FINAL

Comprehensive Wastewater Management Plan/Single Environmental Impact Report

Water Quality Harwich

Town of Harwich, Massachusetts

March 2016

CDM Smith

Appendix A
Public Outreach

CDM Smith worked with the town of Harwich's Water Quality Management Task Force and the Wastewater Management Subcommittee through a series of meetings to complete this CWMP. This section summarizes public presentations and community meetings held from 2007 to 2013. A recent copy of the towns Frequently Asked Questions related to wastewater management is also included in this section.

- Public Presentations
- Community Meetings 1 -6
- Frequently Asked Questions

Public Presentations

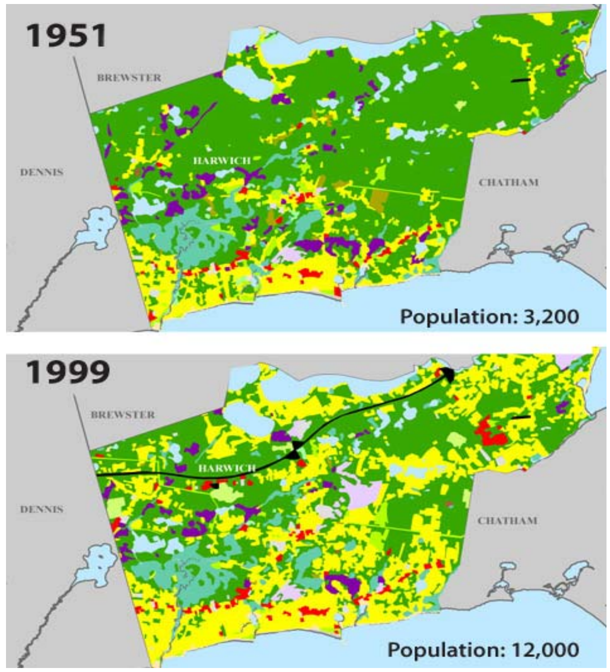
Summary of Harwich Utility

- 180 Miles of Utility Pipes
- 5 Pumping Stations
- 3 Storage Tanks
- Treatment Facility
- Administration Offices and Maintenance Garages
- 40+ Year Program
- Capital Cost Range (Today's Dollars):

$215 to $255 Million

Harwich Land Use Development 1951 and 1999

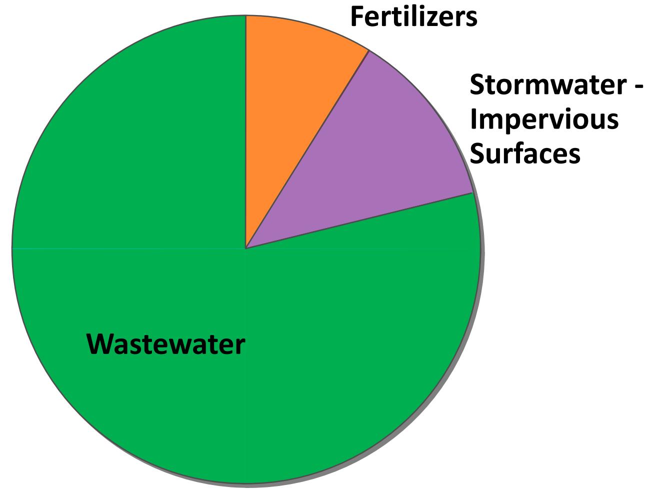
- 400% population growth from 1951 to 1999



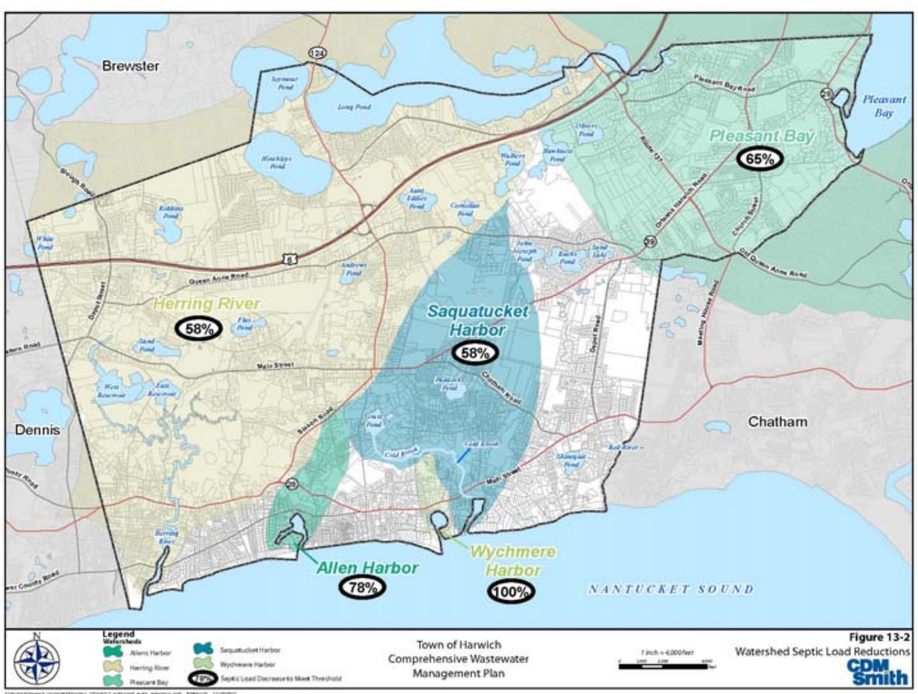
Allen Harbor Algae Bloom

Summer 2007

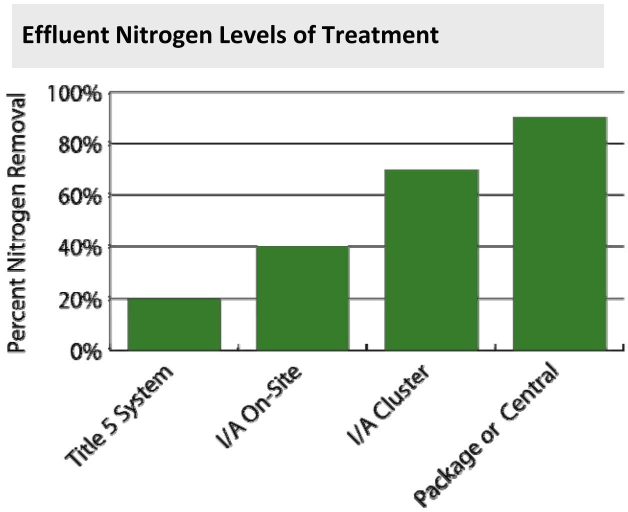
Controllable Sources of Nitrogen

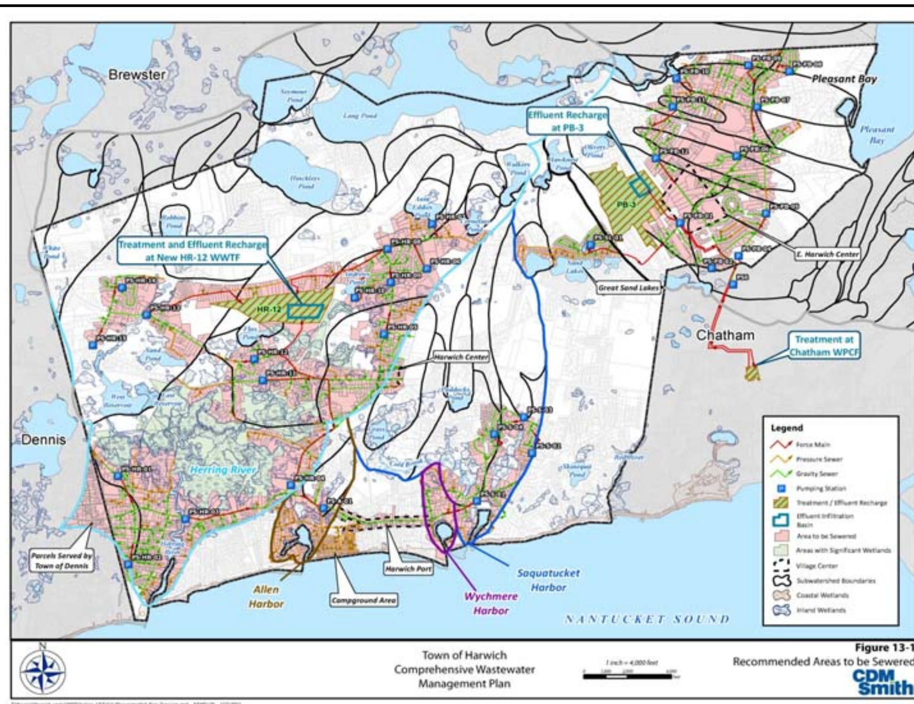


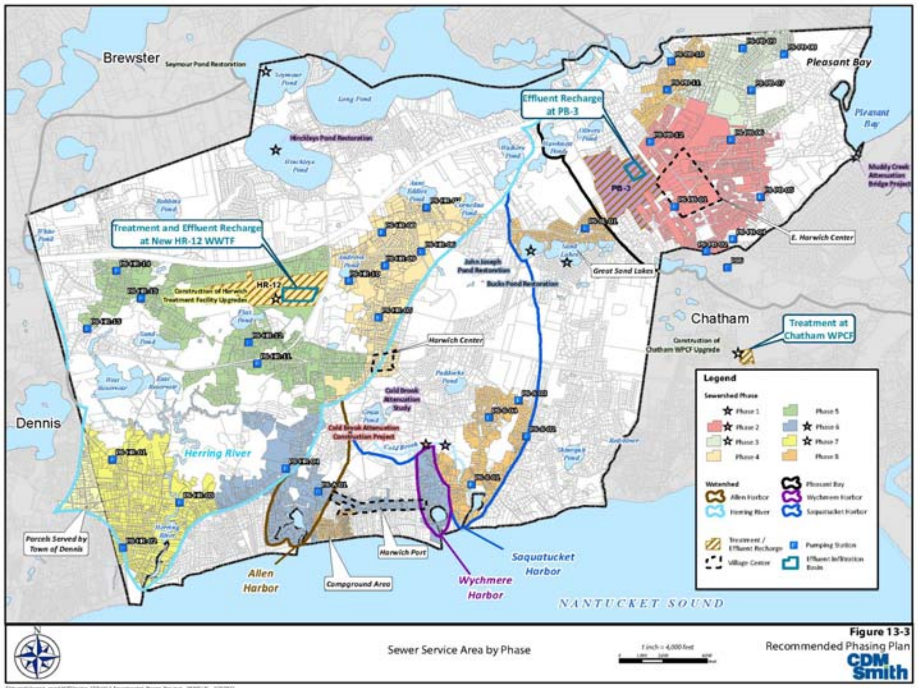
Local Control - Typical



Nitrogen Removal By Technology







Recommended Program – Scenario 5A With Updates

- **Two Treatment Plants**
- **First phases utilize regional solution by using Chatham wastewater plant to treat Harwich flows from Pleasant Bay watershed**
- **Future phases utilize Harwich treatment plant built at landfill site to treat and recharge wastewater from other four watersheds**
- **Program built in eight phases over 40 years**
- **Includes 23 % growth at build-out**
- **Capital costs range $180 to $230 Million**

Recommended Program – Scenario 5A With Updates

- Non-infrastructure Components
  - Public Outreach
  - Fertilizer Management Education
  - Stormwater Best Management Practices
  - Freshwater Pond Evaluations and Restoration
  - Land Use Planning/ Zoning/ Acquisition
  - Other
- Adaptive Management Process

CWMP Schedule

- November 2012 – WQMTF Wastewater Management Subcommittee endorsed recommended program
- January 2013 - Board of Selectmen endorse filing of recommended Draft CWMP program - ?
- February 2013 - Begin year long State and County permitting review of Draft CWMP
- Spring 2013 Town Meeting actions
  - Fund remainder of CWMP
  - Fund Phase 1 of recommended program

Summary

- This is a complex planning process – one that will continue indefinitely – as things will change – adaptive management process
- The CWMP is intended to be a living document that will adapt depending on results of earlier implementation phases
- Most properties in town contribute to the problem – not just those along a water body or those proposed for sewering
- All benefit from improved water quality

Community Meeting 1

Harwich, Massachusetts

Comprehensive Wastewater Management Plan (CWMP)

Community Meeting
Harwich Community Center
7:00PM September 27, 2007

Welcome by:
Harwich Wastewater Management Subcommittee (WMS)

- Larry Ballantine
- Dr. Stanley Kocot
- George Myers
- Robert Owens
- Frank Sampson (Chair)

Town Staff Advisors

- Paula Champagne (Board of Health)
- Sue Leven (Town Planner)
- Heinz Proft (Assistant Harbormaster)
- Craig Wiegand (Water Department)

- Jim Merriam (Town Administrator)
- Ed McManus (Selectmen’s liaison)

- Town Consultant – CDM

Meeting Purpose

- Provide an overview of CWMP development process and schedule
- Review why Harwich is undertaking this important program
- Notify local residents and business owners of the importance for them to participate and how they can do so.

Need for Citizen's Advisory Committee (CAC)

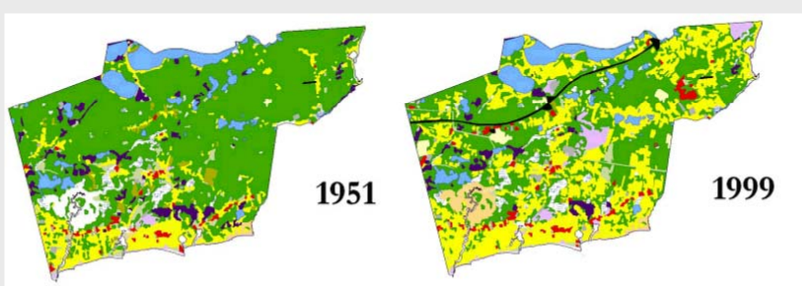
- Information exchange between residents and Wastewater Management Subcommittee
- Active involvement to help formulate the "right" plan for Harwich

Presentation Overview

- Principal members – CDM Project Team
- Discuss what is a Comprehensive Wastewater Management Plan (CWMP)
- Describe the planning process
- Review the project schedule
- Discuss the opportunities for public input
- Questions and comments

Challenges for Harwich

- Growth controls / planned growth
- Protection of water supplies
- Surface water and groundwater quality
- Massachusetts Estuaries Project (MEP)



Why we are doing a CWMP?

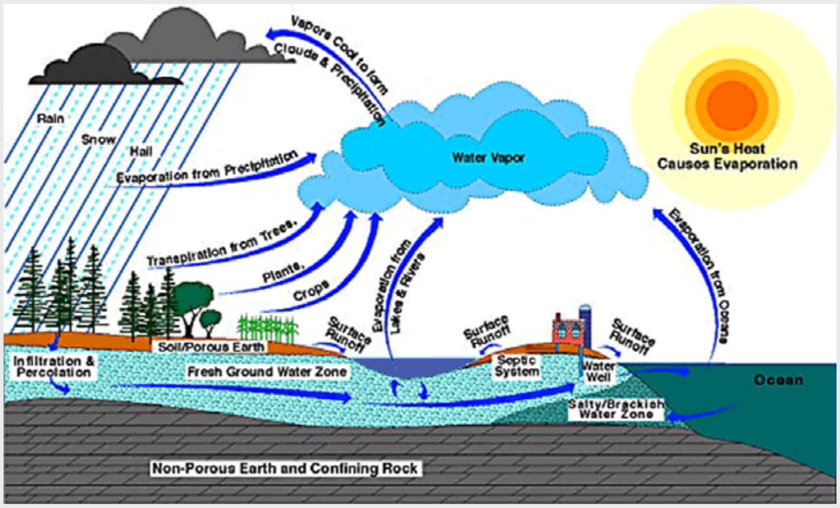
- **Develop a dynamic and formal program for wastewater (and nitrogen) management to meet future needs of community**
- **Preserve water resources**
- **Address the MEP nitrogen reduction goals**
- **Meet DEP requirements to address nitrogen issues**
- **Provide for "Smart" or planned growth (Village Centers initiative)**

Comprehensive Wastewater Management Plan

A CWMP Includes:

- **A comprehensive wastewater needs evaluation**
- **Development of Wastewater management alternatives to meet those needs**
- **A careful consideration and evaluation of alternative plans**
- **A planning process "standardized" by DEP**
- **Continuous public participation**

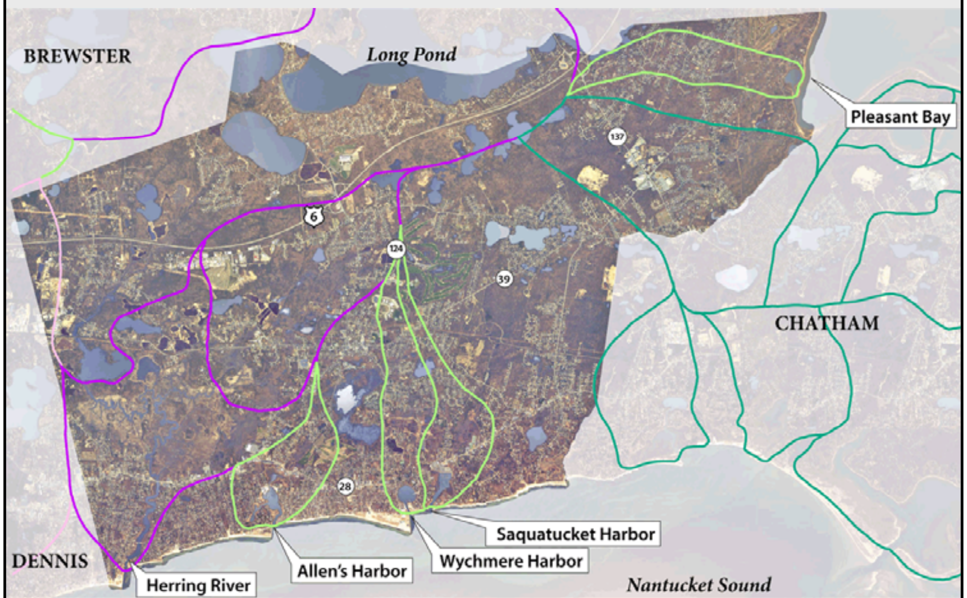
Conceptual Water Cycle



MEP Status

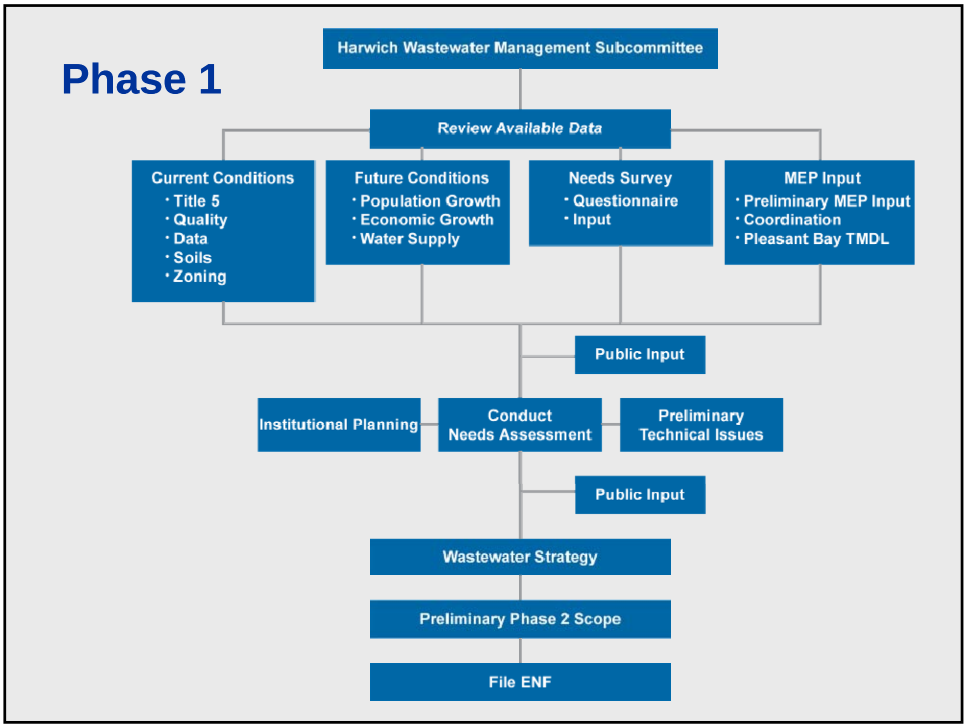
- Project on schedule
- Final results due in 2008
- Harwich embayments
  - Pleasant Bay
  - Allen's Harbor
  - Saquatucket Harbor
  - Wychmere Harbor
  - Herring River

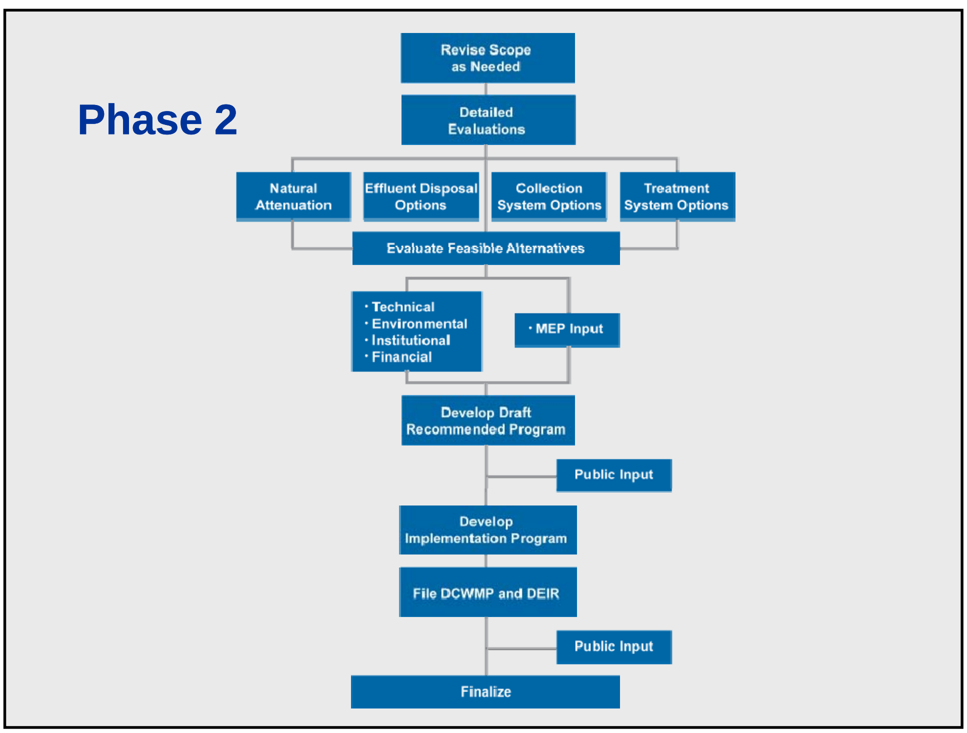
Harwich MEP Embayments



The CWMP Planning Process

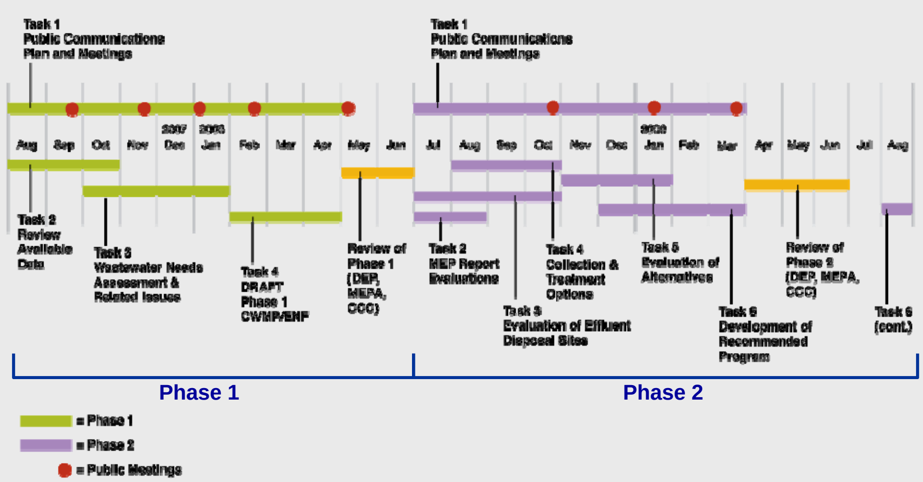
- Wastewater Management Subcommittee
- Project scope
  - Phase 1
  - Phase 2
- Public involvement
- Regulatory / environmental review


Phase 1
Harwich Wastewater Management Subcommittee
Review Available Data
Current Conditions
· Title 5
· Quality
· Data
· Soils
· Zoning
Future Conditions
· Population Growth
· Economic Growth
· Water Supply
Needs Survey
· Questionnaire
· Input
MEP Input
· Preliminary MEP Input
· Coordination
· Pleasant Bay TMDL
Public Input
Institutional Planning
Conduct Needs Assessment
Preliminary Technical Issues
Public Input
Wastewater Strategy
Preliminary Phase 2 Scope
File ENF


Phase 2
Revise Scope as Needed
Detailed Evaluations
Natural Attenuation
Effluent Disposal Options
Collection System Options
Treatment System Options
Evaluate Feasible Alternatives
· Technical
· Environmental
· Institutional
· Financial
· MEP Input
Develop Draft Recommended Program
Public Input
Develop Implementation Program
File DCWMP and DEIR
Public Input
Finalize

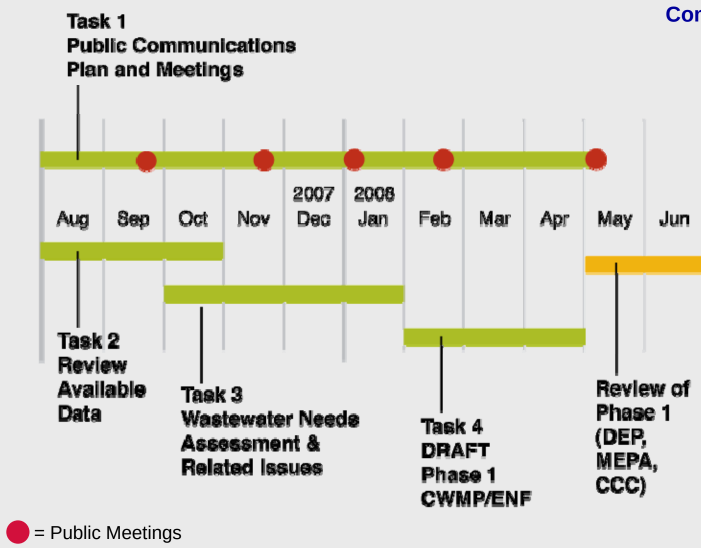
Iterative Process

Schedule



Phase 1

Phase 1
Community Meetings
Sept. 27, 2007
Nov. 15, 2007
Jan. 10, 2008
Feb. 21, 2008
May 1, 2008



Opportunities for Public Participation

- **CAC involvement**
- **Community meeting participation**
- **Website—hwqtf.com**
- **Cable TV**

Town Web Site

HWQTF Web Site

Next Community Meeting

Save the date: **November 15, 2007**

Topic: **Summary of Existing Conditions**

Contacts:

- **WMS Chairperson – Frank Sampson**
  - **mailbox at Town Hall – hwqtf-wms**
  - **Email: sampscape@capecod.net**

Community Meeting 1

Massachusetts Estuaries Project
Estuarine Restoration and Management

Estuaries of the Town of Harwich: Present Health and Steps Toward Restoration

Brian L. Howes, Technical Director
DEP/SMAST Massachusetts Estuary Project
Director, Coastal Systems Program
School for Marine Science & Technology – UMassD

Town of Harwich & CDM
January 10,2008

FOCUS: Major Problems Facing Embayments Throughout SE Mass

- ***The 2 primary issues:***

→**increased nutrient loading to the estuary, resulting in wholesale decline in estuarine health from shifting land-use.**

--> bacterial contamination resulting in shellfish bed closures.

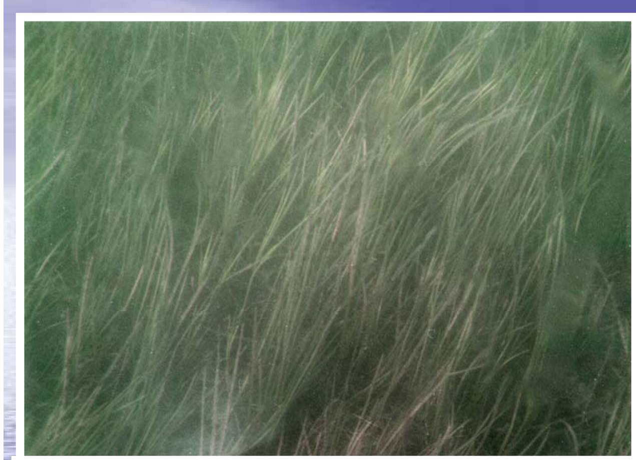
Embayment Nutrient Related Health:

Degradation of Estuaries and Bays by nutrient enrichment is primarily through Nitrogen from surrounding watersheds.

Over-Fertilization results in declining health:

- ↑ *Phytoplankton Blooms and turbid waters*
- ↑ *Loss of eelgrass beds*
- ↑ *Decline in benthic animal populations, fish & shellfish*
- ↑ *Low Oxygen in bay waters, fish kills, possibly odors*
- ↑ *Macro-algal accumulations*
- ↑ *At highest levels → loss of aesthetics*

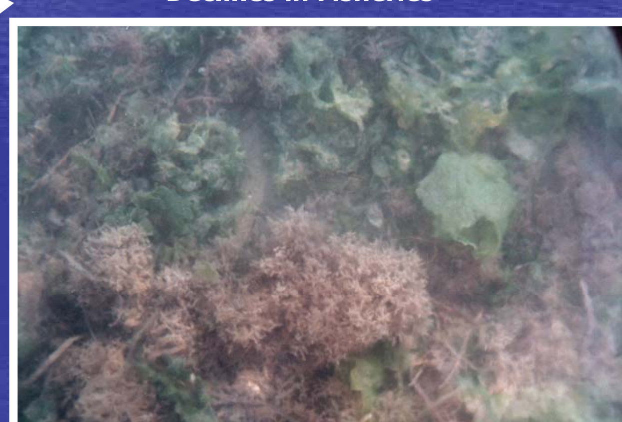
Nitrogen Enrichment -->Habitat Decline
Example: Eelgrass Loss



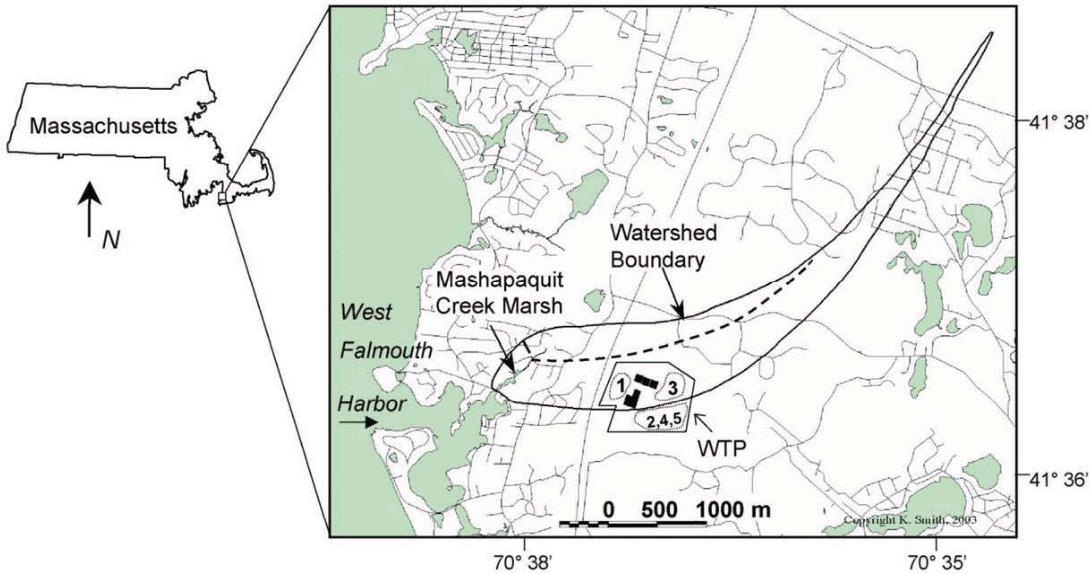
Low Nitrogen Loading, **Healthy Eelgrass and Diverse Animal Communities**

High Nitrogen Loading, **Macroalgae Replacing Eelgrass, Declining Animal Communities**

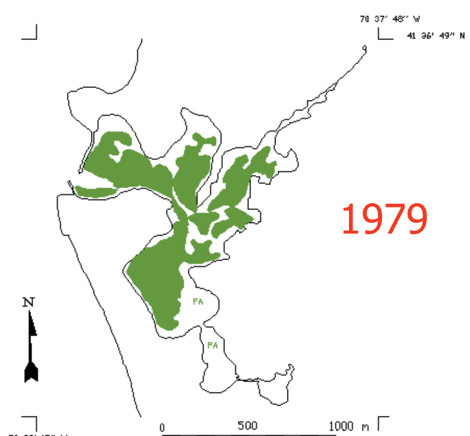
Very High Nitrogen Loading
Macroalgae Replaces Eelgrass and Smothers Animal Communities, Declines in Fisheries



West Falmouth Harbor Wastewater Treatment Facility Effluent Groundwater Discharge Plume

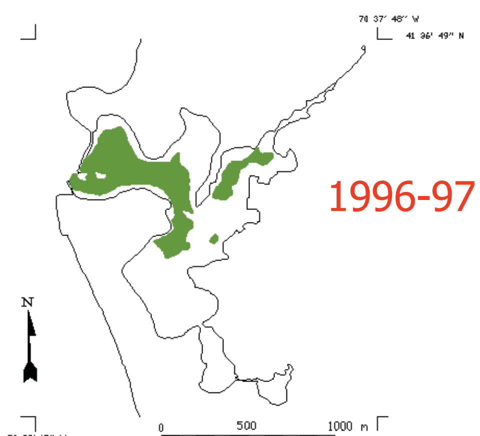


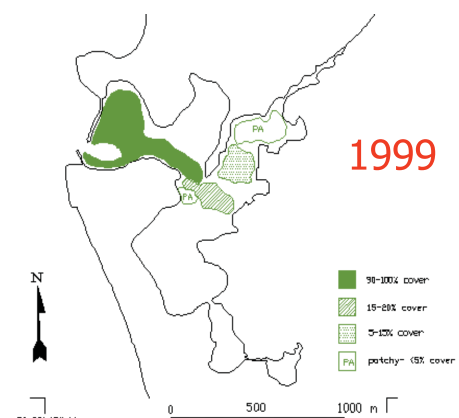
Over a ~1 yr period (1993-94) the watershed nitrogen load to the Harbor <u>more than doubled.</u>



Falmouth WWTF Nitrate Plume reached West Falmouth Harbor in 1993-94, doubling the Total Input of Watershed Nitrogen.

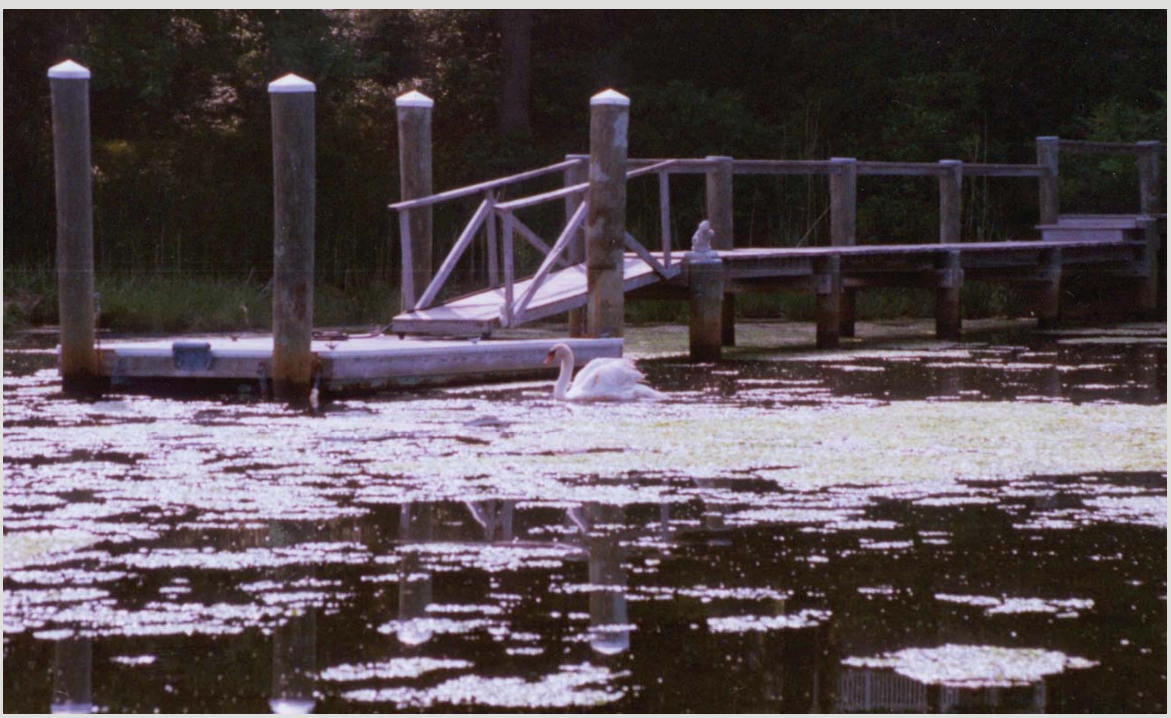
>50% eelgrass loss in 5 yrs





Embayment Response to Nitrogen Over-Enrichment: Three Bays, Cape Cod

Embayment Response to Nitrogen Over-Enrichment



What is needed to restore and protect our estuaries?

- → Nitrogen management is the only way to restore degraded estuarine habitat and to prevent future habitat degradation.
- → Nitrogen management must focus primarily on control of watershed nitrogen inputs and maximizing tidal flushing.

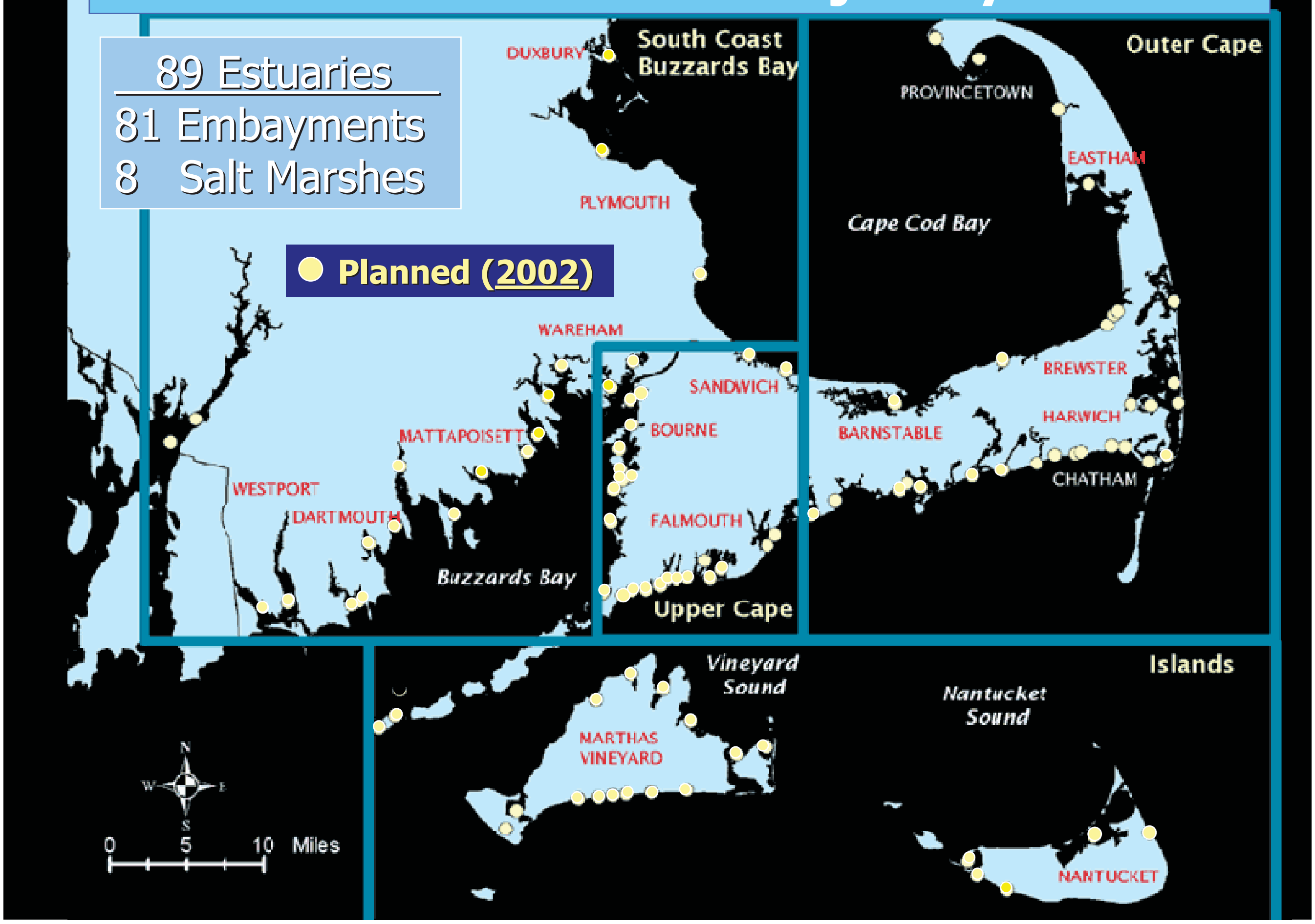
SMAST/DEP Massachusetts Estuaries Project

- A partnership between
  - –DEP/EOEA (regulatory, TMDL's)
  - –SMAST/UMassD (science, assessment & modeling)
  - – with S.E. Mass. Municipalities, Barnstable County, Cape Cod Commission, MVCommission, SRPEDD, USGS, EPA, DMF
- Purpose:
  - – to develop nitrogen thresholds and target loads for the embayments of southeastern Massachusetts
  - – to bring new approaches & tools to watershed nitrogen management for estuarine restoration

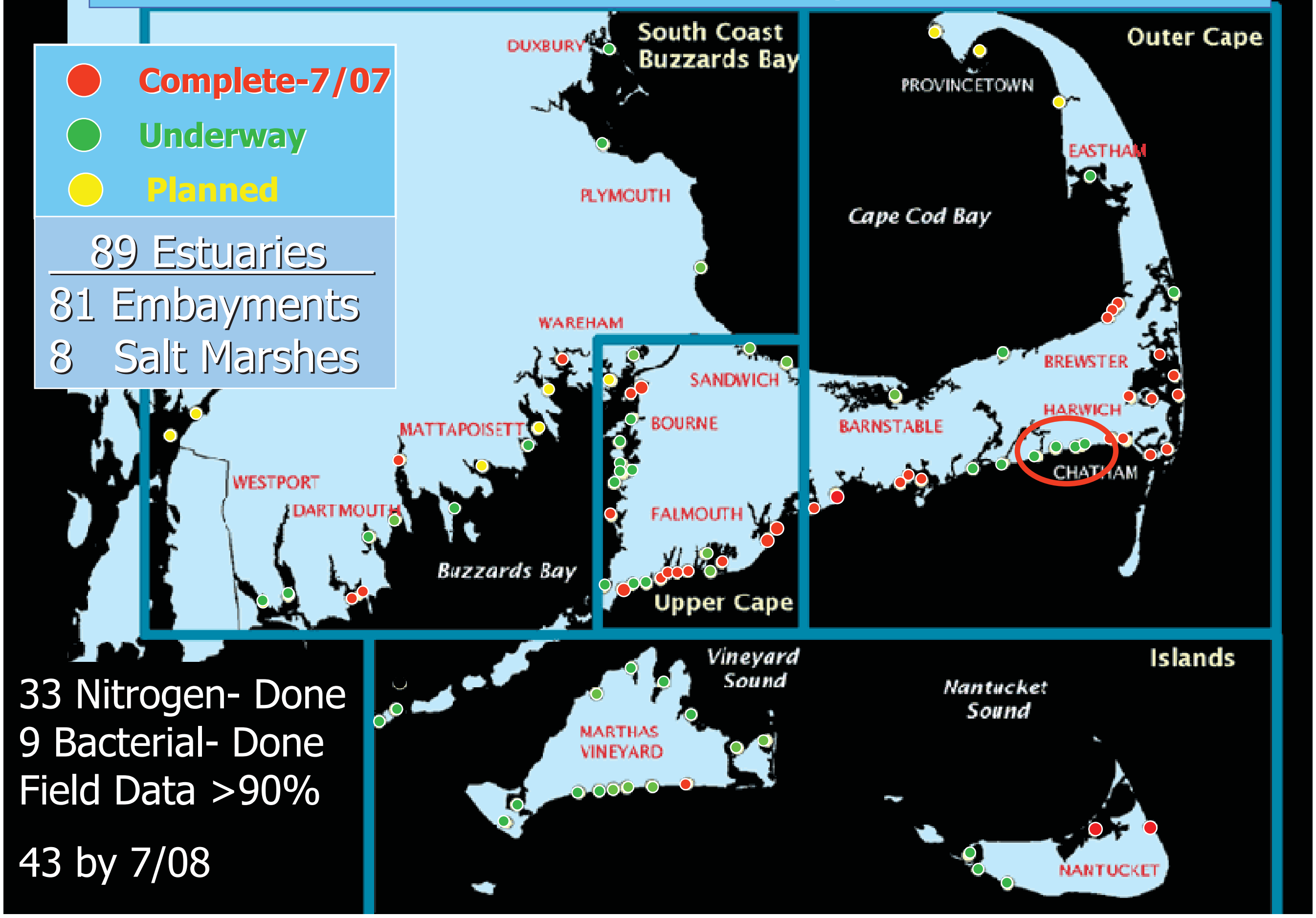
Regulatory Framework for MEP

- Federal Clean Water Act
- States classify all aquatic resources as to their highest and best use.
- Waters failing to meet their classification require restoration plans (TMDLs).
- Estuaries Project provides the scientific basis for all of the estuaries in s.e. MA.

Massachusetts Estuaries Project Systems



Massachusetts Estuaries Project Estuaries



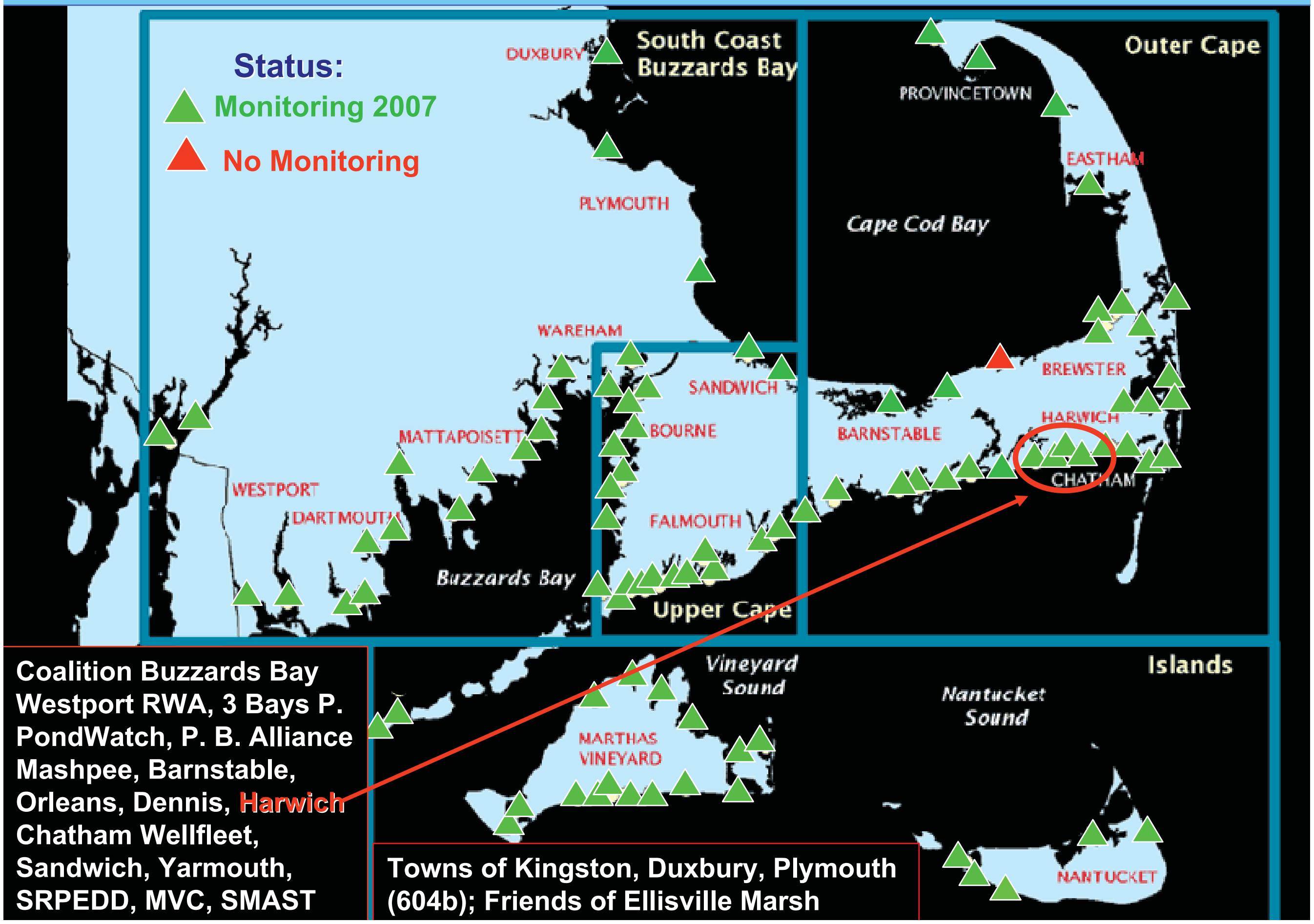
33 Nitrogen- Done
9 Bacterial- Done
Field Data >90%

43 by 7/08

Watershed Nitrogen Management for Embayment Protection/Restoration

- ✓ **Phase I:** Monitoring of Embayment Nutrient Related Health
- ✓ **Phase II:** Quantitative Watershed-Embayment Assessment & Modeling
- ➢ **Phase III:** Implementation-Design, use of Validated Watershed-Embayment Model to Prioritize Management Options, cost/benefit
- **Phase IV:** Engineering Design & Implementation of Selected N Management Alternatives
- **Phase V:** Embayment Monitoring to support Adaptive Management

Water Quality Monitoring Programs – SMAST Tech Support



Coalition Buzzards Bay
Westport RWA, 3 Bays P.
PondWatch, P. B. Alliance
Mashpee, Barnstable,
Orleans, Dennis, Harwich
Chatham Wellfleet,
Sandwich, Yarmouth,
SRPEDD, MVC, SMAST

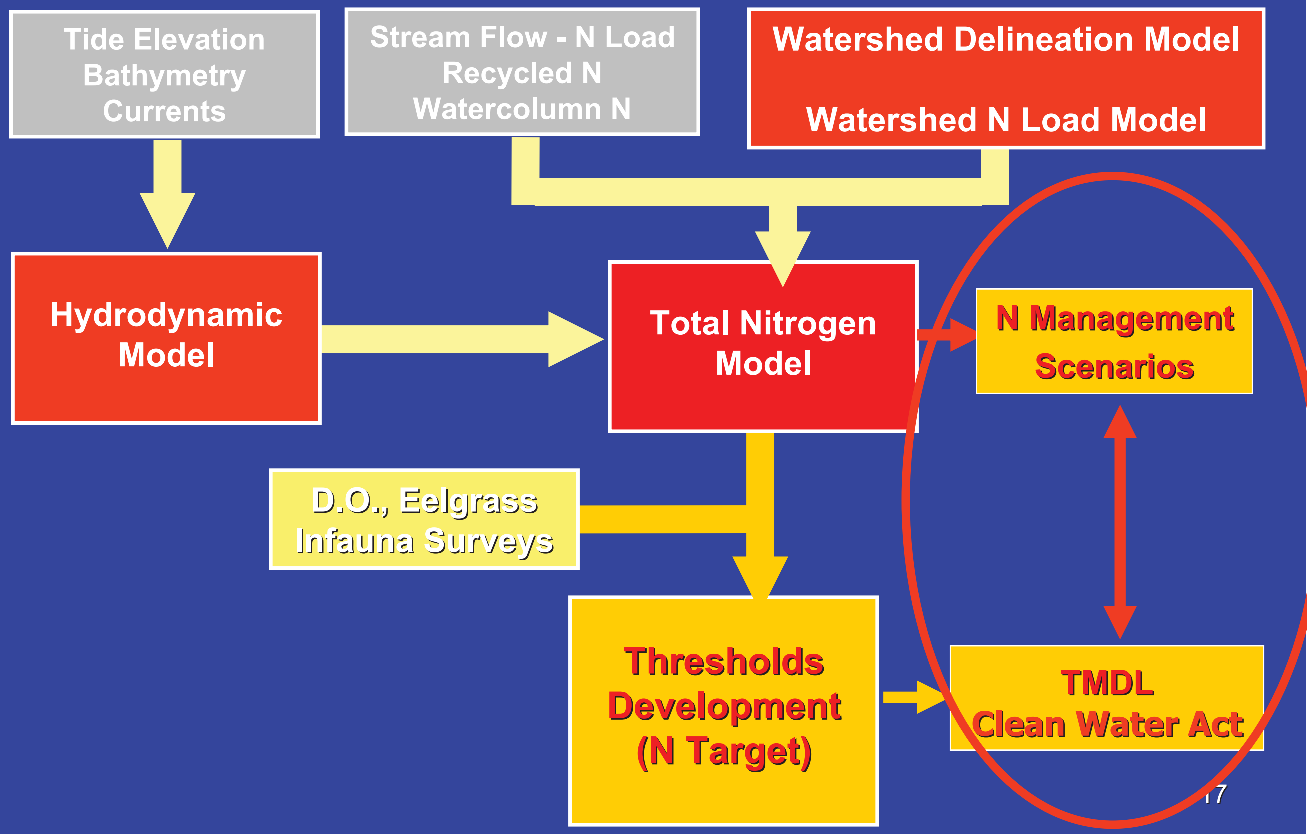
Towns of Kingston, Duxbury, Plymouth
(604b); Friends of Ellisville Marsh

Estuaries Project Approach:

Site-specific Integrated N Model based upon the watershed and embayment conditions <u>REQUIRING</u>:

- Data collection
- Assessment
- Model Construction, Calibration & Validation
- N Management Alternatives Analysis

MA Estuaries Project: Linked Watershed-Embayment Approach



Why is the Commonwealth using the Estuaries Project Approach for Estuaries?

Uncertainty costs $$

- Provides the most accurate linkage of watershed N loads to estuarine health.
- Determines the site-specific N Threshold level for sustaining a healthy estuarine system
- Creates a tool for quantitative Management Alternatives Analysis

Massachusetts Estuaries Project Restoration Analysis

Status of MEP Analysis:

Allens Harbor

Saquatucket Harbor

Wychmere Harbor

Herring River

Town of Harwich – Massachusetts Estuaries Project Partnership for the Nitrogen Management of the Herring River, Wychmere Harbor, Allens Harbor & Saquatucket Harbor

Hydrodynamic Modeling

Bathymetric Survey: All 4 Estuaries – Complete
Tides, salinity & flow validation: All 4 Estuaries – Complete
Hydro Model & Validation: All 4 Estuaries – Complete

Watershed Nitrogen Loading

Delineation and incorporation into GIS: **All 4 Estuaries – Complete**
Stream flow & N load: All streams - **Complete**
Validation of watershed using streams - Complete 1/08
Land-Use Analysis: In Progress for Completion <6/08
Watershed Nitrogen Model: In Progress for Completion <6/08

Quantitative Linked Watershed-Embayment Nitrogen Model

Nitrogen regeneration within embayments - Complete
System predictive model & validation : In Progress for Completion <6/08

Town of Harwich – Massachusetts Estuaries Project Partnership for the Nitrogen Management of the Herring River, Wychmere Harbor, Allens Harbor & Saquatucket Harbor

Habitat Assessment

Dissolved oxygen (high frequency measures in targeted areas): **Complete**
Eelgrass & macroalgae Surveys+ historical analysis - **Complete**
Benthic Animal Communities (indicators of stress): **Complete**

Nitrogen Threshold Analysis – Restoration Targets

- determination of embayment nitrogen loading tolerances (spatially)
- projection of embayment health at build-out & best case potential loadings
-evaluation of soft and hard nitrogen management options (initial screening)

Allens, Wychmere and Saquatucket Harbors → In Progress for Completion 6/08
Herring River → In Progress for Completion 9/08

Estuaries of the Town of Harwich

Present Nutrient Related Health of:

Allens Harbor

Saquatucket Harbor

Wychmere Harbor

Herring River

Allens Harbor
Nutrient Related Water Quality

Estuarine Quality Index

Red = Poor

Yellow = Moderate

Blue = High

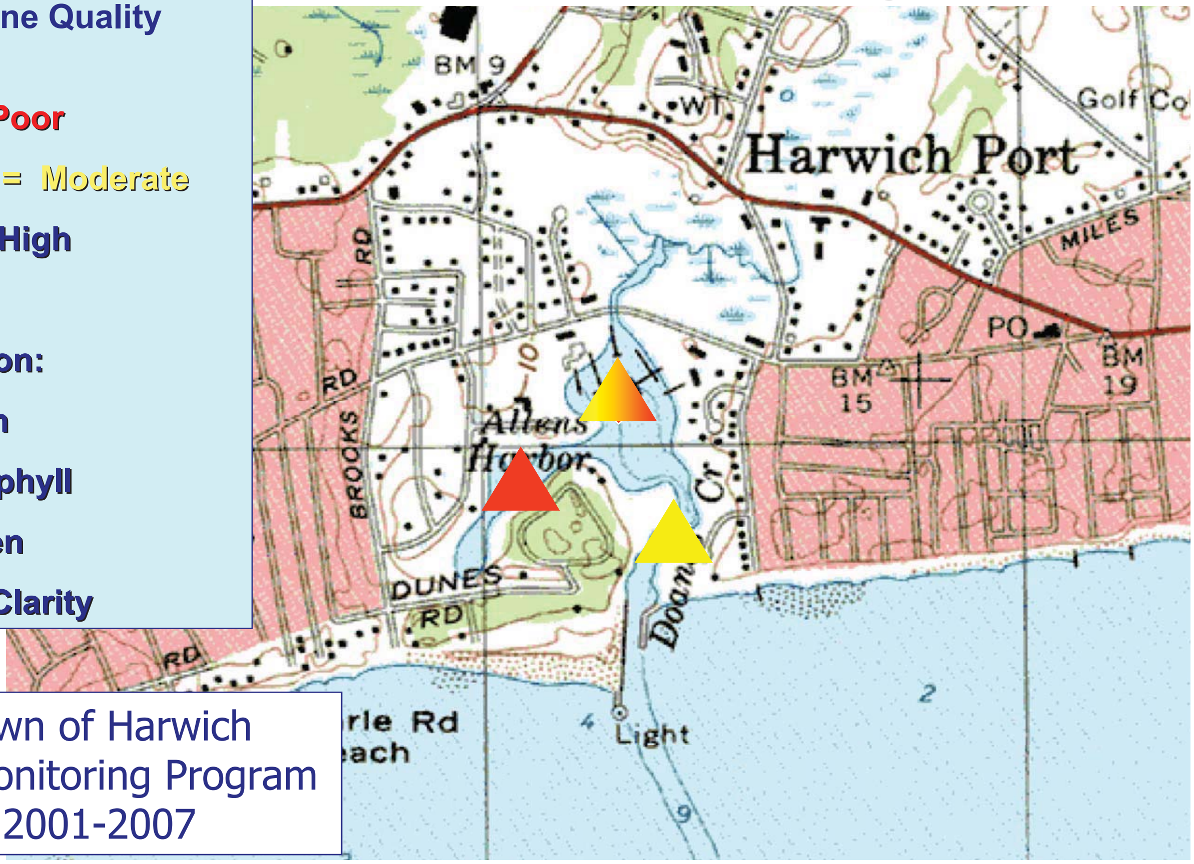
based on:

Oxygen

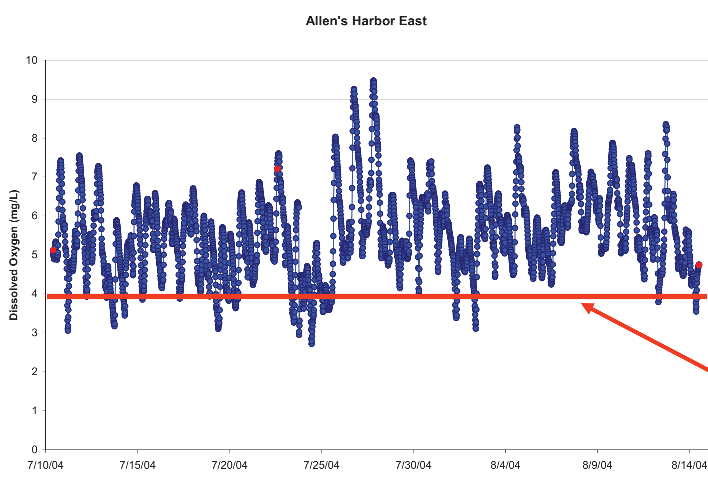
Chlorophyll

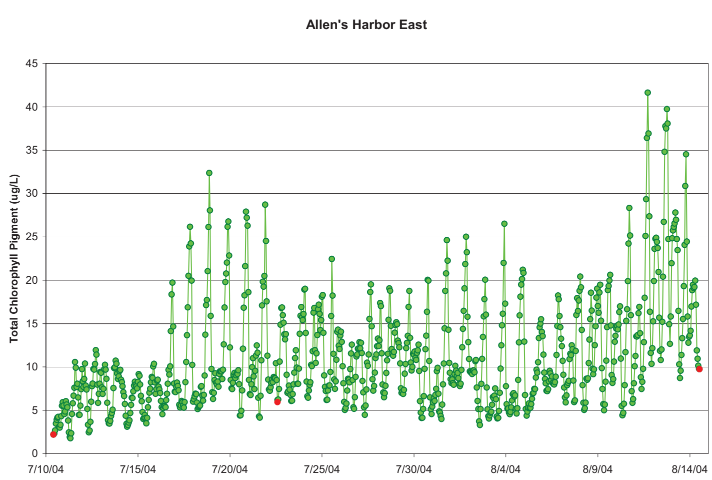
Nitrogen

Water Clarity



Town of Harwich
WQ Monitoring Program
2001-2007

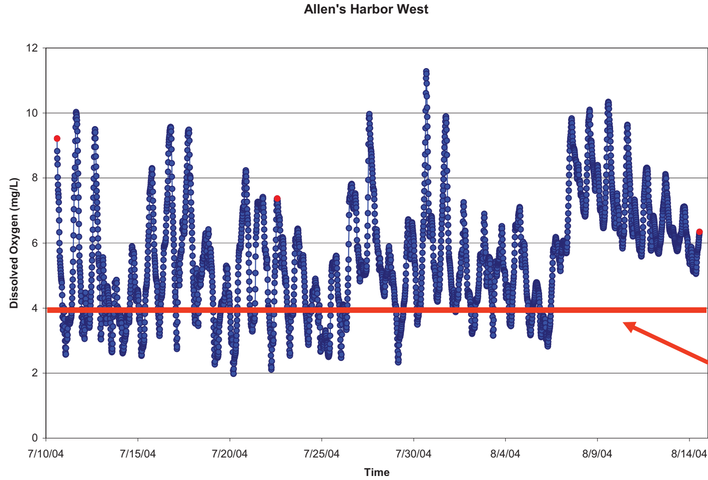


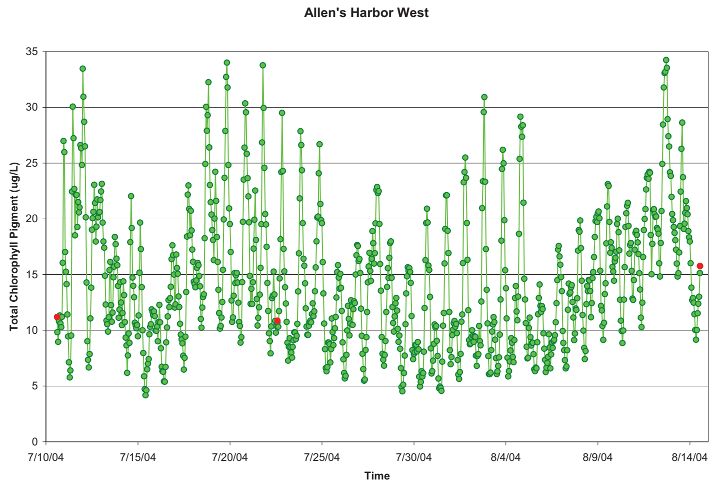


Allens Harbor East Summer 2004

- Dissolved Oxygen
- Chlorophyll-a

Critical DO Level indicative of Habitat Impairment



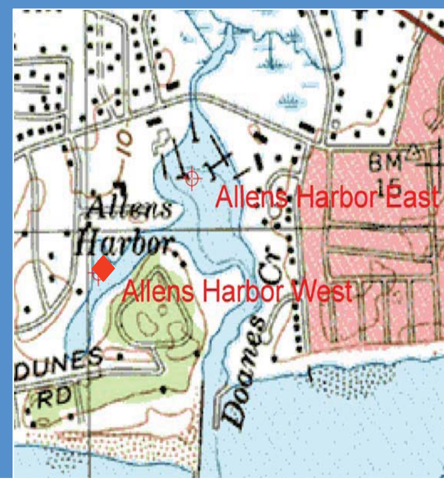


Allens Harbor West [Oyster Creek]

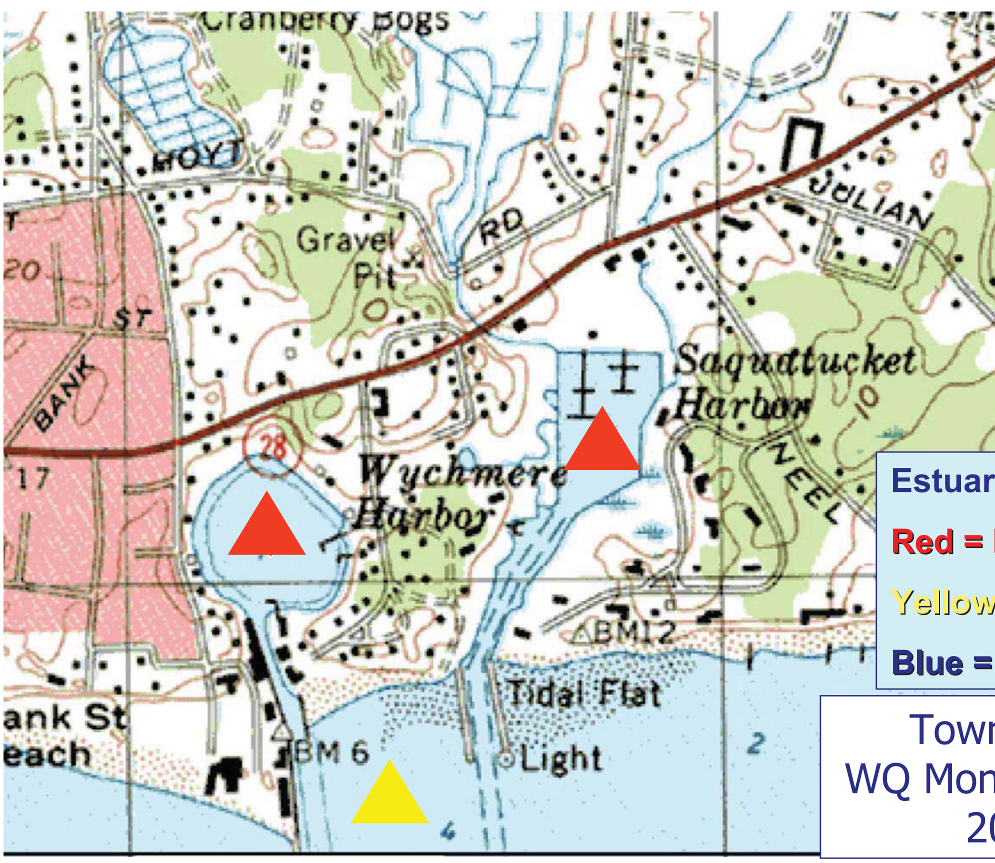
Summer 2004

- Dissolved Oxygen
- Chlorophyll-a

Critical DO Level indicative of Habitat Impairment



Wychmere and Saquatucket Harbors Nutrient Related Water Quality



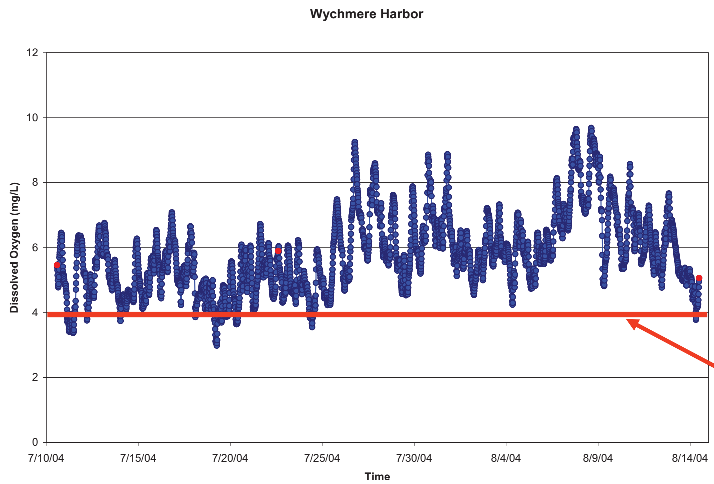
Estuarine Quality Index

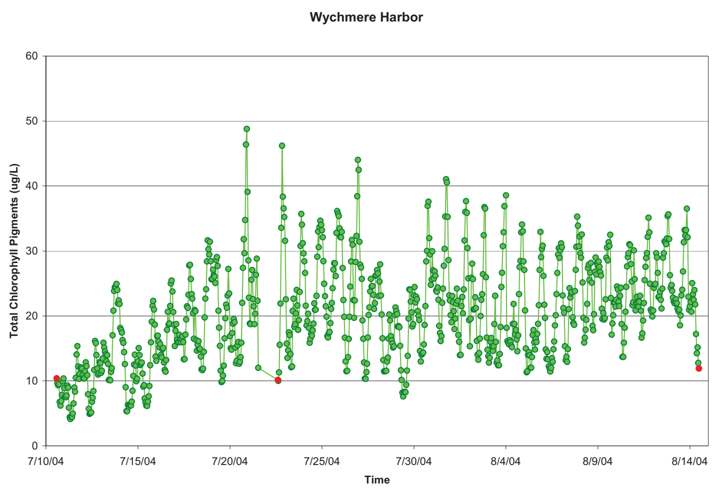
Red = Poor

Yellow = Moderate

Blue = High

Town of Harwich
WQ Monitoring Program
2001-2007

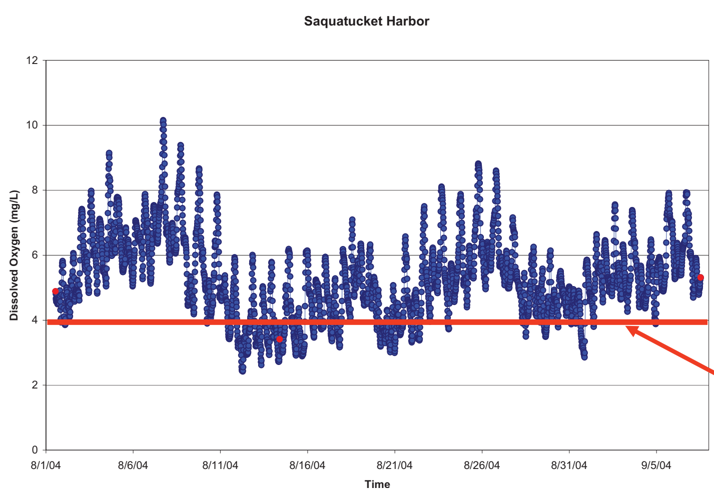


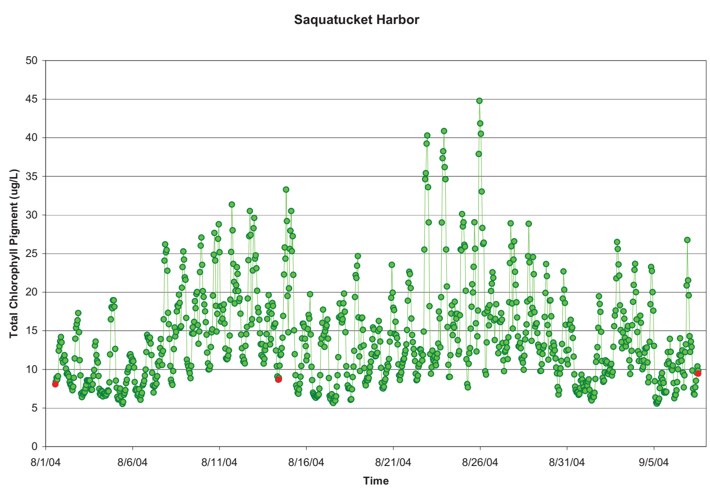


Wychmere Harbor Summer 2004

- Dissolved Oxygen
- Chlorophyll-a

Critical DO Level indicative of Habitat Impairment



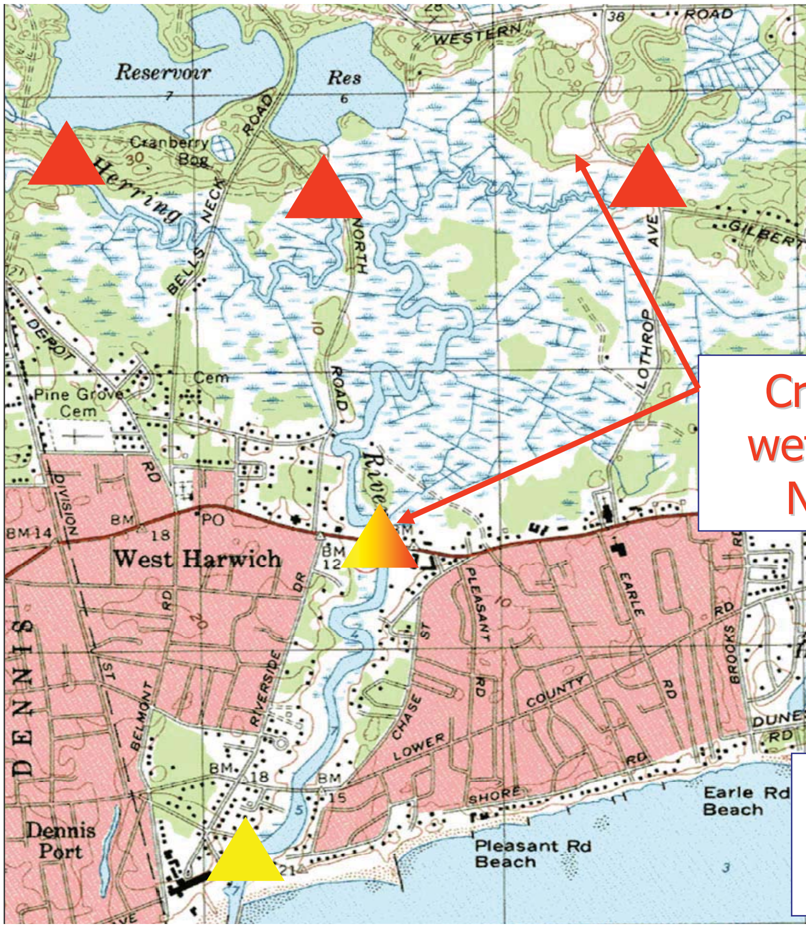


Saquatucket Harbor Summer 2004

- Dissolved Oxygen
- Chlorophyll-a

Critical DO Level indicative of Habitat Impairment

Herring River Nutrient Related Water Quality



Estuarine Quality Index

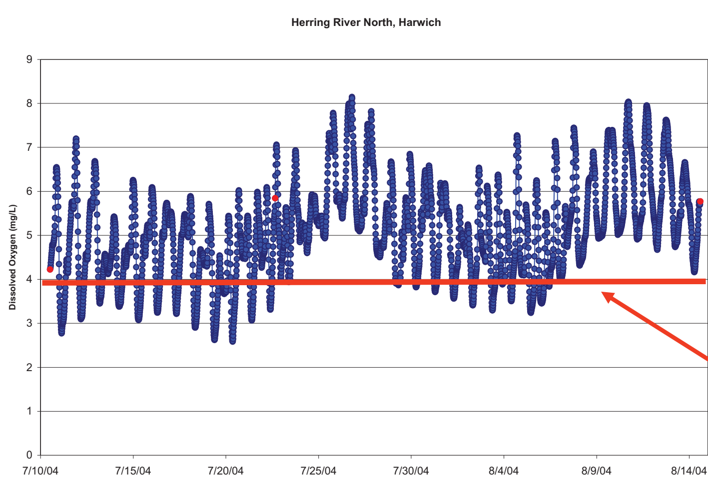
Red = Poor

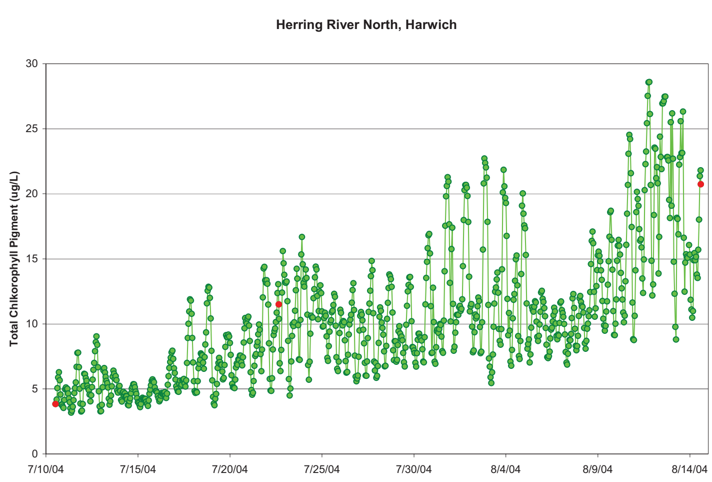
Yellow = Moderate

Blue = High

Critical to account for wetland vs embayment Nitrogen Sensitivity

Town of Harwich
WQ Monitoring Program
2001-2007

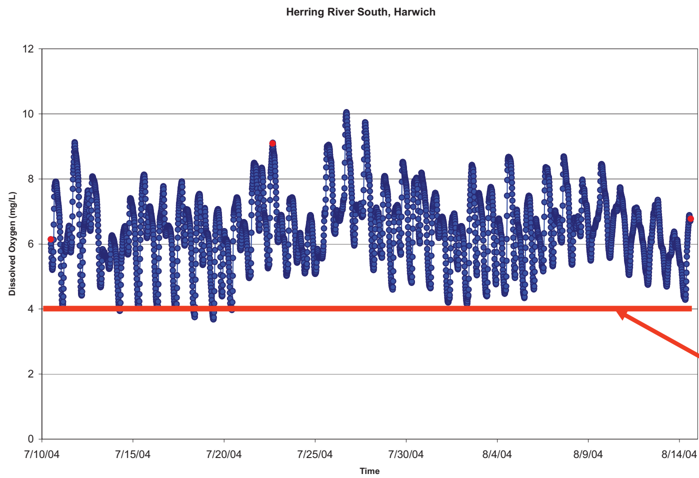


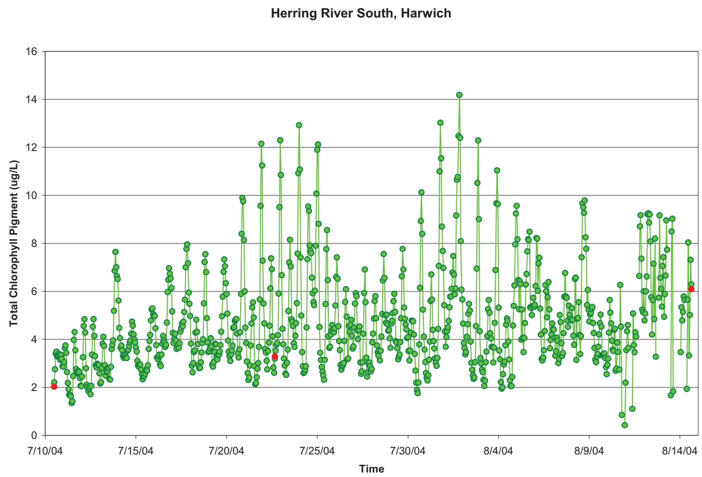


Herring River North
[Upper River]
Summer 2004

- **Dissolved Oxygen**
- **Chlorophyll-a**

Critical DO Level indicative of Habitat Impairment



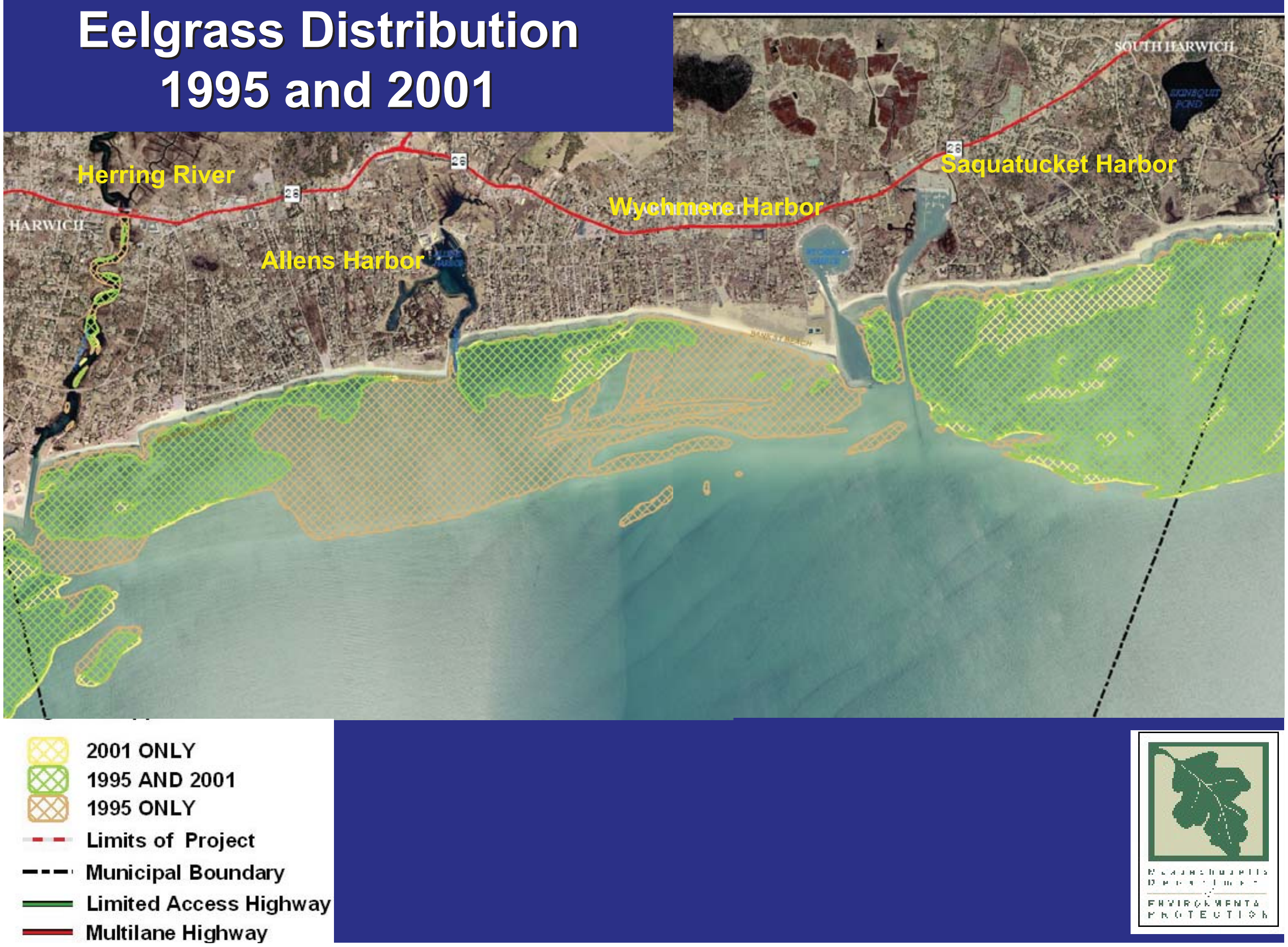


Herring River South [Lower River] Summer 2004

- Dissolved Oxygen
- Chlorophyll-a

Critical DO Level indicative of Habitat Impairment

Eelgrass Distribution 1995 and 2001



MEP Bathymetry Transects
(depth in meters)

Harwich Estuaries
Present Nutrient Related Health

Allens, Wychmere, Saquatucket Harbors:

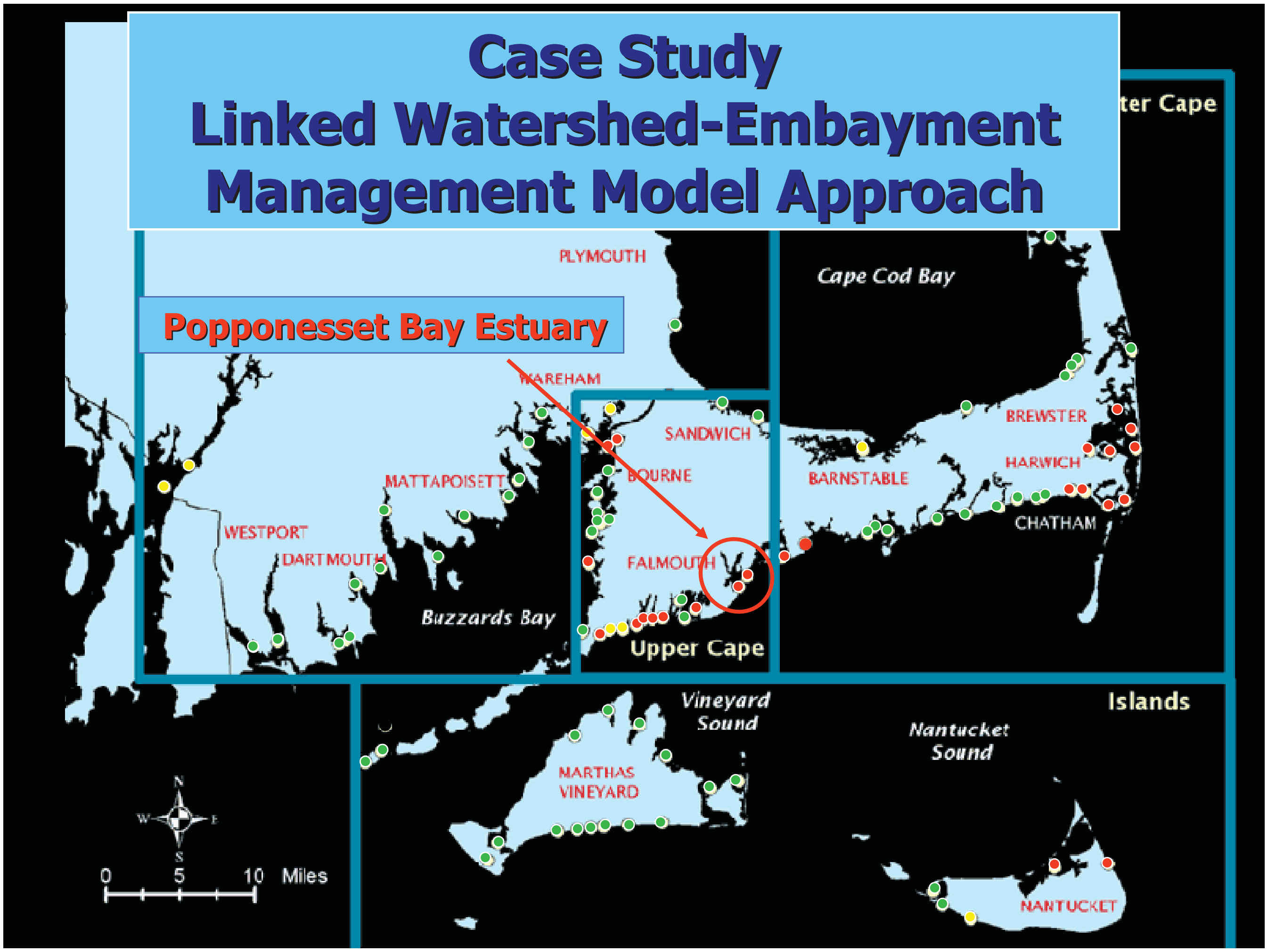
Nitrogen enriched –>

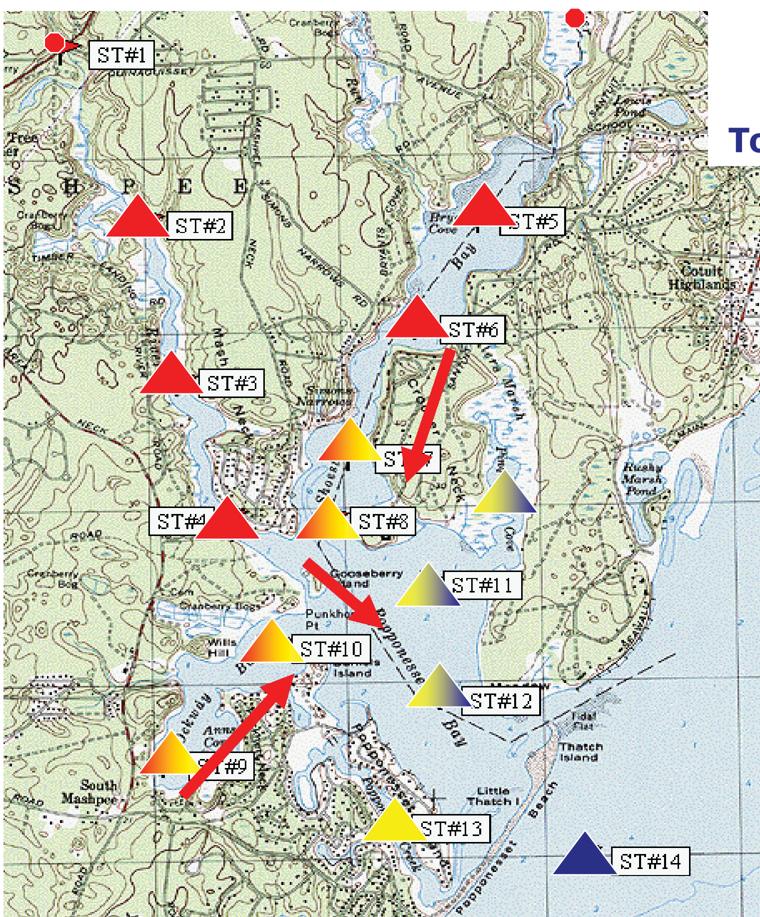
Significantly Impaired Habitat

Herring River:

Upper Wetland Reach: Healthy

Lower Reach: Generally Healthy





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Nutrient Related Water Quality Monitoring

Towns of Mashpee & Barnstable

Popponesset Bay 1999-2005

Estuarine Quality Index

Red = Poor

Yellow = Moderate

Blue = High

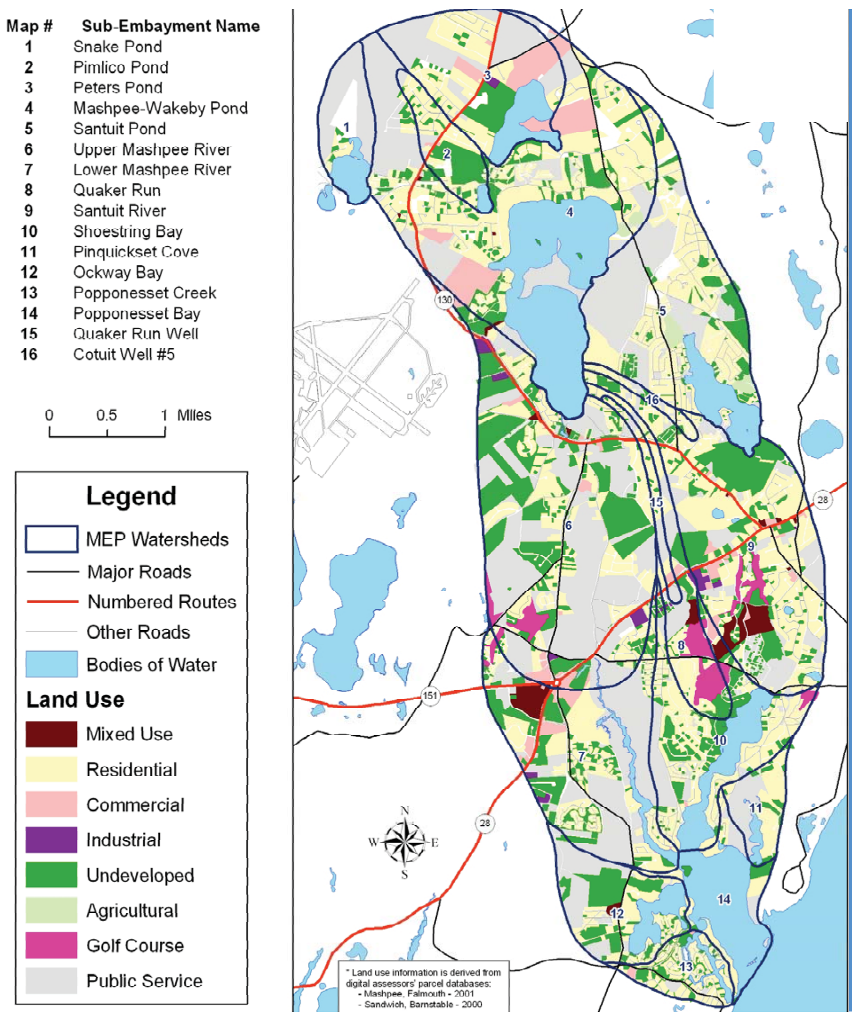
Watershed N Loading to Estuary

- **Watershed N Load to Bay =**
  N Sources - N Sinks + N Storage

-- **Sources:** wastewater, fertilizers, agriculture, impermeable surfaces, etc.

-- **Sinks:** denitrification within wetlands, aquifer transport, surface water ecosystems, well withdrawals

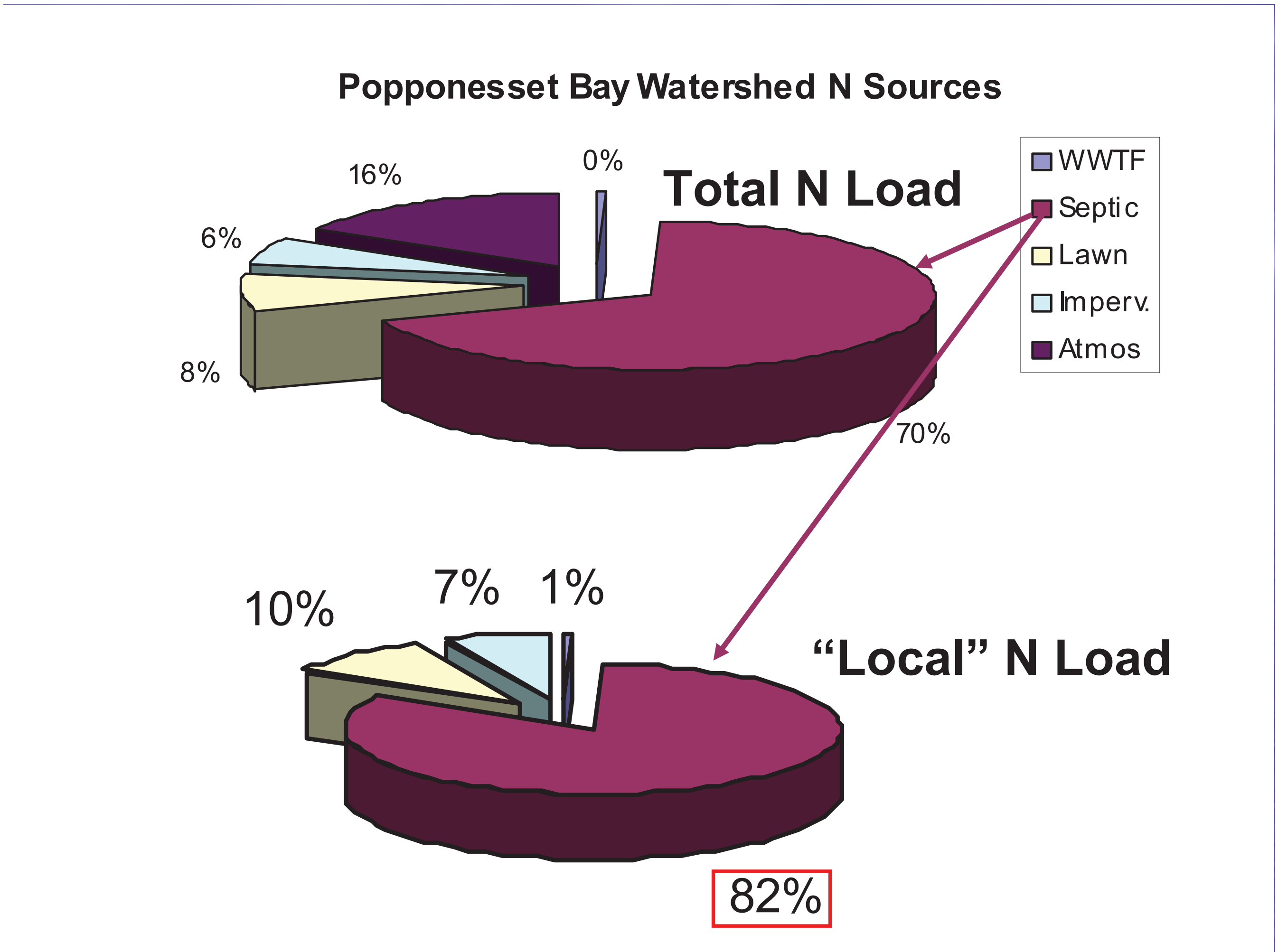
-- **Storage:** sorption, aquifer transport, biomass accumulation, etc.



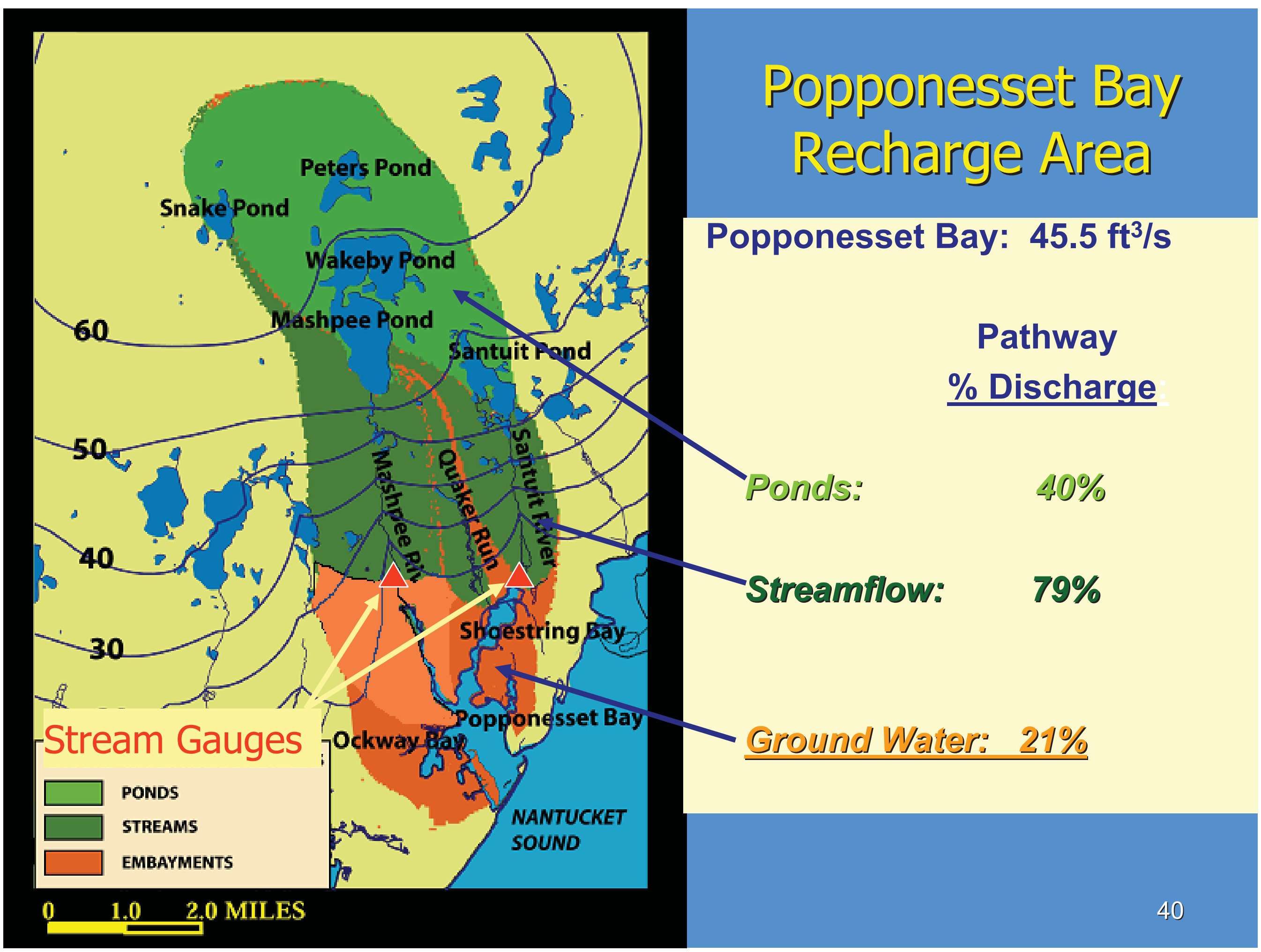
Popponesset Bay System

Parcel by parcel analysis of existing land-uses to develop present N loading

Water-use based Septic N Loading Analysis

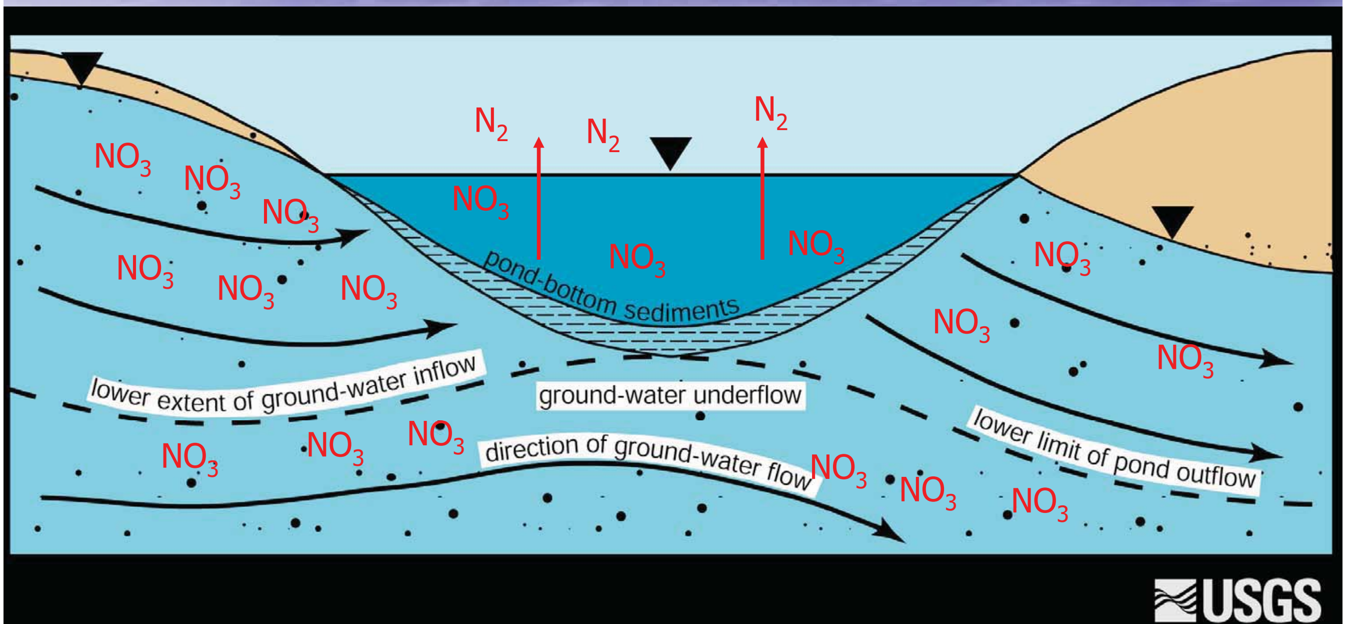


Popponesset Bay Watershed N Sources
Total N Load
WWTF
Septic
Lawn
Imperv.
Atmos
0%
16%
6%
8%
70%
"Local" N Load
10%
7%
1%
82%



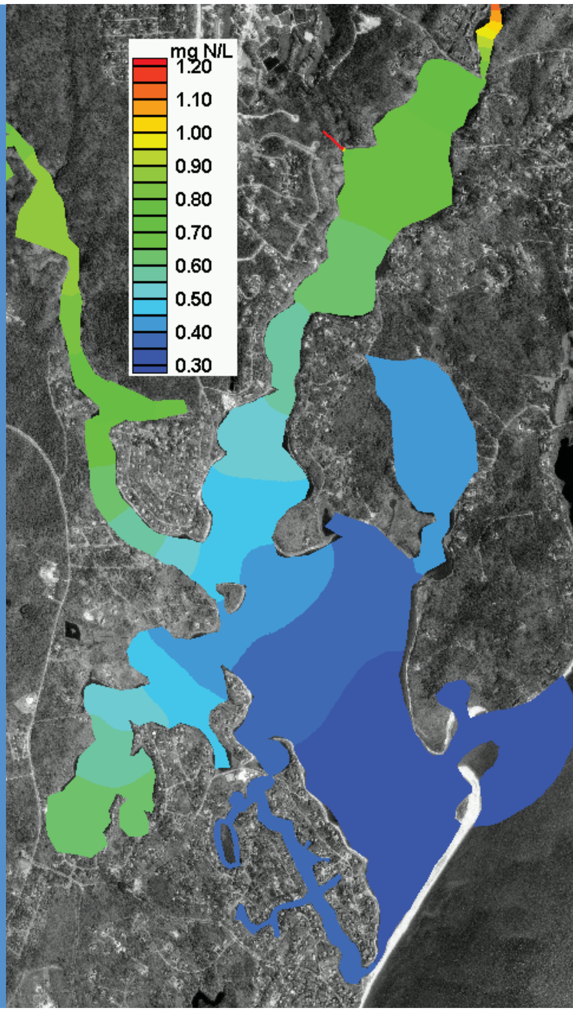
Popponesset Bay Recharge Area
Popponesset Bay: 45.5 ft³/s
Pathway
% Discharge
Ponds: 40%
Streamflow: 79%
Ground Water: 21%
Peters Pond
Snake Pond
Wakeby Pond
Mashpee Pond
Santuit Pond
Mashpee Rv
Quaker Run
Santuit River
Shoestring Bay
Popponesset Bay
Ockway Bay
NANTUCKET SOUND
60
50
40
30
Stream Gauges
PONDS
STREAMS
EMBAYMENTS
0 1.0 2.0 MILES

Nitrogen Attenuation:
Ground Water Flow-Through Pond



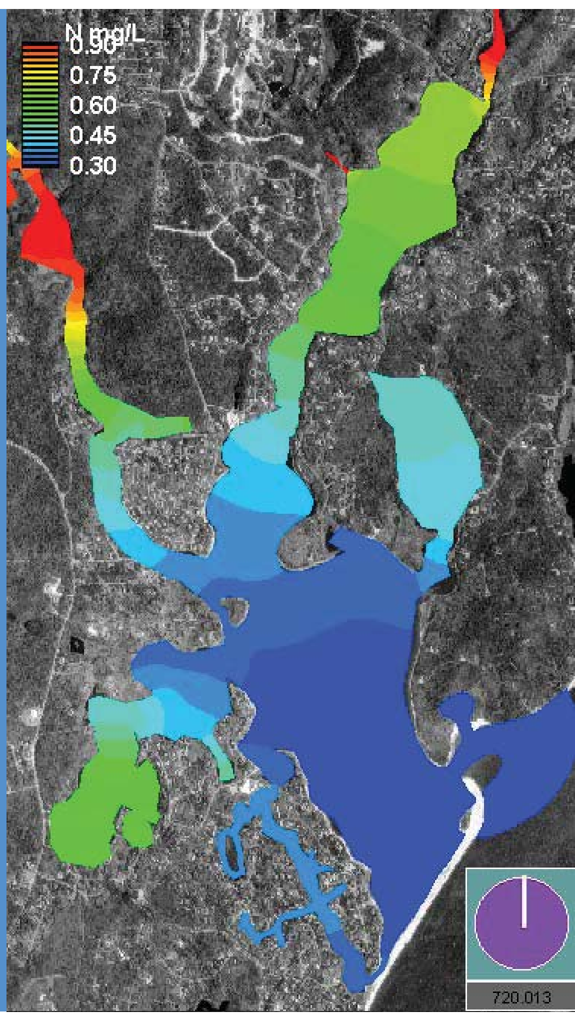
MEP Measured Natural N Attenuation
"Not all Nitrogen discharged to watershed gets to bay"

Cape Cod Estuaries	Nitrogen Loads (kg N yr -1)			
	Watershed Loading	Discharge to Estuary	Natural Attenuation	% Attenuation
Falmouth Salt Ponds				
Coonamesset River (Great Pond)	20601	8260	12341	60%
Backus Brook (Green Pond)	3719	1391	2328	63%
Bournes Brook (Bournes Pond)	3201	1201	2000	62%
Waquoit Bay System				
Quashnet River	12290	7541	4749	39%
Popponesset Bay System				
Mashpee River	19671	7989	11682	**59%**
Santuit River	11693	5687	6006	**51%**
Phinney's Harbor System				
Back River	**1018**	**498**	**520**	**51%**
Three Bays System				
Marstons Mills Pond/River	**14,539**	**5,299**	**9,238**	**64%**
Little River	**2,932**	**1,446**	**1,486**	**51%**



Popponesset Bay
Average total nitrogen concentrations
Present N Loading

Model is <u>Calibrated</u> with site-specific data and then Independently <u>Validated</u>

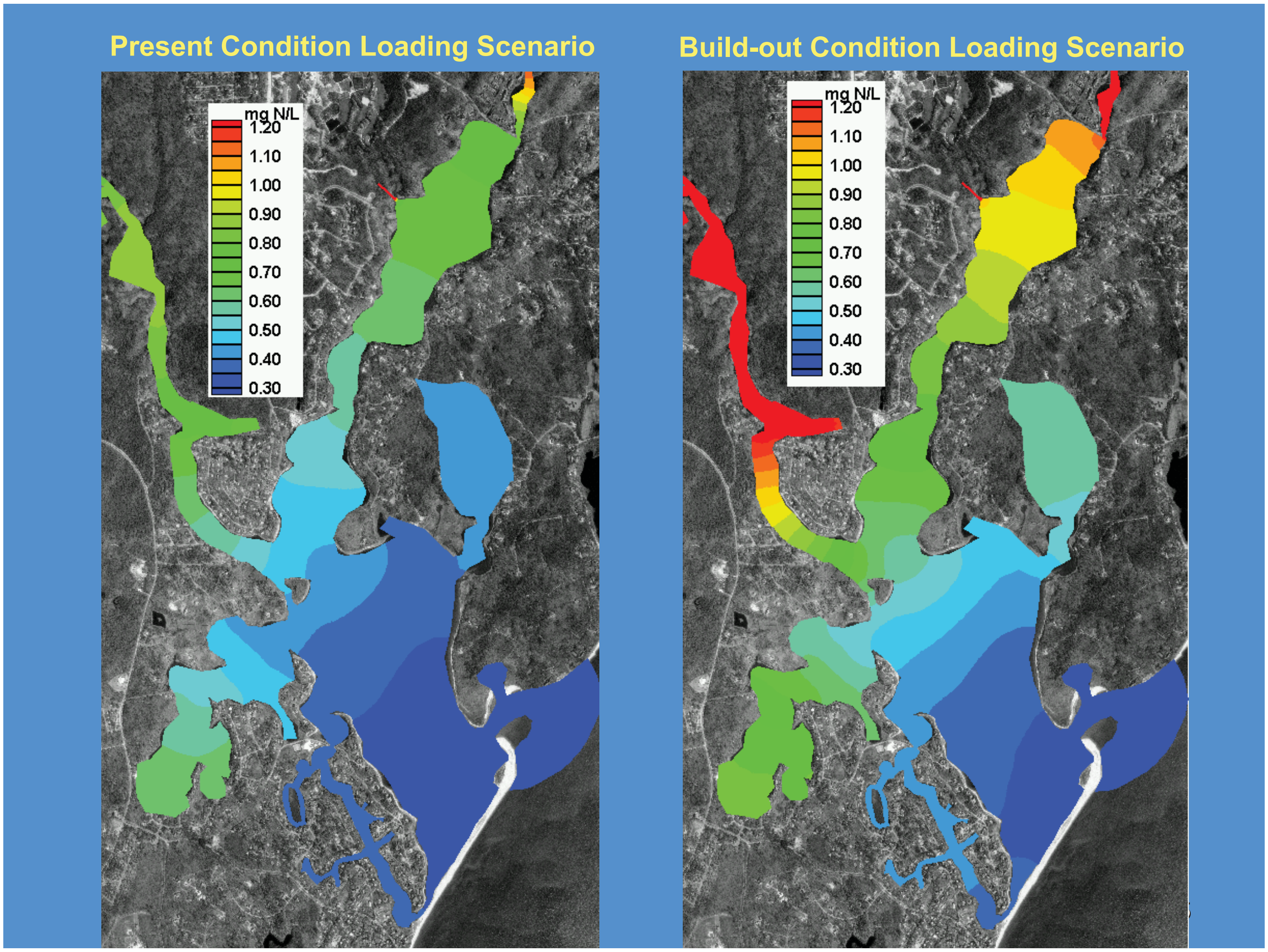


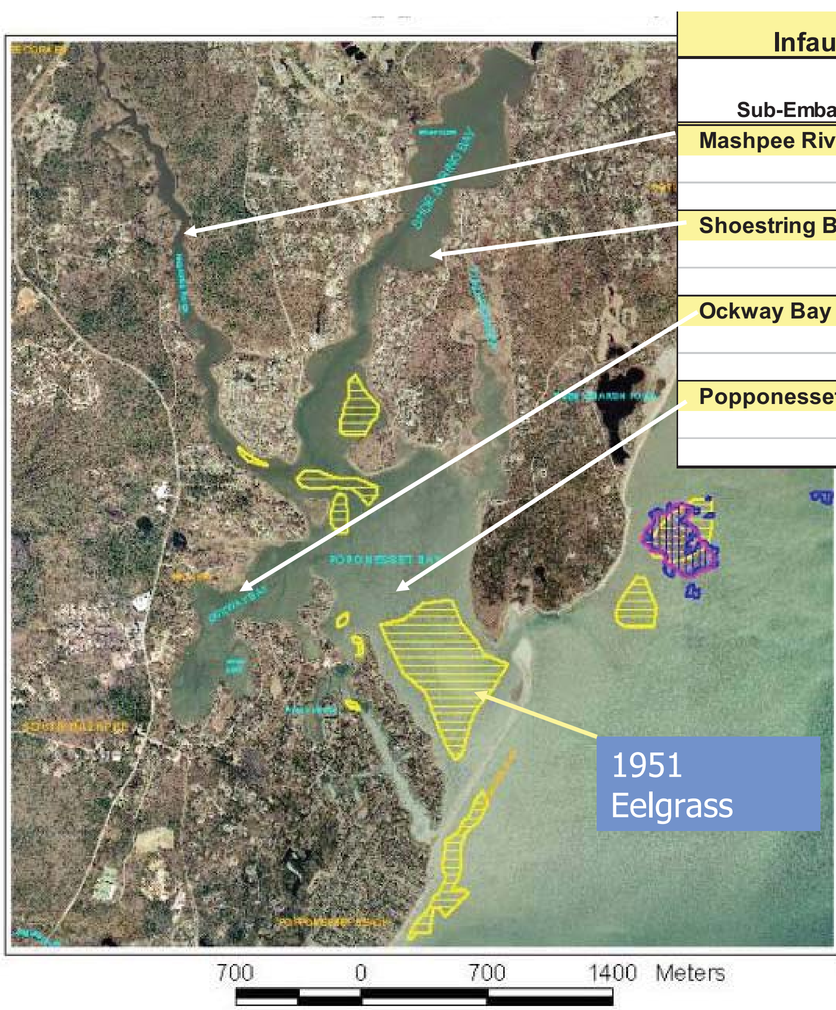
Popponesset Bay System

MEP
Watershed-Embayment
Nitrogen Model

Present Conditions

Variation in Nitrogen Gradients through a Tidal Cycle





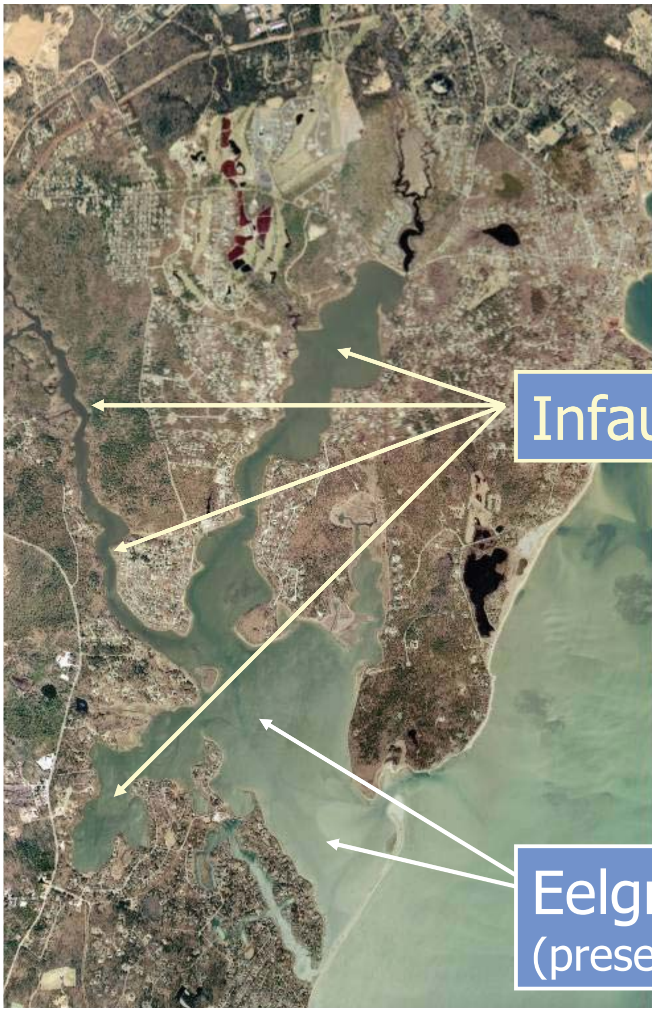
Infaunal Animal Communities

Sub-Embayment		Average # Species	Average # Individuals
Mashpee River			
	Mid	7	147
	Lower	12	223
Shoestring Bay			
	Inner	16	595
	Outer	15	534
Ockway Bay			
	Inner	2	16
	Mid	14	98
Popponesset Bay - Main Basin			
	Upper	9	548
	Lower	31	489

Historical Eelgrass Beds

Status: currently no beds in System

Restoration Goals
Popponesset Bay System



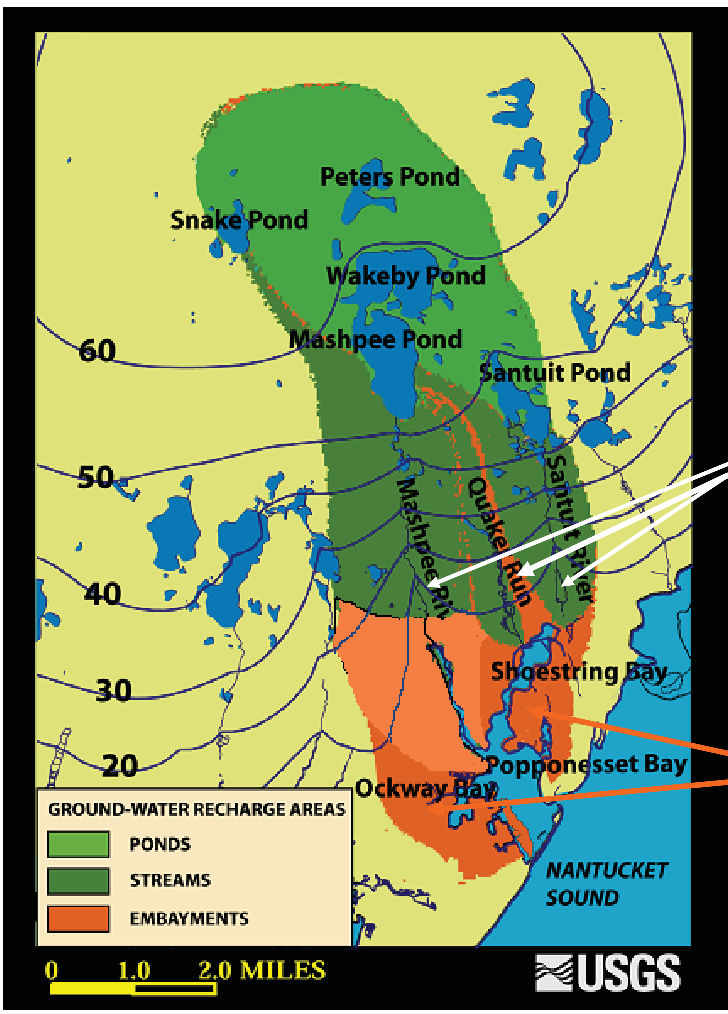
Nitrogen Management Options for Estuaries Generally via CWMP and TMDL Processes:

- Hydrodynamic options
  - Tidal flushing/circulation enhancement & management
- Natural attenuation options
  - Nitrogen source location to maximize natural attenuation
  - Wetland/riparian zone restoration to increase attenuation
  - Pond restoration to create zones of natural attenuation
- Nitrogen source reductions
  - Fertilizer education
- Wastewater options (what, where, how much)
  - Centralized and decentralized systems

MEP Restoration Approach

for Development of Nitrogen Management Alternatives:

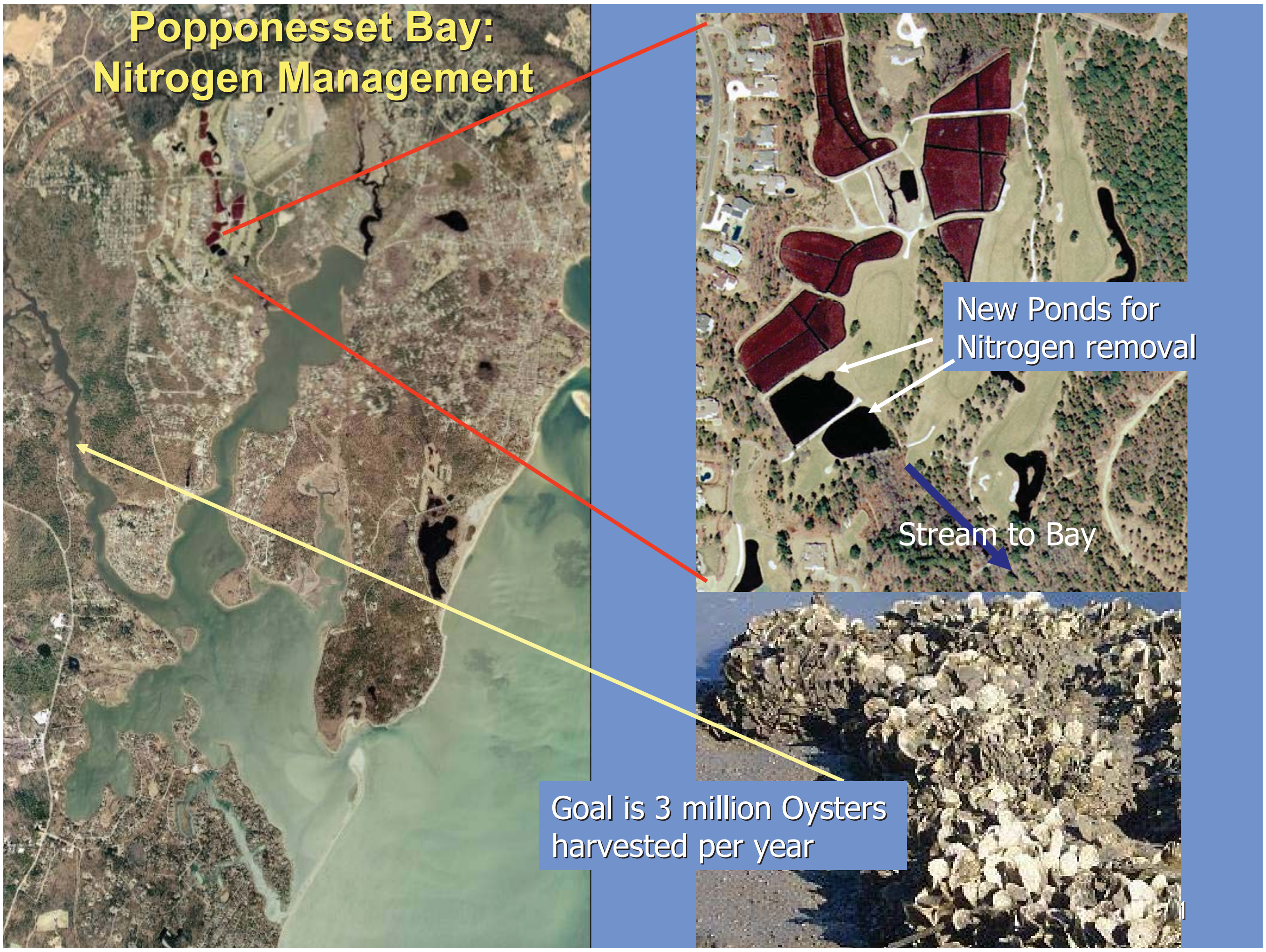
- **First** - maximize the hydrodynamics (Flushing)
- **Second** - maximize natural nitrogen removal processes within watershed and estuary
- **Third** - source reduction through education
- **Last** - targeted nitrogen removal through wastewater treatment systems



Popponesset Bay Nitrogen Management Alternative

Enhanced Attenuation (26% removal or ½ Nitrate Load in Rivers)

91% Septic Removal (sewers)



How long does restoration take?

