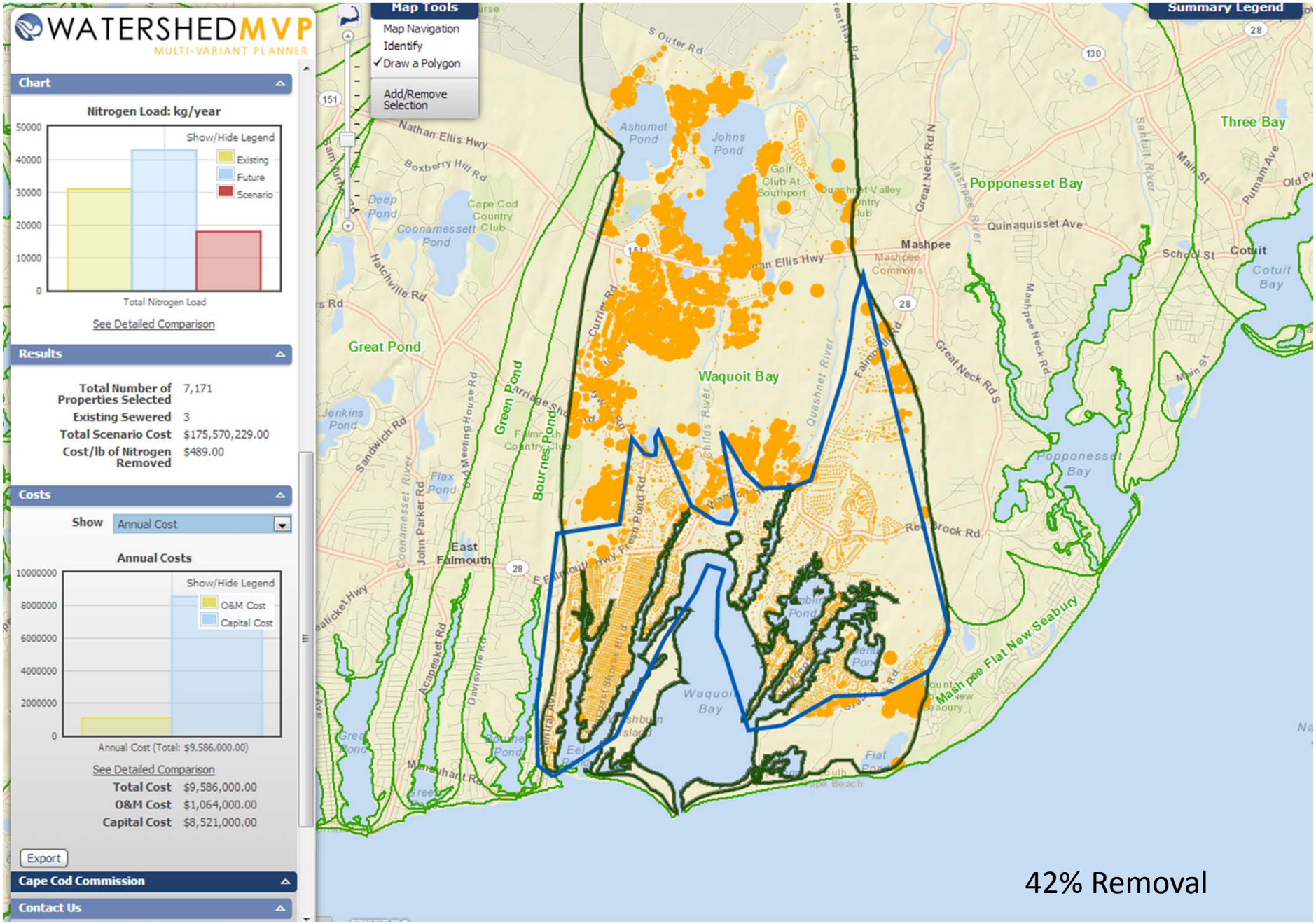
67%

100%

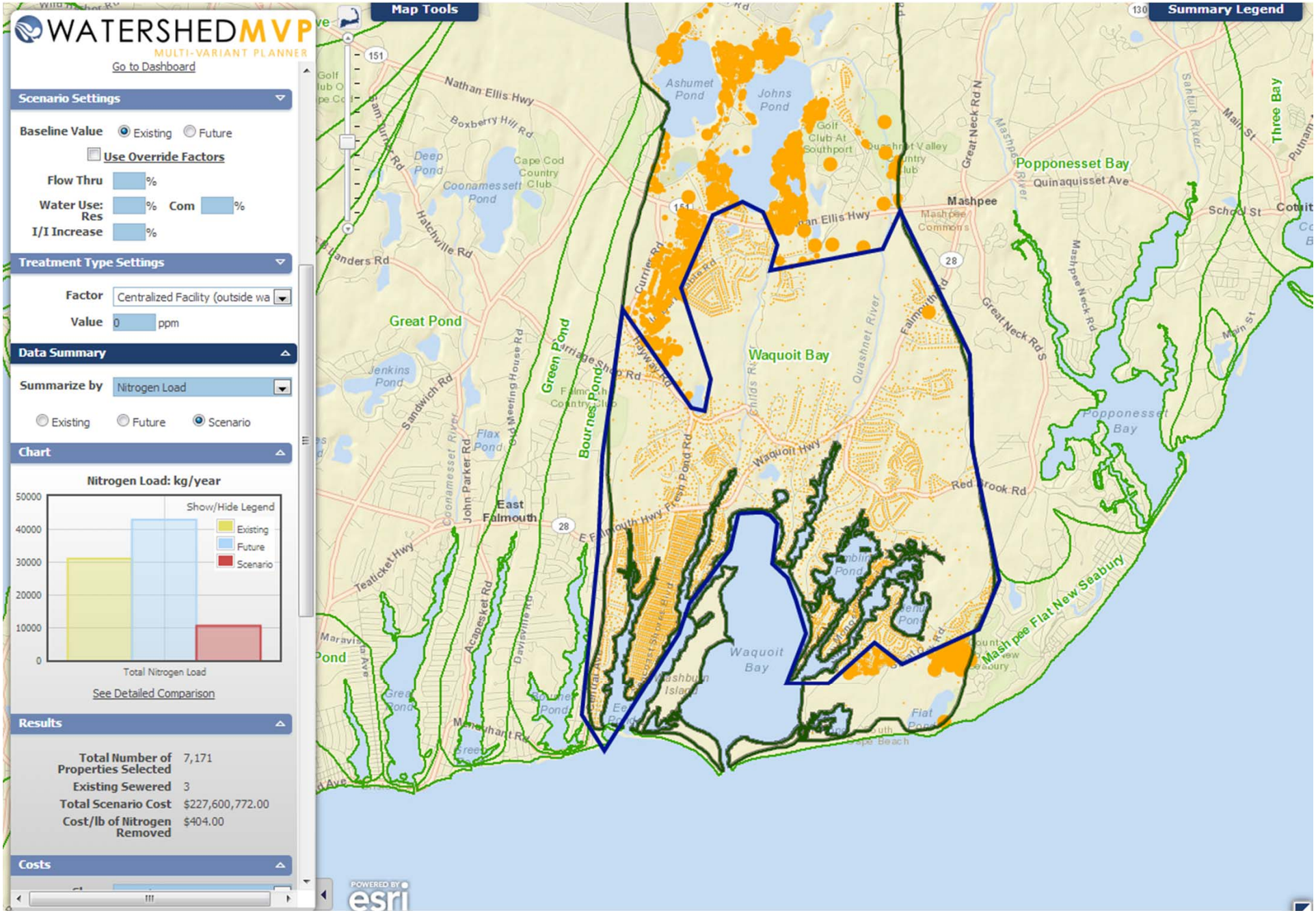
Waquoit Scenario #1 – Centralized Inside Watershed for TMDL Compliance