- Recovery of estuarine systems is relatively rapid. Significant recovery of animal populations and habitat and water quality within 3-5 years.
- Implementation is a local and municipally driven effort, which requires significant funding. Time-line?

Community Meeting 3

Welcome by Harwich Wastewater Management Subcommittee (WMS)

Larry Ballantine
Dr. Stanley Kocot
George Myers
Robert Owens
Frank Sampson (Chair)

Town Staff Advisors to WMS
Paula Champagne (Board of Health)
Sue Leven (Town Planner)
Heinz Proft (Natural Resources Officer)
Craig Wiegand (Water Department)

Citizens Advisory Committee

- Dana DaCosta
- Kathy Green
- Christopher Harlow
- James Mangan
- Matt McCaffery
- Allin Thompson (Chair)
- John Webby

Other Key Players

- Town CWMP Consultant – CDM
- Town Administrator – Jim Merriam
- Selectmen Liaison – Ed McManus

- School of Marine Science and Technology – SMAST
- Department of Environmental Protection – DEP
- Cape Cod Commission – CCC

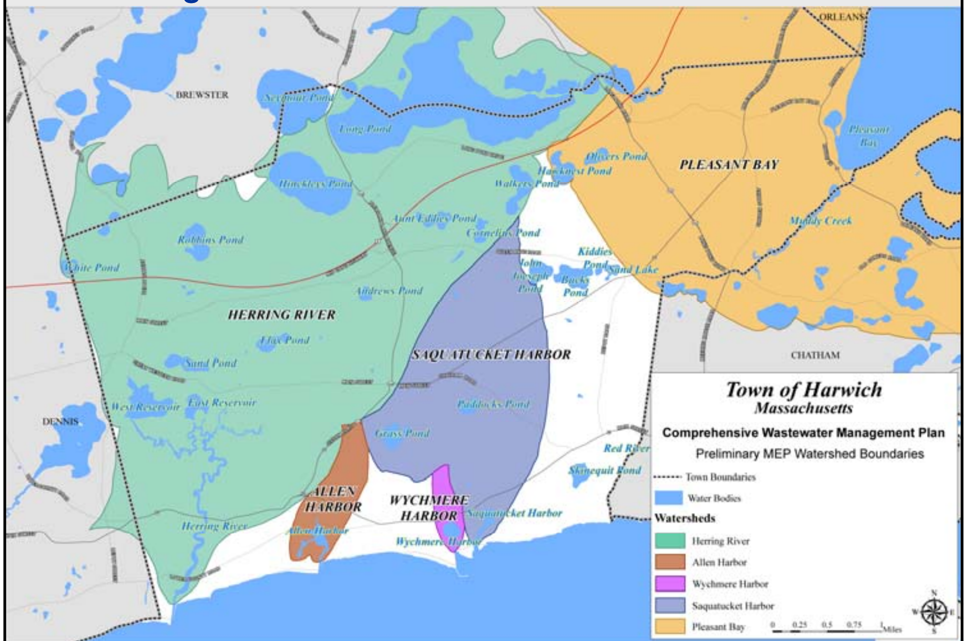
Meeting Purpose

- Provide a progress update on the Comprehensive Wastewater Management Plan (CWMP)
- Review Existing Conditions in context of CWMP
- Discuss Preliminary Wastewater Needs
- Reinforce the importance of local residents and business owners to participate in the process

Presentation Overview

- Project Drivers – Massachusetts Estuaries Project (MEP)
- Existing Conditions in Context of the CWMP
- Preliminary Wastewater Management Needs
- Next Steps in Process
- Review Project Schedule
- Discuss Opportunities for Public Input
- Questions and Comments

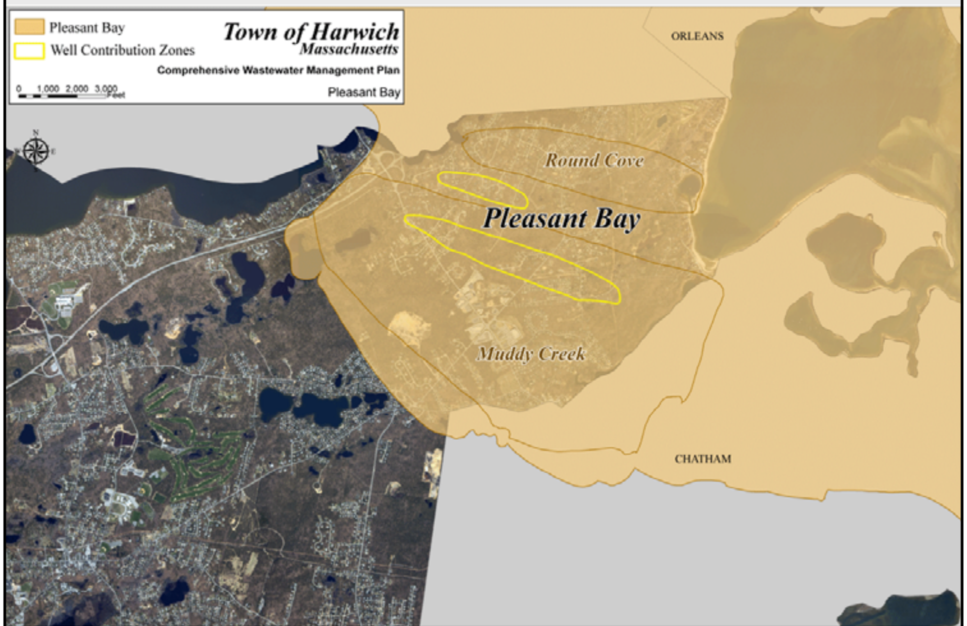
Existing Conditions – MEP Watersheds



Existing Conditions – MEP Watersheds

- Status of MEP Watersheds
- Pleasant Bay – Complete
- Southern embayments (Herring River, Allen Harbor, Wychmere Harbor and Saquatucket Harbor) are preliminary as of 2/28/08 and may be further refined during MEP evaluation/analysis

Existing Conditions – Pleasant Bay Watershed

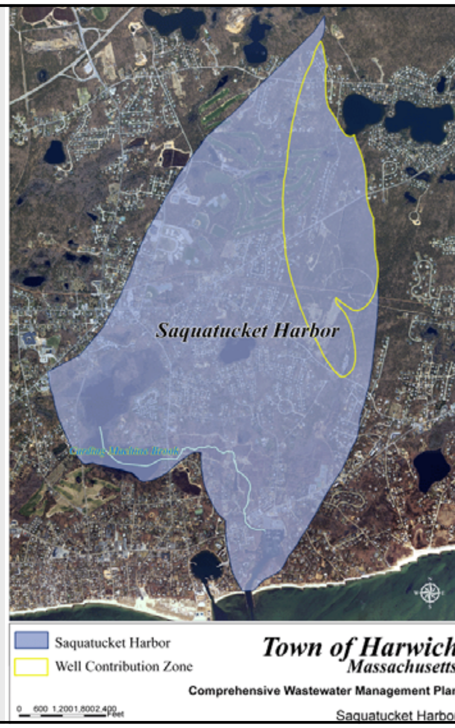


Existing Conditions – Herring River Watershed

Existing Conditions – Allen Harbor Watershed

Existing Conditions – Wychmere Harbor Watershed

Existing Conditions – Saquatucket Harbor Watershed



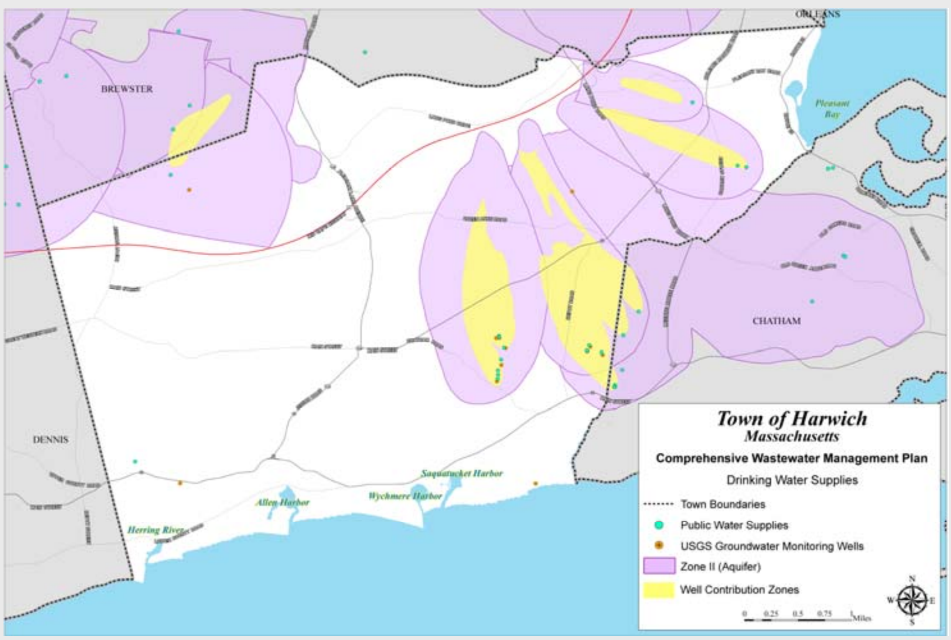
Existing Conditions – Estuaries Water Quality

- **Initial MEP Findings:**
  - **Pleasant Bay – Poor Quality**
  - **Herring River – High to Moderate Quality**
  - **Allen Harbor – Poor Quality**
  - **Wychmere Harbor – Poor Quality**
  - **Saquatucket Harbor – Poor Quality**

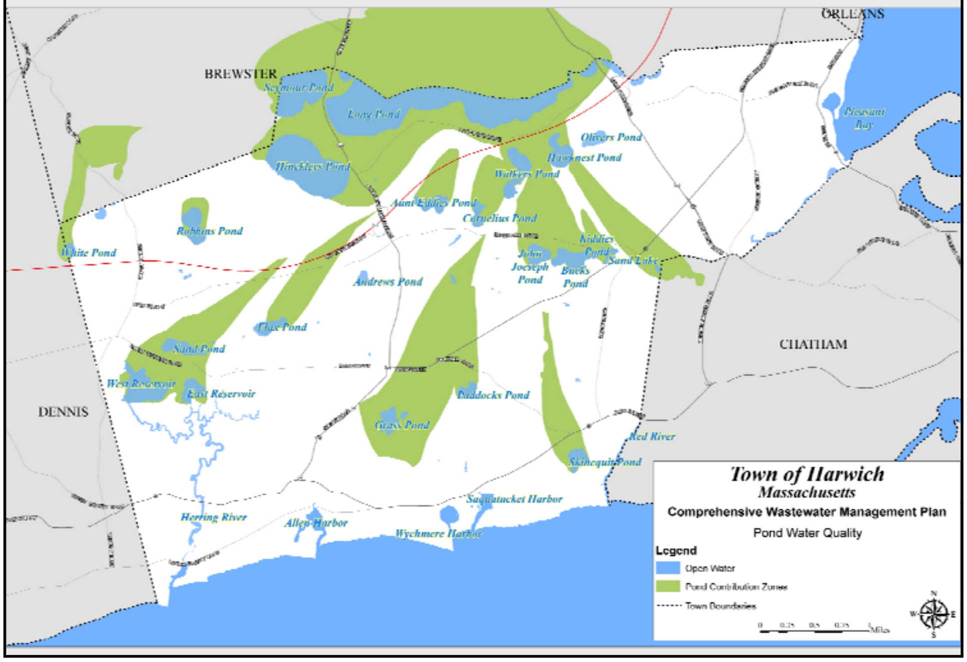
Key Existing Conditions Reviewed

- Drinking Water Supplies
- Ponds Water Quality
- On-site System Performance (Title 5)
  - Soils – Surficial Geology
  - Depth to Groundwater
  - Existing Development Lot Density
- Package Treatment Systems
- Town Open Space
- Defined Wetlands
- Zoning Map
- Land Areas to be Developed
- Harwich development from 1951 to 1999

Existing Conditions – Drinking Water Supplies



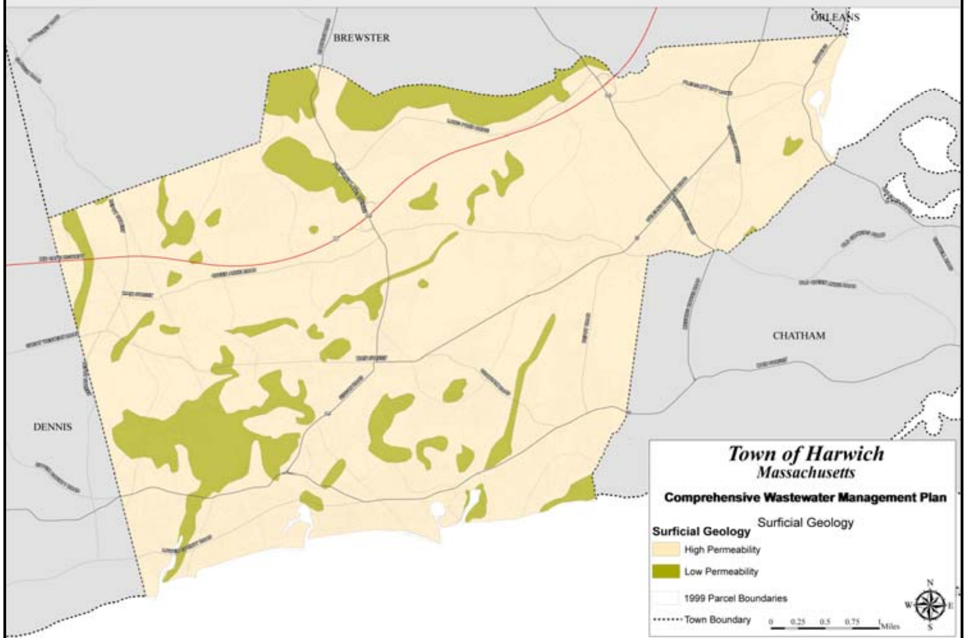
Existing Conditions – Ponds Water Quality



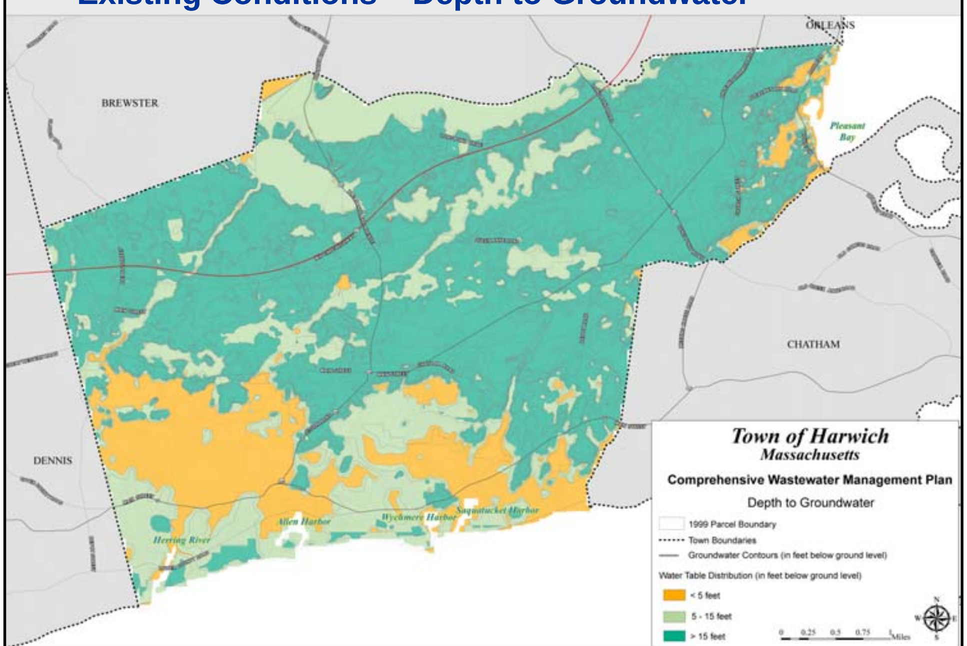
Existing Conditions – Ponds Water Quality

- Phosphorus (P) is the nutrient of concern in most fresh water ponds; not nitrogen.
- To date Town has utilized or studied in-pond, neighborhood and sewering options to help address.
- Several ponds have not been analyzed and need further assessment to evaluate best means of addressing P.

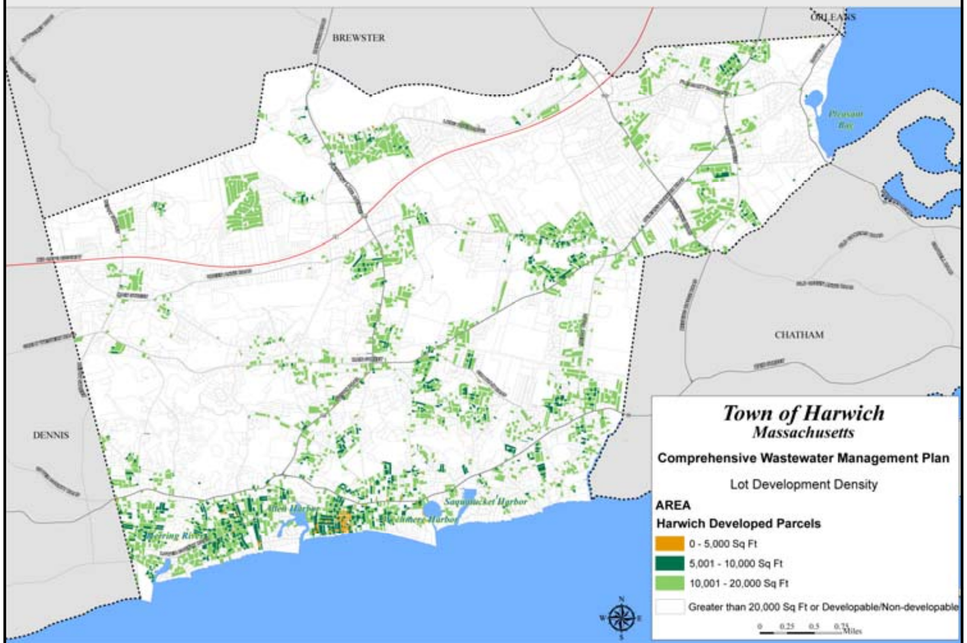
Existing Conditions – Surficial Geology



Existing Conditions – Depth to Groundwater



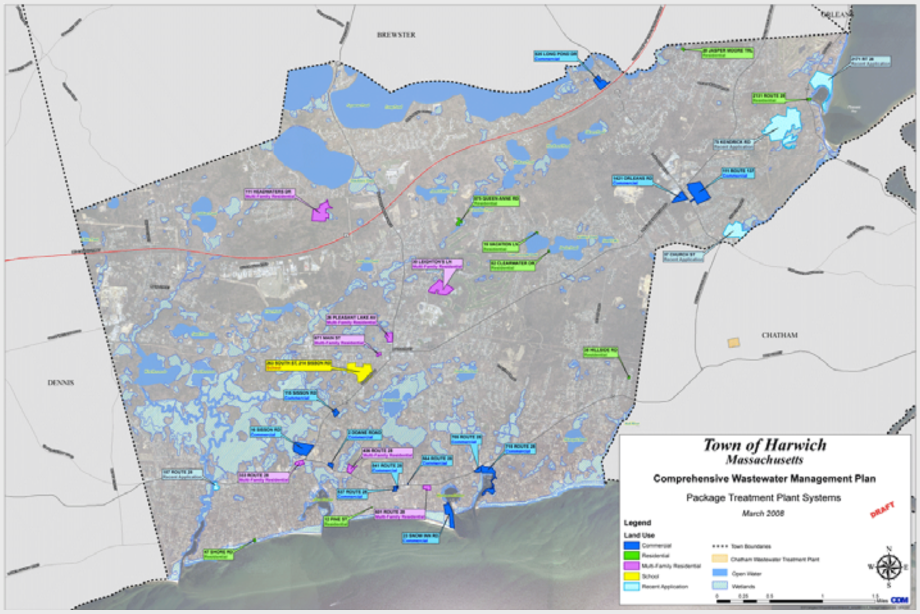
Existing Conditions – Lot Development Density



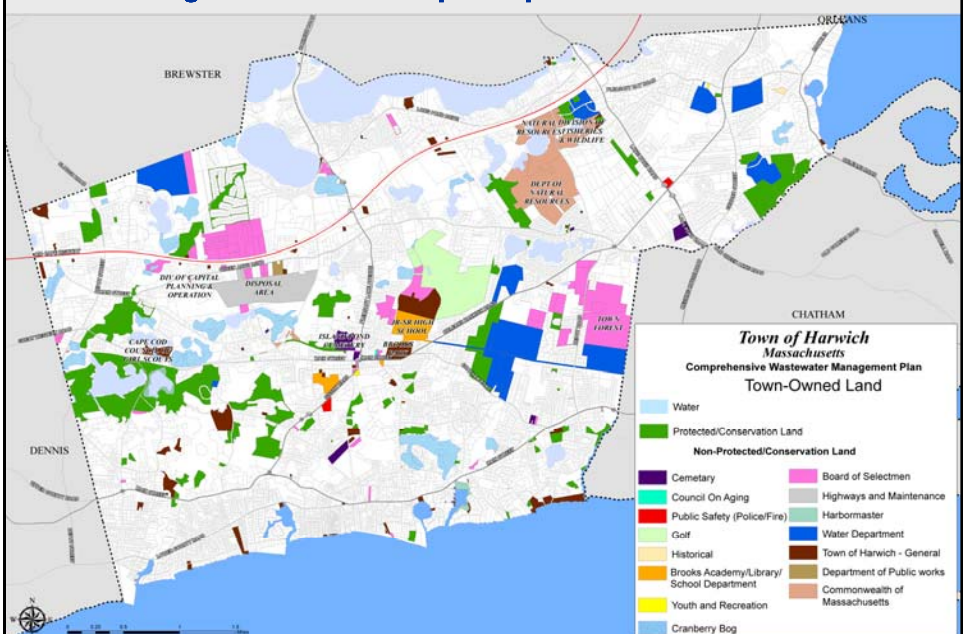
Existing Conditions – On-site System Performance (Title 5)

- **Harwich predominantly has well draining soils**
- **Most areas have sufficient depth to groundwater or have mounded systems**
- **Densely developed areas have history of Title 5 waivers for setback requirements or deed restrictions limiting size**

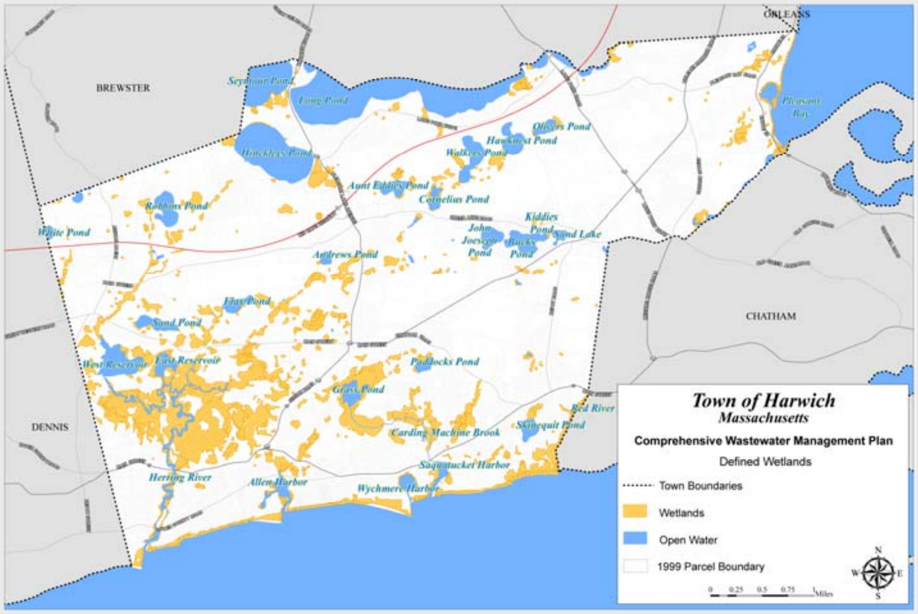
Existing Conditions – Package Treatment Systems



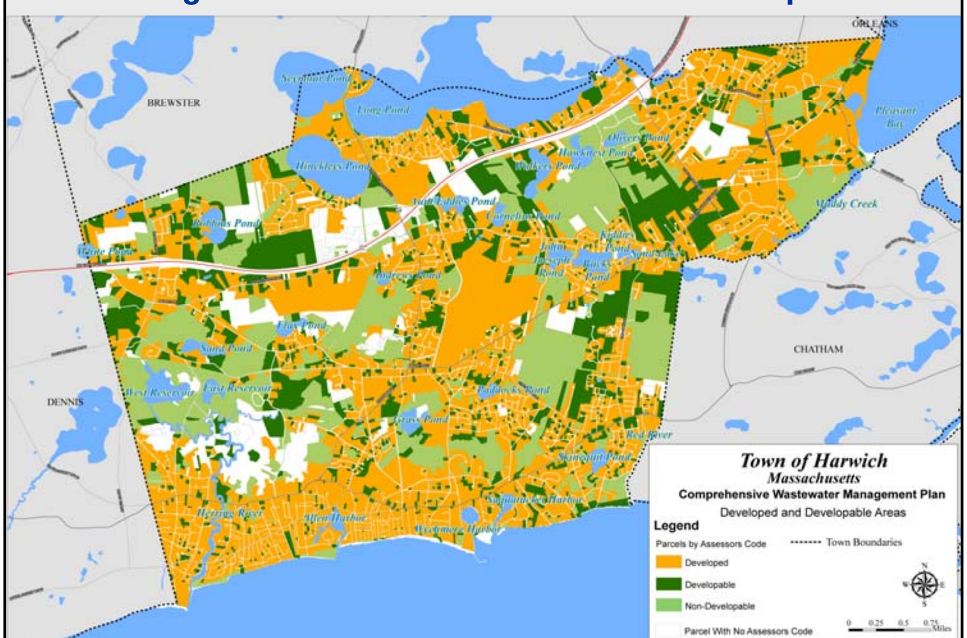
Existing Conditions – Open Space



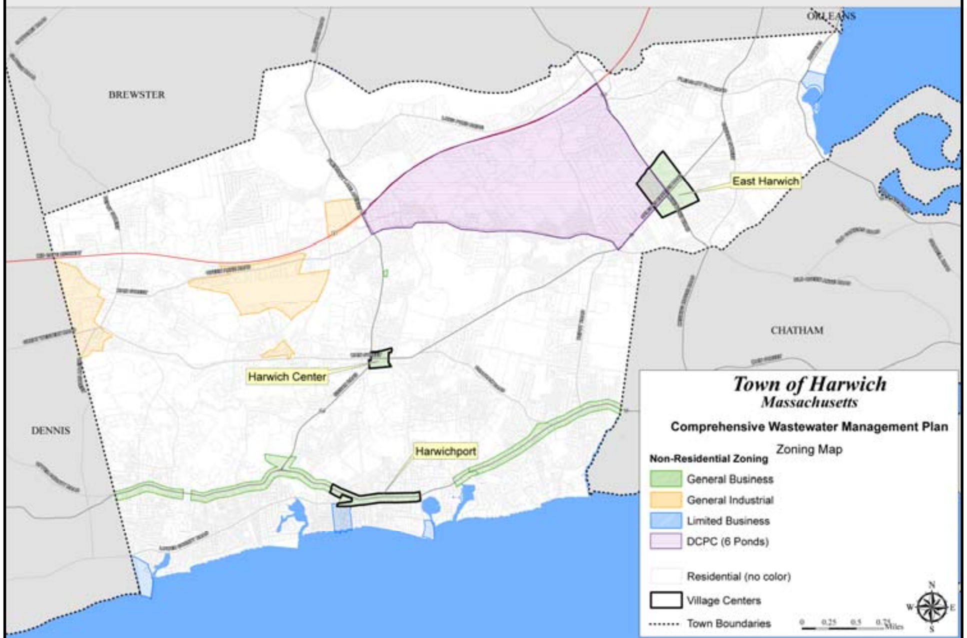
Existing Conditions – Defined Wetlands



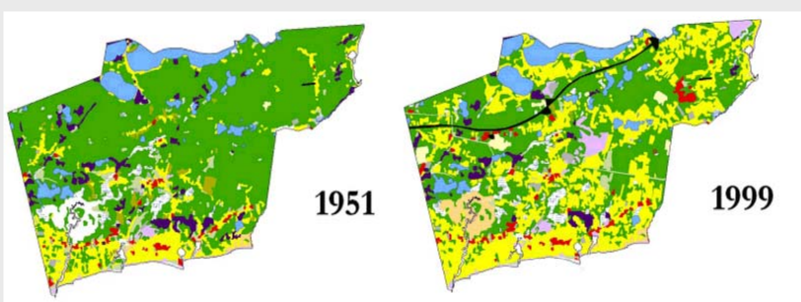
Existing Conditions – Land Areas to be Developed



Existing Conditions – Zoning Map



Extent of Development



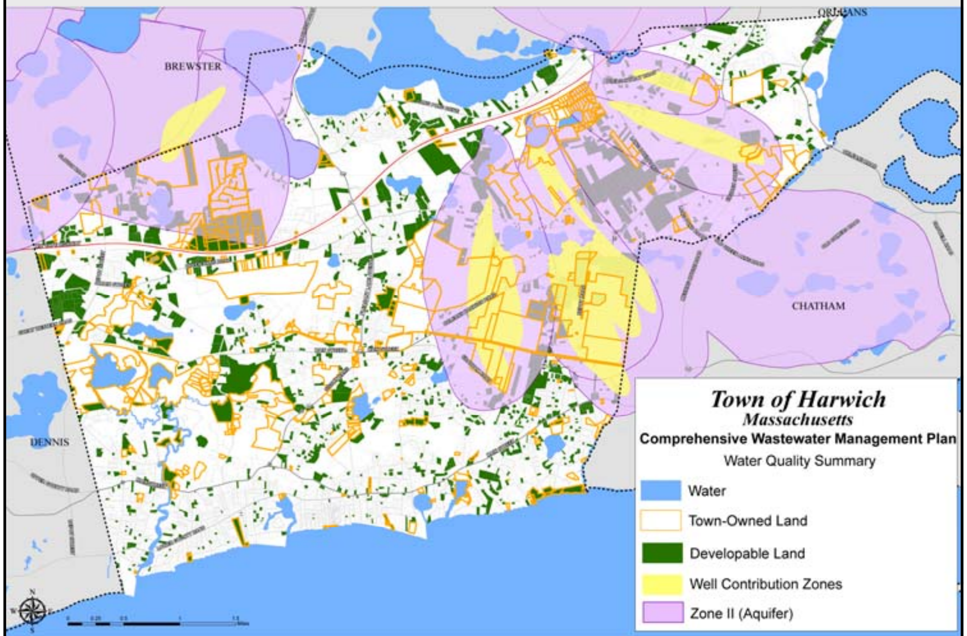
Wastewater Management Needs

- Drinking Water
- Pond Water Quality
- Title 5 Issues
- Nitrogen Management
- Socio- Economic

Drinking Water

- Drinking water quality does not appear to be a driver for sewers based on existing conditions.
- Majority of proposed development is not in well protection areas.
- Nitrate concentrations at wells are low.

Water Quality Summary



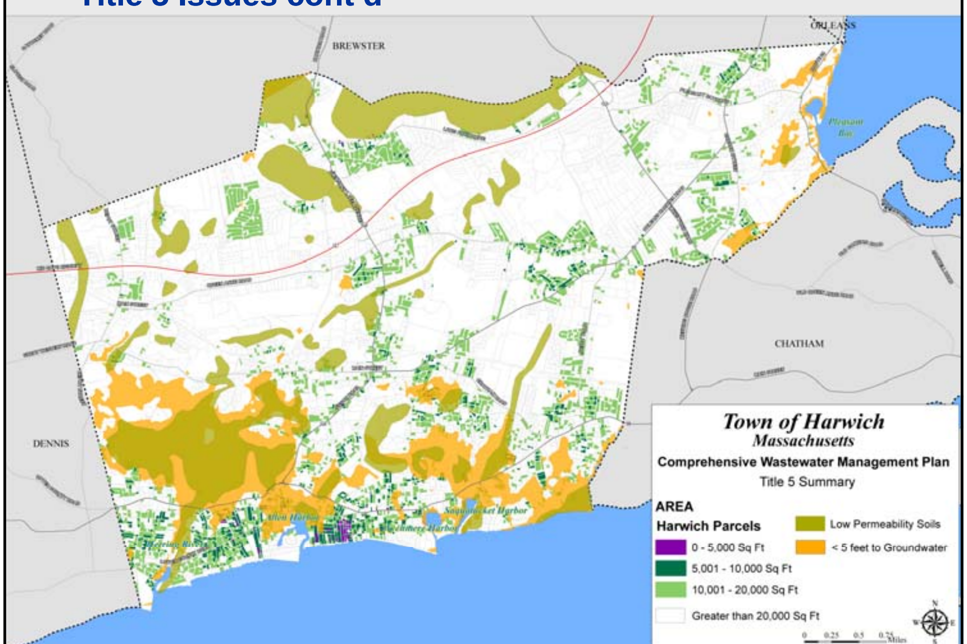
Ponds Water Quality

- **Main concern is from Phosphorus loading versus Nitrogen**
- **Some ponds such as Great Sand Lakes area may need sewers to address up-gradient loading to ponds**
- **Several ponds may require further assessment based on minimal existing data to evaluate.**

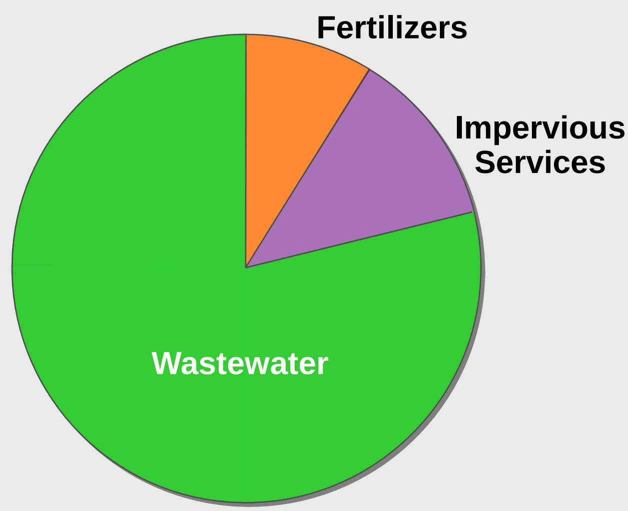
Title 5 Issues

- Title 5 does not appear to be a driver for sewers based on existing conditions.
- Some areas may continue to require waivers for setbacks.
- Some areas may still require mounded systems.
- Some areas could be sewered to eliminate waivers and mounded systems.

Title 5 Issues cont'd



Nitrogen Management



Local Control – Muddy River

Nitrogen Management cont'd

- **MEP results to date indicate significant nitrogen removal will be required in 4 of the 5 estuaries/ watersheds.**
- **Stormwater best management practices (BMPs) are important but have less impact**
- **Fertilizer management and education about use / impacts is important but also has less impact.**

Future Conditions (Build-Out)

Number of Properties needing Nitrogen Removal

MEP Watershed	*Number of Developed Properties @ Build-Out*	*Nitrogen (ŅNǾ Removal rates from Wastewater to meet TMDL*	*Number of MEP Watershed Properties needing Nitrogen Removal*
Herring River	3,500	0 to 10 %	0 - 350
Allen Harbor	300	75 - 100 %	225 - 300
Wychmere Harbor	100	75 - 100 %	75 - 100
Saquatucket Harbor	1,200	50 - 75 %	600 - 900
Pleasant Bay	2,100	80 %	1,700
MEP Watershed Subtotal	**7,200**		**2,600 Š 3,350**
Total Town-wide	**10,000**		

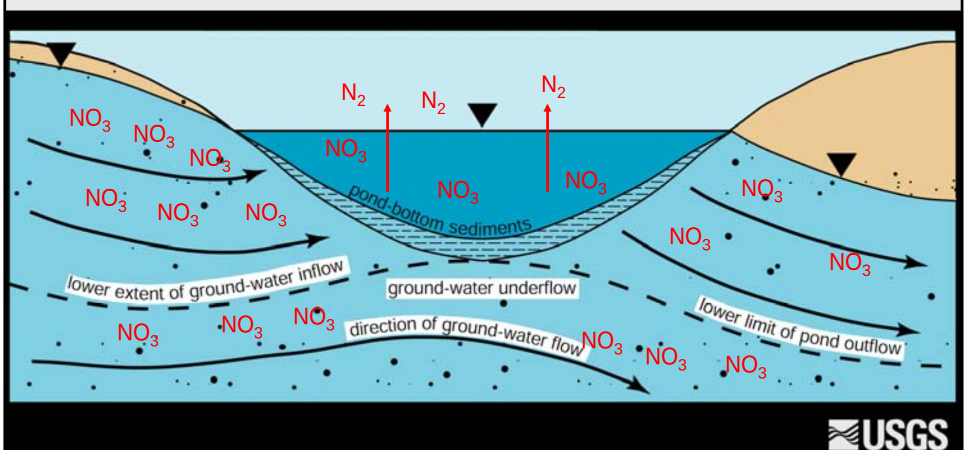
Wastewater Needs Categories

1. **Area needs an off-site solution due to MEP N-removal requirements, socio-economic requirements or other reasons.**
2. **Area can remain with on-site systems using nonstructural nutrient management solutions**

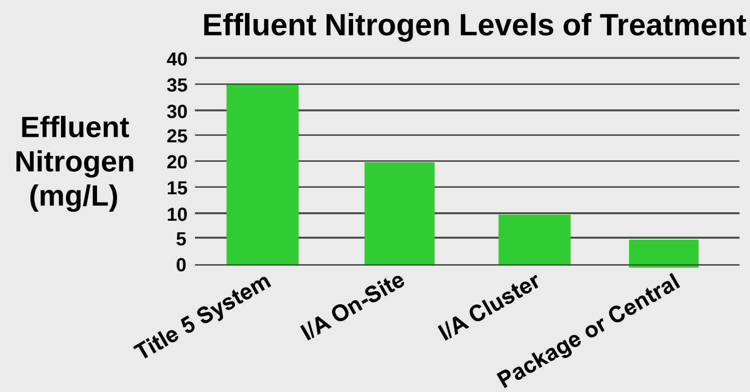
Nitrogen Reduction

- Natural attenuation (Muddy Creek, Bogs)
- Nitrogen treatment levels with available technologies

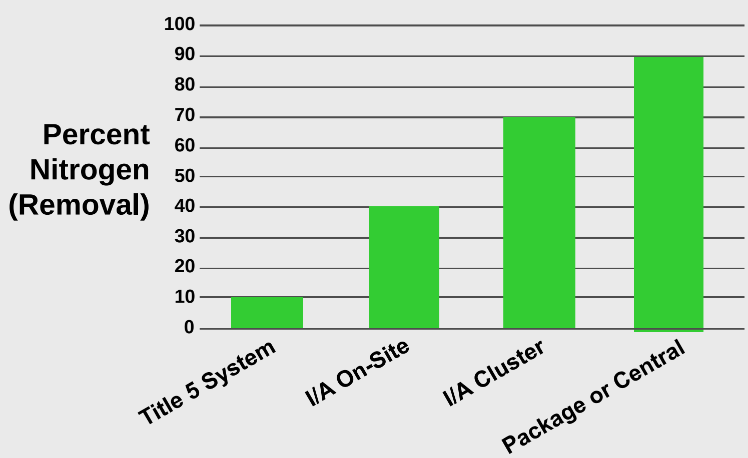
Nitrogen Attenuation: Ground Water Flow-Through Pond



Nitrogen Treatment Levels Suggest Most Likely Solutions



Nitrogen Treatment Levels Suggest Most Likely Solutions



Next Steps

- Develop criteria and ratings system to prioritize wastewater needs
- Conduct site screening review for potential effluent recharge sites
- Develop Feasible Alternatives
- Evaluate Nitrogen reducing technologies and off-site or regional options
- Identify Potential Effluent Recharge Sites

Key Project Dates

- Community Meeting No. 4 – July 2008
  - Review wastewater needs and preliminary alternatives to be evaluated
- Community Meeting No. 5 – September 2008
  - Finalize recommended projected wastewater needs and recommended alternatives for evaluation in Phase 2.
- Submit Phase 1 CWMP in October 2008

How to get involved ?

- Water Quality Task Force – Wastewater Management Subcommittee
- Citizens Advisory Committee
- Website
  - Meeting Schedule and Meeting Minutes (see website, Calendar of Events, etc.)
- Channel 18
  - Postings
- email
  - sign-ups

Community Meeting 4

TOWN OF HARWICH

Comprehensive Wastewater Management Plan (CWMP)

Community Meeting No. 4
Harwich Town Hall

7:00PM
April 21, 2011

CDM

Meeting Purpose

- Present and Discuss Site Screening Process to Identify Effluent Recharge Sites

Goal of Site Screening Process

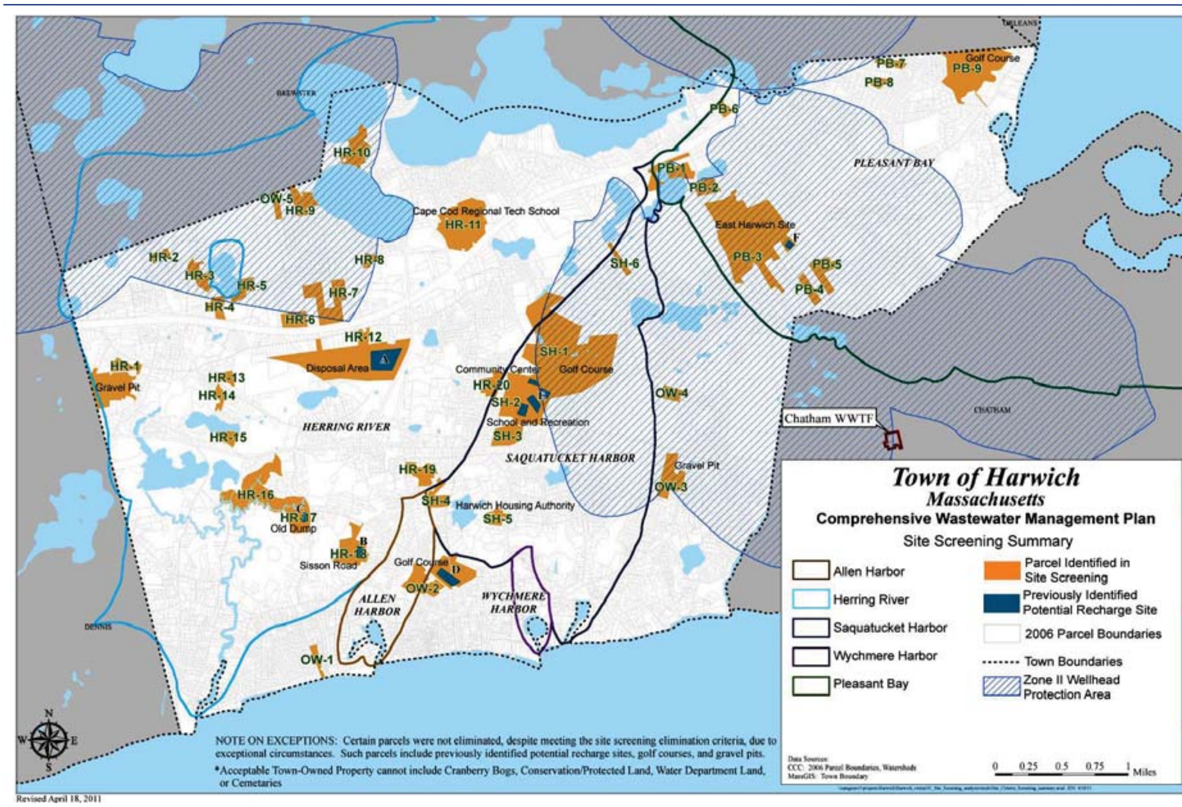
- Goal – Analyze the Whole Town to Identify the Best Candidate Sites Across Town That Offer the Potential for Effluent Recharge.

Site Screening Process

Site Screening – Ten Criteria

- Outside of a Well Contribution Zone
- Parcel Size Greater than 5 Acres
- Outside of a 100-Year Floodplain Zone
- Sites With Permeable Soils
- Undeveloped Property
- Parcels Outside of Wetlands
- Favorable Depth to Groundwater
- Outside Priority Habitat
- Outside Municipal Wellhead Protection Zone II
- Town-Owned Property

Initial Site Screening Results

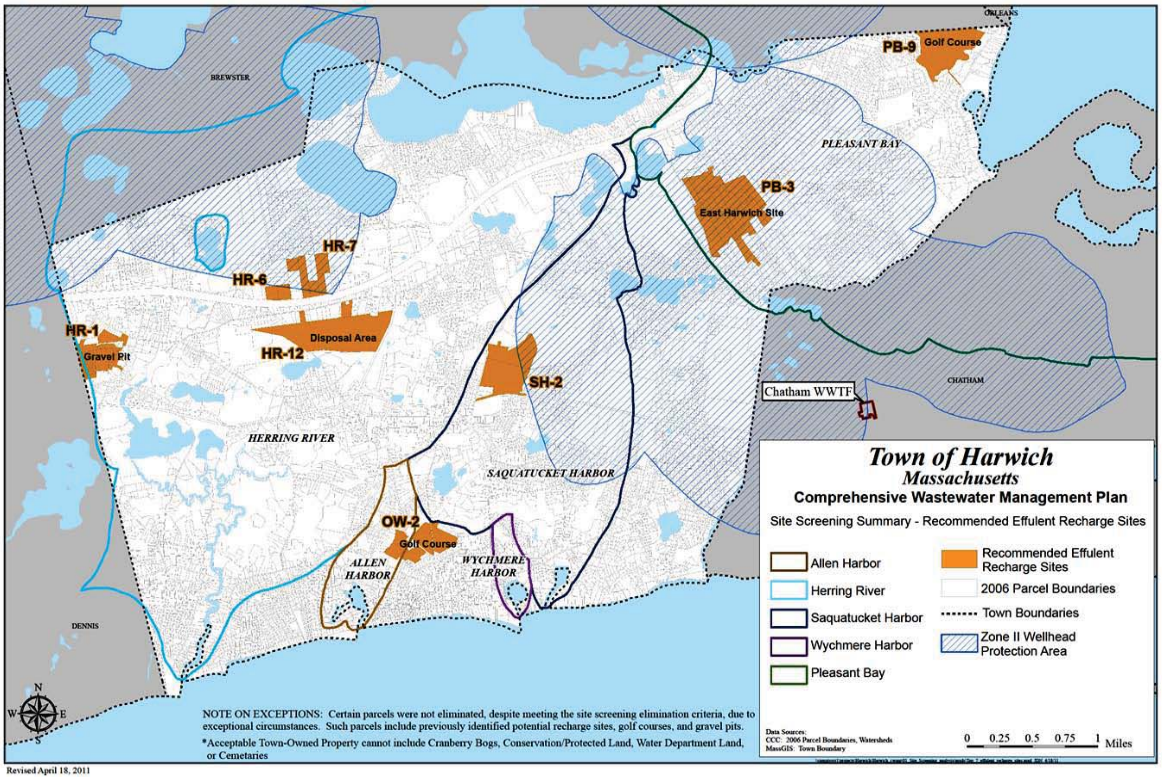


Second Step of Site Screening Process (continued)

Site Screening Results

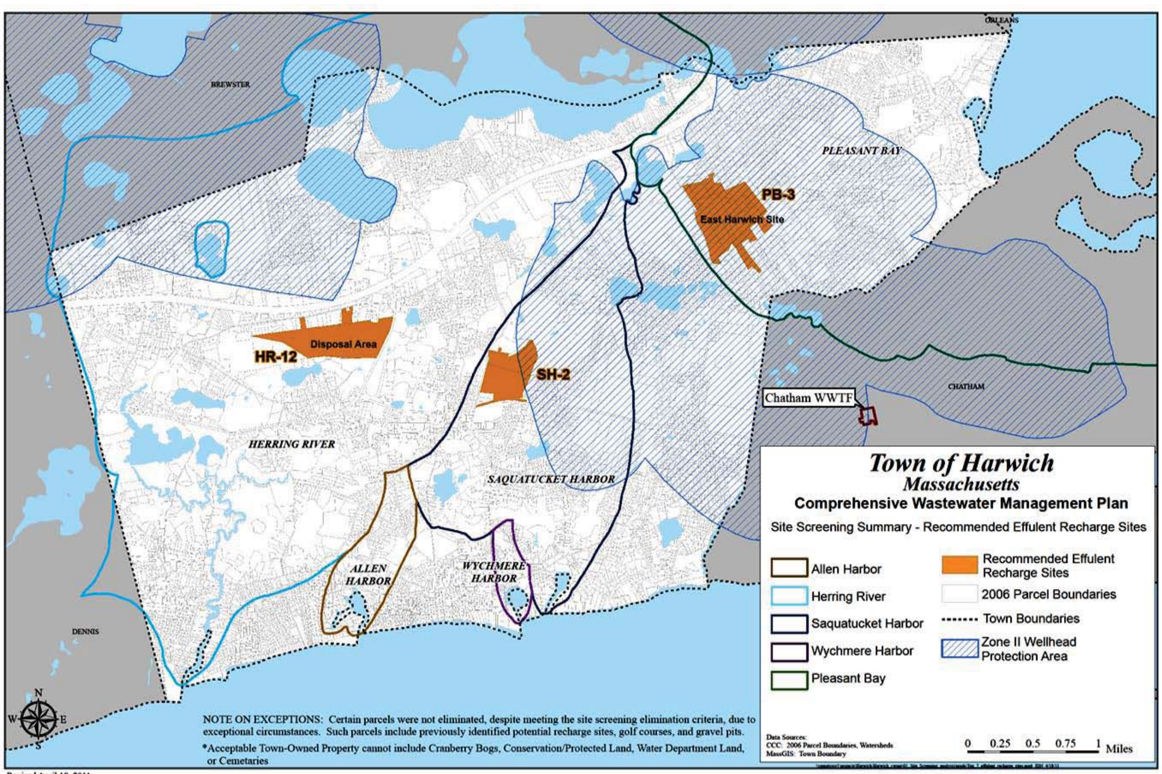
- 40 Sites reduced to 7 Sites (10 Sites Combined to 7)
- Most of the Sites Meet 8 or More Criteria
- Specific Emphasis On:
  - Town Owned Sites
  - Larger Sites
  - Multiple Watersheds
- Weighted Criteria Based on CWMP Committee Input:
  - 8 to 9 Criteria With One From Each Watershed

Site Screening
7 Recommended Sites



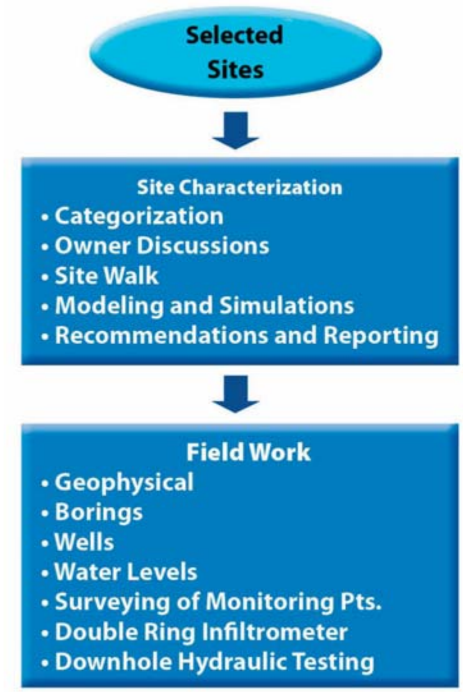
CDM

Site Screening
Selected Sites For Field Work



CDM

Next Steps

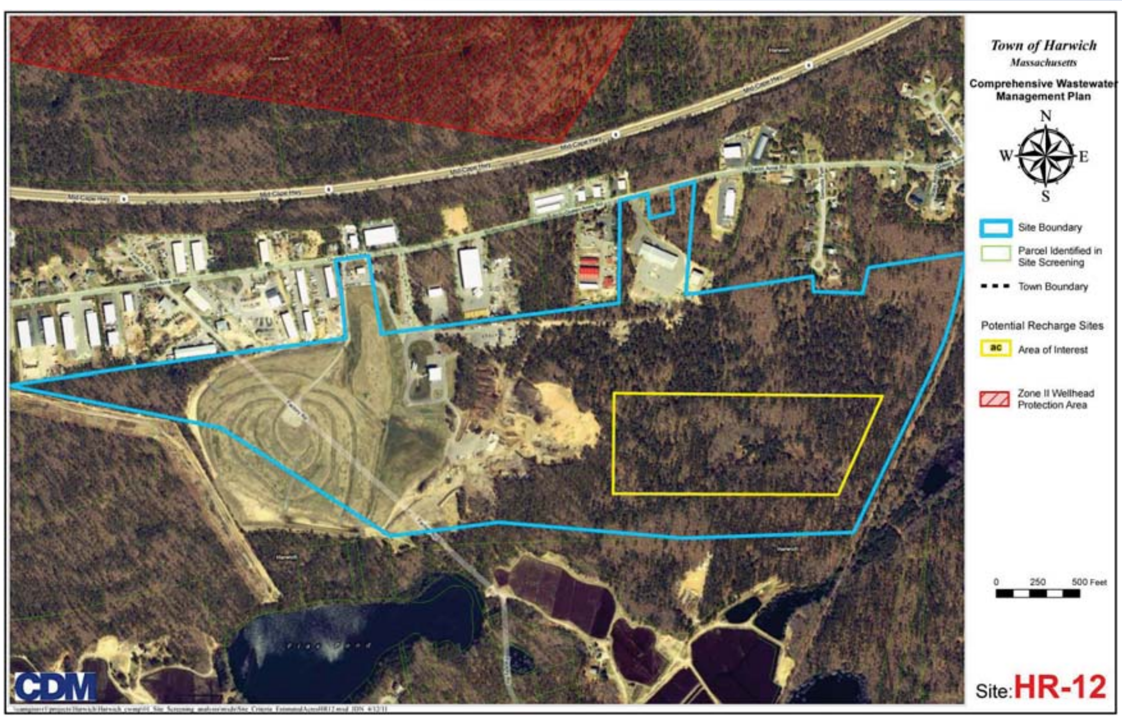


SH-2 – The High School
Saquatucket Harbor Watershed

PB-3 – Privately Owned Gravel Pit in the Pleasant Bay Watershed

CDM

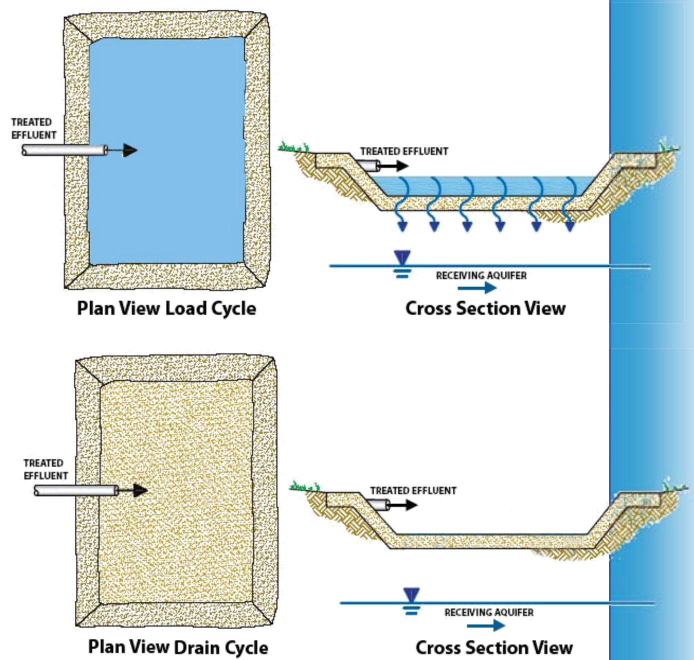
HR-12 – Adjacent to Former Town Landfill in the Herring River Watershed



CDM

Infiltration Basins for Effluent Recharge

- Infiltration Basins allow for additional land treatment and recharge of wastewater effluent
- Applied wastewater percolates through the soil and the treated effluent drains to ground water or surface water
- Simple design and operation (rotated on/off)
- Relatively easy to maintain
- Higher loading rates compared with other subsurface wastewater effluent recharge technologies (3-5 gallons per day per square foot)



Infiltration Basin Drying – Bourne, Massachusetts

Otis Air National Guard Base

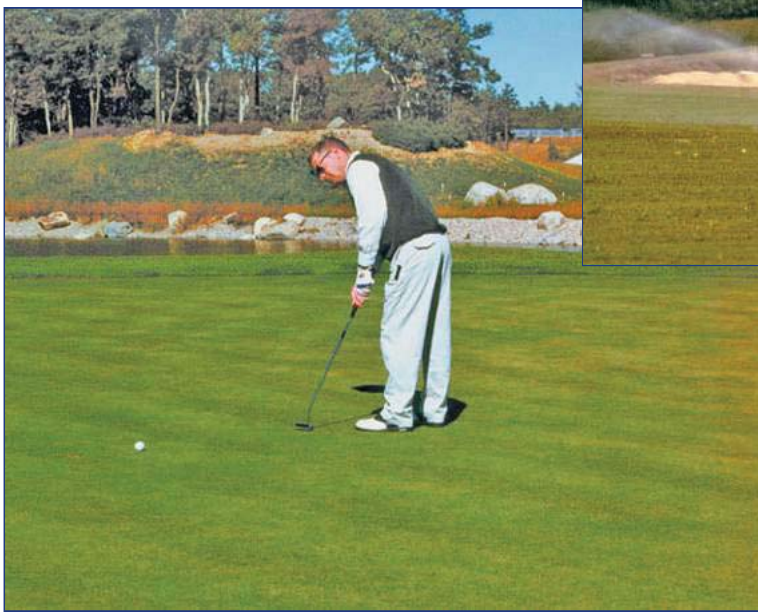
Infiltration Basins

Water Reuse – Kingston, Massachusetts

Indian Pond Golf Course – 300,000 gpd effluent recharge site

Water Reuse – Yarmouth, Massachusetts

Links at Bayberry Hills Golf Course Irrigation



Community Meeting 5

Welcome by Harwich Wastewater Management Subcommittee (WMS)

- Peter de Bakker (Chair)
- Brad Chase
- Dr. Stanley Kocot
- George Myers
- Robert Owens

and by Harwich Water Quality Management Task Force (WQMTF)

- Danette Gonsalves
- Ray Gottwald
- Tony Piro
- Bob Sarantis

Town Staff Advisors to WMS

- Bob Cafarelli (Town Engineer)
- Paula Champagne (Board of Health)
- Heinz Proft (Environmental Science Director)
- David Spitz (Town Planner)
- Amy Usowski (Conservation Commission)
- Craig Wiegand (Water Department)

Citizens Advisory Committee

- Ted Borman
- Dana DaCosta
- Christopher Harlow
- Bill Lean
- Gerry Loftus
- James Mangan
- Matt McCaffery
- Val Peter
- Allin Thompson (Chair)

Other Key Players

- Selectmen Liaison – Larry Ballantine
- Town Administrator – Jim Merriam
- Town CWMP Consultant – CDM Smith

- School of Marine Science and Technology – SMAST
- Department of Environmental Protection – DEP
- Cape Cod Commission – CCC

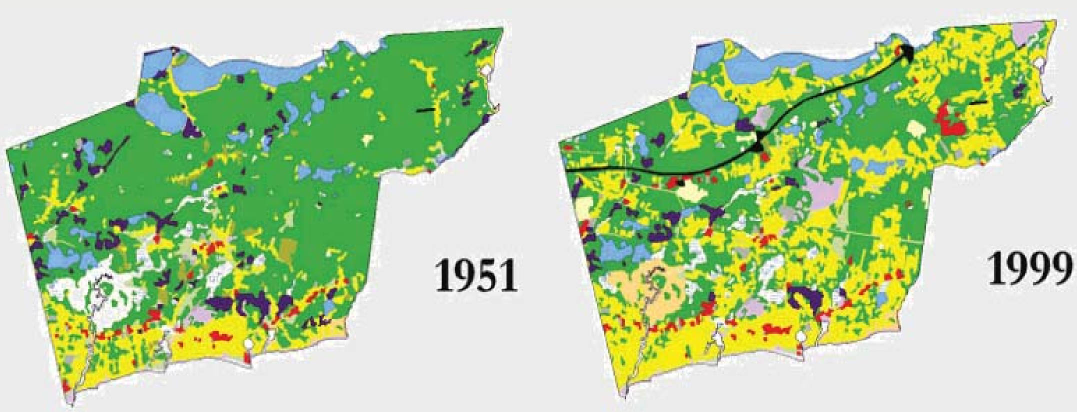
Meeting Purpose

- Provide progress update on Comprehensive Wastewater Management Plan (CWMP)
- Discuss preliminary wastewater needs
- Show possible sites of wastewater treatment facilities
- Present final three scenarios under evaluation
- Reinforce the importance of local residents and business owners to participate in the process

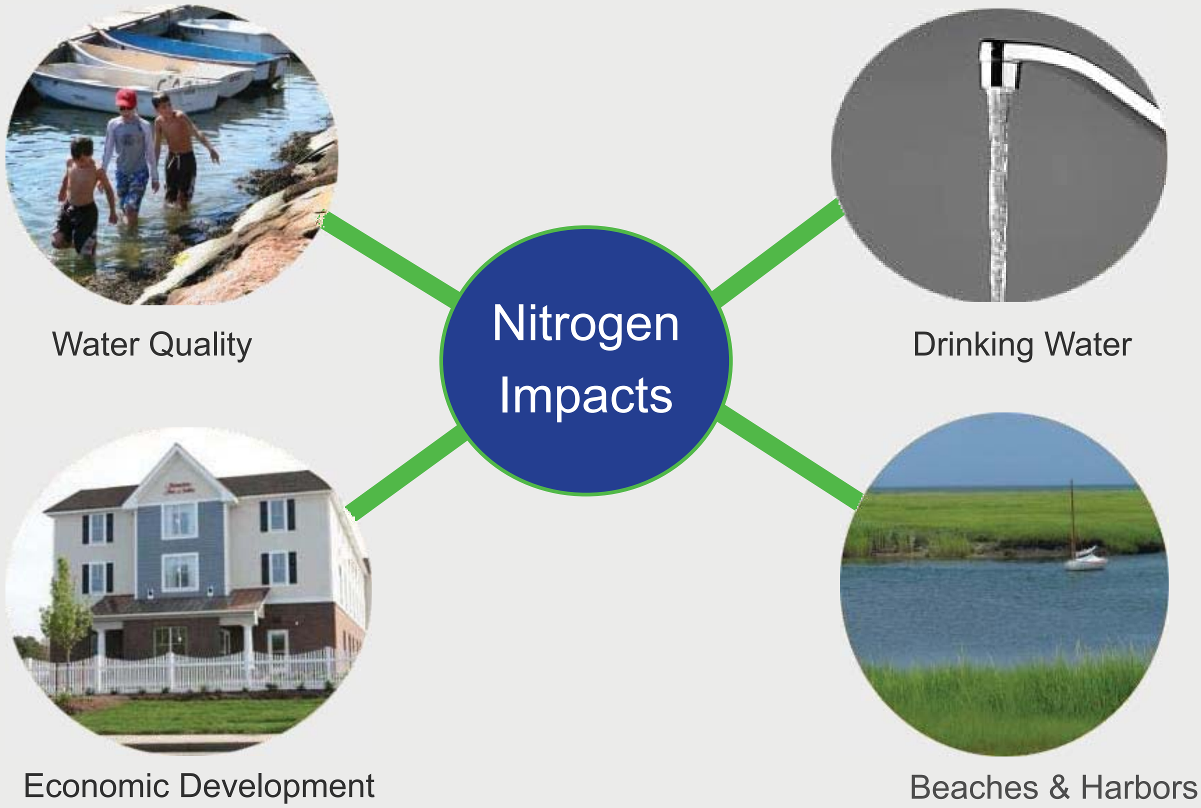
Presentation Outline

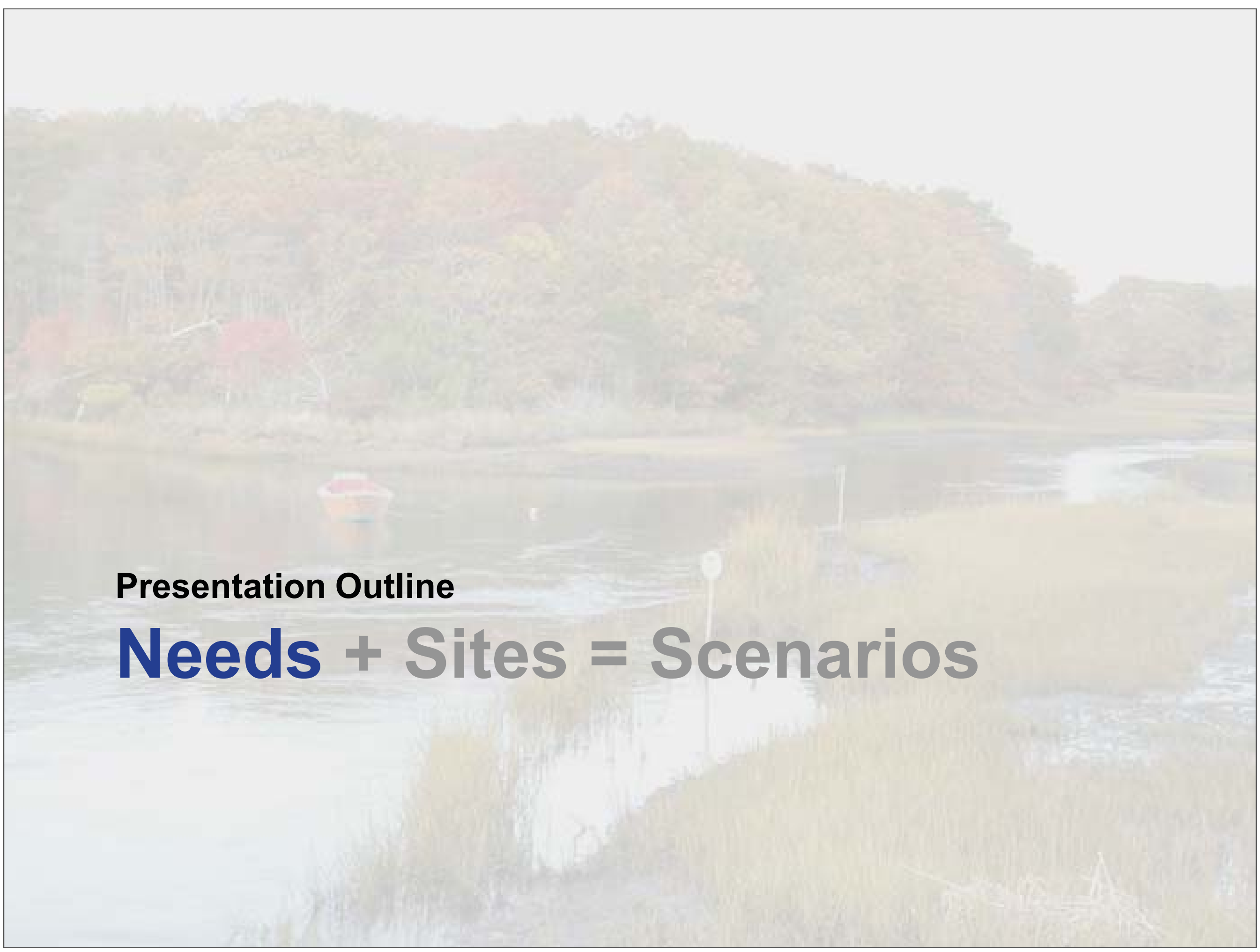
Needs + Sites = Scenarios

Extent of Development

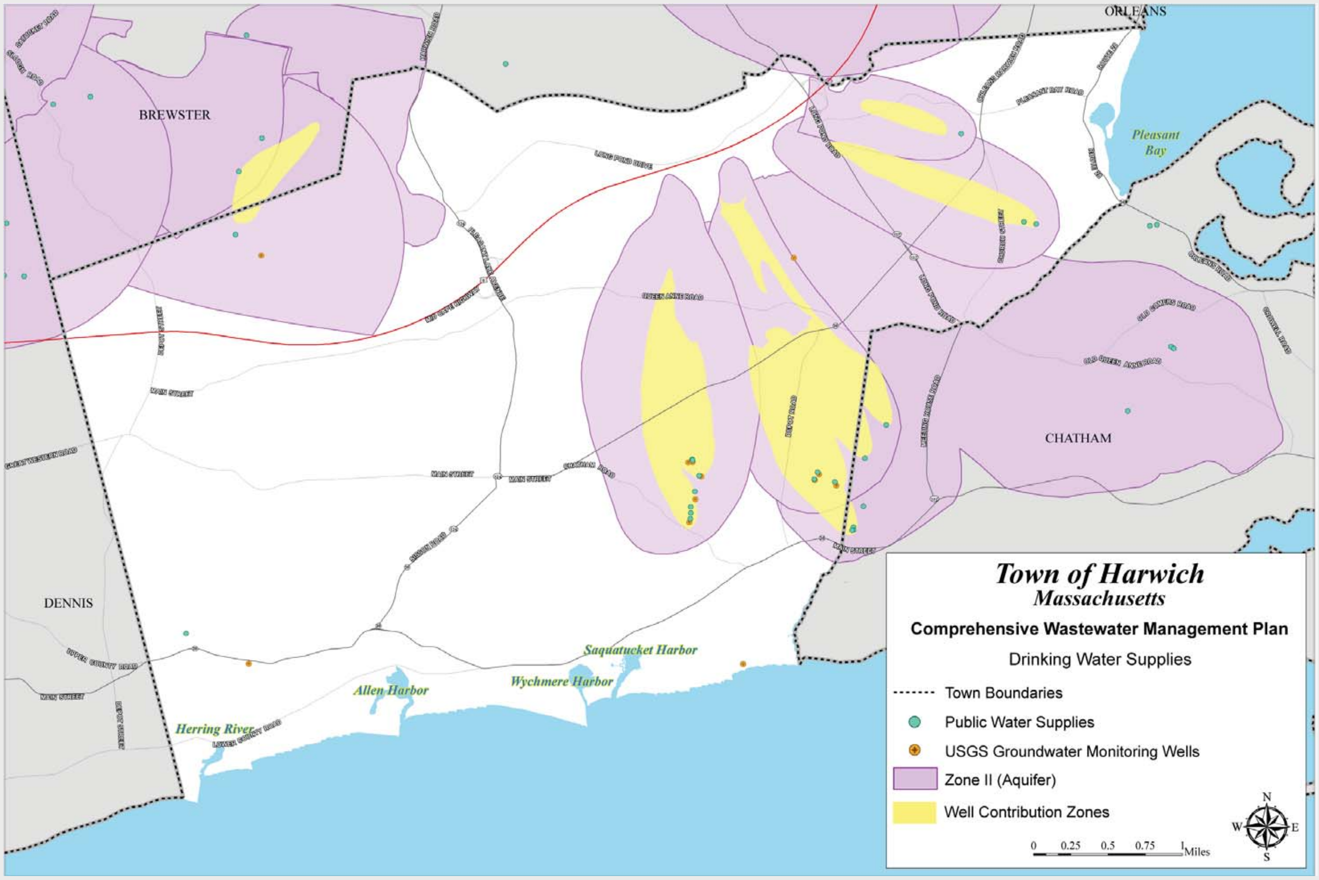


Harwich Needs to Control Nitrogen

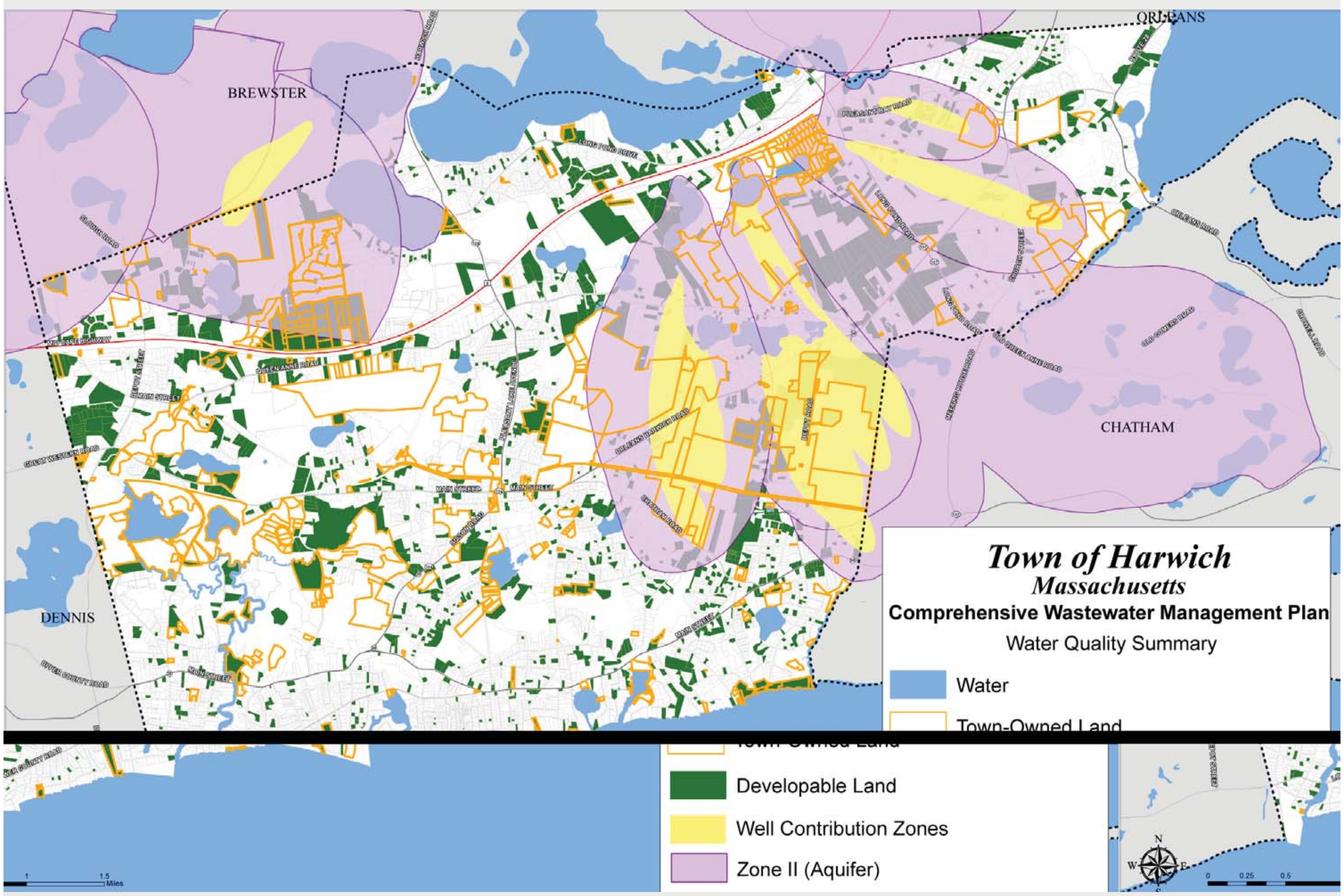




Existing Conditions – Drinking Water Supplies



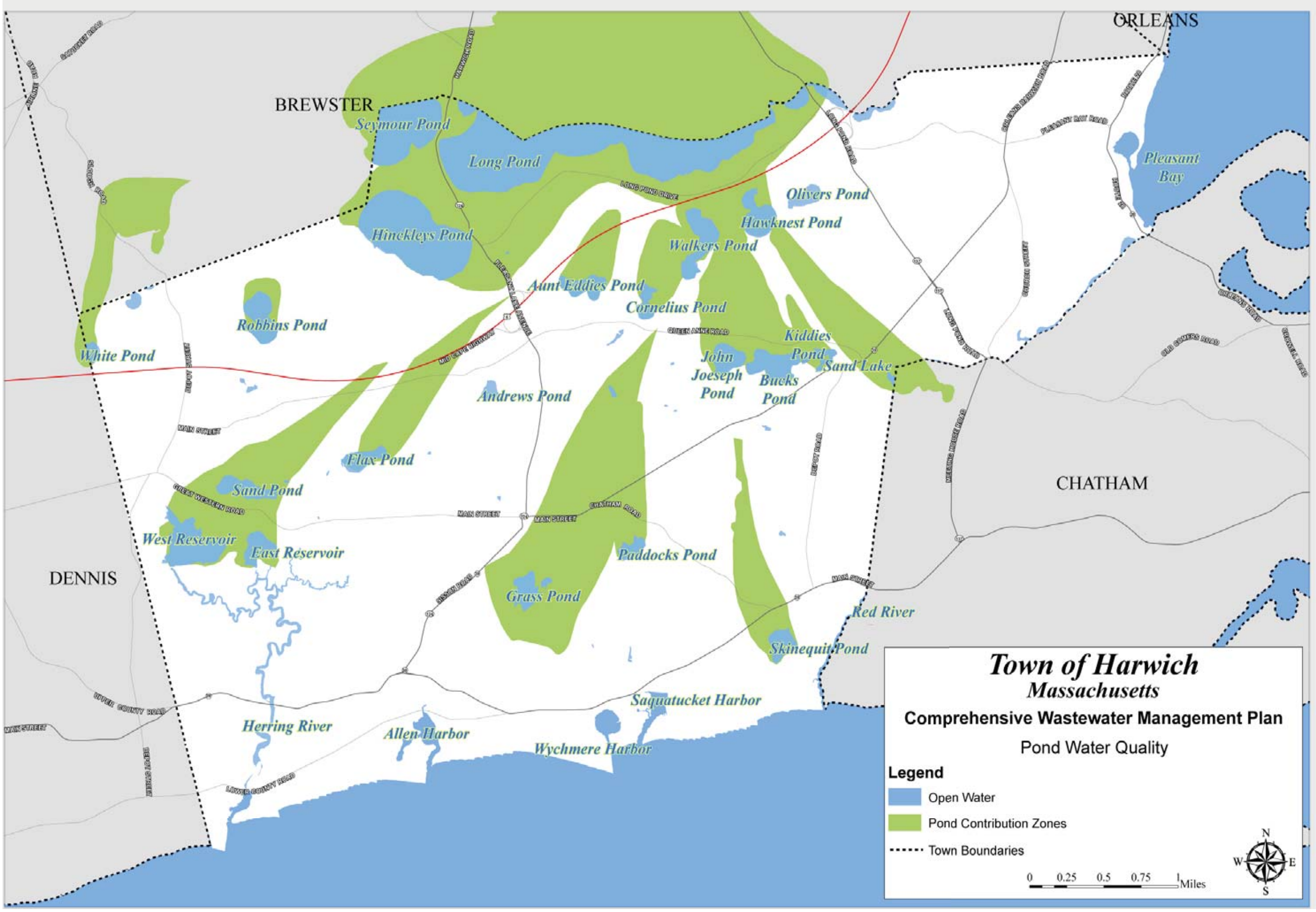
Water Quality Summary



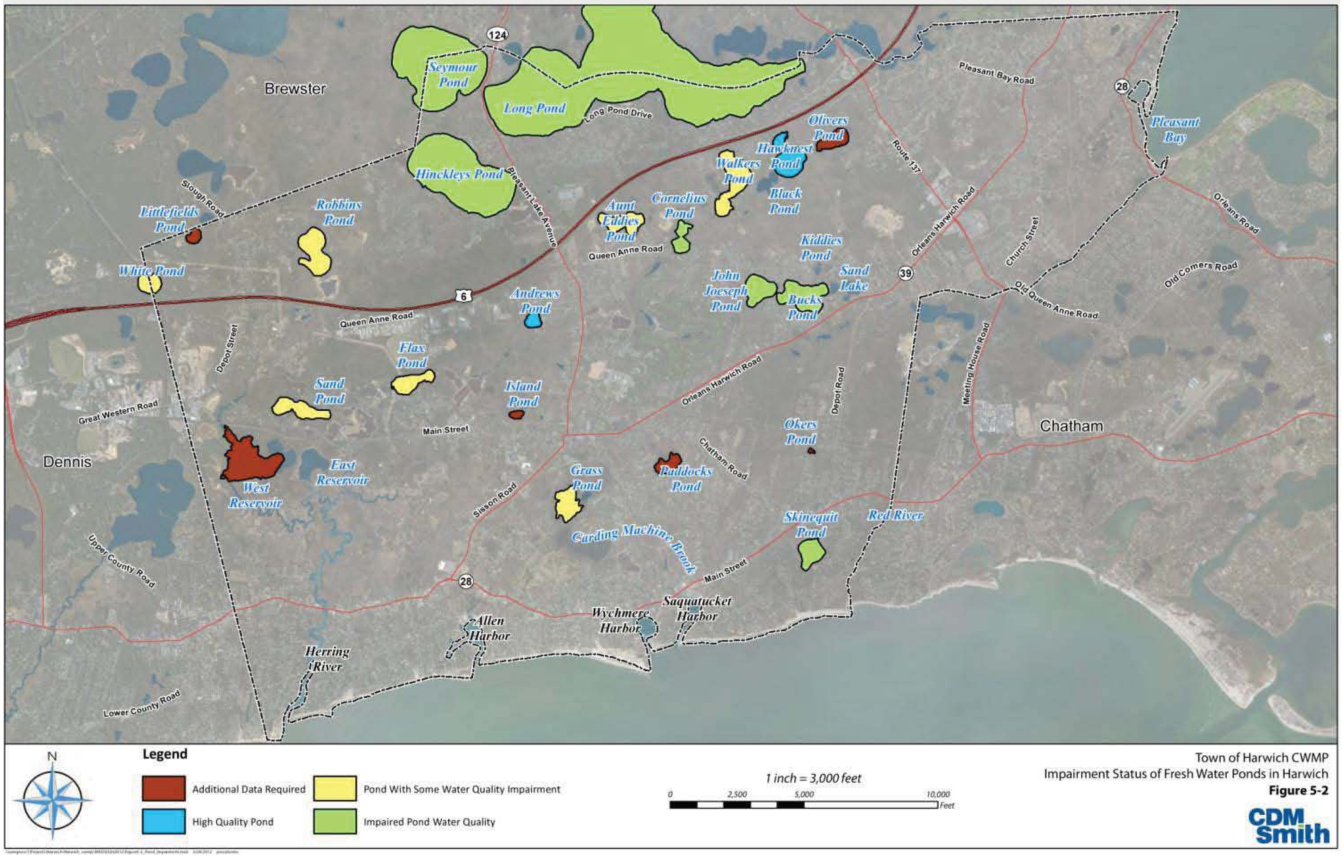
Existing Conditions Assessment - Drinking Water Supplies

- Nitrate concentrations at wells are (typically <1.0 mg/l) below drinking water standard of 10 mg/l
- Drinking water quality does not appear to be a driver for sewers based on existing conditions
- Majority of proposed development is not in well protection areas (Zone II's)

Existing Conditions – Ponds Water Quality



Impaired Fresh Water Ponds in Harwich

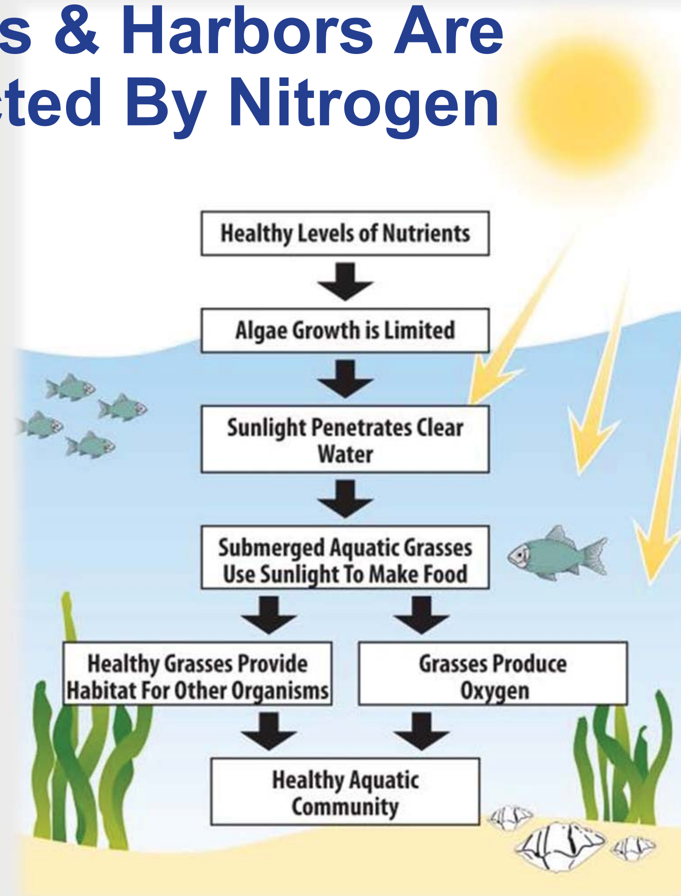


Existing Conditions Assessment – Ponds Water Quality

- Phosphorus (P) is the nutrient of concern in most fresh water ponds; not nitrogen.
- To date Town has utilized or studied in-pond, neighborhood and sewering options to help address.
- Some ponds such as Great Sand Lakes area may need sewers to address up-gradient loading to ponds
- Several ponds have not been analyzed and need further assessment to evaluate best means of addressing P.

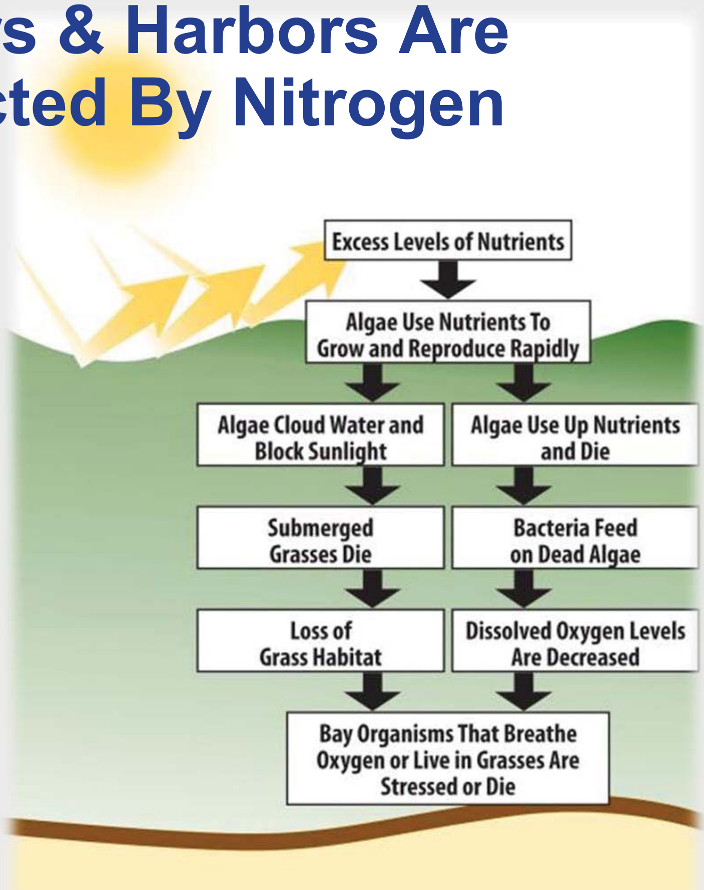
Beaches, Rivers & Harbors Are Severely Impacted By Nitrogen

Healthy Nitrogen Levels

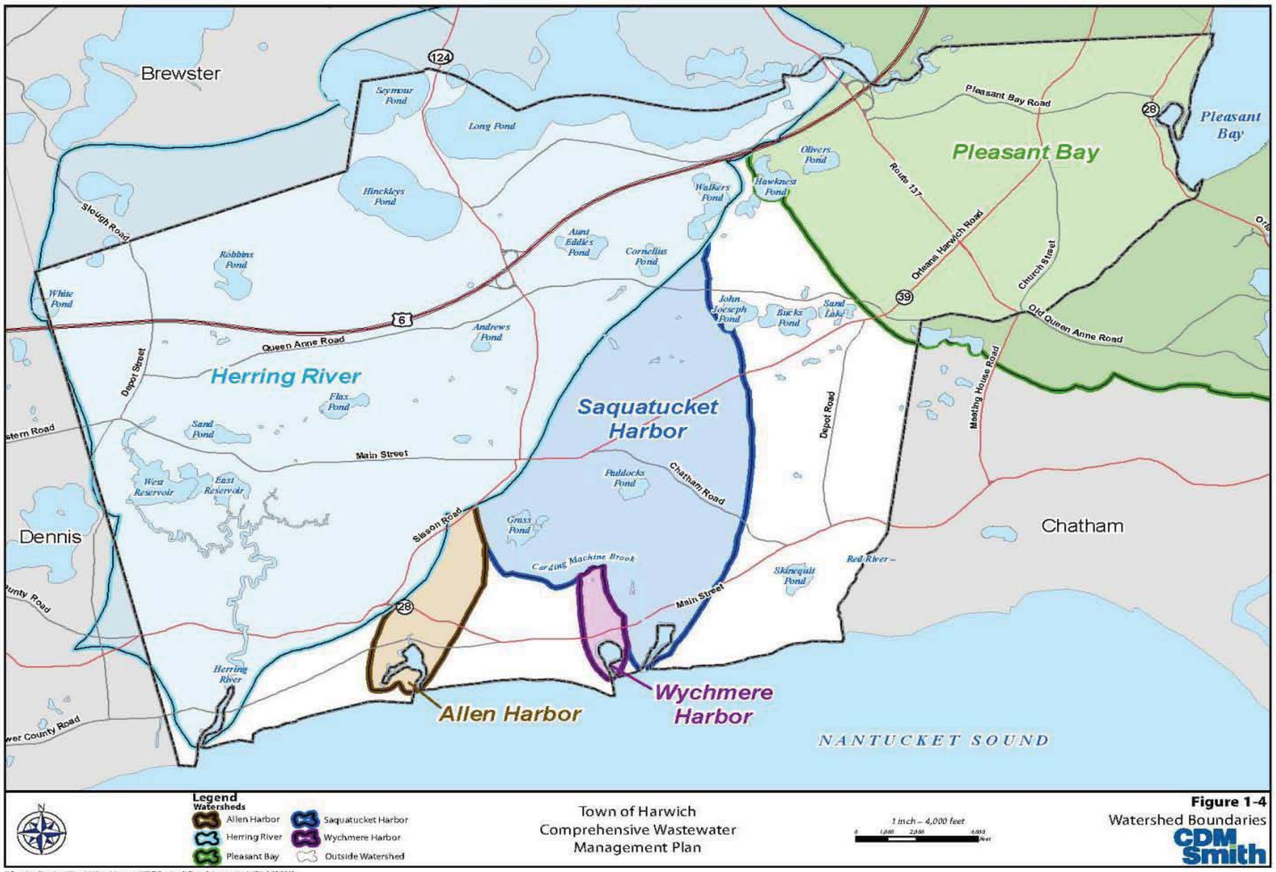


Beaches, Rivers & Harbors Are Severely Impacted By Nitrogen

Unhealthy Nitrogen Levels



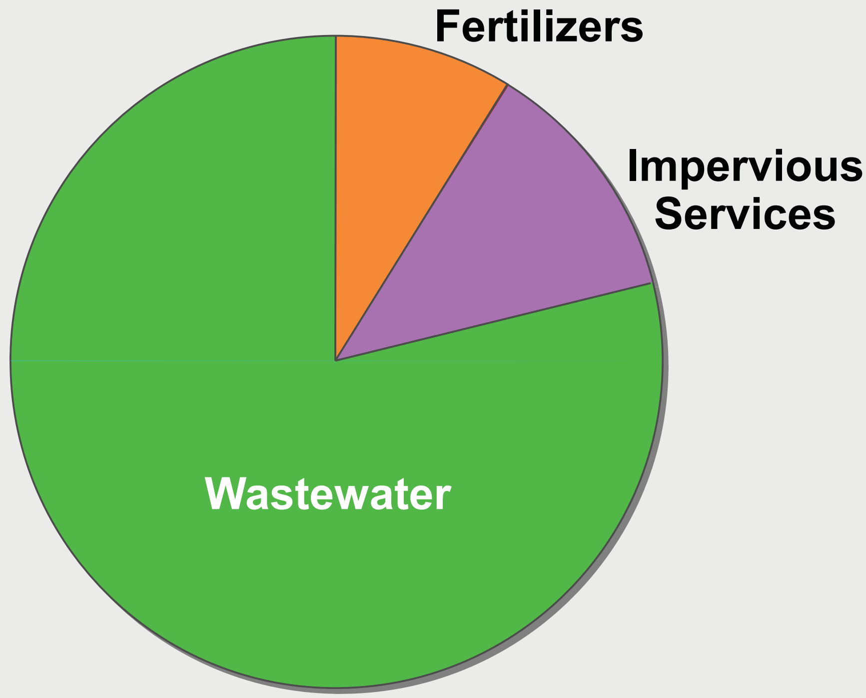
Existing Conditions – MEP Watersheds



Goals for CWMP

Harwich MEP Watershed	*Septic Nitrogen ("N") Removal Rates from Wastewater to Meet TMDL*
Herring River	25% (to be confirmed)
Allen Harbor	70-90 %
Wychmere Harbor	100 %
Saquatucket Harbor	70-90 %
Pleasant Bay	70-80%

Nitrogen Management

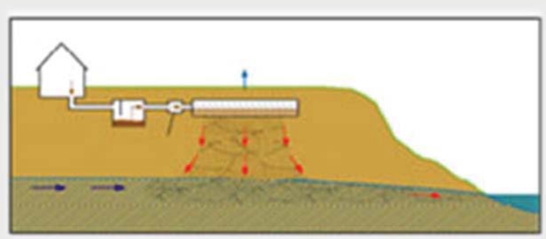


Local Control – Muddy Creek

Nitrogen From Septic Systems Is Our Biggest Issue

Septic Systems Permit Nitrogen to:

- Invade Our Ground Water
- Travel with Groundwater to the Beaches & Rivers

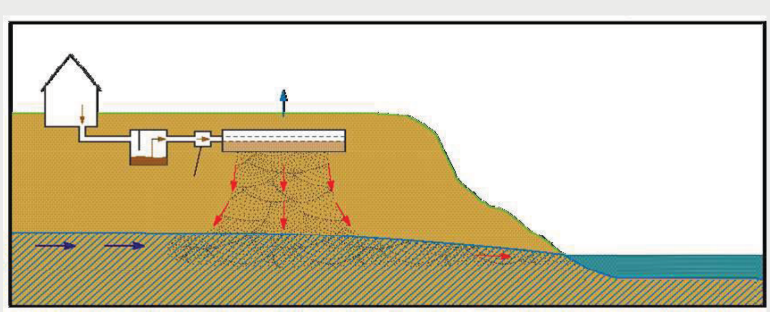


Nitrogen Management Is the Priority

- MEP results to date indicate significant nitrogen removal will be required in 4 of the 5 estuaries/ watersheds.
- Stormwater best management practices (BMPs) are important but have less impact
- Fertilizer management and education about use / impacts is important but also has less impact

Existing Conditions Assessment – Septic Systems (Title 5)

- Harwich predominantly has well draining soils
- Most areas have sufficient depth to groundwater or have mounded systems
- Densely developed areas have history of Title 5 waivers for setback requirements or deed restrictions limiting size



Septic System (Title 5) Issues

- Title 5 does not appear to be a driver for sewers based on existing conditions.
- Some areas may continue to require waivers for setbacks.
- Some areas may still require mounded systems.
- Some areas could be sewered to eliminate waivers and mounded systems.

Overall Areas Fall into 2 Wastewater Categories

- Area needs an off-site solution due to MEP N-removal requirements, socio-economic requirements or other reasons.
- Area can remain with on-site systems using nonstructural nutrient management solutions

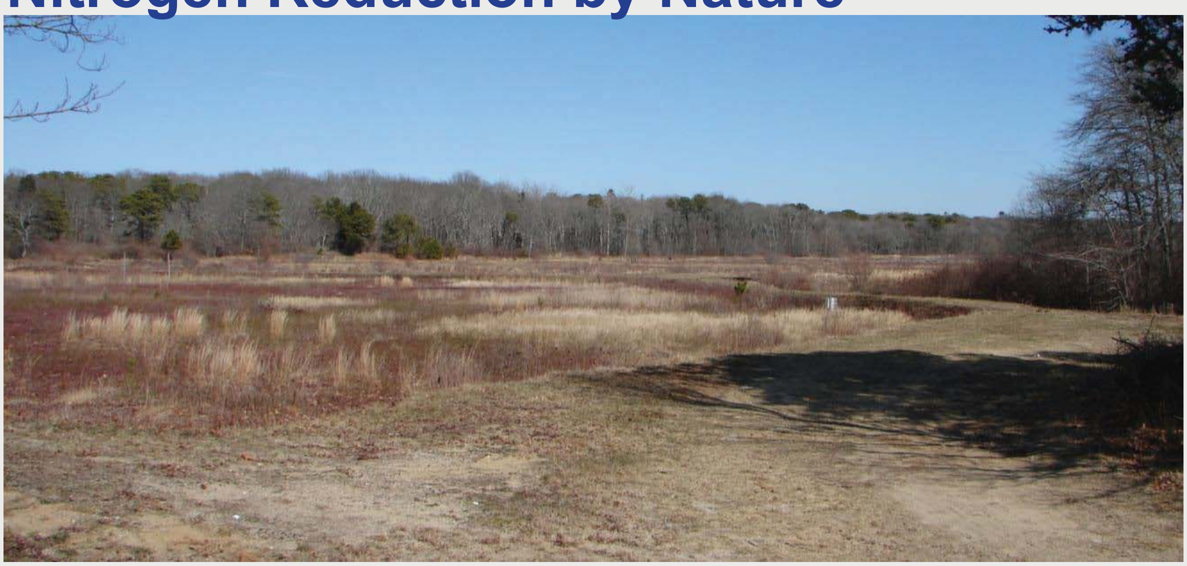
How Do We Solve?

Protect Beaches, Rivers & Harbors

Protect Drinking Water

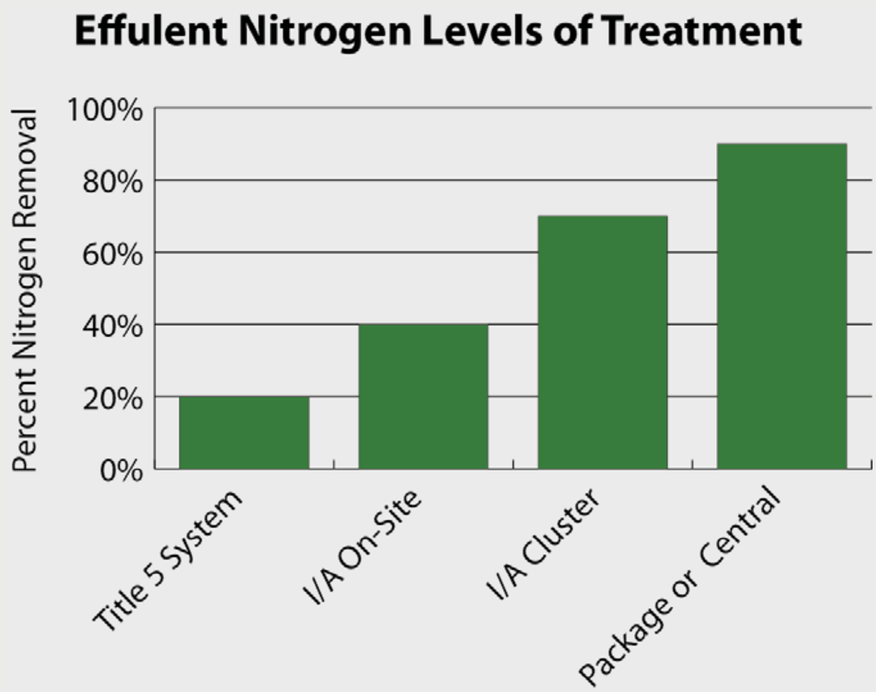
Encourage Economic Revitalization

Nitrogen Reduction by Nature



- Natural attenuation at Muddy Creek and Cold Brook Bogs
- Nitrogen treatment levels vary with available technologies

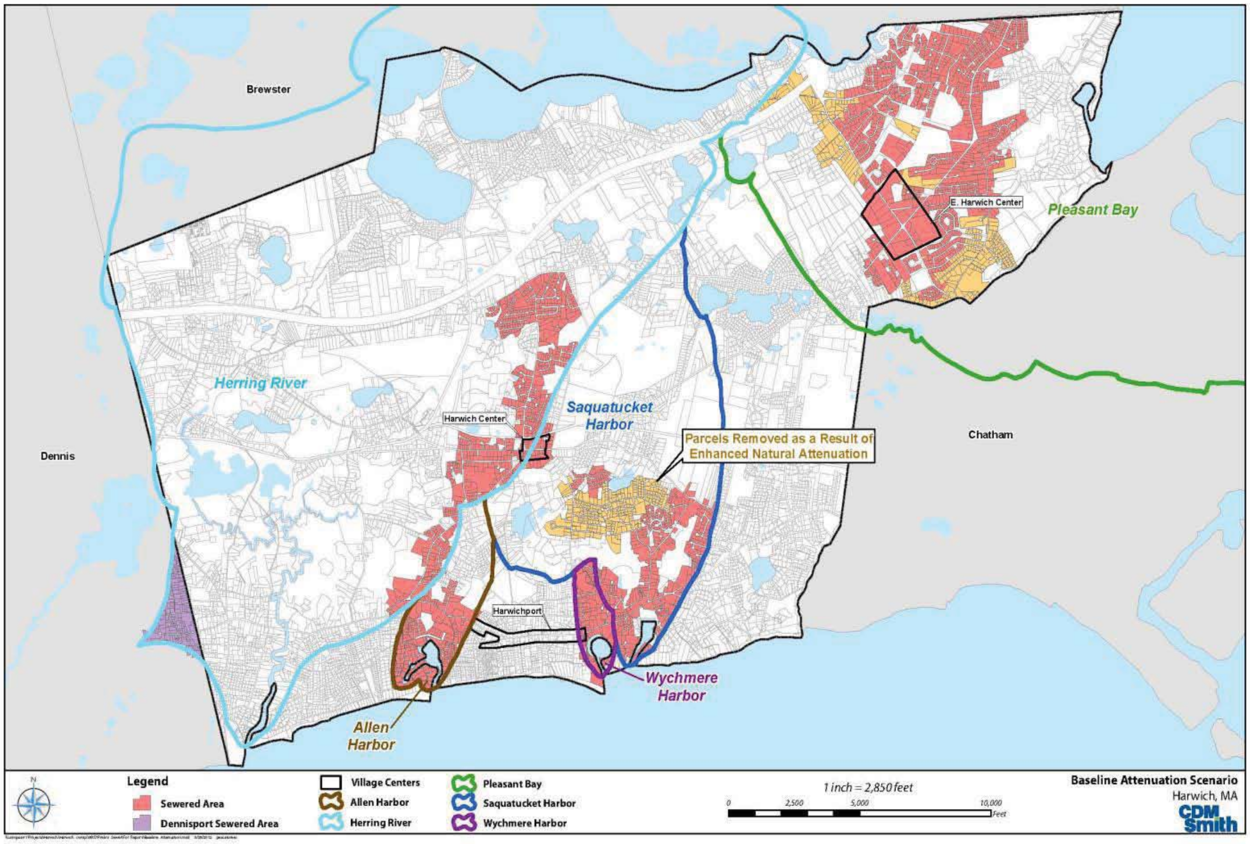
Nitrogen Removal By Technology



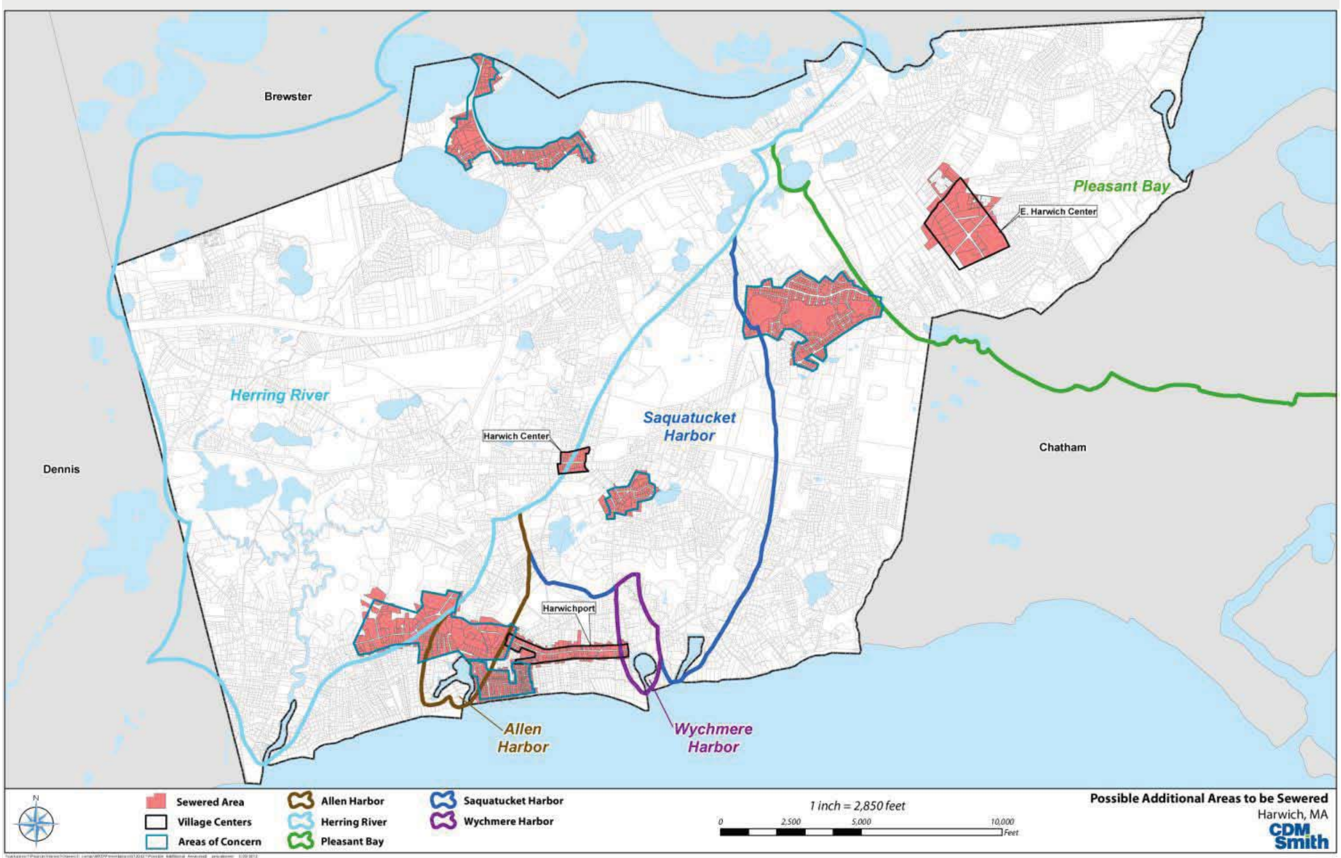
Harwich Properties Needing Nitrogen Removal

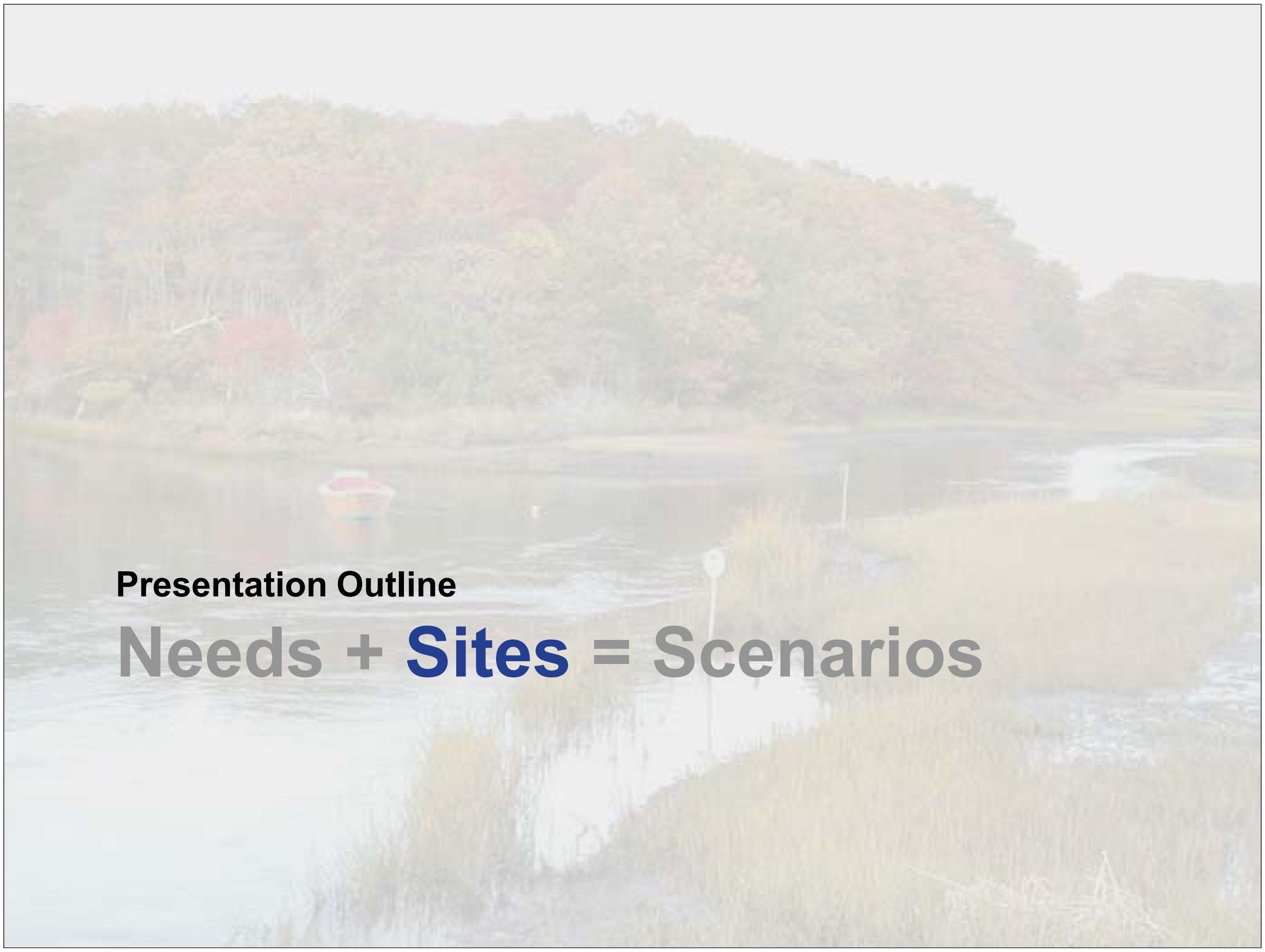
MEP Watershed	***Number of Developed Properties @ Build-Out***	***Nitrogen ("N") Removal rates from Wastewater to meet TMDL***	***Number of MEP Watershed Properties needing Nitrogen Removal***
Herring River	3,500	25 % (est.)	1,100
Allen Harbor	350	70-90 %	230
Wychmere Harbor	120	100 %	120
Saquatucket Harbor	1,400	70-90 %	400
Pleasant Bay	1,900	70-80 %	1,300
MEP Watershed Subtotal	**7,300**		**3,150**
Total Town-wide	**10,000**		

Minimum Sewer Service Areas to Meet Requirements = 30% of Town



Potential Areas Needing Treatment Include:





Presentation Outline

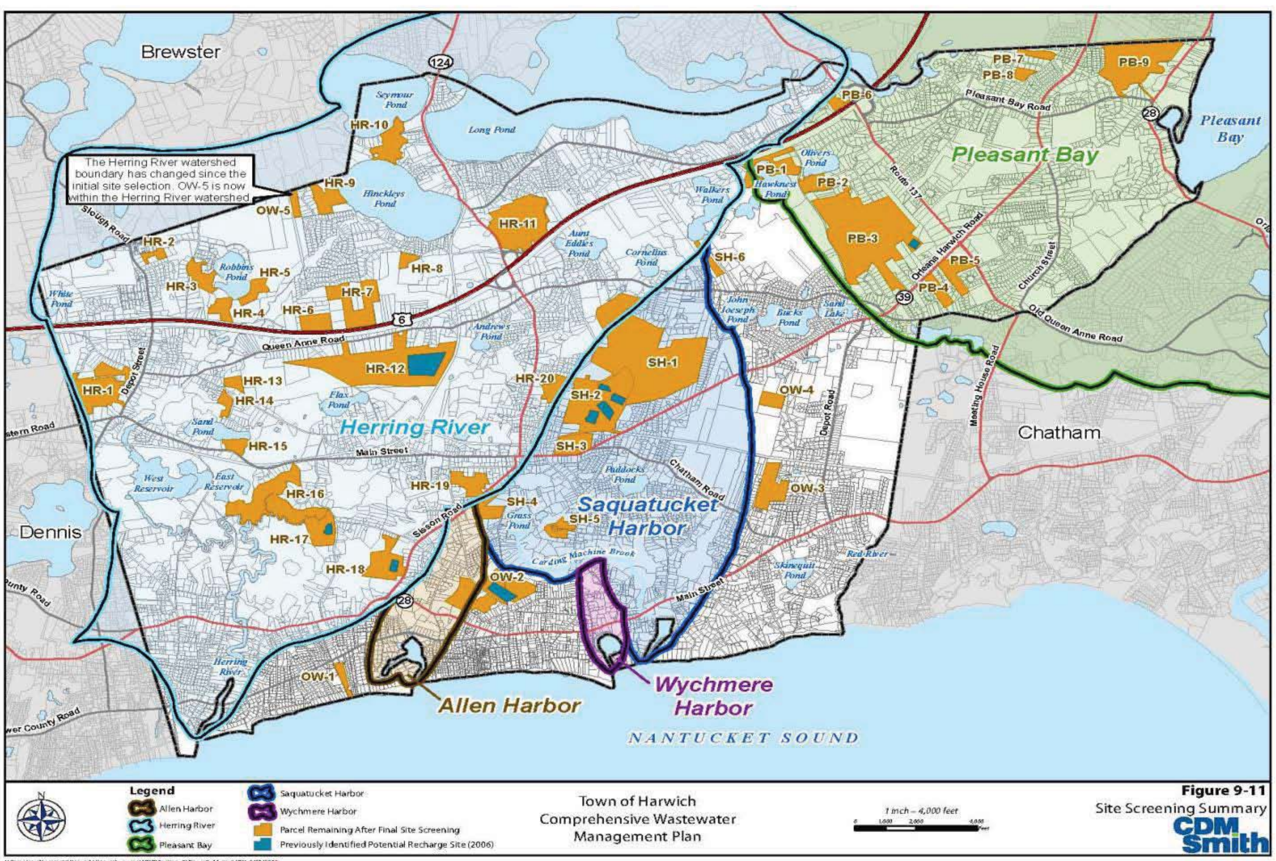
Needs + Sites = Scenarios

Treatment Site Screening Process

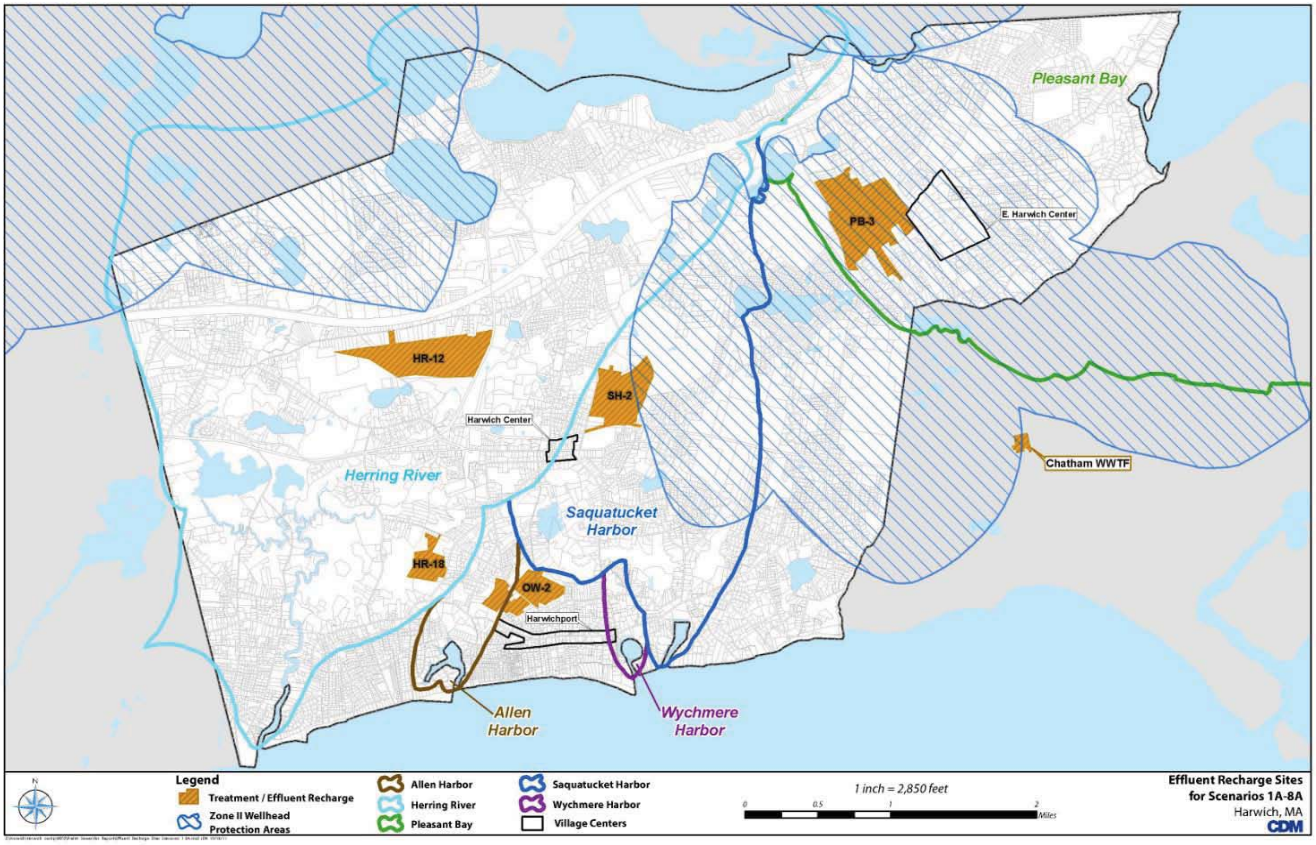
Treatment Site Screening Criteria

1. Outside of a Well Contribution Zone
2. Parcel Size Greater than 5 Acres
3. Outside of a 100-Year Floodplain Zone
4. Sites With Permeable Soils
5. Undeveloped Property
6. Parcels Outside of Wetlands
7. Favorable Depth to Groundwater
8. Outside Priority Habitat
9. Outside Municipal Wellhead Protection Zones
10. Town-Owned Property

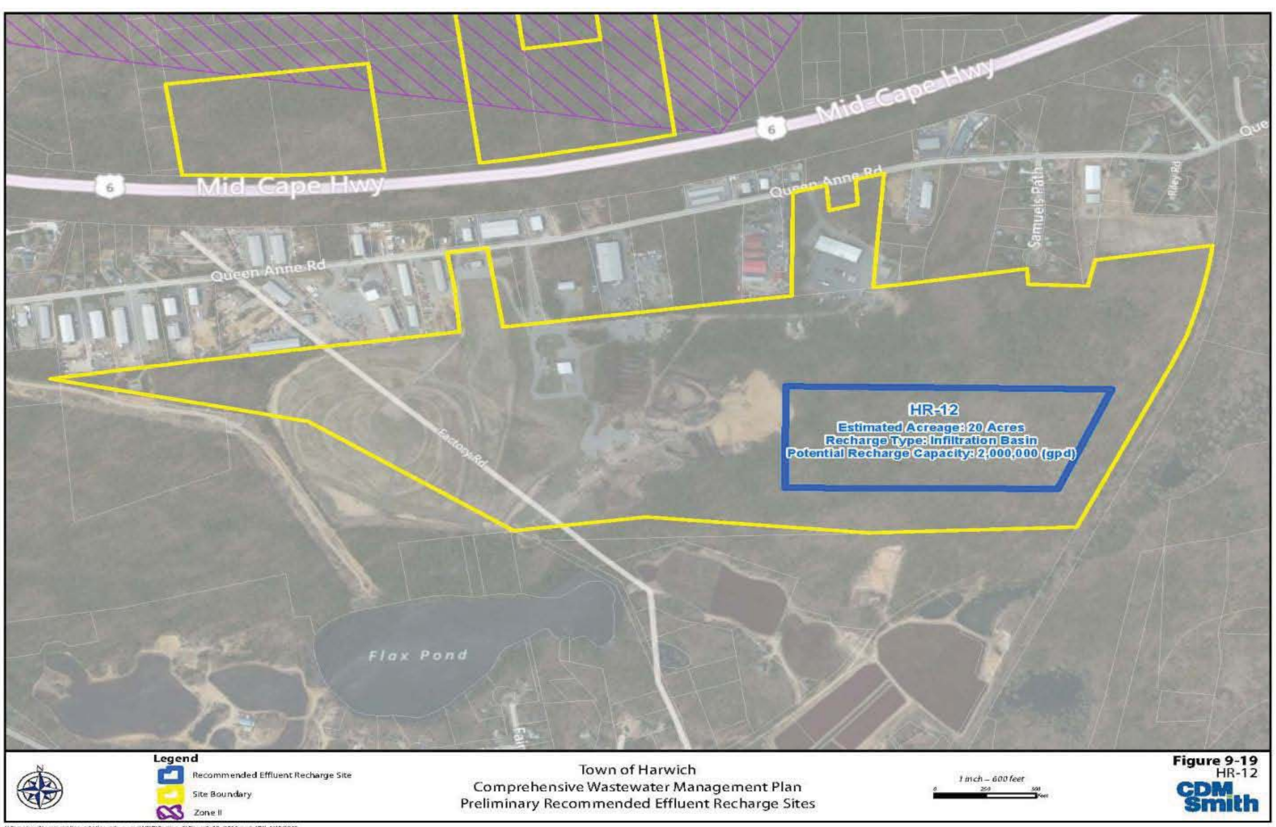
Site Screening Summary



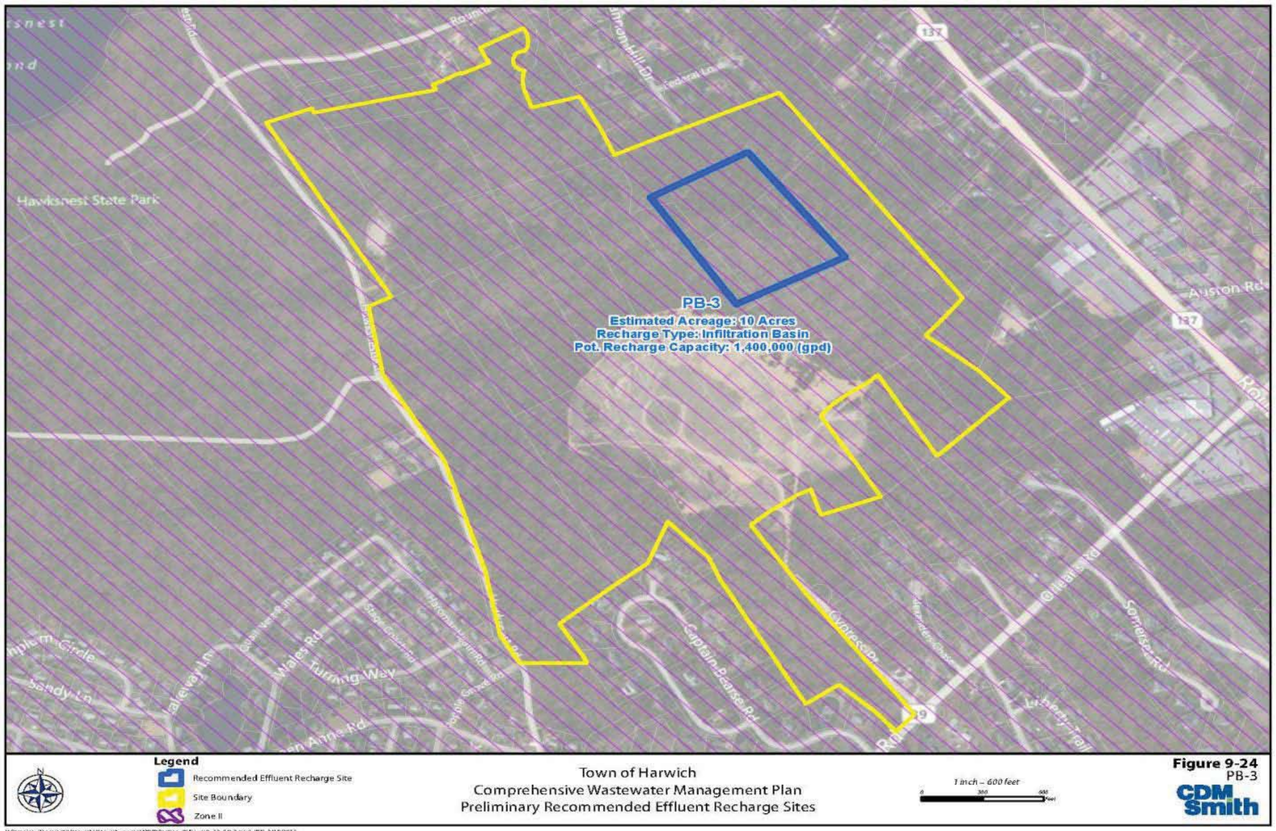
Site Screening
Final Recommended Sites



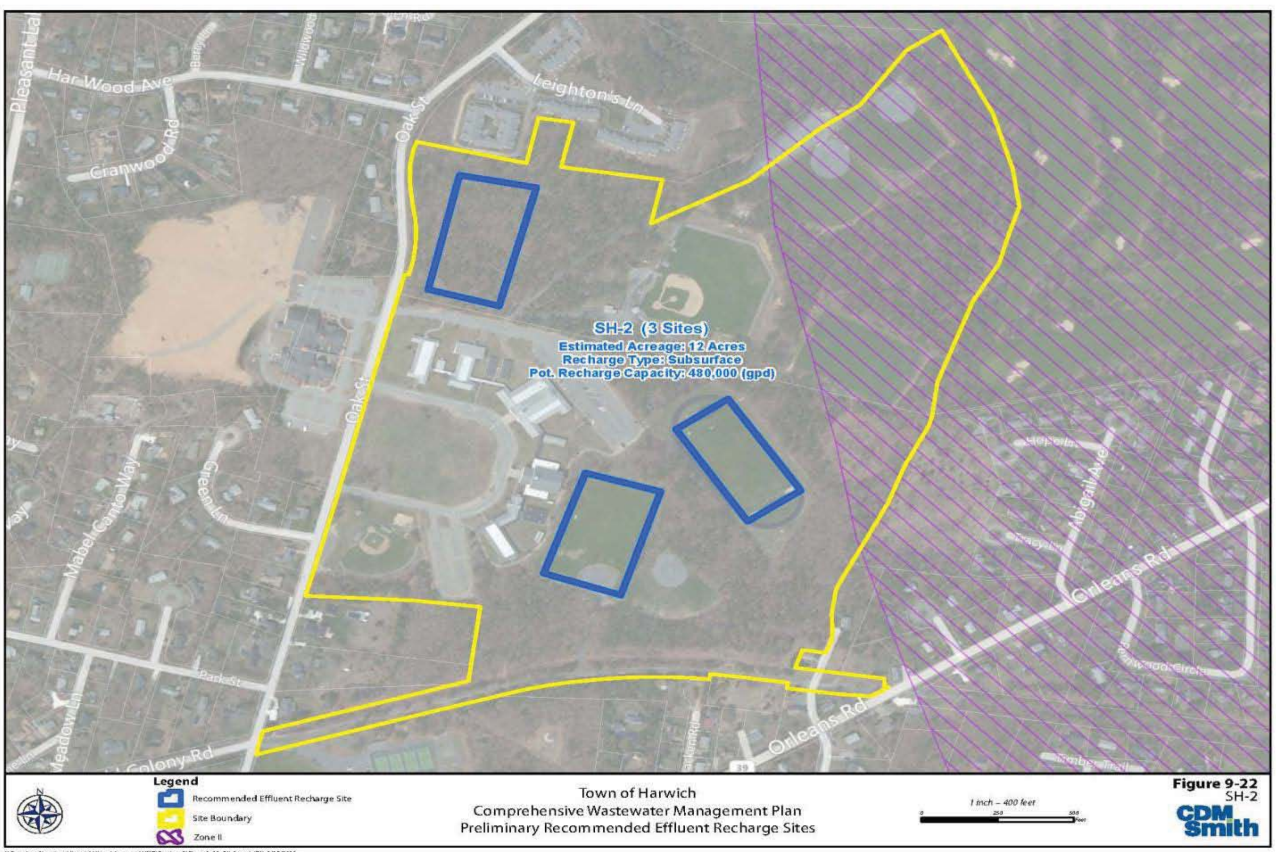
HR-12 – Adjacent to Former Town Landfill
In the Herring River Watershed



PB-3 – Privately Owned Gravel Pit In the Pleasant Bay Watershed



SH-2 – The High School Saquatucket Harbor Watershed

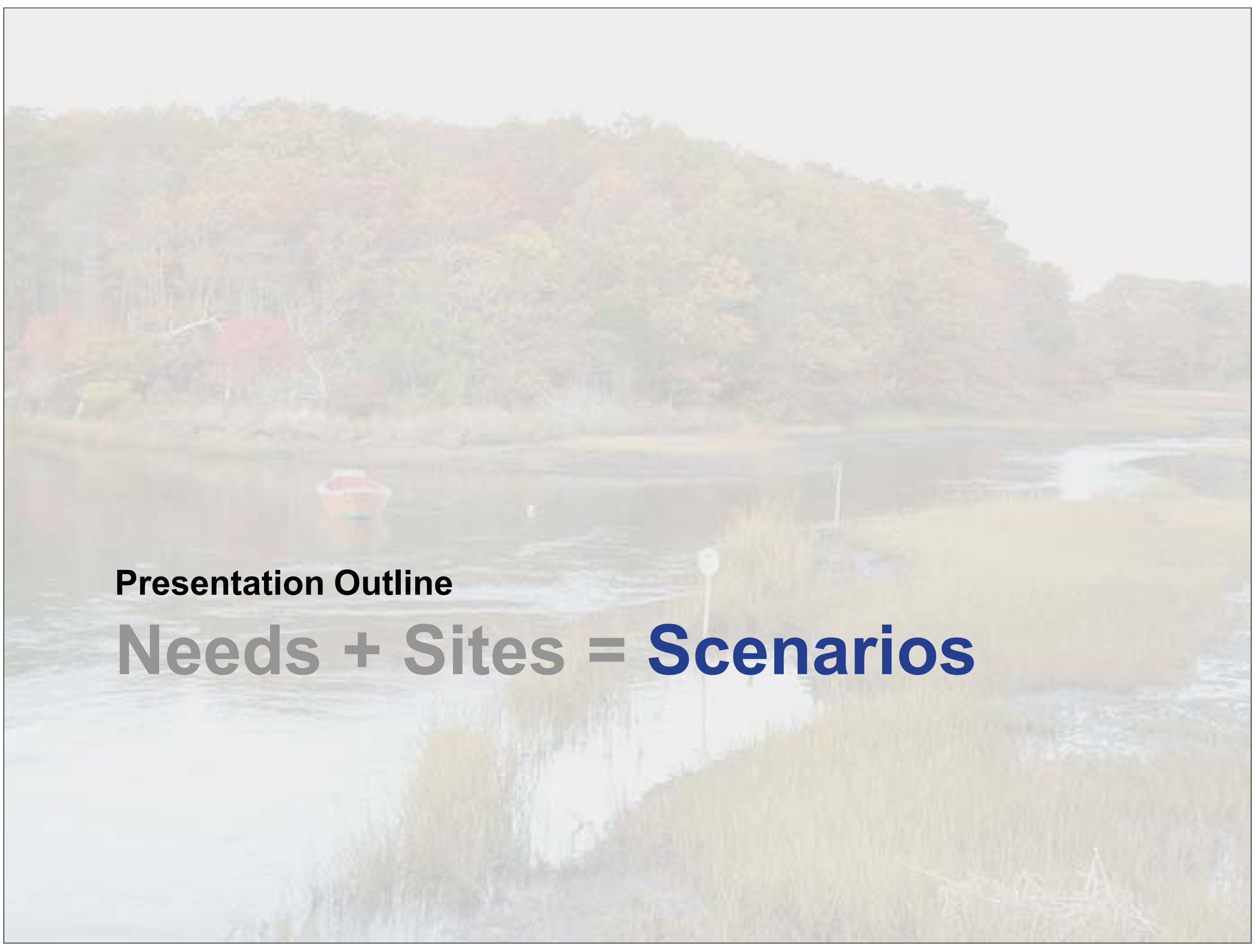


Chatham Wastewater Treatment Plant

Infiltration Basins

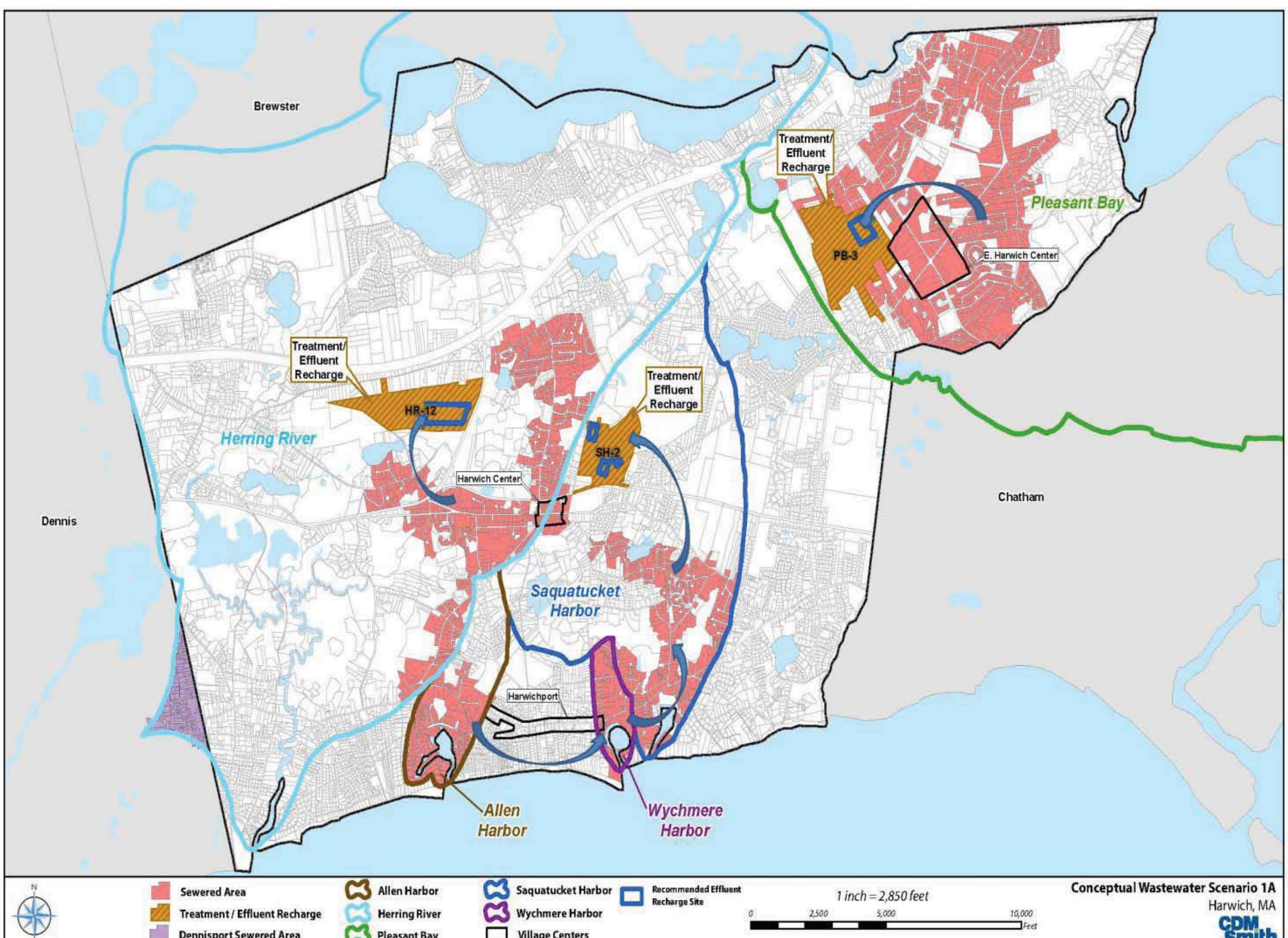
Water Reuse - Kingston Massachusetts

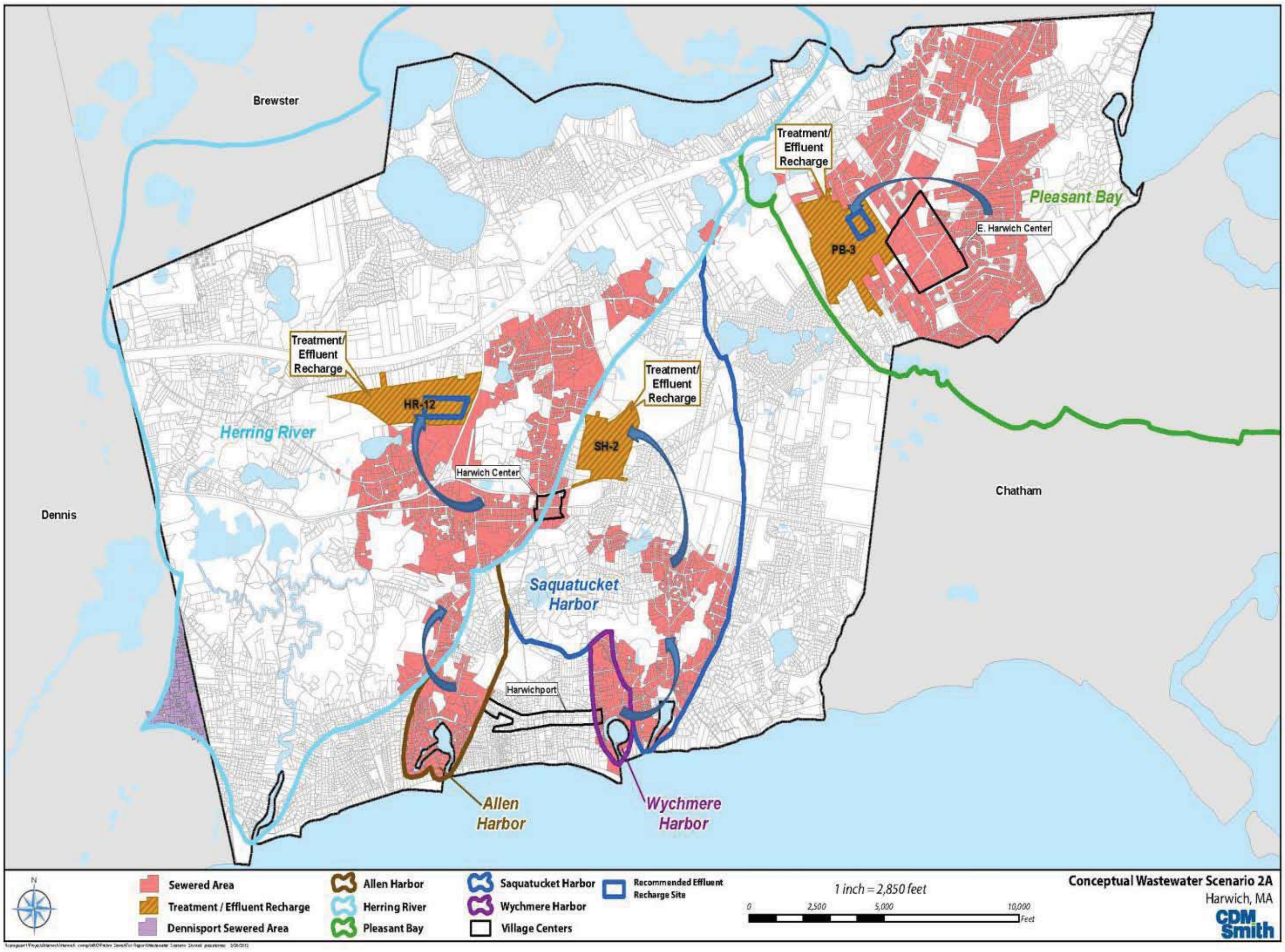
Indian Pond Golf Course – 300,000gpd effluent recharge site

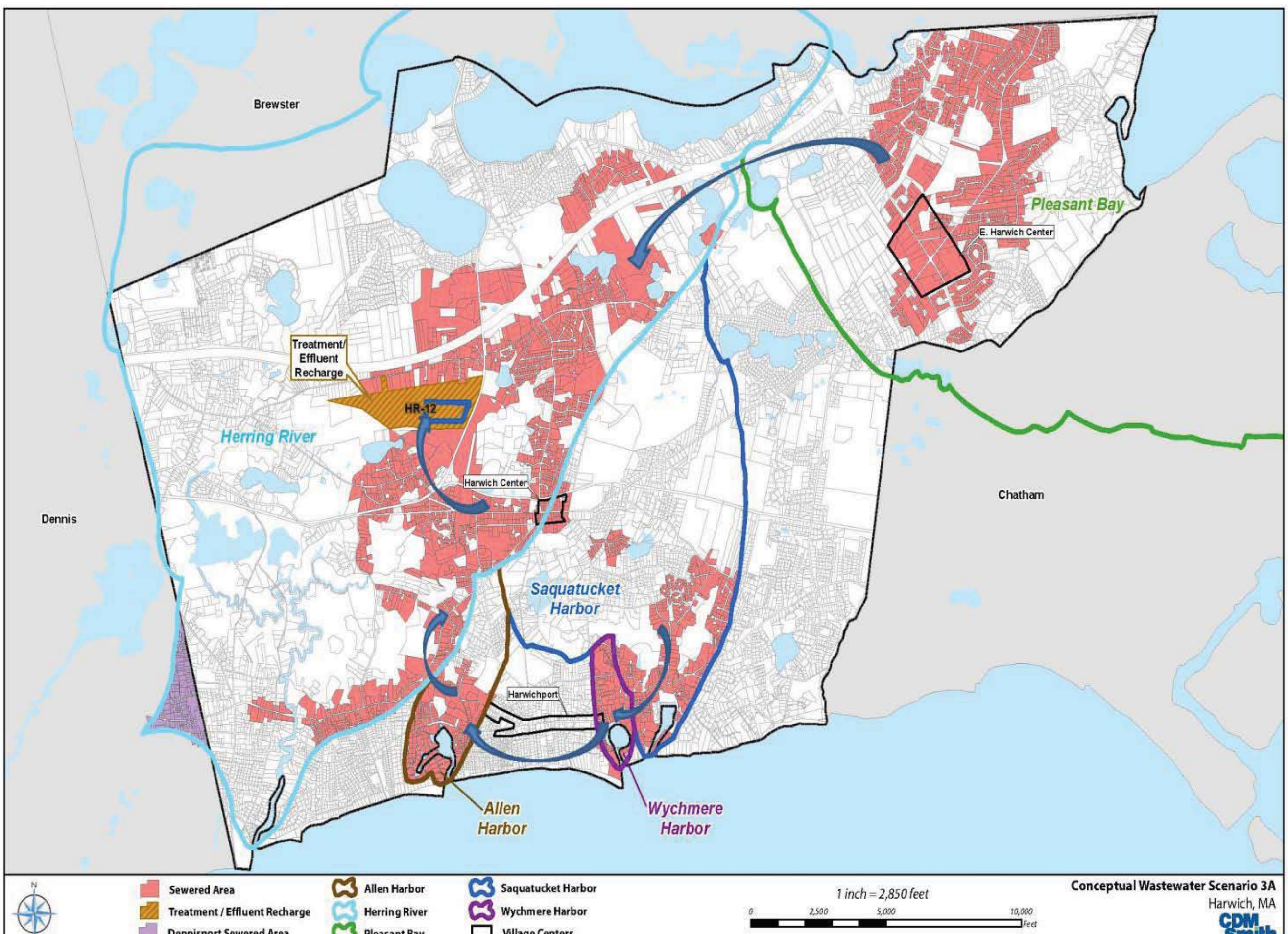


Summary of Wastewater Scenarios and Effluent Recharge Sites

Wastewater Service Scenario	Herring River Recharge Site HR-12	Saquatucket Harbor Recharge Site SH-2	Pleasant Bay Recharge Site PB-3	Outside MEP Watershed Recharge Site OW-2	Treatment Only At HR-18 : Ocean Used for Recharge Outfall
1A	x	x	x		
2A	x	x	x		
3A	x				
4A	x		x		
5A	x		x		
6A	x	x	x	x	
7A	x	x	x	x	
8A					x




Brewster
Dennis
Chatham
Pleasant Bay
Treatment/
Effluent
Recharge
PB-3
E. Harwich Center
Treatment/
Effluent
Recharge
HR-12
Treatment/
Effluent
Recharge
SH-2
Herring River
Harwich Center
Saquatucket
Harbor
Harwichport
Allen
Harbor
Wychmere
Harbor
Sewered Area
Treatment / Effluent Recharge
Dennisport Sewered Area
Allen Harbor
Herring River
Pleasant Bay
Saquatucket Harbor
Wychmere Harbor
Village Centers
Recommended Effluent
Recharge Site
1 inch = 2,850 feet
0
2,500
5,000
10,000
Feet
Conceptual Wastewater Scenario 2A
Harwich, MA
CDM
Smith


Brewster
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Pleasant Bay
E. Harwich Center
Treatment/
Effluent
Recharge
HR-12
Herring River
Harwich Center
Saquatucket
Harbor
Harwichport
Allen
Harbor
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Treatment / Effluent Recharge
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Allen Harbor
Herring River
Pleasant Bay
Saquatucket Harbor
Wychmere Harbor
Village Centers
1 inch = 2,850 feet
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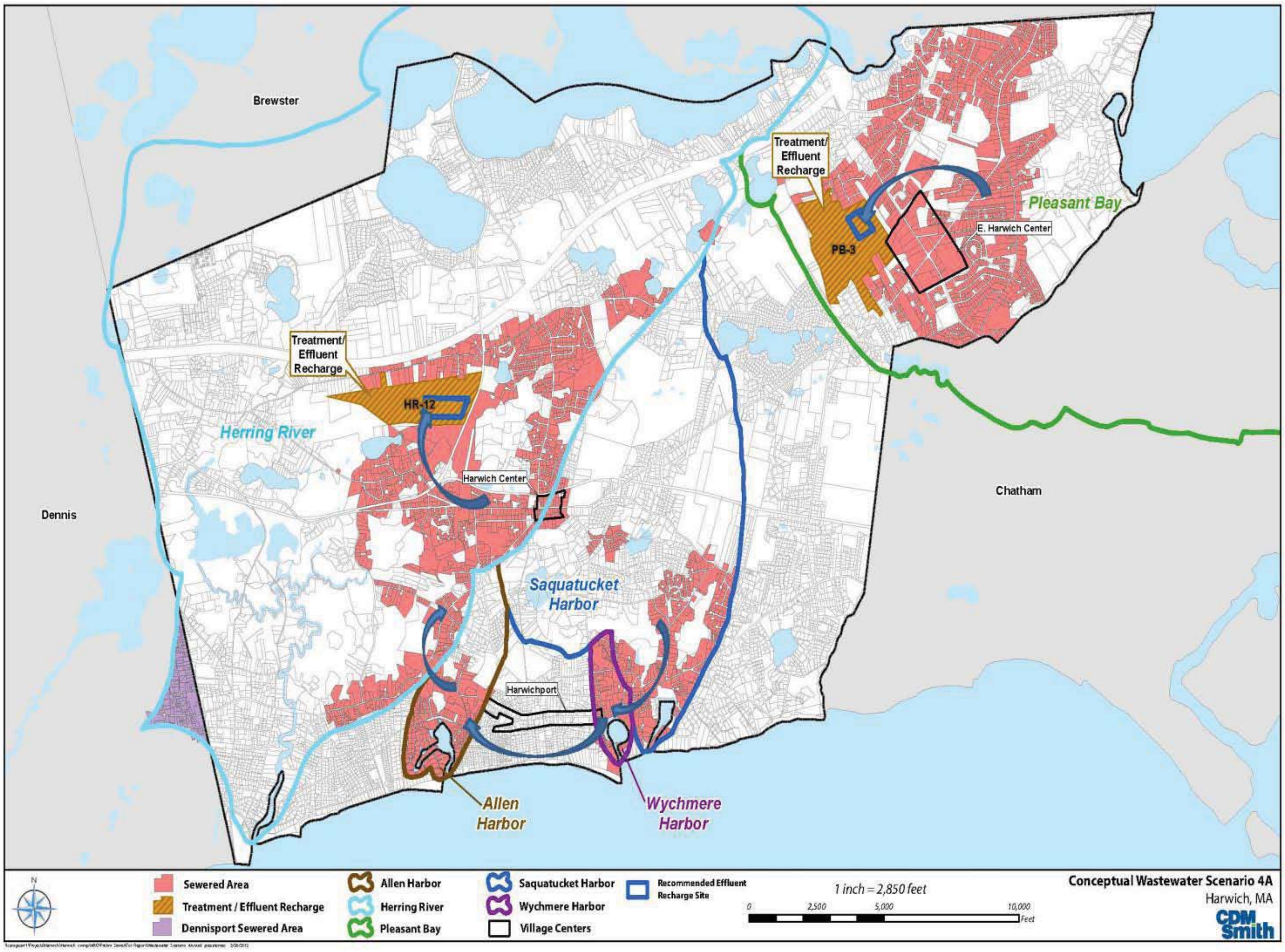
Feet
Conceptual Wastewater Scenario 3A
Harwich, MA
CDM
Smith


Brewster
Treatment/
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Recharge
Pleasant Bay
PB-3
E. Harwich Center
Treatment/
Effluent
Recharge
HR-12
Herring River
Harwich Center
Dennis
Chatham
Saquatucket
Harbor
Harwichport
Allen
Harbor
Wychmere
Harbor
Sewered Area
Treatment / Effluent Recharge
Dennisport Sewered Area
Allen Harbor
Herring River
Pleasant Bay
Saquatucket Harbor
Wychmere Harbor
Village Centers
Recommended Effluent
Recharge Site
1 inch = 2,850 feet
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2,500
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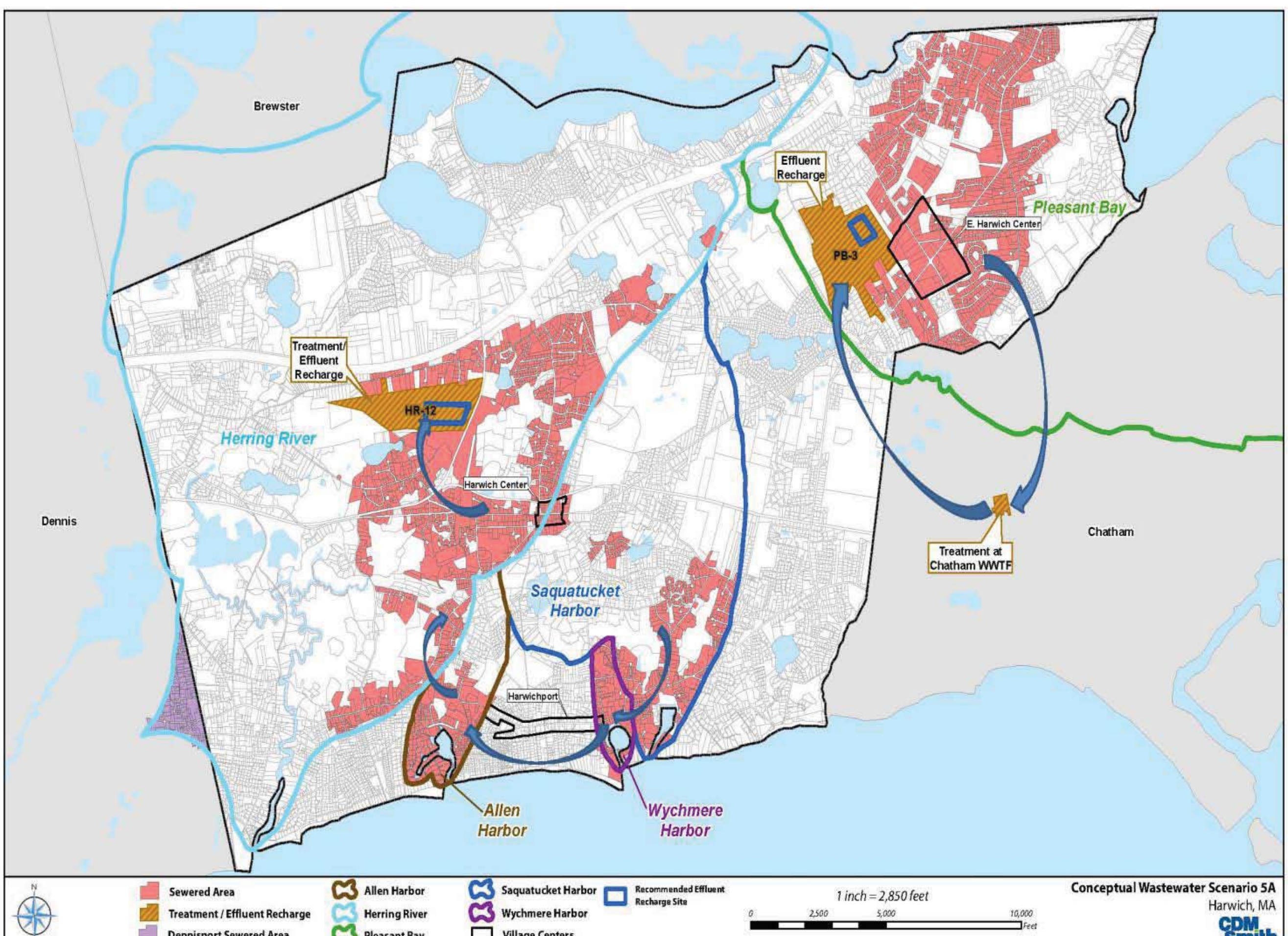
Feet
Conceptual Wastewater Scenario 4A
Harwich, MA


Brewster
Effluent
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Treatment/
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Harwich Center
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Chatham WWTF
Saquatucket
Harbor
Harwichport
Allen
Harbor
Wychmere
Harbor
Sewered Area
Treatment / Effluent Recharge
Dennisport Sewered Area
Allen Harbor
Herring River
Pleasant Bay
Saquatucket Harbor
Wychmere Harbor
Village Centers
Recommended Effluent
Recharge Site
1 inch = 2,850 feet
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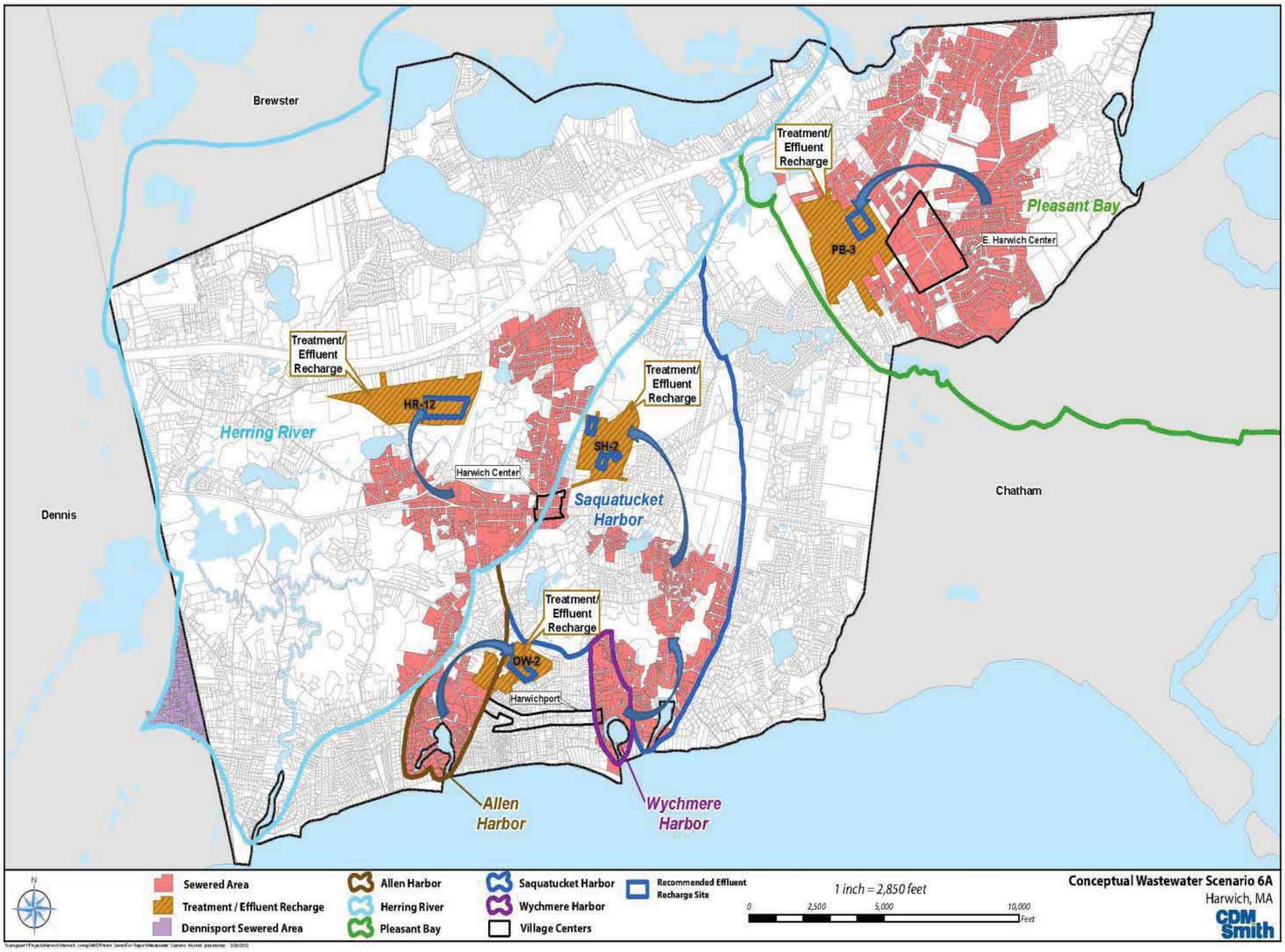
Feet
Conceptual Wastewater Scenario 5A
Harwich, MA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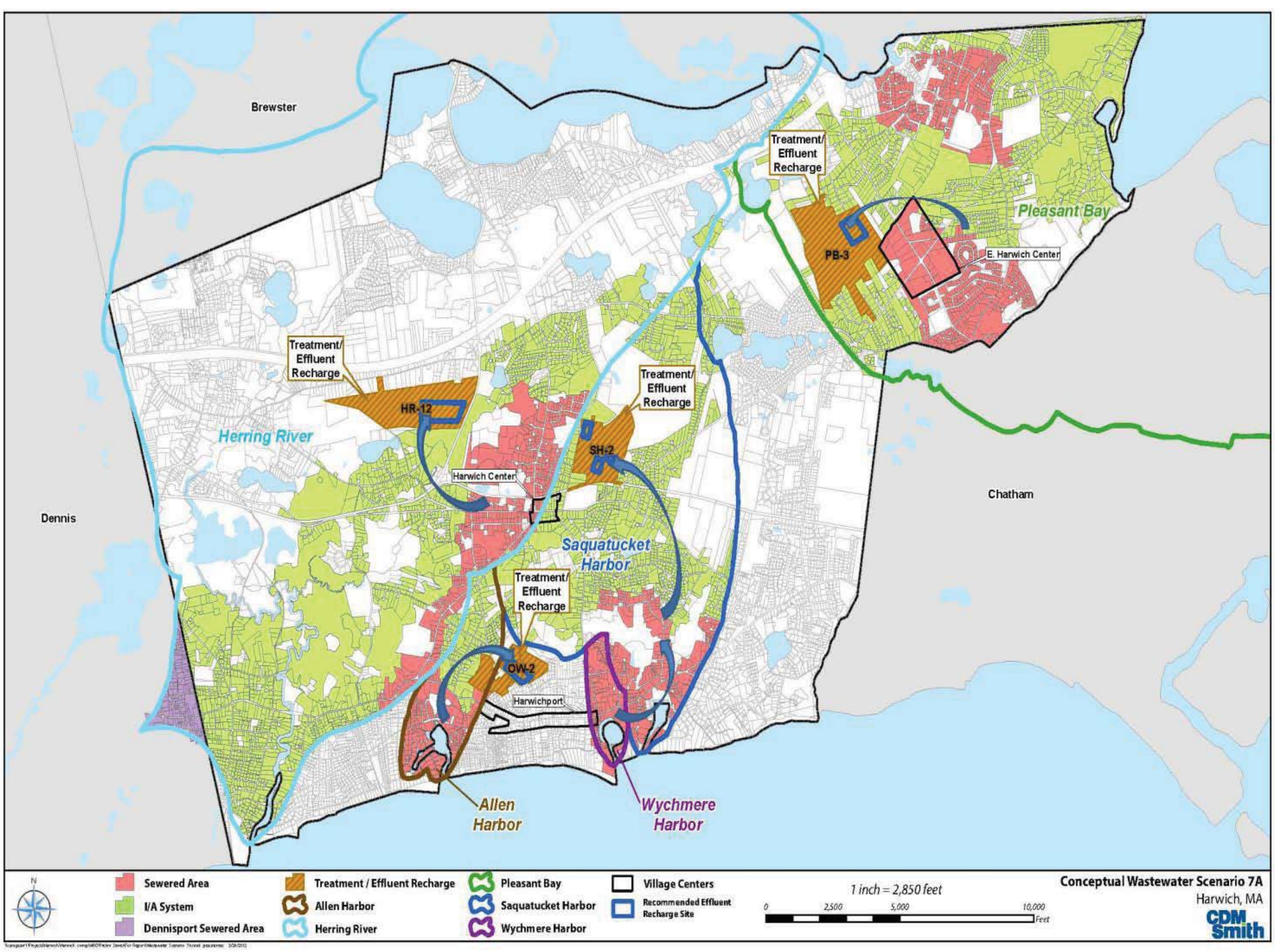
Treatment/ Effluent Recharge
Treatment/ Effluent Recharge
Pleasant Bay
PB-3
E. Harwich Center
HR-12
SH-2
Herring River
Harwich Center
Saquatucket Harbor
OW-2
Harwichport
Allen Harbor
Wychmere Harbor
Sewered Area
Treatment / Effluent Recharge
Dennisport Sewered Area
Allen Harbor
Herring River
Pleasant Bay
Saquatucket Harbor
Wychmere Harbor
Village Centers
Recommended Effluent Recharge Site
1 inch = 2,850 feet
0 2,500 5,000 10,000 Feet
Conceptual Wastewater Scenario 6A
Harwich, MA
CDM Smith


Brewster
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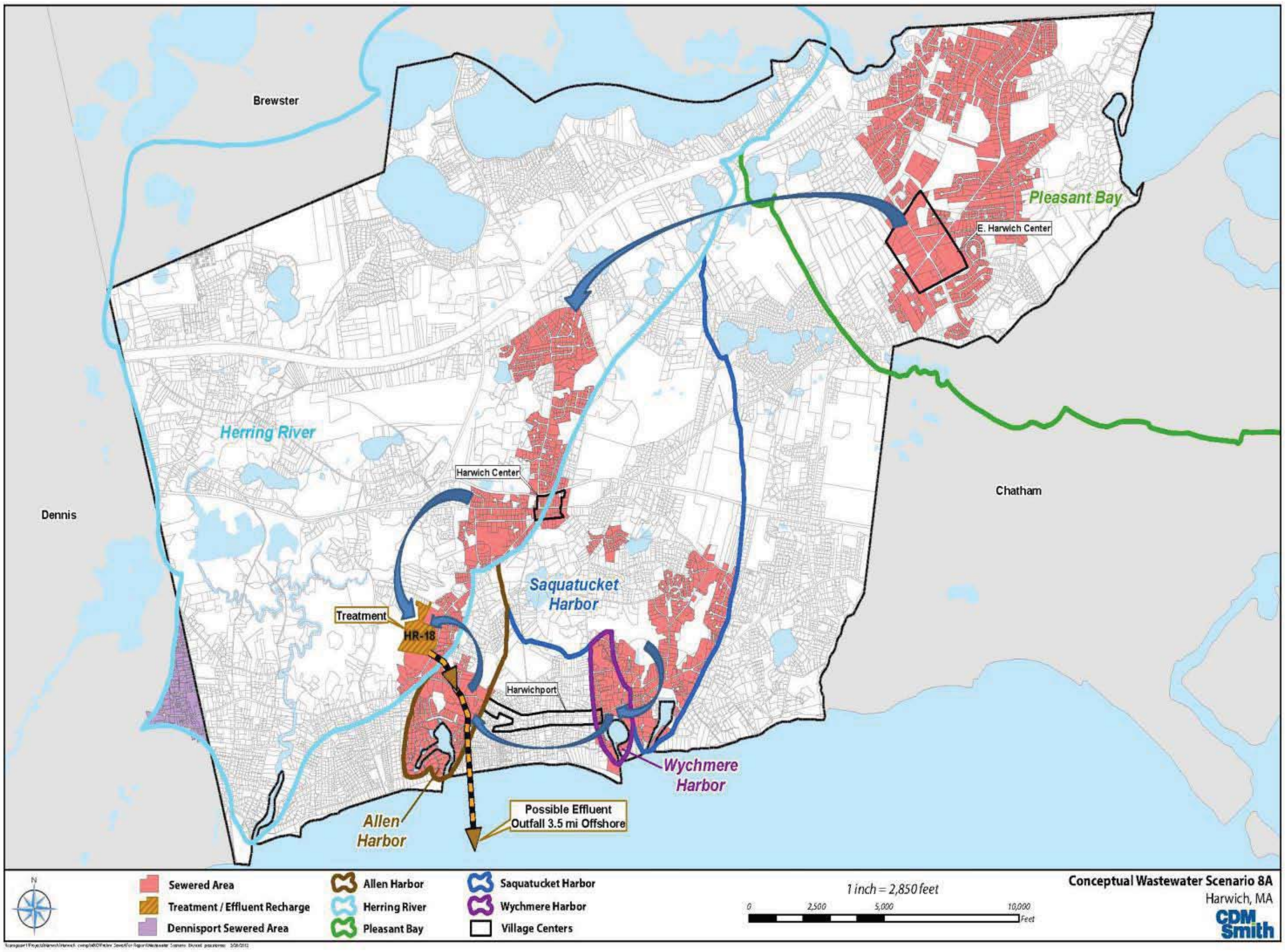
Treatment/ Effluent Recharge
Pleasant Bay
PB-3
E. Harwich Center
HR-12
SH-2
Herring River
Harwich Center
Saquatucket Harbor
OW-2
Harwichport
Allen Harbor
Wychmere Harbor
Sewered Area
I/A System
Dennisport Sewered Area
Treatment / Effluent Recharge
Allen Harbor
Herring River
Pleasant Bay
Saquatucket Harbor
Wychmere Harbor
Village Centers
Recommended Effluent Recharge Site
1 inch = 2,850 feet
0 2,500 5,000 10,000 Feet
Conceptual Wastewater Scenario 7A
Harwich, MA
CDM Smith



Results of Scenario Screening

Evaluation of Alternatives - Harwich CWMP Wastewater Scenarios								
Scenarios	***1A***	***2A***	***3A***	***4A***	***5A***	***6A***	***7A***	***8A***
TOTAL WITH WEIGHTING	**270**	**266**	**145**	**223**	**204**	**321**	**402**	**366**

Rankings Are Based On The Following Four Criteria:

1. Relative Costs
2. Technical Criteria
3. Institutional Criteria
4. Environmental Criteria

Summary of Final Recommended Wastewater Scenarios and Effluent Recharge Sites

- **3A – Single Treatment Plant**
- **4A – Two Treatment Plants**
- **5A – Two Treatment Plants: Includes Regional Solution with Chatham**

Wastewater Service	*Herring River Recharge Site*	*Pleasant Bay Recharge Site*
Scenario	*HR-12*	*PB-3*
3A	x	
4A	x	x
5A	x	x

Next Steps

- **Finalize effluent recharge modeling and evaluate potential impacts**
- **Evaluate collection system types and treatment technologies**
- **Develop life cycle costs for each scenario**
- **Develop criteria and ratings system to prioritize three final wastewater scenarios**

CWMP Schedule

- April - June 2012 – Develop Draft Recommended Wastewater Program
- June 2012 – Community meeting to present recommended wastewater program
- July – August 2012 – Begin State and County permitting review of Draft CWMP

How to get involved?

- Contact Committees
  - Water Quality Management Task Force – Wastewater Management Subcommittee
  - Citizens Advisory Committee
  - Wastewater Implementation Advisory Committee
- Go to Website - Meeting Schedule and Meeting Minutes (Calendar of Events, etc.)
- Watch Channel 18 - Postings
- Join email – see sign-up sheet

Summary

- This is a complex planning process – one that will continue indefinitely – as things will change – adaptive management
- The CWMP is intended to be a living document that will adapt depending on results of earlier implementation phases
- Most properties in town contribute to the problem – not just those along a water body or those proposed for sewering
- All benefit from improved water quality

Community Meeting 6

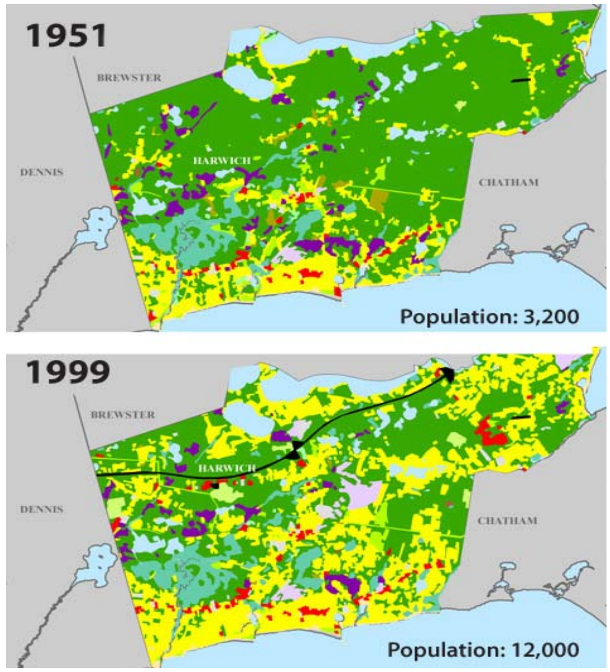
Summary of Harwich Utility

- 180 Miles of Utility Pipes
- 5 Pumping Stations
- 3 Storage Tanks
- Treatment Facility
- Administration Offices and Maintenance Garages
- 40+ Year Program
- Capital Cost Range (Today's Dollars):

$215 to $255 Million

Harwich Land Use Development 1951 and 1999

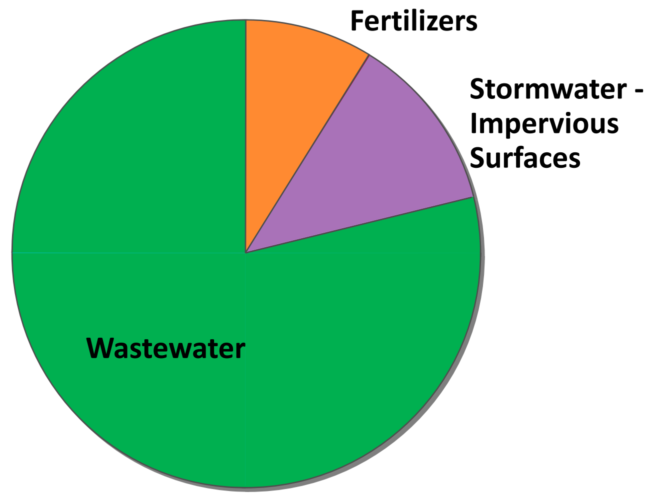
- 400% population growth from 1951 to 1999



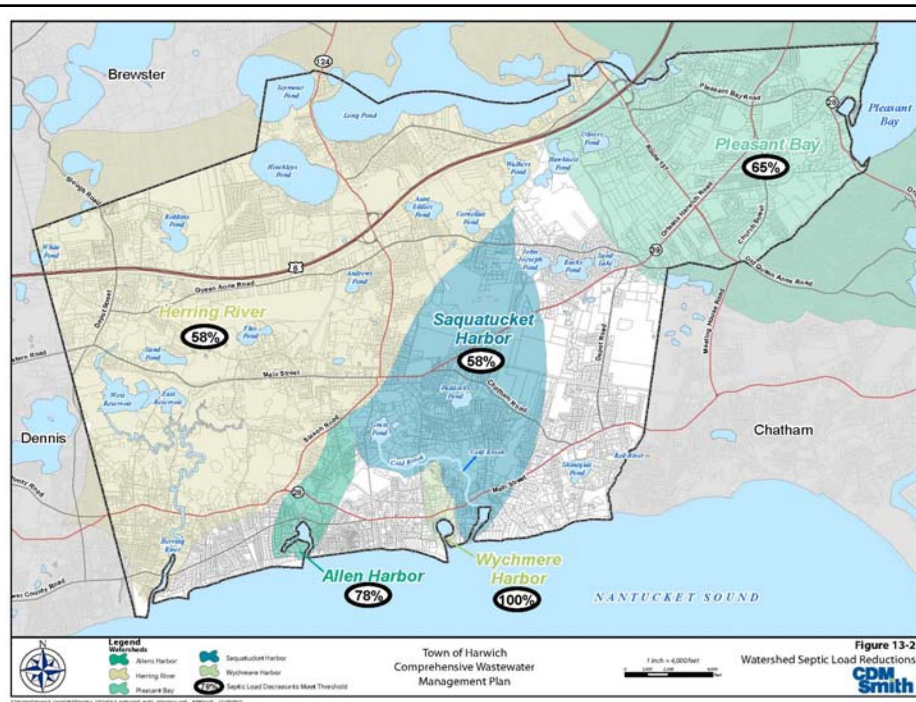
Allen Harbor Algae Bloom

Summer 2007

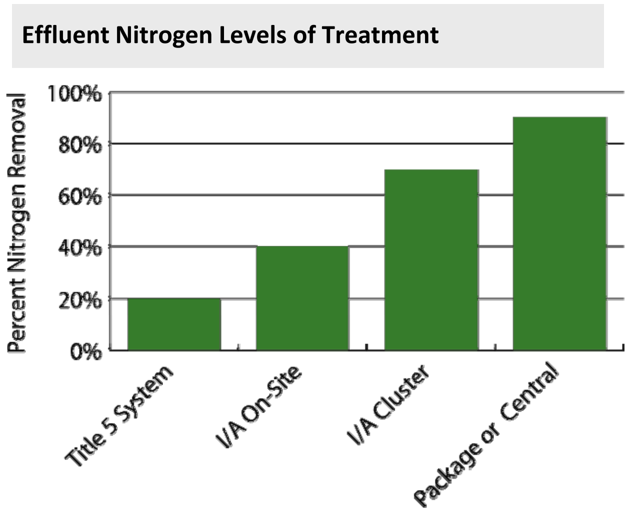
Controllable Sources of Nitrogen

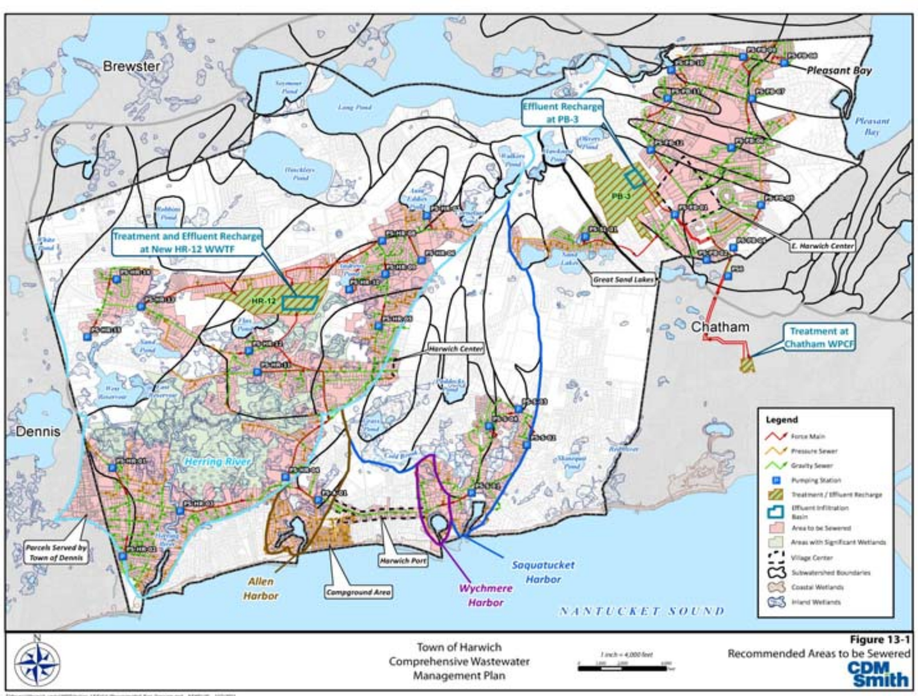


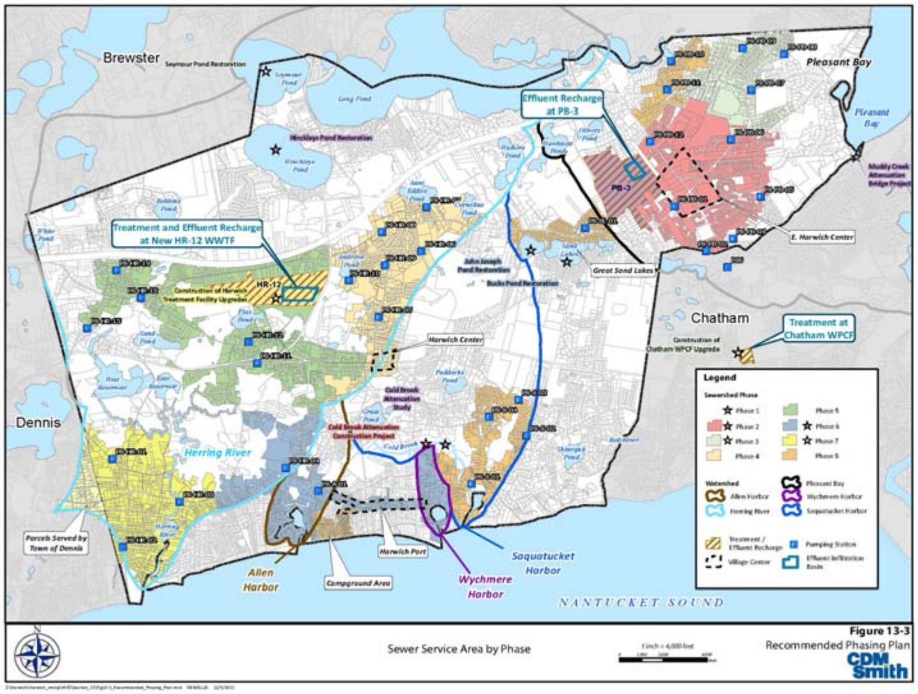
Local Control - Typical



Nitrogen Removal By Technology







Recommended Program – Scenario 5A With Updates

- Two Treatment Plants
- First phases utilize regional solution by using Chatham wastewater plant to treat Harwich flows from Pleasant Bay watershed
- Future phases utilize Harwich treatment plant built at landfill site to treat and recharge wastewater from other four watersheds
- Program built in eight phases over 40 years
- Includes 23 % growth at build-out
- Capital costs range $180 to $230 Million

Recommended Program – Scenario 5A With Updates

- Non-infrastructure Components
  - Public Outreach
  - Fertilizer Management Education
  - Stormwater Best Management Practices
  - Freshwater Pond Evaluations and Restoration
  - Land Use Planning/ Zoning/ Acquisition
  - Other
- Adaptive Management Process

CWMP Schedule

- November 2012 – WQMTF Wastewater Management Subcommittee endorsed recommended program
- January 2013 - Board of Selectmen endorse filing of recommended Draft CWMP program - ?
- February 2013 - Begin year long State and County permitting review of Draft CWMP
- Spring 2013 Town Meeting actions
  - Fund remainder of CWMP
  - Fund Phase 1 of recommended program

Summary

- This is a complex planning process – one that will continue indefinitely – as things will change – adaptive management process
- The CWMP is intended to be a living document that will adapt depending on results of earlier implementation phases
- Most properties in town contribute to the problem – not just those along a water body or those proposed for sewering
- All benefit from improved water quality

Frequently Asked Questions

Harwich Comprehensive Wastewater Management Plan
Frequently Asked Questions - Update January 28, 2013

The Town of Harwich (the Town) is developing a town-wide Comprehensive Wastewater Management Plan (CWMP) to address long-term wastewater needs and restore and maintain the quality of all of the town's water resources. The CWMP will provide the flexibility to create a lasting solution by addressing the existing sources of pollution within a given watershed as well as potential sources of pollution posed by changing development patterns. The CWMP will seek to balance water quality needs with the ability to finance necessary improvements. Priorities will be set and an implementation schedule established to maximize the effect of any public improvements within a watershed and between watersheds.

A Draft CWMP is currently available and posted on the Town's website. A workshop to review and discuss this Draft was held on January 19, 2013 at the Harwich Community Center from 9:00 am to 11:00 am. The Board of Selectmen is approved the filing of the Draft CWMP on January 28, 2013. The document will be filed with state agencies in February, 2013 which begins about a one year approval process.

Q1. What is the current status of the Comprehensive Wastewater Management Plan (CWMP)?

A1. After a delay of over a year, while the Town awaited the results of the Massachusetts Estuaries Project (MEP) evaluation of the Town water quality in the five embayments, the Town has received the information required to move the project forward. Thus, a Draft CWMP is now available for review and comment.

Q2. What is the purpose of this project?

A2. The CWMP is an integral part of the planning process to address Harwich's long-term wastewater and water resource needs over the next 30 to 40 years. These critical needs include:

- Addressing existing nitrogen issues that are degrading the water quality of the harbors and estuaries along the Harwich shore
- Maintaining the excellent drinking water quality in the Town's 14 municipal groundwater supply wells
- Preserving the valuable fresh water pond resources in town
- Providing future utilities for Harwich to implement smart growth via its Village Centers Initiatives
- Meeting acceptable wastewater management practices either through continued use of on-site Title 5 subsurface disposal systems and/or an offsite treatment and disposal system

By addressing these needs Harwich will remain a vibrant tourist community that provides a desired quality of life for year-round and seasonal residents.

Q3. Will wastewater treatment lead to explosive growth and development, including condominium developments, large apartment complexes, strip malls, and such. What will happen to the "villages" of Harwich?

A3. The plan addresses existing needs and future desired needs. Existing land use controls are being evaluated and will be revised accordingly to ensure only planned growth occurs.

Q4. What does this Project involve?

A4. This project consists of two main elements. One is to address the MEP identified nitrogen reductions required in each of the five embayments. The second is a comprehensive review of wastewater management practices in Harwich to evaluate how those reductions can best be realized. Using available information and planning projections, the future needs of the Town were assessed, and alternatives to address those needs were fully evaluated for effectiveness, implementabability and cost.

Q5. Who is involved in this Project?

A5. Several groups are involved at both the local and the state level. Locally, the Water Quality Management Task Force (WQMTF) Wastewater Management Subcommittee (WMS) is coordinating the CWMP. This subcommittee is working with town staff, a Citizens Advisory Committee (CAC), a Wastewater Implementation Advisory Committee (WIAC), the Board of Selectmen (BOS), consultants and many other stakeholders. At the state level the Massachusetts Department of Environmental Protection (MassDEP) is overseeing the MEP, which is being prepared by the School for Marine Science and Technology (SMAST), the Cape Cod Commission (CCC), the United States Geological Survey (USGS), and several other advisory or peer review groups. The WMS is the lead group for the Town, and it contracted with engineering consultant CDM Smith for technical guidance during this process. Coordination among all the groups will be crucial to developing an implementable program that meets Harwich's needs now and into the future. The WMS has been working on this project since 2007.

Q6. Will the Harwich wastewater plan be managed by current town departments or will a new organization need to be created?

A6. The Town currently does not have a wastewater department. Thus the Town is conducting an evaluation of how best to integrate this department into its organization structure.

Q7. Isn't wastewater a single Cape-wide problem which requires a single Cape-wide solution? Shouldn't the county address this problem and not individual towns? Does the Commonwealth of Massachusetts know about the challenges of wastewater on the Cape? What about the federal government?

A7. Wastewater Management is an issue being addressed by every town on Cape Cod. While nitrogen coming from septic systems and entering estuaries resulting in degrading water quality is a common theme in the communities, the variables and solutions are different in each community. The nitrogen in groundwater flows by watersheds, not town boundaries. Thus communities are evaluating regional solutions and the County is assisting in that process. Whether a local or regional solution, each town will want to implement an environmentally sound solution for the least cost. Both the MassDEP and the federal Environmental Protection Agency (EPA) are well aware of the wastewater issues facing Cape Cod.

Q8. What is the MEP?

A8. The MEP is a program to evaluate the nitrogen impacts on up to 89 embayments in the southeastern part of the state, including all of Cape Cod. The MEP is funded by the communities and by the state. The SMAST is conducting the program in partnership with the local communities, the CCC, the USGS and the MassDEP. The MEP includes five Harwich embayments: Pleasant Bay, Allen, Wychmere and Saquatucket Harbors and Herring River.

The purpose of the MEP is to provide an analytical means to quantify and evaluate nitrogen entering the embayment and develop nitrogen thresholds for each embayment that will restore or maintain healthy water quality. Ultimately, the MEP will develop an acceptable Total Maximum Daily Load (TMDL) for nitrogen that can enter each of the embayments. Under the Federal Clean Water Act, the EPA and MassDEP have the authority to require communities contributing nitrogen to the particular embayment to meet the TMDL.

Q9. Why is nitrogen an issue?

A9. Nitrogen deposited in an estuary or embayment acts as a fertilizer and stimulates the over production of algae in the salt water. The algae can become so dense that desirable eel grass beds, shellfish resources, and overall water quality (as well as boating, swimming and overall aesthetics) are negatively affected. Also, reduced light penetration affects healthy plant growth, and decaying plants and algae settle to the bottom, using up oxygen in the water, often resulting in fish kills and odors. If nitrogen is allowed to continue to flow to the embayments at excessive levels, the embayments will become severely degraded.

Nitrogen enters the embayments from several sources, including wastewater effluent from on-site Title 5 septic systems, leaching from lawn and garden commercial fertilizers, stormwater run-off from pavements and roofs, and atmospheric deposition. Nitrogen from these sources enters the groundwater or surface waters that ultimately discharge to the embayments. The first three sources are considered to be controllable while the direct atmospheric deposition is not. A standard Title 5 septic system only removes about 10 to 20 percent of the nitrogen entering it while more sophisticated on-site nutrient removal systems can remove up to about 50 percent nitrogen. Studies on the Cape have shown that nitrogen entering the embayments from septic systems account for 75 to 85 percent of the controllable source while fertilizers and stormwater run-off each account for about 7 to 8 percent.

Q10. This whole wastewater issue has been around for decades, why is it a big deal now?

A10. The Cape has experienced significant residential growth over the past 50 years and transitioned to an increased year round population. The result is more nitrogen entering the groundwater from the septic systems resulting in excessive nitrogen flowing to the estuaries.

Q11. Why does Harwich have to do this?

A11. Harwich representatives and residents understand the need to address this nitrogen issue to maintain the quality of life in town. MassDEP will also be establishing a TMDL for each embayment once the MEP reports are finalized. That will require the Town to implement a plan to remove the required amount of nitrogen to restore the water quality of the particular embayment. The Town is moving forward now with the CWMP so it can develop the appropriate plan on its own timeline rather than on a MassDEP mandated schedule. The abutting towns of Chatham, Orleans, Brewster and Dennis are all in various stages of completing CWMPs to address the nitrogen issues in their communities. All the other Cape Cod communities are doing similar CWMPs. Some watersheds are shared by communities such as Pleasant Bay and will require a joint effort to meet the TMDL for that embayment.

Q12. What are the lessons that Harwich has learned from studying the activities of other Cape towns?

A12. Each community is different but educating the public and receiving input from them is crucial to developing an implementable program. Developing a program that is flexible and can adapt to changes and feedback while being implemented is crucial.

Q13. We've heard solving our wastewater problem will cost tens of millions of dollars. Is that true? Who will pay for this? How will they pay?

A13. The overall cost of the Harwich recommended wastewater program is estimated to be in the $180 to $230 Million range implemented over a 40 year period. The WIAC is currently evaluating cost recovery methods to be used in developing a recommended finance plan. However, this overall program is very similar in cost and implementation timeframe to our current municipal water system.

Q14. Can Harwich afford not to do this?

A14. No. We are all living here because of the beautiful beaches, the active and convenient waterways, the high-quality drinking water, and general access to several recreational activities, all of which lead to a desired quality of life. Our economy is based around tourism for those same reasons. Even if the MassDEP did not regulate implementation of a plan to meet the TMDLs for each embayment, we must maintain the tourism economy and our quality of life.

Q15. Harwich is helping to pay for an expensive new regional school system. Can the Town really afford to fund both schools and wastewater at the same time?

A15. Both are being done to maintain our wonderful quality of life, now and in the future.

Q16. Won't the cost of wastewater treatment be so expensive that modest income taxpayers will be forced out of town?

A16. Multiple cost recovery options are being evaluated now with the goal that no single group is negatively impacted. Several entities are also pursuing potential outside funding sources and Harwich will do everything it can to make sure it qualities for those funding sources should they become available. This is in part also why a 40 year implementation timeframe has been recommended.

Q17. Are neighboring communities participating where watersheds are shared between adjacent communities?

A17. Yes, Harwich is participating in a collaborative effort that has been ongoing (Pleasant Bay Alliance) for the Pleasant Bay Watershed. Harwich is one of four communities along with Brewster, Chatham, and Orleans that share this watershed. Small portions of the Herring River Watershed are shared with Dennis and Brewster who will participate in some manner. The watersheds for Allen, Wychmere, and Saquatucket Harbors are all within Harwich.

Q18. Why not have Harwich pipe its wastewater to the facilities of neighboring towns (like Chatham), and pay them to clean our wastewater?

A18. The recommended wastewater alternative includes treatment of the Harwich wastewater collected from the Pleasant Bay Watershed at the Chatham wastewater facility with treated effluent recharged in Chatham or back in Harwich.

Q19. If impacts are affecting estuaries, are the groundwater wells protected?

A19. Fresh water bodies and groundwater supply wells are more resilient to nitrogen impacts than salt water embayments. Salt water is much more sensitive to elevated nitrogen levels, since the recommended limits to the estuaries are less than 1.0 mg/L, and limits for drinking water are 10 mg/L. There is an order-of-magnitude higher sensitivity to estuary systems. The most recent five-year average of nitrogen sampling in the Harwich water system is about 0.77 mg/l (Nitrate), indicating the Zone of Contribution to the Town's wells have limited development and are sufficiently protected.

Q20. As a Harwich resident, what can I do to reduce my nitrogen contribution?

A20. While septic systems contribute 75 to 85 percent of the controllable nitrogen, residents can minimize the remaining contribution sources. Education on the use and types of fertilizers can help. Using slow release fertilizers and not applying commercial fertilizers before a rainstorm (where it can run-off) would help. Also, using alternative landscapes that do not require as much fertilizer would have a positive impact. Channeling run-off from paved surfaces or roofs onto grasses for nitrogen uptake will help compared with direct discharge into a surface water or coarse sand where it enters the groundwater table. The run-off from these areas or stormwater contains the nitrogen from atmospheric deposition. Although these actions alone will not meet the nitrogen removal recommended in the MEP reports for embayments in Harwich, they will potentially help reduce the amount of sewering required.

Q21. If home septic systems are the main problem, why not just restrict the number of bathrooms and kitchens in all renovations and new construction?

A21. Much of the Town of Harwich is already built out.

Q22. Wouldn't this wastewater problem be solved if all homes and businesses restricted the use of detergents, lawn fertilizers, and toxic chemicals?

A22. Reducing those controllable nitrogen sources will certainly help but they only account for about 7 to 8 percent of the controllable nitrogen.

Q23. Will all of the wastewater within the MEP watersheds need to be conveyed out of the watersheds to achieve the desired levels of nitrogen removal?

A23. Not necessarily. Although nitrogen reduction is required for each MEP watershed, the amount in each watershed varies between 58 and 100 percent. A watershed requiring 100 percent nitrogen reduction will require sewering and recharge of the treated effluent outside that watershed. However, a watershed requiring 70 percent nitrogen reduction could sewer a higher percentage than that (say 80 percent) since the septic system effluent contains nitrogen with around 26 to 35 mg/l and treatment plant effluent contains around 3 to 5 mg/l or about 90 percent nitrogen removal. In this case 72 percent of the nitrogen would be removed from the area sewered, allowing the effluent to be recharged in the watershed. Combined with fertilizer and stormwater management programs the Town could attain acceptable nitrogen removal levels.

Q24. Does wastewater include the water which goes into storm drains? Is rain runoff a problem?

A24. Wastewater is separate from stormwater in new systems built today. Both contain nitrogen, however stormwater collects atmospheric nitrogen deposited on roof tops and pavement and can also collect fertilizers. Thus stormwater should be diverted to vegetative areas instead of directly to water bodies.

Q25. What is the timeline of the Project?

A25. Development of the CWMP began in earnest in August, 2007. Water quality sampling for the MEP began a few years before. Originally the program was divided into two phases. Phase 1 of the CWMP (Existing Data Review and Needs Analysis) was originally scheduled for completion in late 2008. Phase 2 of the CWMP (Alternatives Evaluation and Recommended Plan) was scheduled for completion in mid 2009.

However, a delay in receiving the MEP reports resulted in a corresponding delay in the original schedule for completing Phase 1 and 2. Thus the decision was made to combine both phases into one document which resulted in the development of the current Draft CWMP. Implementation of the recommended plan will occur over a 40 year period once the Town endorses and the MassDEP approves the recommended plan.

Q26. Will this plan result in sewers for the entire Town of Harwich?

A26. No. Based on the MEP report results sewers are recommended as part of the overall strategy to address nitrogen impacts to our estuaries. This recommendation was developed after evaluating several alternatives that would meet the percent nitrogen removals required. However, only specific portions of Harwich are planned to have a new sewer collection system and the areas outside those will remain with on-site septic systems. Approximately 60 percent of the Town will be sewered.

Q27. We pump our home septic system as required and never have problems. Why can't we just leave things as they are? Aren't our beaches and harbors pretty good as is?

A27. Pumping a septic system removes the solids and should be done approximately every 3 years to keep it in good working order. However the nitrogen is mainly contained in the liquid that leaves the system daily and exists in groundwater ultimately surfacing in our estuaries and harbors which has shown signs of degradation.

Q28. If wastewater treatment facilities are recommended to be built, will they be an eyesore?

A28. Through careful planning and site selection the treatment facilities will be designed to be harmonious with the architectural style within the community and employ property-screening techniques to minimize visual and other aesthetic impacts. Also, state-of-the-art odor control measures will address potential odor issues.

Q29. As a Harwich property owner, will my property values be decreased?

A29. Projects in other communities have demonstrated that sewers and/or enhanced wastewater management actually may increase property values. Improving wastewater management procedures will restore water quality in the embayments and protect the other water resources so that the tourist economy continues to flourish and the quality of life is maintained. All these factors combine to preserve property values. If nothing is done, property values likely would decrease.

Q30. Can the wastewater just be piped out into the ocean like in Boston?

A30. No, environmental regulations (Massachusetts Ocean Sanctuaries Act) prohibit new wastewater outfalls (discharge pipes) to the ocean. Some communities such as Boston and Plymouth already had an ocean discharge prior to this regulation being implemented. Thus, they were allowed to continue to use it but only after significantly increasing the treatment level of the effluent and/or relocating the pipe several miles further out into the ocean.

Q31. We have the entire Atlantic Ocean on our doorstep, can the ocean be used in some way?

A31. The Ocean Sanctuaries Act prevents new outfalls. The water quality of the receiving ocean waters and the tidal flushing characteristics have been factored into the MEP modeling which determined the amount of nitrogen to be removed.

Q32. How can I get more information, or contact the WMS, CAC or WIAC to get my opinions heard?

A32. An important element of this project includes public outreach. The CAC has been formed to provide for an exchange of information. Moreover, community meetings are scheduled to keep residents and business owners informed about the progress, and the Harwich WQMTF has a website (www.hwqtf.com). Copies of the meeting schedule and other project documents are available at Town Hall and the public library. The WMS also has a mailbox at Town Hall. WMS meetings and community meetings are listed on the calendar on the Town's website, and all are welcome. Lastly, the WIAC is seeking input on the cost recovery model to recommend and their meetings which are also posted on the Town's website are open to the public.

Appendix B

MEP Memos

The Massachusetts Estuaries Project has released several documents related to water resources in Harwich, relative to the CWMP planning process. Included in this appendix are the memoranda related to the MEP reports. Full MEP reports are several hundred pages long. These reports have been made available on the Town of Harwich website, and links are provided below.

- MEP Published Reports – draft and Final
    - Pleasant Bay Final Report – May 2006
    - Allen, Wychmere, Saquatucket Report – June 2010
    - Muddy Creek Final Report – November 2008
    - All reports available on Town of Harwich website: http://harwichma.virtualtownhall.net/Public_Documents/HarwichMA_BComm/CWMP/MEP%20Reports/
- Technical Memoranda
    - Nitrogen Loads by TMDL Watershed/Segments to Pleasant Bay – November 2007
    - Water use and Muddy Creek Nitrogen Attenuation – June 2010
    - MEP Scenarios to Evaluate Water Quality Impacts of the Addition of a 24 foot Culvert in Muddy Creek Inlet – October 2010

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MEMORANDUM

TO: Pleasant Bay Resource Management Alliance, Watershed Working Group
Carole Ridley, Coordinator, Pleasant Bay Resource Management Alliance
Cape Cod Commission members: Brewster, Chatham, Harwich, Orleans

CC: Brian Howes, SMAST, UMASS Dartmouth
Tom Cambareri, CCC
Paul Niedzwiecki, CCC

FROM: Ed Eichner, Water Scientist

DATE: November 28, 2007

RE: Individual town nitrogen loads by TMDL watershed/segments to Pleasant Bay

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As a follow-up on my September 25 memo detailing each town's nitrogen loading contribution to each of the individual subwatersheds to the Pleasant Bay estuary, the Alliance Watershed Working Group requested additional analysis to aggregate the loads according to the subembayments listed in the MassDEP TMDL for Pleasant Bay (May 2007). As with the September 25 analysis, each town's contribution of attenuated and unattenuated nitrogen loads under existing and buildout conditions were determined beginning with the Massachusetts Estuaries Project watershed model and reworking its results and equations to complete the requested analysis. Funding for this effort was provided by the current Management Challenges for Nitrogen Control grant that the Commission has from the US Environmental Protection Agency.

Table 1 show the results of the analysis with existing and buildout unattenuated loads for each of the 20-listed TMDL segments for Pleasant Bay, as well as the complementary attenuated loads and the TMDL watershed thresholds. This analysis incorporates the results of the analysis completed to breakdown the loads by town for each of the 95 subwatersheds. Total loads from this analysis by town are generally within 1% of the September 25 memo loads. This analysis also incorporates the percentage reductions in nitrogen load for the portion of the loads that flow out of the system at ponds that straddle the overall watershed boundary.

Table 1. Nitrogen Loads by Town for the Pleasant Bay TMDL Segments

All nitrogen loads are in kilograms per year. All loads account for load reductions caused by groundwater flow out of the watershed from ponds that straddle the outer boundary of the Pleasant Bay watershed. Watershed names are based on the segments listed in the MassDEP TMDL document for Pleasant Bay (May 2007). Target watershed loads for each TMDL segment are listed for comparison. No loads are listed for Little Pleasant Bay because the boundaries of this portion of the system are not included in the TMDL or the MEP Technical Report, which is the basis for the TMDL.

	Target Watershed Load from TMDL	EXISTING UNATTENUATED w/outflows included					EXISTING ATTENUATED					% Atten	BUILDOUT UNATTENUATED w/outflows included					BUILDOUT ATTENUATED					% Atten
Watershed Name	Annual Load	ORL	BRE	HAR	CHA	TOTAL	ORL	BRE	HAR	CHA	TOTAL		ORL	BRE	HAR	CHA	TOTAL	ORL	BRE	HAR	CHA	TOTAL	
Meetinghouse Pond	387	2256	0	0	0	2256	2256	0	0	0	2256	0%	3008	0	0	0	3008	3008	0	0	0	3008	0%
The River - upper	635	1174	61	0	0	1235	998	7	0	0	1005	19%	1685	76	0	0	1761	1433	10	0	0	1443	18%
The River - lower	891	1549	107	0	0	1656	1390	16	0	0	1405	15%	2603	117	0	0	2720	2392	19	0	0	2411	11%
Kescayo Gansett Pond	595	1139	248	0	0	1388	838	40	0	0	878	37%	1628	283	0	0	1910	1230	53	0	0	1283	33%
Areys Pond	336	367	282	0	0	650	367	95	0	0	463	29%	636	286	0	0	922	636	96	0	0	732	21%
Namequoit River	631	1034	117	0	0	1151	935	51	0	0	987	14%	1494	167	0	0	1661	1367	98	0	0	1465	12%
Pah Wah Pond	266	679	0	0	0	679	679	0	0	0	679	0%	1023	0	0	0	1023	1023	0	0	0	1023	0%
Pochet Neck	1504	3135	0	0	0	3135	3073	0	0	0	3073	2%	4411	0	0	0	4411	4336	0	0	0	4336	2%
Little Pleasant Bay	2146																						
Quanset Pond	394	723	142	0	0	865	569	72	0	0	641	26%	965	175	0	0	1141	771	89	0	0	859	25%
Round Cove	1080	0	2	1553	0	1554	0	1	1544	0	1545	1%	0	2	1900	0	1901	0	1	1891	0	1892	1%
Muddy Creek - Upper	1683	0	0	2584	1234	3819	0	0	2510	1154	3663	4%	0	0	3501	1373	4874	0	0	3403	1290	4694	4%
Muddy Creek - Lower	781	0	0	1809	1488	3297	0	0	1802	1294	3096	6%	0	0	2421	1501	3922	0	0	2413	1306	3719	5%
Pleasant Bay	7975	4055	6212	2732	1526	14525	3538	6077	2622	1526	13763	5%	6237	7468	3743	2265	19712	5543	7187	3630	2265	18625	6%
Ryder Cove	1632	0	0	0	4054	4054	0	0	0	3613	3613	11%	0	0	0	4559	4559	0	0	0	4424	4424	3%
Frostfish Creek	256	0	0	0	1059	1059	0	0	0	1059	1059	0%	0	0	0	1211	1211	0	0	0	1211	1211	0%
Crows Pond	1540	0	0	0	1542	1542	0	0	0	1537	1537	0%	0	0	0	1699	1699	0	0	0	1694	1694	0%
Bassing Harbor	610	0	0	0	620	620	0	0	0	607	607	2%	0	0	0	730	730	0	0	0	716	716	2%
Chatham Harbor	6242	0	0	0	6377	6377	0	0	0	6309	6309	1%	0	0	0	7106	7106	0	0	0	7030	7030	1%
System TOTAL	29656	16112	7171	8678	17900	49860	14644	6360	8478	17099	46580	7%	23691	8574	11565	20443	64272	21739	7553	11337	19935	60564	6%

Table 2 shows the percentage of the nitrogen loads from this analysis. The load percentages are the same as the September 25 memo results except for the attenuated buildout in Brewster which decreased by 1% due to a slight change in rounding.

Table 2 also shows percentage watershed land area and the watershed including estuary surface areas by town. These comparisons were used in the Popponesset Bay discussions of town fair shares and are provided in anticipation of similar future discussions for Pleasant Bay. The areas that these percentages are based on do not account for the portions of recharge that flow out of the system.

As mentioned above, this effort to determine subwatershed loads by individual town was funded using grant funds from the Commission's Management Challenges for Nitrogen Control grant that the Commission has from the US Environmental Protection Agency. The effort represents approximately $2,000 worth of Cape Cod Commission staff time.

Table 2. Watershed Nitrogen Load and Watershed Area by Town for Pleasant Bay

NITROGEN LOADS (%)	Orleans	Brewster	Harwich	Chatham
Existing Unattenuated	32%	14%	17%	36%
Existing Attenuated	31%	14%	18%	37%
Buildout Unattenuated	37%	13%	18%	32%
Buildout Attenuated	36%	12%	19%	33%
WATERSHED AREA				
Watershed Land (acres)	5,293	3,527	2,643	3,655
Estuary Surface (acres)	3,528	-	153	2,802
Land and Estuary (acres)	8,822	3,527	2,795	6,456
Watershed Land (%)	35%	23%	17%	24%
Estuary Surface (%)	54%	0%	2%	43%
Land and Estuary (%)	41%	16%	13%	30%

Notes:

1) nitrogen loading percentages based on watershed load only; do not include loads on estuary surfaces
2) all loads adjusted to account for nitrogen loads that flow out of the watershed
3) attenuated loads account for reductions caused by application of multiple attenuation factors in situations where loads flow through multiple ponds
4) watershed land area is not adjusted to account for flow out of the watershed system
5) rounding may cause some totals to appear inaccurate

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MEMORANDUM

TO: Pleasant Bay Resource Management Alliance, Watershed Working Group
Carole Ridley, Coordinator, Pleasant Bay Resource Management Alliance
Cape Cod Commission members: Brewster, Chatham, Harwich, Orleans

CC: Brian Howes, SMAST, UMASS Dartmouth
Tom Cambareri, CCC
Paul Niedzwiecki, CCC

FROM: Ed Eichner, Water Scientist

DATE: September 25, 2007

RE: Individual town nitrogen loads by individual subwatersheds to Pleasant Bay

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During past Alliance Watershed Working Group discussions, it was decided that it would be useful to the Alliance and member towns to determine each town's contribution of attenuated and unattenuated nitrogen loads within each individual subwatershed to the Pleasant Bay estuary. Since the Cape Cod Commission had created the Massachusetts Estuaries Project watershed nitrogen loading model, I offered to rework the model's components to determine these nitrogen loads using funding from the current Management Challenges for Nitrogen Control grant that the Commission has from the US Environmental Protection Agency.

The results show that attenuation rates in individual subwatersheds vary between 0 and 79% (Table 1). Attenuated loads account for splitting of downgradient loads among various ponds, as well as application of all the attenuation factors these loads are reduced by prior to discharge into Pleasant Bay or its subestuaries. So, for example, one portion of an upgradient subwatershed load may pass through two ponds and be subject to two 50% reductions, while another portion may pass through only one pond before reaching the estuary. Both attenuated and unattenuated loads also account for portions of nitrogen loads that flow out of the system watershed at ponds that straddle the watershed boundary, such as Cliff Pond in Brewster or Goose Pond in Chatham. Watershed loads do not include any nitrogen loads on the surface of the estuary or subestuaries. The overall system loads are within 0.8% or less of the overall loads presented in the MEP report on Pleasant Bay. Overall attenuation rates for the entire system show that 7% of the load is attenuated under existing conditions, while 6% is projected to be attenuated under buildout conditions.

Table 1. Individual Subwatershed Nitrogen Loads for Pleasant Bay.

All analysis based on Massachusetts Estuaries Project watershed nitrogen loading model, which is documented in the Pleasant Bay MEP Technical Report (Howes, *et al.*, 2006). Loads are adjusted to account for portions of subwatershed loads that leave the system watershed via ponds that straddle the system watershed boundary. Loads include only watershed loads and do not include loads on estuary or subestuary surfaces.