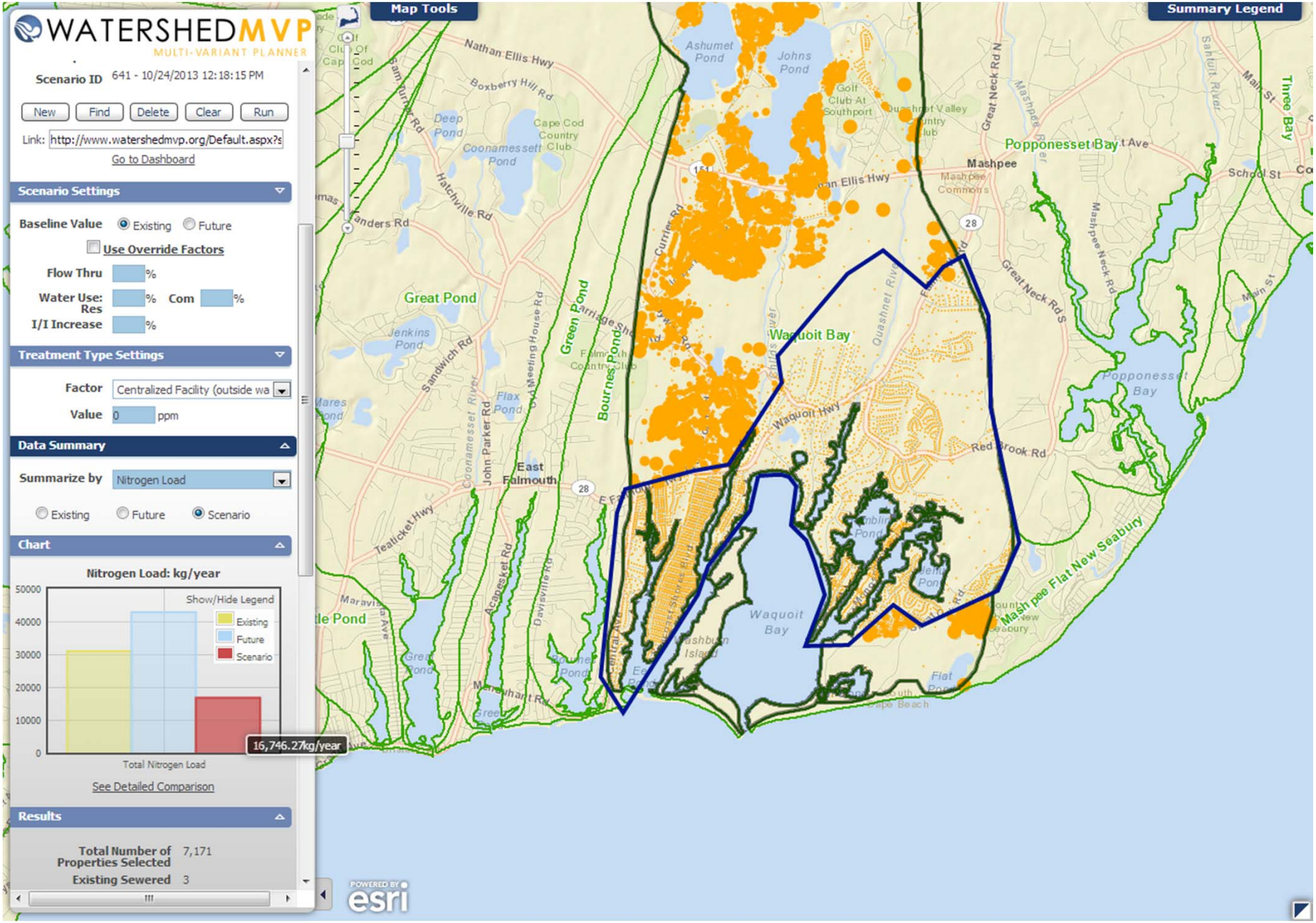
Waquoit Scenario #1 – Fert/Storm 50 % Reduction Centralized Inside Watershed for TMDL Compliance (Upper Sheds Removed)



Waquoit Scenario #1 – Centralized Outside Watershed for TMDL Compliance (Upper Sheds Removed)



Waquoit Scenario #1 – Fert/Storm 50 % Reduction Centralized Outside Watershed for TMDL Compliance (Upper Sheds Removed)



Waquoit Scenarios Achieving TMDL Compliance			
Scenario Description	**Total Cost Millions**	**Percent Septic Removal**	**Sewered Wastewater Flow (1000 g/day)**
Total Watershed IA @ 19 ppm	$385	31	914
Total Watershed Centralized inside	$391	81	914
Centralized Inside Treatment (5 ppm)	$291	T-66	667
Fert/Storm Centralized Inside Treatment (5 ppm)	$176	T-42	417

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CAPE COD COMMISSION

Cape Cod 208 Water Quality Planning
Panel on Technologies

Minutes – October 10, 2013

The meeting of the Cape Cod 208 Water Quality Planning Panel on Technologies convened on Thursday, October 10, 2013 at 1:00 p.m. in the Strategic Information Office/Innovation Room, Barnstable, MA.

Panelists Present:	Ivan Valiela, Marine Biological Laboratory (MBL) Chris Neill, Marine Biological Laboratory (MBL) Eric Davidson, Woods Hole Research Center Anamarija Frankic, UMASS Boston
Remote participation via Conference Call:	Sarah Slaughter, Built Environment Coalition
CCC Staff :	Paul Niedzwiecki, Executive Director Heather McElroy, Natural Resources Specialist Scott Michaud, Hydrologist Patty Daley, Deputy Director Tom Cambareri, Water Resources Program Manager Erin Perry, Special Projects Coordinator
CCC Consultants:	Scott Horsley, Horsley Witten Group Tom Parece, AECOM Mark Owen, AECOM Betsy Schreve-Gibb, AECOM Kate Kennen, Offshoots, Inc. (phone)

Panel on Technologies Mtg – 10/28/13

Present: Eric Davidson, Anamarija Frankic
Phone: Sarah Slaughter, Chris Neill, Ivan Valiela, Jay Prager, Patrick Lucey
CCC/Consultants: Tom Cambareri, Scott Michaud, Heather McElroy, Scott Horsley, Tom Parece, Mark Owen, Patty Daley, Erin Perry

Patty

In middle of second meetings

Matrix shared with stakeholders after 11/6 panel meeting
Invite to meeting on Nov 13, Dennis – cape20 wrap up, stakeholder engagement process (Jan-June)
Panel has been helpful, would like to ask for additional assistance from group through the June timeframe
Outside emails – please forward so we can respond and all have the same info moving forward

Fact sheets discussion:
Fact sheet revisions between meetings 2 and 3
Anamarija – suggests more clear communication about what revisions have been included and what have not
More detailed discussion next meeting

Heather – green infrastructure site selection methodology

Criteria – combinations of criteria that are necessary for siting and what are bonus criteria that would make site more suitable for siting that type of technology

3 technologies – constructed wetlands, phytotechnology, PRBs

Presentation text

Potential PRB sites

- Tan is depth to groundwater and black lines with the yellow highlighting is PRB location

Anamarija – constructed wetlands within 100 year to the flood plain, which actually talks directly about restoration of the saltmarshes, floating islands (has a document to share on effectiveness). Did you do the same for saltmarsh restoration? Or aquaculture restoration?

Heather – we have not done that for these types of approaches – can you provide us with the criteria to use for this process?

Anamarija – it probably exists, what we have, what we lost, what we need to replace. Looking for larger chunks of area, but we should focus on the smaller areas too. Could have tremendous impact on water quality.

Ivan – general comment about strategy. If I were doing this I would look at the individual watersheds, what are the major inputs, hit big items first. You want to look first at items that have to do with inputs. Cascade where nitrogen is attenuated downstream. The earlier you hit, the bigger impact you have further down the watershed.

Heatehr – more questions on screening process?

Eric D – those areas that need remediation the most? If they are not in places that they are needed, then it's not helpful. Rank based on areas that need them most.

Heather – screenings were done at regional scale. Constructed wetlands were done at a regional scale. PRBs we started with priority watersheds and looked for sites in those sheds.

Heather – specific thoughts on criteria and specific thoughts on types of approaches to screen for.

Anamarija – first choice and best choice is habitat restoration. If that can have a big impact we don't need to do anything else.

Sarah – monitoring units in the groundwater system? Tracking actual nitrogen and phosphorus?

Scott – MEP process, ongoing monitoring in the embayments themselves is ongoing.

Sarah – in the surface water in streams and ponds you have an estimate, but not real time.

Scott – monitoring in summer in the embayments when water quality impairment is at its peak.

Sarah – being able to follow it up to the sources. If you are measuring at embayment, then it's harder to figure out what the sources are.

Chris – framework of MEP models provides a pretty good way of estimating sources. Done with validated modeling, not done with a lot of real time monitoring. Not a lot of monitoring of whats leaching in leaching fields of residential neighborhoods. Models in every shed that allows us to figure out the relative inputs by shed.

Validated by matching model estimates with what's arriving in the bays and streams.

Models get us to identification of sources that can be extrapolated to Cape.

Anamarija – not good in the Wellfleet case, disagrees.

Sarah – you've got a model that was validated in a couple of embayments, validated in a couple embayments

Ivan – no, validated in atleast 18 or so watersheds. It's been done in 38 southern New England estuaries. Maryland, Virginia are other areas it was evaluated. Models we have used give almost identical sources as MEP models.

Sarah – can identify sources, using these models.