		EXISTING UNATTENUATED w/outflows included					EXISTING ATTENUATED						UNATTENUATED BUILDOUT w/outflows included					ATTENUATED BUILDOUT					
Watershed Name	Shed ID#	ORL	BRE	HAR	CHA	TOTAL	ORL	BRE	HAR	CHA	TOTAL	% Atten	ORL	BRE	HAR	CHA	TOTAL	ORL	BRE	HAR	CHA	TOTAL	% Atten
Baker Pond GT 10	1	0	21	0	0	21	0	7	0	0	7	67%	0	34	0	0	34		11			11	67%
Baker Pond LT 10	2	107	23	0	0	130	35	8	0	0	43	67%	118	57	0	0	175	39	19			58	67%
Cliff Pond GT 10	3	0	231	0	0	231	0	48	0	0	48	79%	0	242	0	0	242		50			50	79%
Cliff Pond LT 10	4	0	176	0	0	176	0	36	0	0	36	79%	0	176	0	0	176		36			36	79%
Crystal Lake GT 10	5	128	0	0	0	128	64	0	0	0	64	50%	239	0	0	0	239	120				120	50%
Crystal Lake LT 10	6	388	0	0	0	388	194	0	0	0	194	50%	527	0	0	0	527	263				263	50%
Deep Pond GT 10	7	0	5	0	0	5	0	2	0	0	2	50%	0	173	0	0	173		86			86	50%
Deep Pond LT 10	8	117	53	0	0	171	59	27	0	0	85	50%	165	101	0	0	266	82	51			133	50%
Grassy Pond	9	0	0	183	0	183	0	0	87	0	87	52%	0	0	189	0	189			90		90	52%
Higgins Pond	10	0	134	0	0	134	0	37	0	0	37	72%	0	134	0	0	134		37			37	72%
Little Cliff Pond	11	0	123	0	0	123	0	25	0	0	25	79%	0	123	0	0	123		25			25	79%
Mud Pond	12	0	7	47	0	54	0	3	24	0	27	50%	0	7	47	0	54		3	24		27	50%
Pilgrim Lake LT 10	13	562	0	0	0	562	281	0	0	0	281	50%	730	0	0	0	730	281				281	62%
Rafe Pond	14	0	42	0	0	42	0	21	0	0	21	50%	0	42	0	0	42		21			21	50%
Ruth Pond GT 10	15	0	41	0	0	41	0	8	0	0	8	80%	0	41	0	0	41		8			8	80%
Ruth Pond LT 10	16	0	7	0	0	7	0	1	0	0	1	80%	0	7	0	0	7		1			1	80%
Sarahs Pond GT 10	17	311	0	0	0	311	156	0	0	0	156	50%	420	0	0	0	420	210				210	50%
Sarahs Pond LT 10	18	85	0	0	0	85	43	0	0	0	43	50%	166	0	0	0	166	83				83	50%
Shoal Pond GT 10	19	0	4	0	0	4	0	2	0	0	2	50%	0	4	0	0	4		2			2	50%
Shoal Pond LT 10	20	251	155	0	0	405	125	77	0	0	203	50%	315	177	0	0	492	158	88			246	50%
Twinings Pond GT 10	21	11	69	0	0	80	4	27	0	0	31	61%	22	103	0	0	125	9	40			49	61%
Twinings Pond LT 10	22	298	0	0	0	298	116	0	0	0	116	61%	362	0	0	0	362	141				141	61%
Uncle Harvey Pond	23	123	0	0	0	123	61	0	0	0	61	50%	151	0	0	0	151	75				75	50%
Uncle Seths Pond GT 10	24	0	6	0	0	6	0	3	0	0	3	50%	0	6	0	0	6		3			3	50%
Uncle Seths Pond LT 10	25	179	17	0	0	196	90	9	0	0	98	50%	193	56	0	0	250	97	28			125	50%
Cliff Pond WELL_ORL	26	5	22	0	0	27	5	22	0	0	27	0%	5	22	0	0	27	5	22			27	0%
Freeman's Way WELL_BRE	27	0	1063	0	0	1063	0	1063	0	0	1063	0%	0	1203	0	0	1203		1203			1203	0%
Gould Pond WELL_ORL	28	249	27	0	0	276	124	14	0	0	138	50%	321	38	0	0	360	161	19			180	50%
Pleasant Bay Rd WELL_HAR	29	0	0	331	0	331	0	0	331	0	331	0%	0	0	337	0	337			337		337	0%
Silas Rd Well_BRE	30	0	240	0	0	240	0	221	0	0	221	8%	0	296	0	0	296		273			273	8%
WELL 7 WELL_ORL	31	345	61	0	0	406	345	61	0	0	406	0%	438	139	0	0	577	438	139			577	0%
Arey's Pond GT 10N	32	10	8	0	0	18	10	8	0	0	18	0%	16	8	0	0	24	16	8			24	0%
Arey's Pond GT 10S	33	2	0	0	0	2	2	0	0	0	2	0%	2	0	0	0	2	2				2	0%
Arey's Pond LT 10	34	351	0	0	0	351	351	0	0	0	351	0%	614	0	0	0	614	614				614	0%
Barley Neck GT 10	35	433	0	0	0	433	433	0	0	0	433	0%	517	0	0	0	517	517				517	0%
Barley Neck LT 10	36	456	0	0	0	456	456	0	0	0	456	0%	582	0	0	0	582	582				582	0%
Kescayo Gansett Pond GT 10	37	103	0	0	0	103	103	0	0	0	103	0%	204	0	0	0	204	204				204	0%
Kescayo Gansett Pond LT 10	38	268	0	0	0	268	268	0	0	0	268	0%	405	0	0	0	405	405				405	0%
Kescayo Gansett River	39	132	0	0	0	132	132	0	0	0	132	0%	171	0	0	0	171	171				171	0%
Kescayo Gansett Stream	40	45	0	0	0	45	45	0	0	0	45	0%	65	0	0	0	65	65				65	0%
Lower River LT 10	41	1237	0	0	0	1237	1237	0	0	0	1237	0%	2188	0	0	0	2188	2188				2188	0%
Meetinghouse Pond GT 10	42	953	0	0	0	953	953	0	0	0	953	0%	1278	0	0	0	1278	1278				1278	0%
Meetinghouse Pond LT 10	43	1303	0	0	0	1303	1303	0	0	0	1303	0%	1730	0	0	0	1730	1730				1730	0%
Namequoit River GT 10	44	98	40	0	0	138	98	40	0	0	138	0%	115	84	0	0	199	115	84			199	0%
Namequoit River LT 10	45	741	0	0	0	741	741	0	0	0	741	0%	1127	0	0	0	1127	1127				1127	0%
Pah Wah Pond Bog	46	48	0	0	0	48	48	0	0	0	48	0%	56	0	0	0	56	56				56	0%
Pah Wah Pond GT 10	47	386	0	0	0	386	386	0	0	0	386	0%	484	0	0	0	484	484				484	0%
Pah Wah Pond LT 10	48	246	0	0	0	246	246	0	0	0	246	0%	483	0	0	0	483	483				483	0%
Pleasant Bay GT 10_BREHAR	49	0	1361	395	0	1756	0	1361	395	0	1756	0%	0	1400	513	0	1913		1400	513		1913	0%
Pleasant Bay GT 10_HAR	50	0	0	592	0	592	0	0	592	0	592	0%	0	0	769	0	769			769		769	0%
Pleasant Bay GT 10_ORL	51	642	129	0	0	771	642	129	0	0	771	0%	927	230	0	0	1157	927	230			1157	0%
Pleasant Bay GT 10_ORLBRE	52	0	692	0	0	692	0	692	0	0	692	0%	0	1106	0	0	1106		1106			1106	0%
Pleasant Bay LT 10	53	1883	337	1199	1526	4945	1883	337	1199	1526	4945	0%	3098	388	1904	2265	7655	3098	388	1904	2265	7655	0%
Pochet Neck GT 10	54	787	0	0	0	787	787	0	0	0	787	0%	1037	0	0	0	1037	1037				1037	0%
Pochet Neck LT 10	55	465	0	0	0	465	465	0	0	0	465	0%	633	0	0	0	633	633				633	0%
Pochet Neck Stream GT 10	56	377	0	0	0	377	377	0	0	0	377	0%	478	0	0	0	478	478				478	0%
Pochet Neck Stream LT 10	57	493	0	0	0	493	493	0	0	0	493	0%	1014	0	0	0	1014	1014				1014	0%
Quanset Pond Bog	58	21	0	0	0	21	21	0	0	0	21	0%	47	0	0	0	47	47				47	0%
Quanset Pond GT 10	59	0	6	0	0	6	0	6	0	0	6	0%	0	6	0	0	6		6			6	0%
Quanset Pond LT 10	60	427	0	0	0	427	427	0	0	0	427	0%	592	0	0	0	592	592				592	0%
Round Cove GT 10	61	0	0	772	0	772	0	0	772	0	772	0%	0	0	900	0	900			900		900	0%
Round Cove LT 10	62	0	0	766	0	766	0	0	766	0	766	0%	0	0	984	0	984			984		984	0%
Tar Kiln Stream GT 10	63	0	1413	0	0	1413	0	1413	0	0	1413	0%	0	1464	0	0	1464		1464			1464	0%
Tar Kiln Stream LT 10	64	172	696	0	0	868	172	696	0	0	868	0%	388	746	0	0	1134	388	746			1134	0%
The Horseshoe	65	35	0	0	0	35	35	0	0	0	35	0%	68	0	0	0	68	68				68	0%
Upper River GT 10	66	238	0	0	0	238	238	0	0	0	238	0%	327	0	0	0	327	327				327	0%
Upper River LT 10	67	601	0	0	0	601	601	0	0	0	601	0%	872	0	0	0	872	872				872	0%
Mill Pond Fresh	68	0	0	115	53	168	0	0	54	25	79	53%	0	0	162	56	217			76	26	102	53%
Goose Pond	69	0	0	0	174	174	0	0	0	70	70	59%	0	0	0	176	176				72	72	59%
Trout Pond	70	0	0	0	320	320	0	0	0	160	160	50%	0	0	0	320	320				160	160	50%
Schoolhouse Pond	71	0	0	0	195	195	0	0	0	94	94	52%	0	0	0	200	200				97	97	52%
Stillwater Pond	72	0	0	0	387	387	0	0	0	367	367	5%	0	0	0	415	415				394	394	5%
Lovers Lake	73	0	0	0	559	559	0	0	0	265	265	53%	0	0	0	592	592				281	281	53%
Emery Pond	74	0	0	0	71	71	0	0	0	36	36	50%	0	0	0	78	78				39	39	50%
Bassing Pond	75	0	0	0	160	160	0	0	0	80	80	50%	0	0	0	182	182				91	91	50%
Hawksnest Pond	76	0	0	31	0	31	0	0	16	0	16	47%	0	0	31	0	31			16		16	47%
Muddy Crk WELL	77	0	0	589	0	589	0	0	589	0	589	0%	0	0	734	0	734			734		734	0%
Lower Muddy Crk	78	0	0	384	937	1321	0	0	384	937	1321	0%	0	0	692	937	1629			692	937	1629	0%
Lower Muddy Crk 10E	79	0	0	0	164	164	0	0	0	164	164	0%	0	0	0	175	175				175	175	0%
Lower Muddy Crk 10W	80	0	0	828	0	828	0	0	828	0	828	0%	0	0	984	0	984			984		984	0%
Upper Muddy Crk	81	0	0	1561	952	2513	0	0	1561	952	2513	0%	0	0	1723	1053	2776			1723	1053	2776	0%
Upper Muddy Crk 10E	82	0	0	0	123	123	0	0	0	123	123	0%	0	0	0	157	157				157	157	0%
Upper Muddy Crk 10W	83	0	0	881	0	881	0	0	881	0	881	0%	0	0	1591	0	1591			1591		1591	0%
Ryder Cove	84	0	0	0	1833	1833	0	0	0	1833	1833	0%	0	0	0	2118	2118				2118	2118	0%
Ryder Cove 10S	85	0	0	0	485	485	0	0	0	485	485	0%	0	0	0	558	558				558	558	0%
Ryder Cove 10E	86	0	0	0	167	167	0	0	0	167	167	0%	0	0	0	228	228				228	228	0%
Ryder Cove 10W	87	0	0	0	367	367	0	0	0	367	367	0%	0	0	0	378	378				378	378	0%
Crows Pond	88	0	0	0	882	882	0	0	0	882	882	0%	0	0	0	1005	1005				1005	1005	0%
Crows Pond 10	89	0	0	0	651	651	0	0	0	651	651	0%	0	0	0	685	685				685	685	0%
Bassing Harbor	90	0	0	0	360	360	0	0	0	360	360	0%	0	0	0	394	394				394	394	0%
Bassing Harbor 10	91	0	0	0	234	234	0	0	0	234	234	0%	0	0	0	307	307				307	307	0%
Frostfish Creek	92	0	0	0	432	432	0	0	0	432	432	0%	0	0	0	510	510				510	510	0%
Frostfish Creek 10	93	0	0	0	363	363	0	0	0	363	363	0%	0	0	0	397	397				397	397	0%
Upper Frostfish Crk	94	0	0	0	264	264	0	0	0	264	264	0%	0	0	0	304	304				304	304	0%
Chatham Harbor	95	0	0	0	6242	6242	0	0	0	6242	6242	0%	0	0	0	6953	6953				6953	6953	0%
TOTALS		16112	7209	8673	17900	49894	14655	6404	8478	17079	46616	7%	23691	8612	11560	20443	64306	21679	7598	11338	19583	60197	6%

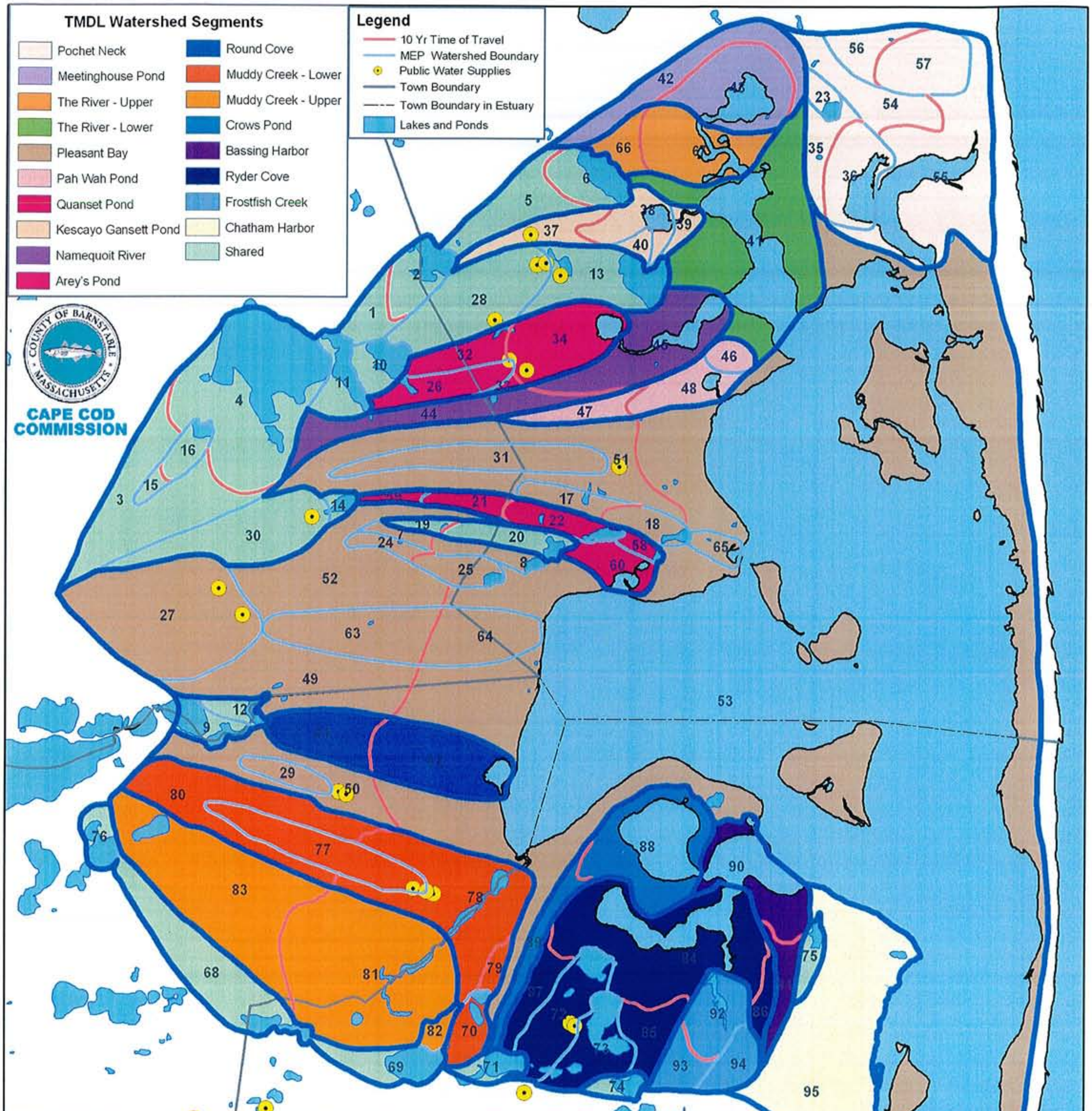
The preparation of these loads also presented the opportunity to re-evaluate the cumulative loads by individual town. Table 1 shows the sum of nitrogen load by town and Table 2 shows the relative percentage by town under existing and buildout conditions for both attenuated and unattenuated loads. Brewster and Harwich contribute a relatively stable percentage of the overall load to Pleasant Bay, while Chatham is the largest percentage under existing conditions and Orleans is the largest percentage under buildout conditions (see Table 2).

As mentioned above, this effort to determine subwatershed loads by individual town was funded using grant funds from the Commission's Management Challenges for Nitrogen Control grant that the Commission has from the US Environmental Protection Agency. The effort represents approximately $2,000 worth of Cape Cod Commission staff time.

Table 2. Percentage Watershed Nitrogen Load by Town for Pleasant Bay

	Orleans	Brewster	Harwich	Chatham
Existing Unattenuated	32%	14%	17%	36%
Existing Attenuated	31%	14%	18%	37%
Buildout Unattenuated	37%	13%	18%	32%
Buildout Attenuated	36%	13%	19%	33%

Notes:
1) percentages based on watershed load only; do not include loads on estuary surfaces
2) all loads adjusted to account for nitrogen loads that flow out of the watershed
3) attenuated loads account for reductions caused by application of multiple attenuation factors in situations where loads flow through multiple ponds



Individual Massachusetts Estuaries Project Subwatersheds

SHED_ID	NAME	SHED_ID	NAME	SHED_ID	NAME	SHED_ID	NAME
1	Baker Pond GT 10	25	Uncle Seths Pond LT 10	49	Pleasant Bay GT 10_BREHAR	73	Lovers Lake
2	Baker Pond LT 10	26	Cliff Pond WELL_ORL	50	Pleasant Bay GT 10_HAR	74	Emery Pond
3	Cliff Pond GT 10	27	Freeman's Way WELL_BRE	51	Pleasant Bay GT 10_ORL	75	Bassing Pond
4	Cliff Pond LT 10	28	Gould Pond WELL_ORL	52	Pleasant Bay GT 10_ORLBRE	76	Hawknest Pond
5	Crystal Lake GT 10	29	Pleasant Bay Rd WELL_HAR	53	Pleasant Bay LT 10	77	Muddy Creek Well
6	Crystal Lake LT 10	30	Silas Rd Well_BRE	54	Pochet Neck GT 10	78	Lower Muddy Creek
7	Deep Pond GT 10	31	WELL 7 WELL_ORL	55	Pochet Neck LT 10	79	Lower Muddy Creek 10 E
8	Deep Pond LT 10	32	Arey's Pond GT 10N	56	Pochet Neck Stream GT 10	80	Lower Muddy Creek 10 W
9	Grassy Pond	33	Arey's Pond GT 10S	57	Pochet Neck Stream LT 10	81	Upper Muddy Creek
10	Higgins Pond	34	Arey's Pond LT 10	58	Quanset Pond Bog	82	Upper Muddy Creek 10 E
11	Little Cliff Pond	35	Barley Neck GT 10	59	Quanset Pond GT 10	83	Upper Muddy Creek 10 W
12	Mud Pond	36	Barley Neck LT 10	60	Quanset Pond LT 10	84	Ryders Cove
13	Pilgrim Lake LT 10	37	Kescayo Gansett Pond GT 10	61	Round Cove GT 10	85	Ryders Cove 10 S
14	Rafe Pond	38	Kescayo Gansett Pond LT 10	62	Round Cove LT 10	86	Ryders Cove 10 E
15	Ruth Pond GT 10	39	Kescayo Gansett River	63	Tar Kiln Stream GT 10	87	Ryders Cove 10 W
16	Ruth Pond LT 10	40	Kescayo Gansett Stream	64	Tar Kiln Stream LT 10	88	Crows Pond
17	Sarahs Pond GT 10	41	Lower River LT 10	65	The Horseshoe	89	Crows Pond 10
18	Sarahs Pond LT 10	42	Meetinghouse Pond GT 10	66	Upper River GT 10	90	Bassing Harbor
19	Shoal Pond GT 10	43	Meetinghouse Pond LT 10	67	Upper River LT 10	91	Bassing Harbor 10
20	Shoal Pond LT 10	44	Namequoit River GT 10	68	Mill Pond Fresh	92	Frostfish Creek
21	Twinings Pond GT 10	45	Namequoit River LT 10	69	Goose Pond	93	Frostfish Creek 10
22	Twinings Pond LT 10	46	Pah Wah Pond Bog	70	Trout Pond	94	Upper Frostfish Creek
23	Uncle Harvey Pond	47	Pah Wah Pond GT 10	71	Schoolhouse Pond	95	Chatham Harbor
24	Uncle Seths Pond GT 10	48	Pah Wah Pond LT 10	72	Stillwater Pond		

Coastal Systems Program
School for Marine Science and Technology
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New Bedford, MA 02744-1221

MEP Technical Memo

To: David Young, CDM
Frank Sampson, Chair, Harwich Water Quality Management Task Force

From: Ed Eichner, CSP/SMAST
Brian Howes, CSP/SMAST
Sean Kelley, ACRE
John Ramsey, ACRE

Date: June 25, 2010

Re: Updated water use and Muddy Creek nitrogen attenuation and nitrogen loading to Pleasant Bay

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On behalf of the Town of Harwich, Camp Dresser & McKee (CDM) requested a scenario using the linked Massachusetts Estuaries Project (MEP) models for Pleasant Bay to assess the impact of updated information on the findings for Round Cove and Muddy Creek. The scenario results documented in this Technical Memo include the inclusion of the following updated information:

- updated average Harwich water use based on 2004 to 2007 data,
- updated Harwich land use coverages from 2006, and
- updated nitrogen attenuation from the 2008 SMAST analysis of Muddy Creek.

A summary of the scenario development and its results are described below.

Scenario Development

During the collection of information for the development of the MEP linked models for Wychmere Harbor, Saquatucket Harbor, Allen Harbor, and the Herring River, MEP staff obtained 2004 to 2007 water use information from the Harwich Water Department for parcels throughout the Town. This enhanced the prior Pleasant Bay nitrogen loading analysis, which had access to only the 2004 water-use data from the Water Department at the time of the development of the Pleasant Bay MEP linked model (Howes, *et al.*, 2006)[1]. Similarly, the Town of Harwich provided updated land use information for the review of all systems. The Pleasant Bay MEP assessment is based on 2004 Harwich land use data, while the other MEP systems in town will be based on 2006 land use data. The Town of Harwich and CDM wanted to have a consistent and comprehensive basis for the current Comprehensive Wastewater Management

[1] Howes B., S. W. Kelley, J. S. Ramsey, R. Samimy, D. Schlezinger, E. Eichner (2006). Linked Watershed-Embayment Model to Determine Critical Nitrogen Loading Thresholds for Pleasant Bay, Chatham, Massachusetts. Massachusetts Estuaries Project, Massachusetts Department of Environmental Protection. Boston, MA.

Planning effort and requested that a MEP scenario be completed for Pleasant Bay that uses the 2006 land use base and 2004 to 2007 water use that is used for the assessment of all of the other MEP estuaries within the town.

In addition, MEP Technical Team members completed a 2008 assessment of Muddy Creek (White, *et al*., 2008)[2]. This assessment, which was completed for the Pleasant Bay Alliance, included collection and analysis of sediment nitrogen regeneration, wetland characterization, water quality analysis, and nitrogen exchange measurements between the upper and lower basins of Muddy Creek. This assessment is a much more detailed and comprehensive review of Muddy Creek than was possible during the MEP assessment and allowed for an updated assessment of nitrogen attenuation in the Upper and Lower portions of Muddy Creek. The Town of Harwich and CDM requested that the findings from the 2008 Muddy Creek assessment be incorporated into the scenario with the Town's updated water use and land use. The requested scenario does not modify the inlet to Pleasant Bay to include the 2007 breach nor does it change the inlet culvert configuration or size into Muddy Creek.

In order to integrate the updated information, MEP Technical Team members were required to check the calibration and validation of the MEP Linked Models for Muddy Creek and Pleasant Bay. This step checked the effects of incorporating the new information and compared these results to the available water quality and salinity data to ensure that any significant changes did not cause unacceptable variability in the comparison of model results to collected field data. This step was especially important for the Muddy Creek area where much more refined data were incorporated. These checks showed that modest re-calibration was required in Muddy Creek (mainly as a result of the new attenuation rates) and that validation of the model was sustained.

MEP Scenario Results and Discussion

Based on the incorporation of the new information, watershed nitrogen loads for Muddy Creek and Round Cove increased (Table 1). Aside from the new water use, revised loads also include: a) changes in the treatment of both existing and buildout conditions at the Wequassett Inn (personal communication, Dave Michniewicz, Coastal Engineering, 6/26/08), b) load additions from farm animals, c) inclusion of a cranberry bog in Lower Muddy Creek that was previously excluded, d) inclusion of innovative/alternative septic systems in the Upper Muddy Creek subwatersheds, and e) updated land use coverages from 2006. These changes are consistent with updates provided as a result of data gathering for MEP assessments of other estuaries in Harwich.

After incorporating the revised nitrogen loads, the attenuation factors based on the more refined assessment of Muddy Creek were incorporated (White, *et al*., 2008). The attenuation factor used for watershed nitrogen loading from Upper Muddy Creek is 57%, while the attenuation factor for Lower Muddy Creek is 2%. These attenuation factors are based on the measured water quality in Muddy Creek documented in the 2008 report and the revised watershed nitrogen loads completed for this scenario.

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[2] White, D., B. Howes, S. Kelley, J. Ramsey. 2008. Resource Assessment to Evaluate Ecological & Hydrodynamic Responses to Reinstalling a Water Control Structure in the Muddy Creek Dike. Report to the Pleasant Bay Alliance by the Coastal Systems Program-SMAST, University of Massachusetts-Dartmouth, New Bedford MA

The overall attenuated load for the upper Muddy Creek basin decreased (41%) mainly as a result of including the large measured attenuation in the upper basin (2008), while the attenuated watershed load for the lower basin increased by 27% (Table 2). Round Cove attenuated load increased by 48%. Overall, the updated attenuated watershed nitrogen load for the combined Muddy Creek decreases 10% and is similar to the MEP report, 16.59 kg d^{-1} and 18.46 kg d^{-1}, respectively. The net combined result of the changes in the watershed loads, attenuation factors, and more refined sediment characterization is that the overall Muddy Creek nitrogen load changes only very slightly: 2006 MEP Report nitrogen load is 22.16 kg d^{-1}, while the load in this revised scenario is 22.19 kg d^{-1}. The Round Cove overall load increases by 16% (from 12.82 to 14.83 kg d^{-1}).

It is also notable that the 2008 study found that Upper Muddy Creek sediments serve as a net nitrogen sink during summer conditions, while Lower Muddy Creek sediments are a net nitrogen source (see Table 2). The 2006 MEP report included the reverse assessment of the sediments in Upper (net source) and Lower Creeks (net sink). The main difference found in the more detailed 2008 assessment is due mostly to the very large nitrogen uptake in the uppermost brackish wetland, which was previously not measured. The 2006 MEP upper basin analysis was based upon measurement at a single location near this wetland.

Incorporation of the increased natural nitrogen attenuation in Upper Muddy Creek decreases the wastewater nitrogen that must be removed from its watershed to meet its threshold if wastewater is the only nitrogen source that is reduced (Table 3). The percentage of wastewater nitrogen that must be removed to meet the threshold decreases from 75% in the 2006 MEP analysis to 66% in this revised scenario. Lower Muddy Creek remains at 100% wastewater removal under the revised scenario and Round Cove increases from 40% wastewater removal to 64% removal. Round Cove's increase is largely due to an increase in the septic load based on the incorporation of the water use revisions.

When all loads, including septic wastewater, fertilizer, and stormwater runoff, are considered as sources for nitrogen removal to meet the threshold, the necessary percentage reductions in attenuated watershed nitrogen loads are different (Table 4) than if only septic loads are considered (see Table 3), but the relative relationships among the estuaries are essentially the same. Lower Muddy Creek has the highest required removal, which increased slightly in the requested scenario (from 75% to 80%), while Upper Muddy Creek has a slight drop in required removal (from 54% removal to 52% removal) and Round Cove has an increase in the required removal (from 30% to 53%). Although Upper Muddy Creek has an increase in the watershed load (see Table 1), this increase is largely offset by the better documented increase in system nitrogen attenuation. The opposite effect is seen in Lower Muddy Creek and Round Cove where the increased total watershed load increases the percentage of watershed load that must be removed.

Table 5 compares the threshold loads for bioactive nitrogen (DIN+PON) under the 2006 MEP Report and this updated scenario. As also shown in Table 4, the watershed threshold loads for Lower Muddy Creek and Round Cove generally did not change, but the watershed threshold load for Upper Muddy Creek decreased due to the increased attenuation in the system. The changes in the benthic fluxes due to the 2008 study also are noted.

In interpreting the results, it is important to consider that Muddy Creek is a heavily altered system, which previously was divided by a dike, and has a large restriction of tidal exchange at its outlet to Pleasant Bay due to a small culvert under Rt. 28. Tributary estuaries with large restrictions to tidal exchange (reduced flushing) have increased nitrogen levels over the similar systems with unrestricted tidal exchange. Extreme examples of the effect of tidal exchange on nitrogen levels can be seen in West End Pond (Gosnold) and Rushy Marsh (Barnstable), where removing all anthropogenic watershed nitrogen loading is insufficient to meet water quality restoration goals. The flushing rates in these systems are so low that even small amounts of entering nitrogen accumulate to produce high water column nitrogen levels and low oxygen conditions. While Muddy Creek is not at this level of restriction, it is virtually certain that much of its nitrogen related water quality "problem" results from its restricted tidal circulation.

The overall impact of incorporating all the Harwich changes, including updated land use and water use, incorporation of monitoring from innovative/alternative septic systems, loading from farm animals, Wequassett Inn wastewater clarifications, and the better characterization of Muddy Creek, is summarized as:

1) Lower Muddy Creek is not changed; the watershed threshold load remains the same and the required septic removal to meet the threshold remains at 100%.
2) Upper Muddy Creek has a slight improvement in nitrogen removal to meet the threshold. Incorporation of the better documented natural nitrogen attenuation in the Creek largely balances watershed nitrogen loading increases. The net result is that the watershed threshold load is reduced and the required septic removal to meet the threshold also decreases to 66%.
3) Round Cove watershed threshold load remains the same, but the addition of the modified water use has increased the watershed nitrogen load. The net result is that in order to meet the watershed threshold load, the required septic removal within the watershed increases to 64%.

Table 1. Comparison of Watershed Nitrogen Loads for Round Cove and Muddy Creek. A) Watershed nitrogen loads from Table IV-5 of the Massachusetts Estuaries Project Technical Report for Pleasant Bay (Howes, *et al*., 2006). B) Watershed nitrogen loads prepared for this scenario including the incorporation of updated water use and land use from the Town of Harwich. Muddy Creek attenuated loads do not include attenuation assigned to within the wetlands and sediments of the Muddy Creek.

A) 2006 MEP Pleasant Bay Technical Report Nitrogen Loads for Round Cove and Muddy Creek

		Pleasant Bay N Loads by Input (kg/yr):							Present N Loads		
Name	Watershed ID#	Wastewater	Fertilizers	Impervious Surfaces	Water Body Surface Area	"Natural" Surfaces	Buildout	% of Pond Outflow	UnAtten N Load	Atten %	Atten N Load
Round Cove	61,62 + MP	1157	175	154	77	54	347		1616		1607
Round Cove Estuary surface deposition					62				62		62
Muddy Creek	77, 78, 79, 80, 81, 82, 83 + MPF, GOP, HWP, TTP	5275	612	776	400	332	1946		7395		7027
Upper Muddy Creek	81,82,83 + MPF,GOP,HWP	2839	344	395	247	189	1322		4014		3860
Upper Muddy Creek Estuary surface deposition					59				59		59
Lower Muddy Creek	77,78,79,80 + TTP	2436	268	381	153	143	624		3381		3167
Lower Muddy Creek Estuary surface deposition					75				75		75

B) 2008 MEP Technical Memo Nitrogen Loads with updated Harwich water use and land use for Round Cove and Muddy Creek

		Pleasant Bay N Loads by Input (kg/yr):							Present N Loads		
Name	Watershed ID#	Wastewater	Fertilizers	Impervious Surfaces	Water Body Surface Area	"Natural" Surfaces	Buildout	% of Pond Outflow	UnAtten N Load	Atten %	Atten N Load
Round Cove	61,62 + MP	1884	175	162	77	53	263		2350		2341
Round Cove Estuary surface deposition					62				62		62
Muddy Creek	77, 78, 79, 80, 81, 82, 83 + MPF, GOP, HWP, TTP	7321	685	781	398	331	2235		9516		9086
Upper Muddy Creek	81,82,83 + MPF,GOP,HWP	4088	351	402	245	189	1543		5276		5066
Upper Muddy Creek Estuary surface deposition					59				59		59
Lower Muddy Creek	77,78,79,80 + TTP	3233	333	379	153	143	692		4241		4020
Lower Muddy Creek Estuary surface deposition					75				75		75

Table 2. Nitrogen loads (attenuated) under existing conditions for Harwich subestuaries of the Pleasant Bay system. Existing nitrogen loads for the watersheds to Round Cove and Muddy Creek are compared for the scenario discussed in this Technical Memo and the MEP report (Howes, *et al*., 2006). The requested scenario includes the incorporation of revised information gathered in Harwich into the 2006 MEP Linked Models for Pleasant Bay including: 1) average Harwich water use based on 2004 to 2007 data, 2) updated Harwich land use coverages from 2006, and 3) updated nitrogen attenuation from the 2008 SMAST assessment of Muddy Creek (White, *et al*., 2008). All values have been rounded.

Sub-embayment	Revised Harwich scenario				MEP Report				% change
	Attenuated watershed load (kg/day)	direct atmospheric deposition (kg/day)	benthic flux net (kg/day)	Total Load (kg/d)	Attenuated watershed load (kg/day)	direct atmospheric deposition (kg/day)	benthic flux net (kg/day)	Total Load (kg/d)	Total Load
Round Cove	6.24	0.17	8.42	14.83	4.23	0.17	8.42	12.82	+16%
Muddy Creek - upper	5.85	0.16	-0.64	5.37	9.98	0.16	4.56	14.70	-63%
Muddy Creek - lower	10.74	0.21	5.87	16.82	8.48	0.21	-1.23	7.46	+125%
Muddy Creek - total	16.59	0.37	5.23	22.19	18.46	0.37	3.33	22.16	0%

Table 3. Comparison of sub-embayment watershed ***septic loads*** (attenuated) used for modeling of present and threshold loading scenarios for Harwich subestuaries in the current requested scenario. These loads do not include direct atmospheric deposition (onto the sub-embayment surface), benthic flux, runoff, or fertilizer loading terms. All values have been rounded.

Sub-embayment	Revised Harwich scenario			MEP Report			change		
	Attenuated Septic load (kg/day)	Threshold septic load (kg/day)	septic load reduction to attain threshold % change	Attenuated Septic load (kg/day)	Threshold septic load (kg/day)	septic load reduction to attain threshold % change	Attenuated Septic load (kg/day)	Threshold septic load (kg/day)	septic load reduction to attain threshold % change
Round Cove	5.18	1.865	-64%	3.16	1.897	-40%	+2.02	-0.03	-24%
Muddy Creek - upper	4.72	1.603	-66%	7.16	1.789	-75%	-4.13	-1.79	+9%
Muddy Creek - lower	8.6	0	-100%	6.34	0	-100%	+2.26	0	0%

Table 4. Comparison of sub-embayment ***total watershed loads*** (attenuated, including septic, runoff, and fertilizer) used for modeling of present and threshold loading scenarios for Harwich subestuaries in the current Harwich-requested scenario and the 2006 MEP Technical Report. These loads do not include direct atmospheric deposition (onto the sub-embayment surface) or benthic flux loading terms. All values have been rounded.

Sub-embayment	Revised Harwich scenario			MEP Report			change		
	Attenuated total load (kg/day)	Threshold total load (kg/day)	load reduction to attain threshold % change	Attenuated total load (kg/day)	Threshold total load (kg/day)	load reduction to attain threshold % change	Attenuated total load (kg/day)	Threshold total load (kg/day)	load reduction to attain threshold % change
Round Cove	6.24	2.93	-53%	4.23	2.96	-30%	+2.019	-0.03	-23%
Muddy Creek - upper	5.85	2.82	-52%	9.98	4.61	-54%	-4.134	-1.79	+2%
Muddy Creek - lower	10.74	2.14	-80%	8.48	2.14	-75%	+2.26	0	-5%

Table 5. Threshold sub-embayment loads used for bioactive nitrogen (DIN+PON) modeling of the Harwich subestuaries in the current Harwich-requested scenario and the 2006 MEP Technical Report, with threshold loads for total attenuated watershed N loads, atmospheric N loads, and benthic flux. All values have been rounded.

Sub-embayment	Revised Harwich scenario				MEP Report				% change
	Attenuated watershed load (kg/day)	direct atmospheric deposition (kg/day)	benthic flux net (kg/day)	Total Load (kg/d)	Attenuated watershed load (kg/day)	direct atmospheric deposition (kg/day)	benthic flux net (kg/day)	Total Load (kg/d)	Attenuated Watershed load (kg/d)
Round Cove	2.93	0.17	5.59	8.69	2.96	0.17	6.74	9.87	-1%
Muddy Creek - upper	2.82	0.16	-0.37	2.61	4.61	0.16	2.7	7.47	-40%
Muddy Creek - lower	2.14	0.21	2.92	5.27	2.14	0.21	-0.71	1.64	0%
Muddy Creek - total	4.96	0.37	2.55	7.88	6.75	0.37	1.99	9.11	-27%

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MEP Technical Memo

To: Carole Ridley, Pleasant Bay Alliance, Coordinator
Bob Duncanson, Chair, Technical Resource Committee, Pleasant Bay Alliance

From: Ed Eichner, Coastal Systems Program/SMAST/UMassD
Brian Howes, Coastal Systems Program/SMAST/UMassD
Sean Kelley, Applied Coastal Research and Engineering
John Ramsey, Applied Coastal Research and Engineering

Date: October 5, 2010

Re: MEP Scenarios to evaluate water quality impacts of the addition of a 24 ft culvert in Muddy Creek inlet

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The Pleasant Bay Alliance (PBA) requested two (2) scenarios, one under existing conditions and another under buildout conditions using an updated version of the Massachusetts Estuaries Project (MEP) model for Pleasant Bay that incorporates recent updates requested by the Town of Harwich.[1] The PBA scenarios are designed to evaluate potential changes in water quality throughout the Pleasant Bay System resulting from reducing the tidal restriction caused by the current culvert at the outlet of Muddy Creek (under Route 28) by installing a 24-foot wide culvert.

The updates in the MEP Pleasant Bay model that were requested by the Town of Harwich focused on Muddy Creek and Round Cove. The updates are documented in a June 25, 2010 MEP Technical Memo and include the additions of the following information:

- updated average Harwich water use based on 2004 to 2007 data,
- updated Harwich land use coverages from 2006, and
- updated nitrogen attenuation from the 2008 SMAST analysis of Muddy Creek.[2]

Incorporating these updates required a check of the calibration and validation of the MEP Linked Model for Pleasant Bay.[3] This step checked the effects of incorporating the new information and

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[1] CSP/SMAST and ACRE. MEP Technical Memo. June 25, 2010. Updated water use and Muddy Creek nitrogen attenuation and nitrogen loading to Pleasant Bay. Completed for Camp Dresser McKee and Town of Harwich Water Quality Management Task Force.
[2] White, D., B. Howes, S. Kelley, J. Ramsey. 2008. Resource Assessment to Evaluate Ecological & Hydrodynamic Responses to Reinstalling a Water Control Structure in the Muddy Creek Dike. Report to the Pleasant Bay Alliance by the Coastal Systems Program-SMAST, University of Massachusetts-Dartmouth, New Bedford MA

compared these results to the available water quality and salinity data to ensure that any significant changes did not cause unacceptable variability in the comparison of model results to collected field data. This step was especially important for the Muddy Creek area where much more refined data were incorporated. These checks showed that modest re-calibration was required in Muddy Creek (mainly as a result of the new attenuation rates) and that validation of the overall Pleasant Bay model was sustained.

For the assessment of the Pleasant Bay-wide water quality changes of installing a 24-foot culvert at the outlet of Muddy Creek, PBA requested two (2) scenarios:

1) Scenario 1 - Existing watershed N loading and updated N Muddy Creek attenuation with the addition of a single 24-foot culvert.
2) Scenario 2- same as #1 above, except that the build-out N load will be used as the watershed N load.

Requested outputs from the scenarios are: a) modeled N concentrations at the TMDL sentinel and check water quality stations throughout the Pleasant Bay System and b) required N load reductions from watershed septic loads to meet the nitrogen TMDL for Pleasant Bay. PBA specified that model modifications should not include changes to the inlet to Pleasant Bay to include the impacts of the 2007 breach, so as to allow comparison of these results to the existing USEPA/MassDEP TMDL for this system.

MEP Technical Team members from the Coastal Systems Program/SMAST and Applied Coastal Research and Engineering, completed the development of the scenarios and prepared the following summary of the scenario results.

MEP Scenario Results and Discussion: Pleasant Bay Alliance updates

The changes requested by the Town of Harwich, including the changes in the attenuation of nitrogen by Muddy Creek ecological systems, resulted in small, generally insignificant increases in watershed nitrogen loads throughout the Pleasant Bay watershed with the most significant changes within watersheds of sub-embayments predominantly within Harwich (Table 1). Changes occurred throughout the Bay watershed because the changes in the Harwich water use increased the average water use for the Pleasant Bay System. The change in the average water use also impacted the buildout loads since these rely extensively on this value.

Evaluation of the effect of installing the 24 ft culvert can be conducted by comparing the needed reduction in septic loads based upon the updated septic thresholds for both attenuated existing and buildout nitrogen loads relative to the MEP Technical Report[4]. This comparison shows that the necessary percent reductions to meet the thresholds are generally the same throughout most of the system with and without the new culvert; percent removals generally increase by ~1% (Table 2). Muddy Creek and Round Cove, however, show notable changes due to the updates to the Harwich water use, the refinements in the Muddy Creek N attenuation and the association with the new culvert. Given that the new culvert directly effects Muddy Creek, the decreased percent removal of existing septic watershed loads to meet threshold in Upper Muddy Creek (from 75% removal to 45% removal) and Lower Muddy Creek (from 100% removal to 50%

[3] Howes B., S. W. Kelley, J. S. Ramsey, R. Samimy, D. Schlezinger, E. Eichner (2006). Linked Watershed-Embayment Model to Determine Critical Nitrogen Loading Thresholds for Pleasant Bay, Chatham, Massachusetts. Massachusetts Estuaries Project, Massachusetts Department of Environmental Protection. Boston, MA.
[4] Howes B., S. W. Kelley, J. S. Ramsey, R. Samimy, D. Schlezinger, E. Eichner (2006).

removal) was expected. Round Cove's increased percent removal from 40% to 64% primarily results from changes in watershed loading.

In addition to evaluating loadings, the affect of adding the 24 ft culvert at the inlet to Muddy Creek on bioactive N concentrations throughout Pleasant Bay was evaluated using the updated model, incorporating the updates requested by the Town of Harwich. This evaluation was conducted under both existing (Table 3) and buildout (Table 4) watershed loadings. It appears that replacing the existing inlet to Muddy Creek with a 24-foot culvert has little effect on the nitrogen levels throughout the Pleasant Bay System. This is not surprising as Muddy Creek represents only about 12% of the watershed load to the overall system and the inlet has little effect on the amount of nitrogen leaving Muddy Creek, but reduces the build-up in concentration, so the concentration in ebb waters will be lower. A small, but insignificant, lowering of concentrations can be seen system-wide likely resulting from this lower Muddy Creek ebb concentration and the small increase in total system tidal prism (flushing) that will result from the larger tide range in Muddy Creek with the new inlet.

While there is a clear reduction in the bioactive nitrogen level at the Muddy Creek check station, due to the wider culvert, there is little or no change in bioactive N concentrations at the other check stations and sentinel stations. The wider culvert results in a 20% drop in the difference between the existing conditions modeled N concentration and the threshold concentration (0.21 mg/l) at the Lower Muddy Creek check station (PBA-05). Additional N reductions are necessary in the Muddy Creek watershed to meet the threshold concentration in Lower Muddy Creek, but the magnitude of the reductions are reduced through the installation of the wider culver. All other stations throughout Pleasant Bay have insignificant changes in concentration, *i.e.*, less than one percent. These results suggest that addition of a 24-foot culvert at the head of Muddy Creek will improve water quality in Muddy Creek and will not result in any significant changes in the rest of the Pleasant Bay system.

It should be noted that the attenuation rate in Upper Muddy Creek was not adjusted based on the addition of the wider culvert. MEP Technical Team members reviewed the modeled increase in Mean High Water (MHW) elevation (+1.2 ft) due to the wider culvert and compared it to the wetland elevation data indicated in the Muddy Creek study.[5] This comparison found that it was likely that the MHW increase would expand the salt marsh area significantly in the uppermost wetland basin, but not really change the area in the larger open water upper basin (above the former dike but below the marsh basin). This increase in salt marsh area would cause an inward/upward shift of fringing freshwater vegetation in the uppermost wetland basin to an undetermined higher elevation based on the change in tide height and how the marsh adapted to the surrounding land elevation. Since salt marsh is nitrogen limited and tends to hold or denitrify nitrogen, it is thought that this expansion of salt marsh area might increase the nitrogen attenuation in Upper Muddy Creek above the attenuation measured in the Muddy Creek study. However, given that the wetland elevation contours are in two foot increments and the change in MHW fits within this increment, it was thought that any attenuation estimate above that assigned in the Muddy Creek study would not have been properly derived and constrained. With that in mind, MEP Technical Team used the nitrogen attenuation determined in the Muddy Creek Study for the analysis with the installation of the 24-foot culvert.

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[5] White, D., B. Howes, S. Kelley, J. Ramsey. 2008..

As additional nitrogen sources are added to the watershed through buildout development, these loads will need to be offset to meet the bioactive nitrogen threshold for Pleasant Bay determined in the USEPA/MassDEP TMDL (Table 4). These greater loads increase the percent reductions in N concentrations to meet the N thresholds at the sentinel and check stations throughout the Pleasant Bay System. However, the necessary percentage reduction to meet the N concentrations at the Lower Muddy Creek station at buildout with the 24-foot culvert is less than the percent reduction required at buildout with the existing culvert. It should also be noted that all Pleasant Bay water quality and sentinel stations exceed their MEP N thresholds under buildout conditions with or without the proposed culvert.

In conclusion, the addition of a 24-foot culvert at the outlet of Muddy Creek without accounting for any impacts of the 2007 Pleasant Bay breach will:

1) reduce nitrogen concentrations at the Lower Muddy Creek check/benthic infauna water quality station (PBA-05) to within 23% of its MEP threshold concentration with current watershed development (an improvement from a required 43% reduction to meet the threshold without the widened culvert),
2) reduce nitrogen concentrations at the Lower Muddy Creek check/benthic infauna water quality station (PBA-05) to within 36% of its MEP threshold concentration with buildout watershed development, and
3) not significantly impact nitrogen concentrations elsewhere in the Pleasant Bay estuary.

Table 1. Total existing and buildout watershed N loads for current Pleasant Bay Alliance Scenario and 2006 MEP Technical Report (Howes, *et al.*) (including septic, runoff, and fertilizer) used for modeling of present conditions. These loads reflect updates in the Harwich water use and Muddy Creek nitrogen attenuation. These loads do not include direct atmospheric deposition (onto the sub-embayment surface) or benthic flux loading terms.				
sub-embayment	Existing PBA scenario watershed load (kg/day)	Existing 2006 MEP Report watershed load (kg/day)	Buildout PBA scenario watershed load (kg/day)	Buildout 2006 MEP Report watershed load (kg/day)
Meetinghouse Pond	6.197	6.197	8.48	8.26
The River – upper	2.803	2.773	4.12	3.98
The River – lower	3.942	3.879	6.99	6.65
Lonnies Pond	2.471	2.441	3.69	3.56
Areys Pond	1.318	1.304	2.13	2.05
Namequoit River	2.767	2.737	4.22	4.05
Paw Wah Pond	1.882	1.860	2.93	2.81
Pochet Neck	8.468	8.422	12.29	11.89
Little Pleasant Bay	9.430	7.496	14.26	12.03
Quanset Pond	1.786	1.781	2.46	2.39
Tar Kiln Stream	6.142	6.123	7.10	6.99
Round Cove	6.244	4.225	6.96	5.18
The Horseshoe	0.647	0.638	1.04	0.99
Muddy Creek - upper	5.937	9.981	7.71	13.96
Muddy Creek - lower	10.737	8.477	12.69	10.19
Pleasant Bay	26.767	23.159	35.03	31.03
Pleasant Bay/Chatham Harbor Channel	-	-	-	
Bassing Harbor - Ryder Cove	10.063	9.819	11.50	11.14
Bassing Harbor - Frost Fish Creek	2.912	2.904	3.37	3.32
Bassing Harbor - Crows Pond	4.282	4.219	4.76	4.65
Bassing Harbor	1.707	1.668	2.02	1.97
Chatham Harbor	17.175	17.099	19.33	19.05
TOTAL - Pleasant Bay System	133.679	127.203	173.085	166.14

Table 2. Comparison of sub-embayment watershed ***septic loads*** (attenuated) used for modeling of present, buildout, and threshold loading scenarios of the Pleasant Bay system in the PBA Alliance scenarios. These loads include the updated attenuation in Muddy Creek (White, *et al.*, 2008) and the **24 foot-wide culvert at Muddy Creek**. These loads do not include direct atmospheric deposition (onto the sub-embayment surface), benthic flux, runoff, or fertilizer loading terms. MEP report present threshold septic load % changes are also presented for comparison.						
sub-embayment	Present PBA scenario septic load (kg/day)	Buildout PBA scenario septic load (kg/day)	Threshold PBA scenario septic load (kg/day)	Present Threshold PBA scenario septic load % change	Buildout Threshold PBA scenario septic load % change	MEP Report Present Threshold septic load % change
Meetinghouse Pond	5.14	7.03	0.00	-100%	-100%	-100%
The River – upper	2.10	3.09	1.03	-51%	-67%	-50%
The River – lower	2.93	5.20	1.44	-51%	-72%	-50%
Lonnies Pond	1.66	2.48	0.81	-51%	-67%	-50%
Areys Pond	0.79	1.28	0.39	-51%	-70%	-50%
Namequoit River	2.04	3.11	1.00	-51%	-68%	-50%
Paw Wah Pond	1.53	2.39	0.37	-76%	-85%	-75%
Pochet Neck	6.66	9.67	2.33	-65%	-76%	-65%
Little Pleasant Bay	6.45	9.75	2.26	-65%	-77%	-50%
Quanset Pond	1.41	1.94	0.70	-50%	-64%	-50%
Tar Kiln Stream	1.82	2.10	0.89	-51%	-58%	-50%
Round Cove	5.18	5.78	1.87	-64%	-68%	-40%
The Horseshoe	0.48	0.77	0.48	0%	-38%	0%
Muddy Creek - upper	4.72	6.12	2.59	-45%	-58%	-75%
Muddy Creek - lower	8.60	10.16	4.30	-50%	-58%	-100%
Pleasant Bay	16.69	21.84	6.51	-61%	-70%	-50%
Pleasant Bay/Chatham Harbor Channel	-	-	-	-		-
Bassing Harbor - Ryder Cove	7.38	8.44	1.77	-76%	-79%	-75%
Bassing Harbor - Frost Fish Creek	2.21	2.56	0.00	-100%	-100%	-100%
Bassing Harbor - Crows Pond	3.39	3.77	3.39	0%	-10%	0%
Bassing Harbor	1.44	1.70	1.44	0%	-15%	0%
Chatham Harbor	14.27	16.06	14.27	0%	-11%	0%
TOTAL - Pleasant Bay System	96.88	125.23	47.84	-50%	-62%	-52%

Table 3. Comparison of model average bioactive N (DIN+PON) concentrations from present watershed loading with the **existing Muddy Creek culvert and the 24-foot wide alternative culvert**, with percent change, for the threshold and benthic infauna restoration (check) stations in the Pleasant Bay system. The modeled conditions are based on 2004 hydrodynamic conditions (pre-2007 breach of north inlet). The threshold stations for **eelgrass restoration are shown in bold print** (0.16 mg/L at PBA-12 and the average of PBA-03 and CM-13) and the rest of the listed stations are for benthic infauna restoration (0.21 mg/L at WMO-10, PBA-15, WMO-6, WMO-5, PBA-11, WMO-12, PBA-09 and PBA-05).

Installation of the 24-foot culvert reduces the bioactive N concentration at the Lower Muddy Creek station and has insignificant changes in concentration at the other stations in Pleasant Bay.

Sub-Embayment	monitoring station	present existing culvert (mg/L)	present 24-foot culvert (mg/L)	Threshold (mg/L)	% change to meet threshold - existing	% change to meet threshold – 24-foot culvert
Meetinghouse Pond	WMO-10	0.264	0.264	0.207	-28%	-28%
Lonnies Pond (Kescayo Gansett Pond)	PBA-15	0.251	0.251	0.208	-21%	-21%
Namequoit River - upper	WMO-6	0.240	0.239	0.206	-17%	-16%
Pochet – upper	WMO-05	0.270	0.270	0.211	-28%	-28%
Little Pleasant Bay - head	**PBA-12**	**0.178**	**0.178**	**0.160**	**-11%**	**-11%**
Paw Wah Pond	PBA-11	0.258	0.258	0.209	-23%	-23%
Little Quanset Pond	WMO-12	0.233	0.231	0.194	-20%	-19%
Round Cove	PBA-09	0.255	0.253	0.207	-23%	-22%
Muddy Creek - lower	PBA-05	0.298	0.255	0.208	-43%	-23%
Ryders Cove - upper	**PBA-03**	**0.252**	**0.252**	**0.190**	**-33%**	**-33%**
Ryders Cove - lower	**CM-13**	**0.160**	**0.159**	**0.138**	**-16%**	**-15%**

Table 4. Comparison of model average bioactive N (DIN+PON) concentrations from **existing and buildout watershed loading with the installation of a 24-foot alternative**, with MEP threshold concentrations for the Pleasant Bay system and the percent changes in concentrations to meet the threshold concentrations. The modeled conditions represent 2004 hydrodynamic conditions (pre 2007 breach of north inlet). The threshold stations for **eelgrass restoration are shown in bold print** (0.16 mg/L at PBA-12 and the average of PBA-03 and CM-13) and the rest of the listed stations are for benthic infauna restoration (0.21 mg/L at WMO-10, PBA-15, WMO-6, WMO-5, PBA-11, WMO-12, PBA-09 and PBA-05). Buildout watershed nitrogen loading increases bioactive N concentrations and increases the percent reductions in nitrogen concentrations to meet the MEP threshold concentrations.

Sub-Embayment	monitoring station	Existing PBA scenario watershed loading - 24-foot culvert (mg/L)	Buildout PBA scenario watershed loading - 24-foot culvert (mg/L)	Threshold (mg/L)	% change to meet threshold Existing – 24-foot culvert	% change to meet threshold Buildout - 24-foot culvert
Meetinghouse Pond	WMO-10	0.264	0.300	0.207	-28%	-45%
Lonnies Pond (Kescayo Gansett Pond)	PBA-15	0.251	0.289	0.208	-21%	-39%
Namequoit River - upper	WMO-6	0.239	0.271	0.206	-16%	-32%
Pochet – upper	WMO-05	0.270	0.321	0.211	-28%	-52%
Little Pleasant Bay - head	**PBA-12**	**0.178**	**0.193**	**0.160**	**-11%**	**-21%**
Paw Wah Pond	PBA-11	0.258	0.307	0.209	-23%	-47%
Little Quanset Pond	WMO-12	0.231	0.263	0.194	-19%	-36%
Round Cove	PBA-09	0.253	0.277	0.207	-22%	-34%
Muddy Creek - lower	PBA-05	0.255	0.283	0.208	-23%	-36%
Ryders Cove - upper	**PBA-03**	**0.252**	**0.273**	**0.190**	**-33%**	**-44%**
Ryders Cove - lower	**CM-13**	**0.159**	**0.168**	**0.138**	**-15%**	**-22%**

Appendix C

Nitrogen Loading Spreadsheets

Detailed Cost Spreadsheets

Wastewater Scenarios Summary (Collection Systems)

Evaluation of Alternatives - Harwich CWMP Wastewater Scenarios

Data for Cost Analysis	1A	2A	3A	4A	5A	6A	7A	8A
Allen								
Areas tributary to WWTP #3	Allen	Allen	Allen	Allen	Allen	Allen	Allen	Allen
# parcels sewered	234	234	234	234	234	234	185	234
Total lf of roads in sewered area (from GIS)	30,587	30,587	30,587	30,587	30,587	30,587	27,956	30,587
lf roads (90%)/parcel in sewered area	118	118	118	118	118	118	136	118
# pump stations (est. 1/100 parcel)	2	2	2	2	2	2	2	2
Cons. Cost per property (from chart)	22,500	22,500	22,500	22,500	22,500	22,500	25,600	22,500
Collection cost	5,265,000	5,265,000	5,265,000	5,265,000	5,265,000	5,265,000	4,736,000	5,265,000
Length of FMs (collection system to WWTP)	6,095	0	0	0	0	5,720	5,720	0
Additional Pump Station (Collection to WWTF)	1,500,000					1,500,000	1,500,000	
Additional Pump Station O&M	$75,000	$0	$0	$0	$0	$75,000	$75,000	$0
Total water use in watershed	94,100	94,100	94,100	94,100	94,100	94,100	94,100	94,100
ADF to WWTP (100% water use)	61,237	61,237	61,237	61,237	61,237	61,237	54,408	61,237
TOTAL CAPITAL COST	$5,340,000	$5,265,000	$5,265,000	$5,265,000	$5,265,000	$5,340,000	$4,811,000	$5,265,000
Wychmere								
Areas tributary to WWTP #3	Wychmere	Wychmere	Wychmere	Wychmere	Wychmere	Wychmere	Wychmere	Wychmere
# parcels sewered	123	123	123	123	123	123	123	123
Total lf of roads in sewered area (from GIS)	19,222	19,222	19,222	19,222	19,222	19,222	19,222	19,222
lf roads (90%)/parcel in sewered area	141	141	141	141	141	141	141	141
# pump stations (est. 1/100 parcel)	1	1	1	1	1	1	1	1
Cons. Cost per property (from chart)	26,400	26,400	26,400	26,400	26,400	26,400	26,400	26,400
Collection cost	3,247,200	3,247,200	3,247,200	3,247,200	3,247,200	3,247,200	3,247,200	3,247,200
Length of FMs (collection system to WWTP)	0	0	0	0	0	0	0	0
Additional Pump Station (Collection to WWTF)								
Additional Pump Station O&M	$0	$0	$0	$0	$0	$0	$0	$0
Force main + PS cost (PS to WWTP @$175/ft)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total water use in watershed	31,208	31,208	31,208	31,208	31,208	31,208	31,208	31,208
ADF to WWTP (100% water use)	31,208	31,208	31,208	31,208	31,208	31,208	31,208	31,208
TOTAL CAPITAL COST	$3,247,200	$3,247,200	$3,247,200	$3,247,200	$3,247,200	$3,247,200	$3,247,200	$3,247,200
Saquatucket								
Areas tributary to WWTP #3	Saquatucket	Saquatucket	Saquatucket	Saquatucket	Saquatucket	Saquatucket	Saquatucket	Saquatucket
# parcels sewered	508	484	415	415	415	484	248	415
Total lf of roads in sewered area (from GIS)	74,117	81,752	83,655	83,655	83,655	81,752	42,001	83,655
lf roads (90%)/parcel in sewered area	131	152	181	181	181	152	152	181
# pump stations (est. 1/100 parcel)	5	5	4	4	4	5	2	4
Cons. Cost per property (from chart)	24,800	28,300	33,300	33,300	33,300	28,300	28,400	33,300
Collection cost	12,598,400	13,697,200	13,819,500	13,819,500	13,819,500	13,697,200	7,043,200	13,819,500
Length of FMs (collection system to WWTP)	13,308	13,308	16,430	16,430	16,430	13,308	13,308	12,795
Additional Pump Station (Collection to WWTF)	3,000,000	1,500,000	1,500,000	1,500,000	1,500,000	1,500,000	1,500,000	1,500,000
Additional Pump Station O&M	$150,000	$75,000	$75,000	$75,000	$75,000	$75,000	$75,000	$75,000
Force main + PS cost (PS to WWTP @$175/ft)	$ 5,328,900	$ 3,828,900	$ 4,375,250	$ 4,375,250	$ 4,375,250	$ 3,828,900	$ 3,828,900	$ 3,739,125
Total water use in watershed	291,967	291,967	291,967	291,967	291,967	291,967	291,967	291,967
ADF to WWTP (100% water use)	115,420	111,607	102,370	102,370	102,370	111,607	63,243	102,370
TOTAL CAPITAL COST	$17,927,300	$17,526,100	$18,194,750	$18,194,750	$18,194,750	$17,526,100	$10,872,100	$17,558,625
Pleasant Bay								
Areas tributary to WWTP #3	PB	PB	PB	PB	PB	PB	PB	PB
# parcels sewered	1,295	1,295	1,031	1,295	1,205	1,295	681	1,031
Total lf of roads in sewered area (from GIS)	151,942	151,942	132,613	151,942	139,810	151,942	92,369	132,613
lf roads (90%)/parcel in sewered area	106	106	116	106	104	106	122	116
# pump stations (est. 1/100 parcel)	13	13	10	13	12	13	7	10
Cons. Cost per property (from chart)	20,500	20,500	22,200	20,500	20,300	20,500	23,300	22,200
Collection cost	26,547,500	26,547,500	22,888,200	26,547,500	24,461,500	26,547,500	15,867,300	22,888,200
Length of FMs (collection system to WWTP)	5,400	5,400	23,050	5,411	12,965	5,411	5,411	24,087
Additional Pump Station (Collection to WWTF)	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000
Additional Pump Station O&M	$150,000	$150,000	$150,000	$150,000	$150,000	$150,000	$150,000	$150,000
Force main + PS cost (PS to WWTP @$175/ft)	$ 3,945,000	$ 3,945,000	$ 7,033,750	$ 3,946,925	$ 5,268,875	$ 3,946,925	$ 3,946,925	$ 7,215,225
Total water use in watershed	386,474	386,474	386,474	386,474	386,474	386,474	386,474	386,474
ADF to WWTP (100% water use)	277,465	277,465	216,997	277,465	253,639	277,465	150,664	216,997
TOTAL CAPITAL COST	$30,492,500	$30,492,500	$29,921,950	$30,494,425	$29,730,375	$30,494,425	$19,814,225	$30,103,425
Herring River								
Areas tributary to WWTP #3	Herring	Herring	Herring	Herring	Herring	Herring	Herring	Herring
# parcels sewered	832	956	1,395	1,117	1,117	832	406	635
Total lf of roads in sewered area (from GIS)	98,711	124,459	190,828	147,766	147,766	98,711	60,342	77,569
lf roads (90%)/parcel in sewered area	107	117	123	119	119	107	134	110
# pump stations (est. 1/100 parcel)	8	10	14	11	11	8	4	6
Cons. Cost per property (from chart)	20,700	22,400	23,400	22,700	22,700	20,700	25,200	21,200
Collection cost	17,222,400	21,414,400	32,643,000	25,355,900	25,355,900	17,222,400	10,231,200	13,462,000
Length of FMs (collection system to WWTP)	7,300	7,300	7,300	7,300	7,300	7,300	7,300	3,949
Additional Pump Station (Collection to WWTF)	3,000,000	3,000,000	5,000,000	3,000,000	3,000,000	3,000,000	1,500,000	3,000,000
Additional Pump Station O&M	$150,000	$150,000	$250,000	$150,000	$150,000	$150,000	$75,000	$150,000
Force main + PS cost (PS to WWTP @$175/ft)	$ 4,277,500	$ 4,277,500	$ 6,277,500	$ 4,277,500	$ 4,277,500	$ 4,277,500	$ 2,777,500	$ 3,691,075
Total water use in watershed	613,025	613,025	613,025	613,025	613,025	613,025	613,025	613,025
ADF to WWTP (100% water use)	184,267	200,969	284,797	231,970	231,970	184,267	117,097	152,256
TOTAL CAPITAL COST	$21,499,900	$25,691,900	$38,920,500	$29,633,400	$29,633,400	$21,499,900	$13,008,700	$17,153,075

	1A	2A	3A	4A	5A	6A	7A	8A
Summary Number of Parcels Sewered	2,992	3,092	3,198	3,184	3,094	2,968	1,643	2,438
Summary Collection System cost	$ 64,880,500	$ 70,171,300	$ 77,862,900	$ 74,235,100	$ 72,149,100	$ 65,979,300	$ 41,124,900	$ 58,681,900
Summary Force Main & PS Cost	$ 13,626,400	$ 12,051,400	$ 17,686,500	$ 12,599,675	$ 13,921,625	$ 12,128,325	$ 10,628,325	$ 14,645,425
Summary Total Capital Cost	**$78,500,000**	**$82,200,000**	**$95,500,000**	**$86,800,000**	**$86,100,000**	**$78,100,000**	**$51,800,000**	**$73,300,000**
Summary Pumping Station O&M	$525,000	$375,000	$475,000	$375,000	$375,000	$450,000	$375,000	$375,000

	1A	2A	3A	4A	5A	6A	7A	8A
Fm Length (feet)	32,000	26,000	47,000	29,000	37,000	32,000	32,000	41,000
Fm Length (Miles)	6.1	4.9	8.9	5.5	7.0	6.1	6.1	7.8
Linear Feet of Roads (*90%)	337,121	367,166	411,215	389,855	378,936	343,993	217,701	309,281
Miles of Roads (*90%)	64	70	78	74	72	65	41	59
Estimated Miles of Sewer	70	74	87	79	79	71	47	66

Wastewater Scenarios Summary (Treatment Systems)

Evaluation of Alternatives - Harwich CWMP Wastewater Scenarios

Data for Cost Analysis	1A	2A	3A	4A	5A	6A	7A	8A
WWTP #1 Gravel Pit (HR-12)								
ADF to WWTP #3 (100% water use)	184,000	262,000	697,000	427,000	427,000	184,000	117,000	0
Short Term Peak Flow (2.2 x ADF)	404,800	576,400	1,533,400	939,400	939,400	404,800	257,400	0
Unit Construction Cost (from chart) ($/gpd)	22.0	19.0	14.0	15.0	15.0	22.0	26.0	
Treatment goal (mg/L TN)	5	5	5	5	5	5	5	5
Capital cost for WWTP (120%)	$ 10,686,720	$ 13,141,920	$ 25,761,120	$ 16,909,200	$ 16,909,200	$ 10,686,720	$ 8,030,880	$ -
Regional Solution With Chatham? (80%)	100%	100%	100%	100%	100%	100%	100%	100%
Added % for lower TOC (Zone II)	100%	100%	100%	100%	100%	100%	100%	100%
Revised capital cost for WWTP	$ 10,686,720	$ 13,141,920	$ 25,761,120	$ 16,909,200	$ 16,909,200	$ 10,686,720	$ 8,030,880	$ -
Acres Required (100,000 GPD/ACRE)+(5AC for Treatment)	8	9	15	11	11	8	7	5
LAND PURCHASE COSTS (25k / PER ACRE)								
Effluent Disposal Cost (225,000 per acre)	$ 621,000	$ 884,250	$ 2,352,375	$ 1,441,125	$ 1,441,125	$ 621,000	$ 394,875	$ -
Length of FMs (WWTP to Recharge) (feet)	0	0	0	0	0	0	0	0
Force main cost (@$175/ft)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Force main cost (Ocean Outfall @$2,500/ft)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Additional Implementation Cost (Legal and Permitting)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
TOTAL CAPITAL COST	$11,307,720	$14,026,170	$28,113,495	$18,350,325	$18,350,325	$11,307,720	$8,425,755	$0
O&M Dollars Per gpd of Flow	5.0	3.8	2.5	3.0	3.0	5.0	5.0	0.0
ANNUAL O&M COST	$920,000	$995,600	$1,742,500	$1,281,000	$1,281,000	$920,000	$585,000	$0
WWTP #2 High School (SH-2)								
ADF to WWTP #3 (100% water use)	208,000	143,000	0	0	0	143,000	95,000	0
Short Term Peak Flow (2.2 x ADF)	457,600	314,600	0	0	0	314,600	209,000	0
Unit Construction Cost (from chart) ($/gpd)	22.0	24.0				24.0	26.0	
Treatment goal (mg/L TN)	5	5	5	5	5	5	5	5
Capital cost for WWTP (120%)	$ 12,080,640	$ 9,060,480	$ -	$ -	$ -	$ 9,060,480	$ 6,520,800	$ -
Regional Solution With Chatham? (80%)	100%	100%	100%	100%	100%	100%	100%	100%
Added % for lower TOC (Zone II)	100%	100%	100%	100%	100%	100%	100%	100%
Revised capital cost for WWTP	$ 12,080,640	$ 9,060,480	$ -	$ -	$ -	$ 9,060,480	$ 6,520,800	$ -
Acres Required (100,000 GPD/ACRE)+(5AC for Treatment)	8	7	5	5	5	7	6	5
LAND PURCHASE COSTS (25k / PER ACRE)								
Effluent Disposal Cost (225,000 per acre)	$ 702,000	$ 482,625	$ -	$ -	$ -	$ 482,625	$ 320,625	$ -
Length of FMs (WWTP to Recharge) (feet)	0	0	0	0	0	0	0	0
Force main cost (@$175/ft)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Force main cost (Ocean Outfall @$2,500/ft)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Additional Implementation Cost (Legal and Permitting)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
TOTAL CAPITAL COST	$12,782,640	$9,543,105	$0	$0	$0	$9,543,105	$6,841,425	$0
O&M Dollars Per gpd of Flow	4.3	5.3	0.0	0.0	0.0	5.5	6.5	0.0
ANNUAL O&M COST	$894,400	$757,900	$0	$0	$0	$786,500	$617,500	$0
WWTP #3 Gravel Pit (PB-3)								
ADF to WWTP #3 (100% water use)	278,000	278,000	0	278,000	254,000	278,000	151,000	0
Short Term Peak Flow (2.2 x ADF)	611,600	611,600	0	611,600	558,800	611,600	332,200	0
Unit Construction Cost (from chart) ($/gpd)	18.0	18.0	0.0	18.0	19.0	18.0	24.0	0.0
Treatment goal (mg/L TN)	5	5	5	5	3	5	3	5
Capital cost for WWTP (120%)	$ 13,210,560	$ 13,210,560	$ -	$ 13,210,560	$ 12,740,640	$ 13,210,560	$ 9,567,360	$ -
Regional Solution With Chatham? (80%)	100%	100%	100%	100%	80%	100%	100%	100%
Added % for lower TOC (Zone II) or Est. Cost	130%	130%	130%	130%	$4,359,485	130%	130%	130%
Revised capital cost for WWTP	$ 17,173,728	$ 17,173,728	$ -	$ 17,173,728	$ 14,551,997	$ 17,173,728	$ 12,437,568	$ -
Acres Required (100,000 GPD/ACRE)+(5AC for Treatment)	9	9	5	9	9	9	7	5
LAND PURCHASE COSTS (25k / PER ACRE)	$ 229,000	$ 229,000	$ -	$ 229,000	$ 220,000	$ 229,000	$ 182,000	$ -
Effluent Disposal Cost (225,000 per acre)	$ 938,250	$ 938,250	$ -	$ 938,250	$ 857,250	$ 938,250	$ 509,625	$ -
Length of FMs (WWTP to Recharge) (feet)	0			0	17,437	0		0
Additional Chatham Pumping Station					$ 2,000,000			
Additional Chatham Pumping Station O&M					$ 100,000			
Force main cost (@$175/ft)	$ -	$ -	$ -	$ -	$ 3,051,475	$ -	$ -	$ -
Force main cost (Ocean Outfall @$2,500/ft)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Additional Implementation Cost (Legal and Permitting)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
TOTAL CAPITAL COST	$18,340,978	$18,340,978	$0	$18,340,978	$18,680,722	$18,340,978	$13,129,193	$0
O&M Dollars Per gpd of Flow	3.8	3.8	0.0	3.8	1.7	3.8	5.2	0.0
Additional O&M Cost for TOC in Zone II	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
ANNUAL O&M COST	$1,612,400	$1,612,400	$0	$1,612,400	$1,039,800	$1,612,400	$1,087,200	$0
WWTP #4 Harwich Port Golf Club (OW-2)								
ADF to WWTP #3 (100% water use)	0	0	0	0	0	61,000	54,000	0
Short Term Peak Flow (2.2 x ADF)	0	0	0	0	0	134,200	118,800	0
Unit Construction Cost (from chart) ($/gpd)						34.0	33.0	
Treatment goal (mg/L TN)	5	5	5	5	5	5	5	5
Capital cost for WWTP (120%)	$ -	$ -	$ -	$ -	$ -	$ 5,475,360	$ 4,704,480	$ -
Regional Solution With Chatham? (80%)	100%	100%	100%	100%	100%	100%	100%	100%
Added % for lower TOC (Zone II)	100%	100%	100%	100%	100%	100%	100%	100%
Revised capital cost for WWTP	$ -	$ -	$ -	$ -	$ -	$ 5,475,360	$ 4,704,480	$ -
Acres Required (100,000 GPD/ACRE)+(5AC for Treatment)	5	5	5	5	5	9	8	5
LAND PURCHASE COSTS (25k / PER ACRE)						$ 217,000	$ 206,000	
Effluent Disposal Cost (225,000 per acre)	$ -	$ -	$ -	$ -	$ -	$ 823,500	$ 729,000	$ -
Length of FMs (WWTP to Recharge) (feet)	0	0	0	0	0	0	0	0
Force main cost (@$175/ft)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Force main cost (Ocean Outfall @$2,500/ft)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Additional Implementation Cost (Legal and Permitting)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
TOTAL CAPITAL COST	$0	$0	$0	$0	$0	$6,515,860	$5,639,480	$0
O&M Dollars Per gpd of Flow	0.0	0.0	0.0	0.0	0.0	7.8	8.2	0.0
ANNUAL O&M COST	$0	$0	$0	$0	$0	$475,800	$442,800	$0
WWTP #5 Town Gardens (HR-18)								
ADF to WWTP #3 (100% water use)	0	0	0	0	0	0	0	564,000
Short Term Peak Flow (2.2 x ADF)	0	0	0	0	0	0	0	1,240,800
Unit Construction Cost (from chart) ($/gpd)								14.5
Treatment goal (mg/L TN)	5	5	5	5	5	5	5	5
Capital cost for WWTP (120%)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 21,589,920
Regional Solution With Chatham? (80%)	100%	100%	100%	100%	100%	100%	100%	100%
Added % for lower TOC (Zone II)	100%	100%	100%	100%	100%	100%	100%	100%
Revised capital cost for WWTP	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 21,589,920
Acres Required (100,000 GPD/ACRE)+(5AC for Treatment)	5	5	5	5	5	5	5	13
LAND PURCHASE COSTS (25k / PER ACRE)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Effluent Disposal Cost (225,000 per acre)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,903,500
Length of FMs (WWTP to Outfall (feet))	0	0	0	0	0	0	0	25,362
Force main cost (@$175/ft)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 4,438,350
Force main cost (Ocean Outfall @$2,500/ft)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 63,405,000
Additional Implementation Cost (Legal and Permitting)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,000,000
TOTAL CAPITAL COST	$0	$0	$0	$0	$0	$0	$0	$92,336,770
O&M Dollars Per gpd of Flow	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0
ANNUAL O&M COST	$0	$0	$0	$0	$0	$0	$0	$1,692,000
WWTP #6 Innovative / Alternative Systems								
# proposed I/A systems 19 mg/L TN	0	0	0	0	0	0	5369	0
# proposed I/A systems 13 mg/L TN	0	0	0	0	0	0	1226	0
Capital cost I/A systems (15K and 20K)	$ -	$ -	$ -	$ -	$ -	$ -	$ 105,055,000	$ -
Annual O&M cost I/A systems @ $2,500 per system	$ -	$ -	$ -	$ -	$ -	$ -	$ 11,118,500	$ -
TOTAL CAPITAL COST	$0	$0	$0	$0	$0	$0	$105,055,000	$0
ANNUAL O&M COST	$0	$0	$0	$0	$0	$0	$11,118,500	$0

	1A	2A	3A	4A	5A	6A	7A	8A
Summary ADF to WWTP #3 (100% water use)	670,000	683,000	697,000	705,000	681,000	666,000	417,000	564,000
Capital Cost for WWTP	$ 39,941,088	$ 39,376,128	$ 25,761,120	$ 34,082,928	$ 31,461,197	$ 42,396,288	$ 31,693,728	$ 21,589,920
Summary Capital Cost I/A Systems	$ -	$ -	$ -	$ -	$ -	$ -	$ 105,055,000	$ -
Summary Land Purchase + Eff Disp. Cost	$ 2,490,250	$ 2,534,125	$ 2,352,375	$ 2,608,375	$ 2,518,375	$ 3,311,375	$ 2,342,125	$ 1,903,500
Summary Force Main Cost	$ -	$ -	$ -	$ -	$ 3,051,475	$ -	$ -	$ 4,438,350
Summary Ocean Outfall Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 63,405,000
Summary Additional Implementation Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,000,000
Summary Annual O&M Cost WWTP	$ 3,426,800	$ 3,365,900	$ 1,742,500	$ 2,893,400	$ 2,320,800	$ 3,794,700	$ 2,732,500	$ 1,692,000
Summary Annual O&M Cost I/A Systems	$ -	$ -	$ -	$ -	$ -	$ -	$ 11,118,500	$ -
Summary Total Capital Cost	$42,400,000	$41,900,000	$28,100,000	$36,700,000	$37,000,000	$45,700,000	$139,100,000	$92,300,000
Summary Total O&M Cost	$3,400,000	$3,400,000	$1,700,000	$2,900,000	$2,300,000	$3,800,000	$13,900,000	$1,700,000

Final Recommended Plan
Harwich MA - 2012
Allen Harbor

Name	Watershed #	Total (kg/yr)	Septic (kg/yr)	% Removal	Net Septic Load (kg/yr)	Attenuation % (Stream)	Attenuated Septic Load (kg/yr)	Attenuated Septic Load (kg/day)	From Table VIII-2 Attenuated Septic Load Thresholds (kg/day)
Build-out									
Stream GT 10	1	269	224	0%	224				
Stream LT 10	2	942	744	30%	521				
Stream Total		1211	968		745	30%	521	1.428	0.642
Harbor	3	1999	1774	100%	0		0	0.000	0.841
Harbor Total		**3210**	**2742**		**745**		**521**	**1.428**	**1.483**
Treated Load			**1997**	**73%**					

Final Recommended Plan
Harwich MA - 2012
Wychmere Harbor

Build-out									
Name	Watershed #	Total (kg/yr)	Septic (kg/yr)	% Removal	Net Septic Load (kg/yr)	Attenuation % (Stream)	Attenuated Septic Load (kg/yr)	Attenuated Septic Load (kg/day)	From Table VIII-2 Attenuated Septic Load Thresholds (kg/day)
Harbor	4	1523	1206	100%	0		0	0.000	0.000
Harbor Total		**1523**	**1206**		**0**		**0**	**0.000**	**0.000**
Treated Load			**1206**	**100%**					

Final Recommended Plan
Harwich MA - 2012
Saquatucket Harbor

Build-out												
Name	Watershed #	Total (kg/yr)	Septic (kg/yr)	Outflow %	Total (kg/yr)	Septic (kg/yr)	% Removal	Net Septic Load (kg/yr)	Attenuation %	Attenuated Septic Load (kg/yr)	Attenuated Septic Load (kg/day)	From Table VIII-2 Attenuated Septic Load Thresholds
Grass Pond	13	1152	903	100%	1152	903	43%	515	50%	257		
Banks St Bogs LT10	12	2284	1941		2284	1941	10%	1747		1747		
Banks St Bogs GT10	11	322	175		322	175	1%	173		173		
			Recharge to Upper Muddy Creek Watershed 13									
							Removed Septic (kg/yr)	Recharge Septic (kg/yr)				
Cold Spring Brook Recharge							1567					
John Joseph Recharge							0					
E. Saq Stream Recharge							989					
Harbor Load Recharge							1012					
Allen Harbor Load Recharge							0					
Wychmere Harbor Load Recharge							1206					
Total Septic Load From Harwich							4774					
Recharge at what Concentration.			0	mg/l				0	50%	0		
Banks St Bogs Total					**3758**	**3019**	**19%**	**2435**	**35%**	**1415**		
Paddocks Pond	14	898	648	100%	898	648	2%	635	50%	318		
Cold Spring Brook LT10	10	2825	2064		2825	2064	47%	1094		1094		
Cold Spring Brook GT10	9	1178	861		1178	861	0%	861		861		
Cold Spring Brook Total					**8659**	**6592**	**24%**	**5025**	**35%**	**2397**		
Black Pond	5	18	6	14%	2	1	0%	1	50%	0		
John Joseph Pond GT10	6	109	89		109	89	0%	89		89		
John Joseph Pond LT10	7	500	335		500	335	0%	335		335		
John Joseph Pond Total		627	430	27%	164	114	0%	114	74%	30		
Chatham Road WELLS	8	1004	667	80%	803	534	0%	534		534		
Saq Harbor LT10N	15	1166	1009		1166	1009	98%	20		20		
E. Saquatucket Stream Total					**2133**	**1657**	**60%**	**668**	**15%**	**496**	**1.359**	**1.274**
Harbor LT10S	16	1113	1012		1113	1012	100%	0		0	0.000	0.507
Harbor Total					**11905**	**9261**		**5693**		**1915**	**5.246**	**5.28**
Treated Load						**3568**	**39%**					

Final Recommended Plan
Harwich MA - 2012
Pleasant Bay

Name	Watershed #	Total (kg/yr)	Septic (kg/yr)	Outflow %	Total (kg/yr)	Septic (kg/yr)	% Removal	Net Septic Load (kg/yr)	Attenuation %	Attenuated Septic Load (kg/yr)	Attenuated Septic Load (kg/day)	Attenuated load; table3,pg 6 of 6/25/10 SMAST memo
Build-out												
Grassy Pond	9	189	7		189	7	0%	7	50%	4		
Grassy Pond to Mud Pond				9%	17	1		1		0		
Mud Pond (Harwich)	12	47	0		47	0	0%	0		0		
Mud Pond (Brewster)	12	7	0		7	0	0%	0		0		
Mud Pond Total					71	1		0	50%	0		
Hawksnest Pond	76	126	0		126	0	0%	0	50%	0		
Hawksnest Pond to Mill Pond				14%	18	0		0		0		
Mill Pond (Harwich)	68	1231	1017		1231	1017	0%	1017		1017		
Mill Pond (Chatham)	68	232	112		232	112	0%	112		112		
Mill Pond Fresh Total					1481	1129		1129	50%	565		
Mill Pond to Goose Pond				6%	89	68		68		34		
Goose Pond (Chatham)	69	355	137		349	137	0%	137		137		
Goose Pond Total					438	205		205	50%	86		
Goose Pond to Trout Pond				19%	83	39	0%	39		16		
Trout Pond (Chatham)	70	325	211		325	211	0%	211		211		
Trout Pond Total					408	250		250	50%	114		
Mud Pond				24%	17	0		0		0		
Round Cove GT 10	61	1238	1064		1238	1064	100%	0		0		
Round Cove LT 10	62	1295	1052		1295	1052	30%	736		736		
Round Cove Total					**2485**	**1989**		**609**		**609**	**1.670**	**1.865**
Hawksnest Pond				20%	25	0		0		0		
Mill Pond Fresh				23%	341	260		260		130		
Goose Pond				32%	140	66		66		27		
Upper Muddy Crk 10 W(Harwich)	83	1980	1703		1980	1703	79%	358		358		
Upper Muddy Crk 10 W(Chatham)	83	0	0		0	0	58%	0		0		
Upper Muddy Crk(Harwich)	81	2863	2394		2863	2394	80%	479		479		
Upper Muddy Crk (Chatham)	81	1139	886		1139	886	58%	372		372		
Upper Muddy (Unaccounted)	81	35	0		35	0	0%	0		0		
Upper Muddy Crk (Regional?)	81	72	25		72	25	0%	25		25		
Upper Muddy Crk 10E (Chatham)	82	162	131		162	131	58%	55		55		
Atmospheric		59			59							
Recharge to Upper Muddy Creek Watershed 83												
							Removed Septic (kg/yr)	Recharge Septic (kg/yr)				
Round Cove Recharge							1380					
Muddy Creek Recharge							4945					
Pleasant Bay Recharge							2155					
Total Septic Load From Harwich							8480					
Recharge at what Concentration.			3	mg/l				978				
Upper Muddy Creek Total					**6816**	**5464**		**1614**	**57%**	**1042**	**4.204**	**2.59**
Trout Pond				100%	408	250		250		114		
Muddy Crk WELL	77	1037	876		1037	876	100%	0		0		
Lower Muddy Crk (Chatham)	78	1161	959		1161	959	50%	480		480		
Lower Muddy Crk (Harwich)	78	708	508		708	508	50%	254		254		
Lower Muddy Crk (Regional?)		11	8		11	8	0%	8		8		
Lower Muddy Crk10E (Chatham)	79	178	141		178	141	50%	71		71		
Lower Muddy Crk 10W(Harwich)	80	1376	1109		1376	1109	50%	555		555		
Atmospheric		80			80							
Lower Muddy Creek Total					4959	3851		1616		1480	**4.055**	**4.3**
Muddy Creek Total					**11775**	**9315**		**3230**	**2%**	**2472**	**6.773**	**6.89**
Grassy Pond				91%	172	6		6		3		
Mud Pond Harwich				76%	54	0		0		0		
Pleasant Bay Rd WELL_HAR	29	528	464		528	464	100%	0		0		
Pleasant Bay GT 10 BreHar (Harwich)	49	687	610		687	610	72%	171		171		
Pleasant Bay GT 10 Harwich	50	1080	879		1080	879	74%	229		229		
Pleasant Bay LT 10 Harwich	53N	1178.6	604.6		1179	605	64%	218		218		
Wequasset Inn	53N	867	867		867	867	83%	152		152		Net Load Based on 11,000 gpd@ 1
Pleasant Bay LT 10 Harwich	53S	516	456		516	456	47%	242		242		
Pleasant Bay Total					**5083**	**3887**	**74%**	**1017**		**1014**		

Final Recommended Plan
Harwich MA - 2012
Herring River

Total Buildout Septic Attenuated Loads												
Name	Watershed #	Pres Total Unattenuated (kg/yr)	BO Septic Unattenuated (kg/yr)	Outflow %	Total (kg/yr)	Septic (kg/yr)	% Removal	Net Septic Load (kg/yr)	Attenuation %	Attenuated Septic Load (kg/yr)	Attenuated Septic Load (kg/day)	Threshold
Lothrup Rd GT10 N	19	2019	1968.1	100%	2019	1968.1	28%	1417	0%	1417		kg/day
Lothrup Road GT 10N **WWTF**										68		
Flax Pond	22	696	5.9	100%	696	5.9	100%	0	50%	0		
Lothrup Rd LT10	20	4073	3597.2	100%	4073	3597.2	100%	0	0%	0		
				Recharge to Watershed 20								
							Removed Septic (kg/yr)	Recharge Septic (kg/yr)				
Lothrup Recharge							6410					
West Res Recharge							3168					
East Res Recharge							5108					
Lower Herring Recharge							2840					
Scenario Recharge Outside Watershed							6771					
Remove Dennisport							-870					
added Recharge Other Areas	Total of 110,500 galons per day						3600					
Total Recharge							27027					
Recharge			3	mg/l				3209	0%	3209		
Lothrup Rd GT10 S	**21**	**2496**	2255.9	100%	2496	2255.9	100%	0	0%	0		
Lothrup Rd GT10 S WWTF										90		
Aunt Edies Pond	**AEP**	**183**	**83**	100%	183	83		83		83		
Cornelius Pond	**CP**	**240**	**0**	100%	240	0		0		0		
Walker Pond (Alone)	**WP**	266	0	53%	141	0		0		0		
Lothrup Totals					9848	7910		1500	50%	2433	6.666	4.504
Cornelius Pond GT10	16	**49**	59.1	100%	49	59.1	100%	0	0%	0		
Cornelius Pond LT10	17	**66**	23.7	100%	66	23.7	100%	0	0%	0		
Walker to Cornelius		**266**	236.5	**47%**	125	111		0	50%	0		
Cornelius Pond Total					240	194		0	50%	0		
Aunt Edies Pond GT10	14	**58**	47.8	100%	58	47.8	0%	48	0%	48		
Aunt Edies Pond LT10	15	**125**	118	100%	125	118	0%	118	0%	118		
Aunt Edies Pond Total					183	166		166	50%	83		
Walker Pond	**18**	**266**	236.5	100%	266	236.5	100%	0	50%	0		
West Reservoir LT10	24	5132	4874	100%	5132	4874	65%	1706	0%	1706		
West Reservoir GT10	23	1854	1469	100%	1854	1469	0%	1469	0%	1469		
White Pond	1	114	258.7	55%	63	142.285	0%	142	50%	71		
Elbow Pond	**2**	309	120.1	100%	309	120.1	0%	120	50%	60		
Herring River N LT 10	**13**	2504	2621.5	100%	2504	2621.5	0%	2622	0%	2622		
N_HarWell	**4**	20	41.4	100%	20	41.4	0%	41	0%	41		
Robbins Pond	**3**	180	41.4	100%	180	41.4	0%	41	50%	21		
Herring River N GT10	12	266	364.5	100%	266	364.5	0%	365	0%	365		
Seymour Pond	SEP	2147	358	25%	537	89.41814375		89		89		
Hinckleys Pond	HP	12086	1870	100%	12086	1869.925569		1870		1870		
West Reservoir Totals					22951	11634		8465	25%	6235	17.083	12.137
Seymour Pond LT10	6	**1477**	572.2	100%	1477	572	0%	572	0%	572		
Seymour Pond GT10	7	**496**	573.6	100%	496	574	0%	574	0%	574		
Sheep To Seymour Pond		**1393**	64	13%	174	8		8		8		
Seymour Pond Total		**3366**	**1209.66**		2147	1154		1154	69%	358		
Long Pond GT10 S	11	**625**	578.1	100%	625	578	0%	578	0%	578		
Long Pond LT10	10	**7244**	3640.7	100%	7244	3641	0%	3641	0%	3641		
Long Pond GT10 N	9	**706**	825.1	100%	706	825	0%	825	0%	825		
Sheep Pond		**1393**	64	30%	417	19		19		19		
Seymour Pond Total		**2147**	358	40%	859	143		143		143		
Long Pond Total		12115	5465		9850	5206		5206	73%	1406		
Long Pond		**9850**	1406	100%	9850	1406		1406		1406		
Hinckleys Pond	5	**2236**	1304	100%	2236	1304	0%	1304	0%	1304		
Hinckleys Pond Total		12086	2710		12086	2710		2710	31%	1870		
Sheep Pond	**8**	**1393**	638.6	100%	1393	638.6	0%	639	90%	64		
East Resevior	25	107	17.4	100%	107	17.4	100%	0	0%	0	0.000	0.047
Upper Herring R_Main_LT10	27	3005	2901.1	100%	3005	2901.1	100%	0	0%	0		
Upper Herring R_Main_GT10	26	1848	2189	100%	1848	2189	100%	0	0%	0		
Atmospheric		0	0	100%	0	0	0%	0	0%	0		
Total		**4960**	**5107.5**		**4960**	**5107.5**		**0**		**0**	**0.000**	**0.000**
Lower Herring R_Main_LT10	29	2732	2331	100%	2732	2331	100%	0	0%	0		
Lower Herring R_Main_GT10	28	566	509.2	100%	566	509.2	100%	0	0%	0		
Atmospheric		0	0	100%	0	0	0%	0	0%	0		
Total		**3298**	**2840.2**		**3298**	**2840.2**		**0**		**0**	**0.000**	**7.063**

Allen Scenario 1A

Name	Watershed #	Total (kg/yr)	Septic (kg/yr)	% Removal	Net Septic Load (kg/yr)	Attenuation % (Stream)	Attenuated Septic Load (kg/yr)	Attenuated Septic Load (kg/day)	From Table VIII-2 Attenuated Septic Load Thresholds (kg/day)
Build-out									
Stream GT 10	1	269	224	0%	224				
Stream LT 10	2	942	744	30%	521				
Stream Total		1211	968		745	30%	521	1.428	0.642
Harbor	3	1999	1774	100%	0		0	0.000	0.841
Harbor Total		**3210**	**2742**		**745**		**521**	**1.428**	**1.483**
Total Treated Load			**1997**	**73%**					

Wychmere Scenario 1A

Name	Watershed #	Total (kg/yr)	Septic (kg/yr)	% Removal	Net Septic Load (kg/yr)	Attenuation % (Stream)	Attenuated Septic Load (kg/yr)	Attenuated Septic Load (kg/day)	From Table VIII-2 Attenuated Septic Load Thresholds (kg/day)
					Build-out				
Harbor	4	1523	1206	100%	0		0	0.000	0.000
Harbor Total		**1523**	**1206**		**0**		**0**	**0.000**	**0.000**
Treated Load			**1206**	**100%**					

Name	Watershed #	Total (kg/yr)	Septic (kg/yr)	Outflow %	Total (kg/yr)	Septic (kg/yr)	% Removal	Net Septic Load (kg/yr)	Attenuation %	Attenuated Septic Load (kg/yr)	Attenuated Septic Load (kg/day)	From Table VIII-2 Attenuated Septic Load Thresholds (kg/day)
					Build-out							
Grass Pond	13	1152	903	100%	1152	903	43%	515	50%	257		
Banks St Bogs LT10	12	2284	1941		2284	1941	10%	1747		1747		
Banks St Bogs GT10	11	322	175		322	175	1%	173		173		
					Recharge to Upper Muddy Creek Watershed 13							
							Removed	Recharge				
Cold Spring Brook Recharge							2021					
John Joseph Recharge							0					
E. Saq Stream Recharge							989					
Harbor Load Recharge							1012					
Allen Harbor Load Recharge							1997					
Wychmere Harbor Load Recharge							1206					
Total Septic Load From Harwich							7225					
Recharge at what Concentration			5	mg/l				1389	50%	695		
Banks St Bogs Total					**3758**	**3019**	**19%**	**2435**	**35%**	**1867**		
Paddocks Pond	14	898	648	100%	898	648	2%	635	50%	318		
Cold Spring Brook LT10	10	2825	2064		2825	2064	69%	640		640		
Cold Spring Brook GT10	9	1178	861		1178	861	0%	861		861		
Cold Spring Brook Total					**8659**	**6592**	**31%**	**4571**	**35%**	**2395**		
Black Pond	5	18	6	14%	2	1	0%	1	50%	0		
John Joseph Pond GT10	6	109	89		109	89	0%	89		89		
John Joseph Pond LT10	7	500	335		500	335	0%	335		335		
John Joseph Pond Total		627	430	27%	164	114	0%	114	74%	30		
Chatham Road WELLS	8	1004	667	80%	803	534	0%	534		534		
Saq Harbor LT10N	15	1166	1009		1166	1009	98%	20		20		
E. Saquatucket Stream Total					**2133**	**1657**	**60%**	**668**	**15%**	**496**	**1.359**	**1.274**
Harbor LT10S	16	1113	1012		1113	1012	100%	0		0	0.000	0.507
Harbor Total					**11905**	**9261**		**5239**		**1913**	**5.242**	**5.28**
Treated Load						**4022**	**43%**					

Build-out

Name	WS #	Total (kg/yr)	Septic (kg/yr)	Outflow %	Total (kg/yr)	Septic (kg/yr)	% Removal	Net Septic Load (kg/yr)	Attenuation %	Attenuated Septic Load (kg/yr)	Attenuated Septic Load (kg/day)	Attenuated load; table3,pg 6 of 6/25/10 SMAST memo
Grassy Pond	9	189	7		189	7	0%	7	50%	4		
Grassy Pond to Mud Pond				*9%*	*17*	*1*		*1*		*0*		
Mud Pond (Harwich)	12	47	0		47	0	0%	0		0		
Mud Pond (Brewster)	12	7	0		7	0	0%	0		0		
Mud Pond Total					71	1		0	50%	0		
Hawksnest Pond	76	126	0		126	0	0%	0	50%	0		
Hawksnest Pond to Mill Pond				*14%*	*18*	*0*		*0*		*0*		
Mill Pond (Harwich)	68	1231	1017		1231	1017	0%	1017		1017		
Mill Pond (Chatham)	68	232	112		232	112	0%	112		112		
Mill Pond Fresh Total					1481	1129		1129	50%	565		
Mill Pond to Goose Pond				*6%*	*89*	*68*		*68*		*34*		
Goose Pond (Chatham)	69	355	137		349	137	0%	137		137		
Goose Pond Total					438	205		205	50%	86		
Goose Pond to Trout Pond				*19%*	*83*	*39*	*0%*	*39*		*16*		
Trout Pond (Chatham)	70	325	211		325	211	0%	211		211		
Trout Pond Total					408	250		250	50%	114		
Mud Pond				*24%*	*17*	*0*		*0*		*0*		
Round Cove GT 10	61	1238	1064		1238	1064	100%	0		0		
Round Cove LT 10	62	1295	1052		1295	1052	30%	736		736		
Round Cove Total					**2485**	**1990**		**610**		**610**	**1.671**	**1.865**
Hawksnest Pond				*20%*	*25*	*0*		*0*		*0*		
Mill Pond Fresh				*23%*	*341*	*260*		*260*		*130*		
Goose Pond				*32%*	*140*	*66*		*66*		*27*		
Upper Muddy Crk 10 W(Harwich)	83	1980	1703		1980	1703	99%	10		10		
Upper Muddy Crk 10 W(Chatham)	83	0	0		0	0	58%	0		0		
Upper Muddy Crk(Harwich)	81	2863	2394		2863	2394	100%	0		0		
Upper Muddy Crk (Chatham)	81	1139	886		1139	886	58%	372		372		
Upper Muddy (Unaccounted)	81	35	0		35	0	0%	0		0		
Upper Muddy Crk (Regional?)	81	72	25		72	25	0%	25		25		
Upper Muddy Crk 10E (Chatham)	82	162	131		162	131	58%	55		55		
Atmospheric		59			59							
Recharge to Upper Muddy Creek Watershed 83												
							Removed Septic (kg/yr)	Recharge Septic (kg/yr)				
Round Cove Recharge							1380					
Muddy Creek Recharge							5771					
Pleasant Bay Recharge							2871					
Total Septic Load From Harwich							10022					
Recharge at what Concentration.			5	mg/l				1904				
Upper Muddy Creek Total					**6816**	**5464**		**788**	**57%**	**1085**	**4.204**	**2.59**
Trout Pond				*100%*	*408*	*250*		*250*		*114*		
Muddy Crk WELL	77	1037	876		1037	876	100%	0		0		
Lower Muddy Crk (Chatham)	78	1161	959		1161	959	50%	480		480		
Lower Muddy Crk (Harwich)	78	708	508		708	508	50%	254		254		
Lower Muddy Crk (Regional?)		11	8		11	8	0%	8		8		
Lower Muddy Crk10E (Chatham)	79	178	141		178	141	50%	71		71		
Lower Muddy Crk 10W(Harwich)	80	1376	1109		1376	1109	50%	555		555		
Atmospheric		80			80							
Lower Muddy Creek Total					4959	3851		1616		1480	**4.055**	**4.3**
Muddy Creek Total					**11775**	**9315**		**2404**	**2%**	**2514**	**6.888**	**6.89**
Grassy Pond				*91%*	*172*	*6*		*6*		*3*		
Mud Pond Harwich				*76%*	*54*	*0*		*0*		*0*		
Pleasant Bay Rd WELL_HAR (Harwich)	29	528	464		528	464	100%	0		0		
Pleasant Bay GT 10 BreHar	49	687	610		687	610	72%	171		171		
Pleasant Bay GT 10 Harwich	50	1080	879		1080	879	74%	229		229		
Pleasant Bay LT 10 Harwich	53N	1178.6	604.6		1179	605	64%	218		218		
Wequasset Inn	53N	867	867		867	867	83%	152		152		
Pleasant Bay LT 10 Harwich	53S	516	456		516	456	47%	242		242		
Pleasant Bay Total					**5083**	**3887**	**74%**	**1017**		**1014**		

Allen Scenario 2A

Build-out									
Name	Watershed #	Total (kg/yr)	Septic (kg/yr)	% Removal	Net Septic Load (kg/yr)	Attenuation % (Stream)	Attenuated Septic Load (kg/yr)	Attenuated Septic Load (kg/day)	From Table VIII-2 Attenuated Septic Load Thresholds (kg/day)
Stream GT 10	1	269	224	0%	224				
Stream LT 10	2	942	744	30%	521				
Stream Total		1211	968		745	30%	521	1.428	0.642
Harbor	3	1999	1774	100%	0		0	0.000	0.841
Harbor Total		**3210**	**2742**		**745**		**521**	**1.428**	**1.483**
Treated Load			**1997**	**73%**					

Wychmere Scenario 2A

Name	Watershed #	Total (kg/yr)	Septic (kg/yr)	% Removal	Net Septic Load (kg/yr)	Attenuation % (Stream)	Attenuated Septic Load (kg/yr)	Attenuated Septic Load (kg/day)	From Table VIII-2 Attenuated Septic Load Thresholds
Build-out									
Harbor	4	1523	1206	100%	0		0	0.000	0.000
Harbor Total		**1523**	**1206**		**0**		**0**	**0.000**	**0.000**
Treated Load			**1206**	**100%**					

Saquatucket Scenario 2A

Build-out

Name	Watershed #	Total (kg/yr)	Septic (kg/yr)	Outflow %	Total (kg/yr)	Septic (kg/yr)	% Removal	Net Septic Load (kg/yr)	Attenuation %	Attenuated Septic Load (kg/yr)	Attenuated Septic Load (kg/day)	From Table VIII-2 Attenuated Septic Load Thresholds (kg/day)
Grass Pond	13	1152	903	100%	1152	903	43%	515	50%	257		
Banks St Bogs LT10	12	2284	1941		2284	1941	10%	1747		1747		
Banks St Bogs GT10	11	322	175		322	175	1%	173		173		
				Recharge to Upper Muddy Creek Watershed 13								
							Removed Septic	Recharge Septic (kg/yr)				
Cold Spring Brook Recharge							1877					
John Joseph Recharge							0					
E. Saq Stream Recharge							989					
Harbor Load Recharge							1012					
Allen Harbor Load Recharge							0					
Wychmere Harbor Load Recharge							1206					
Total Septic Load From Harwich							5084					
Recharge at what Concentration.			5	mg/l				978	50%	488.8076923		
Banks St Bogs Total					**3758**	**3019**	**19%**	**2435**	**35%**	**1733**		
Paddocks Pond	14	898	648	100%	898	648	2%	635	50%	318		
Cold Spring Brook LT10	10	2825	2064		2825	2064	62%	784		784		
Cold Spring Brook GT10	9	1178	861		1178	861	0%	861		861		
Cold Spring Brook Total					**8659**	**6592**	**28%**	**4715**	**35%**	**2402**		
Black Pond	5	18	6	14%	2	1	0%	1	50%	0		
John Joseph Pond GT10	6	109	89		109	89	0%	89		89		
John Joseph Pond LT10	7	500	335		500	335	0%	335		335		
John Joseph Pond Total		627	430	27%	164	114	0%	114	74%	30		
Chatham Road WELLS	8	1004	667	80%	803	534	0%	534		534		
Saq Harbor LT10N	15	1166	1009		1166	1009	98%	20		20		
E. Saquatucket Stream Total					**2133**	**1657**	**60%**	**668**	**15%**	**496**	**1.359**	**1.274**
Harbor LT10S	16	1113	1012		1113	1012	100%	0		0	0.000	0.507
Harbor Total					**11905**	**9261**		**5383**		**1920**	**5.261**	**5.28**
Treated Load						**3878**	**42%**					

Build-out

Name	Watershed #	Total (kg/yr)	Septic (kg/yr)	Outflow %	Total (kg/yr)	Septic (kg/yr)	% Removal	Net Septic Load (kg/yr)	Attenuation %	Attenuated Septic Load (kg/yr)	Attenuated Septic Load (kg/day)	Attenuated load; table3,pg 6 of 6/25/10 SMAST memo
Grassy Pond	9	189	7		189	7	0%	7	50%	4		
Grassy Pond to Mud Pond				9%	17	1		1		0		
Mud Pond (Harwich)	12	47	0		47	0	0%	0		0		
Mud Pond (Brewster)	12	7	0		7	0	0%	0		0		
Mud Pond Total					71	1		0	50%	0		
Hawksnest Pond	76	126	0		126	0	0%	0	50%	0		
Hawksnest Pond to Mill Pond				14%	18	0		0		0		
Mill Pond (Harwich)	68	1231	1017		1231	1017	0%	1017		1017		
Mill Pond (Chatham)	68	232	112		232	112	0%	112		112		
Mill Pond Fresh Total					1481	1129		1129	50%	565		
Mill Pond to Goose Pond				6%	89	68		68		34		
Goose Pond (Chatham)	69	355	137		349	137	0%	137		137		
Goose Pond Total					438	205		205	50%	86		
Goose Pond to Trout Pond				19%	83	39	0%	39		16		
Trout Pond (Chatham)	70	325	211		325	211	0%	211		211		
Trout Pond Total					408	250		250	50%	114		
Mud Pond				24%	17	0		0		0		
Round Cove GT 10	61	1238	1064		1238	1064	100%	0		0		
Round Cove LT 10	62	1295	1052		1295	1052	30%	736		736		
Round Cove Total					**2485**	**1990**		**610**		**610**	**1.671**	**1.865**
Hawksnest Pond				20%	25	0		0		0		
Mill Pond Fresh				23%	341	260		260		130		
Goose Pond				32%	140	66		66		27		
Upper Muddy Crk 10 W(Harwich)	83	1980	1703		1980	1703	99%	10		10		
Upper Muddy Crk 10 W(Chatham)	83	0	0		0	0	58%	0		0		
Upper Muddy Crk(Harwich)	81	2863	2394		2863	2394	100%	0		0		
Upper Muddy Crk (Chatham)	81	1139	886		1139	886	58%	372		372		
Upper Muddy (Unaccounted)	81	35	0		35	0	0%	0		0		
Upper Muddy Crk (Regional?)	81	72	25		72	25	0%	25		25		
Upper Muddy Crk 10E (Chatham)	82	162	131		162	131	58%	55		55		
Atmospheric		59			59							
				Recharge to Upper Muddy Creek Watershed 83								
							Removed Septic	Recharge Septic				
Round Cove Recharge							1380					
Muddy Creek Recharge							5771					
Pleasant Bay Recharge							2870					
Total Septic Load From Harwich							10021					
Recharge at what Concentration.			5	mg/l				1927				
Upper Muddy Creek Total					**6816**	**5464**		**788**	**57%**	**1095**	**4.204**	**2.59**
Trout Pond				100%	408	250		250		114		
Muddy Crk WELL	77	1037	876		1037	876	100%	0		0		
Lower Muddy Crk (Chatham)	78	1161	959		1161	959	50%	480		480		
Lower Muddy Crk (Harwich)	78	708	508		708	508	50%	254		254		
Lower Muddy Crk (Regional?)		11	8		11	8	0%	8		8		
Lower Muddy Crk10E (Chatham)	79	178	141		178	141	50%	71		71		
Lower Muddy Crk 10W(Harwich)	80	1376	1109		1376	1109	50%	555		555		
Atmospheric		80			80							
Lower Muddy Creek Total					4959	3851		1616		1480	**4.055**	**4.3**
Muddy Creek Total					**11775**	**9315**		**2404**	**2%**	**2524**	**6.914**	**6.89**
Grassy Pond				91%	172	6		6		3		
Mud Pond Harwich				76%	54	0		0		429		
Pleasant Bay Rd WELL_HAR	29	528	464		528	464	100%	0		0		
Pleasant Bay GT 10 BreHar	49	687	610		687	610	72%	171		171		
Pleasant Bay GT 10 Harwich	50	1080	879		1080	879	74%	229		229		
Pleasant Bay LT 10 Harwich	53N	1179	604		1179	604	64%	217		217		
Wequasset Inn	53N	867	867		867	867	83%	152		152	Net Load Based on 11,000 gpd@	
Pleasant Bay LT 10 Harwich	53S	516	456		516	456	47%	242		242		
Pleasant Bay Total					**5083**	**3887**	**74%**	**1017**		**1443**		

Allen Scenario 3A

Name	Watershed #	Total (kg/yr)	Septic (kg/yr)	% Removal	Net Septic Load (kg/yr)	Attenuation % (Stream)	Attenuated Septic Load (kg/yr)	Attenuated Septic Load (kg/day)	From Table VIII-2 Attenuated Septic Load Thresholds (kg/day)
				Build-out					
Stream GT 10	1	269	224	0%	224				
Stream LT 10	2	942	744	30%	521				
Stream Total		1211	968		745	30%	521	1.428	0.642
Harbor	3	1999	1774	100%	0		0	0.000	0.841
Harbor Total		**3210**	**2742**		**745**		**521**	**1.428**	**1.483**
Treated Load			**1997**	**73%**					

Wychmere Scenario 3A

Build-out

Name	Watershed #	Total (kg/yr)	Septic (kg/yr)	% Removal	Net Septic Load (kg/yr)	Attenuation % (Stream)	Attenuated Septic Load (kg/yr)	Attenuated Septic Load (kg/day)	From Table VIII-2 Attenuated Septic Load Thresholds
Harbor	4	1523	1206	100%	0		0	0.000	0.000
Harbor Total		**1523**	**1206**		**0**		**0**	**0.000**	**0.000**
Treated Load			**1206**	**100%**					

Saquatucket Scenario 3A

Name	Watershed #	Total (kg/yr)	Septic (kg/yr)	Outflow %	Total (kg/yr)	Septic (kg/yr)	% Removal	Net Septic Load (kg/yr)	Attenuation %	Attenuated Septic Load (kg/yr)	Attenuated Septic Load (kg/day)	From Table VIII-2 Attenuated Septic Load Thresholds (kg/day)
					Build-out							
Grass Pond	13	1152	903	100%	1152	903	43%	515	50%	257		
Banks St Bogs LT10	12	2284	1941		2284	1941	10%	1747		1747		
Banks St Bogs GT10	11	322	175		322	175	1%	173		173		
				Recharge to Upper Muddy Creek Watershed 13			Removed Septic (kg/yr)	Recharge Septic (kg/yr)				
Cold Spring Brook Recharge							1567					
John Joseph Recharge							0					
E. Saq Stream Recharge							989				3568	
Harbor Load Recharge							1012					
Allen Harbor Load Recharge							0					
Wychmere Harbor Load Recharge							1206					
Total Septic Load From Harwich							4774					
Recharge at what Concentration.			0	mg/l				0	50%	0		
Banks St Bogs Total					**3758**	**3019**	**19%**	**2435**	**35%**	**1415**		
Paddocks Pond	14	898	648	100%	898	648	2%	635	50%	318		
Cold Spring Brook LT10	10	2825	2064		2825	2064	47%	1094		1094		
Cold Spring Brook GT10	9	1178	861		1178	861	0%	861		861		
Cold Spring Brook Total					**8659**	**6592**	**24%**	**5025**	**35%**	**2397**		
Black Pond	5	18	6	14%	2	1	0%	1	50%	0		
John Joseph Pond GT10	6	109	89		109	89	0%	89		89		
John Joseph Pond LT10	7	500	335		500	335	0%	335		335		
John Joseph Pond Total		627	430	27%	164	114	0%	114	74%	30		
Chatham Road WELLS	8	1004	667	80%	803	534	0%	534		534		
Saq Harbor LT10N	15	1166	1009		1166	1009	98%	20		20		
E. Saquatucket Stream Total					**2133**	**1657**	**60%**	**668**	**15%**	**496**	**1.359**	**1.274**
Harbor LT10S	16	1113	1012		1113	1012	100%	0		0	0.000	0.507
Harbor Total					**11905**	**9261**		**5693**		**1915**	**5.246**	**5.28**
Treated Load						**3568**	**39%**					

Build-out

Name	Watershed #	Total (kg/yr)	Septic (kg/yr)	Outflow %	Total (kg/yr)	Septic (kg/yr)	% Removal	Net Septic Load (kg/yr)	Attenuation %	Attenuated Septic Load (kg/yr)	Attenuated Septic Load (kg/day)	Attenuated load; table3,pg 6 of 6/25/10 SMAST memo
Grassy Pond	9	189	7		189	7	0%	7	50%	4		
Grassy Pond to Mud Pond				9%	17	1		1		0		
Mud Pond (Harwich)	12	47	0		47	0	0%	0		0		
Mud Pond (Brewster)	12	7	0		7	0	0%	0		0		
Mud Pond Total					71	1		0	50%	0		
Hawksnest Pond	76	126	0		126	0	0%	0	50%	0		
Hawksnest Pond to Mill Pond				14%	18	0		0		0		
Mill Pond (Harwich)	68	1231	1017		1231	1017	0%	1017		1017		
Mill Pond (Chatham)	68	232	112		232	112	0%	112		112		
Mill Pond Fresh Total					1481	1129		1129	50%	565		
Mill Pond to Goose Pond				6%	89	68		68		34		
Goose Pond (Chatham)	69	355	137		349	137	0%	137		137		
Goose Pond Total					438	205		205	50%	86		
Goose Pond to Trout Pond				19%	83	39	0%	39		16		
Trout Pond (Chatham)	70	325	211		325	211	0%	211		211		
Trout Pond Total					408	250		250	50%	114		
Mud Pond				24%	17	0		0		0		
Round Cove GT 10	61	1238	1064		1238	1064	100%	0		0		
Round Cove LT 10	62	1295	1052		1295	1052	30%	736		736		
Round Cove Total					**2485**	**1990**		**610**		**610**	**1.671**	**1.865**
Hawksnest Pond				20%	25	0		0		0		
Mill Pond Fresh				23%	341	260		260		130		
Goose Pond				32%	140	66		66		27		
Upper Muddy Crk 10 W(Harwich)	83	1980	1703		1980	1703	59%	698		698		
Upper Muddy Crk 10 W(Chatham)	83	0	0		0	0	58%	0		0		
Upper Muddy Crk(Harwich)	81	2863	2394		2863	2394	58%	1005		1005		
Upper Muddy Crk (Chatham)	81	1139	886		1139	886	58%	372		372		
Upper Muddy (Unaccounted)	81	35	0		35	0	0%	0		0		
Upper Muddy Crk (Regional?)	81	72	25		72	25	0%	25		25		
Upper Muddy Crk 10E (Chatham)	82	162	131		162	131	58%	55		55		
Atmospheric		59			59							
Recharge to Upper Muddy Creek Watershed 83							Removed Septic (kg/yr)	Recharge Septic (kg/yr)				
Round Cove Recharge							1380					
Muddy Creek Recharge							4078					
Pleasant Bay Recharge							2871					
Total Septic Load From Harwich							8328					
Recharge at what Concentration.			0	mg/l				0				
Upper Muddy Creek Total					**6816**	**5464**		**2481**	**57%**	**995**	**4.204**	**2.59**
Trout Pond				100%	408	250		250		114		
Muddy Crk WELL	77	1037	876		1037	876	100%	0		0		
Lower Muddy Crk (Chatham)	78	1161	959		1161	959	50%	480		480		
Lower Muddy Crk (Harwich)	78	708	508		708	508	50%	254		254		
Lower Muddy Crk (Regional?)		11	8		11	8	0%	8		8		
Lower Muddy Crk10E (Chatham)	79	178	141		178	141	50%	71		71		
Lower Muddy Crk 10W(Harwich)	80	1376	1109		1376	1109	50%	555		555		
Atmospheric		80			80							
Lower Muddy Creek Total					4959	3851		1616		1480	**4.055**	**4.3**
Muddy Creek Total					**11775**	**9315**		**4098**	**2%**	**2425**	**6.645**	**6.89**
Grassy Pond				91%	172	6		6		3		
Mud Pond Harwich				76%	54	0		0		0		
Pleasant Bay Rd WELL_HAR	29	528	464		528	464	100%	0		0		
Pleasant Bay GT 10 BreHar (Harwich)	49	687	610		687	610	72%	171		171		
Pleasant Bay GT 10 Harwich	50	1080	879		1080	879	74%	229		229		
Pleasant Bay LT 10 Harwich	53N	1178.6	604.6		1179	605	64%	218		218		
Wequasset Inn	53N	867	867		867	867	82.5%	152		152	Net Load Based on 11,000 gpd @	
Pleasant Bay LT 10 Harwich	53S	516	456		516	456	47%	242		242		
Pleasant Bay Total					**5083**	**3887**	**74%**	**1017**		**1014**		

Allen Scenario 4A

Build-out

Name	Watershed #	Total (kg/yr)	Septic (kg/yr)	% Removal	Net Septic Load (kg/yr)	Attenuation % (Stream)	Attenuated Septic Load (kg/yr)	Attenuated Septic Load (kg/day)	From Table VIII-2 Attenuated Septic Load Thresholds
Stream GT 10	1	269	224	0%	224				
Stream LT 10	2	942	744	30%	521				
Stream Total		1211	968		745	30%	521	1.428	0.642
Harbor	3	1999	1774	100%	0		0	0.000	0.841
Harbor Total		**3210**	**2742**		**745**		**521**	**1.428**	**1.483**
Treated Load			**1997**	**73%**					