Ivan – is it fertilizer derived, ww derived or atmospheric derived

Sarah – so stormwater is caught in fertilizer?

Scott – there is a impervious surfaces

Anamarija – stormwater is the biggest concern in southern New England

Chris – not on Cape Cod

Eric – majority of n is from atmospheric – since you have the tools for doing the screening, including proximity of roadways to embayments, opportunity to screen specifically for impervious surfaces near impacted water bodies, low hanging fruit where you can address runoff from impervious surfaces that can contribute quickly to water body. Mass balance of Cape, atmospheric is very important, only small amount ends up on impervious and contributes as stormwater runoff

Sarah – inexpensive solutions that can have impact at source. If atmospheric deposition is a large contributor you can address some of the n in this way. And make things more beautiful – swales, etc

Ivan – if you worry about n inputs from watershed surface to the edge of the receiving waters, wastewater is much larger source. Atmospheric deposition is often intercepted by natural systems.

Chris – if you calculate total amount of n to CC watersheds, atmospheric is large, most falls on green surface. Small amount falls on road. What's actually making it to estuary is wastewater.

Sarah – doing it at the parking lot and major roadways would intercept prior to it being diluted.

Ivan – only about 2-3% in most areas, after it is diluted

Eric – disagrees, thinks it's larger percent, and there are other co benefits to managing that amount of water

Heather – move on to watershed approaches presentations, tom will review conventional approach and then scott with the non-traditional approaches

Tom – applying technologies. Looking at conventional approach (or traditional or gray infrastructure approach)

Waquoit Bay – example watershed

WatershedMVP – water use information from water districts, wastewater flow (10% is non returned water/10% of water use), nitrogen load in kg/year, land use, and treatment type

Remediation options – gray infrastructure options in this tool, shows us the approaches and provides cost factors for each.

Relative loads in Waquoit from MEP – 75% from septic, 13% impervious surfaces, and 12% lawns

75% septic nitrogen load needs to be removed, about 53% of the total load

If we remove fertilizer and stormwater then the amount of reduction required from septic goes down

All I/As for entire watershed, you get about 30% removal of nitrogen
Centralized treatment with disposal inside the watershed, you get 81% removal

That's for worst case scenario, you don't know, you have to sewer all to remediate. But we know how much we need to remove by subwatershed from MEP.

In Waquoit Bay we can evaluate percent removals by subwatershed and target our approach. Instead of collecting from the entire watershed you only need to collect from a portion to meet target.
Remove 50% of the n from fertilizer and stormwater and you can collect from a much smaller area.

If you remove the wastewater from the watershed and send it to an area that can assimilate more nitrogen, then you can minimize your footprint even further.

Missed conversation here about pre disturbance nitrogen flux

Scott – non traditional approach for Waquoit Bay

Process slide – how would we apply this approach

No assumption we can remove 100% of fertilizer or stormwater – you'll see examples of about 40% reduction in these sources

Working our way down from targeted load

Eric – saltmarsh restoration in here?

Heather – no, but where MEP has indicated that inlet widening might be beneficial, we've also included those

Spreadsheet follows the 7 step process

Ivan – how many of a particular technology can you realistically implement?

Scott – we need to target them to particular areas to start, closer to the water body

Ivan – in the winter, the plants die and this is discharged back in to the groundwater

Patrick Lucey – we have some experience in this field, different landscape, what we found here was road side ditch management was very traditional. Get water off the land as fast as possible. We've worked with municipalities to re think role that a ditch plays as hydrological profile as part of watershed. Create bioswales for n and p uptake, but manage water in swale is dependent on microbial community. Harvest biomass so it can be composted elsewhere and becomes part of soil conditioner. Good success in terms of downstream impacts. Ditch maintenance targeted at equipment managers – public works crew. Increasing effectiveness at much lower cost.

Eric – pointed out error in calculation (lines 12-14)

If the solutions presented in spreadsheet perform at highest capacity/effectiveness then gray/traditional infrastructure is not necessary.

Is approach practical? Looking for feedback on approach?

Eric – will include costs? What about cobenefits?

Scott – yes, we will include costs. Non-traditional approaches seem to be coming out to be less expensive. Good point on cobenefits.

Kate – constructed wetlands could prevent storm surge, example

Anamarija – ecological services

Chris Neill – this approach requires ringing the entire seacoast shores area?