Wychmere Scenario 4A

Build-out

Name	Watershed #	Total (kg/yr)	Septic (kg/yr)	% Removal	Net Septic Load (kg/yr)	Attenuation % (Stream)	Attenuated Septic Load (kg/yr)	Attenuated Septic Load (kg/day)	From Table VIII-2 Attenuated Septic Load Thresholds
Harbor	4	1523	1206	100%	0		0	0.000	0.000
Harbor Total		**1523**	**1206**		**0**		**0**	**0.000**	**0.000**
Treated Load			**1206**	**100%**					

Saquatucket Scenario 4A

Name	Watershed #	Total (kg/yr)	Septic (kg/yr)	Outflow %	Total (kg/yr)	Septic (kg/yr)	% Removal	Net Septic Load (kg/yr)	Attenuation %	Attenuated Septic Load (kg/yr)	Attenuated Septic Load (kg/day)	From Table VIII-2 Attenuated Septic Load Thresholds
Build-out												
Grass Pond	13	1152	903	100%	1152	903	43%	515	50%	257		
Banks St Bogs LT10	12	2284	1941		2284	1941	10%	1747		1747		
Banks St Bogs GT10	11	322	175		322	175	1%	173		173		
Recharge to Upper Muddy Creek Watershed 13							Removed Septic (kg/yr)	Recharge Septic (kg/yr)				
Cold Spring Brook Recharge							1567					
John Joseph Recharge							0					
E. Saq Stream Recharge							989					
Harbor Load Recharge							1012					
Allen Harbor Load Recharge							0					
Wychmere Harbor Load Recharge							1206					
Total Septic Load From Harwich							4774					
Recharge at what Concentration.			0	mg/l				0	50%	0		
Banks St Bogs Total					**3758**	**3019**	**19%**	**2435**	**35%**	**1415**		
Paddocks Pond	14	898	648	100%	898	648	2%	635	50%	318		
Cold Spring Brook LT10	10	2825	2064		2825	2064	47%	1094		1094		
Cold Spring Brook GT10	9	1178	861		1178	861	0%	861		861		
Cold Spring Brook Total					**8659**	**6592**	**24%**	**5025**	**35%**	**2397**		
Black Pond	5	18	6	14%	2	1	0%	1	50%	0		
John Joseph Pond GT10	6	109	89		109	89	0%	89		89		
John Joseph Pond LT10	7	500	335		500	335	0%	335		335		
John Joseph Pond Total		627	430	27%	164	114	0%	114	74%	30		
Chatham Road WELLS	8	1004	667	80%	803	534	0%	534		534		
Saq Harbor LT10N	15	1166	1009		1166	1009	98%	20		20		
E. Saquatucket Stream Total					**2133**	**1657**	**60%**	**668**	**15%**	**496**	**1.359**	**1.274**
Harbor LT10S	16	1113	1012		1113	1012	100%	0		0	0.000	0.507
Harbor Total					**11905**	**9261**		**5693**		**1915**	**5.246**	**5.28**
Treated Load						**3568**	**39%**					

Name	Watershed #	Total (kg/yr)	Septic (kg/yr)	Outflow %	Build-out Total (kg/yr)	Septic (kg/yr)	% Removal	Net Septic Load (kg/yr)	Attenuation %	Attenuated Septic Load (kg/yr)	Attenuated Septic Load (kg/day)	Attenuated load; table3,pg 6 of 6/25/10 SMAST memo
Grassy Pond	9	189	7		189	7	0%	7	50%	4		
Grassy Pond to Mud Pond				9%	17	1		1		0		
Mud Pond (Harwich)	12	47	0		47	0	0%	0		0		
Mud Pond (Brewster)	12	7	0		7	0	0%	0		0		
Mud Pond Total					71	1		0	50%	0		
Hawksnest Pond	76	126	0		126	0	0%	0	50%	0		
Hawksnest Pond to Mill Pond				14%	18	0		0		0		
Mill Pond (Harwich)	68	1231	1017		1231	1017	0%	1017		1017		
Mill Pond (Chatham)	68	232	112		232	112	0%	112		112		
Mill Pond Fresh Total					1481	1129		1129	50%	565		
Mill Pond to Goose Pond				6%	89	68		68		34		
Goose Pond (Chatham)	69	355	137		349	137	0%	137		137		
Goose Pond Total					438	205		205	50%	86		
Goose Pond to Trout Pond				19%	83	39	0%	39		16		
Trout Pond (Chatham)	70	325	211		325	211	0%	211		211		
Trout Pond Total					408	250		250	50%	114		
Mud Pond				24%	17	0		0		0		
Round Cove GT 10	61	1238	1064		1238	1064	100%	0		0		
Round Cove LT 10	62	1295	1052		1295	1052	30%	736		736		
Round Cove Total					**2485**	**1989**		**609**		**609**	**1.670**	**1.865**
Hawksnest Pond				20%	25	0		0		0		
Mill Pond Fresh				23%	341	260		260		130		
Goose Pond				32%	140	66		66		27		
Upper Muddy Crk 10 W(Harwich)	83	1980	1703		1980	1703	100%	0		0		
Upper Muddy Crk 10 W(Chatham)	83	0	0		0	0	58%	0		0		
Upper Muddy Crk(Harwich)	81	2863	2394		2863	2394	100%	0		0		
Upper Muddy Crk (Chatham)	81	1139	886		1139	886	58%	372		372		
Upper Muddy (Unaccounted)	81	35	0		35	0	0%	0		0		
Upper Muddy Crk (Regional?)	81	72	25		72	25	0%	25		25		
Upper Muddy Crk 10E (Chatham)	82	162	131		162	131	58%	55		55		
Atmospheric		59			59							
Recharge to Upper Muddy Creek Watershed 83							Removed Septic (kg/yr)	Recharge Septic (kg/yr)				
Round Cove Recharge							1380					
Muddy Creek Recharge							5793					
Pleasant Bay Recharge							2155					
Total Septic Load From Harwich							9328					
Recharge at what Concentration.			5	mg/l				1794				
Upper Muddy Creek Total					**6816**	**5464**		**778**	**57%**	**1033**	**2.831**	**2.59**
Trout Pond				100%	408	250		250		114		
Muddy Crk WELL	77	1037	876		1037	876	100%	0		0		
Lower Muddy Crk (Chatham)	78	1161	959		1161	959	50%	480		480		
Lower Muddy Crk (Harwich)	78	708	508		708	508	50%	254		254		
Lower Muddy Crk (Regional?)		11	8		11	8	0%	8		8		
Lower Muddy Crk10E (Chatham)	79	178	141		178	141	50%	71		71		
Lower Muddy Crk 10W(Harwich)	80	1376	1109		1376	1109	51%	543		543		
Atmospheric		80			80							
Lower Muddy Creek Total					4959	3851		1605		1469	**4.025**	**4.3**
Muddy Creek Total					**11775**	**9315**		**2383**	**2%**	**2452**	**6.719**	**6.89**
Grassy Pond				91%	172	6		6		3		
Mud Pond Harwich				76%	54	0		0		0		
Pleasant Bay Rd WELL_HAR	29	528	464		528	464	100%	0		0		
Pleasant Bay GT 10 BreHar	49	687	610		687	610	72%	171		171		
Pleasant Bay GT 10 Harwich	50	1080	879		1080	879	74%	229		229		
Pleasant Bay LT 10 Harwich	53N	1178.6	604.6		1179	605	64%	218		218		
Wequasset Inn	53N	867	867		867	867	83%	152		152	Net Load Based on 11,000 god @ 10 mg/l	
Pleasant Bay LT 10 Harwich	53S	516	456		516	456	47%	242		242		
Pleasant Bay Total					**5083**	**3887**	**74%**	**1017**		**1014**		

Allen Scenario 5A

Build-out									
Name	Watershed #	Total (kg/yr)	Septic (kg/yr)	% Removal	Net Septic Load (kg/yr)	Attenuation % (Stream)	Attenuated Septic Load (kg/yr)	Attenuated Septic Load (kg/day)	From Table VIII-2 Attenuated Septic Load Thresholds (kg/day)
Stream GT 10	1	269	224	0%	224				
Stream LT 10	2	942	744	30%	521				
Stream Total		1211	968		745	30%	521	1.428	0.642
Harbor	3	1999	1774	100%	0		0	0.000	0.841
Harbor Total		**3210**	**2742**		**745**		**521**	**1.428**	**1.483**
Treated Load			**1997**	**73%**					

Wychmere Scenario 5A

Name	Watershed #	Total (kg/yr)	Septic (kg/yr)	% Removal	Net Septic Load (kg/yr)	Attenuation % (Stream)	Attenuated Septic Load (kg/yr)	Attenuated Septic Load (kg/day)	From Table VIII-2 Attenuated Septic Load Thresholds
Build-out									
Harbor	4	1523	1206	100%	0		0	0.000	0.000
Harbor Total		**1523**	**1206**		**0**		**0**	**0.000**	**0.000**
Treated Load			**1206**	**100%**					

Saquatucket Scenario 5A

					Build-out							
Name	Watershed #	Total (kg/yr)	Septic (kg/yr)	Outflow %	Total (kg/yr)	Septic (kg/yr)	% Removal	Net Septic Load (kg/yr)	Attenuation %	Attenuated Septic Load (kg/yr)	Attenuated Septic Load (kg/day)	From Table VIII-2 Attenuated Septic Load Thresholds (kg/day)
Grass Pond	13	1152	903	100%	1152	903	43%	515	50%	257		
Banks St Bogs LT10	12	2284	1941		2284	1941	10%	1747		1747		
Banks St Bogs GT10	11	322	175		322	175	1%	173		173		
				Recharge to Upper Muddy Creek Watershed 13								
							Removed Septic (kg/yr)	Recharge Septic (kg/yr)				
Cold Spring Brook Recharge							1567					
John Joseph Recharge							0					
E. Saq Stream Recharge							989					
Harbor Load Recharge							1012					
Allen Harbor Load Recharge							0					
Wychmere Harbor Load Recharge							1206					
Total Septic Load From Harwich							4774					
Recharge at what Concentration.			0	mg/l				0	50%	0		
Banks St Bogs Total					**3758**	**3019**	**19%**	**2435**	**35%**	**1415**		
Paddocks Pond	14	898	648	100%	898	648	2%	635	50%	318		
Cold Spring Brook LT10	10	2825	2064		2825	2064	47%	1094		1094		
Cold Spring Brook GT10	9	1178	861		1178	861	0%	861		861		
Cold Spring Brook Total					**8659**	**6592**	**24%**	**5025**	**35%**	**2397**		
Black Pond	5	18	6	14%	2	1	0%	1	50%	0		
John Joseph Pond GT10	6	109	89		109	89	0%	89		89		
John Joseph Pond LT10	7	500	335		500	335	0%	335		335		
John Joseph Pond Total		627	430	27%	164	114	0%	114	74%	30		
Chatham Road WELLS	8	1004	667	80%	803	534	0%	534		534		
Saq Harbor LT10N	15	1166	1009		1166	1009	98%	20		20		
E. Saquatucket Stream Total					**2133**	**1657**	**60%**	**668**	**15%**	**496**	**1.359**	**1.274**
Harbor LT10S	16	1113	1012		1113	1012	100%	0		0	0.000	0.507
Harbor Total					**11905**	**9261**		**5693**		**1915**	**5.246**	**5.28**
Treated Load						**3568**	**39%**					

Build-out

Name	Watershed #	Total (kg/yr)	Septic (kg/yr)	Outflow %	Total (kg/yr)	Septic (kg/yr)	% Removal	Net Septic Load (kg/yr)	Attenuation %	Attenuated Septic Load (kg/yr)	Attenuated Septic Load (kg/day)	Attenuated load; table3,pg 6 of 6/25/10 SMAST memo
Grassy Pond	9	189	7		189	7	0%	7	50%	4		
Grassy Pond to Mud Pond				9%	17	1		1		0		
Mud Pond (Harwich)	12	47	0		47	0	0%	0		0		
Mud Pond (Brewster)	12	7	0		7	0	0%	0		0		
Mud Pond Total					71	1		0	50%	0		
Hawksnest Pond	76	126	0		126	0	0%	0	50%	0		
Hawksnest Pond to Mill Pond				14%	18	0		0		0		
Mill Pond (Harwich)	68	1231	1017		1231	1017	0%	1017		1017		
Mill Pond (Chatham)	68	232	112		232	112	0%	112		112		
Mill Pond Fresh Total					1481	1129		1129	50%	565		
Mill Pond to Goose Pond				6%	89	68		68		34		
Goose Pond (Chatham)	69	355	137		349	137	0%	137		137		
Goose Pond Total					438	205		205	50%	86		
Goose Pond to Trout Pond				19%	83	39	0%	39		16		
Trout Pond (Chatham)	70	325	211		325	211	0%	211		211		
Trout Pond Total					408	250		250	50%	114		
Mud Pond				24%	17	0		0		0		
Round Cove GT 10	61	1238	1064		1238	1064	100%	0		0		
Round Cove LT 10	62	1295	1052		1295	1052	30%	736		736		
Round Cove Total					**2485**	**1989**		**609**		**609**	**1.670**	**1.865**
Hawksnest Pond				20%	25	0		0		0		
Mill Pond Fresh				23%	341	260		260		130		
Goose Pond				32%	140	66		66		27		
Upper Muddy Crk 10 W(Harwich)	83	1980	1703		1980	1703	79%	358		358		
Upper Muddy Crk 10 W(Chatham)	83	0	0		0	0	58%	0		0		
Upper Muddy Crk(Harwich)	81	2863	2394		2863	2394	80%	479		479		
Upper Muddy Crk (Chatham)	81	1139	886		1139	886	58%	372		372		
Upper Muddy (Unaccounted)	81	35	0		35	0	0%	0		0		
Upper Muddy Crk (Regional?)	81	72	25		72	25	0%	25		25		
Upper Muddy Crk 10E (Chatham)	82	162	131		162	131	58%	55		55		
Atmospheric		59			59							
Recharge to Upper Muddy Creek Watershed 83							Removed Septic (kg/yr)	Recharge Septic (kg/yr)				
Muddy Creek Recharge							4945					
Pleasant Bay Recharge							2155					
Total Septic Load From Harwich							8480					
Recharge at what Concentration.			3	mg/l				978				
Upper Muddy Creek Total					**6816**	**5464**		**1614**	**57%**	**1042**	**4.204**	**2.59**
Trout Pond				100%	408	250		250		114		
Muddy Crk WELL	77	1037	876		1037	876	100%	0		0		
Lower Muddy Crk (Chatham)	78	1161	959		1161	959	50%	480		480		
Lower Muddy Crk (Harwich)	78	708	508		708	508	50%	254		254		
Lower Muddy Crk (Regional?)		11	8		11	8	0%	8		8		
Lower Muddy Crk10E (Chatham)	79	178	141		178	141	50%	71		71		
Lower Muddy Crk 10W(Harwich)	80	1376	1109		1376	1109	50%	555		555		
Atmospheric		80			80							
Lower Muddy Creek Total					4959	3851		1616		1480	**4.055**	**4.3**
Muddy Creek Total					**11775**	**9315**		**3230**	**2%**	**2472**	**6.773**	**6.89**
Grassy Pond				91%	172	6		6		3		
Mud Pond Harwich				76%	54	0		0		0		
Pleasant Bay Rd WELL_HAR	29	528	464		528	464	100%	0		0		
Pleasant Bay GT 10 BreHar (Harwich)	49	687	610		687	610	72%	171		171		
Pleasant Bay GT 10 Harwich	50	1080	879		1080	879	74%	229		229		
Pleasant Bay LT 10 Harwich	53N	1178.6	604.6		1179	605	64%	218		218		
Wequasset Inn	53N	867	867		867	867	83%	152		152		Net Load Based on 11,000 gpd@ 1
Pleasant Bay LT 10 Harwich	53S	516	456		516	456	47%	242		242		
Pleasant Bay Total					**5083**	**3887**	**74%**	**1017**		**1014**		

Allen Scenario 6A

Build-out									
Name	Watershed #	Total (kg/yr)	Septic (kg/yr)	% Removal	Net Septic Load (kg/yr)	Attenuation % (Stream)	Attenuated Septic Load (kg/yr)	Attenuated Septic Load (kg/day)	From Table VIII-2 Attenuated Septic Load Thresholds
Stream GT 10	1	269	224	0%	224				
Stream LT 10	2	942	744	30%	521				
Stream Total		1211	968		745	30%	521	1.428	0.642
Harbor	3	1999	1774	100%	0		0	0.000	0.841
Harbor Total		**3210**	**2742**		**745**		**521**	**1.428**	**1.483**
Treated Load			**1997**	**73%**					

Wychmere Scenario 6A

Build-out									
Name	Watershed #	Total (kg/yr)	Septic (kg/yr)	% Removal	Net Septic Load (kg/yr)	Attenuation % (Stream)	Attenuated Septic Load (kg/yr)	Attenuated Septic Load (kg/day)	From Table VIII-2 Attenuated Septic Load Thresholds (kg/day)
Harbor	4	1523	1206	100%	0		0	0.000	0.000
Harbor Total		**1523**	**1206**		**0**		**0**	**0.000**	**0.000**
Treated Load			**1206**	**100%**					

Saquatucket Scenario 6A

							Build-out						
Name	Watershed #	Total (kg/yr)	Septic (kg/yr)	Outflow %	Total (kg/yr)	Septic (kg/yr)	% Removal	Net Septic Load (kg/yr)	Attenuation %	Attenuated Septic Load (kg/yr)	Attenuated Septic Load (kg/day)	From Table VIII-2 Attenuated Septic Load Thresholds (kg/day)
Grass Pond	13	1152	903	100%	1152	903	43%	515	50%	257		
Banks St Bogs LT10	12	2284	1941		2284	1941	10%	1747		1747		
Banks St Bogs GT10	11	322	175		322	175	1%	173		173		
					Recharge to Upper Muddy Creek Watershed 13							
							Removed	Recharge				
Cold Spring Brook Recharge							1877					
John Joseph Recharge							0					
E. Saq Stream Recharge							989					
Harbor Load Recharge							1012					
Allen Harbor Load Recharge							0					
Wychmere Harbor Load Recharge							1206					
Total Septic Load From Harwich							5084					
Recharge at what Concentration.			5	mg/l				978	50%	488.8076923		
Banks St Bogs Total					**3758**	**3019**	**19%**	**2435**	**35%**	**1733**		
Paddocks Pond	14	898	648	100%	898	648	2%	635	50%	318		
Cold Spring Brook LT10	10	2825	2064		2825	2064	62%	784		784		
Cold Spring Brook GT10	9	1178	861		1178	861	0%	861		861		
Cold Spring Brook Total					**8659**	**6592**	**28%**	**4715**	**35%**	**2402**		
Black Pond	5	18	6	14%	18	1	0%	1	50%	0		
John Joseph Pond GT10	6	109	89		109	89	0%	89		89		
John Joseph Pond LT10	7	500	335		500	335	0%	335		335		
John Joseph Pond Total		627	430	27%	168	114	0%	114	74%	30		
Chatham Road WELLS	8	1004	667	80%	803	534	0%	534		534		
Saq Harbor LT10N	15	1166	1009		1166	1009	98%	20		20		
E. Saquatucket Stream Total					**2137**	**1657**	**60%**	**668**	**15%**	**496**	**1.359**	**1.274**
Harbor LT10S	16	1113	1012		1113	1012	100%	0		0	0.000	0.507
Harbor Total					**11909**	**9261**		**5383**		**1920**	**5.261**	**5.28**
Treated Load						**3878**	**42%**					

Build-out

Name	WS #	Total (kg/yr)	Septic (kg/yr)	Outflow %	Total (kg/yr)	Septic (kg/yr)	% Removal	Net Septic Load (kg/yr)	Attenuation %	Attenuated Septic Load (kg/yr)	Attenuated Septic Load (kg/day)	Attenuated load; table3,pg 6 of 6/25/10 SMAST memo
Grassy Pond	9	189	7		189	7	0%	7	50%	4		
Grassy Pond to Mud Pond				9%	17	1		1		0		
Mud Pond (Harwich)	12	47	0		47	0	0%	0		0		
Mud Pond (Brewster)	12	7	0		7	0	0%	0		0		
Mud Pond Total					71	1		0	50%	0		
Hawksnest Pond	76	126	0		126	0	0%	0	50%	0		
Hawksnest Pond to Mill Pond				14%	18	0		0		0		
Mill Pond (Harwich)	68	1231	1017		1231	1017	0%	1017		1017		
Mill Pond (Chatham)	68	232	112		232	112	0%	112		112		
Mill Pond Fresh Total					1481	1129		1129	50%	565		
Mill Pond to Goose Pond				6%	89	68		68		34		
Goose Pond (Chatham)	69	355	137		349	137	0%	137		137		
Goose Pond Total					438	205		205	50%	86		
Goose Pond to Trout Pond				19%	83	39	0%	39		16		
Trout Pond (Chatham)	70	325	211		325	211	0%	211		211		
Trout Pond Total					408	250		250	50%	114		
Mud Pond				24%	17	0		0		0		
Round Cove GT 10	61	1238	1064		1238	1064	100%	0		0		
Round Cove LT 10	62	1295	1062	0.49	1295	1062	30%	743		743		
Round Cove Total					**2485**	**1999**		**616**		**616**	**1.689**	**1.865**
Hawksnest Pond				20%	25	0		0		0		
Mill Pond Fresh				23%	341	260		260		130		
Goose Pond				32%	140	66		66		27		
Upper Muddy Crk 10 W(Harwich)	83	1980	1703		1980	1703	99%	10		10		
Upper Muddy Crk 10 W(Chatham)	83	0	0		0	0	58%	0		0		
Upper Muddy Crk(Harwich)	81	2863	2394		2863	2394	100%	0		0		
Upper Muddy Crk (Chatham)	81	1139	886		1139	886	58%	372		372		
Upper Muddy (Unaccounted)	81	35	0		35	0	0%	0		0		
Upper Muddy Crk (Regional?)	81	72	25		72	25	0%	25		25		
Upper Muddy Crk 10E (Chatham)	82	162	131		162	131	58%	55		55		
Atmospheric		59			59							
Recharge to Upper Muddy Creek Watershed 83							Removed Septic (kg/yr)	Recharge Septic (kg/yr)				
Round Cove Recharge							1383					
Muddy Creek Recharge							5771					
Pleasant Bay Recharge							2155					
Total Septic Load From Harwich							9309					
Recharge at what Concentration.			5	mg/l				1790				
Upper Muddy Creek Total					**6816**	**5464**		**788**	**57%**	**1036**	**4.204**	**2.59**
Trout Pond				100%	408	250		250		114		
Muddy Crk WELL	77	1037	876		1037	876	100%	0		0		
Lower Muddy Crk (Chatham)	78	1161	959		1161	959	50%	480		480		
Lower Muddy Crk (Harwich)	78	708	508		708	508	50%	254		254		
Lower Muddy Crk (Regional?)		11	8		11	8	0%	8		8		
Lower Muddy Crk10E (Chatham)	79	178	141		178	141	50%	71		71		
Lower Muddy Crk 10W(Harwich)	80	1376	1109		1376	1109	50%	555		555		
Atmospheric		80			80							
Lower Muddy Creek Total					4959	3851		1616		1480	**4.055**	**4.3**
Muddy Creek Total					**11775**	**9315**		**2404**	**2%**	**2466**	**6.756**	**6.89**
Grassy Pond				91%	172	6		6		3		
Mud Pond Harwich				76%	54	0		0		0		
Pleasant Bay Rd WELL_HAR	29	528	464		528	464	100%	0		0		
Pleasant Bay GT 10 BreHar (Harwich)	49	687	610		687	610	72%	171		171		
Pleasant Bay GT 10 Harwich	50	1080	879		1080	879	74%	229		229		
Pleasant Bay LT 10 Harwich	53N	1178.6	604.6		1179	605	64%	218		218		
Wequasset Inn	53N	867	867		867	867	83%	152		152		Net Load Based on 11,000 gpd @ 1
Pleasant Bay LT 10 Harwich	53S	516	456		516	456	47%	242		242		
Pleasant Bay Total					**5083**	**3887**	**74%**	**1017**		**1014**		

Allen Scenario 7A

Build-out

Name	Watershed #	Total (kg/yr)	Septic (kg/yr)	% Removal	Net Septic Load (kg/yr)	Attenuation % (Stream)	Attenuated Septic Load (kg/yr)	Attenuated Septic Load (kg/day)	From Table VIII-2 Attenuated Septic Load Thresholds
Stream GT 10	1	269	224	27%	164				
Stream LT 10	2	942	744	27%	543				
Stream Total		1211	968		707	30%	495	1.355	0.642
Harbor	3	1999	1774	100%	0		0	0.000	0.841
Harbor Total		**3210**	**2742**		**707**		**495**	**1.355**	**1.483**
Treated Load			**2035**	**74%**					

Wychmere Scenario 7A

Name	Watershed #	Total (kg/yr)	Septic (kg/yr)	% Removal	Net Septic Load (kg/yr)	Attenuation % (Stream)	Attenuated Septic Load (kg/yr)	Attenuated Septic Load (kg/day)	From Table VIII-2 Attenuated Septic Load Thresholds (kg/day)
Build-out									
Harbor	4	1523	1206	100%	0		0	0.000	0.000
Harbor Total		**1523**	**1206**		**0**		**0**	**0.000**	**0.000**
Treated Load			**1206**	**100%**					

Saquatucket Scenario 7A

Name	Watershed #	Total (kg/yr)	Septic (kg/yr)	Outflow %	Total (kg/yr)	Septic (kg/yr)	% Removal	Net Septic Load (kg/yr)	Attenuation %	Attenuated Septic Load (kg/yr)	Attenuated Septic Load (kg/day)	From Table VIII-2 Attenuated Septic Load Thresholds (kg/day)
					Build-out							
Grass Pond	13	1152	903	100%	1152	903	27%	659	50%	330	100% of Watershed is on I/A	
Banks St Bogs LT10	12	2284	1941		2284	1941	27%	1417		1417	100% of Watershed is on I/A	
Banks St Bogs GT10	11	322	175		322	175	27%	128		128	100% of Watershed is on I/A	
					Recharge to Upper Muddy Creek Watershed 13							
							Removed Septic (kg/yr)	Recharge Septic (kg/yr)				
Cold Spring Brook Recharge							826				40% sewered;13% is on I/A	
John Joseph Recharge							0					
E. Saq Stream Recharge							404				40% sewered;13% is on I/A	
Harbor Load Recharge							1012					
Allen Harbor Load Recharge							0					
Wychmere Harbor Load Recharge							1206					
Total Septic Load From Harwich							3447					
Recharge at what Concentration.			5	mg/l				663	50%	331		
Banks St Bogs Total					**3758**	**3019**	**27%**	**2204**	**35%**	**1434**		
Paddocks Pond	14	898	648	100%	898	648	29%	460	50%	230	100% of Watershed is on I/A	
Cold Spring Brook LT10	10	2825	2064		2825	2064	57%	888		888	40% sewered;60% is on I/A	
Cold Spring Brook GT10	9	1178	861		1178	861	27%	629		629	100% of Watershed is on I/A	
Cold Spring Brook Total					**8659**	**6592**	**37%**	**4180**	**35%**	**2067**		
Black Pond	5	18	6	14%	18	1	27%	1	50%	0	100% of Watershed is on I/A	
John Joseph Pond GT10	6	109	89		109	89	27%	65		65	100% of Watershed is on I/A	
John Joseph Pond LT10	7	500	335		500	335	27%	245		245	100% of Watershed is on I/A	
John Joseph Pond Total		627	430	27%	168	114	27%	83	74%	22		
Chatham Road WELLS	8	1004	667	80%	803	534	27%	390		390	100% of Watershed is on I/A	
Saq Harbor LT10N	15	1166	1009		1166	1009	58%	424		424	40% sewered;60% is on I/A	
E. Saquatucket Stream Total					**2137**	**1657**	**46%**	**897**	**15%**	**710**	**1.944**	**1.274**
Harbor LT10S	16	1113	1012		1113	1012	100%	0		0	0.000	0.507
Harbor Total					**11909**	**9261**		**5077**		**1799**	**4.928**	**5.28**
Treated Load						**4184**	**45%**					

Build-out

Name	Watershed #	Total (kg/yr)	Septic (kg/yr)	Outflow %	Total (kg/yr)	Septic (kg/yr)	% Removal	Net Septic Load (kg/yr)	Attenuation %	Attenuated Septic Load (kg/yr)	Attenuated Septic Load (kg/day)	Attenuated load; table3,pg 6 of 6/25/10 SMAST memo
Grassy Pond	9	189	7		189	7	0%	7	50%	4		
Grassy Pond to Mud Pond				9%	17	1		1		0		
Mud Pond (Harwich)	12	47	0		47	0	0%	0		0		
Mud Pond (Brewster)	12	7	0		7	0	0%	0		0		
Mud Pond Total					71	1		0	50%	0		
Hawksnest Pond	76	126	0		126	0	27%	0	50%	0		
Hawksnest Pond to Mill Pond				14%	18	0		0		0		
Mill Pond (Harwich)	68	1231	1017		1231	1017	50%	509		509		
Mill Pond (Chatham)	68	232	112		232	112	58%	47		47		
Mill Pond Fresh Total					1481	1129		556	50%	278		
Mill Pond to Goose Pond				6%	89	68		33		17		
Goose Pond (Chatham)	69	355	137		349	137	58%	58		58		
Goose Pond Total					438	205		91	50%	37		
Goose Pond to Trout Pond				19%	83	39		17		7		
Trout Pond (Chatham)	70	325	211		325	211	58%	89		89		
Trout Pond Total					408	250		106	50%	48		
Mud Pond				24%	17	0		0		0		
Round Cove GT 10	61	1238	1064		1238	1064	87%	138		138		
Round Cove LT 10	62	1295	1052		1295	1052	50%	526		526		
Round Cove Total					**2485**	**1990**		**538**		**538**	**1.473**	**1.865**
Hawksnest Pond				20%	25	0		0		0		
Mill Pond Fresh				23%	341	260		128		64		
Goose Pond				32%	140	66		29		12		
Upper Muddy Crk 10 W(Harwich)	83	1980	1703		1980	1703	67%	571		571		
Upper Muddy Crk 10 W(Chatham)	83	0	0		0	0	58%	0		0		
Upper Muddy Crk(Harwich)	81	2863	2394		2863	2394	100%	0		0		
Upper Muddy Crk (Chatham)	81	1139	886		1139	886	58%	372		372		
Upper Muddy (Unaccounted)	81	35	0		35	0	0%	0		0		
Upper Muddy Crk (Regional?)	81	72	25		72	25	0%	25		25		
Upper Muddy Crk 10E (Chatham)	82	162	131		162	131	58%	55		55		
Atmospheric		59			59							
			Recharge to Upper Muddy Creek Watershed 83									
							Removed Septic (kg/yr)	Recharge Septic (kg/yr)				
Round Cove Recharge							926					
Muddy Creek Recharge							2905					
Pleasant Bay Recharge							1483				separate plant	
Total Septic Load From Harwich							5313					
Recharge at what Concentration.			3	mg/l				613				
Upper Muddy Creek Total					**6816**	**5464**		**1180**	**57%**	**736**	**2.016**	**2.59**
Trout Pond				100%	408	250		106		48		
Muddy Crk WELL	77	1037	876		1037	876	50%	438		438		
Lower Muddy Crk (Chatham)	78	1161	959		1161	959	58%	403		403		
Lower Muddy Crk (Harwich)	78	708	508		708	508	50%	254		254		
Lower Muddy Crk (Regional?)		11	8		11	8	0%	8		8		
Lower Muddy Crk10E (Chatham)	79	178	141		178	141	58%	59		59		
Lower Muddy Crk 10W(Harwich)	80	1376	1109		1376	1109	50%	555		555		
Atmospheric		80			80							
Lower Muddy Creek Total					4959	3851		1822		1764	**4.834**	**4.3**
Muddy Creek Total					**11775**	**9315**		**3002**	**2%**	**2450**	**6.713**	**6.89**
Grassy Pond				91%	172	6		6		3		
Mud Pond Harwich				76%	54	0		0		211		
Pleasant Bay Rd WELL_HAR	29	528	464		528	464	100%	0		0		
Pleasant Bay GT 10 BreHar (Harwich)	49	687	610		687	610	69%	189		189		
Pleasant Bay GT 10 Harwich	50	1080	879		1080	879	68%	281		281		
Pleasant Bay LT 10 Harwich	53N	1178.6	604.6		1179	605	50%	302		302		
Wequasset Inn	53N	867	867		867	867	83%	152		152	net load based on 11,000 gpd@ 10 mg/l	
Pleasant Bay LT 10 Harwich	53S	516	456		516	456	50%	228		228		
Pleasant Bay Total					**5083**	**3887**	**70%**	**1159**		**2678**		

Appendix D

Hydrogeological Report

Table of Contents

List of Figures

List of Tables

Appendices

Executive Summary

As part of the Harwich Comprehensive Wastewater Management Plan (CWMP), a program for hydrogeologic data-collection and groundwater flow modeling was conducted to predict the impacts of effluent recharge to groundwater at three potential sites in Harwich, Massachusetts. This report describes the hydrogeologic data-collection efforts and the groundwater modeling performed to predict impacts from the proposed effluent recharge.

The sites include an area near the capped Harwich Landfill off of Queen Anne Road (Site HR-12), sports fields at the Harwich High School (now Monomoy Regional) on Oak Street (Site SH-2), and a privately owned parcel identified off of the Orleans-Harwich Road within the Pleasant Bay watershed (Site PB-3). The three sites were screened as presented in Section 9 of the CWMP and are shown in Figure ES-1.

Hydrogeologic data review and field work, including USGS data, previous landfill site investigations (Site HR-12), 2011 supplemental CWMP investigations at sites HR-12 and PB-3, and other data are discussed in Section 2 of this report. Test analysis and results from the 2011 CWMP data collection efforts include boring logs, grain size analysis, infiltration test analysis, groundwater quality results, and a summary of a site visit to the cranberry bogs south of HR-12. The hydrogeologic data review and field work identified a clay layer at HR-12 which impacts groundwater flow rates and direction.

Based on the data review and field work, revisions were made to an existing regional USGS groundwater flow model which had been calibrated for 2003 conditions. Section3 provides information on the MODFLOW model and calibration, including the USGS model used as a basis for the groundwater model, grid and model refinements and adjustments to recharge, clay extent, hydraulic properties, and stream updates.

The model was calibrated to regional groundwater head elevations and 2003 groundwater data from Site HR-12. Recent surface water and groundwater data from 2011 was used to refine the model near HR-12. The revised and recalibrated model was used to assess the flow direction and mounding for recharge flows at the three locations based on the CWMP scenarios.

Three model simulations were completed to assess groundwater recharge scenarios developed for the CWMP. Model simulations and results are discussed in Section 4.

- Simulation 1 is based on the upper end flow loadings for all scenarios for effluent recharge proposed in the CWMP and utilizes all three sites
    - HR-12: 800,000 gpd at a loading rate of 3 gpd/ft^2
    - PB-3: 400,000 gpd at a loading rate of 5 gpd/ft^2
    - SH-2: 210,000 gpd at a loading rate of 1 gpd/ft^2
- Simulation 2 is the maximum loading over a 10 acre area at HR-12 which maintains a minimum four foot depth to the top of the groundwater mound, per MassDEP regulatory guidance.
- Simulation 3 is the same as Simulation 2, but with revisions to the simulation of water levels in the cranberry bogs south of HR-12.

Model simulation results, shown in Table ES-1, indicate that that the selected sites should be able to recharge the proposed CWMP scenario flows in an acceptable manner. Increased flow to Coy Brook near HR-12 would result in enhanced stream flow and would help to maintain a more reliable base flow beneficial for the local cranberry bog agricultural operations, especially during drought conditions.

Table ES-1 Simulation Results Summary

Site	Total Recharge (MGD)	Loading Rate (gpd/ft^2)	Basin Area (acres)	Model Sim. Head (ft NGVD29)	Est. Basin Elev. (ft NGVD29)	Est. Depth to GW Mound (ft)	Est. Mound Height (ft)	Est. Stream Inc. (cfs)	% Est. Stream Inc.
Simulation 1 (Upper End of Flow Loading)									
HR-12	0.8	3.0	6.1	36	40	4	10	1	59%
PB-3	0.4	5.0	1.8	34	50	16	3.2		
SH-2	0.21	1.0	4.8	30	46	16	1.9		
Simulation 2 (Maximum Loading)									
HR-12	1.2	2.7	10	36	40	4	10	1.2	69%
Simulation 3 (Maximum Loading With Revisions near Cranberry Bogs)									
HR-12	1.4	3.0	10	36	40	4	10		

These results are shown in Figures ES-2 thru ES-4.

Based on the hydrogeologic findings and the meeting with the MassDEP and CCC, the following items are recommended as part of the implementation phase of the recommended CWMP program.

- Continue monitoring of surface water and groundwater locations to determine seasonal impacts to groundwater, surface water levels and cranberry bogs.
- Develop an adaptive management approach which uses Phase I wastewater effluent flow as a loading test at the selected effluent recharge sites.
- Assess the flow capacity of existing hydraulic structures in Coy Brook, Flax Pond and the downstream cranberry bogs near HR-12 during the design phase to identify and mitigate the potential for blockages or limitations in flow. This analysis should include the culvert which carries Coy Brook under Great Western Road as it has been reported to have problems carrying existing flows at high groundwater periods

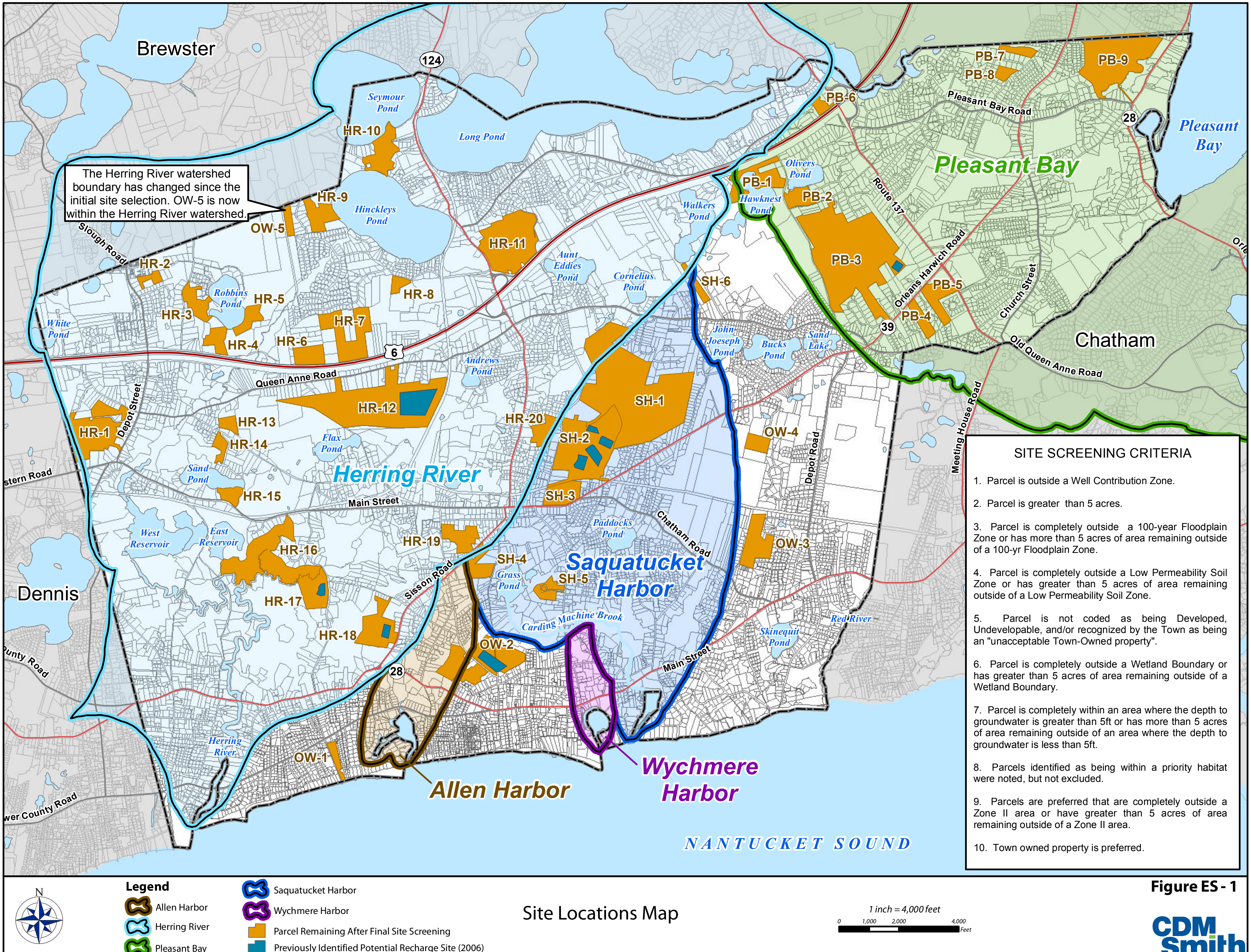

Figure ES - 1

Site Locations Map

1 inch = 4,000 feet

0 1,000 2,000 4,000 Feet

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Figure ES-2
Mounding: Simulation 1

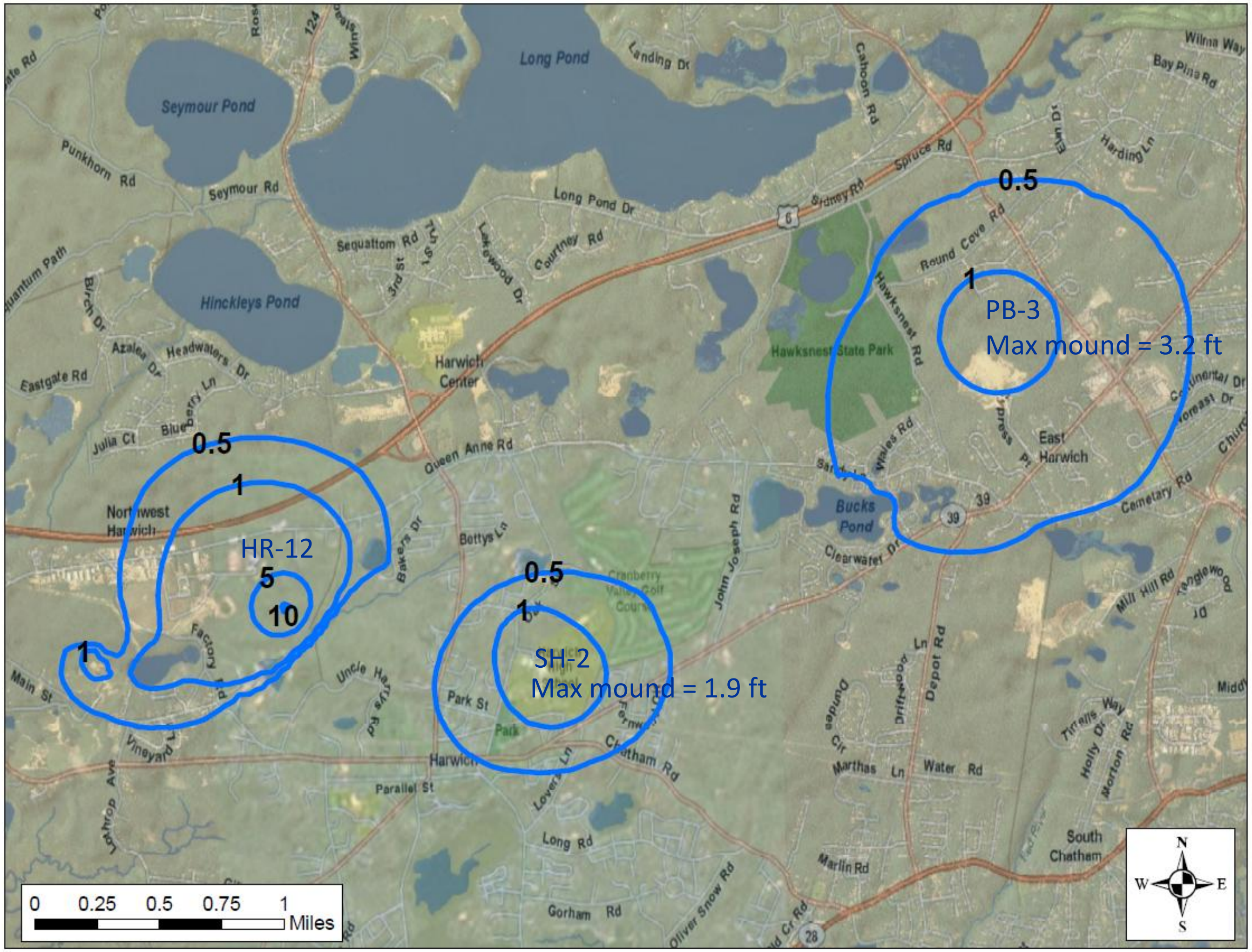

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Figure ES-3
Mounding: Simulation 2

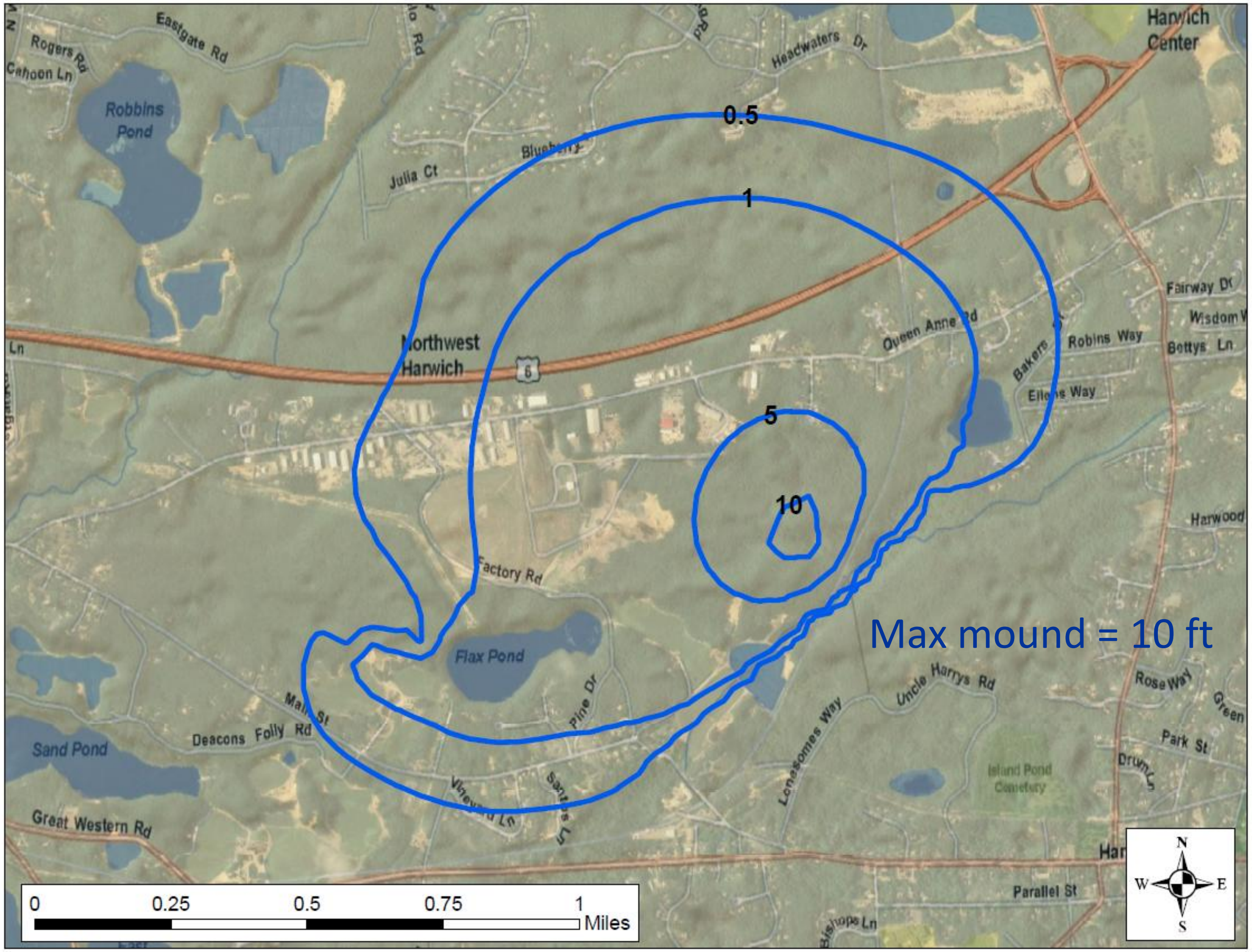
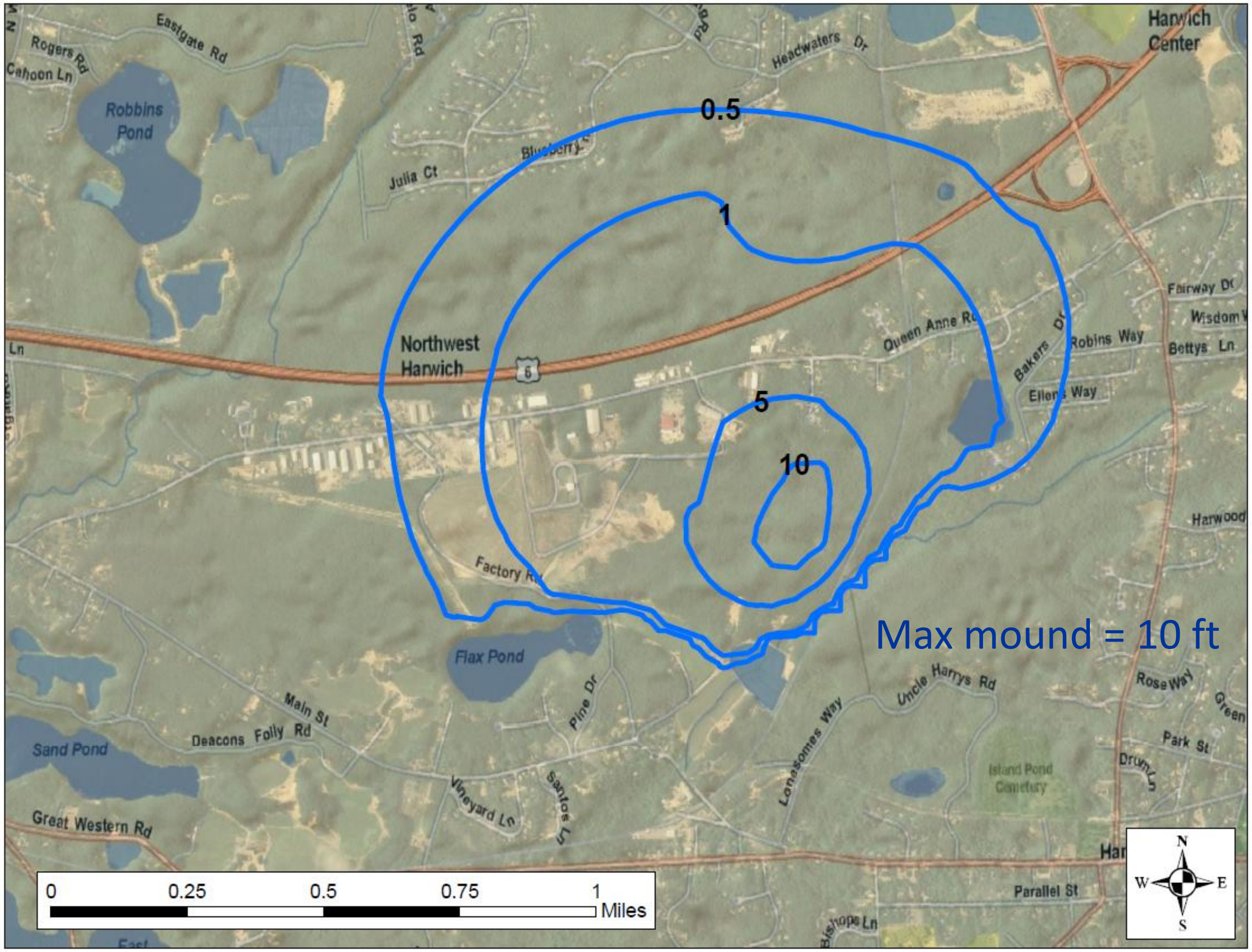


Figure ES-4
Mounding: Simulation 3



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Section 1
Introduction

As part of the Harwich Comprehensive Wastewater Management Plan (CWMP), a program for hydrogeologic data-collection and groundwater flow modeling was conducted to predict the impacts of effluent recharge to groundwater at three potential sites in Harwich, Massachusetts. The sites include an area near the capped Harwich Landfill off of Queen Anne Road (site HR-12), sports fields at the Harwich High School on Oak Street (site SH-2), and a privately owned parcel identified off of the Orleans-Harwich Road within the Pleasant Bay watershed (site PB-3). The three sites were screened as presented in Section 9 of the CWMP and are shown in Figure 1-1.

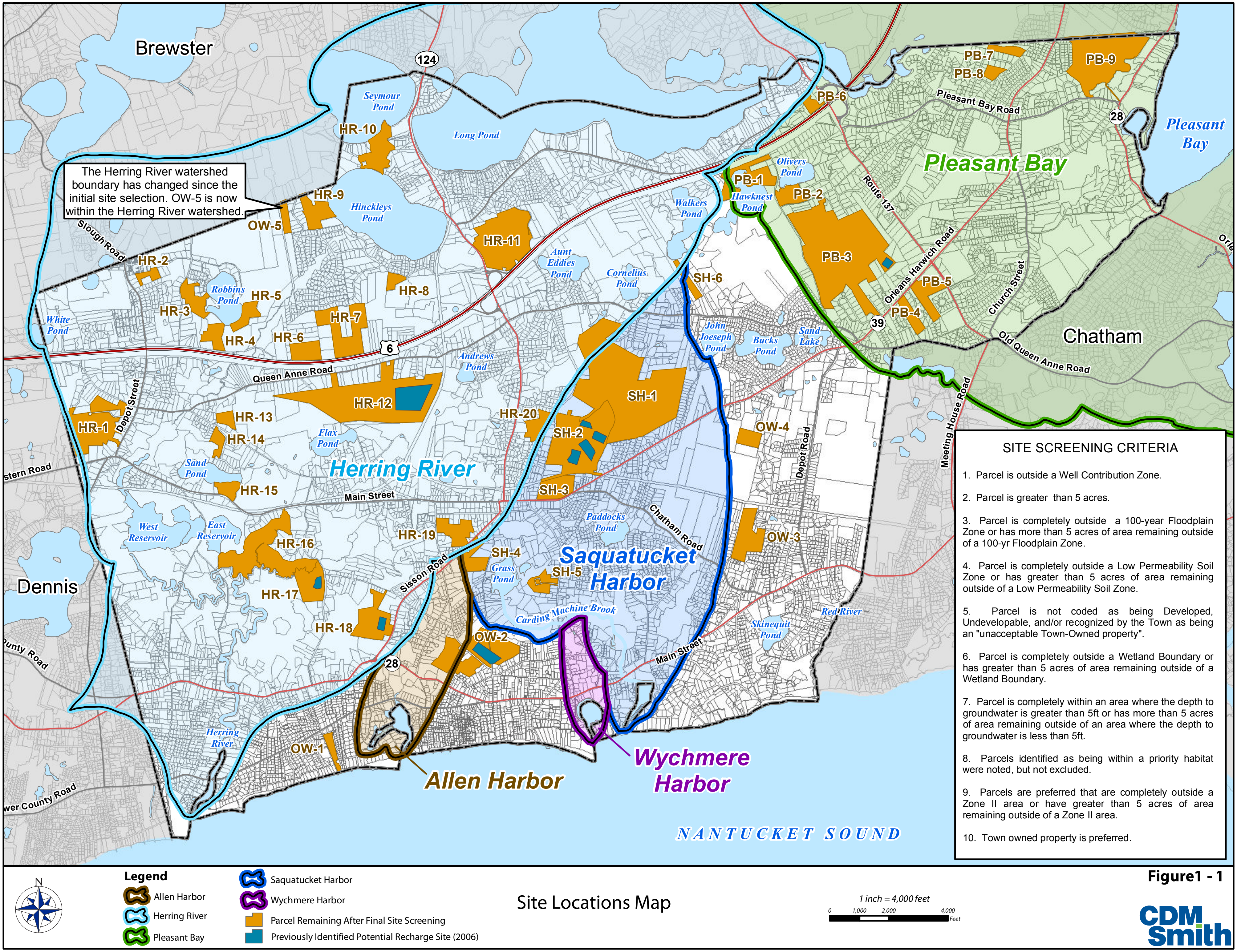
The Harwich Landfill site, HR-12, is a large municipally owned parcel which consists of a capped landfill area in the western end of the site with recycling and waste transfer facilities, and former sludge disposal beds located in the southern portion of the site, north of Flax Pond. Coy Brook is located east of the site near the bike path and water levels in the brook are controlled by structures in the cranberry bogs located southeast of the site. Additional cranberry bogs located east and west of Flax Pond are fed by surface water pumped from the pond. Groundwater and surface water levels in the area are heavily influenced and controlled by operations of the cranberry bogs. Recharge would be via infiltration basins located in the existing wooded southeastern portion of the site.

Subsurface recharge beneath playing fields is proposed for the Harwich High School (future Monomoy High School) site, SH-2. Surface water features near the site are primarily kettle ponds which reflect the groundwater table and likely have little impact on the overall flow patterns.

The third site, PB-3, is located within the Pleasant Bay watershed. The site is primarily uplands adjacent to a former gravel pit with no nearby surface water features. Recharge would be via infiltration basins.

A United Stages Geologic Survey (USGS) MODFLOW groundwater model was used as a basis for site-specific modeling. MODFLOW is a finite-difference groundwater model code developed by the USGS and widely used for groundwater modeling applications. Model refinement efforts were focused on site HR-12. The USGS model simulates annual steady-state conditions for the regional Monomoy Flow Lens. Refinements made to the USGS model included grid discretization, inclusion of site-specific information collected from previous investigations, and inclusion of data collected as part of the CWMP work. The hydrogeologic data-collection efforts focused on site HR-12, and also included limited efforts at site PB-3, as defined in work plan documentation submitted to regulatory reviewers at the Massachusetts Department of Environmental Protection (MassDEP) and the Cape Cod Commission (CCC).

This report describes the hydrogeologic data-collection efforts and the groundwater modeling performed to predict impacts from effluent recharge. A hydrogeologic workplan was submitted to the MassDEP on July 28, 2011. Once approved, field work commenced during August 2011. Initial results from the data-collection and groundwater modeling efforts were presented to the MassDEP and the CCC on December 9, 2011. Comments and recommendations from that meeting were addressed and thus this report serves as a comprehensive summary of the hydrogeologic studies within the current stage of the overall CWMP.



Brewster
Dennis
Chatham
Pleasant Bay
Herring River
Saquatucket Harbor
Allen Harbor
Wychmere Harbor
NANTUCKET SOUND
The Herring River watershed boundary has changed since the initial site selection. OW-5 is now within the Herring River watershed.
SITE SCREENING CRITERIA
1. Parcel is outside a Well Contribution Zone.
2. Parcel is greater than 5 acres.
3. Parcel is completely outside a 100-year Floodplain Zone or has more than 5 acres of area remaining outside of a 100-yr Floodplain Zone.
4. Parcel is completely outside a Low Permeability Soil Zone or has greater than 5 acres of area remaining outside of a Low Permeability Soil Zone.
5. Parcel is not coded as being Developed, Undevelopable, and/or recognized by the Town as being an "unacceptable Town-Owned property".
6. Parcel is completely outside a Wetland Boundary or has greater than 5 acres of area remaining outside of a Wetland Boundary.
7. Parcel is completely within an area where the depth to groundwater is greater than 5ft or has more than 5 acres of area remaining outside of an area where the depth to groundwater is less than 5ft.
8. Parcels identified as being within a priority habitat were noted, but not excluded.
9. Parcels are preferred that are completely outside a Zone II area or have greater than 5 acres of area remaining outside of a Zone II area.
10. Town owned property is preferred.
Legend
Allen Harbor
Herring River
Pleasant Bay
Saquatucket Harbor
Wychmere Harbor
Parcel Remaining After Final Site Screening
Previously Identified Potential Recharge Site (2006)
Site Locations Map
Figure1 - 1
1 inch = 4,000 feet
0 1,000 2,000 4,000 Feet
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Section 2

Site Investigation Summary

Existing data on subsurface geology and surface water levels, groundwater levels, water quality, sieve analysis and hydraulic testing was reviewed for the three selected effluent recharge sites. This data was supplemented by additional borings, groundwater measurements, groundwater quality sampling, surface water level measurements, infiltration tests and sieve analysis at two of the sites, HR-12 and PB-3. All of this data is summarized herein.

2.1 USGS Data

Regional groundwater levels and surface water stage and flow near HR-12 were obtained from the USGS National Water Information System (NWIS) database. This data was used by the USGS for calibration of the USGS MODFLOW model and was used during the CWMP groundwater flow modeling efforts to confirm the regional model calibration after model refinement. Five wells have a period of record that included the model calibration period of 2003 and were used for regional model calibration. These wells are located in Brewster, Chatham, Harwich and Orleans. The wells are listed in Table 2-1 and shown on Figure 2-1.

Stream discharge for the Herring River, which is located west and north of site HR-12, is available from 1970 to 1988 and from 2007 to the present. Discharge in the Herring River varied from 1 to 31 cfs during the period of record. Recent flow data was used as a check for streamflow in the refined model.

Table 2-1 USGS Wells and Herring River Gage Data

Name	Description	Period of Record
BMW-21	Brewster Groundwater Well	1962 to present
BMW-44	Brewster Groundwater Well	1975 to present
CGW-138	Chatham Groundwater Well	1962 to present
HJW-141	Harwich Groundwater Well	1975 to 2007
OSW-24	Orleans Groundwater Well	1975 to present
01105880	Herring River Gage Located at Rt. 6	1970 to 1988, 2007 to present

2.2 Landfill Site Investigations

A Comprehensive Site Assessment (CSA) of the Harwich Landfill was prepared by Weston & Sampson Engineers in 1991. Assessment activities included borings, well installation and sampling, gas sampling, test pits, hydraulic testing and surface water samples. Locations of CSA landfill monitoring wells with water level data from 2003 are shown in Figure 2-2. Boring logs and water level measurements indicate a significant clay layer under the site.

As part of on-going landfill monitoring, water levels have been measured at 20 wells in the spring and fall from the early 1990s to the present (Figure 2-2). Water levels in wells were generally higher in the spring and lower in the fall. Elevations generally varied 2 to 3 feet between spring and fall in 2003. Wells and water levels measured at these 20 locations during 2003 are listed in Table 2-2. Wells were classified as being in the upper aquifer above the clay layer or in the lower aquifer below the clay

Figure 2-1
USGS Wells and Herring River Gage

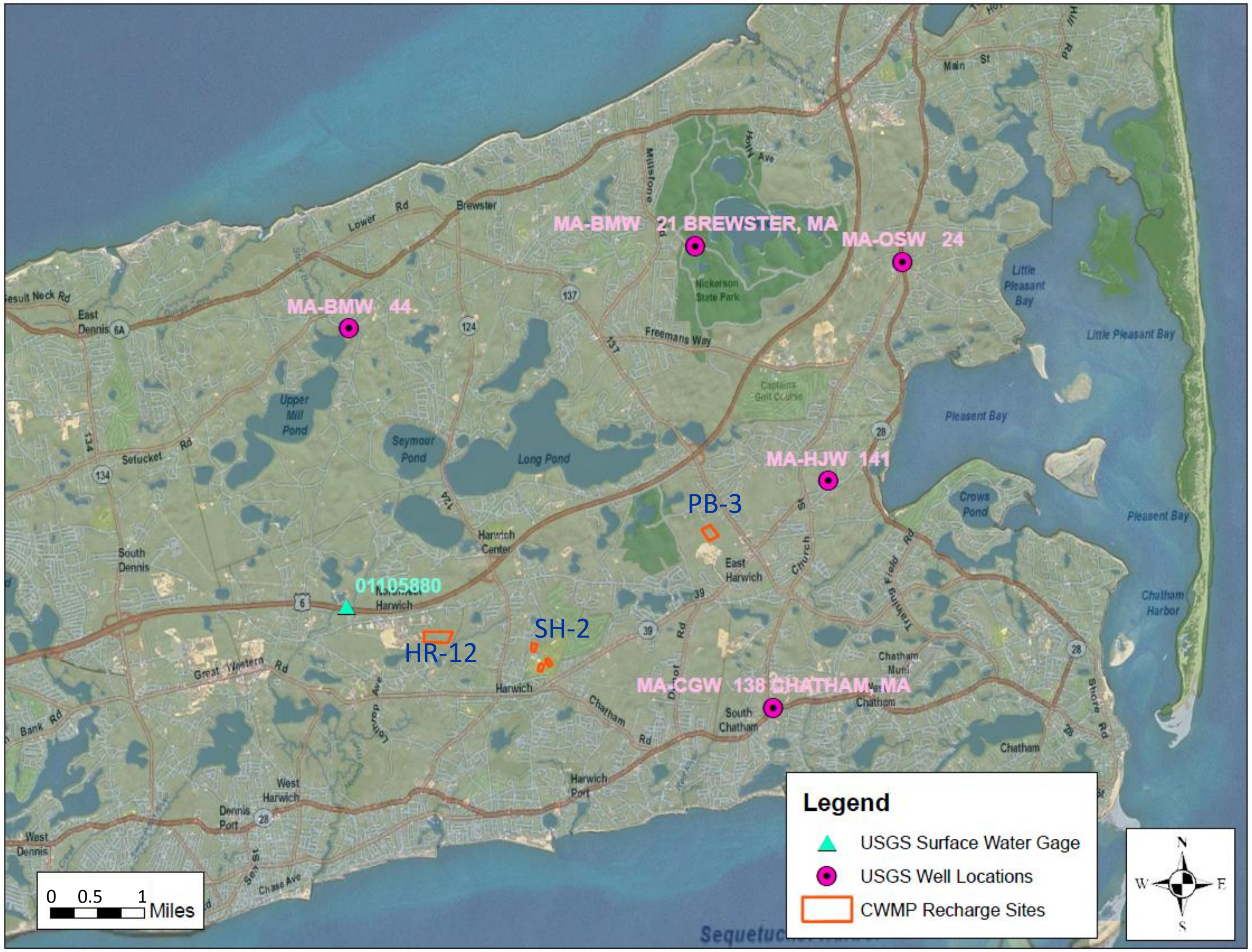

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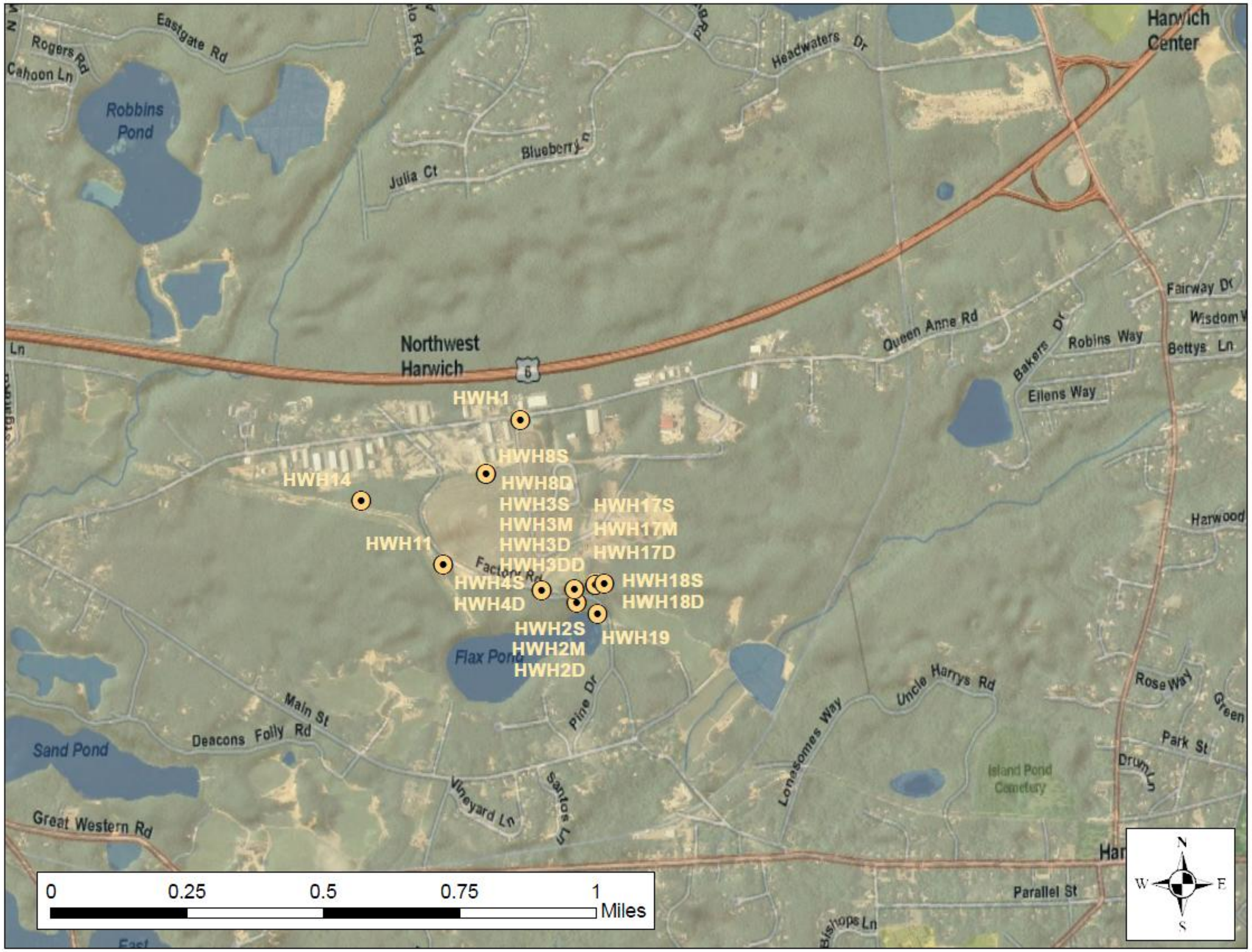
Figure 2-2
Landfill Wells – 2003 Water Level Locations



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layer. Six locations have wells located both above and below the clay layer. These locations were used to calibrate vertical head differences. The nested water level measurements show a vertical gradient which is indicative of a significant confining unit (clay). Screen lengths are 5 feet in length with the exception of HWH-18 S which is 10 feet in length.

Table 2-2 Landfill Water Level Summary 2003

Well	Aquifer	Screen Top Elevation (ft)	Screen Bottom Elevation (ft)	Spring 2003 Water Elevation (ft)	Fall 2003 Water Elevation (ft)	Range of 2003 Water Elevations (ft)
HWH-1	Lower	-5.2	-10.2	28.78	25.97	2.81
HWH-2 S	Upper	23.75	18.75	23.31	20.54	2.77
HWH-2 M	Upper	11.41	6.41	23.4	20.71	2.69
HWH-2 D	Lower	-10.85	-15.85	23.21	16.39	6.82
HWH-3 S	Upper	23.65	18.85	23.57	20.85	2.72
HWH-3 M	Upper	11.57	6.57	23.72	20.99	2.73
HWH-3 D	Lower	-7.59	-12.59	18.87	16.29	2.58
HWH-3 DD	Lower	-21.57	-26.57	18.85	16.34	2.51
HWH-4 S	Upper	27.93	22.93	28.88	NM	--
HWH-4 D	Lower	-14.05	-19.05	18.7	15.4	3.3
HWH-8 S	Upper	33.01	28.01	28.48	25.7	2.78
HWH-8 D	Lower	-1.55	-6.55	28.01	25.1	2.91
HWH-11	Lower	1.57	-3.43	17.24	14.78	2.46
HWH-14	Lower	1.48	-3.52	17.09	14.69	2.4
HWH-17 S	Upper	22.13	17.13	23.51	21.04	2.47
HWH-17 M	Upper	7.6	2.6	23.68	21.02	2.66
HWH-17 D	Lower	-19.3	-24.3	19.4	16.84	2.56
HWH-18 S	Upper	23.44	13.44	23.52	21.29	2.23
HWH-18 D	Lower	-19.81	-24.81	18.74	16.13	2.61
HWH-19	Upper	23	18	9.25	6.61	2.64

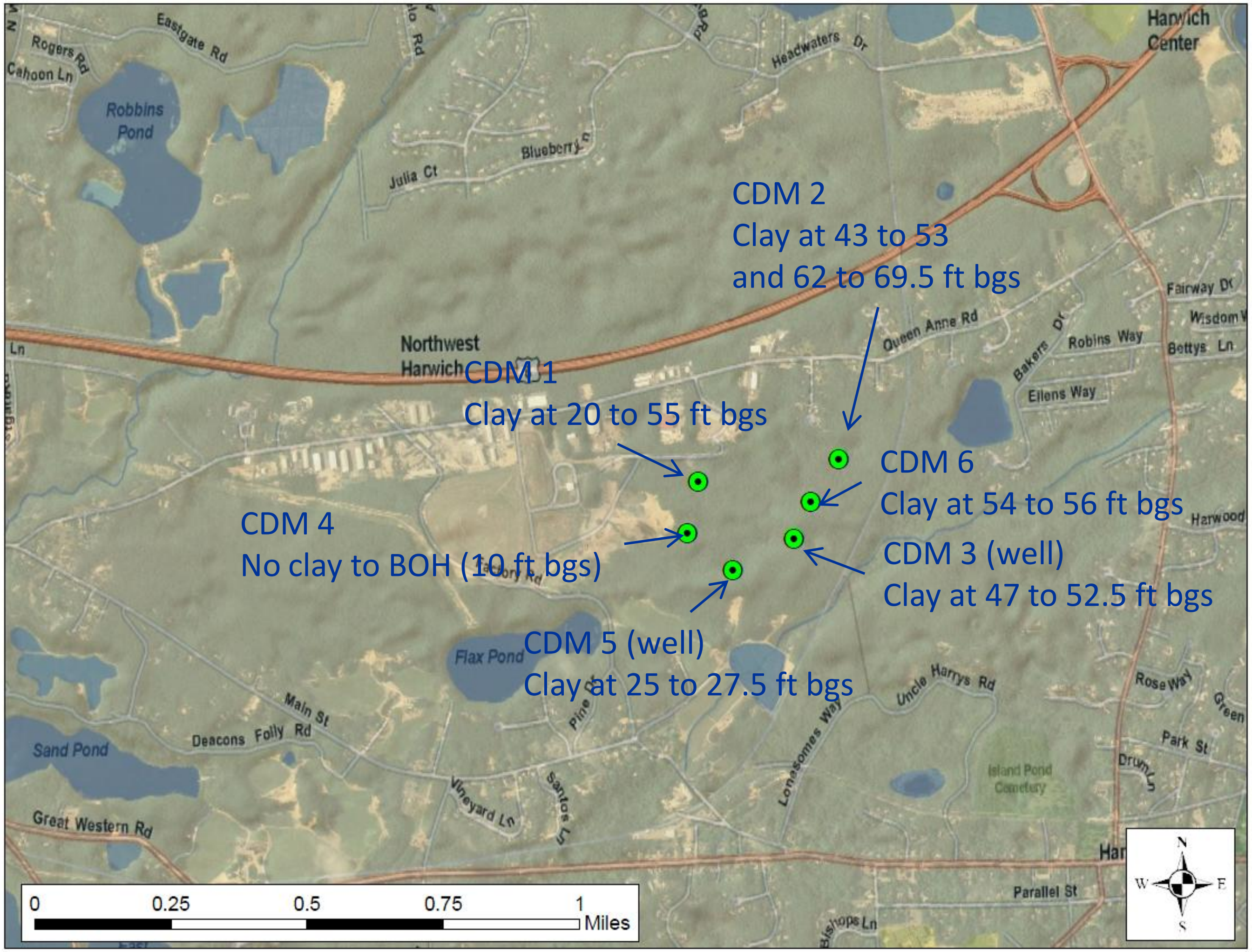
Note: NM – not measured.
HWH-19 measurements are likely incorrect based on known ground and surface water elevations in the area. A new survey would be needed to establish the correct casing and screen elevation.
HWH-2 D spring 2003 water elevation appears to be incorrectly recorded. Recorded spring season water elevations from 2005 to 2011 were between 16.09 and 18.83 ft. The range of water elevations recorded between 2005 and 2011 is 2.78 feet, which is consistent with the water elevation range in other wells in the HWH-2 cluster.

Hydraulic testing results from the CSA report include constant discharge tests, slug tests, and grain size analysis. A summary of hydraulic conductivity values based on these results is shown in Table 3-2.

2.3 2011 Supplemental CWMP Investigations

Additional borings were drilled, three wells were installed, and surface water points were established and surveyed. A round of groundwater samples were collected for water quality analysis at two HR-12 wells. Infiltration tests were performed at three sites at HR-12. Grain size analysis was conducted on 4 samples collected from borings at HR-12. One round of groundwater and surface water elevations were measured in September 2011. Six borings were installed at HR-12 in the eastern portion of the site, one boring was installed at PB-3, and five water level measurement locations were identified and surveyed in along Coy Brook and in Flax Pond near HR-12. Locations of the borings wells and surface water measurement points at HR-12 are shown on Figures 2-3 and 2-4. The location of the boring and well at PB-3 is shown on Figure 2-5. The well at PB-3 was dry and no water level was recorded. Boring logs are summarized in Table 2-3 and included in Appendix A. Infiltration testing results are provided

Figure 2-3
HR-12 CWMP Borings



BOH- bottom of hole
ft bgs – feet below ground surface

CDM Smith

Figure 2-4
HR-12 CWMP Surface Water Elevation Measurement Locations

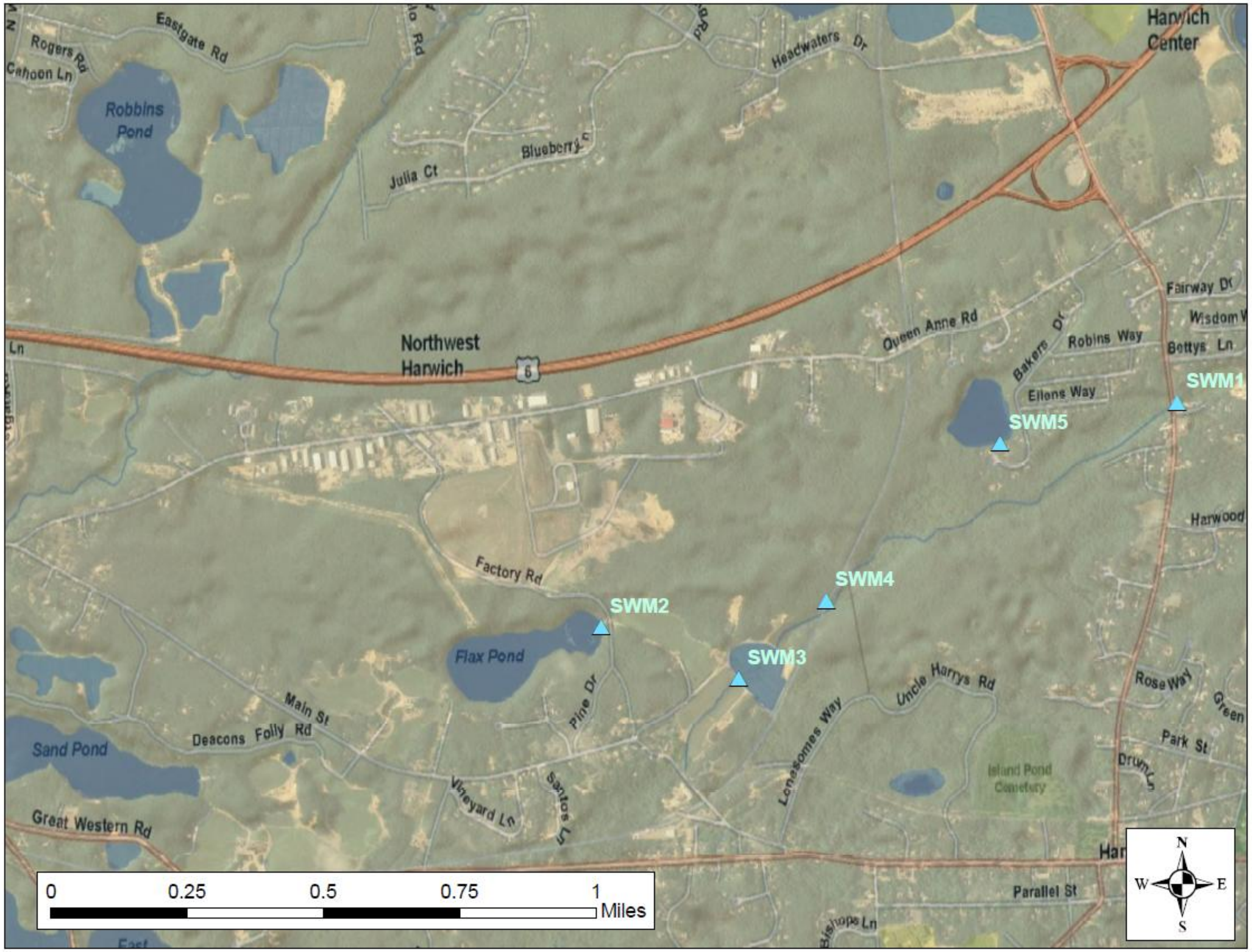
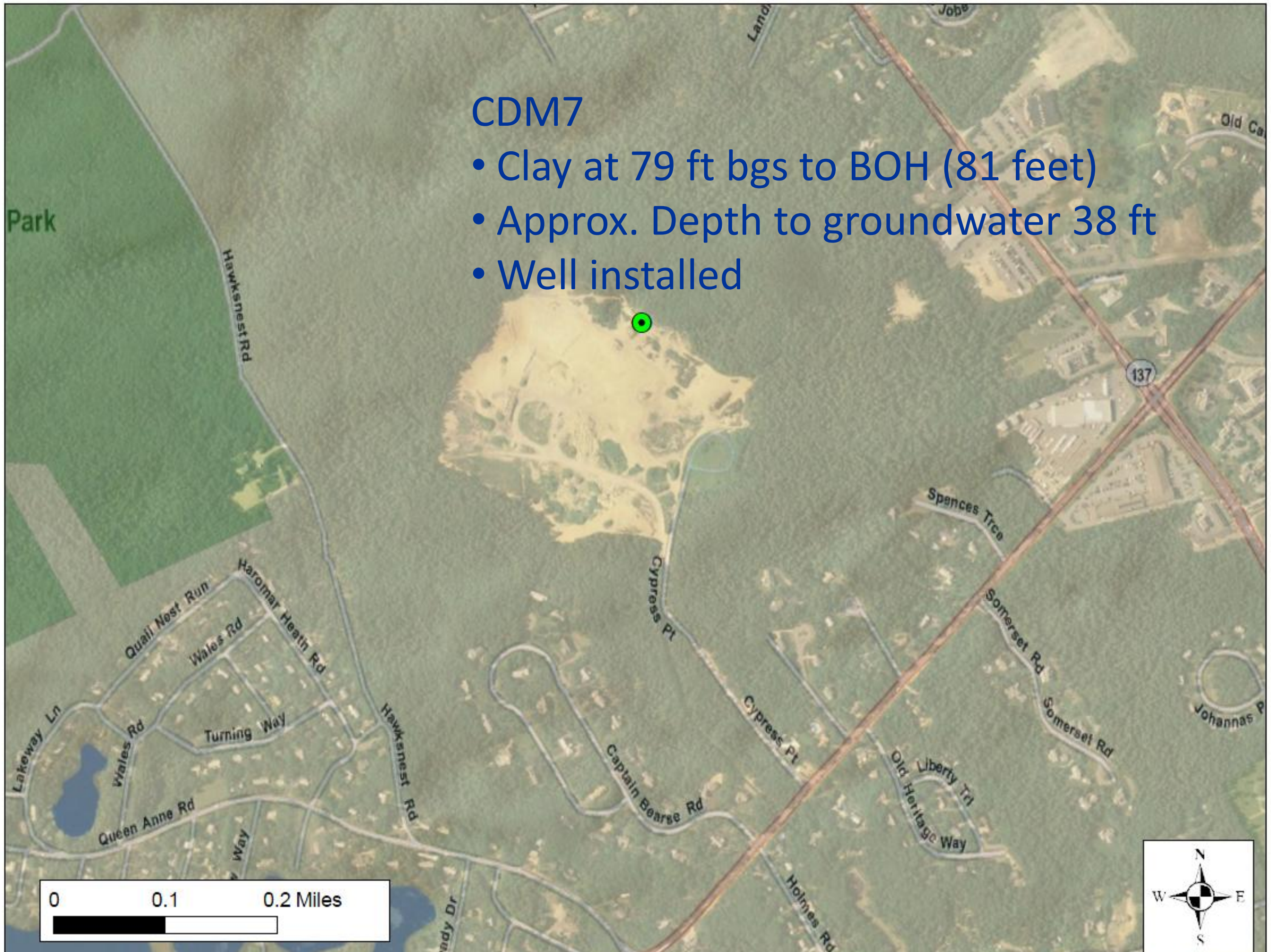


Figure 2-5
PB-3 CWMP Boring



BOH- bottom of hole
ft bgs – feet below ground surface

in Appendix B and grain size analysis is included in Appendix C. Hydraulic conductivity values calculated from the grain size analysis is shown in Table 3-2.

As expected based on the Landfill CSA report, clay was encountered in borings at HR-12. Layers encountered include a sand layer of between 20 and 54 feet thick over a clay layer between 2 and 35 feet thick. A sand layer is below the clay strata. A second clay layer was encountered at CDM-2. Wells were installed in the surficial phreatic layer in two locations, CDM-3 and CDM-5. Results confirm the landfill borings and indicate that clay extends underneath the eastern area of the site. In general, the clay layer was thinner and its contact with the surficial sand layer was deeper in the eastern-most borings, CDM-2, -3 and -6. Cross-sections from west to east through the landfill and from Flax Pond to the northeast are shown in plan view on Figure 2-6 and cross-section in Figures 2-7 and 2-8.

One boring, CDM-7, was installed at PB-3. Clay was encountered in the boring, CDM-7, at a depth of 79 feet below ground surface. A groundwater well was installed at this location.

Table 2-3 CWMP Boring Log Summary

Boring Name	Site	Boring Depth (ft)	Strata Thickness (ft)					Well Installed
			Sand	Clay/Silt	Sand	Clay/Silt	Sand	
CDM-1	HR-12	76	20	35	21 +			
CDM-2	HR-12	86	43	10	9	7.5	16.5 +	
CDM-3	HR-12	61	47	5.5	8.5 +			Y
CDM-4	HR-12	10	>10					
CDM-5	HR-12	61	25	2.5	33.5 +			Y
CDM-6	HR-12	61	54	2	5 +			
CDM-7	PB-3	81	79	2 +				Y

Note: + indicates Strata may be thicker since the bottom of the boring was reached.

Water quality samples were collected at the two CWMP wells at HR-12 on November 16, 2011. Per MassDEP and CCC staff requests, water samples were analyzed for VOCs, surfactants, chloride, fluoride, nutrients, sulfate, total dissolved solids, total metals, and dissolved metals. These parameters were selected to support future site assessment and discharge permitting. Table 2-4 summarizes water quality results for test parameters and detections of filtered (dissolved) metals. Complete groundwater quality results are included in Appendix D.

Figure 2-6
Cross-Section Location Map

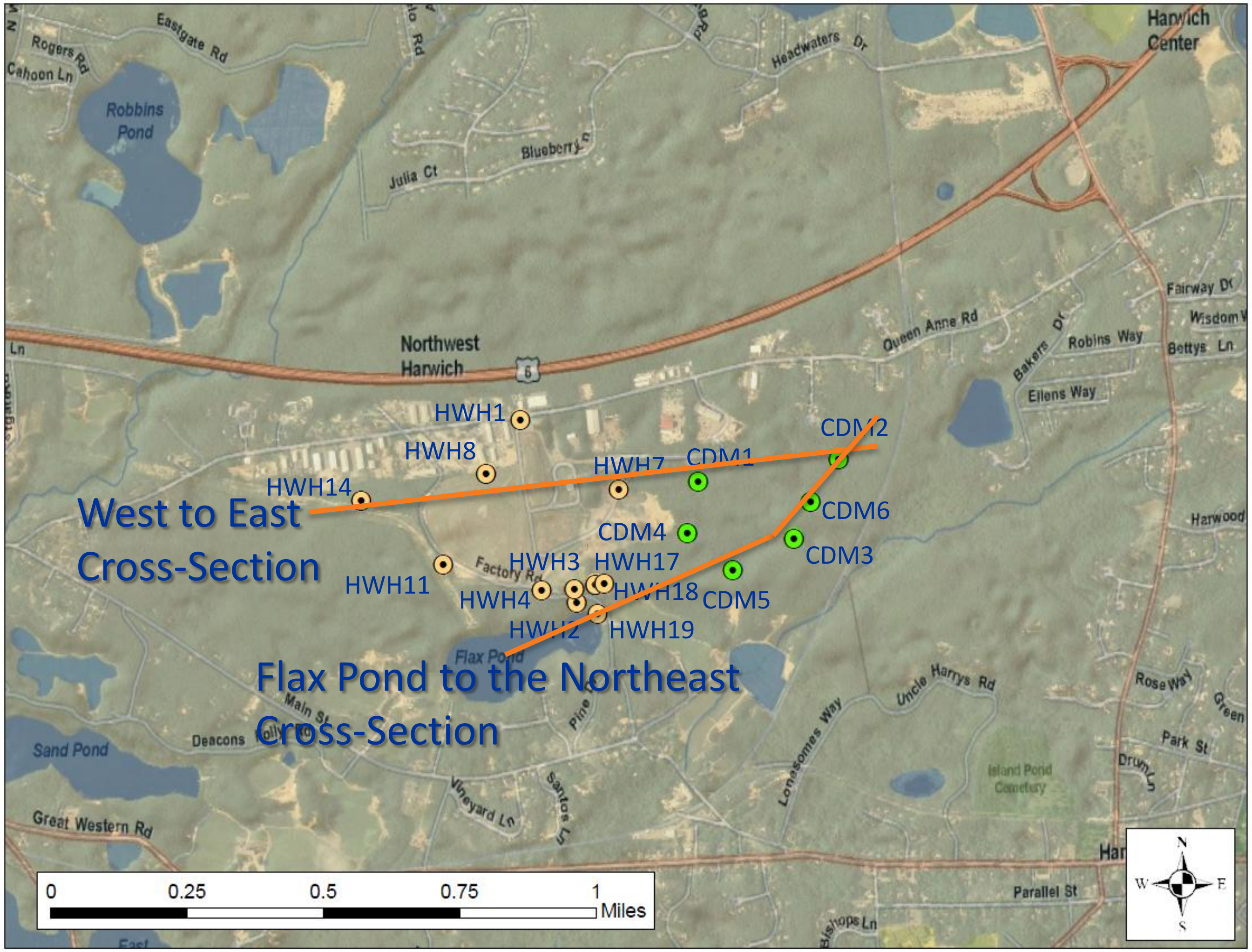
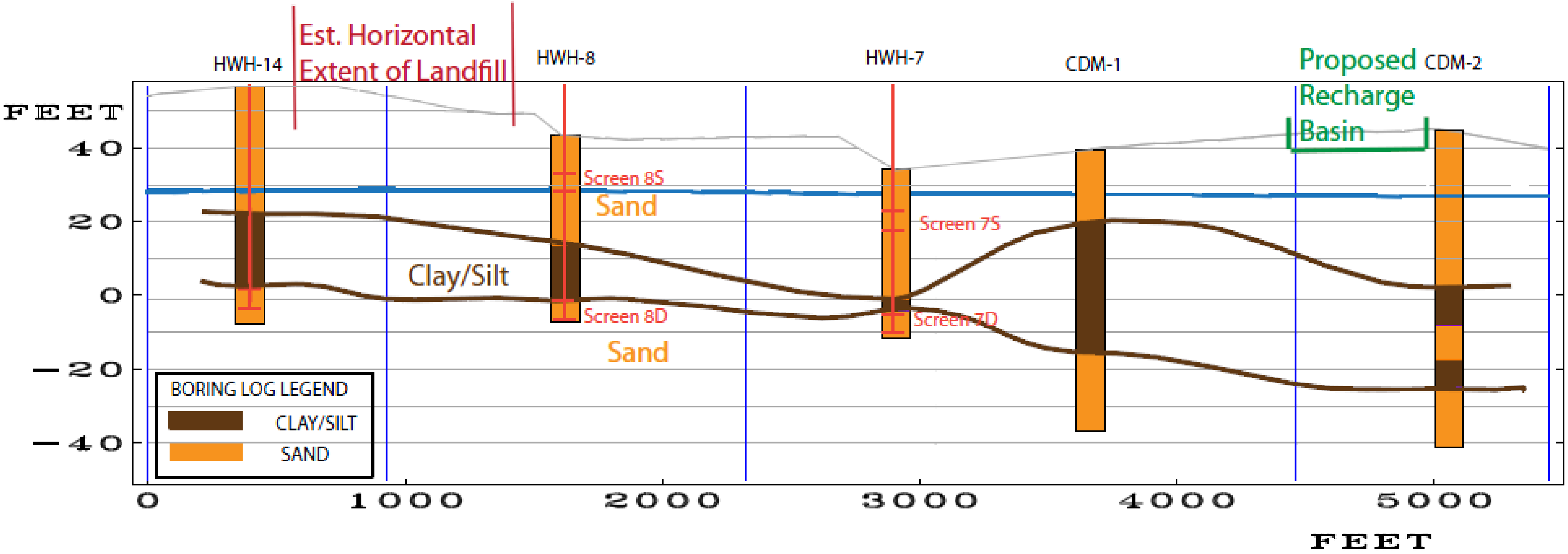
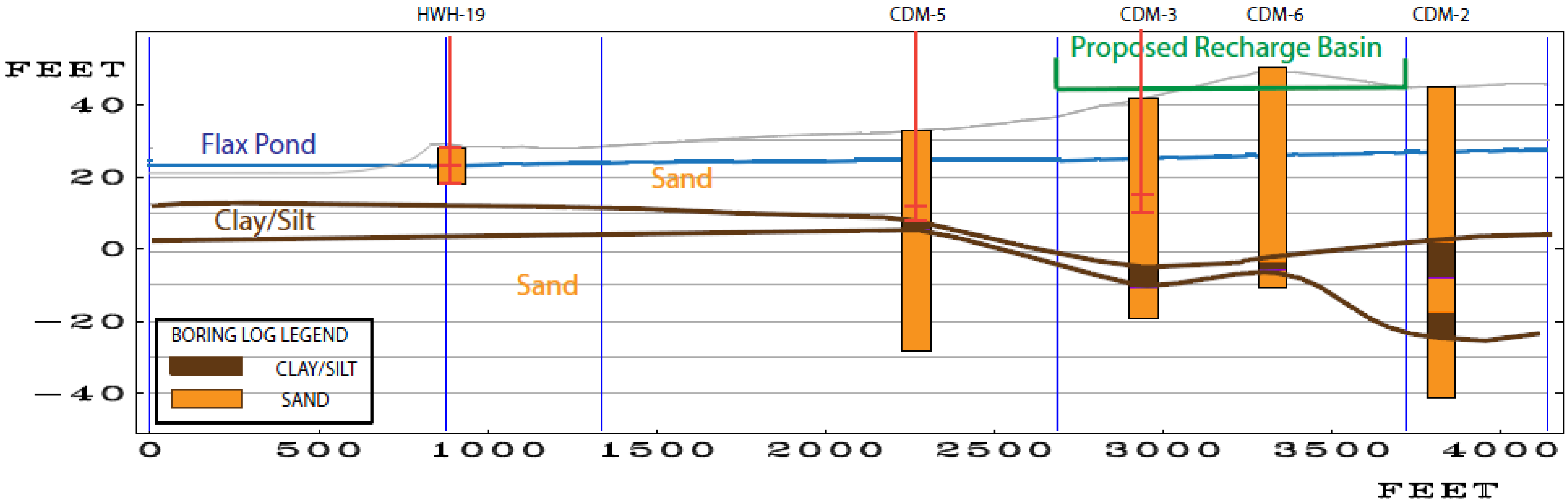


Figure 2-7
West to East Cross-Section HR-12



Ground surface elevations are estimated.

Figure 2-8
Flax Pond to the Northeast Cross-Section HR-12



Ground surface elevations are estimated.

Table 2-4 CWMP Groundwater Quality Results (11/16/2011)

	Well	CDM-5	CDM-3
Chlorides	mg/L	12	14
Sulfate	mg/L	4.1	4.5
Phosphorus, total	mg/L	non-detect	0.11
Total Dissolved Solids	mg/L	34	37
Nitrate as Nitrogen	mg/L	non-detect	non-detect
Nitrite as Nitrogen	mg/L	non-detect	non-detect
Nitrogen, total	mg/L	non-detect	non-detect
Total Kjeldahl Nitrogen	mg/L	non-detect	non-detect
Metals ,- Filtered			
Barium	mg/L	0.02	0.011
Manganese	mg/L	0.032	0.042
Sodium	mg/L	8.1	9.6
Zinc	mg/L	0.005	0.009

2.4 Other Data Sources

In addition to the site-specific data for HR-12 from the Landfill CSA and data collected as part of the CWMP, logs from public water supply exploratory borings northwest of the Herring River were reviewed for information on potential confining units (clay or silt layers). The area includes public water supply well 10 and a series of test wells.

A series of test wells were installed in October 2001. High levels of iron and manganese indicate that the site is not suitable for public water supply without water treatment. Well logs and pumping results suggest a confining or semi-confining unit of clay. Well logs show this unit has a thickness of between 20 and 70 feet. The top of the clay unit was encountered between 50 and 100 feet below ground surface. (Head First Inc, 2004)

A deep boring was drilled to 400 feet below ground surface in September 2007 to assess whether production wells could be installed in the deep aquifer. Clay and silt was observed at 70 to 128 feet below ground surface and 178 to 340 feet below ground surface. Bedrock was not reached. (Head First Inc, 2007)

Section 3

Model Updates and Calibration

The USGS MODFLOW groundwater flow model for the Monomoy Lens includes the towns of Harwich, Brewster, and Chatham. The USGS developed this model in a cooperative effort with the MassDEP, with the overall objectives including use of the model for helping Cape Cod towns assess impacts of water supply and wastewater management alternatives. Therefore, this model was chosen as the basis for conducting CWMP modeling for Harwich. The model uses 2003 steady-state average annual recharge and pumping conditions to simulate regional flow.

Model refinements and updates were conducted prior to performing the CWMP predictive simulations in order to make the regional model more applicable to a site-specific study. Changes were made to the model grid, the representation of local streams, the inclusion of effluent recharge, and the extent of clay as determined through the supplemental site-specific field data collection efforts. The regional model calibration was verified with calibration targets used by the USGS, and local site-specific adjustments were made to refine the model using gathered groundwater and surface water level data. Unless otherwise noted, model-description statements in this report refer to how the model as developed by the USGS and any refinements or adjustments made for this project are clearly indicated as such.

All elevation data values generated during the CWMP field efforts were adjusted to the model vertical datum of NGVD29 that the USGS used in developing the regional model.

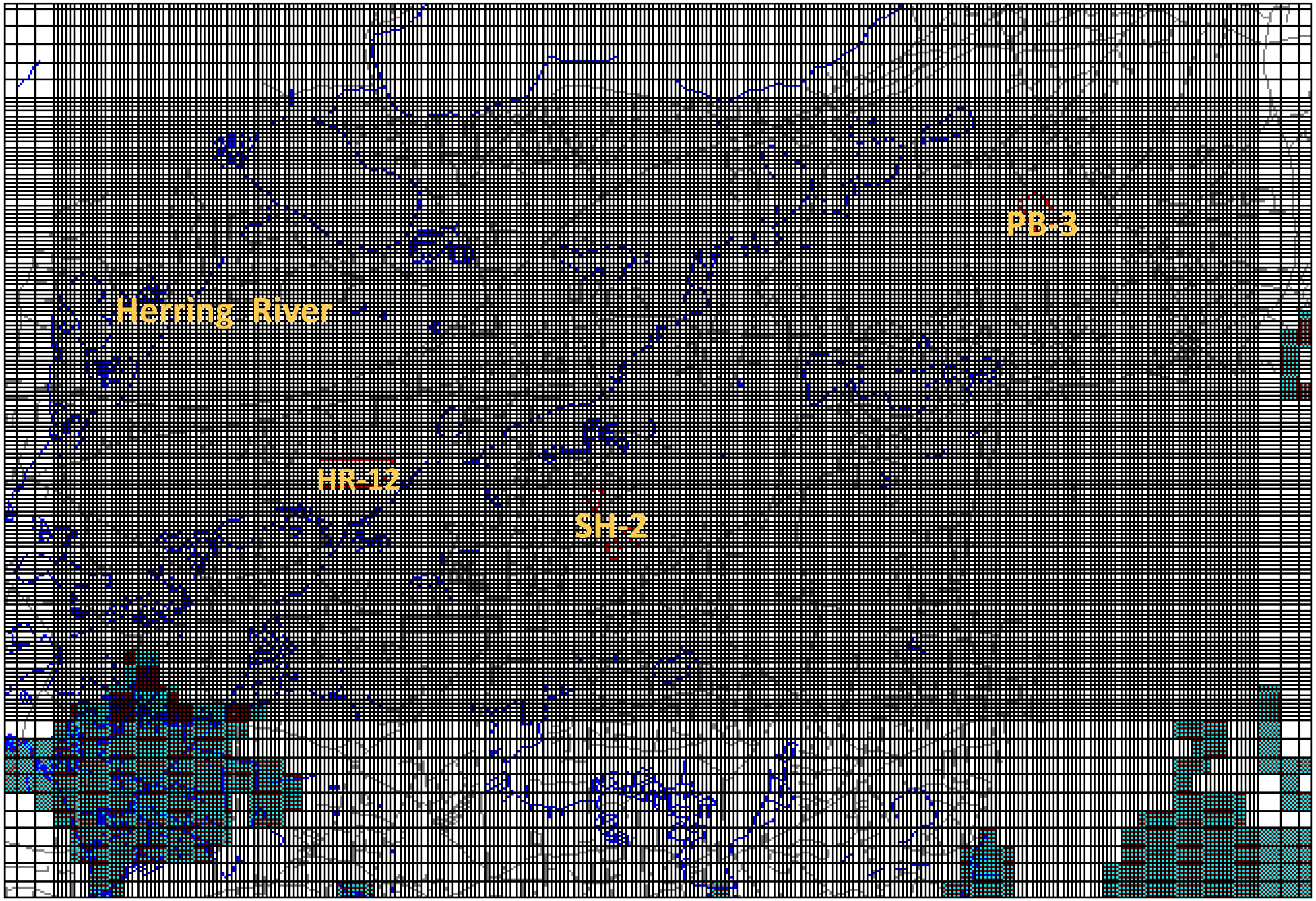
3.1 Grid and Model Refinement

The MODFLOW grid was refined from a cell size of 400 feet by 400 feet to a grid size of 100 feet by 100 feet near the recharge sites as shown in Figure 3-1. Model layers are flat, as designed and implemented by the USGS, and thus the layers do not vary in thickness throughout the model. The only exception is that the two deepest layers have some variation in thickness to help match the observed or estimated bottom of the glacial sediments; this variability in thickness has virtually no effect on the simulation of shallow groundwater flow.

The elevation of the clay layer is based on observed elevations in boring logs and is adjusted in the model in a step-wise (vertical) fashion. The step-wise changes were defined based on initial definition of estimated contact elevations. An example of the step-wise representation is provided in the cross-section shown in Figure 3-2.

Table 3-1 summarizes model layer elevations and hydraulic conductivity value ranges for each model layer. The anisotropy ratios are 10 to 1 for lower conductivity areas and as low as3 to 1 for the highest conductivity areas. Since the lakes and ponds on Cape Cod are primarily groundwater flow-through ponds, they were simulated in the model as areas of high hydraulic conductivity. A horizontal conductivity value of 50,000 feet/day and a vertical conductivity value of 5,000 feet/day were used. After grid refinement, conductivity zones for ponds near the recharge sites were adjusted to better match the horizontal pond extent.

Figure 3-1
USGS MODFLOW Model Grid Refinement



CDM Smith

Figure 3-2
Cross-Section through Groundwater Model

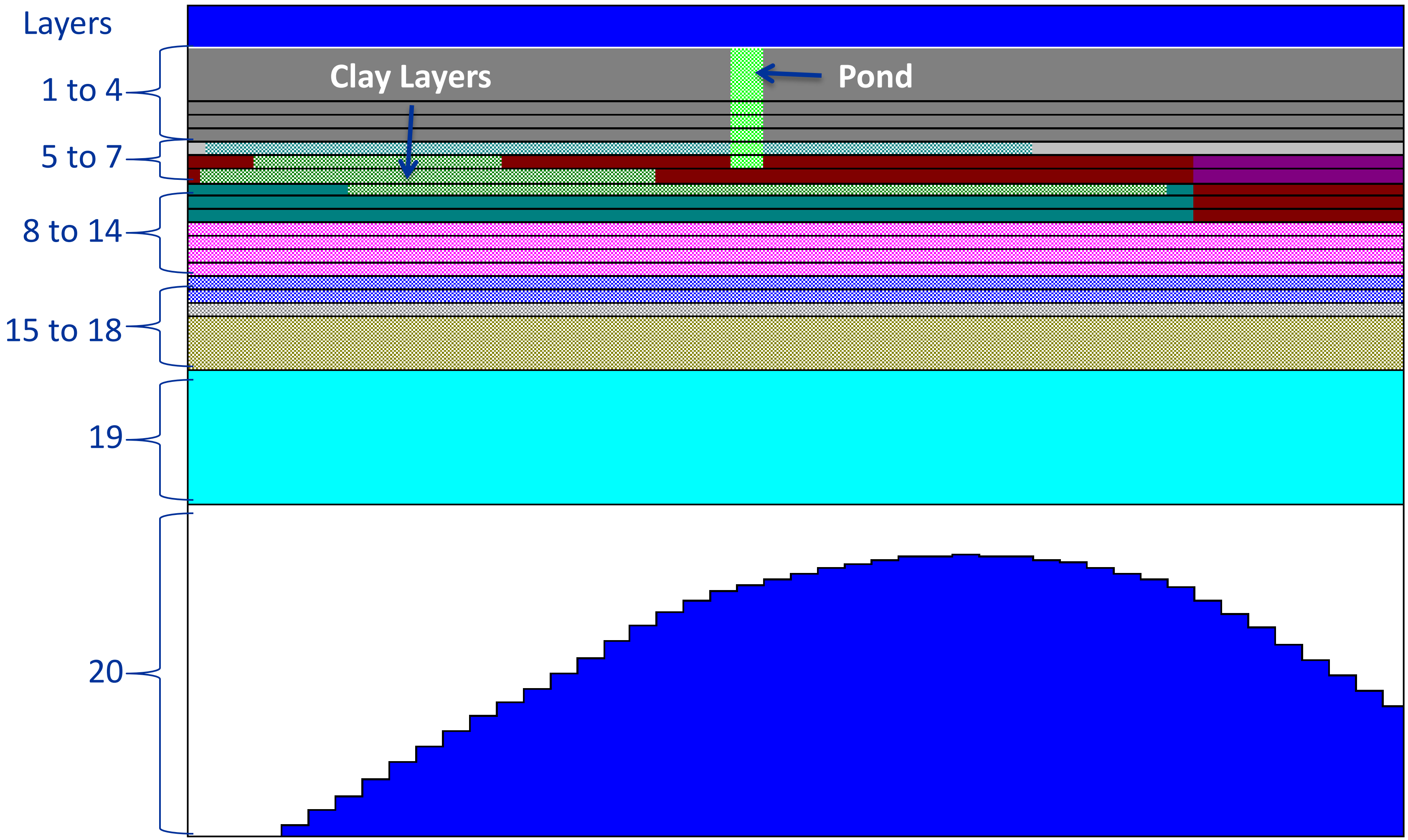


Table 3-1 Model Layers and Hydraulic Conductivity Values

Layers	Elevation Range (ft)	Layer Thickness (ft)	Horizontal Conductivity (ft/day)	Vertical Conductivity (ft/day)
1, 2, 3	100 to 60, 60 to 50, 50 to 40	40, 10, 10	130 to 300	13 to 100
4, 5	40 to 30, 30 to 20	10, 10	100 to 250	10 to 65
6, 7, 8	20 to 10, 10 to -1, -1 to -10	10, 11, 9	10 to 230	1 to 55
9, 10, 11	-10 to -20, -10 to -30, -30 to -40	10, 10, 10	30 to 200	3 to 35
12, 13	-40 to -50, -50 to -60	10, 10	20 to 130	2 to 13
14, 15, 16	-60 to -70, -70 to -80, -80 to -90	10, 10, 10	10 to 100	1 to 10
17, 18	-90 to -100, -100 to -140	10, 40	10 to 80	1 to 8
19	-140 to between -169 and -240	29 to 100	10 to 30	1 to 3
20	-240 to between -241 and -525	1 to 285	10 to 30	1 to 3

Hydraulic conductivity values used in the USGS groundwater model were similar to values measured as part of the recent field investigations near HR-12. Therefore, horizontal and vertical values used in the USGS model were not adjusted, with the exception of inclusion of the clay layer near HR-12. Table 3-2 summarizes the measured horizontal and vertical hydraulic conductivity results for HR-12. Results are summarized for the upper and lower aquifers at HR-12, including comparison of CWMP estimated values and calibrated hydraulic conductivities in the USGS model. The aquifers are separated by a clay layer.

Table 3-2 Hydraulic Conductivity Value Summary

Source	Landfill CSA			2011 Investigation	USGS
Data Type	Constant Discharge Test	Slug Test	Sieve Analysis	Sieve Analysis	Groundwater Model
Upper Aquifer					
Kh (ft/day)	12 to 221	14	238 to 1745	147 to 275	130 to 180
Kv (ft/day)					13 to 25
Lower Aquifer					
Kh (ft/day)	109 to 200	61 to 84			120 to 130
Kv (ft/day)					12 to 13

3.2 Model Net Recharge

The USGS MODFLOW Model includes three recharge types for general areal net recharge, lake and pond net recharge, and bog and wetland net recharge. Values were established to take into account average annual precipitation and average annual evaporation or evapotranspiration. Model net recharge values are shown in Table 3-3. In areas with increased grid discretization near recharge sites, model recharge zones were updated to better match actual pond and bog extents.

Table 3-3 Model Net Recharge Values

Area	Net Recharge (inches/year)
General	27.3
Lake/Pond	16.0
Bog/Wetland	0.0

3.3 Clay Extent and Hydraulic Properties

Based on boring logs from the CSA and HR-12 recent investigations, a clay layer was added and the extent modified based on model calibration. Horizontal and vertical conductivity values for the clay layer were set to 1 and 0.01 feet/day based on model calibration. In general, the clay layer slopes from a high in the west down towards the east. The layer is thickest and deepest underneath the landfill site and in the southern portion of the site. Figures 3-3 through 3-5 show the extent of the clay layer in model layers 6, 7 and 8. The clay layer was also assumed to extend beneath the school site (SH-2) in order to provide a conservative prediction of that site's effluent loading capacity and amount of water table mounding. Changes were not made to the elevations of the model layers. Therefore, the modeled clay layer is limited to thicknesses of the current model layers, which are around 10 feet (see Table 3-1).

3.4 Stream Updates

Model streams were updated based on grid refinement and elevation data as needed. Streams were simulated as fixed head stream boundaries, which enables simulation of flow between the stream and aquifer and calculation of the total flow within the stream. The USGS model did not include Coy Brook, which is located east of HR-12. This brook was added with stream head and elevation data estimated from measured ground elevations, CWMP measured stream elevations and topographic maps. Modeled streams near HR-12 are shown on Figure 3-6. Figures 3-7 and 3-8 show the elevation of the streambed and stream stage for the Herring River, west of the site, and Coy Brook, east of the site. The average annual stream stage for 2003, used to compare simulated and observed stage, at the USGS Gage on the Herring River is shown with an orange triangle.

3.5 Model Calibration

Groundwater elevation data from 2003 were averaged for each calibration well and used as an average annual value for calibration of the steady-state model. Calibration water level targets included regional USGS groundwater data and 2003 average annual water levels from landfill wells. Surface water and groundwater data measurements from 2011 and observed stream stage at the Herring River Gage at Route 6, shown on Figure 3-7, were also used for conducting an additional model calibration check. Graphical methods (i.e. 45-degree model-vs-data plot and contour-plotting) were used to assess model calibration.

The Palmer Drought Severity Index was used to determine how well 2003 represented average climate for the area. For 2003, the index ranges from 1.1 to 3 indicating a moderately wetter condition as compared to average.

3.5.1 Regional USGS Groundwater Points

Groundwater elevations at five points were used to confirm model calibration and ensure that site-specific model refinements did not adversely impact model calibration. The USGS model simulated water table was also visually compared to the water table from the refined model to ensure no significant regional changes to flow patterns were made. Figure 3-9 shows model calibration to the five regional points which were a close match to the calibration documented by the USGS. Measured and observed values are also displayed in Table 3-4.