Scott – yes, and this assumes it's in the road so we don't count septic systems down gradient from the PRB

Chris – we are not seeing 90% in the two PRBs in Waquoit now

Mark Owen – we have broadened the range in PRB reduction in response to the meeting last time

Ivan – I would feel better about aquaculture contribution if Carmichel et al numbers were used in approach. Use flesh of oyster once it's harvested?

Scott – using lowest of the numbers we are seeing on the Cape

Jay Prager – I would think about whether or not you are double counting. You have barriers and septic systems. Then aquaculture. Are you reducing the amount that the oysters are able to address by using the barriers and septic in the shed. You need to reduce load to prb based on septic, and load to aquaculture based on prb, etc

Kate – would it make sense to have a lot more of these picked out. More sites per technology picked out. Range of options that can be chosen later. Flexibility in the plan.

Scott – yes, by having screening for entire Cape we can do that.

Kate – so this is just one option that can meet the TMDL? Include nitrogen data layer with many sites to allow for flexibility?

Eric – technical question about double accounting – you look at golf course fertigation in upper left. Up slope from PRB. PRB would be filtering out inputs from residential areas near it. If you subtract out nutrients from other techs and assume that made your prb less effective you may also not be accurate. Dependent on proximity of inputs to technology?

Scott – yes – prb likely captures only the homes near by.

Eric – there is a potential error by assuming that prb is less effective based on prior treatment techs AND by assuming that prb is only capturing nitrogen from proximate areas

Mark Owen – adaptive management. If we are not getting as much removal from a particular approach we can come back and take some additional measures. Monitoring and recalibrating.

Break

Adaptive management

Eric – depends on the amount of time we are given to test and try technologies

Sarah – cost for removal. Investment costs and cost for paying for money needs to be included too. Oysters can help right now.

Patrick – we've spent 20 years tackling these issues at whole watershed scale. Successful management strategies need to address the entire watershed. Can't only track accounting costs, we need to track ancillary benefits/costs. Example, 20,000 people in watershed in rocky mountains facing drinking water problems. By installing sophisticated monitoring program as well as ecological assessment of conditions of watershed, we discovered we can meet standards at a cost of $10/p/year without filtration. Key is being flexible enough to adapt quickly to what we were seeing. Modeling overall watershed conditions – how is watershed changing, including how people are responding to technologies.

Eric – what would you track?

Patrick – how watershed is functioning. Condition of watershed – processes and attributes, functional elements, not structural, including streams as surrogate measure of health of watershed – hydrological, depositional aspects of streams. As we begin to test efficacy of treatment types we can identify where the biggest bang for the buck is. My gut tells me that there will be a lot of surprises and we need to be flexible to incorporate technologies moving forward.

Eric – would be helpful to monitor over time going forward – the type of vegetation we want in our environment. Monitoring needs to get built in to budget.

Tom – adaptive management – one piece is monitoring and how extensive that is. We have a baseline of informationfrom MEP, used to estimate nitrogen sensitivity and target. Is it sufficient to have these as a start – what was measured, etc? What should we focus on?

Chris – how often are those stations monitored?

Tom – I do monitoring for Centerville River. They are monitored for about 2 weeks during the summer periods. There is other monitoring that goes on during the summer periods.

Bob Duncanson – towns have continued some of the monitoring, sometimes just sentinel stations, throughout Cape, since early 2000s.

Anamarija – monitoring station health doesn't match nitrogen loads

Scott M – sampling water quality vs. ecological indicators. These are ecological habitat measurements. Lower reaches you might see good water quality. What you see on the map is an indication of impaired habitat measurements.

Ivan – in regard to matching habitat and nutrients, please remember summer is time of lowest nutrients in water. Most nutrients are removed. Peak nutrients in water are in winter and early spring. If you look at habitat unfortunately things are changing quite fast, macro algae in 75cm of depth and that is changing. Makes it difficult to target backwards.

Anamarija – nitrogen not the number 1 variable. Health of ecosystem is based on a number of issues, nutrients are just one issue. Look beyond nutrients.

Chris – one of the things that would be interesting for us to think about and make recommendations – what monitoring would be most useful and give us the most feedback. Expanding to different times of year, mobilizing citizens, etc.

Sampling rivers, seepage (basins), pick watershed segments where manipulations are planned and monitor to take in to account the management option.

What else is missing from monitoring scheme?

Patrick – what are the drivers behind broader regional change in habitat functional conditions.