Figure 3-3
Clay Extent Layer 6: 10 to 20 feet elevation

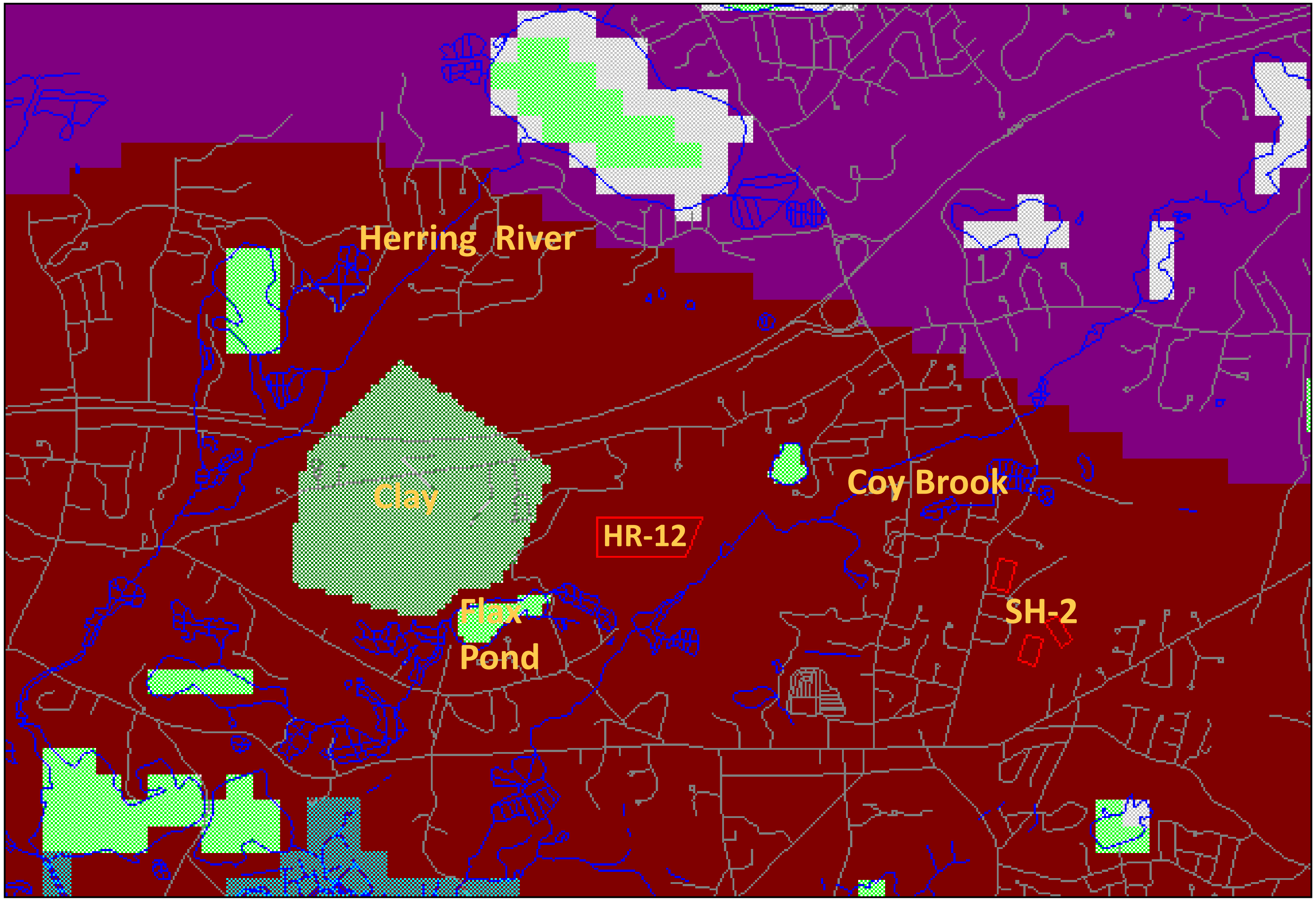


Figure 3-4
Clay Extent Layer 7: -1 to 10 feet elevation

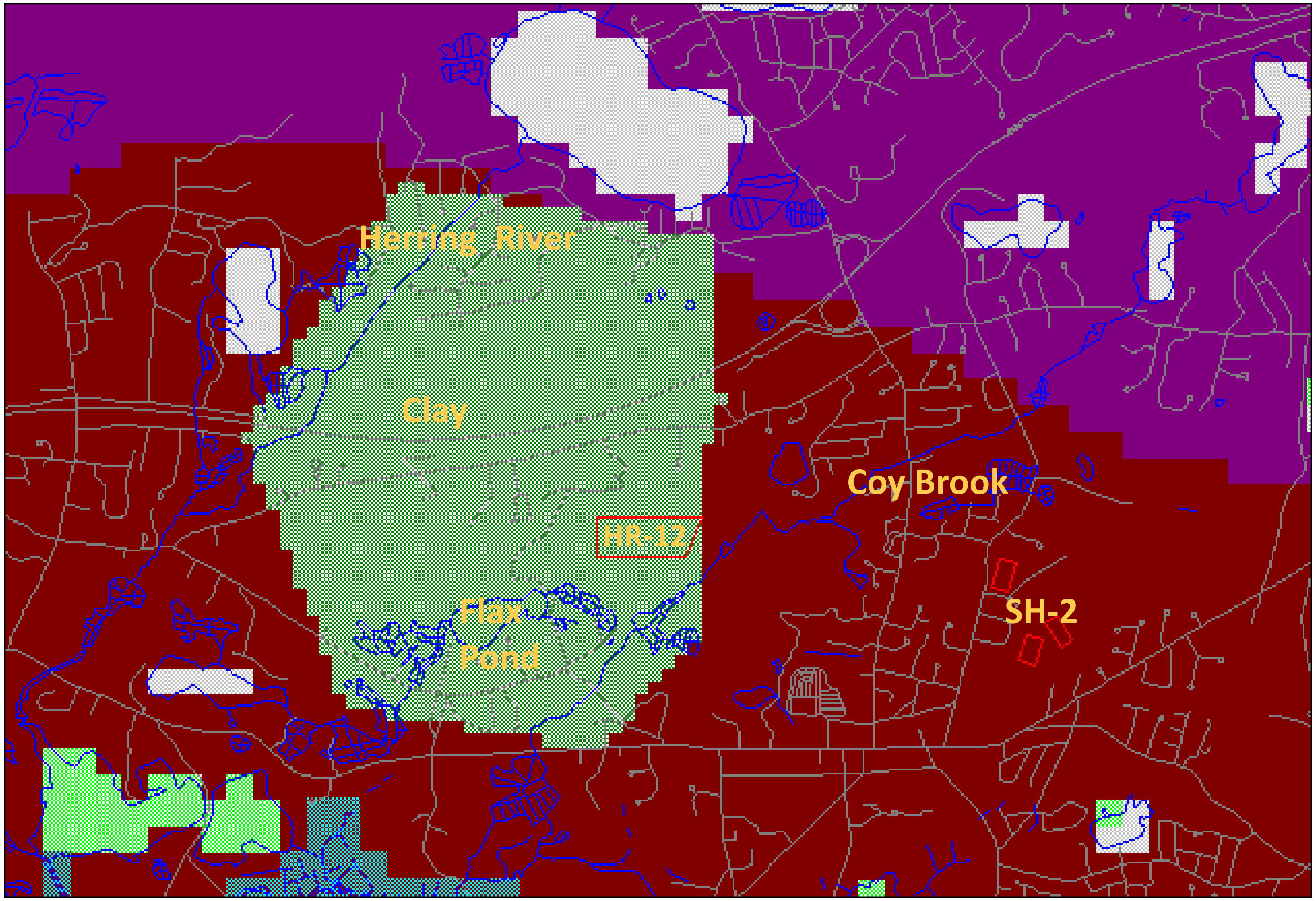


Figure 3-5
Clay Extent Layer 8: -10 to -1 feet elevation

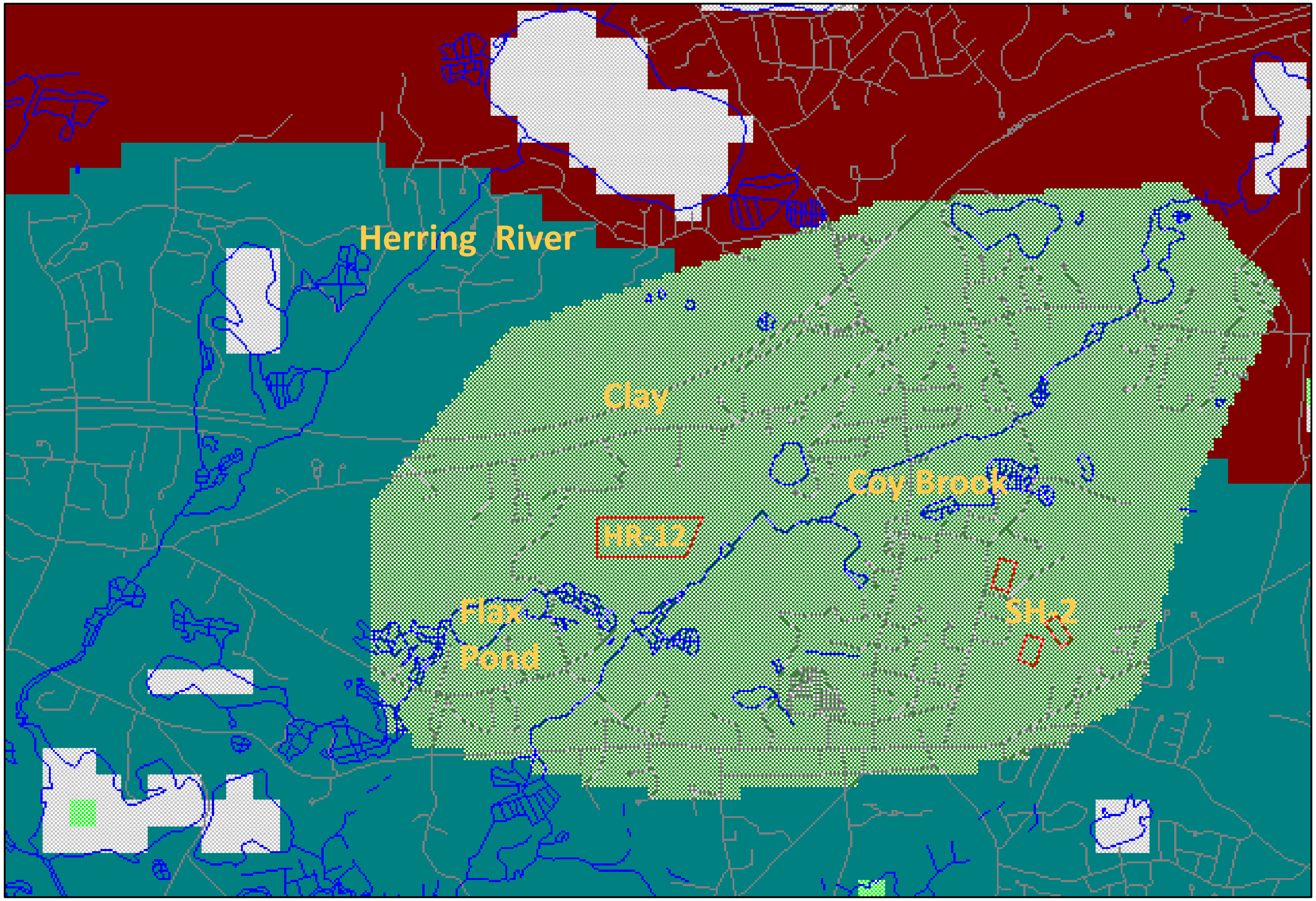


Figure 3-6
Modeled Surface Water Features near HR-12

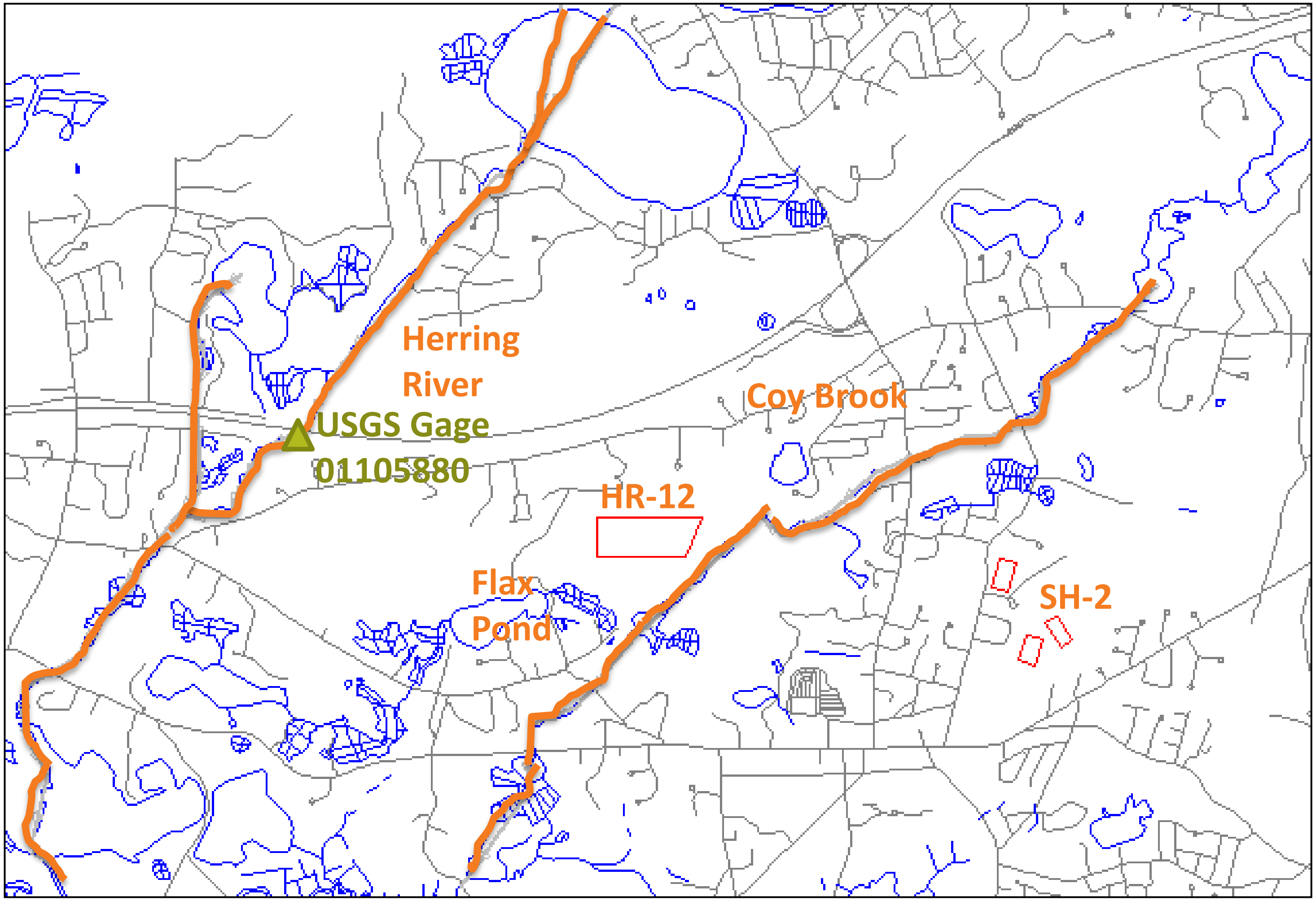


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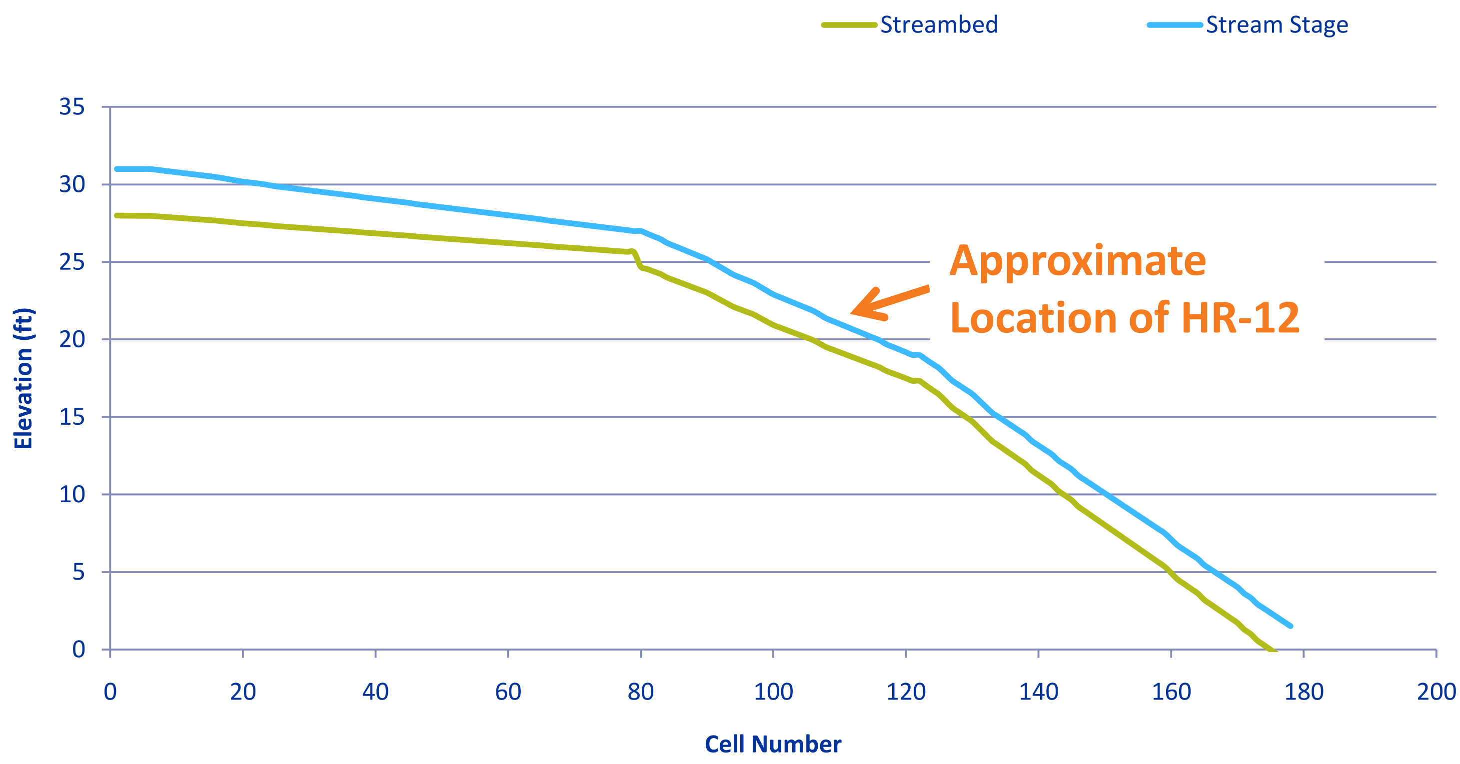
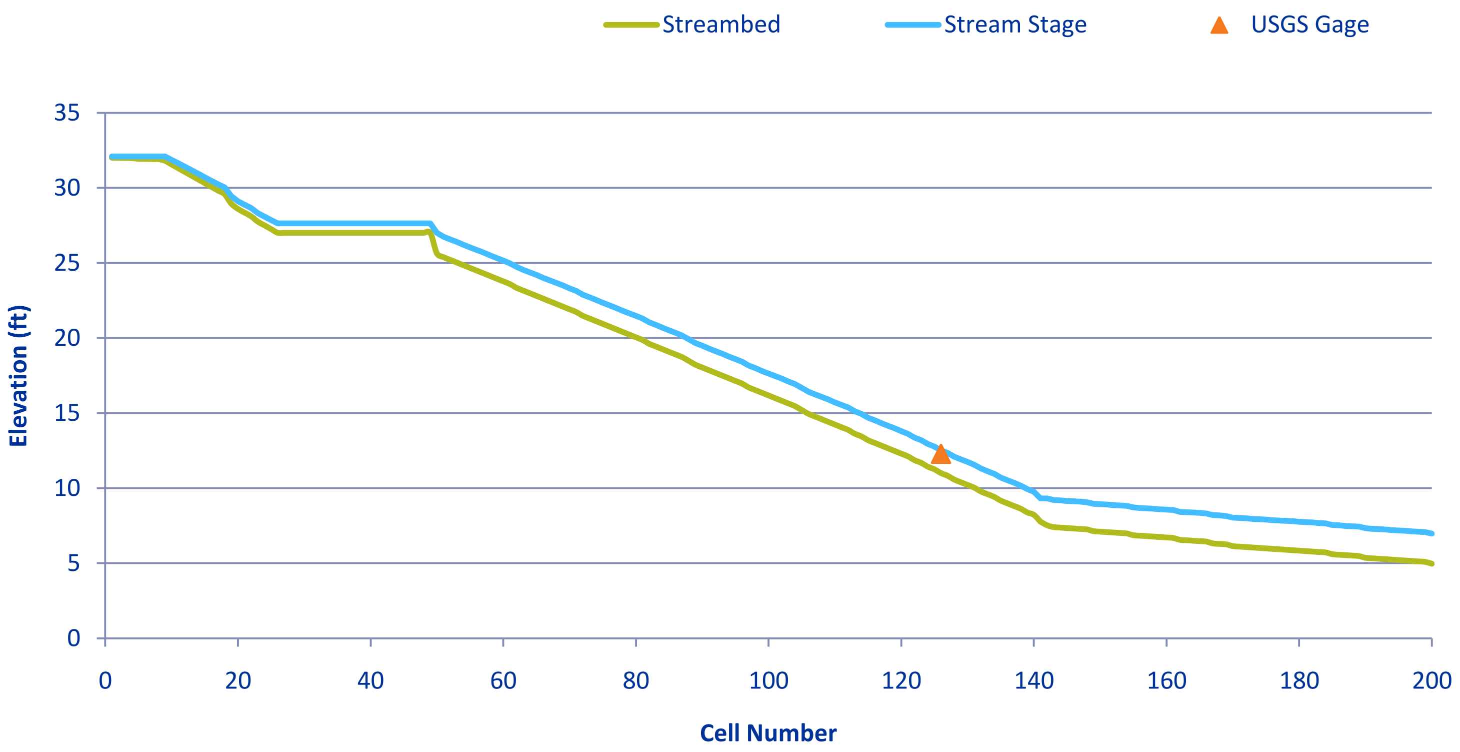
Figure 3-7
Coy Brook Modeled Streambed and Stage



X axis shows the number of model cells from the start of the stream.
Length of stream varies within each cell.

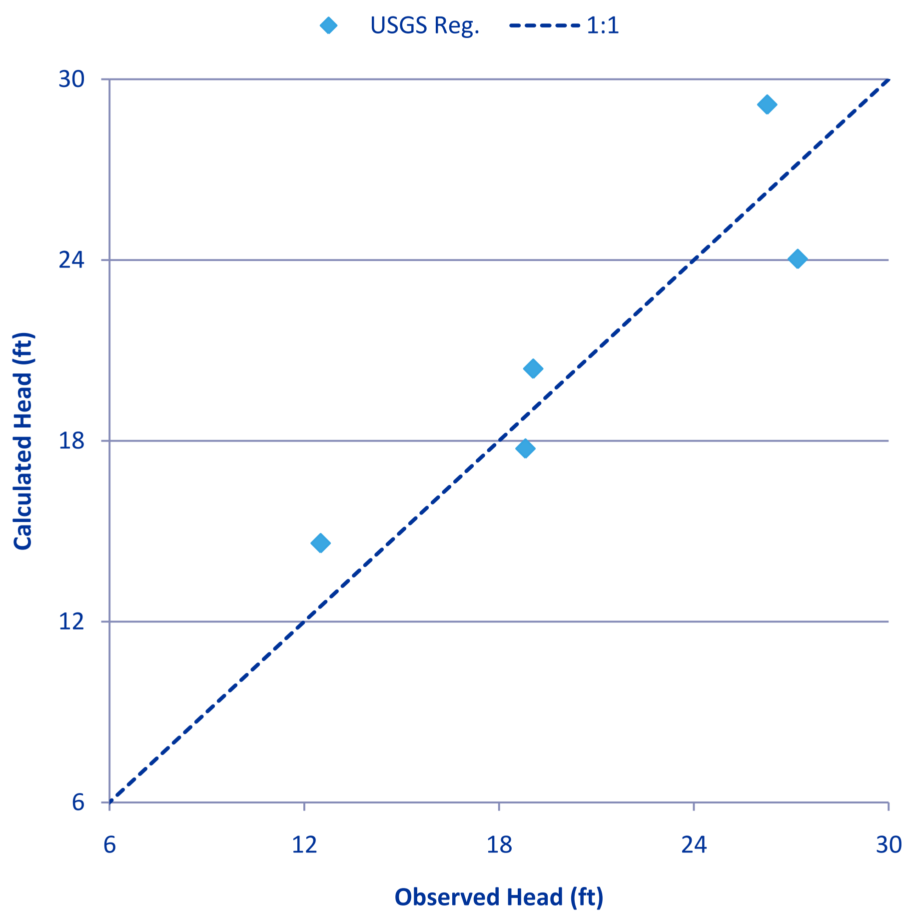
CDM Smith

Figure 3-8
Herring River Modeled Streambed and Stage



X axis shows the number of model cells from the start of the stream.
Length of stream varies within each cell.

Figure 3-9
Model Calibration: USGS Regional Wells



CDM Smith

Table 3-4 Model Calibration for USGS Regional Wells

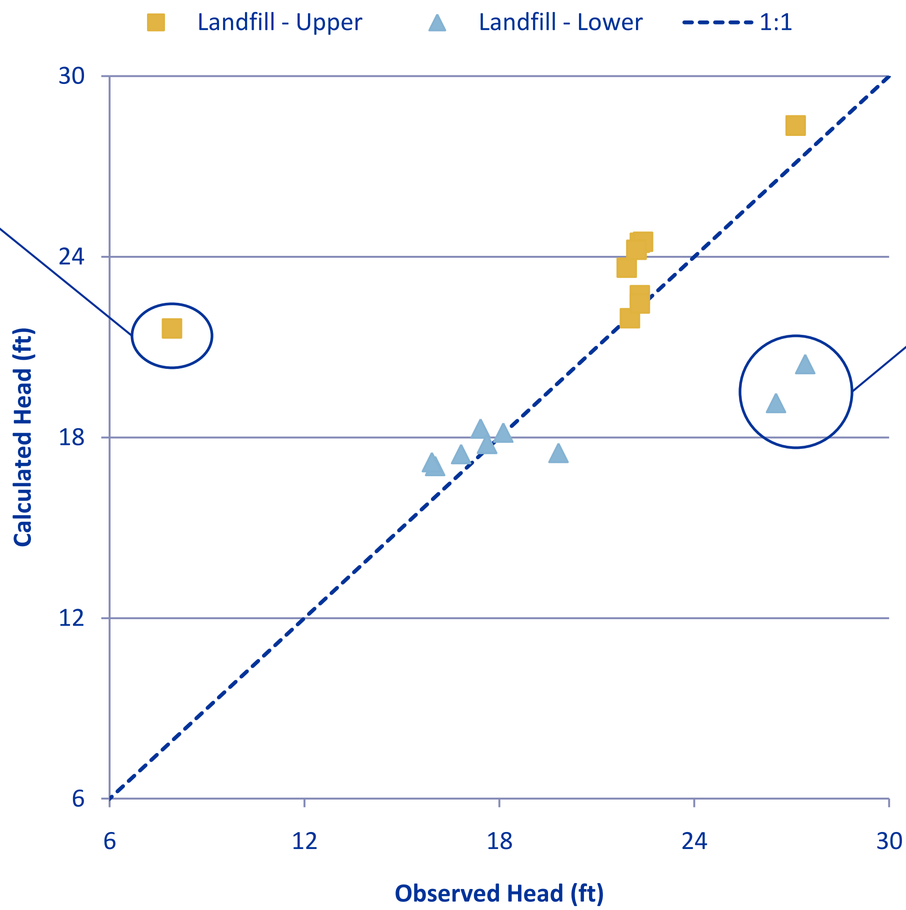
Well	Measured Head (feet)	Modeled Head - CWMP Refined Model (feet)
BMW-21	26.3	29.2
BMW-44	27.2	24.0
CGW-138	12.5	14.6
HJW-141	19.1	20.4
OSW-24	18.8	17.7

3.5.2 Landfill 2003 Average Annual Water Levels

Groundwater elevations at 20 wells were measured twice per year in the spring and fall as part of the Harwich Landfill CSA activities. Measurements from 2003 were averaged to compute an average annual value at each well. Simulated and observed heads are shown in Figure 3-10 and Table 3-5. Each well was identified as being screened in either the upper or lower aquifer unit based on whether it is above or below the observed clay layer. This is important because there is a significant vertical head difference measured between the upper and lower aquifer units, indicative of the low permeability and lateral extensiveness of the clay layer. The model reproduces this vertical head difference nicely throughout the local HR-12 site area, with only 3 monitoring points at which there is a significant mismatch, all three of which may be due to factors that could be explored during future CWMP efforts. The model was not able to replicate observed water levels at one well in the upper aquifer unit (HWH-19) in which the lowest water level was reported, significantly below the lowest head in the lower aquifer unit; thus, measurement error or lack of hydraulic connection is assumed to be the case. Also, the heads measured in two wells in the lower aquifer (HWH-1 and HWH-8D) are significantly higher than simulated in the model; this could be an indication that the wells' screens and/or filter packs may be in hydraulic connection with the upper aquifer unit, or their vertical placement in the simulated stratigraphic sequence may be incorrect. Review of the boring logs suggested a lack of connection to the aquifer for these locations, which could mean that these two wells may be measuring heads within the clay layer that would be higher than the water levels in the lower aquifer unit.

Figure 3-10
Model Calibration: Landfill Wells

Review of the boring logs suggests that this well (HWH-19) may not be connected to the upper aquifer due to heaving sand.



Review of the boring logs suggests that these wells (HWH-1 and HWH-8D) may be connected hydraulically to the upper aquifer.

Table 3-5 Model Calibration for 2003 Landfill CSA Average Annual Water Levels

Well	Aquifer	Measured Head (feet)	Modeled Head (feet)
HWH-1	Lower	27.4 *	20.4
HWH-2 S	Upper	21.9	23.6
HWH-2 M	Upper	22.0	22.0
HWH-2 D	Lower	19.8	17.5
HWH-3 S	Upper	22.2	24.2
HWH-3 M	Upper	22.3	22.4
HWH-3 D	Lower	17.6	17.8
HWH-3 DD	Lower	17.6	17.8
HWH-4 S	Upper	NM	--
HWH-4 D	Lower	16.8	17.4
HWH-8 S	Upper	27.1	28.4
HWH-8 D	Lower	26.5 *	19.1
HWH-11	Lower	16.0	17.0
HWH-14	Lower	15.9	17.2
HWH-17 S	Upper	22.3	24.5
HWH-17 M	Upper	22.3	22.7
HWH-17 D	Lower	18.1	18.2
HWH-18 S	Upper	22.4	24.5
HWH-18 D	Lower	17.4	18.3
HWH-19	Upper	7.9 *	21.6

* Review of the boring log suggests that the well is not connected to the aquifer.
NM – A value was not recorded in the Fall 2003 round, so an annual water level could not be computed.

3.5.3 Recent Surface Water and Groundwater Data

Water levels at surface and groundwater data points were measured in the fall of 2011. This data set was used to refine the local understanding of groundwater flow, assist with model refinement and will support future CWMP work. Measured water levels are shown in Table 3-6.

Table 3-6 CWMP Observed Water Levels – Fall 2011

Location	Observed Water Elevation (feet) Fall 2011
Groundwater	
CDM-3	19.7
CDM-5	20.1
HWH-7D	20.4
Surface Water	
SWM-1	29.3
SWM-2	20.3
SWM-3	18.5
SWM-4	21.7
SWM-5	27.1

Section 4

Recharge Simulations

The refined and calibrated model was used to simulate scenarios for groundwater recharge effluent loading. Basin layout and loading rates were estimated based on supplemental fieldwork, soil types and experience at similar facilities. The predictive simulations provided the basis for estimating potential impacts to stream flow, for facilitating evaluation of surface water quality based on simulated groundwater to surface water discharge locations, and for assessing the lateral extent and magnitude of water table mounding and groundwater flow field modification.

4.1 Basin Layout and Loading Rates

Two simulations were run to assess proposed CWMP scenarios for the three sites shown on Figure 1-1. A third simulation was run after model calibration and conversations with bog owners and is presented in Section 4-3. Simulation 1 is based on the upper end flow loadings for all scenarios for effluent recharge proposed in the CWMP. Simulation 2 is the maximum loading over ten acres at HR-12 while maintaining a four foot separation distance, per MassDEP regulatory guidance. To determine the maximum load, a fixed head was set over the area of the basin. The simulations used the following loading rates and flows:

- Simulation 1
  - HR-12: 800,000 gpd at a loading rate of 3 gpd/ft^2
  - PB-3: 400,000 gpd at a loading rate of 5 gpd/ft^2
  - SH-2: 210,000 gpd at a loading rate of 1 gpd/ft^2
- Simulation 2:
  - HR-12: Maximum loading over 10 acre area which maintains a minimum four foot depth to the top of the groundwater mound.

Figure 4-1 shows the location of proposed basin layout for HR-12 including an approximate area for the wastewater treatment plant. Proposed basin layouts for Simulation 1 (6 acres) and Simulation 2 (10 acres) are shown.

The upper end flow loadings for the CWMP scenarios can be adequately modeled in a single model simulation (Simulation 1) due to the hydrogeologic separation of the sites. The three sites are located in different groundwater contributing areas and HR-12 and SH-2 are additionally separated by Coy Brook which serves as a boundary condition. Recharge at one site will have a minimal impact on flow at the other two sites.

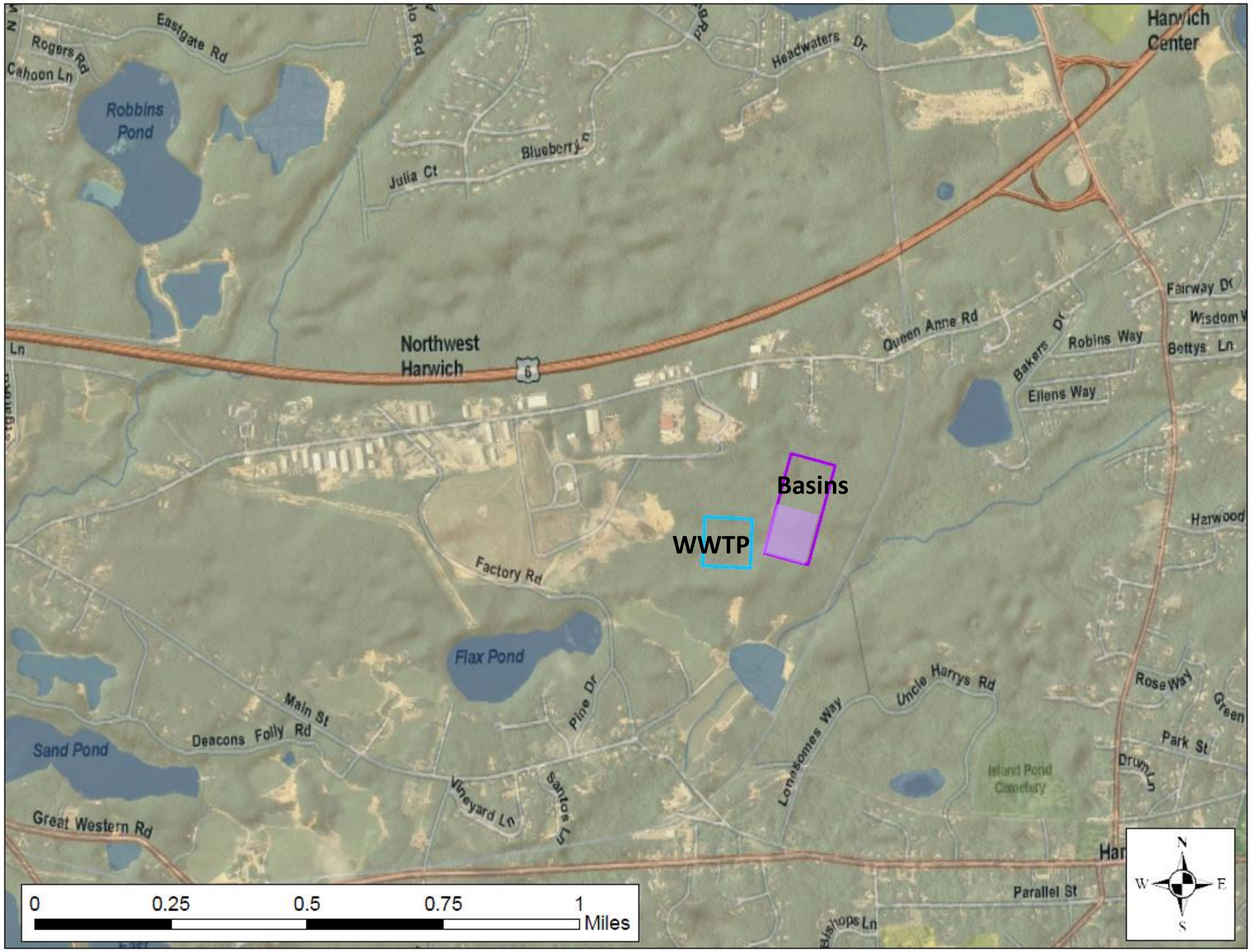
4.2 Simulation Results

The proposed recharge sites can adequately accept the simulated recharge flows while maintaining a four foot separation between the ground surface and the top of the groundwater mound. Results for Simulation 1 and 2 are shown in Table 4-1 including loading rates, estimated basin surface elevation,

Figure 4-1
HR-12 Proposed Basin Area

Purple outline is approximate area for 10 acres of proposed recharge basins

Purple shading is approximate area for 6 acres of proposed recharge basins



WWTP – Approximate area of proposed Wastewater Treatment Plant
Basins – Approximate area of proposed recharge basins

estimated minimum depth to the groundwater mound and estimated stream base flow increases. Because of the fixed head, Simulation 2 assumes that flow will be distributed to maintain the four foot head separation and that some basins will therefore recharge more flow than others. While this simulation approach is able to demonstrate the "optimum" or "maximum" total loading rate by design, the simulated distribution of flow rates from point to point would be operationally different in the field.

Average annual stream flow in Coy Brook near HR-12 is expected to increase by 1 to 1.2 cfs or 59 to 69 % of the average annual model estimated flow. Since streams on Cape Cod are fed primarily by groundwater, flow varies depending on the season. Groundwater flow peaks in early spring with the high water table and decreases during the summer. Effluent recharge flows are expected to be lower in the spring and higher in summer. Thus, the increased flow to Coy Brook would result in enhanced stream flow and would help to maintain a more reliable base flow throughout the year that could be beneficial for the local cranberry bog agricultural operations, especially during drought conditions.

Table 4-1 Simulation Results

Site	Total Recharge (MGD)	Loading Rate (gpd/ft^2)	Basin Area (acres)	Model Sim. Head (ft NGVD29)	Est. Basin Elev. (ft NGVD29)	Est. Depth to GW Mound (ft)	Est. Mound Height (ft)	Est. Stream Inc. (cfs)	% Est. Stream Inc.
Simulation 1 (Upper End of Flow Loading)									
HR-12	0.8	3.0	6.1	36	40	4	10	1	59%
PB-3	0.4	5.0	1.8	34	50	16	3.2		
SH-2	0.21	1.0	4.8	30	46	16	1.9		
Simulation 2 (Maximum Loading)									
HR-12	1.2	2.7	10	36	40	4	10	1.2	69%

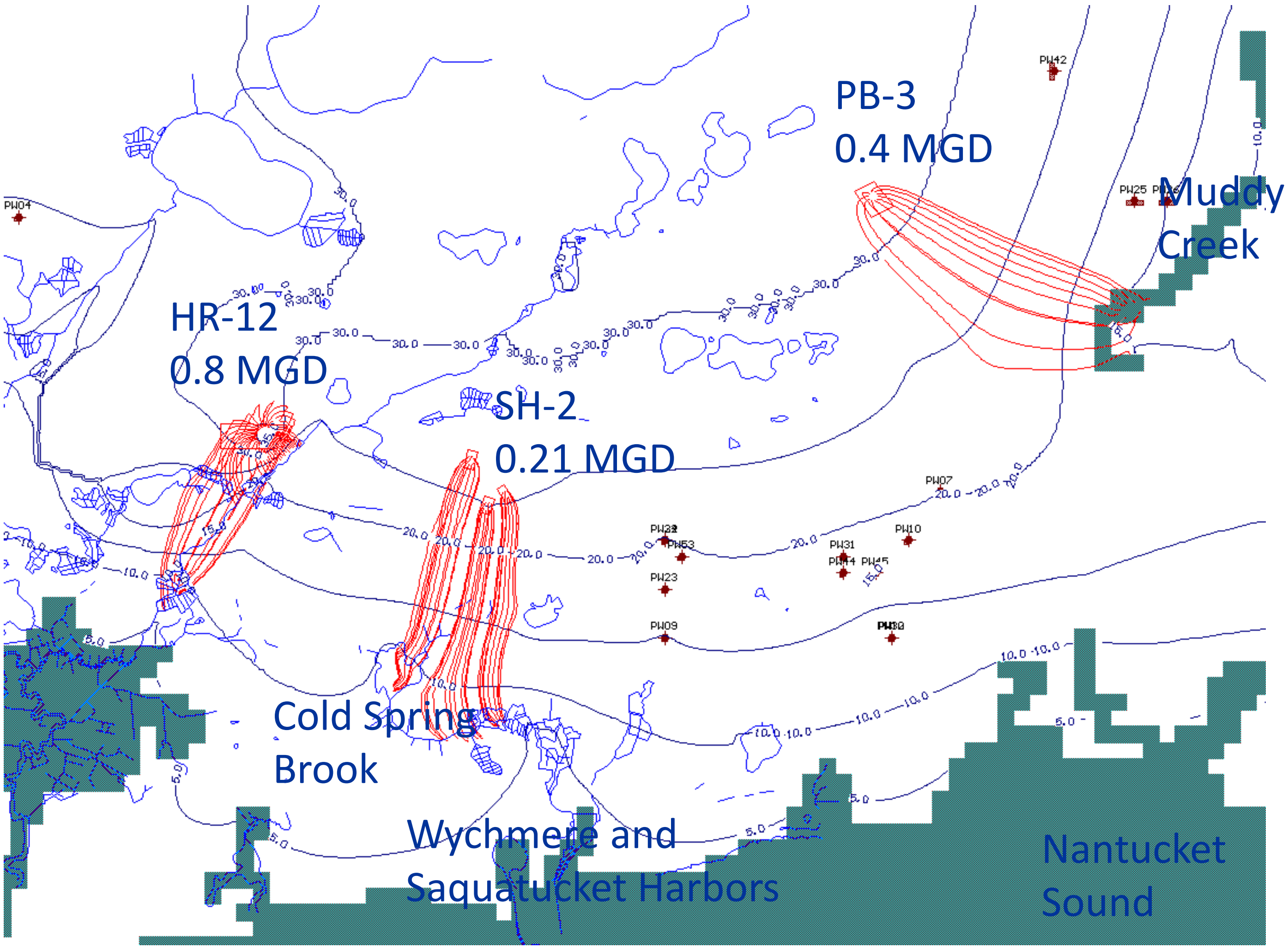
4.2.1 Discharge Locations

Discharge locations were identified by using MODPATH to simulate particle movement within the aquifer. Figure 4-2 shows that recharge at HR-12 is simulated to discharge to Coy Brook and the bogs south of the site. Coy Brook flows into the Herring River. Recharge at SH-2 is simulated to discharge into the Bank Street Bogs and Cold Spring Brook, which empty into the Saquatucket Harbor. Recharge at PB-3 flows into Upper Muddy Creek which empties into Pleasant Bay. These results are based on the average annual steady-state conditions for 2003.

Water recharged at site PB-3 flows near public supply wells 4126000-09G and 4126000-10G (labeled as PW-25 and PW-26 in the groundwater model) before discharging to Upper Muddy Creek. Under the annual steady-state conditions simulated in this model, flows from PB-3 are not in the zone of contribution for either well and travel time to Upper Muddy Creek is greater than 10 years. Higher pumping rates and seasonal recharge fluctuations would bring PB-3 into the zone of contribution for these wells, however the time of travel for water recharged at PB-3 to reach these wells is likely greater than 5 years.

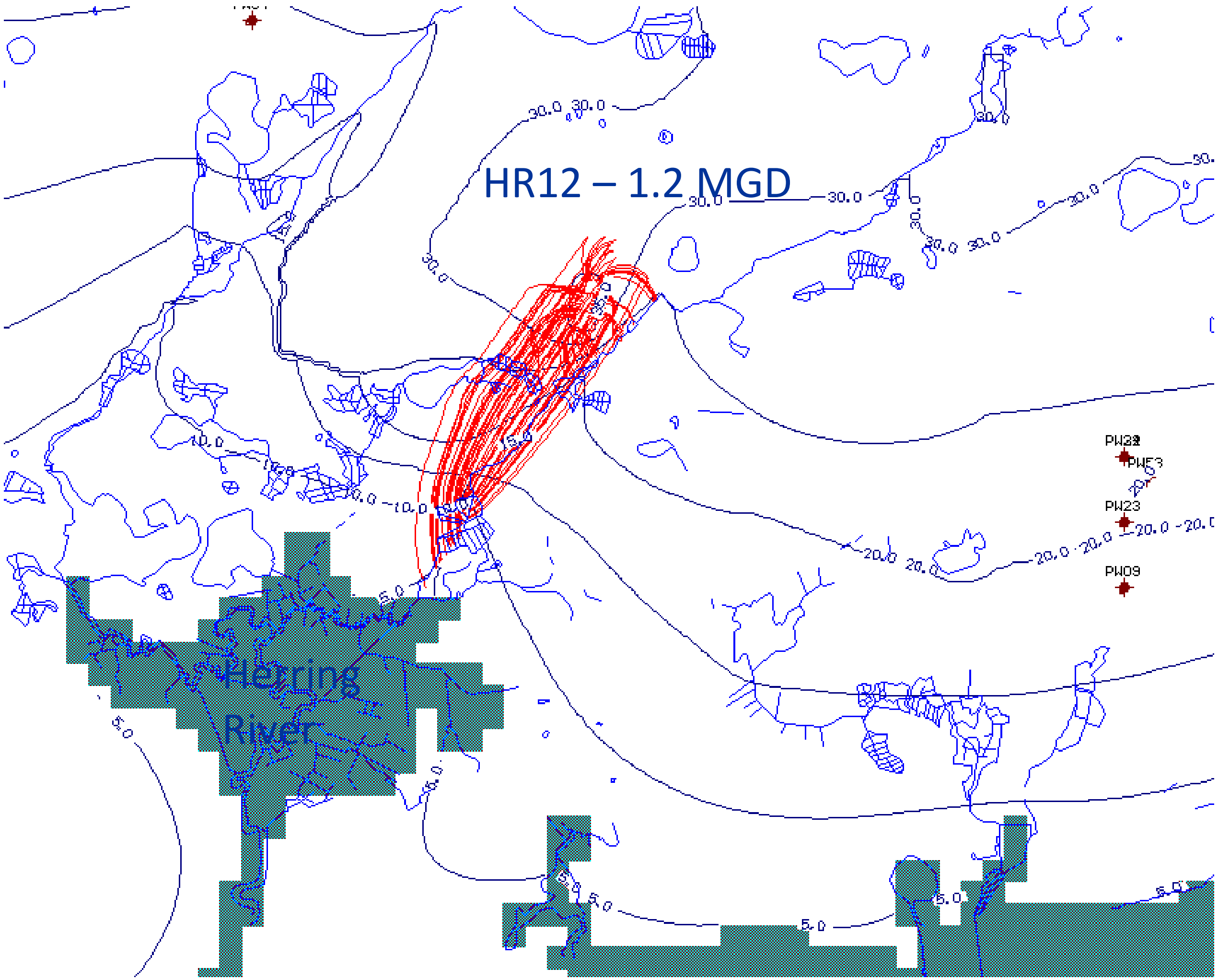
Figure 4-3 shows that recharge at HR-12 is simulated to discharge to Coy Brook and the bogs south of the site. Coy Brook flows into the Herring River. Results are similar to Simulation 1 which has a lower loading rate.

Figure 4-2
Flow Direction: Simulation 1



CDM Smith

Figure 4-3
Flow Direction: Simulation 2



CDM Smith

Groundwater recharge at HR-12 should not have significant impact on the flow direction and discharge of any remaining contaminants from the landfill.

4.2.3 Water Table Mounding

Water table increases due to the proposed recharge are shown in Figure 4-4 and 4-5. The groundwater mound at SH-2 and PB-3 is 1.9 and 3.2 feet respectively. Due to the depth to groundwater, the rise is not expected to impact nearby receptors. Groundwater mounding at Flax Pond was 1.1 feet for Simulation 1 and 1.4 feet for Simulation 2. Mounding will not likely impact any buildings, residences, or water control structures in nearby cranberry bogs.

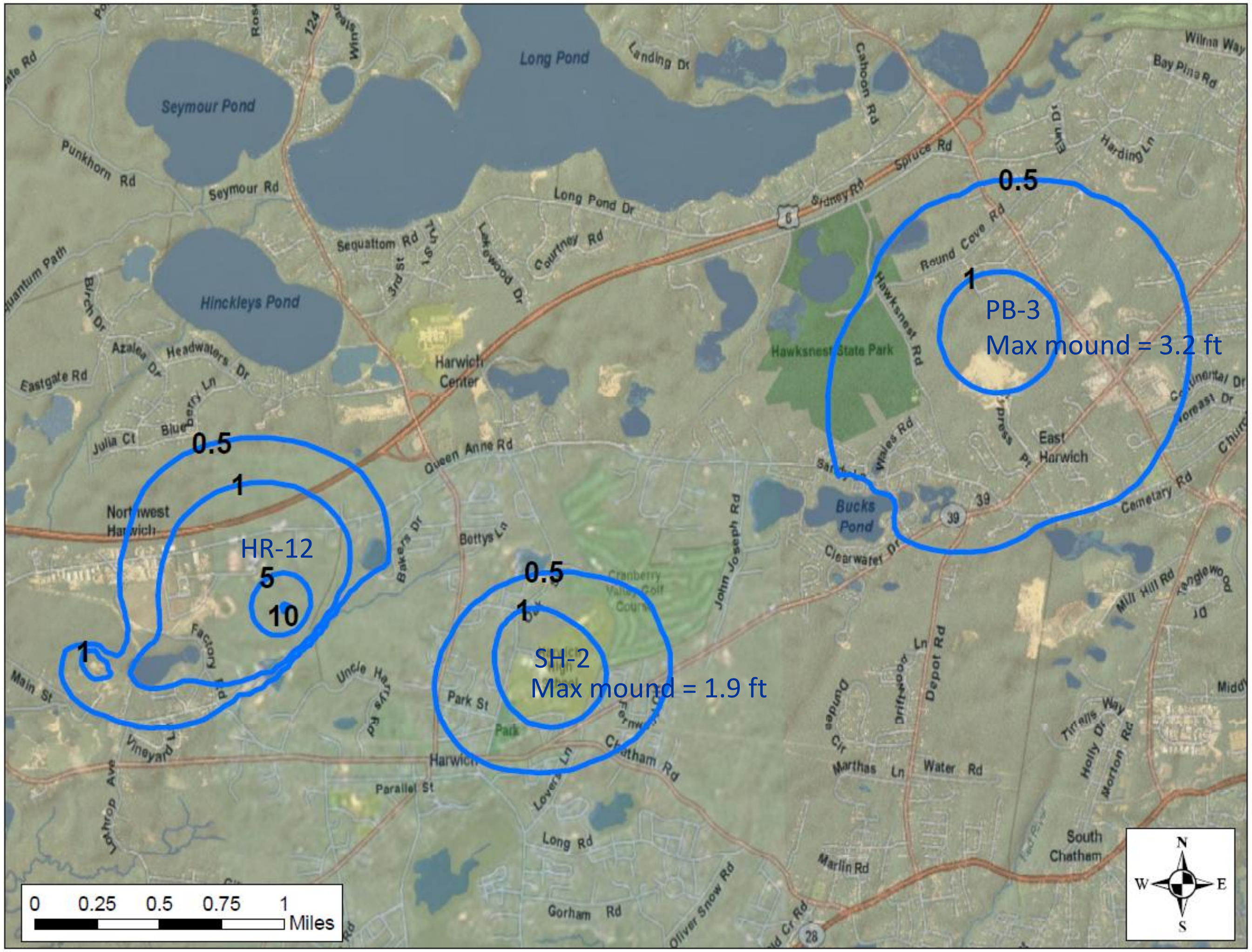
4.3 Revised Simulation of Cranberry Bogs

A site visit on January 27, 2012 and conversations with the cranberry bog operators after completion of Simulations 1 and 2 provided additional information on bog operations which impact water elevations in Flax Pond and Coy Brook near site HR-12. Information from the site visit is provided in Appendix E. The site visit revealed that an outlet and pumping system at the west end of Flax Pond allow the bog owner to control the pond level and limit the rise in the pond. The owner of the bog system along Coy Brook indicated that the water control system there is capable of passing significant flow rates through that bog area, including the capacity to drain off a small pond area that is created when Coy Brook backs up behind the cranberry bog inlet flow structures at the far northern end of the bog property immediately adjacent to HR-12. During the visit, there was a multiple foot difference (at least 4 feet) in stage in Coy Brook above and below the inlet structure. Based on these findings, additional refinements were made in the model including the addition of streams and changes in surface water basin elevations and stages in the cranberry bogs east and west of Flax Pond.

The model was adjusted and model calibration verified prior to running the recharge simulation. Appendix F contains the figures and tables showing the model adjusted stream locations, basin elevations and stream stages, revised clay extent, USGS calibration check, and 2003 water level calibration check.

Loading conditions for Simulation 2 were run on the updated model and the results are referred to as Simulation 3. This simulation models the maximum loading over 10 acres which maintains a minimum four foot depth to the top of the groundwater mound. Results of the simulation show a total recharge of 1.4 MGD, or a loading rate of 3.0 gpd/ft^2. Groundwater rise at Flax Pond was limited to 0.1 feet for Simulation 3, due to the additional drains in the cranberry bogs.

Figure 4-4
Mounding: Simulation 1



CDM Smith

Figure 4-5
Mounding: Simulation 2

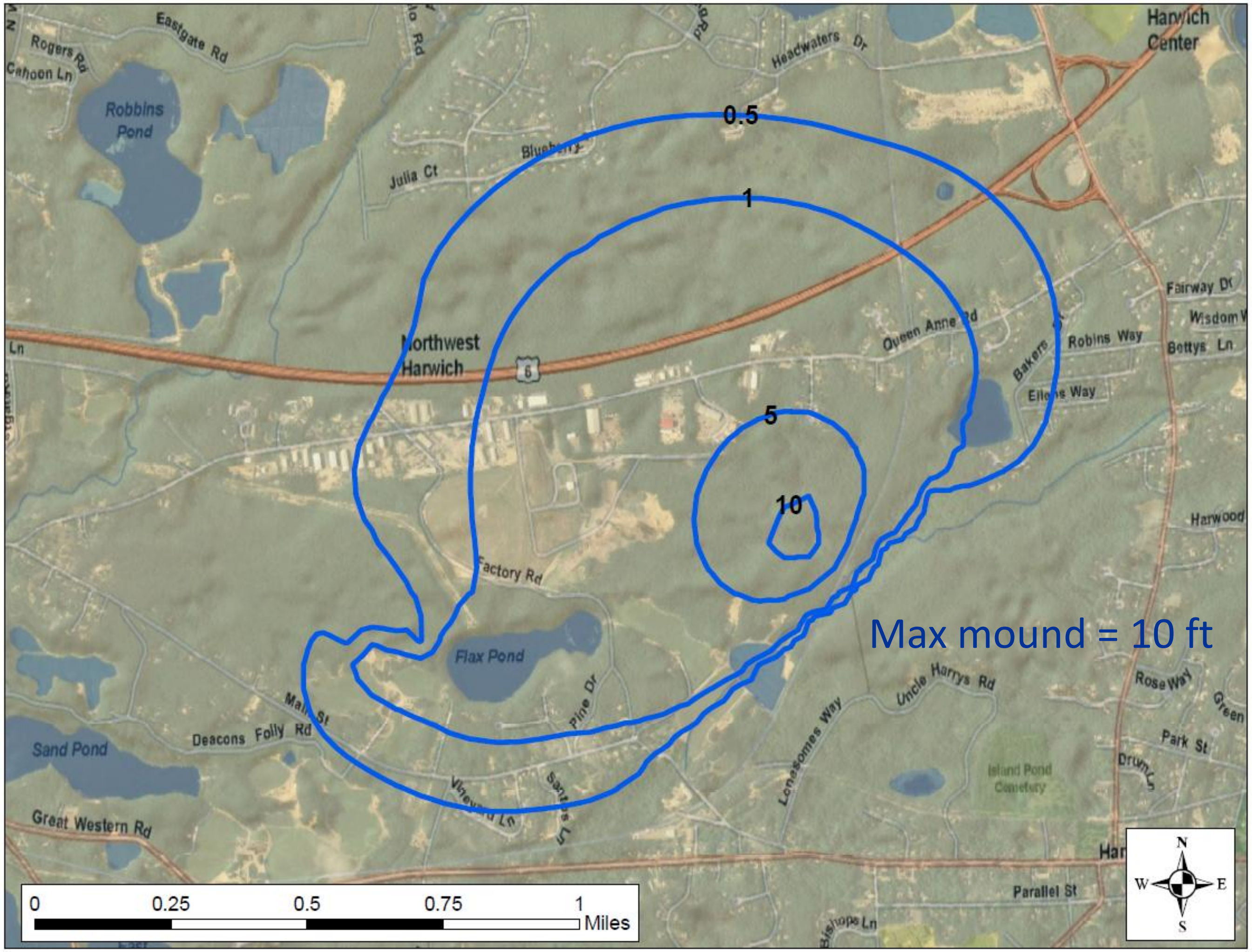
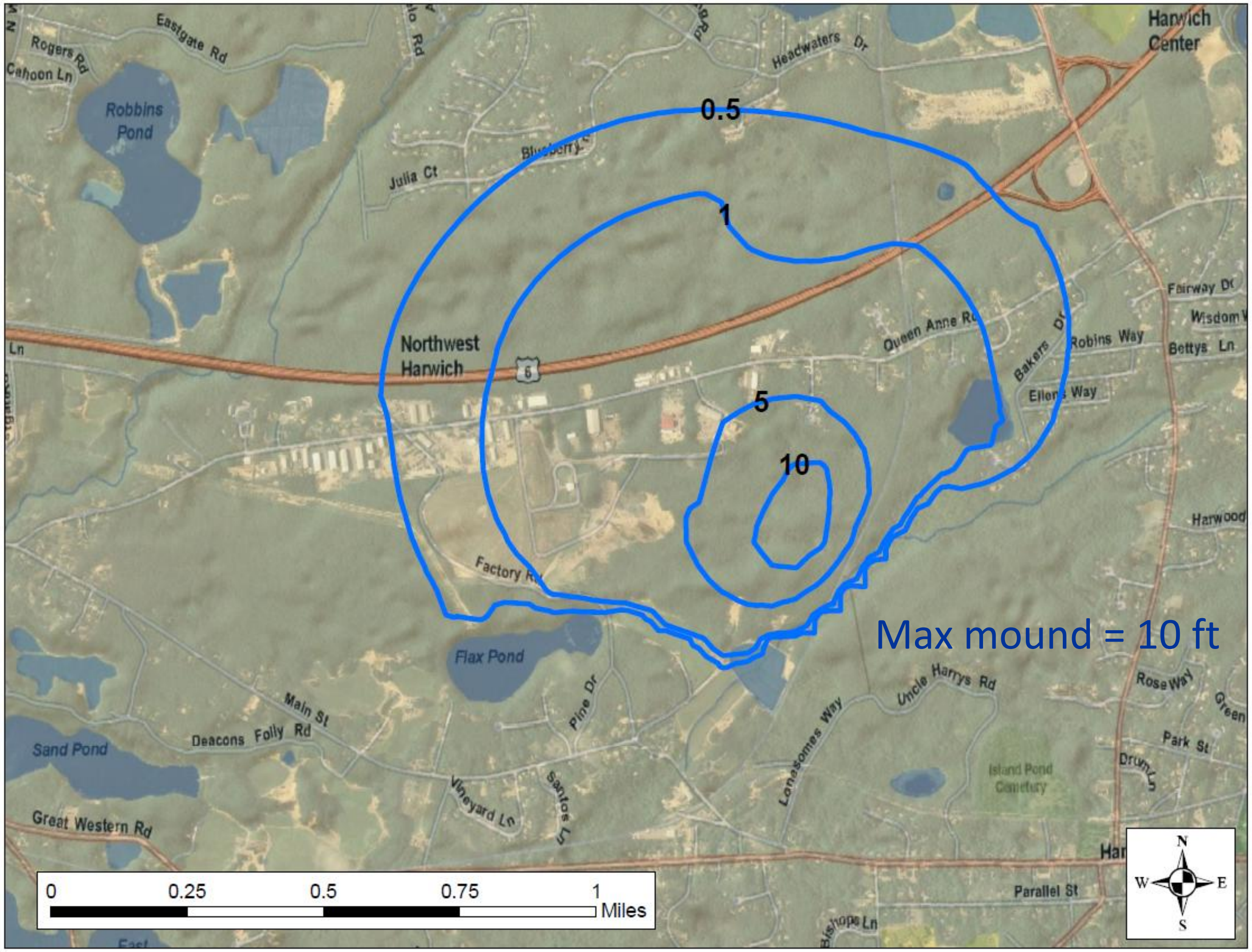


Figure 4-6
Mounding: Simulation 3



CDM Smith

Section 5

Summary and Recommendations

Hydrogeologic data review, field work, model revisions and model calibration were completed as part of the hydrogeologic study. The hydrogeologic data review and field work identified a clay layer at HR-12 which impacts groundwater flow rates and direction. Based on the data review and field work, revisions were made to an existing regional USGS model which had been calibrated for 2003 conditions. Revisions included model grid refinement, addition of a clay layer and addition of surface water features near site HR-12. The revised and recalibrated model was used to assess the flow direction and mounding for recharge flows at three locations based on the CWMP scenarios.

Model simulation results, shown in Table 5-1, indicate that that the selected sites should be able to recharge the proposed CWMP scenario flows in an acceptable manner. Increased flow to Coy Brook near HR-12 would result in enhanced stream flow and would help to maintain a more reliable base flow beneficial for the local cranberry bog agricultural operations, especially during drought conditions.

Table 5-1 Simulation Results Summary

Site	Total Recharge (MGD)	Loading Rate (gpd/ft^2)	Basin Area (acres)	Model Sim. Head (ft NGVD29)	Est. Basin Elev. (ft NGVD29)	Est. Depth to GW Mound (ft)	Est. Mound Height (ft)	Est. Stream Inc. (cfs)	% Est. Stream Inc.
Simulation 1 (Upper End of Flow Loading)									
HR-12	0.8	3.0	6.1	36	40	4	10	1	59%
PB-3	0.4	5.0	1.8	34	50	16	3.2		
SH-2	0.21	1.0	4.8	30	46	16	1.9		
Simulation 2 (Maximum Loading)									
HR-12	1.2	2.7	10	36	40	4	10	1.2	69%
Simulation 3 (Maximum Loading With Revisions near Cranberry Bogs)									
HR-12	1.4	3.0	10	36	40	4	10		

Based on the hydrogeologic findings and the meeting with the MassDEP and CCC, the following items are recommended as part of the implementation phase of the recommended CWMP program.

- Continue monitoring of surface water and groundwater locations to determine seasonal impacts to groundwater, surface water levels and cranberry bogs.
- Develop an adaptive management approach which uses Phase I wastewater effluent flow as a loading test at the selected effluent recharge sites.
- Assess the flow capacity of existing hydraulic structures in Coy Brook, Flax Pond and the downstream cranberry bogs near HR-12 during the design phase to identify and mitigate the potential for blockages or limitations in flow. This analysis should include the culvert which carries Coy Brook under Great Western Road as it has been reported to have problems carrying existing flows at high groundwater periods

Section 6

References

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Hydrogeological Report

Appendix A

CAMP DRESSER & McKEE

CDM

Boring Number: CDM-1

Client: Town of Harwich
Project Location: Harwich, Massachusetts
Project Name: Hydrogeology Evaluation
Project Number: 0324-60650

Drilling Contractor/Driller: New Hampshire Boring, Inc. / Todd Penticost
Drilling Method/Casing/Core Barrel Size: Drive and Wash / 4-in/
Hammer Weight/Drop Height/ Spoon Size: 140-lbs lb / 30-in in /2-in
Bore Hole Location: See Boring Location Plan
N: E:
Drilling Date: Start: 8/2/2011 **End:** 8/2/2011

Surface Elevation (ft.):
Total Depth (ft.): 76
Depth to Initial Water Level (ft):

Depth	Date	Time
18.8	8/2/2011	12:00 P.M.

Abandonment Method: Fill with Cuttings
Logged By: J. Morency

Elev. Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Blows per 6 inches	Sample Recovery (in)	Split Spoon Size (O.D.)	Graphic Log	Strata	Material Description	Remarks
0	SS	S-1	24	2 2 3 5	10			Sand	Dry, loose, brown-orange, fine SAND, some silt, trace fine gravel	
	SS	S-2	24	5 4 5 8	6				Dry, loose, brown-orange, fine SAND, some silt, trace fine gravel	
5	SS	S-3	24	4 3 3 4	13				Dry, loose, brown-orange, fine to medium SAND, trace silt	
	SS	S-4	24	6 4 5 5	15				Dry, loose, light brown, fine to medium SAND, trace silt	
	SS	S-5	24	8 6 5 4	7				Dry, medium dense, light brown, fine to coarse SAND, trace silt	
10	SS	S-6	24	5 5 6 6	11				Dry, medium dense, light brown, fine to coarse SAND, trace silt	
	SS	S-7	24	5 5 6 6	18				Dry, medium dense, light brown, fine to medium SAND, trace silt	
15	SS	S-8	24	10 9 9 10	6				Dry, medium dense, light brown, fine to coarse SAND, trace fine gravel, trace silt	
	SS	S-9	24	10 10 9 10	17				Moist, medium dense, light brown, fine to medium SAND, trace silt	
▼										
	SS	S-10	24	4 5	14				A: Wet, medium dense, brown-orange, fine to coarse SAND, little silt	A: (0"-10")

Sample Types

AS - Auger/Grab Sample	HP - Hydro Punch
CS - California Sampler	SS - Split Spoon
BQ - 1.5" Rock Core	ST - Shelby Tube
NQ - 2" Rock Core	WS - Wash Sample
	GP - Geoprobe

Consistency vs Blowcount/Foot

Granular (Sand):

V. Loose:	0-4	Dense:	30-50
Loose:	4-10	V. Dense:	>50
M. Dense:	10-30		

Fine Grained (Clay):

V. Soft:	<2	Stiff:	8-15
Soft:	2-4	V. Stiff:	15-30
M. Stiff:	4-8	Hard:	>30

Burmister Classification

and	35-50%
some	20-35%
little	10-20%
trace	<10%

moisture, density, color

Reviewed by: **Date:** **Boring Number: CDM-1**

CAMP DRESSER & McKEE

CDM

Boring Number: CDM-1

Client: Town of Harwich
Project Location: Harwich, Massachusetts
Project Name: Hydrogeology Evaluation
Project Number: 0324-60650

Elev. Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Blows per 6 inches	Sample Recovery (in)	Split Spoon Size (O.D.)	Graphic Log	Strata	Material Description	Remarks
20	SS	S-10	24	6 5	14			Clay	B: Wet, medium stiff, light brown, silty CLAY, trace fine sand	B: (10" - 14")
25	SS	S-11	24	5 7 7 9	24				Wet, stiff, gray, clayey SILT, trace fine sand	
30	SS	S-12	24	4 6 8 8	22				Wet, stiff, gray, SILT and CLAY	
35	SS	S-13	24	5 6 8 9	24				Wet, stiff, gray, CLAY	
40	SS	S-14	24	7 6 8 7	16				Wet, stiff, gray, CLAY, trace fine sand	
45	SS	S-15	24	5 5 11 10	19				Wet, very stiff, gray, CLAY, trace fine sand	

CAMP DRESSER & McKEE

CDM

Boring Number: CDM-1

Client: Town of Harwich
Project Location: Harwich, Massachusetts
Project Name: Hydrogeology Evaluation
Project Number: 0324-60650

Elev. Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Blows per 6 inches	Sample Recovery (in)	Split Spoon Size (O.D.)	Graphic Log	Strata	Material Description	Remarks
50	SS	S-16	24	6 7 11 15	24			Clay	A: Wet, very stiff, gray CLAY, trace fine sand B: Wet, very stiff, brown, CLAY	A: (0"-12") B: (12" - 24")
55	SS	S-17	24	5 9 30 28	24			Clay / Sand	A: Wet, hard, brown, CLAY B: Wet, very dense, brown with orange staining, fine to medium SAND, some silt	A: (0"-12") B: (12" - 24")
60	SS	S-18	24	13 18 22 20	20			Sand	Wet, dense, light brown, fine to medium SAND, little silt	
65	SS	S-19	24	13 7 13 9	13			Sand	Wet, medium dense, light brown, fine to medium SAND, trace silt	
70	SS	S-20	24	30 29 24 28	17			Sand	Wet, very dense, light brown, fine SAND, some silt	

CAMP DRESSER & McKEE

CDM

Boring Number: CDM-1

Client: Town of Harwich
Project Location: Harwich, Massachusetts
Project Name: Hydrogeology Evaluation
Project Number: 0324-60650

Elev. Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Blows per 6 inches	Sample Recovery (in)	Split Spoon Size (O.D.)	Graphic Log	Strata	Material Description	Remarks
75	SS	S-21	24	28 32 30 27	10			Sand	Wet, very dense, light brown, fine SAND, some silt	
									END OF BORING = 76'	
80										
85										
90										
95										
100										

CAMP DRESSER & McKEE

CDM

Boring Number: CDM-2

Client: Town of Harwich
Project Location: Harwich, Massachusetts
Project Name: Hydrogeology Evaluation
Project Number: 0324-60650

Drilling Contractor/Driller: New Hampshire Boring, Inc. / Todd Penticost
Drilling Method/Casing/Core Barrel Size: Drive and Wash / 4-in/
Hammer Weight/Drop Height/ Spoon Size: 140-lbs lb / 30-in in /2-in
Bore Hole Location: See Boring Location Plan

N: E:

Drilling Date: Start: 8/3/2011 **End:** 8/4/2011

Surface Elevation (ft.):
Total Depth (ft.): 86
Depth to Initial Water Level (ft):

Depth	Date	Time
20.0	8/4/2011	11:00 P.M.

Abandonment Method: Fill with Cuttings
Logged By: J. Morency

Elev. Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Blows per 6 inches	Sample Recovery (in)	Split Spoon Size (O.D.)	Graphic Log	Strata	Material Description	Remarks
0	SS	S-1	24	2 2 3 4	3				Dry, loose, brown, fine to coarse SAND, little silt	
	SS	S-2	24	2 5 5 4	10				Dry, medium dense, brown-orange, fine to coarse SAND, trace silt, trace fine gravel	
5	SS	S-3	24	3 4 4 6	12				Dry, loose, brown-orange, fine to coarse SAND, trace silt, trace fine gravel	
	SS	S-4	24	5 5 5 7	10				Dry, medium dense, brown-orange, fine to coarse SAND, trace silt, trace fine gravel	
	SS	S-5	24	10 12 13 28	13				Dry, medium dense, brown-orange, fine to coarse SAND, trace silt, trace fine gravel	
10	SS	S-6	24	7 7 8 10	15				Dry, medium dense, brown-orange, fine to medium SAND, trace silt	
	SS	S-7	24	8 7 10 12	12				Dry, medium dense, light brown, fine to medium SAND, trace silt	
15	SS	S-8	24	9 10 11 27	8				Dry, medium dense, orange-brown, fine to coarse SAND, trace fine gravel, trace silt	
	SS	S-9	24	13 11 14 13	8				Dry, medium dense, orange-brown, fine to medium SAND, trace silt	
▼	SS	S-10	24	19 23 22 19	14				Moist, dense, light brown, fine to coarse SAND, trace fine gravel, trace silt	

Sample Types

AS - Auger/Grab Sample
CS - California Sampler
BQ - 1.5" Rock Core
NQ - 2" Rock Core
HP - Hydro Punch
SS - Split Spoon
ST - Shelby Tube
WS - Wash Sample
GP - Geoprobe

Consistency vs Blowcount/Foot

Granular (Sand):

V. Loose:	0-4	Dense:	30-50
Loose:	4-10	V. Dense:	>50
M. Dense:	10-30		

Fine Grained (Clay):

V. Soft:	<2	Stiff:	8-15
Soft:	2-4	V. Stiff:	15-30
M. Stiff:	4-8	Hard:	>30

Burmister Classification

and	35-50%
some	20-35%
little	10-20%
trace	<10%

moisture, density, color

Reviewed by: **Date:** **Boring Number: CDM-2**

CAMP DRESSER & McKEE

CDM

Boring Number: CDM-2

Client: Town of Harwich
Project Location: Harwich, Massachusetts
Project Name: Hydrogeology Evaluation
Project Number: 0324-60650

Elev. Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Blows per 6 inches	Sample Recovery (in)	Split Spoon Size (O.D.)	Graphic Log	Strata	Material Description	Remarks
20										
25	SS	S-11	24	5 5 7 9	17				Wet, medium dense, light brown, fine SAND, little silt	
30	SS	S-12	24	9 7 12 12	19				Wet, medium dense, light brown, fine SAND, little silt	
35	SS	S-13	24	11 14 17 20	13				Wet, dense, light brown, fine to medium SAND, trace silt	
40	SS	S-14	24	16 13 21 14	9				Wet, dense, light brown, fine to medium SAND, trace silt	
45	SS	S-15	24	6 5 7 11	24				Wet, stiff, gray, CLAY	

CAMP DRESSER & McKEE

CDM

Boring Number: CDM-2

Client: Town of Harwich
Project Location: Harwich, Massachusetts
Project Name: Hydrogeology Evaluation
Project Number: 0324-60650

Elev. Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Blows per 6 inches	Sample Recovery (in)	Split Spoon Size (O.D.)	Graphic Log	Strata	Material Description	Remarks
50	SS	S-16	24	8 5 9 9	16				Wet, stiff, gray, silty CLAY	
55										
	SS	S-17	24	6 8 12 17	11				Wet, medium dense, light gray, fine to coarse SAND, trace silt	
60	SS	S-18	24	11 22 23 13	15				Wet, dense, light gray, fine to coarse SAND, trace silt	
65	SS	S-19	24	9 4 3 4	24				Wet, medium stiff, gray CLAY	
70	SS	S-20	24	13 15 18 17	17				A: Wet, dense, gray, fine SAND, some silt B: Wet, dense, light brown, fine SAND, little silt	A: (0"-6") B: (6" - 17")

CAMP DRESSER & McKEE

CDM

Boring Number: CDM-2

Client: Town of Harwich
Project Location: Harwich, Massachusetts
Project Name: Hydrogeology Evaluation
Project Number: 0324-60650

Elev. Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Blows per 6 inches	Sample Recovery (in)	Split Spoon Size (O.D.)	Graphic Log	Strata	Material Description	Remarks
75	SS	S-21	24	13 13 20 16	18				Wet, dense, light brown, fine SAND, little silt	
80	SS	S-22	24	17 20 21 18	13				Wet, dense, light brown, fine SAND, little silt	
85	SS	S-23	24	13 12 19 16	16				Wet, dense, light brown, fine SAND, some silt	
									END OF BORING = 86.0'	
90										
95										
100										

BL HARWICH BORING LOGS.GPJ - 8/24/11

CAMP DRESSER & McKEE

CDM

Boring Number: CDM-3

Client: Town of Harwich

Project Location: Harwich, Massachusetts

Project Name: Hydrogeology Evaluation

Project Number: 0324-60650

Drilling Contractor/Driller: New Hampshire Boring, Inc. / Todd Penticost

Drilling Method/Casing/Core Barrel Size: Drive and Wash / 4-in/

Hammer Weight/Drop Height/ Spoon Size: 140-lbs lb / 30-in in /2-in

Bore Hole Location: See Boring Location Plan

N: E:

Drilling Date: Start: 8/4/2011 **End:** 8/5/2011

Surface Elevation (ft.):

Total Depth (ft.): 61

Depth to Initial Water Level (ft):

Depth	Date	Time
21.6	8/5/2011	2:00 P.M.

Abandonment Method: Monitoring Well

Logged By: J. Morency

Elev. Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Blows per 6 inches	Sample Recovery (in)	Split Spoon Size (O.D.)	Graphic Log	Strata	Material Description	Remarks
0	SS	S-1	24	2 3 3 8	16				Dry, loose, dark brown, fine SAND, some silt, trace gravel	
	SS	S-2	24	3 4 3 4	15				Dry, loose, brown-orange, fine to coarse SAND, some silt, trace fine gravel	
5	SS	S-3	24	4 4 6 8	13				Dry, loose, brown-orange, fine to medium SAND, trace silt	
	SS	S-4	24	8 6 10 12	24				Dry, medium dense, brown-orange, fine to coarse SAND, trace silt	
	SS	S-5	24	10 12 13 17	11				Dry, medium dense, brown-orange, fine to coarse SAND, trace silt	
10	SS	S-6	24	16 14 15 20	14				Dry, medium dense, brown-orange, fine to coarse SAND, trace silt	
	SS	S-7	24	9 9 12 5	18				Dry, medium dense, brown-orange, fine to medium SAND, trace silt	
15	SS	S-8	24	14 16 20 23	20				Dry, dense, brown-orange, fine to coarse SAND, trace silt	
	SS	S-9	24	10 12 13 10	23				Dry, medium dense, light brown, fine to medium SAND, trace silt	
	SS	S-10	24	12 15 13 13	15				Dry, medium dense, light brown, fine to coarse SAND, trace silt	

Sample Types

AS - Auger/Grab Sample
CS - California Sampler
BQ - 1.5" Rock Core
NQ - 2" Rock Core
HP - Hydro Punch
SS - Split Spoon
ST - Shelby Tube
WS - Wash Sample
GP - Geoprobe

Consistency vs Blowcount/Foot

Granular (Sand):

V. Loose:	0-4	Dense:	30-50
Loose:	4-10	V. Dense:	>50
M. Dense:	10-30		

Fine Grained (Clay):

V. Soft:	<2	Stiff:	8-15
Soft:	2-4	V. Stiff:	15-30
M. Stiff:	4-8	Hard:	>30

Burmister Classification

and	35-50%
some	20-35%
little	10-20%
trace	<10%

moisture, density, color

Reviewed by: **Date:** **Boring Number: CDM-3**

Boring Number: CDM-3

Client: Town of Harwich
Project Location: Harwich, Massachusetts
Project Name: Hydrogeology Evaluation
Project Number: 0324-60650

Elev. Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Blows per 6 inches	Sample Recovery (in)	Split Spoon Size (O.D.)	Graphic Log	Strata	Material Description	Remarks
20										
▼										
25	SS	S-11	24	6 6 7 7	11				Wet, medium dense, light brown, fine to coarse SAND, trace fine gravel, trace silt	
30	SS	S-12	24	7 9 10 11	12				Wet, medium dense, light brown, fine to coarse SAND, trace fine gravel, trace silt	
35	SS	S-13	24	5 5 7 7	19				Wet, medium dense, light brown, fine SAND, some silt	
40	SS	S-14	24	11 7 7 7	9				Wet, medium dense, light brown, fine to coarse SAND, little fine to coarse gravel, little silt	
45	SS	S-15	24	8 15 21 12	13				Wet, dense, brown-orange, fine to coarse SAND, some fine to coarse gravel, little silt	

CAMP DRESSER & McKEE

CDM

Boring Number: CDM-3

Client: Town of Harwich

Project Location: Harwich, Massachusetts

Project Name: Hydrogeology Evaluation

Project Number: 0324-60650

Elev. Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Blows per 6 inches	Sample Recovery (in)	Split Spoon Size (O.D.)	Graphic Log	Strata	Material Description	Remarks
50	SS	S-16	24	9 13 15 14	14				A: Wet, very stiff, gray, CLAY and SILT, little fine sand B: Wet, medium dense, brown-orange, fine to coarse SAND and SILT	A: (0"-8") B: (8"-14")
55										
	SS	S-17	24	9 13 21 18	7				Wet, dense, light brown, fine to coarse SAND, some fine gravel, trace silt	
60	SS	S-18	24	16 14 21 20	10				Wet, dense, light brown, fine to coarse SAND, little silt	
									END OF BORING = 61.0'	
65										
70										

CAMP DRESSER & McKEE

CDM

Boring Number: CDM-4

Client: Town of Harwich
Project Location: Harwich, Massachusetts
Project Name: Hydrogeology Evaluation
Project Number: 0324-60650

Drilling Contractor/Driller: New Hampshire Boring, Inc. / Todd Penticost
Drilling Method/Casing/Core Barrel Size: Drive and Wash / 4-in/
Hammer Weight/Drop Height/ Spoon Size: 140-lbs lb / 30-in in /2-in
Bore Hole Location: See Boring Location Plan

N: E:

Drilling Date: Start: 8/8/2011 **End:** 8/8/2011

Surface Elevation (ft.):
Total Depth (ft.): 10
Depth to Initial Water Level (ft):

Depth	Date	Time
	NOT DETECTED	

Abandonment Method: Fill with Cuttings
Logged By: J. Morency

Elev. Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Blows per 6 inches	Sample Recovery (in)	Split Spoon Size (O.D.)	Graphic Log	Strata	Material Description	Remarks
0	SS	S-1	24	1 2 1 2	15				Dry, very loose, brown-orange, fine SAND, some silt, trace fine gravel	
	SS	S-2	24	4 4 6 5	10				Dry, medium dense, brown-orange, fine to coarse SAND, trace fine gravel, trace silt	
5	SS	S-3	24	8 8 9 10	14				Dry, medium dense, brown-orange, fine to coarse SAND, trace fine gravel, trace silt	
	SS	S-4	24	12 10 11 12	16				Dry, medium dense, brown, fine to coarse SAND, trace fine gravel, trace silt	
	SS	S-5	24	9 10 11 13	9				Dry, medium dense, light brown, fine to coarse SAND, little silt, trace fine gravel	
10									END OF BORING = 10.0'	
15										

Sample Types		Consistency vs Blowcount/Foot: Granular (Sand):	Fine Grained (Clay):	Burmister Classification
AS - Auger/Grab Sample CS - California Sampler BQ - 1.5" Rock Core NQ - 2" Rock Core	HP - Hydro Punch SS - Split Spoon ST - Shelby Tube WS - Wash Sample GP - Geoprobe	V. Loose: 0-4 Loose: 4-10 M. Dense: 10-30 Dense: 30-50 V. Dense: >50	V. Soft: <2 Soft: 2-4 M. Stiff: 4-8 Stiff: 8-15 V. Stiff: 15-30 Hard: >30	and 35-50% some 20-35% little 10-20% trace <10% moisture, density, color

Reviewed by: **Date:** **Boring Number: CDM-4**

CAMP DRESSER & McKEE

Boring Number: CDM-5

Client: Town of Harwich
Project Location: Harwich, Massachusetts
Project Name: Hydrogeology Evaluation
Project Number: 0324-60650

Drilling Contractor/Driller: New Hampshire Boring, Inc. / Jason Stokes
Drilling Method/Casing/Core Barrel Size: Drive and Wash / 4-in/
Hammer Weight/Drop Height/ Spoon Size: 140-lbs lb / 30-in in /2-in
Bore Hole Location: See Boring Location Plan

N: E:

Drilling Date: Start: 8/9/2011 **End:** 8/9/2011

Surface Elevation (ft.):
Total Depth (ft.): 61
Depth to Initial Water Level (ft):

Depth	Date	Time
12.0	8/9/2011	7:00 A.M.

Abandonment Method: Monitoring Well
Logged By: J. Morency

Elev. Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Blows per 6 inches	Sample Recovery (in)	Split Spoon Size (O.D.)	Graphic Log	Strata	Material Description	Remarks
0	SS	S-1	24	1 2 2 3	7				Dry, loose, brown-orange, fine to medium SAND, little silt, trace fine gravel	
	SS	S-2	24	7 6 8 9	15				Dry, medium dense, light brown, fine to coarse SAND, trace fine gravel, trace silt	
5	SS	S-3	24	8 9 10 11	9				Dry, medium dense, light brown, fine to coarse SAND, trace fine gravel, trace silt	
	SS	S-4	24	6 9 8 9	13				Dry, medium dense, brown-orange, fine to coarse SAND, trace fine gravel, trace silt	
	SS	S-5	24	6 9 9 10	17				Dry, medium dense, light brown, fine to coarse SAND, little fine to coarse gravel, trace silt	
10	SS	S-6	24	7 7 8 12	16				Moist, medium dense, light brown, fine to coarse SAND, trace fine gravel	
▼	SS	S-7	24	6 8 8 11	13				Wet, medium dense, light brown, fine to coarse SAND, trace fine gravel	
15	SS	S-8	24	12 12 15 14	15				Wet, medium dense, brown-orange, fine to coarse SAND, trace fine gravel, trace silt	
	SS	S-9	24	9 13 15 19	17				Wet, medium dense, brown-orange, fine to coarse SAND, trace fine gravel, trace silt	
	SS	S-10	24	8 9 13 16	7				Wet, medium dense, light brown, fine to medium SAND, little silt, trace fine gravel	

Sample Types

AS - Auger/Grab Sample
CS - California Sampler
BQ - 1.5" Rock Core
NQ - 2" Rock Core
HP - Hydro Punch
SS - Split Spoon
ST - Shelby Tube
WS - Wash Sample
GP - Geoprobe

Consistency vs Blowcount/Foot

Granular (Sand):

V. Loose:	0-4	Dense:	30-50
Loose:	4-10	V. Dense:	>50
M. Dense:	10-30		

Fine Grained (Clay):

V. Soft:	<2	Stiff:	8-15
Soft:	2-4	V. Stiff:	15-30
M. Stiff:	4-8	Hard:	>30

Burmister Classification

and	35-50%
some	20-35%
little	10-20%
trace	<10%

moisture, density, color

Reviewed by: **Date:** **Boring Number: CDM-5**

CAMP DRESSER & McKEE

CDM

Boring Number: CDM-5

Client: Town of Harwich
Project Location: Harwich, Massachusetts
Project Name: Hydrogeology Evaluation
Project Number: 0324-60650

Elev. Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Blows per 6 inches	Sample Recovery (in)	Split Spoon Size (O.D.)	Graphic Log	Strata	Material Description	Remarks
20	SS	S-11	24	10 15 15 19	15				Wet, dense, light brown, fine to medium SAND, little silt, trace fine gravel	
	SS	S-12	24	12 13 17 21	14				Wet, dense, light brown, fine to medium SAND, little silt, trace fine gravel	
25	SS	S-13	24	7 10 15 16	20				A: Wet, medium dense, light brown, fine to medium SAND, little silt, trace fine gravel	A: (0"-15")
									B: Wet, medium dense, brown-orange, fine to coarse SAND and CLAY	B: (15"- 20")
30	SS	S-14	24	13 20 31 22	15				Wet, very dense, light brown, fine SAND, little silt	
35	SS	S-15	24	10 26 34 49	8				Wet, very dense, light brown, fine SAND, little silt	
40	SS	S-16	24	9 13 25 19	10				Wet, dense, light brown, fine to coarse SAND, little silt	
45	SS	S-17	24	12 21 16 21	15				Wet, dense, light brown, fine to medium SAND, trace silt	

CAMP DRESSER & McKEE

CDM

Boring Number: CDM-5

Client: Town of Harwich
Project Location: Harwich, Massachusetts
Project Name: Hydrogeology Evaluation
Project Number: 0324-60650

Elev. Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Blows per 6 inches	Sample Recovery (in)	Split Spoon Size (O.D.)	Graphic Log	Strata	Material Description	Remarks
50	SS	S-18	24	13 21 19 22	24				Wet, dense, light brown, fine to medium SAND, trace silt	
55	SS	S-19	24	10 24 22 26	18				Wet, dense, light brown, fine to medium SAND, trace silt	
60	SS	S-20	24	12 13 16 20	20				Wet, medium dense, light brown, fine to medium SAND, trace silt	
									END OF BORING = 61.0'	
65										
70										

BL HARWICH BORING LOGS.GPJ - 8/24/11

CAMP DRESSER & McKEE

CDM

Boring Number: CDM-6

Client: Town of Harwich

Project Location: Harwich, Massachusetts

Project Name: Hydrogeology Evaluation

Project Number: 0324-60650

Drilling Contractor/Driller: New Hampshire Boring, Inc. / Jason Stokes

Drilling Method/Casing/Core Barrel Size: Drive and Wash / 4-in/

Hammer Weight/Drop Height/ Spoon Size: 140-lbs lb / 30-in in /2-in

Bore Hole Location: See Boring Location Plan

N: E:

Drilling Date: Start: 8/10/2011 **End:** 8/11/2011

Surface Elevation (ft.):

Total Depth (ft.): 61

Depth to Initial Water Level (ft):

Depth	Date	Time
27.0	8/11/2011	7:00 A.M.

Abandonment Method: Fill with Cuttings

Logged By: J. Morency

Elev. Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Blows per 6 inches	Sample Recovery (in)	Split Spoon Size (O.D.)	Graphic Log	Strata	Material Description	Remarks
0	SS	S-1	24	1 1 2 3	7				Dry, very loose, brown-orange, fine SAND, some silt, trace fine gavel	
	SS	S-2	24	5 7 6 8	15				Dry, medium dense, brown-orange, fine to medium SAND, little silt	
5	SS	S-3	24	5 9 10 10	16				Dry, medium dense, brown-orange, fine to medium SAND, trace fine gravel, trace silt	
	SS	S-4	24	7 9 12 11	13				Dry, medium dense, brown-orange, fine to medium SAND, trace silt	
	SS	S-5	24	11 12 10 12	7				Dry, medium dense, brown-orange, fine to coarse SAND, little fine gravel, trace silt	
10	SS	S-6	24	8 12 10 10	15				Dry, medium dense, brown-orange, fine to coarse SAND, trace fine gravel, trace silt	
	SS	S-7	24	8 9 11 12	16				Dry, medium dense, light brown, fine to medium SAND, trace silt	
15	SS	S-8	24	7 8 11 14	11				Dry, medium dense, light brown, fine to medium SAND, trace silt	
	SS	S-9	24	9 12 10 11	12				Dry, medium dense, light brown, fine to coarse SAND, little fine gravel, trace silt	
	SS	S-10	24	9 12 11 14	11				Dry, medium dense, light brown, fine to coarse SAND, some fine gravel, trace silt	

Sample Types

AS - Auger/Grab Sample
CS - California Sampler
BQ - 1.5" Rock Core
NQ - 2" Rock Core
HP - Hydro Punch
SS - Split Spoon
ST - Shelby Tube
WS - Wash Sample
GP - Geoprobe

Consistency vs Blowcount/Foot

Granular (Sand):

V. Loose:	0-4	Dense:	30-50
Loose:	4-10	V. Dense:	>50
M. Dense:	10-30		

Fine Grained (Clay):

V. Soft:	<2	Stiff:	8-15
Soft:	2-4	V. Stiff:	15-30
M. Stiff:	4-8	Hard:	>30

Burmister Classification

and	35-50%
some	20-35%
little	10-20%
trace	<10%

moisture, density, color

Reviewed by: **Date:** **Boring Number: CDM-6**

CAMP DRESSER & McKEE

CDM

Boring Number: CDM-6

Client: Town of Harwich
Project Location: Harwich, Massachusetts
Project Name: Hydrogeology Evaluation
Project Number: 0324-60650

Elev. Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Blows per 6 inches	Sample Recovery (in)	Split Spoon Size (O.D.)	Graphic Log	Strata	Material Description	Remarks
20	SS	S-11	24	10 12 13 14	13				Dry, medium dense, light brown, fine to medium SAND, trace silt	
	SS	S-12	24	12 13 12 17	6				Dry, medium dense, light brown, fine to medium SAND, trace fine gravel, trace silt	
25	SS	S-13	24	12 14 16 19	14				Moist, dense, light brown, fine to coarse SAND, trace fine gravel	
▼	SS	S-14	25	5 6 6 6	8				Wet, medium dense, light brown, fine to medium SAND, little silt, trace fine gravel	
	SS	S-15	26	6 7 8 9	6				Wet, medium dense, light brown, fine to medium SAND, little silt, trace fine gravel	
30										
35	SS	S-16	27	8 11 13 14	10				Wet, medium dense, light brown, fine coarse SAND, trace fine gravel, trace silt	
40	SS	S-17	28	8 10 13 17	9				Wet, medium dense, light brown, fine coarse SAND, trace fine gravel, trace silt	
45	SS	S-18	29	9 12 23 27	9				Wet, dense, light brown, fine coarse SAND, trace fine gravel, trace silt	

BL HARWICH BORING LOGS.GPJ - 8/24/11

CAMP DRESSER & McKEE

CDM

Boring Number: CDM-6

Client: Town of Harwich
Project Location: Harwich, Massachusetts
Project Name: Hydrogeology Evaluation
Project Number: 0324-60650

Elev. Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Blows per 6 inches	Sample Recovery (in)	Split Spoon Size (O.D.)	Graphic Log	Strata	Material Description	Remarks
50	SS	S-19	30	10 21 23 22	13				Wet, dense, light brown, fine coarse SAND, trace fine gravel, trace silt	
55	SS	S-20	31	13 13 24 32	17				A: Wet, brown, hard, SILT and CLAY B: Wet, gray, hard, silty CLAY	A: (0"-10") B: (10"-17")
60	SS	S-21	32	7 9 11 13	10				Wet, medium dense, light brown, fine to coarse SAND, trace fine gravel, trace silt	
									END OF BORING = 61.0'	
65										
70										

BL HARWICH BORING LOGS.GPJ - 8/24/11

CAMP DRESSER & McKEE

Boring Number: CDM-7

Client: Town of Harwich
Project Location: Harwich, Massachusetts
Project Name: Hydrogeology Evaluation
Project Number: 0324-60650

Drilling Contractor/Driller: New Hampshire Boring, Inc. / Jason Stokes
Drilling Method/Casing/Core Barrel Size: Drive and Wash / 4-in/
Hammer Weight/Drop Height/ Spoon Size: 140-lbs lb / 30-in in /2-in
Bore Hole Location: See Boring Location Plan
N: E:
Drilling Date: Start: 8/11/2011 **End:** 8/12/2011

Surface Elevation (ft.):
Total Depth (ft.): 81
Depth to Initial Water Level (ft):

Depth	Date	Time
38.0	8/12/2011	3:30 P.M.

Abandonment Method: Fill with Cuttings
Logged By: J. Morency

Elev. Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Blows per 6 inches	Sample Recovery (in)	Split Spoon Size (O.D.)	Graphic Log	Strata	Material Description	Remarks
0	SS	S-1	24	1 2 2 3	10				Dry, loose, brown-orange, fine to medium SAND, little silt, trace fine gravel	
5	SS	S-2	24	15 17 13 14	6				Dry, dense, brown-orange, fine to coarse SAND, some fine gravel, trace silt	
10	SS	S-3	24	10 7 7 12	12				Dry, medium dense, brown-orange, fine to coarse SAND, trace fine grave, trace silt	
15	SS	S-4	24	10 10 11 11	5				Dry, medium dense, brown-orange, fine to coarse SAND, trace fine grave, trace silt	
	SS	S-5	24	6 7	6				Dry, medium dense, brown-orange, fine to medium SAND, little silt	

Sample Types

AS - Auger/Grab Sample
CS - California Sampler
BQ - 1.5" Rock Core
NQ - 2" Rock Core
HP - Hydro Punch
SS - Split Spoon
ST - Shelby Tube
WS - Wash Sample
GP - Geoprobe

Consistency vs Blowcount/Foot

Granular (Sand):

V. Loose:	0-4	Dense:	30-50
Loose:	4-10	V. Dense:	>50
M. Dense:	10-30		

Fine Grained (Clay):

V. Soft:	<2	Stiff:	8-15
Soft:	2-4	V. Stiff:	15-30
M. Stiff:	4-8	Hard:	>30

Burmister Classification

and	35-50%
some	20-35%
little	10-20%
trace	<10%

moisture, density, color

Reviewed by: **Date:** **Boring Number: CDM-7**

CAMP DRESSER & McKEE

CDM

Boring Number: CDM-7

Client: Town of Harwich
Project Location: Harwich, Massachusetts
Project Name: Hydrogeology Evaluation
Project Number: 0324-60650

Elev. Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Blows per 6 inches	Sample Recovery (in)	Split Spoon Size (O.D.)	Graphic Log	Strata	Material Description	Remarks
20	SS	S-5	24	6 7	6					
25	SS	S-6	24	7 7 8 11	9				Dry, medium dense, light brown, fine to coarse SAND, little fine to coarse gravel, trace silt	
30	SS	S-7	24	8 10 12 15	13				Dry, medium dense, light brown, fine to coarse SAND, trace fine gravel, trace silt	
35	SS	S-8	24	7 9 10 11	11				Dry, medium dense, light brown, fine to coarse SAND, little silt	
▼										
40	SS	S-9	24	7 10 11 15	9				Wet, medium dense, light brown, fine to coarse SAND, little silt	
45	SS	S-10	24	12 15 25 29	10				Wet, dense, light brown, fine to coarse SAND, little silt	

CAMP DRESSER & McKEE

CDM

Boring Number: CDM-7

Client: Town of Harwich
Project Location: Harwich, Massachusetts
Project Name: Hydrogeology Evaluation
Project Number: 0324-60650

Elev. Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Blows per 6 inches	Sample Recovery (in)	Split Spoon Size (O.D.)	Graphic Log	Strata	Material Description	Remarks
50	SS	S-11	24	15 27 61 71	19				Wet, very dense, light brown, fine to coarse SAND, some fine gravel, trace silt	
55	SS	S-12	24	15 31 41 56	9				Wet, very dense, light brown, fine to coarse SAND, some fine gravel, trace silt	
60	SS	S-13	24	13 15 16 17	17				Wet, dense, light brown, fine to medium SAND, little silt	
65	SS	S-14	24	12 14 15 14	19				Wet, medium dense, light brown, fine to medium SAND, little silt	
70	SS	S-15	24	21 32 36 41	16				Wet, very dense, light brown, fine SAND, little silt, trace fine gravel	

CAMP DRESSER & McKEE

CDM

Boring Number: CDM-7

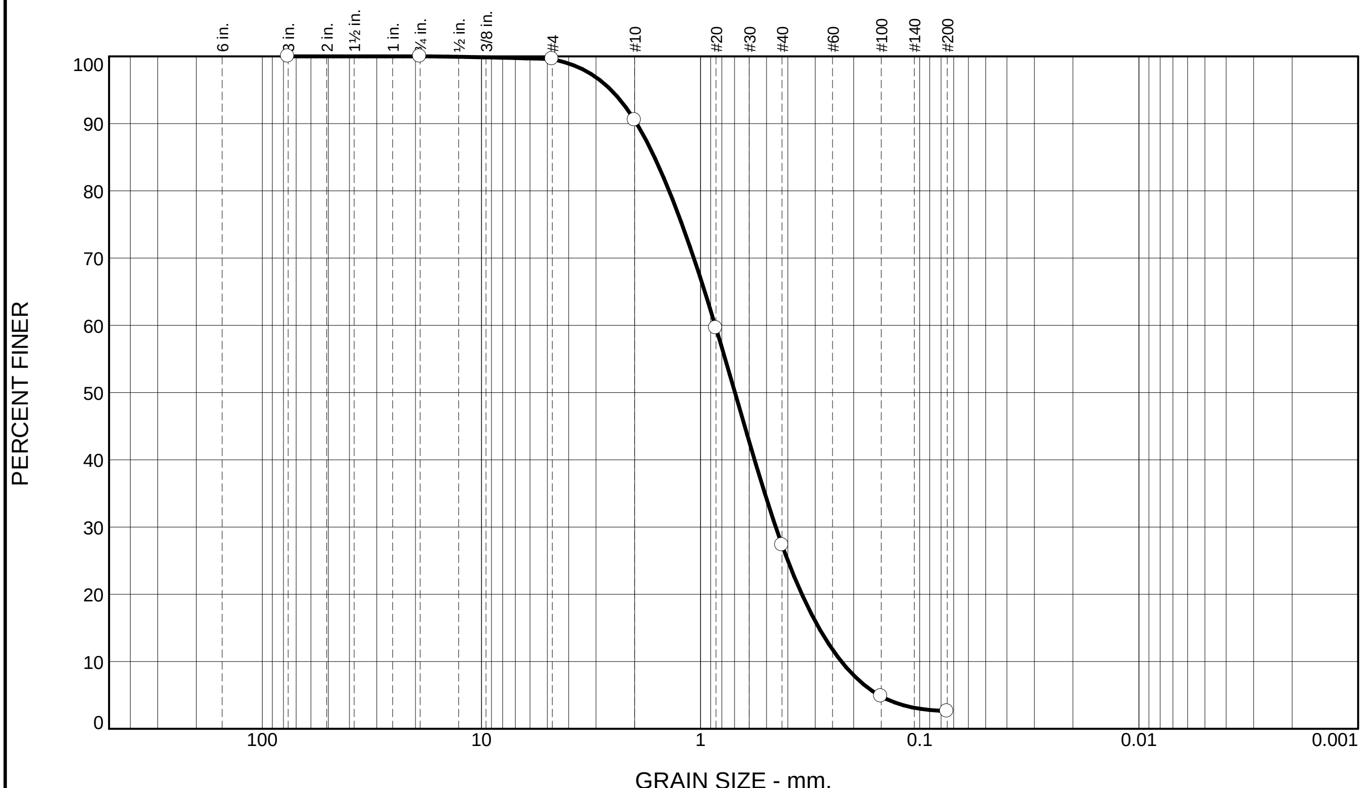
Client: Town of Harwich
Project Location: Harwich, Massachusetts
Project Name: Hydrogeology Evaluation
Project Number: 0324-60650

Elev. Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Blows per 6 inches	Sample Recovery (in)	Split Spoon Size (O.D.)	Graphic Log	Strata	Material Description	Remarks
75	SS	S-16	24	22 31 41 40	24				Wet, very dense, light brown, fine SAND, little silt, trace fine gravel	
80	SS	S-17	24	9 12 15 21	24				Wet, very stiff, gray CLAY	
									END OF BORING = 81.0'	
85										
90										
95										
100										

Hydrogeological Report

Appendix B

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.4	9.1	63.2	24.7	2.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3	100.0		
3/4	100.0		
#4	99.6		
#10	90.5		
#20	59.6		
#40	27.3		
#100	4.8		
#200	2.6		

* (no specification provided)

Material Description

poorly graded sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 1.9564 D_{85}= 1.6230 D_{60}= 0.8576
D_{50}= 0.6969 D_{30}= 0.4541 D_{15}= 0.2885
D_{10}= 0.2278 C_u= 3.76 C_c= 1.06

Classification

USCS= SP AASHTO=

Remarks

As received moisture content = 15.0%

Source of Sample: CDM-2 **Depth:** 8-10
Sample Number: S-5

Date: 8/3/2011

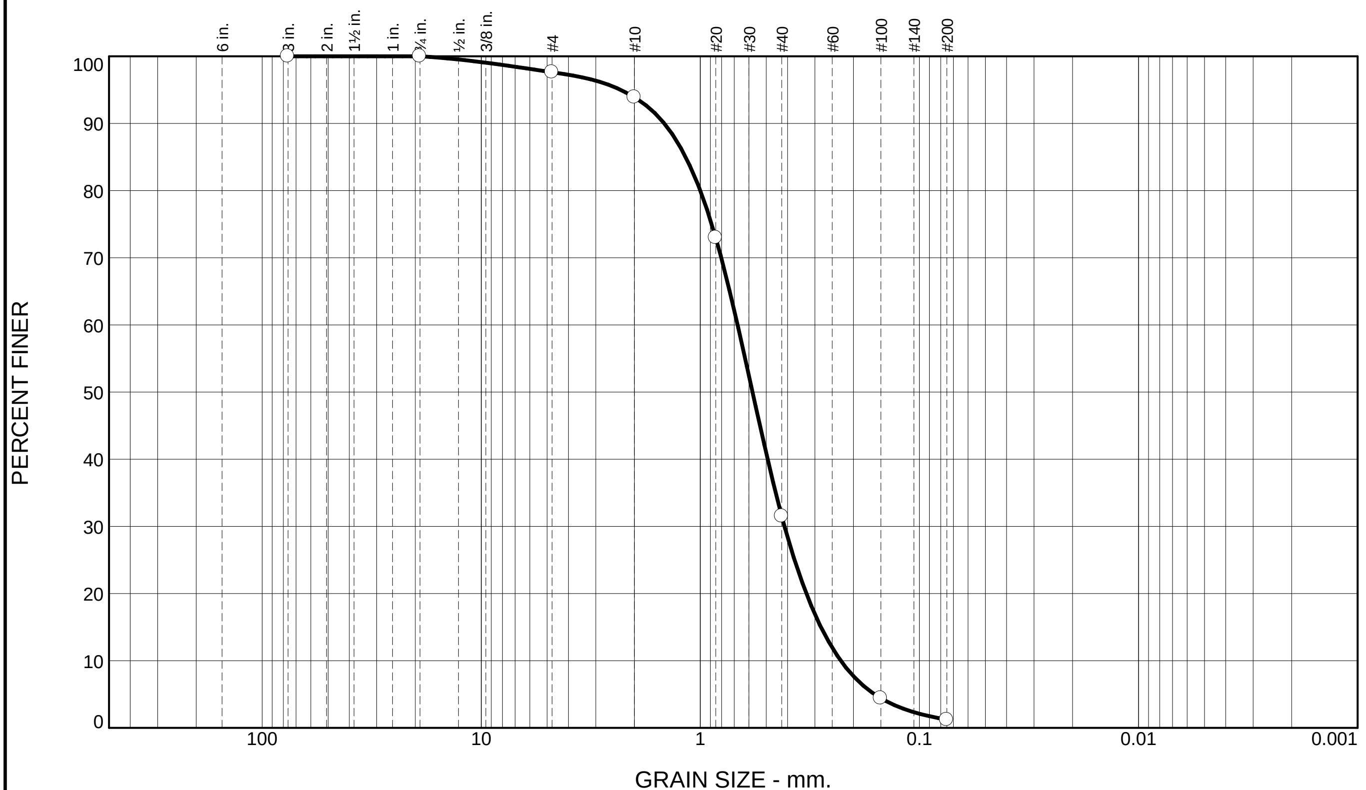
CDM

Cambridge, Massachusetts

Client: Town of Harwich
Project: Hydrogeology Evaluation
Project No: 324-60650 **Figure**

Tested By: MR

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	2.4	3.7	62.4	30.3	1.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3	100.0		
3/4	100.0		
#4	97.6		
#10	93.9		
#20	73.0		
#40	31.5		
#100	4.4		
#200	1.2		

* (no specification provided)

Material Description

poorly graded sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 1.4606 D_{85}= 1.1668 D_{60}= 0.6763
D_{50}= 0.5778 D_{30}= 0.4129 D_{15}= 0.2816
D_{10}= 0.2286 C_u= 2.96 C_c= 1.10

Classification

USCS= SP AASHTO=

Remarks

As received moisture content = 3.6%

Source of Sample: CDM-3 **Depth:** 12-14
Sample Number: S-7

Date: 8/4/2011

CDM

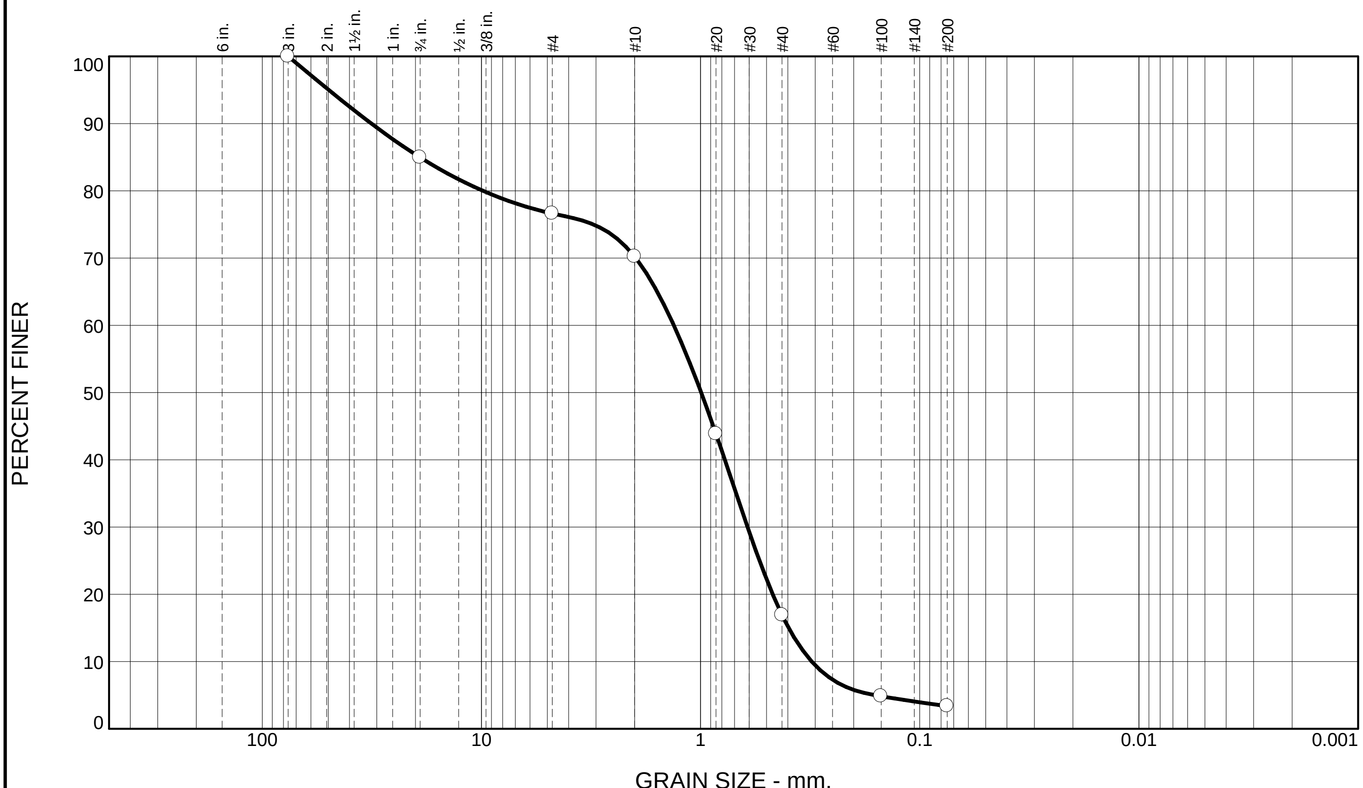
Cambridge, Massachusetts

Client: Town of Harwich
Project: Hydrogeology Evaluation

Project No: 324-60650 **Figure**

Tested By: MR

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	15.0	8.4	6.4	53.3	13.5	3.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3	100.0		
3/4	85.0		
#4	76.6		
#10	70.2		
#20	43.8		
#40	16.9		
#100	4.8		
#200	3.4		

* (no specification provided)

Material Description

poorly graded sand with gravel

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 31.7679 D_{85}= 19.1238 D_{60}= 1.3247
D_{50}= 0.9936 D_{30}= 0.6106 D_{15}= 0.3966
D_{10}= 0.3112 C_u= 4.26 C_c= 0.90

Classification

USCS= SP AASHTO=

Remarks

As received moisture content = 3.1%

Source of Sample: CDM-5 **Depth:** 4-6
Sample Number: S-3 **Date:** 8/9/2011

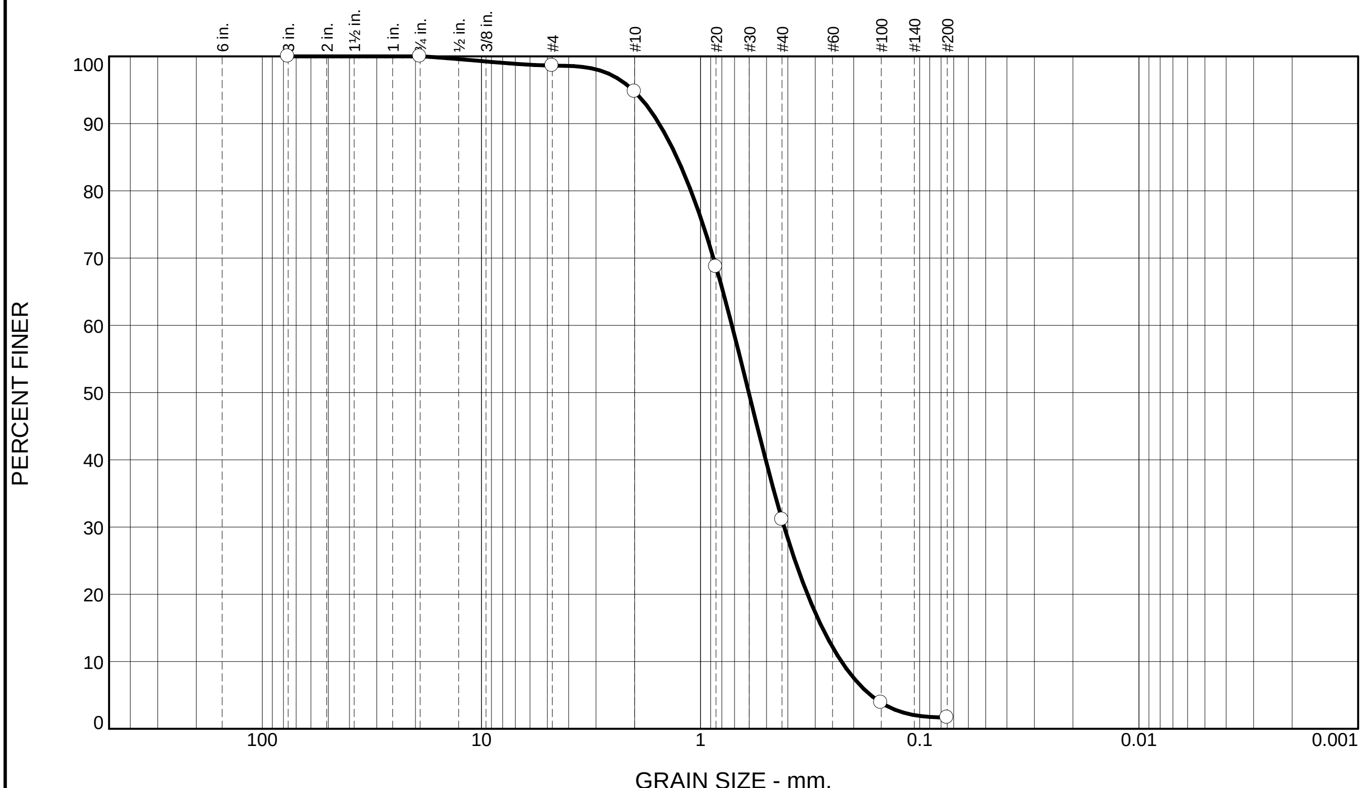
CDM

Cambridge, Massachusetts

Client: Town of Harwich
Project: Hydrogeology Evaluation
Project No: 324-60650 **Figure**

Tested By: MR

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.4	3.9	63.6	29.4	1.7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3	100.0		
3/4	100.0		
#4	98.6		
#10	94.7		
#20	68.7		
#40	31.1		
#100	3.9		
#200	1.7		

* (no specification provided)

Material Description

poorly graded sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 1.5466 D_{85}= 1.2835 D_{60}= 0.7198
D_{50}= 0.6029 D_{30}= 0.4152 D_{15}= 0.2783
D_{10}= 0.2277 C_u= 3.16 C_c= 1.05

Classification

USCS= SP AASHTO=

Remarks

As received moisture content = 2.3%

Source of Sample: CDM-6 **Depth:** 6-8
Sample Number: S-4
Date: 8/10/2011

CDM

Cambridge, Massachusetts

Client: Town of Harwich
Project: Hydrogeology Evaluation
Project No: 324-60650 **Figure**

Tested By: MR

Hydrogeological Report

Appendix C

Town of Harwich
Harwich, MA
Hidrogeology Evaluation

Table 1
Infiltration Test - Summary of Results

Exploration No.	Depth (ft)	Strata	USDA Classification	Peak Infiltration Velocity -Inner Ring (gpm)	Peak Infiltration Rate -Inner Ring (gpd/sf)	Design Loading Rates Based on Infiltration Rate (gpd/sf)[2]	
						2%	4%
DRI-1	3	Sand	C	0.100	180.57	3.61	7.22
DRI-2[1]	3	Sand	C	-	-	-	-
DRI-3[1]	3	Sand	C	-	-	-	-

Notes

1-At Locations DRI-2 and 3, Infiltration Velocity was too high and test could not be performed. Infiltration Velocity was estimated in the field to be 1-3gal/min

2-USEPA, "EPA 625/1-81-013 - Process Design Manual for Land Treatment of Municipal Wastewater", USEPA Center of Environmental Research Information, Cincinnati-OH, 1981; USEPA, "EPA 625 R00 008 Onsite Wastewater Treatment System Manual", USEPA Center of Environmental Research Information, Cincinnati-OH, 2000;

DRIT-1

Project:
Test Location: Harwich, MA
Liquid Used: Water
Tested By: Dan Nyanjom; Max Rolandi
Depth to Water Table: Not Encounter

Constants:

	Area (cm^2)	Area (ft^2)
Inner Ring	740	0.7992
Annular Space	2219	2.39652

Penetration of Ring (in): 6 (Inner) 10 (Annular)

Trial Number		Time	Elapsed Time (min.)	Water Level (in)		Change in Water Level (in)		Infiltration Velocity(cm/hr)		Infiltration Velocity(gpm)		Infiltration Rate (gpd/sf)	
				Inner Ring	Annular Space	Inner Ring	Annular Space	Inner Ring	Annular Space	Inner Ring	Annular Space	Inner Ring	Annular Space
1	Start	9:55		0.00	0.00								
	End	10:10	15.0	3.00	4.00	3.00	4.00	30.48	40.64	0.1002	0.1336	180.57	240.76
2	Start	10:11		0.00	0.00								
	End	10:26	30.0	2.25	4.00	2.25	4.00	22.86	40.64	0.0752	0.1336	135.43	240.76
3	Start	10:27		0.00	0.00								
	End	10:42	45.0	2.25	4.00	2.25	4.00	22.86	40.64	0.0752	0.1336	135.43	240.76
4	End	10:43		0.00	0.00								
	Start	10:58	60.0	2.00	4.00	2.00	4.00	20.32	40.64	0.0668	0.1336	120.38	240.76
5	End	11:00		0.00	0.00								
	Start	11:15	75.0	2.00	4.00	2.00	4.00	20.32	40.64	0.0668	0.1336	120.38	240.76
6	Start	11:16		0.00	0.00								
	End	11:31	90.0	1.75	3.50	1.75	3.50	17.78	35.56	0.0585	0.1169	105.33	210.66
7	Start	11:32		0.00	0.00								
	End	11:47	105.0	1.75	3.00	1.75	3.00	17.78	30.48	0.0585	0.1002	105.33	180.57
8	Start	11:48		0.00	0.00								
	End	12:03	120.0	1.75	3.50	1.75	3.50	17.78	35.56	0.0585	0.1169	105.33	210.66

Notes:

1- A 5 ft wide trench was excavated to remove topsoil. Test was performed at approximately 4 ft of depth, in the Harwich outwash plain deposit; inner and outer ring were pushed 6 to 10 inches into the Harwich outwash plain deposit. Water level in inner ring and annular space were maintained manually

DRIT-2

Project:

Test Location: Harwich, MA

Liquid Used: Water

Tested By: Dan Nyanjom; Max Rolandi

Depth to Water Table: Not Encounter

Constants:	**Area (cm^2)**	**Area (ft^2)**
Inner Ring	740	0.7992
Annular Space	2219	2.39652

Penetration of Ring (in): 6 (Inner) 10 (Annular)

Trial Number		Time	Elapsed Time (min.)	Water Level (in)		Change in Water Level (in)		Infiltration Rate (cm/hr)		Infiltration Velocity(gpm)[2]	Infiltration Rate (gpd/sf)	
				Inner Ring	Annular Space	Inner Ring	Annular Space	Inner Ring	Annular Space		Inner Ring	Annular Space
1			2.0							1.5		
2			2.0							2.5		

Notes:

1- A 5 ft wide trench was excavated to remove topsoil. Test was performed at approximately 4 ft of depth, in the Harwich outwash plain deposit; inner and outer ring were pushed 6 to 10 inches into the Harwich outwash plain deposit. Water level in inner ring and annular space were maintained manually

2 - Infiltration Velocity was too high and test could not be performed. Approximate reedings of change in volume in water tank over time were taken in the field; Infiltration Velocity was estimated in the field to be 1-3gal/min - Test duration was approximately 2 hours.