Ivan – have a proposal to study that but it was turned down! Hypotheses: (missed one), increased sea level, reduction in nitrogen loads from wastewater in the area.

Anamarija – no habitat in hypotheses? In Wellfleet this changed dramatically and in Waquoit you don' thave any shellfish.

Sarah – citizen mobilization. Citizens taking samples in water bodies. Interventions – set them up in controlled experiments. Keep changes in variables constant in each location.

Anamarija – In sustainability conference, suggest to select a watershed as a study area. A lot of productive suggestions a year ago at the Cape Cod Sustainability conference.

Heather – expanded calculator looks at changes in watershed as techs are applied.

Tom P – expanded calculator

Non traditional technologies information taken from matrix, traditional from MVP scenario runs

Includes impact on project, o&m, life cycle costs and cost/kg/year removed

Scott H – cost per oyster/revenue generation (+ or -?)

Anamarija – can provide cost for construction, etc for oyster restoration

Sarah – does lifecycle cost include financing for borrowing?

Tom P – it does not yet.

Mark – likely have one sheet for each subwatershed, tie them together

Sarah – oyster revenue, might be good to have benefits column, whether its direct revenue or ecological benefits.

Anamarija – cost to support aquaculture is known

Sarah – revenues, could look at economic value of oyster with the assumption that you return the shells.

There might also be a value for recharging the local groundwater?

Anamarija – oyster is not only addressing nitrogen, but has a number of other benefits

Mark – primarily looking at putting everything back in to groundwater. Its an easier path not to go thru NPDES and benefit to put it back in groundwater

Patrick – maintaining groundwater available for drinking water is hugely important as less area is available with more sea water influence. Largest loss is at the top – a very small rise can result in a large loss of water availability. A 2ft rise could wipe out all agriculture in California.

Sarah – Everglades restoration is to prevent saltwater intrusion.

Chris – recent presentation, how much it makes a difference that we are moving this water around (Dennis LeBlanc), bottom line – moving it around makes a very small difference in water balance of cape cod and very small difference in saltwater intrusion. Long term sea level rise will impact wastewater remediation efforts. Not a game changer for the amount of water we are moving around.

Ivan – precipitation is increasing (overall annual rain) so its hard to know where we stand. Sea level rise may alleviate some of the loading.

Next meeting – triple bottom line, incorporation of matrix comments

Public comment:

Jeff Eagles – technology panel could make specific recommendations on monitoring and watershed health and function assessment. Establishing a baseline for watersheds and evaluating technologies as they are implemented.

Earle Barnhardt - $/lb of nitrogen removed for ecotoilets?

Tom Parece – yes in this scenario $1500/kg removed

Hilde – life cycle cost of ecotoilets?

Tom – yes, from various sources

Hilde – I would like to see those sources

Tom – we can provide

Landcape woman (from Ptown Group) – top sales of fertilizer on CC is a friend – have removed n and p from golf courses – can provide some information if helpful

What are you doing for plant remediation? Reforestation? To what amounts? What types? Where?

Heather – phytoremediation? Kate can I throw it your way?

Kate – generally the higher biomass that the plant produces the more n it will take up. Two ways it can be remediated – incorporation in to biomass and by improving denitrification process by bacteria in the soil (more significant).

Plants that typically do that the best are the ones that take up the most amount of water – hybrid poplars and willows, but there are studies on other species, prairie grasses (little blue simmons, native to Cape).

Landscape woman (from Ptown group) – working with things that are native to here that is huge to this process, doing something once and doing it right.

Ed Daly – some concern has been expressed about longevitiy of oyster solution – disease and weather, etc.

Anamarija – you think they won't last long enough? Our impaired coastal waters do impact the life, but if we start to restore the shellfish habitat – we know that if we can establish a longer living population they are less susceptible to diseases – biodiversity is much higher.

Ed – long term – diseases come through everything, but in long term is it viable?

Anamarija – if we try to restore habitats that we used to have, in the whole system approach, biomimicry approach, restore everything at same time. I don't think there is one solution here. How can we improve the whole system? If you try to solve in little pockets, disease may be more likely to impact population.

Patrick – accidental study in great lakes – zebra mussels have increased? water quality?

Anamarija – won't clean everything – need a balance

Hilde – for ecotoilets – did you include water savings, capture of pharmaceuticals, etc? that these are kept from water bodies/resources?

Tom – will look at it to be sure they are included.