DRIT-3

Project:
Test Location: Harwich, MA
Liquid Used: Water
Tested By: Dan Nyanjom; Max Rolandi
Depth to Water Table: Not Encounter

Constants:	**Area (cm^2)**	**Area (ft^2)**
Inner Ring	740	0.7992
Annular Space	2219	2.39652

Penetration of Ring (in): 6 (Inner)
10 (Annular)

Trial Number		Time	Elapsed Time (min.)	Water Level (in)		Change in Water Level (in)		Infiltration Rate (cm/hr)		Infiltration Velocity(gpm)[2]	Infiltration Rate (gpd/sf)	
				Inner Ring	Annular Space	Inner Ring	Annular Space	Inner Ring	Annular Space		Inner Ring	Annular Space
1			2.0							1.5		
2			2.0							3.0		

Notes:

1- A 5 ft wide trench was excavated to remove topsoil. Test was performed at approximately 4 ft of depth, in the Harwich outwash plain deposit; inner and outer ring were pushed 6 to 10 inches into the Harwich outwash plain deposit. Water level in inner ring and annular space were maintained manually

2 - Infiltration Velocity was too high and test could not be performed. Approximate reedings of change in volume in water tank over time were taken in the field; Infiltration Velocity was estimated in the field to be 1-3gal/min - Test duration was approximately 1.5 hours.

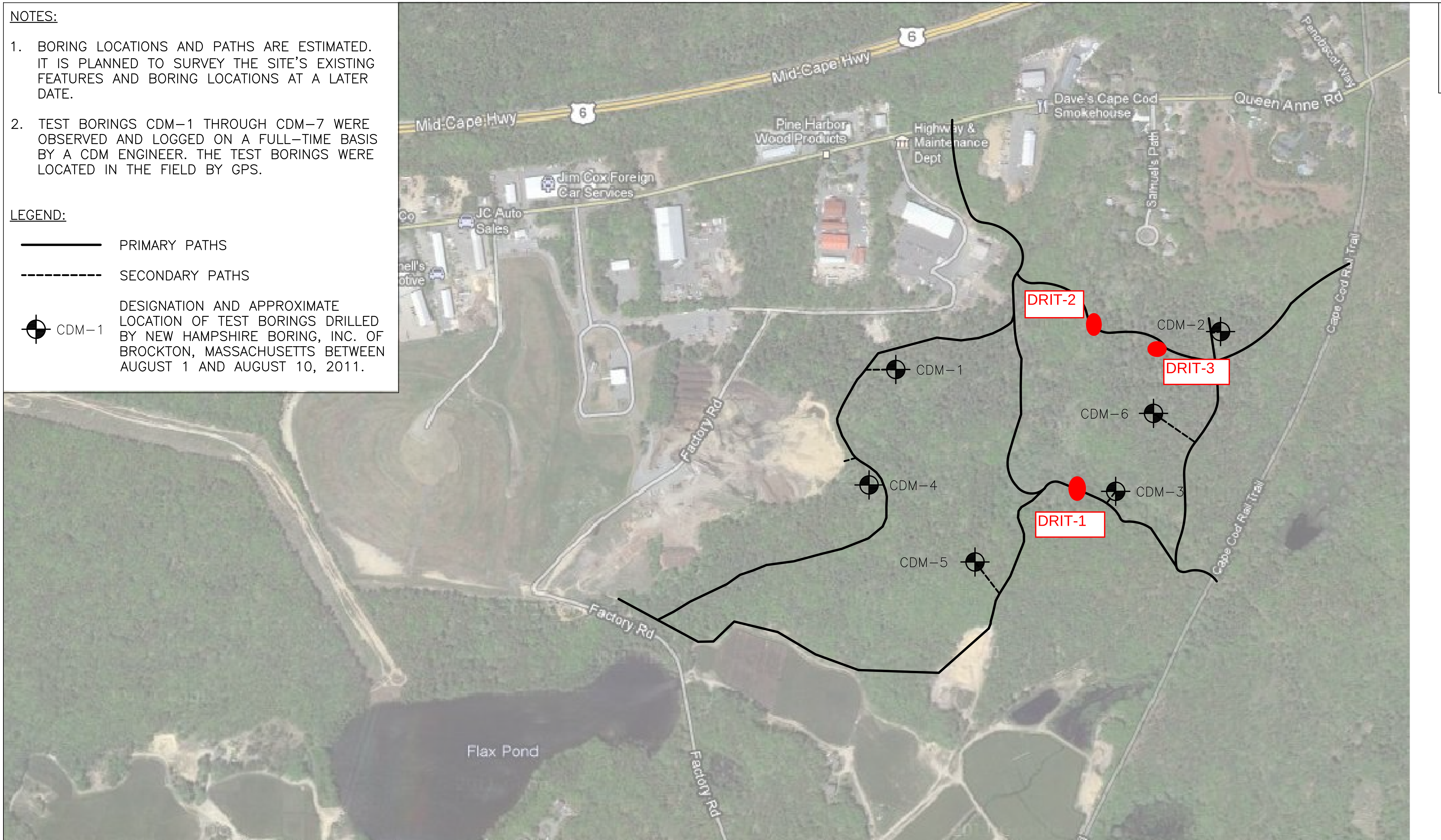
NOTES:

1. BORING LOCATIONS AND PATHS ARE ESTIMATED. IT IS PLANNED TO SURVEY THE SITE'S EXISTING FEATURES AND BORING LOCATIONS AT A LATER DATE.

2. TEST BORINGS CDM-1 THROUGH CDM-7 WERE OBSERVED AND LOGGED ON A FULL-TIME BASIS BY A CDM ENGINEER. THE TEST BORINGS WERE LOCATED IN THE FIELD BY GPS.

LEGEND:

- (solid line) PRIMARY PATHS
- (dashed line) SECONDARY PATHS
- CDM-1 (boring symbol) DESIGNATION AND APPROXIMATE LOCATION OF TEST BORINGS DRILLED BY NEW HAMPSHIRE BORING, INC. OF BROCKTON, MASSACHUSETTS BETWEEN AUGUST 1 AND AUGUST 10, 2011.



CDM
consulting • engineering • construction • operations

TOWN OF HARWICH
HARWICH, MASSACHUSETTS
HYDROGEOLOGY EVALUATION

BORING LOCATION PLAN
SITE HR-12

FIGURE 1

Commonwealth of Massachusetts
City/Town of
Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

A. Facility Information

HIGHWAY AND MAINTENANCE DPT. - TOWN OF HARWICH
Owner Name

273 QUEEN ANN ROAD
Street Address

Map/Lot #

HARWICH
City

MA
State

02645
Zip Code

B. Site Information

1. (Check one) ☒ New Construction ☐ Upgrade ☐ Repair

2. Published Soil Survey Available? ☒ Yes ☐ No If yes: 1969 Year Published 1:24000 Publication Scale GQ-786 Soil Map Unit

   HARWICH OUTWASH PLAIN DEPOSIT
   Soil Name

   Soil Limitations

3. Surficial Geological Report Available? ☐ Yes ☒ No If yes: Year Published Publication Scale Map Unit

   Geologic Material

   Landform

4. Flood Rate Insurance Map

   Above the 500-year flood boundary? ☒ Yes ☐ No Within the 100-year flood boundary? ☐ Yes ☒ No

   Within the 500-year flood boundary? ☐ Yes ☒ No Within a velocity zone? ☐ Yes ☐ No

5. Wetland Area: National Wetland Inventory Map — Map Unit — Name

   Wetlands Conservancy Program Map — Map Unit — Name

6. Current Water Resource Conditions (USGS): 11/2011 Month/Year Range: ☐ Above Normal ☐ Normal ☐ Below Normal NOT RANKED

7. Other references reviewed: BORING TEST LOGS FROM HWH Inc. (1990) AND FROM CDM (2011)

Commonwealth of Massachusetts
City/Town of
Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

C. On-Site Review *(minimum of two holes required at every proposed primary and reserved disposal area)*

Deep Observation Hole Number: 1 — Date: 11/10/2011 — Time: 9.30 — Weather: SUNNY / DRY

1. Location

   Ground Elevation at Surface of Hole: — Location (identify on plan): DRIT-1

2. Land Use: WOODLAND (e.g., woodland, agricultural field, vacant lot, etc.) — Surface Stones: NOT PRESENT — Slope (%): 0%

   Vegetation: ABUNDANT — Landform: HILL — Position on Landscape (attach sheet):

3. Distances from:
   - Open Water Body: 3000 feet
   - Drainage Way: 100 feet
   - Possible Wet Area: — feet
   - Property Line: — feet
   - Drinking Water Well: — feet
   - Other: — feet

4. Parent Material: SANDWICH MARINE DEPOSIT — Unsuitable Materials Present: ☐ Yes ☒ No

   If Yes: ☐ Disturbed Soil ☐ Fill Material ☐ Impervious Layer(s) ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☐ Yes ☒ No — If yes: ______ Depth Weeping from Pit ______ Depth Standing Water in Hole

   Estimated Depth to High Groundwater: — inches — elevation

Commonwealth of Massachusetts
City/Town of

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

C. On-Site Review (continued)

Deep Observation Hole Number: 1

Depth (in.)	Soil Horizon/ Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features (mottles)			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
12	(A) TOPSOIL					MEDIUM					
36	(C) SAND	LOOSE; RED/ BROWN	30"	RED	< 5%	FINE	0%	0%	LOOSE SAND/ ROUNDED GRAINS	LOOSE	/

Additional Notes:

Commonwealth of Massachusetts
City/Town of
Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

C. On-Site Review (continued)

Deep Observation Hole Number: 2   11/10/2011 (Date)   12.30 (Time)   SUNNY/DRY (Weather)

1. Location

   Ground Elevation at Surface of Hole: —   Location (identify on plan): DRI.T.-2

2. Land Use: WOODLAND (e.g., woodland, agricultural field, vacant lot, etc.)   NOT PRESENT (Surface Stones)   1-3% (Slope (%))

   WOODED AREA (Vegetation)   HILL (Landform)   ____ (Position on Landscape (attach sheet))

3. Distances from: Open Water Body 3000 feet   Drainage Way 10 feet   Possible Wet Area — feet

   Property Line — feet   Drinking Water Well — feet   Other — feet

4. Parent Material: SANDWICH MARINE DEPOSIT   Unsuitable Materials Present: ☐ Yes ☒ No

   If Yes: ☐ Disturbed Soil ☐ Fill Material ☐ Impervious Layer(s) ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☐ Yes ☒ No   If yes: ____ Depth Weeping from Pit   ____ Depth Standing Water in Hole

   Estimated Depth to High Groundwater: — inches   — elevation

Commonwealth of Massachusetts
City/Town of
Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

C. On-Site Review (continued)

Deep Observation Hole Number: 2

Depth (in.)	Soil Horizon/ Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features (mottles)			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
12	(A) TOPSOIL					FINE					
40	(C) SAND	LOOSE; RED/ BROWN				MEDIUM	0%	0%	LOOSE SAND ROUND GRAIN	LOOSE	—

Additional Notes:

TEST WAS NOT CONDUCTED AT THIS LOCATION DUE TO HIGH WATER INFILTRATION RATE (1-3 gal/MIN)

Commonwealth of Massachusetts
City/Town of

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

C. On-Site Review *(minimum of two holes required at every proposed primary and reserved disposal area)*

Deep Observation Hole Number: 3 Date: 11/10/2011 Time: 15.00 Weather: SUNNY / DRY

1. Location

Ground Elevation at Surface of Hole: — Location (identify on plan): D.R.I.T. 3

2. Land Use: WOODLAND (e.g., woodland, agricultural field, vacant lot, etc.) Surface Stones: NOT PRESENT Slope (%): 1-3%

Vegetation: WOODED AREA Landform: HILL Position on Landscape (attach sheet):

3. Distances from: Open Water Body 3000 feet Drainage Way 10 feet Possible Wet Area — feet

Property Line — feet Drinking Water Well — feet Other — feet

4. Parent Material: SANDWICH MARINE DEPOSIT Unsuitable Materials Present: ☐ Yes ☒ No

If Yes: ☐ Disturbed Soil ☐ Fill Material ☐ Impervious Layer(s) ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☐ Yes ☐ No If yes: ______ Depth Weeping from Pit ______ Depth Standing Water in Hole

Estimated Depth to High Groundwater: — inches — elevation

Commonwealth of Massachusetts
City/Town of
Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

C. On-Site Review (continued)

Deep Observation Hole Number: 3

Depth (in.)	Soil Horizon/ Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features (mottles)			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
12	(A) TOPSOIL					FINE					
40	(C) SAND	LOOSE; RED/ BROWN				MEDIUM	0%	0%	LOOSE SAND; ROUND GRAIN	LOOSE	/

Additional Notes:

SEE NOTE - TEST 2

Commonwealth of Massachusetts
City/Town of

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

D. Determination of High Groundwater Elevation

1. Method Used:

	A.	B.
☐ Depth observed standing water in observation hole	inches	inches
☐ Depth weeping from side of observation hole	inches	inches
☐ Depth to soil redoximorphic features (mottles)	inches	inches
☐ Groundwater adjustment (USGS methodology)	inches	inches

2. Index Well Number ______ Reading Date ______ Index Well Level ______

Adjustment Factor ______ Adjusted Groundwater Level ______

E. Depth of Pervious Material

1. Depth of Naturally Occurring Pervious Material

   a. Does at least four feet of naturally occurring pervious material exist in all areas observed throughout the area proposed for the soil absorption system?

   ☐ Yes ☐ No

   b. If yes, at what depth was it observed? Upper boundary: ______ inches Lower boundary: ______ inches

Commonwealth of Massachusetts
City/Town of
Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

F. Certification

I certify that I am currently approved by the Department of Environmental Protection pursuant to 310 CMR 15.017 to conduct soil evaluations and that the above analysis has been performed by me consistent with the required training, expertise and experience described in 310 CMR 15.017. I further certify that the results of my soil evaluation, as indicated in the attached Soil Evaluation Form, are accurate and in accordance with 310 CMR 15.100 through 15.107.

Signature of Soil Evaluator	Date
Typed or Printed Name of Soil Evaluator / License #	Date of Soil Evaluator Exam
Name of Board of Health Witness	Board of Health

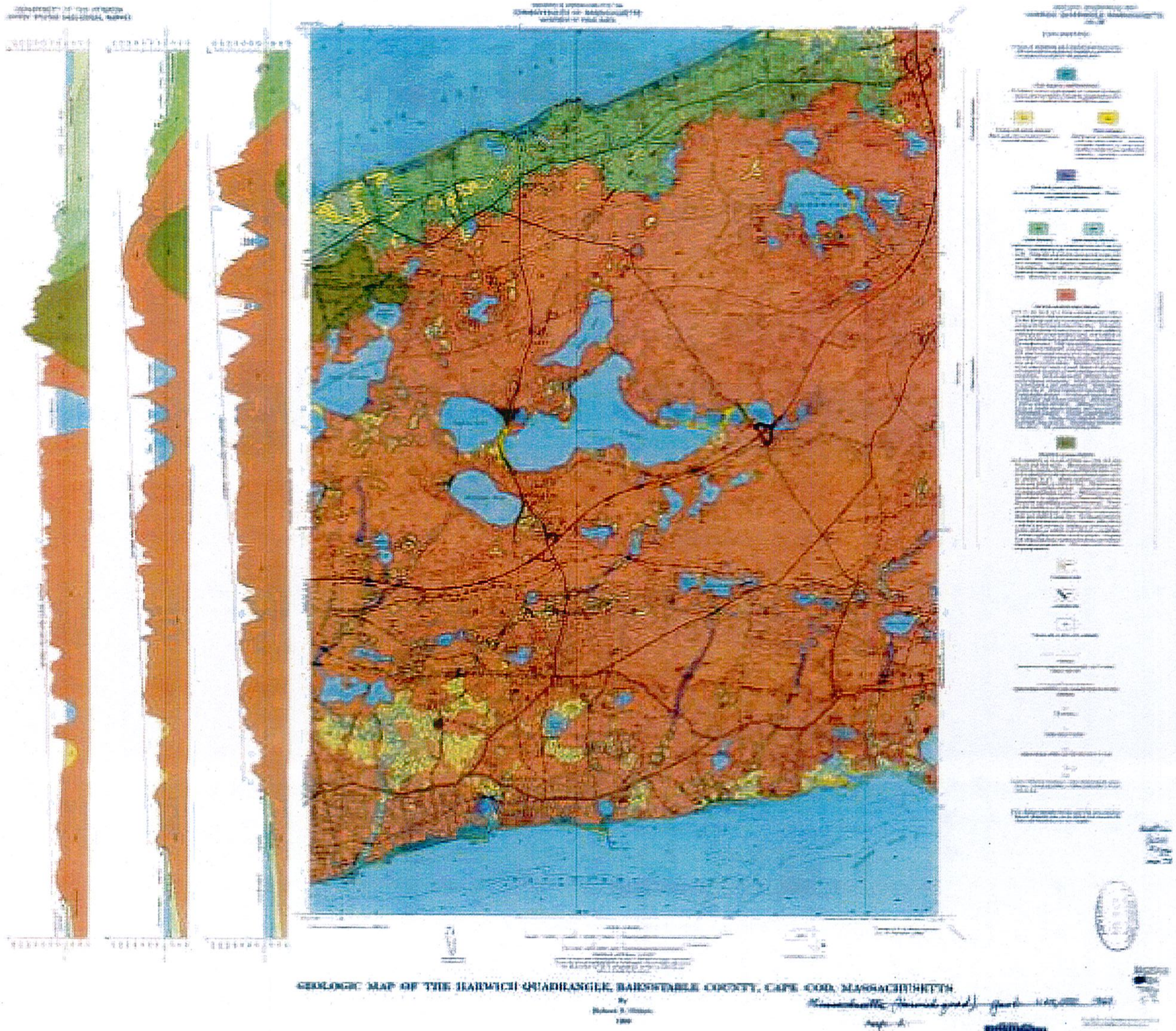
Note: In accordance with 310 CMR 15.018(2) this form must be submitted to the approving authority within 60 days of the date of field testing, and to the designer and the property owner with Percolation Test Form 12.

Commonwealth of Massachusetts
City/Town of

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

Field Diagrams

Use this sheet for field diagrams:



Qhw

Harwich outwash plain deposits

Drift in the form of a large outwash plain with a graded surface that slopes gently south toward Nantucket Sound and an ice-contact head that slopes steeply north toward Cape Cod Bay. Composed mostly of medium to very coarse sand and pebble to cobble gravel in the northern part, and medium to fine sand containing scattered pebbles and cobbles in the southern part. Till, and boulders up to several tens of feet in diameter common in northern part. Till most commonly occurs at or near the surface of the deposit. Lenses and beds of clayey silt or silty clay occur in some places. Boulders up to several feet in diameter occur in some places in the clayey silt deposits exposed in the southwest part of the quadrangle. Sand mostly quartz; feldspar and glauconite common accessories. Grains mostly angular to subrounded, a few well rounded. Stones mostly granite (fig. 2). Stones angular to subrounded. Beds mostly gently dipping. In collapsed deposits gentle to steep dips and normal faulting. Beds generally a foot to several feet thick. Bedding in sand and gravel is mostly planar, tabular and scour-and-fill crossbedding common. Current rippled beds occur in some places. Clayey silt or silty clay beds mostly laminated, some massive. Laminations deformed in some places. Till massive to poorly bedded

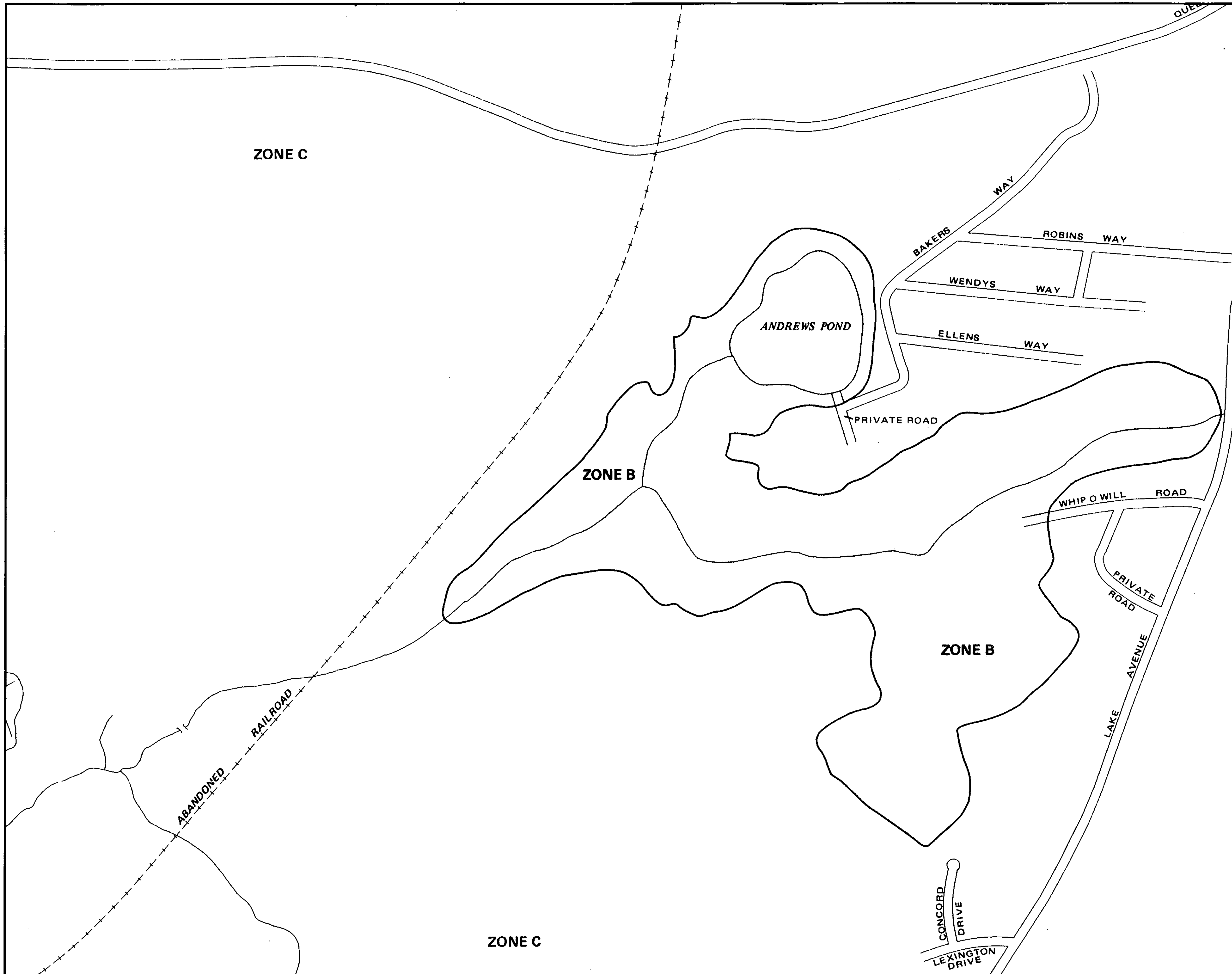
Qsm

Sandwich moraine deposits

Drift deposited as an end moraine by Cape Cod Bay lobe ice and melt water. Maximum altitudes on the sandwich moraine deposits are distinctly above maximum altitudes on the Harwich outwash plain nearby (Section A-A'). Mostly medium to very coarse sand and pebble to cobble gravel. Boulders up to several tens of feet common. Clayey silt and silty sand beds and lenses common. Till occurs at or near the surface in many places. Sand mostly quartz; glauconite and feldspar common accessories. Grains mostly angular to subrounded, some well rounded. Stones mostly granites. Stones angular to subrounded. Beds have gentle to steep dips. In collapsed deposits steep dips and normal faulting common. Beds mostly a foot to a few feet thick. Bedding in sand and gravel mostly planar or tabular and lenticular crossbedded. Current ripples common in some places. Clay silt and silty sand beds mostly laminated, laminations deformed in some places. Till ranges from massive to poorly bedded

*EXPLANATION OF ZONE DESIGNATIONS

ZONE	EXPLANATION
A	Areas of 100-year flood; base flood elevations and flood hazard factors not determined.
A0	Areas of 100-year shallow flooding where depths are between one (1) and three (3) feet; average depths of inundation are shown, but no flood hazard factors are determined.
AH	Areas of 100-year shallow flooding where depths are between one (1) and three (3) feet; base flood elevations are shown, but no flood hazard factors are determined.
A1-A30	Areas of 100-year flood; base flood elevations and flood hazard factors determined.
A99	Areas of 100-year flood to be protected by flood protection system under construction; base flood elevations and flood hazard factors not determined.
B	Areas between limits of the 100-year flood and 500-year flood; or certain areas subject to 100-year flooding with average depths less than one (1) foot or where the contributing drainage area is less than one square mile; or areas protected by levees from the base flood. (Medium shading)
C	Areas of minimal flooding. (No shading)
D	Areas of undetermined, but possible, flood hazards.
V	Areas of 100-year coastal flood with velocity (wave action); base flood elevations and flood hazard factors not determined.
V1-V30	Areas of 100-year coastal flood with velocity (wave action); base flood elevations and flood hazard factors determined.



APPROXIMATE SCALE

400 0 400 FEET

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

TOWN OF
HARWICH, MASSACHUSETTS
BARNSTABLE COUNTY

PANEL 6 OF 11
(SEE MAP INDEX FOR PANELS NOT PRINTED)

COMMUNITY-PANEL NUMBER
250008 0006 B

EFFECTIVE DATE:
SEPTEMBER 30, 1980

U.S. DEPARTMENT OF HOUSING
AND URBAN DEVELOPMENT
FEDERAL INSURANCE ADMINISTRATION

Hydrogeological Report

Appendix D

	CDM ID	**CDM-5-11-11-16**	**CDM-3-11-11-16**	**FB-11-11-16**	Trip Blank
	Lab ID	1165744-01	1165744-02	1165744-03	1165744-04
	Date	11/16/2011	11/16/2011	11/17/2011	11/16/2011
VOCs					
Chloroform	ug/L	1.4	4.8	4.6	ND
Test Parameters					
Surfactants	mg/L	--	--	--	NA
Chlorides	mg/L	12	14	14	NA
Fluoride	mg/L	--	--	--	NA
Nitrate as Nitrogen	mg/L	--	--	--	NA
Sulfate	mg/L	4.1	4.5	4.2	NA
Nitrite as Nitrogen	mg/L	--	--	--	NA
Nitrogen, total	mg/L	--	--	--	NA
Phosphorus, total	mg/L	--	0.11	0.067	NA
TKN	mg/L	--	--	--	NA
Total Dissolved Solids	mg/L	34	37	36	NA
Metals - Total					
Arsenic	mg/L	--	--	--	NA
Barium	mg/L	0.02	0.02	0.02	NA
Cadmium	mg/L	--	--	--	NA
Chromium	mg/L	--	--	--	NA
Copper	mg/L	--	--	--	NA
Iron	mg/L	0.02	0.4	0.048	NA
Lead	mg/L	--	--	--	NA
Manganese	mg/L	0.039	0.074	0.074	NA
Mercury	mg/L	--	--	--	NA
Selenium	mg/L	--	--	--	NA
Silver	mg/L	--	--	--	NA
Sodium	mg/L	7.2	9.3	10	NA
Zinc	mg/L	0.005	0.009	0.01	NA
Metals - Dissolved					
Arsenic	mg/L	--	--	--	NA
Barium	mg/L	0.02	0.011	0.012	NA
Cadmium	mg/L	--	--	--	NA
Chromium	mg/L	--	--	--	NA
Copper	mg/L	--	--	--	NA
Iron	mg/L	--	--	--	NA
Lead	mg/L	--	--	--	NA
Manganese	mg/L	0.032	0.042	0.042	NA
Mercury	mg/L	--	--	--	NA
Selenium	mg/L	--	--	--	NA
Silver	mg/L	--	--	--	NA
Sodium	mg/L	8.1	9.6	7.3	NA
Zinc	mg/L	--	--	--	NA

NA - Not Analyzed
-- Non-detect

Hydrogeological Report

Appendix E

Appendix E

Visits with Cranberry Bog Owners Downgradient from Effluent Recharge Site HR-12

January 27, 2012

Visits conducted by Heinz Proft, Harwich; and Dave Young and Bob Schreiber, CDM Smith.

Following notes summarized by Bob Schreiber

Site Visit No. 1 – Bogs Owned by Leo Cakounes

1. He has plans with elevations of the flow control structure he installed a few years ago on the shore of Flax Pond. He will provide a copy of what he can find.

2. He can control the Flax Pond water level with the flow control structure

3. He reported that Wayne Coulson (bog owner to east of Flax Pond) brings water to his bogs by damming Coy Brook to fill from it.

4. He reported Wayne Coulson has his own flow and thus does not depend on Flax Pond.

5. He reported Mr. Sarkes (bog owner adjacent to eastern edge of Flax Pond) pumps from Flax Pond for his water source, and does not put it back into the pond, rather the flow then goes through ditches/into Coy Brook.

6. Mr. Cakounes' bogs are approximately 1.0 to 1.5 feet higher than Flax Pond, and thus he sometimes pumps water up to that elevation from Flax Pond. In addition, he can put water back into the pond. He estimates that about 70% is put back into the pond and 30% flow out and away/downstream. He puts the flow back into the pond by pulling boards on the structure at the west end of the pond where his pumping system is located.

7. He reported his flow structure can drop Flax Pond 8 to 9 inches in a few hours, and 2 feet within 24 hours.

8. During the summertime, in general and during typical seasonal conditions, Flax Pond is lower than the water level in his bogs. During flood conditions (in the springtime?), the pond may have water levels close to or higher than in the bogs. If the pond's water level gets too high, he can lower the water level

9. Having the Flax Pond water level rise by one foot is better than going down. For instance: To design the pumping system at his Flax Pond pumping/ flow control structure, Mr. Cakounes had to select a minimum Flax Pond water level. Thus, a higher Flax Pond water level would be a benefit to him.

10. Mr. Cakounes can provide us with the maximum Flax Pond water level that he has witnessed. He estimates it to be approximately 14 to 16 inches below the top of the pumping inlet structure (metal).

11. A sand bar separates the eastern small lobe of Flax Pond from the western, much larger lobe. The eastern lobe has gone dry at times (also see comment 15).

12. If Flax Pond rises during higher recharge times, the area southeast (SE) from Mr. Cakounes' property gets wet (some surface ponding and general wetness due to high water table). When this happens, he works with Linc Thacher to move the water down along the water course south of their properties. Mr. Cakounes' southern bog will experience a water level rise in this situation, also; but, his northeast (NE) bog doesn't rise. He believes that there is probably seepage/leakage occurring along a short shoreline stretch in the SW (7:30 o'clock) position of Flax Pond's footprint. The residential homes to the south and S/SW of Flax Pond are up on much higher ground and thus their basements do not flood.

13. In regard to high water levels in Flax Pond and associated impacts, Mr. Cakounes upon questioning indicated that he would be willing to try running an "experiment" in which he would use the hydraulic controls on his property (and perhaps any that his neighbor and fellow bog-owner, Linc Thacher, may be willing to modify as well in cooperation).

14. Regarding water use, Mr. Cakounes noted the following "water use months" in typical years: September, January, and May. September's use is via withdrawal for irrigation purposes.

15. Back on the subject of the Flax Pond sand bar, Mr. Cakounes indicated that he believes that someone probably broke through the sand bar, to ensure that the pond's stored water would extend into the eastern small lobe, while also providing sufficient flow area for pulling in pond water stored in the bigger western/main lobe.

16. Mr. Cakounes indicated that he has probably seen the eastern lobe's sand bar exposed only 2 times in the last 11 years.

17. Mr. Cakounes also indicated that Flax Pond varies by about 2 to 3 feet during the year.

18. When asked about the presence of a shallow clay unit, Mr. Cakounes stated that there was clay found at his bog system's culvert (southern) outlet when the bog was created back in the 1900s.

19. Mr. Cakounes said that the Crapo Family owned the property back in the 1880s, and agricultural operation of the bog(s) was conducted by that family.

20. Mr. Cakounes indicated he would make copies of his design drawings and pumping records available.

21. Mr. Cakounes indicated that the USDA/NRCS (Natural Resource Conservation Service, formerly the SCS, or Soil Conservation Service) set the vertical survey datum. He believes the datum system utilized is noted on his drawings. According to Mr. Cakounes, Mr. Sarkes has complained about Flax Pond being too low; therefore, it would be better for him if the pond were maintained at a generally higher elevation.

22. Regarding the well just beyond the NE corner of Flax Pond, labeled as a USGS installation, Mr. Cakounes recommended contacting Paula Champagne at the Harwich Health Department to see

if they have any records for it. Also in reference to monitoring of water conditions, Mr. Cakounes noted that Mr. Sarkes was close to bringing suit against the Town due to the "sewerage issue".

23. Discussion then focused on Mr. Cakounes' observations of clay, during such activities as construction excavation and well/borehole drilling. He said that excavation and/or drilling encountered clay at various depths below ground surface (BGS) Regarding Mr. Cakounes' fellow bog-owner, Linc Thacher, Mr. Cakounes provided the following information:

    a. Mr. Thacher supplies most of his bogs' agricultural needs with water pumped out of Sand Pond, as well as from a groundwater well that is located within (or immediately adjacent to the pump house on his property.

    b. The Thacher-owned bog system has at least one flow control structure. In the wet season, Mr. Cakounes warned that Sand Pond's water level should not be raised, due to the beaches along part of the pond's shoreline. This was noted as being in significant contrast with the situation along the Flax Pond residential shoreline (generally the southern shore), where the homes were built on much higher-elevation land.

24. Mr. Cakounes told us that he is licensed to use 11 million gallons He went on to say that he typically comes close to using the full amount.

25. Concerning his agricultural operations, Mr. Cakounes conducts wet cultivation/harvesting in his northern two bogs, and dry cultivation/harvesting in the southern bog. He floods the bogs in the springtime, and went on to say that Mr. Thacher does not conduct a spring flooding, whereas Mr. Coulson has started doing this.

26. In addition to the hydraulic/hydrologic considerations cited above, Mr. Cakounes emphasized that he uses organic farming techniques, and thus he must control bugs by flooding even in the wintertime now due to the exceptionally warm weather.

27. Mr. Cakounes stressed that his most pressing concern relates to water quality. Therefore, he has water samples collected and analyzed for a suite of water quality parameters, including E. coli, total coliform, and fecal coliform.

28. Discussion of water quality testing then centered on the sampling & analysis efforts of the Town, related to Flax Pond water quality improvements.

29. On the subject of water quality in Flax Pond, Mr. Cakounes cited how the pond's water quality has changed for the better by a significant amount, with the change starting in earnest about 11 to 12 years ago. He also noted that aerators had been placed in the pond but were removed (as another sign of water quality improvement). He believes the main reasons for the water quality improvements are related to the landfill capping and removal of the septage pits from just north of the pond near the landfill.

Site Visit No. 2 with Bog Owner Wayne Coulson

1. Mr. Coulson has owned and cultivated his bogs since 1974Types of cultivation:
    a. North bog – wet method; "black" fruit for juice.
    b. South bogs (2 of them) – dry method; for the fresh fruit market.
2. Mr. Sarkes' outflow is diverted and carried away, alongside the SW side of Mr. Coulson's southern bogs. The outflow comes in through a pipe that discharges into the ditch that runs alongside Mr. Coulson's bog until it connects to Coy Brook on the south side.
3. Mr. Coulson's operation is not "certified" as organic.
4. Mr. Coulson's operation does not have the ability to supply Mr. Sarkes' bogs with water. (Thus, Mr. Coulson confirms Mr. Cakounes' indication that Mr. Sarkes' operation depends on Flax Pond for all his water.)
5. Mr. Coulson indicated that if the water table rises, due to natural conditions or in the future due to artificially applied recharge, his system could drain it off effectively. As evidence of this capacity, he cited the proven ability to drain down his flooded bogs by 2-ft in 10 hours, overnight, from a maximum water level at only 1 to 1.5 ft below the top level of the bogs (as defined by the ground surface elevation of the land at the edges of the bogs).
6. Mr. Coulson noted that the culvert that carries Coy Brook under Great Western Road has had problems carrying the brook's flow. He also noted that recently Town DPW signs had been posted on Great Western Road in that vicinity, warning of upcoming bridge work – he speculated that the Town might be conducting upgrades to the Road's Coy Brook culvert/bridge [but subsequent windshield-survey checking demonstrated that the work is being done on a bridge further downstream on Lothrop Road].
7. Mr. Coulson indicated that the bogs he now owns were originally constructed in the 1800s.
8. When questioned further about the bog system's hydraulic capacity, Mr. Coulson cited the big rainstorm last summer. He also said that there have only been 3 or 4 times that the bogs' hydraulic capacity and that of the downstream culvert have been stressed and that vegetation blocking the meandering stream could be the main cause.
9. Regarding surveyed or relative elevations, water depths, and operating water levels, as well as surficial geologic conditions affecting subsurface flow-connection, here are several statements and indications from Mr. Coulson:
    a. He does not have surveyed elevations or related topographic mapping for his property.
    b. The two northeast ponds have a bottom elevation that is the same as in the northern bog.
    c. The northern bog has a bottom elevation that is roughly 0.5 ft above the bottom of the southern 2 bogs.

d. When asked what he thinks allows the ponds to be maintained several feet higher than the bogs immediately to the south, he indicated that believes the berm between the ponds and the northern bog has "hardpan" inside it.

e. The pond to the NW is much deeper than the NE pond and the bogs. He said that the bottom of the NW pond is approximately 12 feet below the current water level. That pond is used for irrigation source water.

10. Regarding hydraulic controls, Mr. Coulson provided the following information:

    a. He controls the structure that is located on the eastern side of the bike trail (former RR track alignment).

    b. He controls the flow using that structure as well as the other structures in his bog system in the springtime, for achieving appropriate flow rates to allow for effective bug control..

11. In regard to the history of his property and the cranberry cultivation there, Mr. Coulson offered the following:

    a. Before the RR tracks were placed, the bogs spanned across the RR track alignment, thus connecting the bog area (now uncultivated) with the bogs to the W/SW (currently cultivated or used for water storage).

    b. The bogs were constructed in the 1835-37 time-period.

    c. The historic record indicates that the bogs were constructed in a zone labeled "upland" or "rough swamp", circa 1835; and, by 1837, the historic record calls the property "bogs".

    d. The record also cites "Leonard Underwood" as the owner, and subsequently "Nathaniel Underwood".

12. Regarding flow rates, Mr. Coulson said that his bog system is fed solely by "runoff water". He does not conduct any tracking or measurement of flow rates or volumes.

13. Mr. Coulson noted that there was "a whole chain of bogs upstream (northeast) of his property and bog-system, but many or all of them are now uncultivated.

14. With respect to the presence of clay, Mr. Coulson cited these observations:

    a. He has seen "some veins of clay – such as under the pine trees east of the berm" that separates the ponds and his northern bog.

    b. Near his pump house, the shallowest sediments are "beautiful sands". But, there is a blue clay layer below that top sand layer.

15. Mr. Coulson reiterated that if the water table was to rise 1 ft, his bog system could handle it (without undue/unwanted flooding of the bogs) without any problems. From the other perspective of the potential for insufficient flow for good cultivation, Mr. Coulson cited time-periods – "back in the 1990s, maybe 1995 or so" – when he had some trouble getting enough water due to drought or near-drought conditions. In regard to agricultural practice and required water quality, Mr. Coulson noted the following:

a. He follows "GAP", or "Good Agricultural Practice" as defined by the Cranberry Growers Association.

b. Because he cultivates fresh fruit cranberries, the bogs' water quality must have no coliform bacteria.

16. Back on the subject of historical changes, Mr. Coulson cited the following:

a. There used to be a series of bogs and flumes, in a sort of "step-down" arrangement running from upstream to downstream.

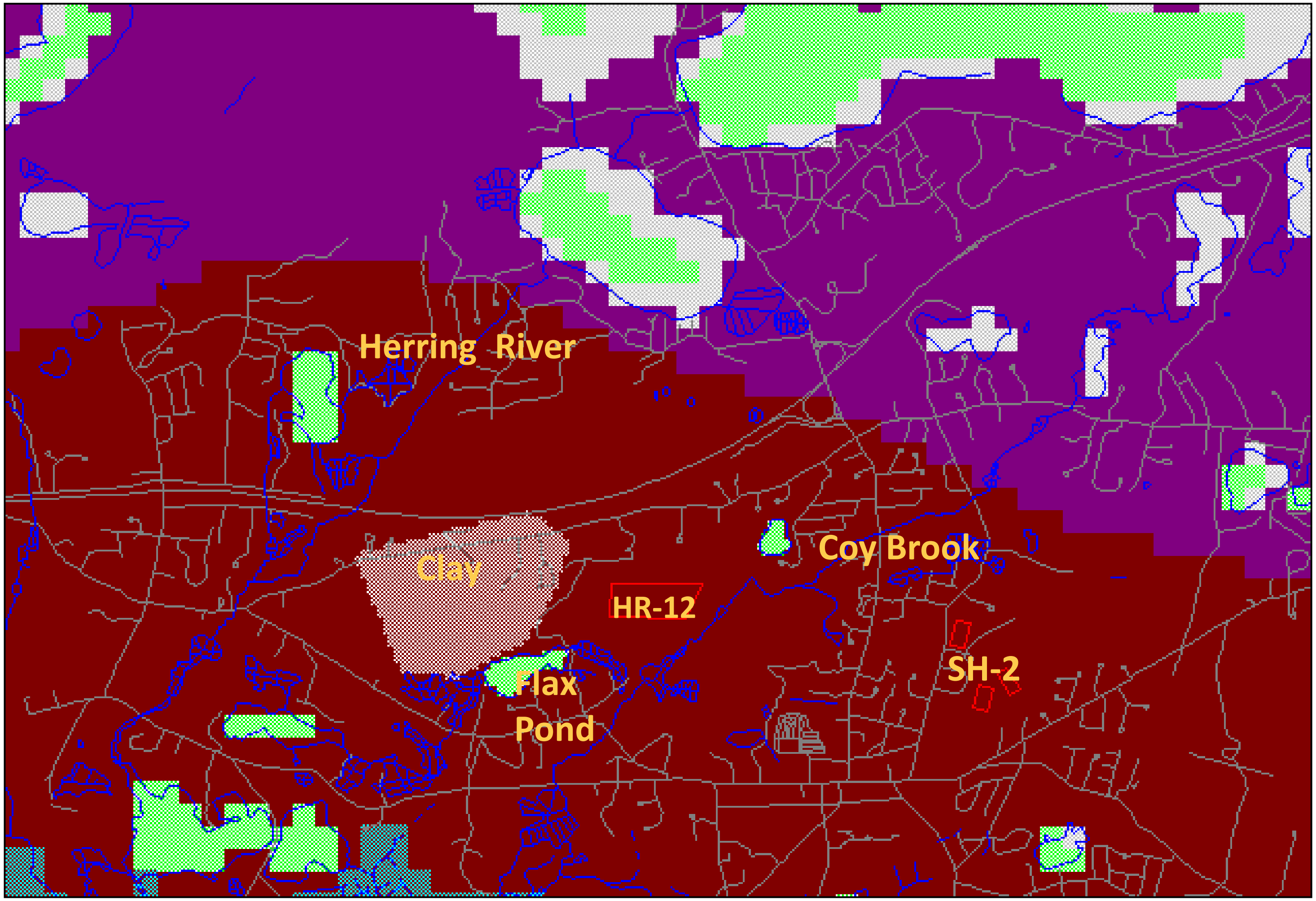
b. Many of these old bogs are now defunct or uncultivated.

17. Further on the subject of the storage ponds on his property, Mr. Coulson noted again that the NW pond is roughly 12 feet deep. In summer, it drops 5 feet from its winter/springtime filled condition, so that its water level is lowered to approximately 1 foot below the bottom, or ground surface elevation of the northern bog – which is the same elevation roughly of the bottom of the NE pond

Hydrogeological Report

Appendix F

Figure F-1
Simulation 3 Clay Extent Layer 6: 10 to 20 feet elevation



CDM Smith

Figure F-2
Simulation 3 Clay Extent Layer 7: -1 to 10 feet elevation

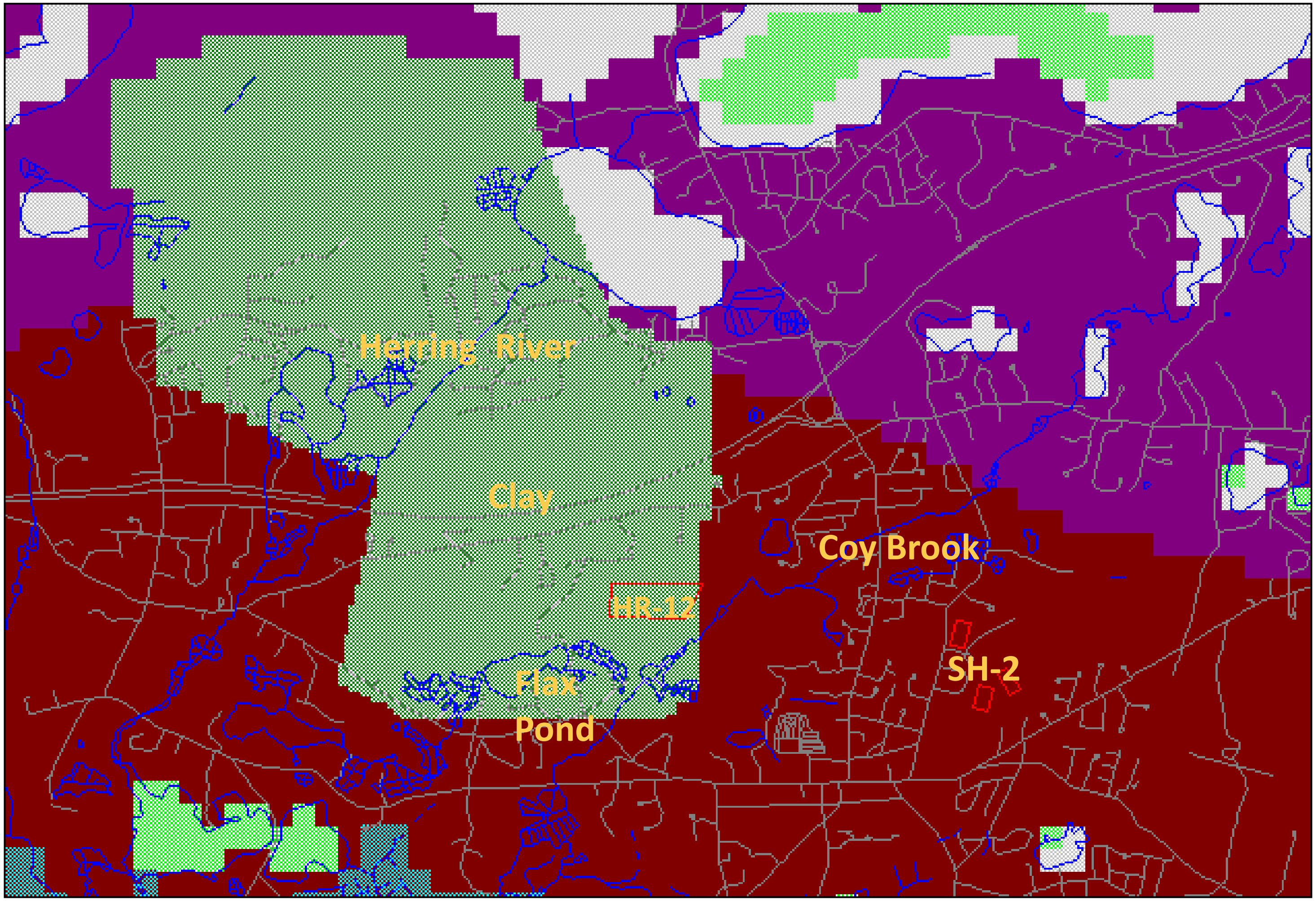
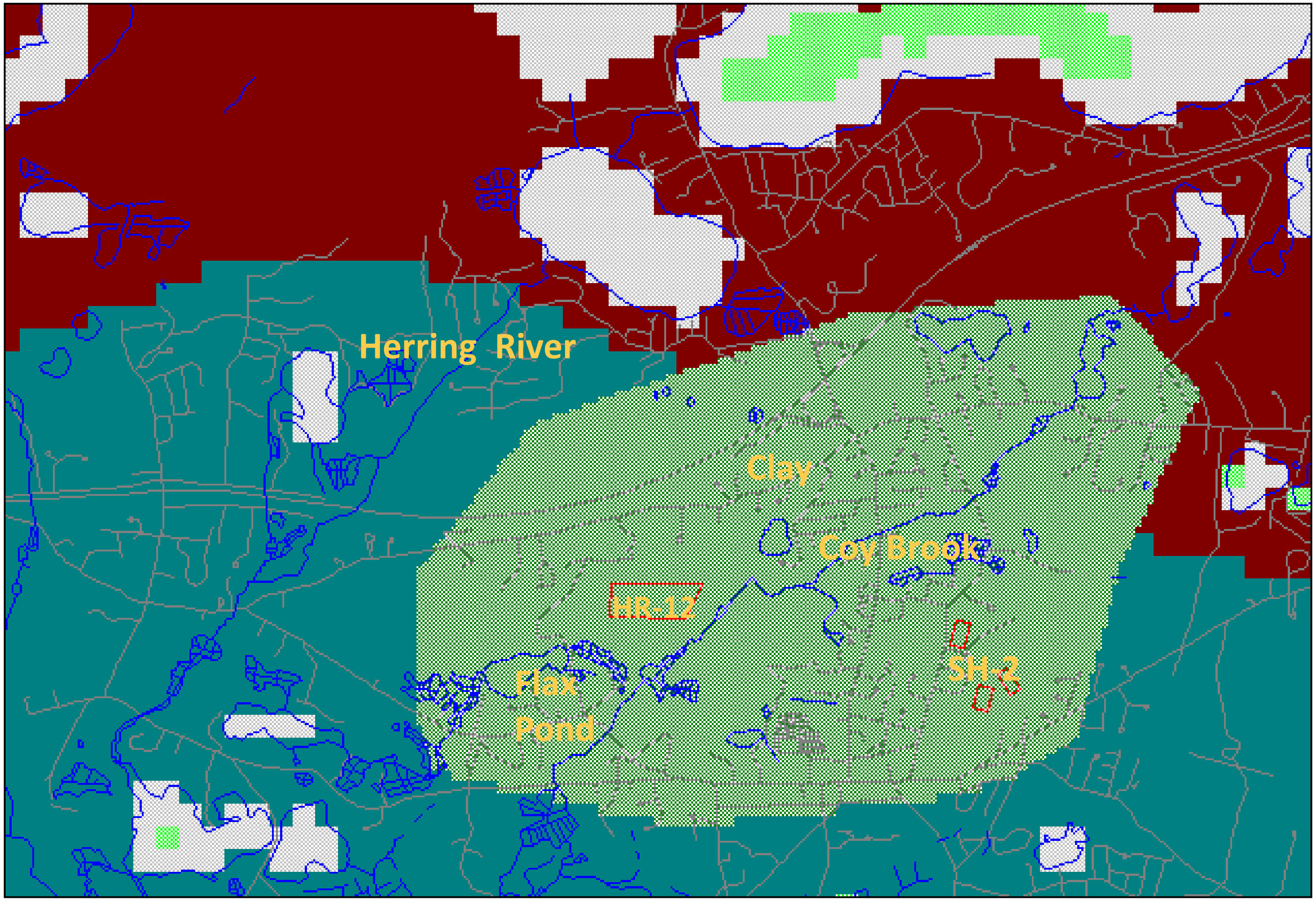


Figure F-3
Simulation 3 Clay Extent Layer 8: -10 to -1 feet elevation



CDM Smith

Figure F-4
Simulation 3 Modeled Surface Water Features near HR-12

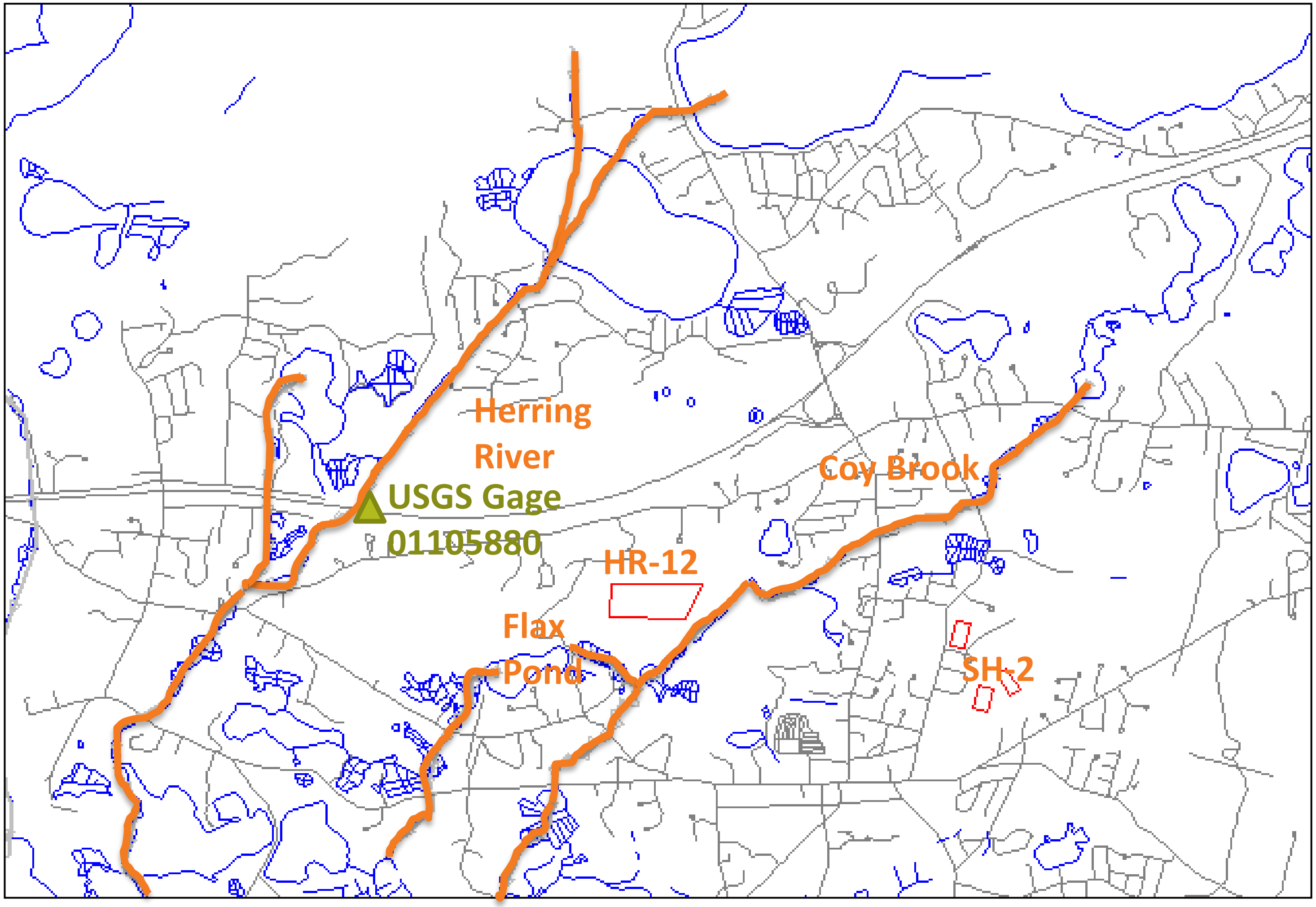
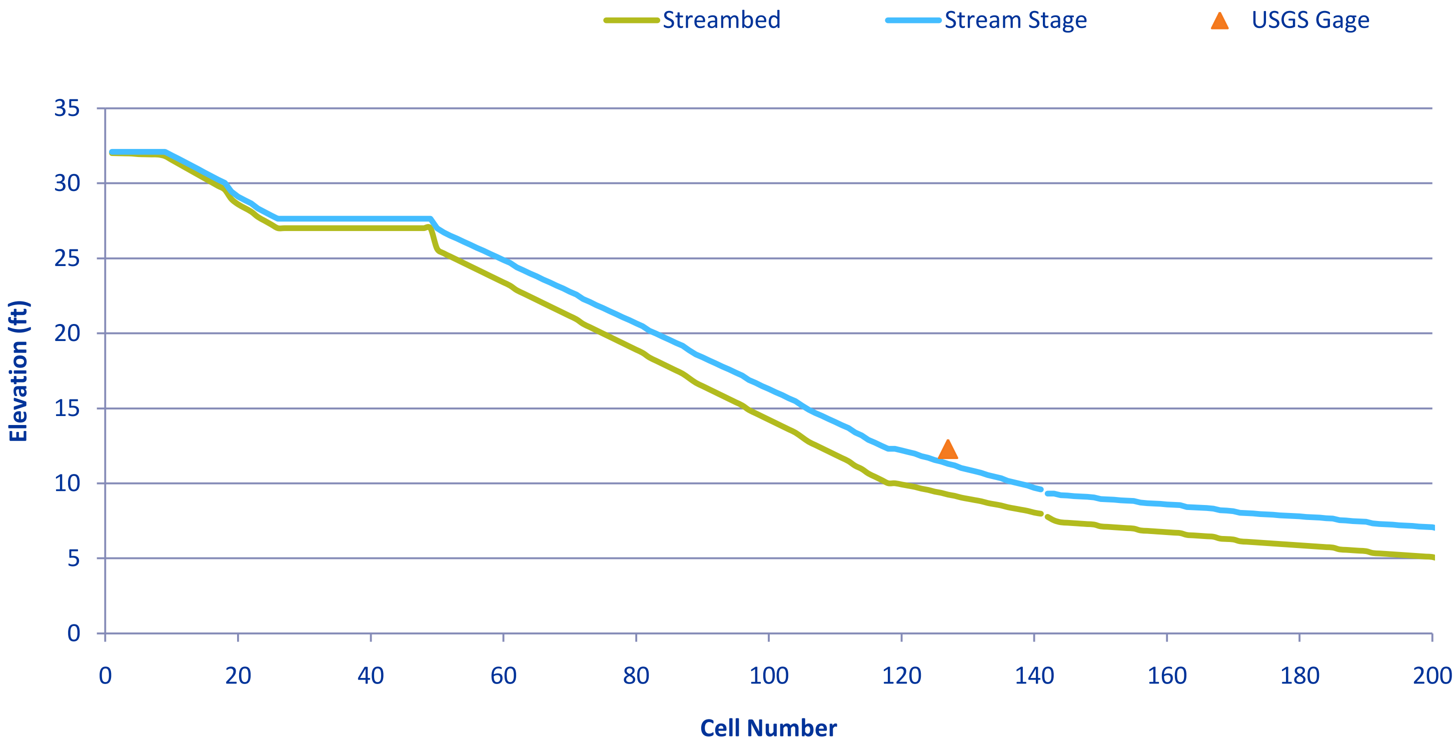
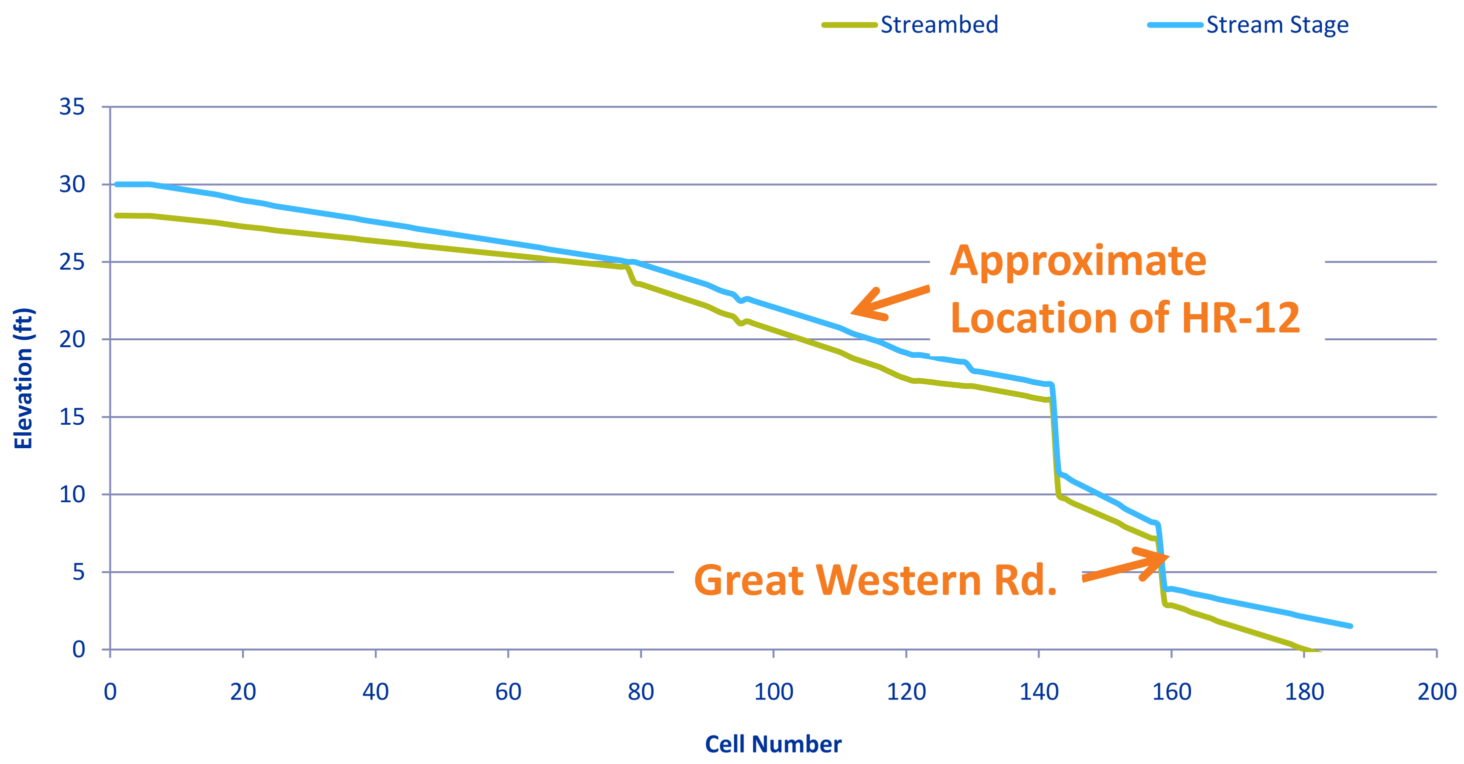


Figure F-5
Simulation 3 Herring River Modeled Streambed and Stage



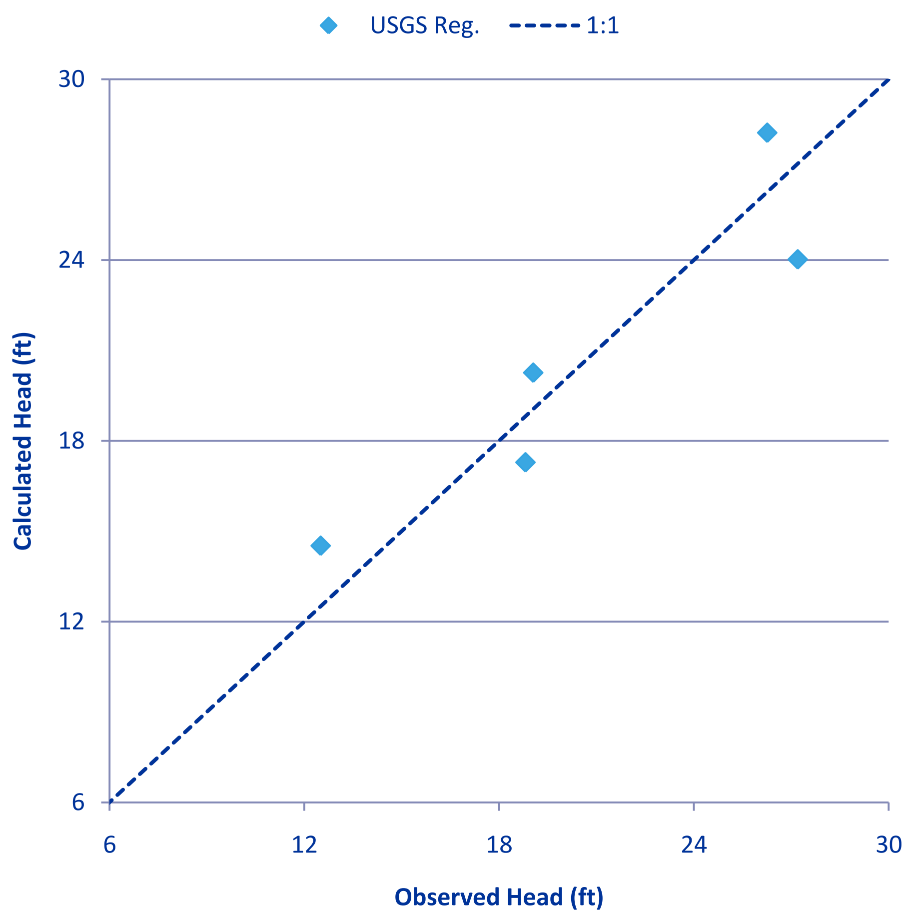
X axis shows the number of model cells from the start of the stream.
Length of stream varies within each cell.

Figure F-6
Simulation 3 Coy Brook Modeled Streambed and Stage



X axis shows the number of model cells from the start of the stream.
Length of stream varies within each cell.

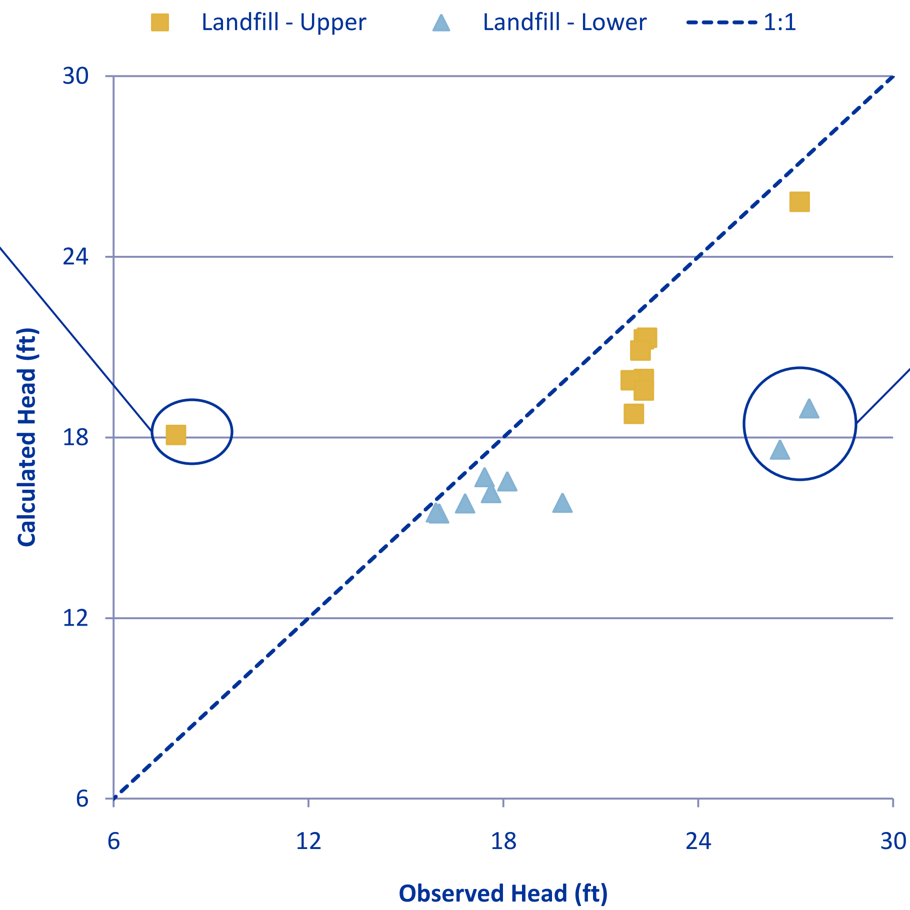
Figure F-7
Simulation 3 Model Calibration Check: USGS Regional Wells



CDM Smith

Figure F-8
Simulation 3 Model Calibration Check: Landfill Wells

Review of the boring logs suggests that this well (HWH-19) may not be connected to the upper aquifer due to heaving sand.



Review of the boring logs suggests that these wells (HWH-1 and HWH-8D) may be connected hydraulically to the upper aquifer.

Table F-1
Simulation 3 Model Calibration Check

Well	Aquifer	Measured Head (feet)	Modeled Head (feet)	Modeled Head – Cranberry Bogs Added (feet)
BMW-21	USGS well	26.3	29.2	28.2
BMW-44	USGS well	27.2	24.0	24.0
CGW-138	USGS well	12.5	14.6	14.5
HJW-141	USGS well	19.1	20.4	20.3
OSW-24	USGS well	18.8	17.7	17.3
HWH-1	Lower	27.4 *	20.4	19
HWH-2 S	Upper	21.9	23.6	19.9
HWH-2 M	Upper	22.0	22.0	18.8
HWH-2 D	Lower	19.8	17.5	15.8
HWH-3 S	Upper	22.2	24.2	20.9
HWH-3 M	Upper	22.3	22.4	19.6
HWH-3 D	Lower	17.6	17.8	16.2
HWH-3 DD	Lower	17.6	17.8	16.2
HWH-4 S	Upper	NM	--	--
HWH-4 D	Lower	16.8	17.4	15.8
HWH-8 S	Upper	27.1	28.4	25.8
HWH-8 D	Lower	26.5 *	19.1	17.6
HWH-11	Lower	16.0	17.0	15.5
HWH-14	Lower	15.9	17.2	15.5
HWH-17 S	Upper	22.3	24.5	21.3
HWH-17 M	Upper	22.3	22.7	19.9
HWH-17 D	Lower	18.1	18.2	16.5
HWH-18 S	Upper	22.4	24.5	21.3
HWH-18 D	Lower	17.4	18.3	16.7
HWH-19	Upper	7.9 *	21.6	18.1

Appendix E

Regional Connection to Chatham Memorandum

GHD developed a technical memorandum "Town of Harwich CWMP – Regional Connection Alternative to Chatham WPCF", dated February 13, 2013, which discusses the options – including opinions and costs – for transporting a portion of sewered wastewater from the Town of Harwich to the Chatham Water Pollution Control Facility (WPCF).

TECHNICAL MEMORANDUM

February 13, 2013

To	David Young, P.E., CDM Smith Inc.		
Copy to	Dr. Robert Duncanson, Town of Chatham		
From	J. Jefferson Gregg, P.E.	Tel	774-470-1640
Subject	Town of Harwich CWMP—Regional Connection Alternative to Chatham WPCF	Job No.	8614969

OBJECTIVE

The purpose of this memo is to evaluate options and provide opinions of costs for conveyance of approximately 300,000 to 340,000 gallons per day (gpd) of wastewater from the Town of Harwich to the Chatham Water Pollution Control Facility (WPCF). The consultant (CDM Smith) for the Town of Harwich has identified this flow range (reflecting whether the Great Sand Lakes area goes into the Pleasant Bay System or not) and tasked GHD with identifying the most appropriate route for this flow to be conveyed to the Chatham WPCF. The route will be selected to work in concert with the preliminary design of the collection system as depicted in the Chatham Comprehensive Wastewater Management Plan (CWMP). Collection system capital costs are developed based on the Chatham CWMP costs and on the proposed route outlined below. Capital costs and operations and maintenance (O&M) for treatment are based on the Harwich contribution to the overall flow amounts at the Chatham WPCF under full build-out conditions in Chatham.

This document reflects an update to the Preliminary Draft document provided to CDMSmith on May 16, 2012 to address their comments and comments from Chatham.

BACKGROUND

The Town of Harwich, and their consultant CDM Smith, is in the process of developing their CWMP and have requested information regarding the possible regional connection and treatment of flow from Harwich at the Chatham WPCF, which is located off of Sam Ryder Road and WPCF Drive in West Chatham. The facility is designed to treat 1.3 million gallons per day (mgd) and is currently permitted for 1.0 mgd. The facility is designed to reduce total nitrogen to 9,132 lb per year for the 1.0 mgd discharge limit. This corresponds to 3 mg/L total nitrogen on average. The facility is designed for a planned expansion to 1.9 mgd if and when Chatham implements the planned Phase 2 collection system expansion. This capacity is sufficient to treat the full build-out flow for the Chatham town-wide collection system, as outlined in the CWMP. However, the treatment facility has the ability to accept flow from Harwich, in the interim, as the collection system expands into new areas of Chatham. However, upon Chatham build-out, the average annual capacity would have to be increased to 2.2 to 2.24 mgd if the Harwich flow is accepted. Harwich has indicated that their summer peaking factor is 1.9 times average annual, which, as shown on the Chatham Final CWMP Table 2-4, is consistent with the Maximum Month peaking factor of 1.9 used for Chatham and as the basis for the flows and loads developed for the Chatham WPCF.

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ROUTING & SIZING

Alternative 1: Pumping Station #63

Under this alternative, Harwich would convey flow to a manhole at the end of a proposed gravity line on State Route 137 (Meetinghouse Road) in Chatham. From here, the flow will travel through the Chatham collection system, and pump station proposed for this area, and be conveyed to the WPCF. Once treated, a pump station at the WPCF would convey a like volume of treated water back to Harwich via a force main for recharge.

Wastewater from Harwich would be collected and is anticipated to be conveyed across the border with Chatham at the intersection of Route 137 and Old Queen Anne Road. From here, a force main would continue until the flow is discharged into the gravity collection system in Chatham. As part of the CWMP, the Town of Chatham developed preliminary sewer layouts for the entire town[1]. However, based on the addition of 300,000 gpd from Harwich, the layout needs to be modified to convey this larger flow to the WPCF efficiently.

In reviewing the proposed collection system, and following discussions with the Town of Chatham, we recommend that flow be conveyed from Harwich south on Route 137 for approximately 2,000 feet before entering a gravity sewer. From here, the flow would be conveyed by gravity sewer south on Route 137 to the Commerce Park industrial park, where pump station #63 would be constructed. Pump station #63 flow would be conveyed east to the WPCF via force main. An existing utility easement connects Commerce Park to the WPCF site via Chick's Way (refer to Figure 1 for additional details). Under this alternative, pump station #63 is proposed to become a major pump station, collecting flow from areas in Chatham north of Route 28 and west of Sam Ryder Road, and along Old Queen Anne Road. This includes flow from pump stations 4, 5, 6, 7, 8, 12, 40, 41, 63, 64, and 65 as depicted on the Chatham town-wide preliminary layout, an excerpt of which is included in Figure 4. Including the Harwich flow, the total size of the station is approximately 1,300 gallons per minute.

Table 1 Pumping Station #63 Sizing and Design Parameters

Source	Average Annual Flow (gpd)
Harwich	300,000
Chatham	138,000
Total	**438,000**

Design Parameters	
Peak Hr Peaking Factor[2]	4.2
Peak Hr Design Flow (gpm)	1,280

[1] Refer to Town of Chatham Preliminary Gravity Sewer and Low Pressure System Layout, April 14, 2006 an excerpt of which is included as part of Figure 4.
[2] Per TR-16, 2011 Edition, Page 2-3.

The industrial area surrounding pump station (PS) #63 was identified as a priority are for sewering in the CWMP, and thus PS #63 may be a good candidate to receive the Harwich flow, depending on the anticipated timetable for construction. However, the topography within the industrial park limits the potential locations for the station. Given the size of the station at approximately 1,300 gallons per minute and using the preferred setup of a self-contained suction lift station, the standard Gorman-Rupp offering is an eight-foot by twelve-foot structure, not including the generator or wet-well. In the feasible locations, there is not a significant amount of space and so the Town of Chatham would need to negotiate the taking of a portion of one of the parcels for this location to be viable. Refer to Figure 2 for additional details.

From pump station #63, a force main would enter the west side of the WPCF site and connect to the influent building. After treatment, Chatham's treated effluent is routed to one of four sand beds via a distribution box. In order to re-collect the Harwich flow, a pump station would be required. The pump station could draw from the distribution box and then return flow to Harwich. It is proposed that the flow returned to Harwich by this station would equal the amount sent from Harwich to Chatham. The on-site force main routing and proposed pump station location are shown on Figure 3 and would return to Harwich via Middle Road and Route 137.

Given the possible constraints in siting pump station #63, the Harwich flow could be routed to proposed pump station #6 (Alternative 2), which is planned to be located further north on Route 137, as shown on Figure 1. There is more potential space at this location and several Town-owned parcels, though it is unknown whether the land is available for use as part of the Chatham collection system or if there are constraints on construction of a station at this site.

Alternative 2: Pumping Station #6

Alternative 2 utilizes planned pumping station 6 (PS#6) to receive the Harwich flow. The location of this site is shown on Figure 1. This site is larger than the site for station #53 and is closer to the Harwich-Chatham town line. However, it is further from the Chatham WPCF and thus requires a longer force main to reach the site. The layout with PS#6 as a major pumping station is shown in Figure 5. The Harwich force main would connect to a planned gravity sewer at the intersection of Old Queen Anne Road and Route 137. From here, gravity sewer would convey the flow to PS#6. From PS#6, flow is conveyed south on Route 137 and then east on Middle Road to the WPCF site. The return force main routing is unchanged as a result of this change in receiving pumping station.

COSTS

Costs developed include the impact of the additional Harwich flow on the Chatham WPCF and collection system but do not include the cost of conveyance of the flow back to Harwich. The costs associated with taking flow from Harwich impact Chatham in three possible ways. First are operations and maintenance costs associated with handling the additional flow such as increased chemical consumption, electricity use, pump run times, and operational overhead. Second, the flow from Harwich consumes capacity at the WPCF that was designed to accommodate the Town of Chatham's sewer expansion, and for which it has borne the costs to date. Lastly, a planned connection by Harwich will alter the plans Chatham had developed for sewering the western portion of the Town where the Harwich flow would be received, potentially increasing the size or layout of the proposed infrastructure.

In the first two instances, a flow-weighted approach has been employed to estimate the cost impacts. As an example, in a hypothetical scenario where the two towns share a facility that cost $20 million to build and $1 million to operate annually, and each contributed 50% of the total flow, the cost would be $10 million to connect for the capital costs of the facility, and $500,000 annually for operations costs.

Table 2 shows the costs estimated to reach the 2.2 mgd capacity required to accommodate the original Town of Chatham projections as well as the Harwich connection.

Table 2 WPCF Costs [3]

Source	Current Construction	Planned Expansion	Expansion w/ Harwich
Capital Cost[4]	$33.5m	$43.2m	$50.0m
Design[5]	$1.8m	$2.3m	$2.6m
Construction Engr.	$5.0m	$6.5m	$7.5m
Total Project Cost	$40.3m	$51.9m	$60.1m
Capacity (mgd)	1.3	1.9	2.2

Total capital costs are estimated at $60.1 million for the fully built-out facility. Utilizing the flow-based approach noted above, Harwich (at 0.3 mgd) would consume 13.6% of 2.2 mgd total capacity, corresponding to a cost of $8.2 million. If this were increased to 340,000 gpd, Harwich would consume approximately 15.5% of the total flow (2.24 mgd) and have a corresponding cost of $9.2 million. The exact timing and breakdown of this cost, relative to the timing of the connection and future upgrades of the WPCF, would require more detailed negotiation between the two towns. Further, the Chatham WPCF is currently designed with an expansion to 1.9 mgd in mind. For instance, piping and electrical equipment sizing is in place to accommodate a third clarifier and a fourth channel on the oxidation ditch reactor. If the facility must accommodate 2.2 mgd, additional facilities or alternative technologies may need to be employed and a more detailed evaluation would be required to characterize the layout, technologies, and costs for such a system. For this evaluation, we have simply expanded the projected 1.9 mgd facility costs on a flow-weighted basis to estimate costs for the 2.2 mgd facility. These costs also exclude the cost of the effluent disposal beds; if Chatham and Harwich negotiate the initial discharge at the existing sand beds, the Towns will have to establish a cost for their usage.

Operations and maintenance costs were projected for the CWMP and are reproduced in the following Table 3. The costs include treatment to the Chatham WPCF permit limits.

[3] Modified to exclude the costs for effluent disposal beds, as Harwich does not benefit from these facilities – and based on 300,000 gpd.
[4] Based on Bid Price and full USDA contingency of 10%
[5] Based on preliminary and final design cost

Table 3 Annual O&M Costs

Source	Total O&M[6]	Harwich Share
Collection and Pump Stations[7]	$27,000	$17,000
WPCF[8]	$1,600,000	$230,000
Total Cost	$1,630,000	$250,000

As shown in Table 3, the Harwich flows are projected to increase O&M costs by $250,000 per year on a flow weighted basis. For the WPCF this is on a flow-weighted basis for the entire facility; while for the collection system, Harwich is responsible for the flow weighted proportion of O&M costs within the relevant sewershed in Chatham and at pumping station #63 under this alternative.

For the collection system capital costs, we have compared the planned sewer costs for the Town of Chatham to the revised sewer costs with the Harwich connection. In the planned gravity sewer area connecting to pumping station #63, the pipe sizes have increased from 8-inches to 12-inches and the only cost assigned to Harwich is the incremental size of the pipe. The pumping station size has increased according to the flows in Table 1. There is an existing force main from the Chatham Fish and Lobster building in the industrial park that connects directly to the WPCF. With a smaller station, the Town could use this force main by allowing the Chatham Fish and Lobster to connect to pumping station #63 by gravity, and then using the force main to connect to the WPCF. However, with the Harwich flow and the increased pumping station size, the 4-inch diameter force main is not sufficient, and so the full cost for the 10-inch main is attributed to Harwich for a portion of the distance between the pumping station and the WPCF. Figure 1 shows the extent of the 4-inch and 10-inch mains.

[6] Adapted from Chatham CWMP Table 11-1
[7] For sewers serving pumping station #63 only
[8] Does not include effluent pumping station and force main or effluent disposal at the existing beds

Table 4 Alternative 1 Collection System Costs[9]

Infrastructure with Harwich Connection	Quantity	Total Unit Cost	Total Cost ($m)	Impact Due to Harwich Connection	Incremental Unit Cost	Harwich Share of Cost
12” Gravity Sewer	3760 (ft)	$322	$1.2	Increase from 8” Sewer	$8	$30,000
Upgrade PS63 to 1,300 gpm[10]	1 (ea)	$1.1m	$1.1	Increase from 400 gpm station	$530,000	$530,000
Upgrade to 10” Forcemain in Industrial Park	450 (ft)	$175	$0.08	Increase from 4” force main	$59	$30,000
Additional 10” Forcemain to WPCF	950 (ft)	$175	$0.17	Install Pipe Not Needed Originally	$175	$170,000
10” Forcemain in Route 137	2,000 (ft)	$215	$0.43	Install Pipe Not Needed Originally	$215	$430,000
Subtotal			**$3,000,000**	**Subtotal**		**$1,200,000**
Contingency (25%)			$750,000	Contingency (25%)		$300,000
Design (10%)			$300,000	Design (10%)		$120,000
Fiscal, Legal, Construction Engineering (15%)			$450,000	Fiscal, Legal, Construction Engineering (15%)		$180,000
Total			**$4,500,000**	**Total**		**$1,800,000**

Combining the collection system upgrades, WPCF costs, and annual O&M, the total costs for Harwich to connect are estimated to be $10 million in capital expenditure ($1.8 million for the collection system and $8.2 million for the WPCF) and $250,000 annually to assist the Town of Chatham in operating and maintaining the system. This does not include the costs for the effluent pumping station and the force main which will return flow to Harwich. These costs are being developed separately and should be added to the costs shown here to estimate the full cost if Harwich plans to pursue this alternative.

Alternative 2 costs are summarized in Table 5

[9] Does not include the cost of effluent pumping station and force main
[10] Does not include the cost of land acquisition

Table 5 Alternative 2 Collection System Costs[11]

Infrastructure with Harwich Connection	Quantity	Total Unit Cost	Total Cost	Impact Due to Harwich Connection	Incremental Unit Cost	Harwich Share of Cost
12" Gravity Sewer	960 (ft)	$292	$280,000	Increase from 8" Sewer	$8	$8,000
Upgrade PS#6 to 900 gpm[12]	1 (ea)	$0.9m	$900,000	Increase from 125 gpm station	$510,000	$510,000
Upgrade to 10" Forcemain	1,100 (ft)	$215	$240,000	Increase from 4" force main	$59	$70,000
Additional 10" Forcemain to WPCF	3,040 (ft)	$175	$530,000	Install Pipe Not Needed Originally	$175	$530,000
10" Forcemain in Route 137	2,190 (ft)	$215	$470,000	Install Pipe Not Needed Originally	$215	$470,000
Subtotal			**$2,300,000**	**Subtotal**		**$1,600,000**
Contingency (25%)			$610,000	Contingency (25%)		$400,000
Design (10%)			$240,000	Design (10%)		$160,000
Fiscal, Legal, Construction Engineering (15%)			$360,000	Fiscal, Legal, Construction Engineering (15%)		$240,000
Total			**$3,600,000**	**Total**		**$2,400,000**

Under this alternative, the total cost of the infrastructure to connect Harwich to the WPCF is less, but the share to Harwich is more than under the PS#63 alternative. There are other advantages under this alternative. First, the PS#6 site has more space available than the site at the industrial park. Also, siting a major pumping station at PS#6 eliminates the need for several pipe runs within Route 137.

Under the Chatham Preliminary Design, pumping stations 6, 7, and 64 were all to connect to gravity sewer within the same short stretch of Route 137, just south of Paulding Drive (refer to Figure 4). Thus, if Harwich connected as well, there would be three 4-inch force mains (pumping stations 6, 7, and 64) two 10-inch force mains (from Harwich to PS#63, from the WPCF back to Harwich) and an 8-inch gravity sewer. The road right-of-way may not be wide enough to support all such utilities in addition to the water and gas mains that are present in this stretch of roadway, and so other accommodations or routing may be necessary.

With PS#6 as a major station, flow from stations 7 and 64 can be re-routed to PS#6 and the PS#6 force main is combined with the large force main carrying the flow from Harwich. This eliminates three 4-inch force mains, making construction of the sewer infrastructure in this area much more straightforward.

The total costs to each town under the different options are shown in the following Table 6.

[11] Does not include the cost of effluent pumping station and force main
[12] Does not include the cost of land acquisition

Table 6 Collection System Costs Comparison

Alternative	Chatham Cost	Harwich Cost	Total Cost
1 (PS#63)	$2.7 million	$1.8 million	$4.5 million
2 (PS#6)	$1.2 million	$2.4 million	$3.6 million

SUMMARY

The Chatham WPCF is currently designed for 1.3 mgd and permitted for 1.0 mgd and could receive flow from Harwich in the near future without encountering capacity issues. However, as sewer expansion in Chatham continues, the facility will approach its design capacity. At that point, an upgrade would be pursued to accommodate the planned flows from both towns. Further, the Chatham collection system proposed to serve this area can receive flow from Harwich, but modifications will be required to the preliminary design developed as part of the CWMP. This portion of the collection system has not been constructed and so this memorandum summarizes the changes that would be required when infrastructure is installed in the area in question. The total cost is estimated to be $10.6 million, with an additional $250,000 in yearly operating and maintenance costs as shown in the following Table 5. These costs are estimated based on an ENR index of 9475 as provided by the consultant (CDM Smith) for the Town of Harwich and should be inflated as costs rise. Costs will also need to be adjusted as the scope of work for the infrastructure and WPCF expansion in question is finalized and design decisions alter any projections made during the planning process.

Table 7 Cost Summary

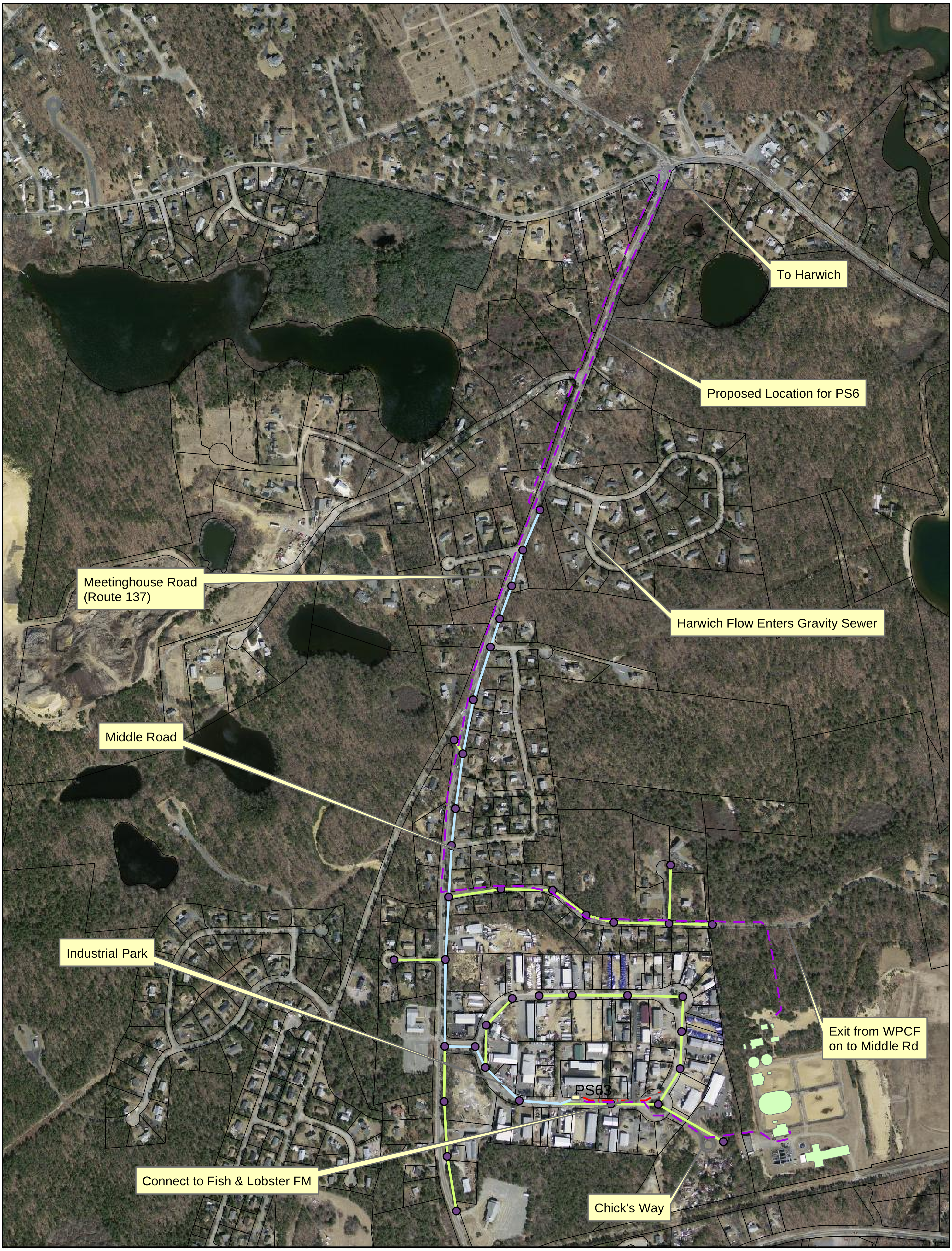
Item	Total	Harwich Share (300,000 gpd)	Harwich Share (340,000 gpd)
WPCF Costs	$60,100,000	$8,200,000	$9,200,000
Collection System Costs[13]	$3,600,000	$2,400,000	$2,400,000
Total Capital Cost	$64,600,000	$10,600,000	$11,600,000
Operation and Maintenance (yearly)[14]	$1,630,000	$250,000	$260,000

Overall, transport from Harwich to Chatham for treatment and back again for disposal offers both towns an advantage. Chatham receives additional flow and an expanded user base sooner without the capital expenditure of accelerating their own collection system expansion, taking advantage of its installed capacity. Harwich could accelerate their implementation schedule by avoiding the need to site and construct a facility with limit of technology nitrogen removal capabilities.

[13] Collection system elements associated with the Harwich connection only. Does not include effluent pumping station and force main.
[14] WPCF costs and collection system costs associated with pumping station #63/#6 only. Does not include effluent disposal at Chatham WPCF.

Chatham's town-wide CWMP is a 30-year master plan, with Phase 1 to meet the nitrogen TMDLs in the Town's embayments planned for the first 20 years. Upon completion of Phase 1 the town would look to implement the Phase 2 treatment facility expansion and sewer extensions. Harwich's phasing plan should be able to be coordinated with Phase 1. The addition of flow from Harwich may result in the planned expansion of the treatment facility (to Phase 2 capacity) occurring earlier (by several (3-5) years) than originally planned. However, other nutrient mitigation actions being evaluated by the two towns may factor into this timing.

The Boards of Selectmen in Harwich and Chatham recently signed a joint statement acknowledging the benefits to each community by continuing to evaluate cooperative approaches to wastewater management.



Legend

Force Main
4"
10"

Gravity Sewer
8"
12"

Manholes

New Buildings

0 250 500 1,000 Feet

Paper Size ANSI B

Map Projection: Lambert Conformal Conic
Horizontal Datum: North American 1983
Grid: NAD 1983 StatePlane Massachusetts Mainland FIPS 2001 Feet

CDM Smith Inc.
Harwich Comprehensive
Wastewater Management Plan

Job Number 86-14969
Revision B
Date 11 May 2012

Force Main Routing and Gravity Sewer Extents

Figure 1

G:\86\14969\GIS\Fig1b - Forcemain Routing.mxd

1545 Iyannough Rd Hyannis MA 02601 USA **T** 774-470-1630 **F**774-470-1631 **E** hyamail@ghd.com **W** www.ghd.com

Data source: Data Custodian, Data Set Name/Title, Version/Date. Created by:arochs

Paper Size ANSI A

0 50 100 200
Feet

Map Projection: Lambert Conformal Conic
Horizontal Datum: North American 1927
Grid: NAD 1927 StatePlane Massachusetts Mainland FIPS 2001

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Wastewater Management Plan

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Revision | A
Date | 11 May 2012

Potential Locations
Pump Station 63

Figure 2

G:\86\14969\GIS\Fig2 - PS Locations.mxd

1545 Iyannough Road, Hyannis Massachusetts 02601 USA T 1 508 362 5680 F 1 508 362 5684 E hyamail@ghd.com W www.ghd.com

Data source: Data Custodian, Data Set Name/Title, Version/Date. Created by:arochs

Paper Size ANSI A

Map Projection: Lambert Conformal Conic
Horizontal Datum: North American 1927
Grid: NAD 1927 StatePlane Massachusetts Mainland FIPS 2001

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Harwich Comprehensive
Wastewater Management Plan

Job Number | 86-14969
Revision | A
Date | 11 May 2012

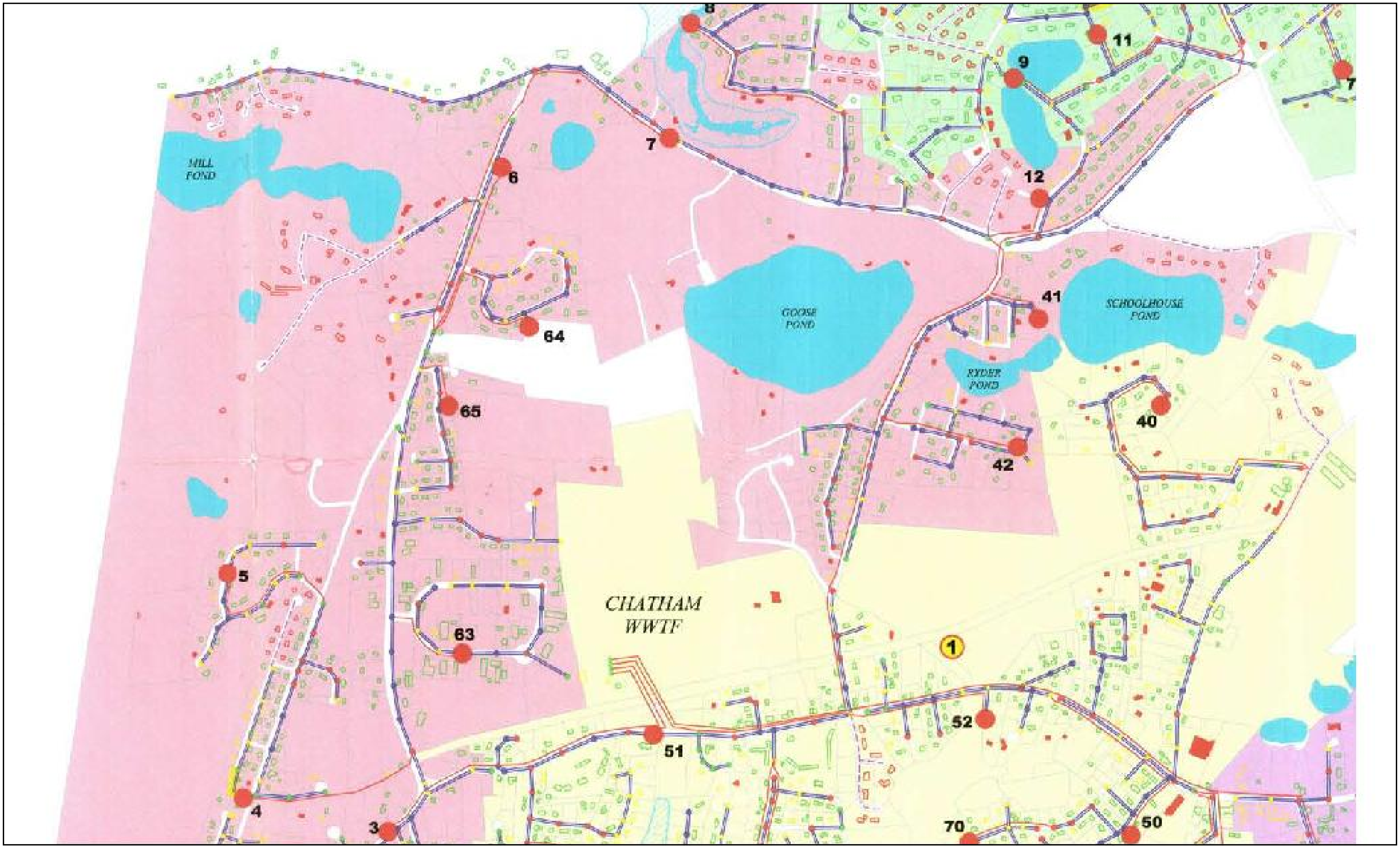
Proposed Force Main Routing
and Pump Station Location

Figure 3

G:\86\14969\GIS\Aerial for Fig3.mxd

1545 Iyannough Road, Hyannis Massachusetts 02601 USA **T** 1 508 362 5680 **F** 1 508 362 5684 **E** hyamail@ghd.com **W** www.ghd.com

Data source: Data Custodian, Data Set Name/Title, Version/Date. Created by:arochs



Paper Size ANSI A

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Wastewater Management Plan

Job Number 86-14969
Revision A
Date 15 May 2012

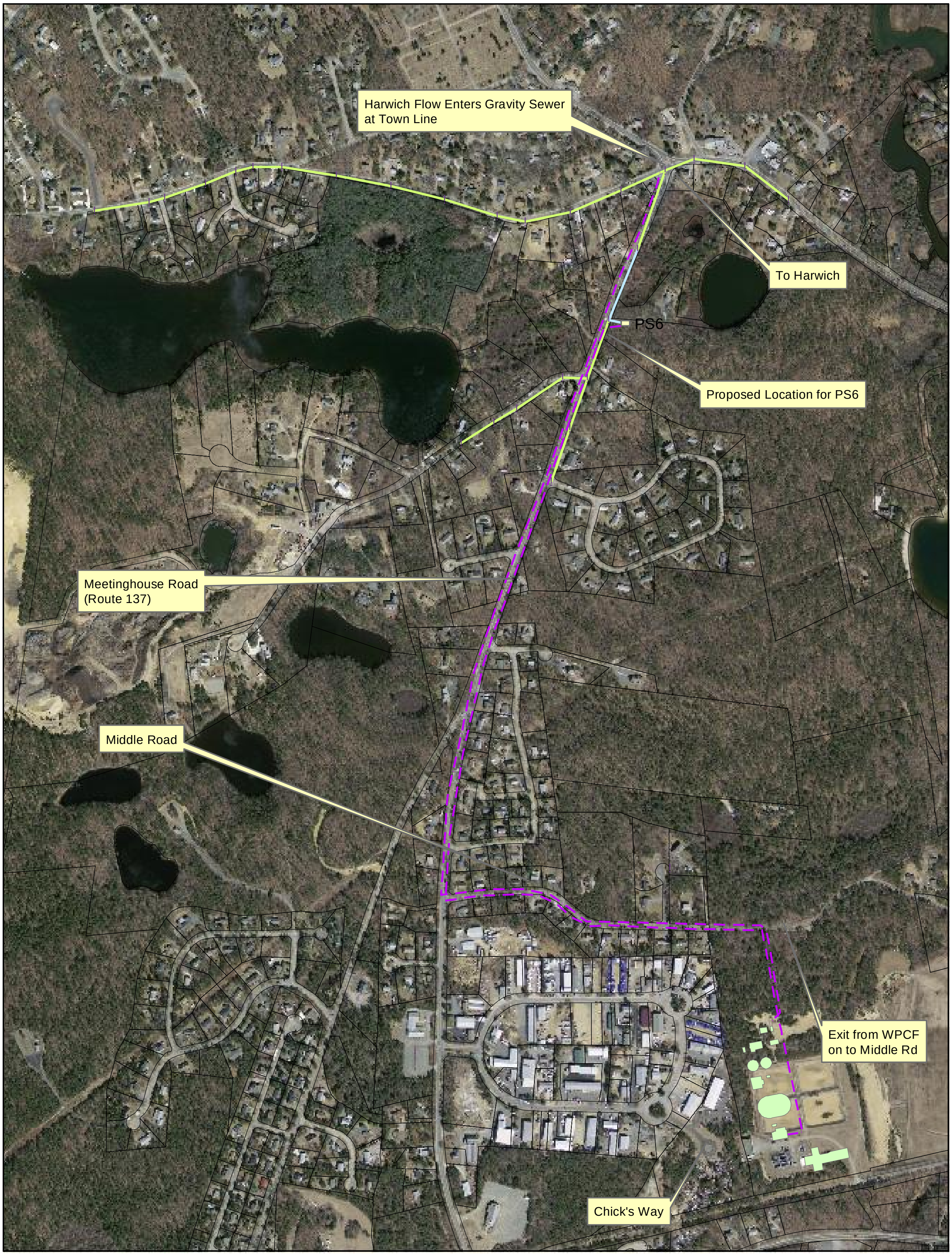
Prelim. Design Pump
Station Locations

Figure 4

G:\86\14969\GIS\Fig4 - Prelim Design Map.mxd

1545 Iyannough Road, Hyannis Massachusetts 02601 USA T 1 508 362 5680 F 1 508 362 5684 E hyamail@ghd.com W www.ghd.com

Data source: Data Custodian, Data Set Name/Title, Version/Date. Created by:arochs



Legend

Force Main
10"

Gravity Sewer
8"
12"

Manholes

New Buildings

0 250 500 1,000 Feet

Paper Size ANSI B

Map Projection: Lambert Conformal Conic
Horizontal Datum: North American 1983
Grid: NAD 1983 StatePlane Massachusetts Mainland FIPS 2001 Feet

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Harwich Comprehensive
Wastewater Management Plan

Site 6 Gravity
and Force Main Extents

Job Number	86-14969
Revision	A
Date	11 Jun 2012

Figure 5

G:\86\14969\GIS\Fig 5 - Site 6.mxd

1545 Iyannough Rd Hyannis MA 02601 USA **T** 774-470-1630 **F**774-470-1631 **E** hyamail@ghd.com **W** www.ghd.com

Data source: Data Custodian, Data Set Name/Title, Version/Date. Created by:arochs

Appendix F

TOC of Solar Array Contract at Site HR-12

This appendix includes the table of contents for the Solar Array Contract at Site HR-12.

A full copy of the contract is available through the Town of Harwich.

ENERGY MANAGEMENT SERVICES AGREEMENT

FOR SOLAR PHOTOVOLTAIC SYSTEM

BETWEEN

CAPE & VINEYARD ELECTRIC COOPERATIVE, INC.

AND

CAPE SOLAR TWO, LLC

Standard Form/(v. 06.28.11)

Harwich Landfill

TABLE OF CONTENTS

Appendix G

Cost Recovery Plan

Wastewater Implementation Committee (WIC) Memorandum Submitted to the Harwich Board of Selectmen (BOS) on April 16, 2015/ Revised July 21, 2015

Memorandum

To: *Harwich Board of Selectmen*

From: *Wastewater Implementation Committee (WIC)*

Date: *April 16, 2015/ Revised July 21, 2015*

Subject: *Recommended Cost Recovery Model for Wastewater Program Implementation*

The Massachusetts Department of Environmental Protection (MassDEP) requires several financial issues to be discussed including capital costs, rate impacts and the method for apportioning capital among different classes of users - residential, commercial, industrial and institutional. Our Draft Comprehensive Wastewater Management Plan (CWMP) currently describes estimated capital and operation and maintenance costs. Thus we need to develop a policy for apportioning costs to generate revenue to pay for the program implementation and then evaluate the impact on various rates from funding options recommended.

The purpose of this memo is to provide information on various funding options for Harwich including potential costs and pros/cons of each to start the discussion on how best to apportion the costs to implement the Draft CWMP. Although the entire CWMP envisions implementation over more than 40 years and eight phases, this discussion covers the first three phases in which we have a reasonable chance of planning. Even then changes in "adaptive management" possibilities, land use, regulations, etc., make planning challenging as the program will change during implementation. But we must move forward now to start to restore our degraded water quality.

As defined in the Draft CWMP, the first three implementation phases include:

Phase	Est. Dates	Est. Cost	Action
1	2015-2016	$2,550,000	Natural Attenuation Projects; Muddy Creek; Cold Brook
2	2016-2020	$24,300,000	Design & Constr. Pleasant Bay Collection (south)
3	2021-2025	$21,010,000	Additional Pleasant Bay Sewers; (north) and Chatham connection costs

WIC Strategy

The WIC conducted several discussions regarding methods available to recover costs as the wastewater program is implemented. During these discussions three tenets developed as various members expressed their beliefs. First, the WIC felt strongly that everyone in the Harwich community will benefit from restored water quality and that everyone contributes in some manner to the biggest problem; nitrogen coming from on-site septic systems. So the overwhelming feeling was that everyone in town should help pay for a large part of the program implementation costs. Second, the WIC felt that there should be a dedicated funding source to help pay for wastewater program components that could not be utilized for other town programs. This dedicated annual source could help build a fund that could help lower or offset some costs for larger program implementation phases. Third, the WIC felt there should be a component that reflected the amount of water used or nitrogen contributed by a specific home or business owner. This aspect would help address the issue of smaller contributors paying less and larger contributors paying more. These three tenets ultimately evolved into the strategy the WIC utilized in developing their recommended cost recovery model.

WIC Recommendation

After much discussion among the WIC members and unanimously voted at their meeting on March 6, 2015, the following three cost recovery options are recommended. Pros and cons for each are listed followed by a projected bond payment schedule utilizing the three options:

1. **Town-wide property taxes. Debt payments for funds borrowed for 20 or 30 years at up to 2% interest.**

   Pros:

   - Utilization of property taxes is a town-wide funding source which is consistent with our goal for the CWMP to implement a plan to protect town's water resources (estuaries, embayments, ponds and drinking water) for the benefit of all residents.

   - Distributes expenses across all property owners as all property owners contribute to the water quality degradation (and solution).

   - Is fair as approximately half the town could potentially be sewered as only the required number of properties will be connected to a treatment plant to reach sufficient nitrogen removal required to meet the Total Maximum Daily Load (TMDL) permit.

   - Simple to implement, not tied to specific wastewater project site, program or implementation phase.

   - Collected tax would go to a dedicated CWMP Implementation Fund; not the Harwich General Fund.

   - Number of connections required may decrease if mitigation options work (adaptive management) based on monitoring feedback.

   - Property tax is progressive which helps align each property owner's ability to pay their fair share of the project cost.

- Cost would be tax deductible.
- Avoids penalizing "first adopters", i.e., those first on the system due to watershed and/or location within watershed/ town.
- Provides funding mechanism not tied to construction so that non-infrastructure components of CWMP recommendations can be implemented. Relevant for Harwich as initial phases include conducting mitigation studies to determine the best way of moving forward and hopefully minimizing long-term costs. Can be used for paying operating costs as well.

Cons:

- All town property owners will help pay program costs whether connected or not connected to a sewer system.
- Prop. 2 1/2 capital exclusion required; increases property taxes (town-meeting vote & ballot approval required).
- Those connecting to a sewer will pay additional costs to connect from collection sewers in street to house/business and annual sewer operating and maintenance costs.
- Nitrogen contribution from a home is not directly proportional to a home's assessed (tax) value.

2. **Water Bill Surcharges/ Sewer Enterprise Account - add a surcharge to water bills to help pay for wastewater program capital and operating costs.**

Pros:

- Town-wide funding source dedicated to wastewater program.
- A non-property funding source.
- Can be used to pay capital costs and operation and maintenance costs.
- Relates fee to water use (sewer) demand.
- Can easily implement, track and invoice users.
- Create and fund sewer enterprise funds with dedicated funding source.
- Could initiate before funds are needed to build a sewer reserve account.
- Water use is essentially proportional to the amount of nitrogen being contributed.

- A block rate structure could be used to shift more of this burden to seasonal users and offset low volume year round users.

Cons:

- May require Special Legislation or formation of sewer district for all fees to apply to all water users not just those connected to sewer.
- Will require creation of a Wastewater/Sewer Enterprise Account.
- Need to develop means to capture fee from approximately 250 residences on wells in Harwich

3. Infrastructure Investment Fund:

Pros:

- Town-wide program.
- Another funding source.
- Attractive if state participates as it does in CPA (currently not in legislation).
- Progressive.
- Doesn't count against Prop 2 1/2 Cap.
- Could shift some of the existing CPA percentage over to the infrastructure percentage to help offset increase (don't exceed combined 3% total; adjust for land bank).
- Cost would be tax deductible.

Cons:

- In essence, an additional property tax

Projected Cost Impacts

Table 1 shows the projected debt service schedule for bonding the capital to implement the first three phases of the wastewater program. It is assumed that the State Revolving Fund (SRF) loan program would be used and that a 1.5 percent interest rate for a 20 year bond period would be received. Harwich should be eligible for a zero to 2 percent SRF loan and could bond for either 20 or 30 years.

Table 1
Projected Debt Service Schedule

Year	Phase 1	Phase 2	Phase 3	Total
2016	$165,750			$165,750
2017	$163,838			$163,838
2018	$161,925			$161,925
2019	$160,013			$160,013
2020	$158,100	$1,579,500		$1,737,600
2021	$156,188	$1,561,275		$1,717,463
2022	$154,275	$1,543,050		$1,697,325
2023	$152,363	$1,524,825		$1,677,188
2024	$150,450	$1,506,600		$1,657,050
2025	$148,538	$1,488,375		$1,636,913
2026	$146,625	$1,470,150	$1,365,650	$2,982,425
2027	$144,713	$1,451,925	$1,349,893	$2,946,530
2028	$142,800	$1,433,700	$1,334,135	$2,910,635
2029	$140,888	$1,415,475	$1,318,378	$2,874,740
2030	$138,975	$1,397,250	$1,302,620	$2,838,845
2031	$137,063	$1,379,025	$1,286,863	$2,802,950
2032	$135,150	$1,360,800	$1,271,105	$2,767,055
2033	$133,238	$1,342,575	$1,255,348	$2,731,160
2034	$131,325	$1,324,350	$1,239,590	$2,695,265
2035	$129,413	$1,306,125	$1,223,833	$2,659,370
2036		$1,287,900	$1,208,075	$2,495,975
2037		$1,269,675	$1,192,318	$2,461,993
2038		$1,251,450	$1,176,560	$2,428,010
2039		$1,233,225	$1,160,803	$2,394,028
2040			$1,145,045	$1,145,045
2041			$1,129,288	$1,129,288
2042			$1,113,530	$1,113,530
2043			$1,097,773	$1,097,773
2044			$1,082,015	$1,082,015
2045			$1,066,258	$1,066,258
TOTALS:	**$2,951,625**	**$28,127,250**	**$24,319,075**	**$55,397,950**

Table 2 shows the cost impacts from implementing the WIC recommended cost recovery model. The first couple of columns show the year and projected tax revenue to be collected from property taxes using a 2016 base year of $47 Million and escalating 2.5 percent annually. Then using 1.5 percent for the Infrastructure Investment Fund the amount collected is shown. That amount is then subtracted from the amount of total principal and interest owed annually to pay the bonds (from Table 1). To simplify this calculation any remaining Infrastructure Investment Fund money would be placed in a stabilization fund to be available for future projects or lowering of rates. The next column shows the amount of revenue needed using 75 percent from property taxes collected annually. The additional tax on an assessed value home of $400,000 is shown. The next couple of columns show the 25 percent raised from the sewer enterprise account (water rate surcharge). The next columns show the amount collected from increasing the water rate via the sewer enterprise account and the impact to the water rate for wastewater program components. For simplicity, the last four years of the water consumption was calculated and divided by revenues received to generate a cost per gallon. This varies from the Harwich Water Department block rate structure which could be utilized in the future. An average homeowner uses around 70,000 gallons/year. The last column indicates the amount of money remaining in a sewer stabilization account that was collected and not re-allocated to a future project.

By example, a homeowner not connected to a sewer in 2026 would pay an infrastructure fund fee of $54 (Tax rate at $8.97/ $1,000 valuation FY15 X $400,000 home) to the infrastructure investment fund, $133 increase in taxes on their $400,000 home and $57 ($0.81/ 1,000 gallons X 70,000 gallons average/ year) more on their annual water bill to the sewer enterprise account for a total annual increase of $244. This is the highest finance year shown in the first three phases. The same person on a sewer would potentially still be paying for their initial hook-up cost loan and an operating cost based on their sewer use (water usage). Since the agreement for using the Chatham wastewater treatment plant is not final the operating costs are not known but are expected to initially be in the $145 to $175 per year range.

Table 3 is provided for comparison and shows what the cost impact to the tax rate would be if the program were funded 100 percent on property taxes. As shown the increase to a homeowner of a $400,000 home in 2026 would be $254 which is similar to the WIC recommended program ($244).

Table 4 similarly is provided for comparison and shows what the cost impact would be for using 75 percent on the tax rate and 25 percent from a sewer enterprise account. As shown the tax increase in 2026 would be $190 and the sewer enterprise fee would be $82 ($1.17/ 1,000 gallons X 70,000gpyr) for a total of $272. This is 11.5 percent more than the WIC recommendation and 7 percent higher than just being on the tax rate but shares the costs based on volume of water used (nitrogen contributed).

Table 2
WIC Recommendation – 1.5% Infrastructure Fund Plus 75% Taxes/25% Sewer Enterprise

Year	Property Tax	Infrastructure Investment Fund Amount	Debt Service	Remaining to Fund	Property Tax Funded	Property Tax Impact	Tax Increase on $400 K Property	Remaining to Sewer Enterprise Account	Average Consumption (1,000 gal)	$ per 1,000 gal	Annual Contribution to Investment Fund	Investment Fund Balance
2016	$47,000,000	$705,000	$165,750	-$539,250	$0	0.00000	$0	$0	638,331	$0.00	$539,250	$539,250
2017	$48,175,000	$722,625	$163,838	-$558,788	$0	0.00000	$0	$0	638,331	$0.00	$558,788	$1,098,038
2018	$49,379,375	$740,691	$161,925	-$578,766	$0	0.00000	$0	$0	638,331	$0.00	$578,766	$1,676,803
2019	$50,613,859	$759,208	$160,013	-$599,195	$0	0.00000	$0	$0	638,331	$0.00	$599,195	$2,275,999
2020	$51,879,206	$778,188	$1,737,600	$959,412	$719,559	0.15309	$61	$239,853	638,331	$0.38	$0	$2,275,999
2021	$53,176,186	$797,643	$1,717,463	$919,820	$689,865	0.14678	$59	$229,955	638,331	$0.36	$0	$2,275,999
2022	$54,505,591	$817,584	$1,697,325	$879,741	$659,806	0.14038	$56	$219,935	638,331	$0.34	$0	$2,275,999
2023	$55,868,230	$838,023	$1,677,188	$839,164	$629,373	0.13391	$54	$209,791	638,331	$0.33	$0	$2,275,999
2024	$57,264,936	$858,974	$1,657,050	$798,076	$598,557	0.12735	$51	$199,519	638,331	$0.31	$0	$2,275,999
2025	$58,696,560	$880,448	$1,636,913	$756,464	$567,348	0.12071	$48	$189,116	638,331	$0.30	$0	$2,275,999
2026	$60,163,974	$902,460	$2,982,425	$2,079,965	$1,559,974	0.33190	$133	$519,991	638,331	$0.81	$0	$2,275,999
2027	$61,668,073	$925,021	$2,946,530	$2,021,509	$1,516,132	0.32257	$129	$505,377	638,331	$0.79	$0	$2,275,999
2028	$63,209,775	$948,147	$2,910,635	$1,962,488	$1,471,866	0.31316	$125	$490,622	638,331	$0.77	$0	$2,275,999
2029	$64,790,019	$971,850	$2,874,740	$1,902,890	$1,427,167	0.30365	$121	$475,722	638,331	$0.75	$0	$2,275,999
2030	$66,409,770	$996,147	$2,838,845	$1,842,698	$1,382,024	0.29404	$118	$460,675	638,331	$0.72	$0	$2,275,999
2031	$68,070,014	$1,021,050	$2,802,950	$1,781,900	$1,336,425	0.28434	$114	$445,475	638,331	$0.70	$0	$2,275,999
2032	$69,771,764	$1,046,576	$2,767,055	$1,720,479	$1,290,359	0.27454	$110	$430,120	638,331	$0.67	$0	$2,275,999
2033	$71,516,058	$1,072,741	$2,731,160	$1,658,419	$1,243,814	0.26464	$106	$414,605	638,331	$0.65	$0	$2,275,999
2034	$73,303,960	$1,099,559	$2,695,265	$1,595,706	$1,196,779	0.25463	$102	$398,926	638,331	$0.62	$0	$2,275,999
2035	$75,136,559	$1,127,048	$2,659,370	$1,532,322	$1,149,241	0.24451	$98	$383,080	638,331	$0.60	$0	$2,275,999
2036	$77,014,973	$1,155,225	$2,495,975	$1,340,750	$1,005,563	0.21394	$86	$335,188	638,331	$0.53	$0	$2,275,999
2037	$78,940,347	$1,184,105	$2,461,993	$1,277,887	$958,415	0.20391	$82	$319,472	638,331	$0.50	$0	$2,275,999
2038	$80,913,856	$1,213,708	$2,428,010	$1,214,302	$910,727	0.19377	$78	$303,576	638,331	$0.48	$0	$2,275,999
2039	$82,936,702	$1,244,051	$2,394,028	$1,149,977	$862,483	0.18350	$73	$287,494	638,331	$0.45	$0	$2,275,999
2040	$85,010,120	$1,275,152	$1,145,045	-$130,107	$0	0.00000	$0	$0	638,331	$0.00	$130,107	$2,406,105
2041	$87,135,373	$1,307,031	$1,129,288	-$177,743	$0	0.00000	$0	$0	638,331	$0.00	$177,743	$2,583,848
2042	$89,313,757	$1,339,706	$1,113,530	-$226,176	$0	0.00000	$0	$0	638,331	$0.00	$226,176	$2,810,025
2043	$91,546,601	$1,373,199	$1,097,773	-$275,427	$0	0.00000	$0	$0	638,331	$0.00	$275,427	$3,085,451
2044	$93,835,266	$1,407,529	$1,082,015	-$325,514	$0	0.00000	$0	$0	638,331	$0.00	$325,514	$3,410,965
2045	$96,181,148	$1,442,717	$1,066,258	-$376,460	$0	0.00000	$0	$0	638,331	$0.00	$376,460	$3,787,425
	Total		**$55,397,950**		**$21,175,477**			**$7,058,492**				**$3,787,425**

Table 3
100% from Property Taxes

Year	Property Tax	Debt Service	Property Tax Funded	Property Tax Impact	Tax; Average
2016	$47,000,000	$165,750	$165,750	0.03527	$14
2017	$48,175,000	$163,838	$163,838	0.03486	$14
2018	$49,379,375	$161,925	$161,925	0.03445	$14
2019	$50,613,859	$160,013	$160,013	0.03404	$14
2020	$51,879,206	$1,737,600	$1,737,600	0.36969	$148
2021	$53,176,186	$1,717,463	$1,717,463	0.36541	$146
2022	$54,505,591	$1,697,325	$1,697,325	0.36113	$144
2023	$55,868,230	$1,677,188	$1,677,188	0.35684	$143
2024	$57,264,936	$1,657,050	$1,657,050	0.35256	$141
2025	$58,696,560	$1,636,913	$1,636,913	0.34827	$139
2026	$60,163,974	$2,982,425	$2,982,425	0.63455	$254
2027	$61,668,073	$2,946,530	$2,946,530	0.62691	$251
2028	$63,209,775	$2,910,635	$2,910,635	0.61927	$248
2029	$64,790,019	$2,874,740	$2,874,740	0.61163	$245
2030	$66,409,770	$2,838,845	$2,838,845	0.60400	$242
2031	$68,070,014	$2,802,950	$2,802,950	0.59636	$239
2032	$69,771,764	$2,767,055	$2,767,055	0.58872	$235
2033	$71,516,058	$2,731,160	$2,731,160	0.58109	$232
2034	$73,303,960	$2,695,265	$2,695,265	0.57345	$229
2035	$75,136,559	$2,659,370	$2,659,370	0.56581	$226
2036	$77,014,973	$2,495,975	$2,495,975	0.53105	$212
2037	$78,940,347	$2,461,993	$2,461,993	0.52382	$210
2038	$80,913,856	$2,428,010	$2,428,010	0.51659	$207
2039	$82,936,702	$2,394,028	$2,394,028	0.50936	$204
2040	$85,010,120	$1,145,045	$1,145,045	0.24362	$97
2041	$87,135,373	$1,129,288	$1,129,288	0.24027	$96
2042	$89,313,757	$1,113,530	$1,113,530	0.23692	$95
2043	$91,546,601	$1,097,773	$1,097,773	0.23356	$93
2044	$93,835,266	$1,082,015	$1,082,015	0.23021	$92
2045	$96,181,148	$1,066,258	$1,066,258	0.22686	$91
	Total	**$55,397,950**	**$55,397,950**		

Table 4
75% from Property Taxes and 25% from Sewer Enterprise Account

Year	Property Tax	Debt Service	Property Tax Funded	Property Tax Impact	Tax; Average	Water Bill Portion	Average Consumption (1,000 gal)	$ per 1,000 gal
2016	$47,000,000	$165,750	$124,313	0.02645	$11	$41,438	638,331	$0.06
2017	$48,175,000	$163,838	$122,878	0.02614	$10	$40,959	638,331	$0.06
2018	$49,379,375	$161,925	$121,444	0.02584	$10	$40,481	638,331	$0.06
2019	$50,613,859	$160,013	$120,009	0.02553	$10	$40,003	638,331	$0.06
2020	$51,879,206	$1,737,600	$1,303,200	0.27727	$111	$434,400	638,331	$0.68
2021	$53,176,186	$1,717,463	$1,288,097	0.27406	$110	$429,366	638,331	$0.67
2022	$54,505,591	$1,697,325	$1,272,994	0.27084	$108	$424,331	638,331	$0.66
2023	$55,868,230	$1,677,188	$1,257,891	0.26763	$107	$419,297	638,331	$0.66
2024	$57,264,936	$1,657,050	$1,242,788	0.26442	$106	$414,263	638,331	$0.65
2025	$58,696,560	$1,636,913	$1,227,684	0.26120	$104	$409,228	638,331	$0.64
2026	$60,163,974	$2,982,425	$2,236,819	0.47591	$190	$745,606	638,331	$1.17
2027	$61,668,073	$2,946,530	$2,209,898	0.47018	$188	$736,633	638,331	$1.15
2028	$63,209,775	$2,910,635	$2,182,976	0.46445	$186	$727,659	638,331	$1.14
2029	$64,790,019	$2,874,740	$2,156,055	0.45873	$183	$718,685	638,331	$1.13
2030	$66,409,770	$2,838,845	$2,129,134	0.45300	$181	$709,711	638,331	$1.11
2031	$68,070,014	$2,802,950	$2,102,213	0.44727	$179	$700,738	638,331	$1.10
2032	$69,771,764	$2,767,055	$2,075,291	0.44154	$177	$691,764	638,331	$1.08
2033	$71,516,058	$2,731,160	$2,048,370	0.43581	$174	$682,790	638,331	$1.07
2034	$73,303,960	$2,695,265	$2,021,449	0.43009	$172	$673,816	638,331	$1.06
2035	$75,136,559	$2,659,370	$1,994,528	0.42436	$170	$664,843	638,331	$1.04
2036	$77,014,973	$2,495,975	$1,871,981	0.39829	$159	$623,994	638,331	$0.98
2037	$78,940,347	$2,461,993	$1,846,494	0.39286	$157	$615,498	638,331	$0.96
2038	$80,913,856	$2,428,010	$1,821,008	0.38744	$155	$607,003	638,331	$0.95
2039	$82,936,702	$2,394,028	$1,795,521	0.38202	$153	$598,507	638,331	$0.94
2040	$85,010,120	$1,145,045	$858,784	0.18272	$73	$286,261	638,331	$0.45
2041	$87,135,373	$1,129,288	$846,966	0.18020	$72	$282,322	638,331	$0.44
2042	$89,313,757	$1,113,530	$835,148	0.17769	$71	$278,383	638,331	$0.44
2043	$91,546,601	$1,097,773	$823,329	0.17517	$70	$274,443	638,331	$0.43
2044	$93,835,266	$1,082,015	$811,511	0.17266	$69	$270,504	638,331	$0.42
2045	$96,181,148	$1,066,258	$799,693	0.17014	$68	$266,564	638,331	$0.42
	Total	**$55,397,950**	**$41,548,463**			**$13,849,488**		

Other revenue sources discussed but dismissed or left for consideration in future included:

A. Occupancy Tax Increase - raise local room tax from 4% to 6%:

Pros:

- Additional funding source.
- Little impact on residents as paid mostly by visitors.
- Not a large overall amount of funding generated but helps.

Cons:

- Possible negative effect on tourism.
- About 18 companies in Harwich impacted by this tax and each is already a major taxpayer.
- Number of motel and B&B rooms has been declining with shift to private home rentals; so collectable fees likely to decrease over time.
- Could put Harwich businesses at a disadvantage to those in neighboring communities.

B. Betterments:

Pros:

- Town may lien property - reasonable chance of insuring payment.
- Appearance of fairness as property which gets direct benefit would pay.
- Low interest loans available to property owners.
- History of use for capital improvements (not much use in recent years by municipalities for sewer projects).
- Can be invoiced on town tax bills (but not tax deductible).

Cons:

- Narrow base of funding for wastewater program that is applicable to entire town.
- Mismatch between benefits and those obligated to pay (i.e., few pay for benefit of everyone).
- Sewered areas selected based on least cost to town and higher density areas; not based on basic need.

- Must be based on uniform unit method - bedrooms, water use, frontage, etc or equivalent dwelling units (EDUs).
- Sewer betterment assessments may be inequitable if based on phasing of each watershed sewering project.
- Not tax deductible.
- Betterments were more common when municipality only had to pay 10% of program costs.
- Perception that property has been "bettered" is open to debate.

C. Impact Fees - New Construction: Potential Revenues:

Pros:

- Extracts fees from new growth and new developments.
- Town-wide fee.

Cons:

- Discourages economic development (supports a no growth policy) - negative impact on new construction with Wastewater Implementation Advisory Committee (WIAC) proposed fees range:
  - $18K/home
  - $6K/addition
  - $6K/condo
  - $3K/commercial
- Must pass "Nexus" test set by Scotus in Koontz, Nolan & Dolan, i.e., fee must be proportional to cost - can't shift cost to new construction as cost should be proportionally borne by all property owners.
- Must pass Emerson College test - can't charge more than expected benefit (fee must be roughly equal cost of providing service).
- Not tax deductible.

D. Flat fee on all parcels: Potential Revenues:

Pros:

- Town-wide fee.

Cons:

- Probably a tax as not specifically related to service (contributes to 2 1/2 cap).
- Must pass Emerson College test.
- Special legislation needed.
- Not tax deductible.
- Requires designating a wastewater district.

E. Increase in Beach Stickers/ Parking Fees

Pros:

- Paid for mainly by tourists.
- Directly related to those using our water resources and improving/ restoring water quality.
- Current fees are modest.

Cons

- Relatively small overall revenue source.

CC: Chris Clark, Town Administrator
David Young, CDM Smith

Appendix H

EENF Certificate and Comment Letters, Phase 1 Waiver and other correspondence

The Commonwealth of Massachusetts
Executive Office of Energy and Environmental Affairs
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Deval L. Patrick
GOVERNOR

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April 4, 2014

PUBLIC BENEFIT DETERMINATION AND CERTIFICATE OF THE SECRETARY OF ENERGY AND ENVIRONMENTAL AFFAIRS ON THE NOTICE OF PROJECT CHANGE

PROJECT NAME	: Muddy Creek Restoration Bridge Project
PROJECT MUNICIPALITY	: Harwich and Chatham
PROJECT WATERSHED	: Pleasant Bay
EEA NUMBER	: 15022
PROJECT PROPONENT	: Towns of Chatham and Harwich
DATE NOTICED IN MONITOR	: February 26, 2014

Pursuant to the Massachusetts Environmental Policy Act (M.G.L. c. 30, ss. 61-62I) and Sections 11.10 and 11.11 of the MEPA Regulations (301 CMR 11.00), I have reviewed the Notice of Project Change (NPC) for this project and hereby determine that it **does not require** further MEPA review. In a separate Draft Record of Decision (DROD) also issued today, I have proposed to grant a Waiver from the requirement to prepare a Mandatory Environmental Impact Report (EIR) for the project. This Certificate sets forth the issues that must be addressed by the Proponent during permitting and discusses recommendations that were submitted on the project during the MEPA comment period.

In addition, this Certificate serves as the Public Benefit Determination consistent with the provisions of *An Act Relative to Licensing Requirements for Certain Tidelands* (2007 Mass. Acts ch. 168, sec.8) (the Act) and the Public Benefit Determination regulations (301 CMR 13.00).

Project Description

As described in the NPC, the Muddy Creek Restoration Bridge Project (MCRBP) consists of the replacement of existing culverts with a single-span bridge to restore natural tidal flow and water quality to 55 acres of Salt Marsh and other wetland resources associated with Muddy Creek (Monomoy River) upstream of Route 28. Currently, tidal flow is impeded by the undersized stone culverts that convey flow between Muddy Creek and Pleasant Bay.

The project is being advanced by the Towns of Chatham and Harwich, with support from the Massachusetts Division of Ecological Restoration (DER) and the U.S. Fish and Wildlife Service Partners for Fish and Wildlife Program.

Specifically, tidal flow will be increased by replacing the undersized culverts under Route 28 (Orleans Road/Orleans-Chatham Road) over Muddy Creek in Harwich and Chatham, with a 94-foot single span steel bridge. This will permanently restore tidal flushing between Muddy Creek and Pleasant Bay. The project will improve public access to Muddy Creek and improve the management of stormwater. The project will include the temporary closure of Route 28, install temporary water control measures, excavate roadway embankment, demolish the existing culverts, construct a trapezoidal channel, install the bridge and abutments, and grade and re-vegetate the construction area.

Procedural History

The Town of Harwich submitted an Expanded Environmental Notification Form (EENF) for the Comprehensive Wastewater Management Plan (CWMP). Within this EENF, the Town requested a Phase 1 Waiver for the MCRBP to proceed as a severable project. I issued a Certificate on April 12, 2013 requiring the submission of an Environmental Impact Report (EIR) for the CWMP. On May 10, 2013 the Final Record of Decision (FROD) was published approving the Phase 1 Waiver allowing the MCRBP to move forward as a severable project from the CWMP. Because the EENF did not contain specific details regarding the configuration of the proposed culvert replacement, or potential impacts to the surrounding natural resources, the Town was directed to submit an NPC when this information became available.

Project Site

Muddy Creek is located on Cape Cod along the boundary between Harwich and Chatham. Muddy Creek is approximately 1.5 miles long and is part of the Pleasant Bay estuarine system. The project site is located within the Pleasant Bay Area of Critical Environmental Concern (ACEC), which is a diadromous fish run and contains shellfish. Shellfishing and swimming is allowed on the north side (Pleasant Bay side) of Muddy Creek; but are prohibited on the south side of Route 28. The improvements to water quality are anticipated to restore shellfishing in the lower basin of Muddy Creek in future years.

Route 28 and its associated earthen embankment separate Muddy Creek from the receiving waters of Pleasant Bay. The 20-foot tall embankment and twin stone culverts were constructed in the 1930s and are approximately 30 inches wide and 45 inches tall. The culverts restrict tidal flow, which exacerbates degradation of water quality caused by bacterial (fecal coliform) contamination from stormwater run-off and wildlife, and nitrogen loading from watershed land uses. In 2005, a Total Maximum Daily Load (TMDL) for bacteria (fecal coliform) was established for Muddy Creek. In 2006, TMDLs for Total Nitrogen were established for Upper and Lower Muddy Creek, respectively. Sustained impairment of water quality in Muddy Creek has been linked to degraded wetlands, fisheries, shellfisheries and avian habitat. Specifically, the limited flushing has led to the proliferation of freshwater and brackish wetland vegetative species such as Phragmites and Typha in lieu of vegetative species that prefer more saline water (i.e. Spartina).

For the past ten years, the Towns of Harwich and Chatham, the Pleasant Bay Alliance (Alliance), and Massachusetts Division of Ecological Restoration (DER) have studied ways to restore water quality, wetlands and habitat in Muddy Creek. The Alliance is an organization formed by the Towns of Orleans, Chatham, Harwich and Brewster to oversee resource management planning for Pleasant Bay. In 2009, DER commissioned hydrodynamic modeling to determine the optimal inlet size necessary to restore tidal exchange. Modeling indicated that a single 24-foot wide opening would optimize tidal exchange with sufficient velocity to prevent the channel from filling in. In 2010, the Alliance commissioned the School for Marine Science and Technology (SMAST) at University of Massachusetts (UMASS) Dartmouth to assess improvements in water quality that would result from a 24-foot wide rectangular opening. In 2011, the Towns and the Alliance obtained funds from the Cape Cod Conservation District through the Cape Cod Water Resources Restoration Project to study impacts to wetlands, shellfish, finfish, rare species and water quality from the larger opening. The study confirmed that a wider opening would significantly improve degraded wetlands, water quality and ecological health in Muddy Creek without negatively impacting the rest of Pleasant Bay. This report also concluded that impacts associated with nitrogen loading could be reduced or eliminated by replacing the existing culverts with a larger channel. DER designated the Muddy Creek Restoration Project a Priority Wetlands Restoration Project in 2012.

Environmental Impacts

This is an environmental restoration project which has been designed to improve wetlands, fish and wildlife habitat, and water quality at the site and within the Muddy Creek system. The project will provide a significant net environmental benefit but will also include temporary and long-term environmental impacts, particularly to wetland resource areas. Potential environmental impacts associated with construction include alteration of approximately 1,680 square feet (sf) of Land Under the Ocean (LUO), approximately 5,100 sf of Coastal Beach (which is expected to change slightly over time as sediment moves), 330 linear feet (lf) of Coastal Bank, 1,000 sf of Salt Marsh, and approximately 1,680 sf of Land Containing Shellfish. Approximately 50,425 sf of the proposed construction area is considered Land Subject to Coastal Storm Flowage (LSCSF).

Project improvements will include the transition of existing Bordering Vegetated Wetlands (BVW) to Salt Marsh. This anticipated transition is due to an increase in water column salinity in upper Muddy Creek and an increase in tidal inundation over 16.6 acres that will result in a transition of 18.6 acres of existing BVW to more salt-tolerant marine and brackish wetlands vegetation.

Permitting and Jurisdiction

The project is subject to MEPA review and preparation of a Mandatory EIR pursuant to 301 CMR 11.03(3)(a)(1)(a) because it requires a State Agency Action and involves the direct alteration of one or more acres of Salt Marsh or Bordering Vegetated Wetland. The project requires a 401 Water Quality Certification (WQC) and a Chapter 91 (c.91) License from the Massachusetts Department of Environmental Protection (MassDEP). The project may require review by Natural Heritage & Endangered Species Program (NHESP) pursuant to the Massachusetts Endangered Species Act (MESA).

The project requires Order of Conditions from the Chatham and Harwich Conservation Commissions (or Superseding Order(s) of Conditions from MassDEP if one or both of the local Orders are appealed).

In addition, the project requires approval under the U.S. Army Corps of Engineers (ACOE) Section 404 Clean Water Act and Section 10 Rivers and Harbor Act, as well as Federal Consistency Review by the Office of Coastal Zone Management (CZM). The Massachusetts Historical Commission (MHC) will also review the project in its role as the State Historic Preservation Officer (SHPO) pursuant to Section 106 of the National Historic Preservation Act (NHPA) and will require a Preliminary Determination from the United States Coast Guard for a Bridge Permit.

Because the project will receive State Financial Assistance, MEPA jurisdiction is broad in scope and extends to all aspects of the project that may cause Damage to the Environment, as defined in the MEPA regulations.

Waiver Request

The proponent submitted an NPC for the project with a request for a Waiver from the requirement to prepare a Draft and Final EIR. The NPC generally describes how the project meets the Wavier criteria outlined in 301 CMR 11.11 and the EENF was subject to an extended comment period, as required. The comments received on the NPC are generally supportive of the waiver request.

Review of the NPC

The NPC included a detailed project description including restoration goals, identified potential environmental impacts, and addressed the project's consistency with the criteria for a Waiver. The NPC contained photographs of the project site identifying the proposed areas of work, and design plans identifying wetland resource areas, existing and proposed conditions, erosion and sedimentation control measures, as well as proposed access and staging areas.

The project has not specified credit for nitrogen reductions that could have a beneficial effect on wastewater management. I expect that the Town of Harwich's CWMP will contain appropriate monitoring to evaluate the effects of nitrogen reductions that can later be applied to wastewater management for the Town of Harwich. The project includes monitoring as part of its mitigation plan, but will need further details to quantify water quality in the CWMP.

Alternative Analysis

Alternatives include the No Build, Pre-cast Concrete Culvert, and Pre-cast Concrete Bridge. The alternatives analysis also looked at four alternative designs for the Preferred Alternative and rated them in terms of restoration benefits, minimization of construction impacts, public access and cost. As a part of the design phase of the project, the Preferred Alternative was selected which is described in the NPC as a design that provides the best combination of maximization of benefits and minimization of construction impacts on wetland resource areas.

The Preferred Alternative, collectively referred to as the accelerated bridge construction technique, is comprised of a steel beam superstructure with a composite pre-cast concrete deck. The use of pre-cast elements will eliminate concrete curing requirements and concrete pour sequencing periods, significantly reducing the substructure construction period. The structures will be pre-fabricated in an off-site construction shop, shipped to the project site for installation (thereby eliminating the need for steel member erection, shear stud welding, steel detail erection, and concrete deck pour and curing). This accelerated approach will significantly reduce the construction duration and impacts to the surrounding natural resources. The total duration of road closures can be reduced from months to weeks using this Accelerated Bridge Construction approach. This approach will also reduce the amount of time needed for work in wetland resource areas, including site management activities such as staging and water control.

The NPC also described two alternatives for gaining construction access to the underside of the bridge. In general, Alternative 1 would minimizes natural resource disturbance, with all construction activity using the footprint of existing roadway. However, construction of under-bridge elements, including channel excavation, may not be feasible from the roadbed. Therefore, a second access alternative, which would employ swamp mats or equivalent, would provide temporary access across Coastal Beach and Salt Marsh. Alternative 2 would have a greater Limit of Work, but a substantially shorter construction period. Alternative 1 is the preferred alternative. The NPC indicates that bid documents will be structured to require this approach; however, the construction means and methods will be selected by the contractor. If Alternative 2 is selected, the NPC states that the Conservation Commissions and MassDEP will be notified in writing prior to the commencement of any work.

Wetlands

As noted previously, the project site contains a variety of wetland resource areas including: LUO; Coastal Beach; Coastal Bank; Land Containing Shellfish; and LSCSF. While the project will be restorative in nature and have many positive benefits to overall wetland habitat, some areas of wetlands will be altered in order to achieve the final project design. In some instances, impacts will be temporary in nature, while others will result in a permanent change to the location and type of wetland resource areas.

The NPC describes the findings of a 2012 report that contains a detailed summary of wetlands and shellfish and finfish resources in and around Muddy Creek. The report evaluated how resources would respond to alternative tidal exchange regimes including a 24-foot channel opening or comparable trapezoidal opening. The key findings of the report based on hydrodynamic and water quality modeling are:

- A 24-foot wide opening would provide optimal tidal flushing to the Muddy Creek sub-estuary to achieve desired restoration benefits while avoiding excessive scouring/sedimentation of the channel at the upstream and downstream ends of the bridge replacement structure. Subsequent modeling determined that a trapezoidal channel with a 22-foot bottom width and 1.7:1 side slope would result in comparable tidal flushing, to accommodate the preferred bridge design.
- Water column concentrations of nutrients and bacteria will be reduced in Muddy Creek, without negative impacts to water quality in surrounding areas of Pleasant Bay. Dissolved oxygen in the water column is expected to increase.
- Increased tidal range and improved water quality will restore wetlands. Specifically, an increase in tidal range is expected to cause expansion of low marsh communities (dominated by Spartina alternaflora). Current subtidal areas will transition into intertidal mud flats that will eventually colonize with vegetation. Areas of high marsh (dominated by Spartina patens) will transition to low marsh. Salt Marsh is expected to increase throughout the project improvement area.
- Changes in salinity and tidal range will result in a contraction of invasive species such as Phragmites.
- The enlarged inlet will improve water quality and habitat for diadromous fish species, and will enhance fish passage currently restricted by the culverts.
- Shellfish habitat will be enhanced as dissolved oxygen improves and environmental conditions become more conducive for shellfish recruitment, settling of shellfish larvae, and expansion of Salt Marsh.

The existing 2.7 acres of Salt Marsh will benefit from increased tidal exchange. In addition, transition of existing Bordering Vegetated Wetlands (BVW) to Salt Marsh is anticipated due to an increase in water column salinity in upper Muddy Creek and an increase in tidal inundation over 16.6 acres that will result in a transition of up to 18.6 acres of existing BVW (below elevation 4.0 feet) to more salt tolerant marine and brackish wetlands vegetation. The inundation resulting from tides less frequent than the annual high tide and less frequent storm events was not considered to have as significant an impact on the Salt Marsh.

Chapter 91 Licensing

I note that Muddy Creek is featured on MassDEP's Massachusetts Mouth of Coastal River Map and would be typically considered Riverfront Area; however, pursuant to 310 CMR10.58(6)(i), the proposed project is water-dependent under the Chapter 91 Regulations, and therefore is exempt from the Riverfront Protection Act. This exemption is valid provided that the project receives a Waterways License under 310 CMR 9.00.

The construction area and project improvement area contain filled and flowed tidelands. The Waterways Regulations categorically restrict the licensing of certain structures and proposed improvement dredging within Areas of Critical Environmental Concern (310 CMR 9.32(1)(e) and 9.40(1)); however, MassDEP stated in its comments that this project would be eligible for a license as it is a "publicly-owned structure for water-dependent use" and would serve the purpose of fisheries or wildlife enhancement.

Public Benefits Determination

Consistent with the provisions of *An Act Relative to Licensing Requirements for Certain Tidelands* (2007 Mass. Acts ch. 168, sec.8) (the Act), which was enacted on November 15, 2007, and corresponding regulations at 301 CMR 13.00, I must conduct a Public Benefit Determination (PBD) for this project in conjunction with the EIR. As a water-dependent project, it is presumed that this project will meet the regulatory criteria and provide adequate public benefit in accordance with 301 CMR 13.04 and, therefore, I am not requiring a separate PBD. I am satisfied that the project's impacts to tideland resources can be adequately addressed during the c.91 licensing process.

Rare Species

The project site is mapped as both *Priority* and *Estimated Habitat* for endangered species in the NHESP Natural Heritage Atlas (13th Edition, 2008). Two State-listed Species of Special Concern have been identified at the site, the Common Tern (*Sterna hirundo*) and Eastern Box Turtle (*Terrapene carolina*). The Division of Fisheries and Wildlife's NHESP has indicated that the project will not result in a prohibitive "take" of state-listed rare species pursuant to MESA.

Stormwater

The NPC describes the contribution of stormwater run-off to nutrient and bacterial contamination in Muddy Creek. The Bacterial TMDL for Muddy Creek indicates that the most likely sources for fecal coliform bacteria are waterfowl and stormwater run-off. The new bridge will include measures to enhance the collection and filtration treatment of stormwater for the removal of total suspended solids and pollutants. The project's stormwater management system will improve stormwater runoff quality in compliance with Stormwater Management Standards. One deep sump catch basin with a hood will be installed along the roadway at each end of the bridge. The deep sump catch basins will remove sediment and other solids and the hoods will trap floatables prior to discharge. The overall drainage of Route 28 will not be affected by this project. The project will not create additional impervious areas nor will it generate additional stormwater runoff. The project will improve stormwater management by incorporating effective treatment prior to discharge within the section of Route 28 that crosses Muddy Creek.

Greenhouse Gas Emissions (GHG)

The project is subject to the MEPA Greenhouse Gas Policy and Protocol (GHG Policy) because it exceeds thresholds for a mandatory EIR. The GHG Policy includes a de minimus exemption for projects that will produce minimal amounts of GHG emissions. This is an ecological restoration project that is designed to improve habitat and water quality. GHG emissions will be limited to the construction period of the project. As such, this project falls under the GHG Policy's de minimis exemption; therefore, the Proponent is not required to prepare a GHG analysis. The Proponent has committed to minimize idling of construction vehicles and I encourage the use of additional measures to reduce construction-period GHG emissions, such as using bio-fuels in off-road construction equipment.

Construction Period

The construction will be divided into three distinct phases:

- Phase 1: Partial excavation of the channel, installation of a temporary pipe and outlet protection to redirect the flow from the existing culverts, and construction of the East side substructure elements. A water control system will be installed to manage the flow of water during construction.
- Phase 2: Full removal of existing culverts and construction of the channel and scour protection, and construction of the West side substructure.
- Phase 3: Construct superstructure, roadway completion, and restoration of disturbed areas.

All project construction activities are anticipated to occur within one full construction season, starting in May 2015 with substantial completion by December 2015. The NPC states that during construction, traffic management will consist of closure of Route 28 for approximately two months, with a proposed detour. In-water work is scheduled to take place outside of the anticipated time-of-year (TOY) restriction for fisheries resources which extends from January 15, 2015 through June 30, 2015; however further discussions with Division of Marine Fisheries will determine final TOY restriction for fisheries resources. To facilitate fish passage and wildlife movement during construction, a water management plan will be approved and implemented that will include maintaining a base flow through the channel. A sediment and erosion control plan will be developed for construction activities and will be employed during all phases of the project.

As recommended by MassDEP, I encourage the Town to participate in the MassDEP Diesel Retrofit Program to mitigate the construction period impacts of diesel emissions. The Town may The project must also comply with the Solid Waste and Air Pollution Control regulations, pursuant to M.G.L. c.40, s.54.

Mitigation Measures

The Proponent has committed to the following measures to avoid, minimize and mitigate environmental impacts, including:

- Removal of abutments in sections to control residual sediments during the restoration of the stream;
- Maintaining tidal flow on one side of Muddy Creek while work is being conducted in-the-dry on the opposite side;

- Implementation of Best Management Practices (BMP) for use of construction machinery in proximity to waters, including refueling outside of the wetlands and waterways, or providing containment, managing debris and waste;
- Use of swamp mats for work on the Coastal Beach/Salt Marsh; and
- Visual water quality and wildlife/fish movement monitoring during in-water work.

The new Muddy Creek channel grades will be established subsequent to the completion of the bridge work. The portion of the stream bank to be impacted by the activities will be restored at the new Mean Annual High Water Line. The slopes of the channel will be graded such that they will match the existing grades as much as possible. All areas of Salt Marsh to be disturbed by construction will be then be planted with two-inch plugs (species to be determined based on disturbance areas).

An important component of the project following implementation will be post-construction monitoring to document the attainment of habitat restoration goals. The monitoring program will encompass tidal flow, vegetation and water quality. Tides will be monitored for a complete lunar cycle following construction and post-construction tidal hydrology will be compared with the pre-restoration condition. Water quality monitoring will also be used to quantify improvements post-construction. Thirteen years of baseline water quality data in Muddy Creek is available and the Pleasant Bay Alliance plans to continue water quality monitoring program in Muddy Creek to demonstrate anticipated improvements in the water quality in the project improvement area. Pre-restoration monitoring of vegetation has been completed and vegetation will be monitored using transects and photographic monitoring after construction is complete. Monitoring will occur for three growing seasons following construction. In addition, newly revegetated Salt Marsh and minor buffer zone restoration areas will be monitored twice every growing season by a botanist or wetland scientist to evaluate whether 75 percent cover by desirable species is established within two full growing seasons following the restoration. If the 75 percent survivorship of the planted and seeded native species cover is not reached at the end of the second full growing season, or if bank failure is occurring, a plan will be submitted to the Harwich and Chatham Conservation Commissions and MassDEP to propose corrective actions and achieve the restoration goals. The monitoring plan will include observation of erosion or rutting issues on the newly established banks.

Conclusion

Based on a review of the information provided in the NPC and consultation with the relevant public agencies, I find that the potential impacts of this project do not warrant further MEPA review. Outstanding issues may be addressed during the local, State, and federal permitting processes. Comment letters support the project, the Waiver request, and do not identify alternatives or mitigation measures that warrant additional analysis through an EIR.

I have also issued today a DROD proposing to grant a Waiver from the requirement to prepare an EIR for the project. The DROD will be published in the next edition of the *Environmental Monitor* on April 9, 2014 in accordance with 301 CMR 11.15(2), which begins the public comment period. The public comment period lasts for 14 days and will end on April 23, 2014. Based on written comments received concerning the DROD, I shall issue a Final

Record of Decision (FROD) or a Scope within seven days after the close of the public comment period, in accordance with 301 CMR 11.15(6).

April 4, 2014
Date

Richard K. Sullivan Jr.

Comments received:

03/13/2014	Chatham Conservation Foundation
03/24/2014	Cape Cod Commission
03/26/2014	Cape Cod Conservation District
03/26/2014	Pleasant Bay Alliance
03/27/2014	Natural Heritage & Endangered Species Program
03/27/2014	Division of Ecological Resources
03/28/2014	Massachusetts Board of Underwater Archaeological Resources
03/28/2014	Massachusetts Department of Environmental Protection – Southeast
03/28/2014	Friends of Pleasant Bay

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April 25, 2014

FINAL RECORD OF DECISION

PROJECT NAME	: Muddy Creek Restoration Bridge Project
PROJECT MUNICIPALITY	: Harwich and Chatham
PROJECT WATERSHED	: Pleasant Bay
EEA NUMBER	: 15022
PROJECT PROPONENT	: Towns of Chatham and Harwich
DATE NOTICED IN MONITOR	: April 9, 2014

Pursuant to the Massachusetts Environmental Policy Act (M.G.L.c.30, ss. 61-62I) and Section 11.11 of the MEPA Regulations (301 CMR 11.00), I have reviewed this project and hereby **grant a Waiver** from the categorical requirement to prepare an Environmental Impact Report (EIR). In a separate Certificate also issued on April 4, 2014, I have set forth the outstanding issues related to the project that can be addressed by permitting agencies.

Project Description

As described in the NPC, the Muddy Creek Restoration Bridge Project (MCRBP) consists of the replacement of existing culverts with a single-span bridge to restore natural tidal flow and water quality to 55 acres of Salt Marsh and other wetland resources associated with Muddy Creek (Monomoy River) upstream of Route 28. Currently tidal flow is impeded by the restrictive undersized stone culverts that convey flow between Muddy Creek and Pleasant Bay.

The project is being advanced by the Towns of Chatham and Harwich, with support from the Massachusetts Division of Ecological Restoration (DER) and the U.S. Fish and Wildlife Service Partners for Fish and Wildlife Program.

Specifically, tidal flow will be increased by replacing the undersized culverts under Route 28 (Orleans Road/Orleans-Chatham Road) over Muddy Creek in Harwich and Chatham, with a 94-foot single span steel bridge. This will permanently restore tidal flushing between Muddy Creek and Pleasant Bay. The project will improve public access to Muddy Creek and improve the management of stormwater. The project will include the temporary closure of Route 28, install temporary water control measures, excavate roadway embankment, demolish the existing culverts, construct a trapezoidal channel, install the bridge and abutments, and grade and re-vegetate the construction area.

Procedural History

The Town of Harwich submitted an Expanded Environmental Notification Form (EENF) for the Comprehensive Wastewater Management Plan (CWMP). Within this EENF, the Town requested a Phase 1 Waiver for the MCRBP to proceed as a severable project. I issued a Certificate on April 12, 2013 requiring the submission of an Environmental Impact Report (EIR) for the CWMP. On May 10, 2013 the Final Record of Decision (FROD) was published approving the Phase 1 Waiver allowing the MCRBP to move forward as a severable project from the CWMP. Because the EENF did not contain specific details regarding the configuration of the proposed culvert replacement, or potential impacts to the surrounding natural resources, the Town was directed to submit an NPC when this information became available.

Project Site

Muddy Creek is located on Cape Cod along the boundary between Harwich and Chatham. Muddy Creek is approximately 1.5 miles long and is part of the Pleasant Bay estuarine system. The project site is located within the Pleasant Bay Area of Critical Environmental Concern (ACEC), which is a diadromous fish run and contains shellfish. Shellfishing and swimming is allowed on the north side (Pleasant Bay side) of Muddy Creek; but are prohibited on the south side of Route 28. The improvements to water quality are anticipated to restore shellfishing in the lower basin of Muddy Creek in future years.

Route 28 and its associated earthen embankment separate Muddy Creek from the receiving waters of Pleasant Bay. The 20-foot tall embankment and twin stone culverts were constructed in the 1930s and are approximately 30 inches wide and 45 inches tall. The culverts restrict tidal flow, which exacerbates degradation of water quality caused by bacterial (fecal coliform) contamination from stormwater run-off and wildlife, and nitrogen loading from watershed land uses. In 2005, a Total Maximum Daily Load (TMDL) for bacteria (fecal coliform) was established for Muddy Creek. In 2006, TMDLs for Total Nitrogen were established for Upper and Lower Muddy Creek, respectively. Sustained impairment of water quality in Muddy Creek has been linked to degraded wetlands, fisheries, shellfisheries and avian habitat. Specifically, the limited flushing has led to the proliferation of freshwater and brackish wetland vegetative species such as Phragmites and Typha in lieu of vegetative species that prefer more saline water (i.e. Spartina).

For the past ten years, the Towns of Harwich and Chatham, the Pleasant Bay Alliance (Alliance), and Massachusetts Division of Ecological Restoration (DER) have studied ways to restore water quality, wetlands and habitat in Muddy Creek. The Alliance is an organization formed by the Towns of Orleans, Chatham, Harwich and Brewster to oversee resource management planning for Pleasant Bay. In 2009, DER commissioned hydrodynamic modeling to determine the optimal inlet size necessary to restore tidal exchange. Modeling indicated that a single 24-foot wide opening would optimize tidal exchange with sufficient velocity to prevent the channel from filling in. In 2010, the Alliance commissioned the School for Marine Science and Technology (SMAST) at University of Massachusetts (UMASS) Dartmouth to assess improvements in water quality that would result from a 24-foot wide rectangular opening. In 2011, the Towns and the Alliance obtained funds from the Cape Cod Conservation District through the Cape Cod Water Resources Restoration Project to study impacts to wetlands, shellfish, finfish, rare species and water quality from the larger opening. The study confirmed that a wider opening would significantly improve degraded wetlands, water quality and ecological health in Muddy Creek without negatively impacting the rest of Pleasant Bay. This report also concluded that impacts associated with nitrogen loading could be reduced or eliminated by replacing the existing culverts with a larger channel. DER designated the Muddy Creek Restoration Project a Priority Wetlands Restoration Project in 2012.

Environmental Impacts

This is an environmental restoration project which has been designed to improve wetlands, fish and wildlife habitat, and water quality at the site and within the Muddy Creek system. The project will provide a significant net environmental benefit but will also include temporary and long-term environmental impacts, particularly to wetland resource areas. Potential environmental impacts associated with construction include alteration of approximately 1,680 square feet (sf) of Land Under the Ocean (LUO), approximately 5,100 sf of Coastal Beach (which is expected to change slightly over time as sediment moves), 330 linear feet (lf) of Coastal Bank, 1,000 sf of Salt Marsh, and approximately 1,680 sf of Land Containing Shellfish. Approximately 50,425 sf of the proposed construction area is considered Land Subject to Coastal Storm Flowage (LSCSP).

Project improvements will include the transition of existing Bordering Vegetated Wetlands (BVW) to Salt Marsh. This anticipated transition is due to an increase in water column salinity in upper Muddy Creek and an increase in tidal inundation over 16.6 acres that will result in a transition of 18.6 acres of existing BVW to more salt-tolerant marine and brackish wetlands vegetation.

Permitting and Jurisdiction

The project is subject to MEPA review and preparation of a Mandatory EIR pursuant to 301 CMR 11.03(3)(a)(1)(a) because it requires a State Agency Action and involves the direct alteration of one or more acres of Salt Marsh or Bordering Vegetated Wetland. The project requires a 401 Water Quality Certification (WQC) and a Chapter 91 (c.91) License from the Massachusetts Department of Environmental Protection (MassDEP). The project may require review by Natural Heritage & Endangered Species Program (NHESP) pursuant to the Massachusetts Endangered Species Act (MESA).

The project requires Order of Conditions from the Chatham and Harwich Conservation Commissions (or Superseding Order(s) of Conditions from MassDEP if one or both of the local Orders are appealed).

In addition, the project requires approval under the U.S. Army Corps of Engineers (ACOE) Section 404 Clean Water Act and Section 10 Rivers and Harbor Act, as well as Federal

Consistency Review by the Office of Coastal Zone Management (CZM). The Massachusetts Historical Commission (MHC) will also review the project in its role as the State Historic Preservation Officer (SHPO) pursuant to Section 106 of the National Historic Preservation Act (NHPA) and will require a Preliminary Determination from the United States Coast Guard for a Bridge Permit.

Because the project will receive State Financial Assistance, MEPA jurisdiction is broad in scope and extends to all aspects of the project that may cause Damage to the Environment, as defined in the MEPA regulations.

Waiver Request

The proponent submitted an NPC for the project with a request for a Waiver from the requirement to prepare a Draft and Final EIR. The NPC generally describes how the project meets the Wavier criteria outlined in 301 CMR 11.11 and the NPC was subject to an extended comment period, as required. The comments received on the NPC are generally supportive of the waiver request.

Standards for All Waivers

The MEPA regulations at 301 CMR 11.11(1) state that I may waive any provision or requirement in 301 CMR 11.00 not specifically required by MEPA and may impose appropriate and relevant conditions or restrictions, provided that I find that strict compliance with the provision or requirement would:

(a) Result in an undue hardship for the Proponent, unless based on delay in compliance by the Proponent; and,
(b) Not serve to avoid or minimize Damage to the Environment.

Determinations for an EIR Waiver

The MEPA regulations at 301 CMR 11.11(3) state that, in the case of a Waiver of a mandatory EIR review threshold, I shall at a minimum base the finding required in accordance with 301 CMR 11.11(1)(b) stated above on a determination that:

(a) The project is likely to cause no Damage to the Environment; and,

(b) Ample and unconstrained infrastructure facilities and services exist to support those aspects of the project within subject matter jurisdiction.

Findings

Based on the NPC and consultation with State Agencies, I find that the Waiver request has merit and that the Proponent has demonstrated that the proposed project meets the standards for all waivers at 301 CMR 11.11(1). I find that strict compliance with the requirement to prepare a Mandatory EIR for the project would result in undue hardship as it would only serve to lengthen the review process without providing additional benefit because additional analysis of alternatives and /or mitigation through MEPA is not warranted. Although the project exceeds the mandatory EIR threshold for alteration of Salt Marsh, Bordering Vegetated Wetlands (BVW) and other wetland resources, the project is proposed as an environmental restoration project and the purpose is to improve wetlands, fish and wildlife habitat, and water quality at the site and within the Muddy Creek system. The existing 2.7 acres of Salt Marsh will benefit from increased tidal exchange. In addition, transition of existing BVW to Salt Marsh is anticipated due to an increase in water column salinity in upper Muddy Creek and an increase in tidal inundation over 16.6 acres that will result in a transition of up to 18.6 acres of existing BVW to more salt tolerant marine and brackish wetlands vegetation.

I also find that compliance with the requirement to prepare an EIR for the project would not serve to avoid or minimize Damage to the Environment. In accordance with 301 CMR 11.11(3), this finding is based on my determination that:

1. The project is not likely to cause Damage to the Environment. The project will employ the following mitigation measures to ensure the impacts of the project are avoided, minimized and mitigated:

   - The project will obtain a Section 401 Water Quality Certificate from MassDEP and will be designed and constructed in a manner consistent with applicable Water Quality Regulations (314 CMR 9.00);
   - The project will obtain a c.91 License from MassDEP because virtually all aspects of the Project will involve work within the regulated Flowed and Filled Tidelands under the jurisdiction of c.91.
   - The Towns will develop and implement pre- and post-restoration monitoring plans to evaluate the effectiveness of the project; and,
   - The Towns will coordinate with resource agencies regarding the applicability of time-of-year (TOY) restrictions for the construction. In a letter dated April 22, 2014, the Towns have committed to start construction in fall of 2015 with substantial completion by May 2016. The timing of construction is intended to avoid heavy traffic conditions typically observed during the summer season. The Towns have also committed to TOY restriction for in-water work from January 15, 2016 through June 30, 2016.
   - The Towns will obtain Orders of Conditions outlining how the project will comply with the Limited Project provisions (310 CMR 10.53(4)) of the Massachusetts Wetlands Protection Act; and
   - The public will have an opportunity for ongoing review and comment on the project through public hearings and comment periods associated with the permitting and licensing processes.

2. Ample and unconstrained infrastructure facilities and services exist to support those aspects of the project within subject matter jurisdiction:

   - The project does not require any infrastructure or services to accomplish its overall goal of habitat restoration. Therefore, this criterion has been met.

Conclusion

Based on these findings, I have determined that the Waiver request has merit, and issued a DROD on April 4, 2014, which was published in the Environmental Monitor on April 9, 2014 beginning the public comment period in accordance with 301 CMR 11.15(2). The public comment period lasted for 14 days and concluded on April 23, 2014. Accordingly, I hereby **grant a waiver** from the requirement to prepare an EIR in accordance with 301 CMR 11.15(6).

April 25, 2014
Date

Richard K. Sullivan Jr.

Comments received on the NPC:

03/13/2014	Chatham Conservation Foundation
03/24/2014	Cape Cod Commission
03/26/2014	Cape Cod Conservation District
03/26/2014	Pleasant Bay Alliance
03/27/2014	Natural Heritage & Endangered Species Program
03/27/2014	Division of Ecological Resources
03/27/2014	Massachusetts Division of Marine Fisheries
03/28/2014	Massachusetts Board of Underwater Archaeological Resources
03/28/2014	Massachusetts Department of Environmental Protection – Southeast
03/28/2014	Friends of Pleasant Bay

Comments received on the DROD:

04/14/2014 Harwich Conservation Commission

RKS/ACC/acc

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April 12, 2013

CERTIFICATE OF THE SECRETARY OF ENERGY AND ENVIRONMENTAL AFFAIRS
ON THE
EXPANDED ENVIRONMENTAL NOTIFICATION FORM

PROJECT NAME	: Harwich Comprehensive Wastewater Management Plan
PROJECT MUNICIPALITY	: Harwich
PROJECT WATERSHED	: Cape Cod
EEA NUMBER	: 15022
PROJECT PROPONENT	: Town of Harwich
DATE NOTICED IN MONITOR	: March 6, 2013

Pursuant to the Massachusetts Environmental Policy Act (MEPA) (G. L. c. 30, ss. 61 – 62I) and Section 11.06 of the MEPA regulations (301 CMR 11.00), I hereby determine that this project **requires** the preparation of an Environmental Impact Report (EIR). The Town submitted an Expanded Environmental Notification Form (EENF) with a request that I allow a Single EIR to be prepared in lieu of the usual two-stage Draft and Final EIRs. The EENF received an extended comment period pursuant to Section 11.06(8) of the MEPA regulations. Pursuant to 301 CMR 11.06(8), the Town may submit a Single EIR (SEIR) in accordance with the Scope below.

The Town has also requested a Phase 1 Waiver to allow the first phase of the project to proceed, pending the preparation of a Comprehensive Wastewater Management Plan (CWMP)/Environmental Impact Report (EIR) for the entire project. The Phase 1 Waiver Request was presented within the Expanded Environmental Notification Form (EENF) and was discussed at a public consultation meeting held on March 26, 2013. In a Draft Record of Decision (DROD), also issued today, I have proposed to grant a Phase 1 Waiver with conditions allowing the Phase 1 component to proceed while the Single EIR is being prepared.

Project Overview

The Town has filed the EENF/Draft Comprehensive Wastewater Management Plan (CWMP) concurrently with the Cape Cod Commission (CCC) for joint review pursuant to the November 1991 Memorandum of Understanding regarding joint MEPA/CCC review for

Developments of Regional Impact (DRI). The Town is pursuing a long-term, multi-phased wastewater management program with intermunicipal and centralized treatment to reduce nutrient loading to coastal waters, and to meet anticipated total maximum daily loads (TMDLs) for estuaries/embayments along Nantucket Sound.

Over the last five years the Town of Harwich, through its Water Quality Management Task Force (WQMTF) Wastewater Management Subcommittee (WMS), has been working to develop a program to address wastewater management needs, protect drinking water sources, protect fresh water ponds and restore valuable estuaries. The Town has been working with the University of Massachusetts (UMass)-Dartmouth School of Marine Science and Technology and the Massachusetts Estuaries Project (MEP) to identify nutrient loads and devise a wastewater management program to meet water quality criteria.

The CWMP presents a 40-year phased plan with a primary focus on mitigating nitrogen enrichment to the Herring River, Allens Harbor, Saquatucket Harbor, Wychmere Harbor and Pleasant Bay watersheds. The CWMP also addresses phosphorus management of freshwater ponds and areas of Harwich with specific difficulties meeting the minimum standards of the Massachusetts on-site sewage treatment and disposal regulations (310 CMR 15.000, Title 5 of the State Environmental Code). The CWMP provides for inter-municipal cooperation with the Town of Chatham in order to reduce costs and help utilize more fully Chatham's new wastewater treatment facility while it is in the initial phases of sewer construction. The CWMP also incorporates alternative strategies such as improved flushing at Muddy Creek and enhanced attenuation at the Bank Street bogs.

Specifically, the Town is recommending a traditional wastewater program that includes: approximately 92 miles of sewer pipes, 30 pumping stations, and two centralized treatment facilities phased over 40 years. For this program, the treatment will occur at the existing facility in Chatham and a new facility in Harwich. Implementing this program will allow Harwich to meet its water resource management needs as defined throughout the CWMP, including consistency with the MEP nitrogen reduction goals as well as protecting freshwater resources, including ponds and drinking water resources. The EENF describes the recommended program components. It also presents the wastewater phasing plan and identifies the potential cost recovery strategy being developed by the Town.

In addition, the Draft CWMP incorporates a number of non-structural elements designed to reduce nutrient loading including: growth management regulations; public outreach and education programs for controlling the use of fertilizer products on lawns, gardens and agricultural areas; low impact landscaping; stormwater management; enhancement of embayment flushing rates; and water conservation.

The Draft CWMP also incorporates an Adaptive Management Strategy that enables the Town to revisit the Recommended Program and modify the phasing, timing, or the specific areas to be sewered based on the results of the earlier implementation phases to comply with the anticipated nitrogen TMDLs. The strategy also allows for the inclusion of additional features or innovative alternatives that will improve nitrogen removal levels. The Town intends to continue to reassess each phase prior to design and construction.

MEPA Jurisdiction and Permitting

The project is undergoing review and requires the preparation of a Mandatory EIR pursuant to Section 11.03(5)(a)(3) of the MEPA regulations because it requires State Agency Action and it will involve the construction of one or more new sewer mains of ten or miles in length. The project is also undergoing MEPA review pursuant to Sections 11.03(5)(b)(1), 11.03(11)(b) and 11.03(3)(b)(1)(f) because it will involve the construction of a new wastewater treatment facility with a capacity of more than 100,000 gallons per day, is located in an Area of Critical Environmental Concern (ACEC) and will alter ½ or more acres of other wetlands.

The project requires: an Order of Conditions from the Harwich Conservation Commission (and on appeal only, a Superseding Order of Conditions from the Massachusetts Department of Environmental Protection (MassDEP)); a Sewer Connection/Extension Permit and a Groundwater Discharge Permit from MassDEP; a State Highway Access Permit from the Massachusetts Department of Transportation (MassDOT); review under the Massachusetts Endangered Species Act (MESA) by the Natural Heritage Endangered Species Program (NHESP); review by the Massachusetts Historical Commission; and a National Pollutant Discharge Elimination System (NPDES) Construction General Permit from the U.S. Environmental Protection Agency. The project may require Federal Consistency Review by the Massachusetts Coastal Zone Management Office and a Section 404 Permit from the U.S. Army Corps of Engineers. The project is subject to the EEA/MEPA Greenhouse Gas Emissions Policy and Protocol.

The Town anticipates applying for State Revolving Fund (SRF) loans for subsequent planning and construction of each phase of the proposed project. Because the Town is seeking State Financial Assistance, MEPA jurisdiction is broad and extends to all aspects of the project that may cause Damage to the Environment, as defined in the MEPA regulations.

Phase 1 Waiver

The Town is requesting a MEPA Phase 1 Waiver to widen the Muddy Creek culvert under Route 28 within the Pleasant Bay Area of Critical Environmental Concern (ACEC). The CWMP element, widening the Muddy Creek culvert under Route 28 (the Harwich and Chatham corporate boundary) is concomitantly identified by the Pleasant Bay Alliance (Alliance) as a project to improve the creek and estuarine habitats and water quality. Widening the culvert will improve tidal flushing which will both improve habitat and water quality.

Review of the EENF and SCOPE

I recognize that the impacts caused by the discharge of nitrogen through both private septic and municipal sewer systems to surrounding water bodies can be severe and that this is a significant issue for towns on Cape Cod. These impacts also create issues related to economic development. I support the comprehensive planning for wastewater management and applaud the effort that has gone into the development of this draft CWMP. I also commend and support the intermunicipal approach and cooperative agreement between the Towns of Harwich and Chatham to advance wastewater management efforts in both communities. The CWMP provides for inter-municipal cooperation with the Town of Chatham in order to reduce costs and help utilize more fully Chatham's new wastewater treatment facility while that community is in the initial phases of sewer construction. The CWMP also incorporates alternative strategies such as improved flushing at Muddy Creek and enhanced attenuation at the Bank Street bogs. In addition, the adaptive management approach proposed in this plan provides a flexible management framework that allows for changes to the planned implementation schedule, based upon future unknown variables, such as changes in water quality, future build-out rates in different watersheds, and economics.

The EENF describes a thorough evaluation of Harwich's needs for wastewater and nutrient management. Specifically, much of the recommended plan is driven by the findings of the MEP which documented resource impairment from excess nitrogen loads in the five embayments listed above. Based on the amount of nitrogen reduction necessary, the CWMP recommends targeted sewering, using a hybrid system of gravity and low pressure sewers, with the remaining non-sewered areas relying on conventional on-site sewage treatment and disposal. A portion of the town's wastewater flow in the Pleasant Bay watershed will be directed to Chatham's wastewater treatment facility and disposed of at infiltration beds at a gravel pit in the Pleasant Bay watershed. Wastewater flow from the remaining watersheds (Allens Harbor, Wychmere Harbor, Saquatucket Harbor and the Herring River) are proposed to be treated at a new sequencing batch reactor (SBR) wastewater treatment facility and new infiltration beds, located at the Harwich Department of Highways and Maintenance property at the former landfill site in the Herring River watershed.

The Town of Harwich has taken an important step forward to address nutrient enrichment in the five major embayments. This EENF/Draft CWMP has championed an intermunicipal approach in partnering with Chatham and utilizing its wastewater treatment facility to best advantage. However, the Town should strive for additional intermunicipal partnering with Dennis and Brewster and any such efforts should be more fully explored and addressed in the SEIR. Given that there will be eight phases of the project, modifications to the existing plan can accommodate anticipated studies on regional alternatives that are being developed under the 208 Water Quality Management Plan for Cape Cod. Nonetheless, there is nothing in the first two phases of this plan that would jeopardize any future regional initiatives, in fact, several commenters believe that they serve as a strong foundation for future regional efforts.

General

The Town should prepare the SEIR in accordance with the general guidance for outline and content found in Section 11.07 of the MEPA regulations, as modified by this Scope. The Town should use the SEIR as a tool to ensure appropriate planning for the full build-out of the site, analyze cumulative impacts, and provide an understanding of background conditions and resources present within project areas.

Project Description

The SEIR should include a detailed executive summary explaining what is being proposed under the Town's Recommended Program. It should identify significant environmental benefits and impacts, and measures that will be taken to avoid, minimize and mitigate adverse impacts. The SEIR should describe the proposed schedule for the remaining phases of project planning, design, environmental permitting and review, and construction. Detailed information should be provided for each area where construction of new sewers or cluster systems are proposed, including maps that show where sewer lines, cross-country easements, pumping stations, and other facilities will be located. The SEIR should provide the best information currently available for the five sewer construction phases proposed under the Recommended Program, and explain what additional information is proposed for later collection and analysis. The SEIR should discuss the state permitting process for this project and describe how it will meet applicable performance standards.

Comments

The MEPA Office received many thoughtful and detailed comments on this project. The SEIR should contain a copy of this Certificate and a copy of each comment letter received on the EENF. In order to ensure that the issues raised by commenters are addressed, the SEIR should include a response to comments received to the extent they are within MEPA jurisdiction. This directive is not intended to and shall not be construed to enlarge the scope of the SEIR beyond what has been expressly identified in this Certificate. I recommend that the Town use either an indexed response to comments format, or a direct narrative response.

Regional Approach

The CWMP provides opportunities for regional cooperation along several fronts. The Water Pollution Abatement Trust recently provided the CCC with a $3.35 million grant to prepare an update to the 1978 Water Quality Management Plan for Cape Cod. The updated Federal Clean Water Act Section 208 Plan will be a regional, watershed-based plan designed to restore and protect water quality on the Cape. The plan will include a comprehensive analysis of all factors contributing to water quality degradation, but prioritize management of controllable nutrients due to the current conditions in the region. The updated plan will:

- Prioritize water resources, identifying the most impaired or endangered, and the actions required to achieve water quality goals as quickly as possible;
- Limit the amount of infrastructure needed by prioritizing those areas requiring "shared" systems to restore water quality;
- Provide an opportunity to more fully evaluate decentralized and innovative approaches, as well as the continued use of conventional septic systems where appropriate;
- Identify preferred solutions for nutrient management in nitrogen sensitive watersheds;
- Achieve greatest economies of scale, and identify methods to equitably share costs among all parties benefitting from the improvements;
- Feature a robust public participation process, including a facilitated outreach effort, watershed level advisory committees, and extensive public input opportunities to fully consider all views, and to build consensus for identified solutions; and
- To the greatest extent possible, identify ways in which solving the wastewater problem could also address other challenges facing the Cape.

It is anticipated that a draft 208 plan will be completed in one year, and that a final plan will be issued within two years. I strongly encourage the Town of Harwich to become an active participant in this planning process and to coordinate the Town of Harwich's planning efforts with the Cape Cod Commission's regional efforts. This would help to ensure Harwich can take advantage of any proposals for regional solutions, cost efficiencies and/or cost-sharing opportunities the regional approach will yield.

Although the draft 208 plan is not completed, MassDEP and other State Agencies currently recommend a regional watershed-based approach to addressing water quality impairment. Such an approach focuses on cost-effective solutions, cost sharing and innovation, not on municipal boundaries. The Town of Harwich's CWMP does address the most significant watersheds and shared watersheds in the Town of Harwich and proposes partnering with Chatham to address those impairments. MassDEP has identified some remaining shared watersheds in need of additional inter-municipal planning before cost-effective solutions could be developed. The CWMP Phases 1 and 2 are appropriate first steps that will not jeopardize future opportunities for regional cooperation. As other studies evolve regarding regional approaches, these can inform the strategies and direction in future phases of the CWMP.

As noted at the MEPA site visit, ongoing discussions with Chatham appear to be very promising regarding the use of the Chatham facility to accommodate some of Harwich's wastewater flows in the near term. Further, it is encouraging that there is a recognition of long-term needs and preliminary plans for Harwich to consider funding a portion of the expansion of the Chatham facility when that need may arise in order to continue allowing Harwich access to the Chatham facility. The responsibility for implementing flushing improvements for Muddy Creek will be shouldered by Harwich with the knowledge that there will be benefit to both Harwich and Chatham, as the Muddy Creek subwatershed is shared by both Towns. The CWMP mentions the possibility of inter-municipal cooperation with Dennis, especially since a portion of the village of Dennisport lies within the Herring River watershed. The Town of Harwich should initiate discussions on the mutual benefit that could be realized by coordinating the respective Towns' wastewater planning. In addition, Harwich shares a small portion of the Swan Pond River watershed with the Towns of Brewster and Dennis and the Herring River watershed with Brewster. The EENF/Draft CWMP recognizes that the wastewater treatment facility proposed for the Herring River watershed may have the potential to serve portions of the watershed outside Harwich's boundaries. Harwich should open immediate discussions with Dennis and Brewster regarding how these Towns with shared watersheds can best approach watershed planning on an inter-municipal basis. With regard to Swan Pond River, very little of Harwich is in that watershed; however, the MEP report models a scenario showing that 100 percent of the septic load must be removed to achieve target thresholds. The Town of Harwich should work with the neighboring communities on this shared watershed to ensure that planning results in proposed solutions that address the entire watershed in a cost-effective manner.

Massachusetts Estuary Project Reports

MEP has developed three technical reports that establish the in-stream total nitrogen thresholds necessary to restore estuarine water bodies in Harwich including the Herring River, Allen Harbor, Wychmere Harbor, Saquatucket Harbor, and Muddy Creek. The SEIR should clearly describe how the proposed wastewater management plan and its total nitrogen loads are consistent with the total nitrogen thresholds in these reports. The projected total nitrogen loads for each watershed should clearly describe the contributions and specific total nitrogen attenuation values for: 1) sewered parcels at build-out (including any increases in per parcel load attributed to increased parcel development), 2) unsewered parcels in the watershed of interest (including those in adjacent Towns), and 3) natural sources of total nitrogen. For example, the EENF suggests that at buildout, the proposed PB-3 infiltration basin alone will contribute 8 lbs/day of total nitrogen to the Muddy Creek watershed while the MEP threshold for Muddy Creek is only 3.9 lbs/day. Additional sources of total nitrogen from the parcels in Chatham's portion of the Muddy Creek watershed and from unsewered parcels in Harwich will increase the daily total nitrogen load even beyond 8 lbs.

Growth

The Town conducted a needs assessment to assess the wastewater needs of each area of Harwich and prioritized these areas according to their level of need. The EENF describes a significant number of parcels in the Town of Harwich that are currently undeveloped but could be developed under build-out conditions once a sewer system is installed. The SEIR should describe how build-out conditions are consistent with MEP in-watershed nitrogen thresholds and, if not, what methods of growth limitation the Town will employ to ensure that habitat restoration thresholds will be met. In some cases, this may require taking into account the build-out in adjacent communities (e.g., Brewster and Dennis along the Herring River and Chatham along Muddy Creek). In addition, the SEIR's wastewater and nitrogen loading analysis should account for existing built parcels that may be increased in built size (and/or subdivided) once sewer services are provided.

The SEIR should include a discussion of institutional issues including, if applicable, the development of a sewer connection policy and plans, funding, and public education. The DEIR should describe potential impacts relating to secondary growth associated with proposed new sewering and discuss the town's growth management plans.

Needs Assessment

The SEIR should include a reevaluation of the study areas with respect to prioritization and re-categorization with a more accurate weighting factor. As further detailed in the comment letter from the CCC, the SEIR should include an update on the Needs Assessment that describes how the CWMP process will address water quality impacts to wells, ponds and river in the study area. Several commenters have recommended that evaluation of future impacts from build-out and shifts in seasonal occupancy and/or occupancy rates should be considered. The Town should address this issue and provide an update in the SEIR.

Alternatives Analysis

The EENF includes two proposals for alternative approaches to nutrient reduction described in the CWMP. The first approach is to provide for improved flushing at the Muddy Creek culverts running under Route 28. Modeling has shown that a 24-foot wide culvert will provide benefit to water quality in the Muddy Creek subwatershed. This may result in a reduction of the amount of conventional infrastructure that would ordinarily be needed to meet target thresholds within the subwatershed. In its comments, MassDEP has stated that it will work with the Town to develop an appropriate monitoring plan to determine if the anticipated improvements in water quality can actually occur. If the project does not result in the projected water quality improvements, the SEIR should provide a discussion of the additional mitigation required to meet the target thresholds.

The second proposal is to modify or manipulate flow through the Bank Street cranberry bogs to increase nitrogen attenuation from a measure of 35% to a projected 50%. Enhanced natural attenuation at this site will be considered as a demonstration project which will require appropriate review and permitting under the Wetlands Protection Act and related regulations. The town and MassDEP should discuss permitting requirements at the earliest opportunity. Should the project be permitted, the town will need to develop a design and monitoring protocol with MassDEP so that the effectiveness of the modifications is adequately documented in order to secure credit for the anticipated additional nitrogen removal. The plan should provide a discussion of alternate mitigation strategies if the enhanced attenuation does not meet expectations.

Wastewater Treatment

The EENF/draft CWMP provides a hydrogeological report for the proposed infiltration sites HR-12, SH-2 and PB-3. As part of the recommended plan, only sites HR-12 and PB-3 were carried forward. The SEIR should provide more detail on the recommended discharge sites to allow for further evaluation.

The SEIR should include a detailed description of the proposed wastewater treatment facility and discharge areas, any further hydrogeological analysis as raised in comment letters, and an evaluation of impacts associated with all aspects of the project including the proposed effluent discharge, sewering and facility construction. The SEIR should evaluate any limiting factors for the proposed discharge locations including the potential for interaction with existing contamination and the costs associated with permitting and constructing wastewater pipelines. The SEIR should describe measures to avoid and minimize, or mitigate impacts associated with the proposed project.

The SEIR should evaluate project impacts on groundwater hydrology, surface water and wetlands resources, wildlife habitat and other sensitive resources in the project area. The SEIR should discuss monitoring plans for groundwater and surface water to evaluate impacts and inform a long-term planning process.

The Town should continue to work with the CCC on watershed analysis and other aspects of the CWMP development during preparation of the SEIR. The Town should also coordinate closely with MassDEP regarding permitting issues and allowable removal rates. The SEIR should describe how the project will meet applicable MassDEP permit requirements, including requirements for disinfection of water proposed for recharge. The SEIR should provide an update on consultations with MassDEP regarding the groundwater discharge and other applicable permits.

Water Quality

The Town of Harwich is currently exceeding the TMDL for nitrogen in five of its coastal embayments. The primary source of the problem is stormwater discharges, septic system failures, boat waste discharges, wildlife and other sources. Hydrographic modeling by MEP identified that 100% of the wastewater and fertilizers from residential lawns and cranberry bogs in Wychmere Harbor must be eliminated in order to meet the Total Maximum Daily Loads (TMDL). In Herring River and Saquatucket Harbor, the nitrogen load must be reduced by 58%, while in Allen Harbor and Pleasant Bay, the nitrogen load must be reduced by 78% and 65% respectively. All alternatives assessed in the CWMP are expected to meet TMDLs set for the ponds.

I have received many letters of support for the Town of Harwich in its efforts to develop a CWMP that serves as a water resources management strategy to meet TMDL requirements. Development of a CWMP is an important step toward meeting TMDLs and restoring impaired waters. However, the plans to meet TMDL requirements for nutrient loading must always consider source reduction as the primary means of long-term nutrient control. Source reduction usually focuses on controlling watershed land use loads generated from human activity and can include but are not limited to constructing new sewer systems, upgrading existing sewer systems (e.g. providing higher levels of treatment and eliminating combined sewer outflows), eliminating fertilizers, constructing on-site systems with enhanced nutrient removal capability, reducing runoff from impervious surfaces, reducing impervious surfaces, and tightening standards for new and upgraded septic systems. In addition to source controls, successful nutrient management plans may include alternative nutrient control strategies to achieve the desired nitrogen concentrations specified in the TMDL and MEP reports. The EENF provided a detailed discussion of the source controls proposed. The SEIR should continue to evaluate and adopt additional source controls in the future to the maximum extent possible to reduce the need for alternative nutrient control strategies.

Wetlands

The project is expected to impact a variety of inland and coastal wetland resources. The SEIR should describe and quantify all impacts to wetlands resource areas. The SEIR should include an analysis of cumulative impacts, a breakdown of impacts for different project components, and a comparison of impacts among project alternatives.

All wetlands resource areas and buffer zones on and adjacent to the project site, including Riverfront Area and Bordering Land Subject to Flooding, should be clearly identified and delineated on site plans. Proposed project elements should be superimposed on a plan with existing conditions to facilitate review and assessment. Proposed areas of impact and replication areas should be identified on site plans, and described and quantified. The SEIR should describe measures that will be implemented to avoid and minimize, or mitigate adverse impacts to wetlands and buffer zones.

The EENF/Draft CWMP contains two proposed alternative nutrient control strategies that will result in direct alteration of wetland resource areas. The Town proposes to implement the CWMP in phases and Phase 1 includes the replacement of the two existing four foot wide culverts with a 24-foot wide culvert at Route 28 to increase flushing of Muddy Creek and restore ecological habitat. Although source reduction should be the primary focus of all nutrient control strategies, MassDEP details in its comment letter certain instances where historical alteration of a resource area from its natural condition has exacerbated nutrient enrichment. With the increased

24-foot opening, residence time of nitrogen is projected to be reduced, thus contributing to overall reduction in nitrogen loads in the Muddy Creek subwatershed.

In addition to the Muddy Creek culvert improvements, modifications to Cold Brook and associated wetlands to maximize residence time of groundwater are proposed to achieve 15% of the total nitrogen attenuation required in the Saquatucket Harbor estuary. Specifically, construction of depositional ponds in abandoned cranberry bogs off of Bank Street is proposed for the retention of pollutants. This strategy is concerning and may require a Wetland Variance. Therefore, the SEIR should explore other alternatives (e.g. natural succession, different restoration techniques and wetland creation) that may better meet both the goals of wetland protection and water quality restoration.

The SEIR should also consider wetland creation as a viable alternative to the alteration of existing wetlands in and around the abandoned bog. There appear to be a number of upland areas that may allow for successful wetland creation in and around these abandoned cranberry bogs that should be investigated further.

The SEIR should analyze both direct and indirect impacts on wetlands and water bodies resulting from the project, and quantify the amount of direct wetland impacts. The analysis should also discuss the consistency of any proposed drainage and stormwater management systems that are included in the project with the MassDEP Stormwater Management regulations and the Wetlands Protection Act performance standards. Proposed activities, including construction mitigation, erosion and sedimentation control, phased construction, and drainage discharges or overland flow into wetland areas, should be evaluated.

The SEIR should examine alternatives that avoid impacts to wetland resource areas, their associated buffer zones, riverfront protection areas and 100-year flood plain areas. Where it has been demonstrated that impacts are unavoidable, the SEIR should demonstrate that the impacts have been minimized, and that the project will be accomplished in a manner that is consistent with the Performance Standards of the Wetlands Regulations (310 CMR 10.00).

Coastal Hazards

The availability of sewer infrastructure in coastal areas subject to storm damage, flooding, and erosion could allow new or expanded development in these hazard-prone areas. This development may also adversely impact natural buffers to storm waves and erosion, and compromise the storm protection provided to landward development, infrastructure, natural resources, and upland areas. The resulting impacts of development in these coastal areas could include loss of life and property, increased public expenditures for storm recovery activities, taxpayer subsidies for flood insurance and disaster relief, and risks to emergency personnel. CZM Coastal Hazards Policy #3 states that federally funded public works projects shall not promote growth and development in hazard-prone or buffer areas. In addition, State Executive Order 181 states that state and federal grants for construction projects shall not be used to encourage growth and development in hazard prone barrier beach areas. Executive Order 181 also seeks to minimize and mitigate potential storm damage by prohibiting development within flood velocity zones. Furthermore, Executive Order 149 directs State Agencies responsible for programs that affect land use planning to take flood hazards into account when evaluating plans. The SEIR should contain a detailed analysis of specific planning considerations to be developed for areas located within mapped coastal flood zones and barrier beach areas. The comments from CZM provide details as to how the Town should address this issue.

The Federal Emergency Management Agency (FEMA) has acknowledged that its Flood Insurance Rate Maps (FIRMs) need to be updated to more accurately reflect the extent of the floodplain. In 2011, FEMA began a study to update the FIRMs for Barnstable County with new analysis. One of the significant updates to the FIRMs will be to extend the velocity zone to the landward toe of the primary frontal dune. Therefore, CZM recommends that the Town's analysis of potential growth in hazard-prone areas also include, at a minimum, primary frontal dunes in addition to those areas shown on the current maps as flood zones. The SEIR should use the revised FIRMs, when they are available, to determine the extent of the flood zones.

Rare Species

As described in the EENF, a portion of the phased sewer main installation is located near or within Priority and Estimated Habitat of rare or endangered species. According to comments from the Massachusetts Natural Heritage and Endangered Species Program (NHESP) there are identified state-listed rare species in the vicinity of the Muddy Creek culvert replacement project including the Common Tern (Sterna hirundo) and the Eastern Box Turtle (Terrapene carolina). Additional estimated habitat of rare wildlife is located in the abandoned cranberry bog to the east of Bank Street. During implementation of the CWMP, the Town must comply with 310 CMR 10.59, 310 CMR 10.32(6) and related performance standards for other resource areas, and 310 CMR 10.37 to ensure that there are no short or long-term adverse effects on estimated habitats of rare wildlife.

The SEIR should analyze the impacts to rare or endangered species and evaluate avoidance/mitigation strategies and address the comments raised in NHESP's comments on the EENF. I ask that the Town continue to work closely with NHESP and consult with the Harwich Conservation Commission during the preparation of this section of the SEIR. The final project design should include necessary project construction and post-construction conditions and commitments to avoid adverse impacts to resource area habitats of state-listed species located within and adjacent to the project areas. The SEIR should report on the results of the Town's consultations with NHESP.

Fisheries Resources

The Division of Marine Fisheries (DMF) has indicated concern about the aquatic health of coastal salt ponds which are critical nursery areas for many marine species including winter flounder, anadromous fish, horseshoe crabs, and shellfish. Both winter flounder and blue crab are sensitive to eutrophication. There are several areas in Harwich where shellfishing is prohibited due to bacterial contamination, including Bass River, Allen's Harbor, Saquatucket Harbor, Wychmere Harbor, and Muddy Creek. DMF states in its comments that it supports efforts to reduce nitrogen loading in coastal salt ponds, including efforts to remediate the current eutrophied state of these ponds.

DMF has requested that the SEIR examine monitoring studies for the permeable reactive barrier study sites that include other contaminants from wastewater, not just nitrogen. For example, ecosystem quality will still be impaired if the barriers remove nitrogen but not endocrine disrupting compounds. In addition, the Town should commit to monitoring within Pleasant Bay and Saquatucket Harbor to determine if the natural attenuation projects in those watersheds are reducing nitrogen loads to the receiving waters. DMF recommends a stronger approach to Section 13.7 of the EENF, "Other Recommended Program Components." In particular, the Town should assess its carrying capacity to service boats for pumpout. I encourage the Town to work with DMF to ensure that these species are protected and that habitat impacts from the project are avoided or minimized.

Historical/Archaeological Resources

The Town should provide Massachusetts Historical Commission (MHC) with a U.S. Geological Survey topographical map that clearly locates the phased project areas and scaled project plans showing existing and proposed conditions. These plans should be submitted to MHC as early as possible during the design of each of the proposed project development phases. The Town should coordinate with MHC to ensure review of any potential historic impacts from the project and the SEIR should provide an update on the status of these discussions. If MHC deems the project to have an "adverse effect" on historic or archaeological resources, the SEIR should include a discussion of mitigation measures that the Town will undertake to address the adverse effect.

Greenhouse Gas Emissions

The project is subject to the MEPA Greenhouse Gas Emissions Policy and Protocol ("the Policy"). The Policy requires projects to quantify carbon dioxide (CO_2) emissions and identify measures to avoid, minimize or mitigate such emissions. The Town will be required to quantify the direct and/or indirect CO_2 emissions associated with the project's stationary source energy usage (e.g., building energy use, process-related energy use) and transportation-related emissions (mobile sources), if applicable. To facilitate this evaluation, the GHG analysis should include a comparison of CO_2 emissions associated with an established project baseline to estimated CO_2 emissions associated with a final build condition that incorporates feasible mitigation measures to reduce CO_2 emissions. Unlike many projects reviewed under the Policy, wastewater treatment process energy loads and subsequent CO_2 emissions play a large role in the overall project's GHG emissions rather than the buildings that contain the facilities themselves. As outlined below, the Department of Energy Resources (DOER) has provided guidance to assist the Town in making a good faith effort to quantify project-related GHG emissions.

The Town has requested a waiver for compliance with the GHG Policy due to the fact that it has committed to the installation of a solar photovoltaic renewable energy system. Although I commend the Town for this commitment this is not a sufficient justification for the granting of a waiver for compliance with the GHG Policy.

The EENF contained descriptions of project alternatives that include either modification of existing wastewater management systems, pump stations and discharge facilities and the construction of new WWTF. As noted above, these systems and facilities represent potential direct and indirect sources of GHG emissions due to related electrical and thermal loads. The Policy directs proponents to use applicable building codes to establish a project emissions baseline that is "code-compliant." However, there is no building energy code equivalent that applies specifically to WWTFs. Furthermore, there is no readily available energy use model (such as eQUEST) to estimate the projected energy use of the WWTF processing energy loads. According to discussions with the DOER, requiring Towns to estimate energy consumption, particularly by process equipment, would involve a detailed design and selection of systems and equipment well in advance of the conceptual CWMP project planning information that is typically included in ENFs and DEIRs submitted for MEPA review. Therefore, DOER's comment letter provided an alternative method to estimate GHG emissions from the proposed WWTF. This analysis should be provided in the SEIR, including supporting data, graphics and narrative to demonstrate that GHG emissions have been avoided, minimized and mitigated to the extent feasible. The Town should arrange a meeting with representatives from MassDEP, DOER and the MEPA Office prior to preparing the analysis to confirm the proposed methodology and to discuss any questions the Proponent may have with regard to the content of the comment letters.

The Town should use the EPA's Energy Star Portfolio Manager (ESPM) computer modeling program to quantify the energy usage associated with wastewater treatment technologies included in its Draft CWMP. Using EPA's ESPM will allow the Town to rank the estimated energy use of the proposed facilities included in the Draft CWMP and to compare this ranking with the energy usage of other wastewater management facilities that have similar fundamental operating parameters and are located in similar climate zones.

The Town should use the ESPM program together with the guidance and methodology cited specifically in the DOER comment letter to prepare a GHG analysis that demonstrates the Town's Draft CWMP's consistency with the Policy. The SEIR should clearly identify potential GHG reduction mitigation measures that will be adopted by the Town, or, those mitigation measures that will continue to be evaluated as project design advances. The Town should review EPA's BMP guidance document to identify additional GHG and energy reduction strategies that the Town should explore. The Town may wish to consider committing to minimum equipment performance standards as a method to meet GHG reduction goals at this stage of the project design. I also encourage the Town to consider the use of energy audits to assist in the identification of potential energy reduction measures that could be implemented into the existing portions of the wastewater treatment system.

The MEPA GHG Policy and Protocol requires that energy modeling be performed to establish the expected energy usage and corresponding GHG emissions for both the baseline and mitigated as-proposed cases. In this case, however, the DOER recommends that this requirement be waived for the actual WWTF building if certain conditions are met as detailed in DOER's comment letter because the loads and energy consumption for the buildings are included in the computation of the overall facility site kBTU/mgd. If the Town cannot meet these conditions as outlined in DOER's comment letter it will need provide GHG analysis of the WWTF building as outlined in the Policy.

The SEIR should include a feasibility study of installation of the solar (photovoltaic (PV)), installation. Installation of PV systems on municipal properties may achieve cost-savings beneficial to the community and offset ongoing operational costs. The SEIR should include a separate analysis of PV systems in association with this project in order to calculate potential project cost, payback periods and returns on investment. The Town should consider both first-party and third-party ownership/lease scenarios. The SEIR should state assumptions with regard to available area for PV equipment, efficiencies, etc.

The SEIR should also clarify if the project will include measurable transportation-related CO_2 emissions in the form of delivery of septic sludge/waste from septic haulers for treatment at the facility. The Town should consult with the MEPA Office prior to preparation of the GHG analysis to discuss a potential methodology to calculate these GHG emissions if applicable.

The Town should commit to continue to work closely with MassDEP and DOER during future final WWTF design and permitting to identify and incorporate appropriate energy efficiency measures into the buildings, treatment processes and operations for the future Harwich WWTF. It is anticipated that the Town will be required to provide a certification to the MEPA Office indicating that the mitigation measures identified in the MEPA process have been incorporated into the project. The proposed draft Section 61 Findings in the SEIR should include this self-certification requirement and incorporate the commitments listed in the EENF. For each of the considered mitigation measures, the Town should provide to MassDEP, as part of the facility permitting in conjunction with the submittal of the project manual for the facility permit documentation, which of these measures were incorporated into the final design, where the adoption of substitute measures of equal or greater efficiency took place, and an explanation and justification of the measures that were determined to be technically or financially infeasible to implement.

Land Use and Alteration

The SEIR should quantify the total amount of alteration associated with the proposed project (including areas to be altered for sewer mains, wastewater treatment and disposal, and other project components). The SEIR should include a breakdown showing the amount of alteration for different project elements. The SEIR should clarify the location, type and amount of alteration in previously undisturbed areas.

The SEIR should clarify the amount of new impervious area associated with the construction of the components of the Town's Draft CWMP. The SEIR should describe how the Town's proposed stormwater management system will be designed and constructed to be consistent with MassDEP's stormwater management regulations and policy standards and avoid and minimize adverse impacts associated with any new impervious area. The SEIR should describe proposed measures to manage stormwater during project construction.

Phasing

The draft CWMP is based on a 40-year design horizon divided intp eight phases. The SEIR should provide further discussion on the timetable required to arrive at the schedule for completion. For example, the northeast Herring River collection system (upper) is scheduled for Phase 4B and the northwest (upper) Herring River collection system is scheduled for Phase 5 while the southwest (lower) Herring River collection system is scheduled for Phase 7. Because the lower Herring River collection system would likely have a more immediate effect on improving water quality due to its proximity to the marine portion of the Herring River watershed, it should be considered for Phase 4B or Phase 5 and the upper Herring River collection systems should be considered for later phases. I advise the Town to have further discussions with MassDEP before finalizing a phasing plan.

Costs

The Town of Harwich is encouraged to work with MassDEP's State Revolving Fund (SRF) section to develop funding alternatives as project development proceeds. The SEIR should include an updated summary of the Recommended Program costs. The SEIR should document any assumptions concerning the probable cost of acquiring parcels for wastewater purposes. The Town should consult with MassDEP during the preparation of this section of the SEIR.

Public Participation

I note that the SRF regulations require the Town to conduct a minimum of one public meeting and one public hearing for this project. The SEIR should include a discussion of the Town's public participation program activities completed and proposed.

Hazardous Materials

MassDEP has indicated that the Town should consider the potential for encountering contamination during excavation. The SEIR should identify known hazardous waste sites governed by the Massachusetts Oil and Hazardous Material Release Prevention and Response Act (M.G.L. c. 21E) in the vicinity of the project area and provide an updated summary on the status of these sites consistent with the Massachusetts Contingency Plan (MCP, 310 CMR 40.0000). The Town should provide an overview of planned remediation efforts. The Town is advised that, if oil and/or hazardous material (OHM) is identified during the implementation of the project, notification pursuant to the MCP must be made to MassDEP, if necessary. A Licensed Site Professional (LSP) may be retained to determine if notification is required and, if need be, to render appropriate opinions. Construction protocols and procedures should reflect the potential for discovery of OHM during the construction period. I refer the Town to the comments from MassDEP for additional guidance on the prevention and management of potential releases of OHM.

Construction Period Impacts

The SEIR should include a detailed draft Construction Management Plan (CMP) describing project activities and their schedule and sequencing, and BMPs that will be used to avoid and minimize adverse environmental impacts. The CMP should address potential demolition and construction period impacts (including but not limited to land disturbance, noise, vibration, dust, odor, nuisance, vehicle emissions, construction and demolition debris, impacts on trees and other vegetation, and construction-related traffic) and analyze and outline feasible measures that can be implemented to eliminate or minimize these impacts. The SEIR should outline potential measures to address materials management during the construction period. The CMP should discuss plans for reuse and recycling of construction materials including asphalt, brick and concrete (ABC). The CMP should include an erosion control component to address protection of water quality and wetlands resources. The project must comply with MassDEP's Solid Waste and Air Quality Control regulations during construction.

I ask that the Town participate in MassDEP's Clean Air Construction Initiative (CACI) and the MassDEP Diesel Retrofit Program to mitigate the construction-period impacts of diesel emissions to the maximum extent feasible. The Town should consult with MassDEP during the preparation of the SEIR to develop appropriate construction-period diesel emission mitigation, which could include the installation of after-engine emission controls such as diesel oxidation catalysts (DOCs) or diesel particulate filters (DPFs). Project contractors are required to use ultra low sulfur diesel (ULSD) fuel (15 parts per million sulfur) in off-road engines and MassDEP can provide additional resources to assist with implementation of this program.

The Town is required to prepare a Stormwater Pollution Prevention Plan (SWPPP), which must clearly and reasonably delineate all areas to be 'altered', and describe the practices that will be implemented to protect the resources during construction as well as upon completion of the project. This includes Erosion and Sedimentation Control Plans and design calculations to assess all drainage leaving the construction areas. The SWPPP must also include designation of areas where stockpiling of material and operations are to occur. The Town should consult with MassDEP and others to ensure that the Project will meet any performance standards associated with a federal NPDES permit for all proposed project construction activities.

Mitigation and Section 61 Findings

The SEIR should include a separate chapter on mitigation measures, which should include a summary table of all mitigation commitments as well as detailed draft Section 61 Findings for all state permits. The draft Section 61 Findings should describe proposed mitigation measures, contain clear commitments to mitigation and a schedule for implementation based on the construction phases of the project, estimate the individual cost of each proposed measure, and identify parties responsible for funding and implementing the mitigation measures. The draft Section 61 Findings will serve as the primary template for permit conditions.

Circulation

The SEIR should be circulated in compliance with Section 11.16 of the MEPA regulations. Copies should be sent to those parties that submitted comments on the EENF, and to each federal, state and local agency from which the Town will seek permits or approvals. A copy of the SEIR should be made available for public review at the Harwich Public Library.

April 12, 2013
Date

Richard K. Sullivan, Jr.

Comments received:

04/01/2013	Harwich Conservation trust, Association to Preserve Cape Cod, Friends of Pleasant Bay, East Harwich Community Association
04/01/2013	Harwich Office of Selectmen, 1st Letter
04/02/2013	Town of Harwich Planning Department
04/03/2013	Cape Cod Commission
04/04/2013	Division of Fisheries & Wildlife, Natural Heritage and Endangered Species Program
04/05/2013	Pleasant Bay Alliance
04/05/2013	Association to Preserve Cape Cod
04/05/2013	Massachusetts Division of Marine Fisheries
04/08/2013	Harwich Office of Selectmen, 2nd Letter
04/08/2013	Massachusetts Coastal Zone Management Office
04/08/2013	Department of Energy Resources
04/09/2013	Massachusetts Department of Environmental Protection – SERO

RKS/ACC/acc

AC

March 21, 2013

RECEIVED

APR = 1 2013

MEPA

Mr. Richard K. Sullivan, Jr.
Secretary
Executive Office of Energy and Environmental Affairs
100 Cambridge Street, Suite 900 (9th Floor)
Attention: Anne Canaday, MEPA Office
Boston, MA 02114

Mr. Paul Niedziewicki
Executive Director
Cape Cod Commission
PO Box
Barnstable, MA 02630

Re: EEA #15022: Draft Comprehensive Wastewater Management Plan for the Town of Harwich

Dear Sirs:

The Draft Comprehensive Wastewater Management Plan (DCWMP) for the Town of Harwich has been prepared by CDM-Smith. The purpose of the plan is to describe the Town's wastewater needs and recommend a program for meeting those needs. The plan contains insufficient information about underlying build-out assumptions and the costs of treating wastewater resulting from new development. It also lacks consideration of alternative methods of achieving community growth goals in ways that could reduce wastewater treatment costs. It is vital that these issues be addressed in the DCWMP. Below is a discussion that details these issues.

Wastewater from on-site septic systems accounts for 75-85% of the nitrogen traveling from watersheds to estuaries in Harwich. Validated scientific evidence has documented the negative impact that the continued flow of excess nutrients will have on the condition of our coastal waters. Degraded water quality will have far-reaching ecological consequences that would diminish our quality of life and the vitality of our regional economy. Total Maximum Daily Loads (TMDLs) have been set for the Town by watershed. In East Harwich, TMDLs for the Pleasant Bay watershed require a 65% reduction in septic nitrogen load. This means removing nitrogen from existing development and preventing any additional nitrogen from future growth.

Given the extent of treatment needed, sewers are an important part of the treatment solution. However, sewers should be scaled to accommodate a level of growth that coincides with clearly defined community goals for growth and resource protection. All alternative measures to use land use tools to reduce the costs of sewers need to be fully considered. In making decisions about investments in sewers, communities should understand the resulting growth effects and costs associated with wastewater treatment designed to accommodate growth.

The importance of in-depth public review of growth assumptions and associated wastewater costs is emphasized in the Cape Cod Commission's *Guidance for Local Wastewater Management Plans* (December 2012). The Guidance instructs towns in the earliest stages of planning to estimate the cost of wastewater treatment for mitigating wastewater flows based on current zoning, and to estimate the cost of wastewater treatment for new growth. Later stages of planning should not begin until the town has "addressed the potential cost of future growth (including presentation at public meetings) and concluded that the setting of the [proposed growth] flows is consistent with the community's willingness to expend capital for future growth needs."

Based on information provided in the DCWMP, the undersigned organizations are concerned that the growth effects of wastewater and the associated treatment costs for new growth are not fully described, particularly for the region of town with the highest growth potential, East Harwich.

The DCWMP assumes that wastewater flows in the Town will grow 26% due to new development. This means that town-wide wastewater flow will increase from 860,000 gallons per day (gpd) currently to 1,080,000 gpd at build-out, an increase of 220,000 gpd (Table 13-1).

In terms of new development, an additional 500,000 square feet (sf) of commercial space and 250 dwelling units beyond build-out under existing zoning for East Harwich have been added to build-out projections in the DCWMP. According to the DCWMP, this assumption is attributed to the Town's desire to increase growth in that area (page 13-2), although these build-out estimates do not coincide with any approved community growth plan. The DCWMP also states that this new development will generate an additional 55,000 gpd of wastewater at build-out (Page 13-2). This 55,000 gpd increase specifically associated with new development in East Harwich amounts to 25% of the total town-wide increase of 220,000 gpd in wastewater flow due to projected growth.

The wastewater cost impact of this new development in East Harwich is $20 million. This is supported by information included in the DCWMP that discusses cost reductions.

The DCWMP states that the overall cost of the plan could be reduced by $50 million provided half of projected town-wide growth does not occur, and stormwater and fertilizer controls are put in place (page 13-29). If we assume that 20% or $10 million of that savings would come from fertilizer and stormwater controls, that leaves a potential cost savings of $40 million from halving growth, which would eliminate 110,000 gpd of wastewater flow (half of 220,000 gpd attributed to growth townwide). Added new development in East Harwich accounts for 55,000 gpd of wastewater, or half of the 110,000 gpd. Eliminating that added growth above current zoning could achieve half of the growth-related savings, or $20 million. Thus the additional 500,000 sf of commercial space and 250 new dwelling units in East Harwich, by generating 55,000 gpd of wastewater, accounts for approximately $20 million in wastewater costs.

It is also possible that projected wastewater flow resulting from an additional 500,000 sf of commercial growth in East Harwich could be significantly higher than the 55,000 gpd projected in the DCWMP. To estimate wastewater flow from new commercial development in the Pleasant Bay watershed, the DCWMP uses a factor of 35 gpd per 1000 sf of commercial development (Table 7-7). However, the DCWMP uses a water use factor of 236 gpd per 1,000 sf of commercial development for every other watershed in Harwich (Table 7-7). A survey of commercial water use factors in Massachusetts Estuaries Project Technical Reports for commercial districts in other watersheds on Cape Cod shows factors in the range of 80-120 gpd per 1,000 sf. Thus, the amount of wastewater flow from new commercial development in the Pleasant Bay watershed could be two to six times what is currently estimated. There is no explanation given as to why water use and wastewater flow for commercial activity in East Harwich is so low compared to other watersheds in town, or to commercial areas in other watersheds on Cape Cod.

It is also important to note that the 55,000 gpd increase in wastewater flow in East Harwich is in addition to the 30,000 gpd that the DCWMP assumes would be generated at build-out under current zoning in the Pleasant Bay watershed. Thus the total wastewater flow at the higher density build-out scenario is 85,000 gpd. An estimate of wastewater flow under various development scenarios conducted by Wright-Pierce for APCC (February 2012) calculates wastewater flow at build-out under current zoning as 82,000 gpd, just 3,000 gpd less than the DCWMP high growth scenario. Thus the projections in the DCWMP could seriously underestimate wastewater flow and resulting costs from added development in East Harwich. If the estimated wastewater flow from added growth in East Harwich is higher than 55,000 gpd, then the cost of treating that added growth could be dramatically higher than $20 million.

We are also concerned that land use management alternatives that could help to achieve growth goals and save wastewater costs have not been fully evaluated. The Commission's Guidance document recommends that, once a town has estimated wastewater treatment costs associated with growth, it should then "review its build-out analysis to consider possible growth restrictions in areas identified for sewering but not currently identified for future growth." The importance of growth controls in East Harwich as a way to reduce wastewater treatment costs is acknowledged in the DCWMP. On page 13-36 of the DCWMP it is noted that the Pleasant Bay watershed is one of two areas in town where land use controls could be effective in bringing down treatment costs. Yet there is no evidence in the DCWMP that growth management tools have been evaluated as a way of achieving millions of dollars in potential cost savings.

In light of the information contained in the DCWMP, we are concerned that the impact of proposed growth in development on wastewater flows and resulting wastewater collection, treatment and disposal costs in East Harwich have not been adequately represented. This information is essential for Harwich residents to have a full understanding of the wastewater-related costs associated with different decisions about growth, and the options available for accommodating growth in concert with land use management that could help to mitigate wastewater flows and reduce wastewater-related costs.

Therefore, we are requesting that the Town of Harwich and its consultants be asked to provide the following analyses:

1. A sensitivity analysis that projects wastewater flows from commercial growth in East Harwich based on a factor of water use that is consistent with other watersheds in Harwich, and other watersheds on Cape Cod.
2. A sensitivity analysis that projects wastewater flows and nitrogen loads from commercial and residential growth in East Harwich based on different growth assumptions including:
   - Growth at the level of build-out in the village center and remainder of the watershed under current zoning;
   - Growth in the village center that is beyond build-out at current zoning without offsets to that growth. Examples would be the addition of 500,000 sf and 250 units shown in the DCWMP, and a higher level of increase to reflect current zoning proposals put forward by the Planning Board (dated 12/14/12).
   - Growth in the village center that is beyond build-out at current zoning with offsets to balance that growth. Examples would be the plan put forward by the East Harwich Collaborative (dated 9/15/11).
   - Growth under land use controls that reduce the amount of future commercial and residential growth below existing zoning for East Harwich.
3. Wastewater costs for each growth scenario noted above should be provided, including collection, treatment, effluent disposal costs and on-going operations and maintenance costs associated with that treatment. Assumptions underlying costs projections should be clearly stated.
4. Comparable analysis should be prepared for all areas of Harwich where future growth beyond build-out under current zoning is projected.

Thank you for your consideration of these comments.

Respectfully,

Harwich Conservation Trust

Robert Smith, Esq
President

Association to Preserve Cape Cod

Ed DeWitt
President

Friends of Pleasant Bay

Jay Tichenor
President

East Harwich Community Association

Briget Rutten
President

Cc: Harwich Board of Selectmen
Harwich Water Quality Task Force
Harwich Wastewater Implementation Committee
Pleasant Bay Alliance
Harwich Real Estate and Open Space Committee
Harwich Conservation Commission
Harwich Board of Health
Massachusetts Department of Environmental Protection
Town of Chatham, c/o Dr. Robert Duncanson
State Senator Daniel Wolf
Representative Sarah Peake

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SEAL OF THE TOWN OF HARWICH INCORPORATED SEPT. 14, 1694 ADOPTED SEPT. 4, 1897

AC

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APR - 1 2013

MEPA

March 26, 2013

Ms. Anne Canaday
Executive Office of Energy and Environmental Affairs
100 Cambridge Street; Suite 900
Attn: MEPA Office
Boston, MA 02114

Subject: Comments on Harwich, MA Draft Comprehensive Wastewater Management Plan (CWMP); EOEEA No. 15022

Dear Ms. Canaday:

The Harwich Board of Selectmen (BOS) held a public meeting on January 19, 2013, to receive comments on the Draft CWMP. After a brief presentation on the Draft CWMP by our Water Quality Management Task Force (WQMTF) who is overseeing the development of this program for the town and their consultant, CDM Smith, there was an open comment period where the vast majority of those attending supported the program put forth in the plan. Subsequently on February 19, 2013 the BOS voted to approve submission of the Draft CWMP to the MEPA Office for review and comment.

The Town of Harwich understands that we must protect and restore our valuable water resources. The water quality in our harbors and embayments has become degraded and the main contributing source to this degradation is nitrogen leaching from the Title 5 septic systems throughout our community. Our WQMTF supported by town staff and our consultant has dedicated a significant amount of time to develop what we believe is a well thought out program that best addresses this important nitrogen impact issue. The program includes a combination of several unique solutions including: regionalization with Chatham, eight phases over 40 years to allow us to implement in a reasonable manner and several non-infrastructure aspects that will allow us to potentially build less infrastructure which will lower the program costs. There is no question this program is costly and we need to continue to look to minimize costs via adaptive management approaches during the implementation phase. Currently we have a Wastewater Implementation Advisory Committee that is reviewing potential cost recovery models for us to implement the program. A recommended cost model will be presented in the Final CWMP.

While the BOS remain concerned about the overall costs to implement the program presented in the Draft CWMP and will continue to work with local, county, state and federal officials to seek funding for this project, we voted on March 25, 2013, to further endorse the water resource protection defined needs and the recommended program to address them as presented in that plan which will be reviewed by MEPA.

Very truly yours,

Linda Cebula, Chair
Harwich Board of Selectmen

cc: Peter de Bakker, Chair WQMTF
Brian Dudley, MassDEP
Paul Niedzwiecki, Cape Cod Commission
David Young, CDM Smith

#15022 AC

Town of Harwich
Planning Department

April 2, 2013

Richard K. Sullivan, Jr.
Secretary, EOEEA
100 Cambridge Street
Suite 900 (9th Floor)
ATTN: MEPA Office c/o Anne Canaday
Boston, MA 02114

RECEIVED
APR 8 - 2013
MEPA

Mr. Paul Niedzwiecki
Executive Director
Cape Cod Commission
P.O. Box 226
Barnstable, MA 02630

Dear Secretary Sullivan and Mr. Niedzwiecki,

I am writing as Harwich Town Planner and as a member of the Pleasant Bay Alliance watershed work group. As Town Planner, I worked very closely with CDM-Smith in the development of growth projections for Harwich. All projections provided by me were based on planning and zoning discussions at the time among the Planning Board, the East Harwich Collaborative and others. These discussions continue and will ultimately result in an adopted zoning by-law based on growth assumptions which may change. While this planning work proceeds, it is critical not to delay valuable steps that address current wastewater issues.

As a member of the Pleasant Bay Alliance watershed work group, I offered the following comments on that group's draft comment letter:

> *We need to move beyond Title 5 and the "status quo". In response to water quality issues throughout the town, Harwich has developed a carefully researched and long-discussed Comprehensive Wastewater Management Plan. Initially, the first areas to be served were to be along Nantucket Sound. However, within the past year the Town has recognized the regional environmental and economic advantages of connecting first to the existing Chatham wastewater treatment plan. The significant benefit for our town and our neighbors is the removal of nitrogen flow to Pleasant Bay from existing development. Of course, additional information is relevant and further studies may be*

pursued. But the top priority of the Pleasant Bay Alliance should be to support construction of the Harwich connection to the Chatham plant at the earliest possible date.

A key component of the Harwich CWMP is adaptive management (section 13.8). We don't know yet what benefits will be provided by the Muddy Creek bridge project. We have not yet implemented fertilizer management and other non-structural methods nor have we measured any ensuing nitrogen reduction. We have spent six years on possible zoning changes for the East Harwich area, and we remain far apart. Adaptive management will allow the town to move forward on current wastewater treatment measures while continuing to review issues such as those mentioned here.

The draft CWMP provides specific measures that will benefit the Pleasant Bay watershed in Phases 1, 2, 3, and 8. By delaying the final work until Phase 8, the Town will have full opportunity to pursue its adaptive management process and to make changes to ultimate service areas as needed.

I hope your final comment letter will include both support for immediate construction of the connection to the Chatham plant and continued review of other important issues through the Town's proposed adaptive management process.

Thank you for the opportunity to comment on the Harwich Draft Comprehensive Wastewater Management Plan. I fully support that plan and hope that you give it your approval.

Sincerely,

David H. Spitz

David H. Spitz,
Town Planner
dspitz@town.harwich.ma.us

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CAPE COD
COMMISSION

Fax (617-626-1181) and Regular Mail

April 4, 2013

Secretary Richard K. Sullivan, Jr.
Executive Office of Energy and Environmental Affairs
Attn: MEPA Office – Anne Canaday
100 Cambridge Street, Suite 900
Boston, MA 02114

RE: ***MEPA Unit Project Number 15022***
Draft Comprehensive Wastewater Management Plan, Harwich

Dear Secretary Sullivan:

On February 28, 2013, the Cape Cod Commission (Commission) staff received a copy of the Expanded Environmental Notification Form (ENF) and Supplemental Report for the above-referenced project prepared by CDM Smith.

As the project requires the preparation of an Environmental Impact Report (EIR), it is also subject to Commission Development of Regional Impact (DRI) review pursuant to Section 2(d)(i) of the *Enabling Regulations* (revised July 2012) as "*[a]ny proposed development for which an Environmental Impact Report (EIR) is required to be prepared under the provisions of MEPA shall be deemed a DRI.*" The Town requested Joint MEPA/Commission Review pursuant to the Memorandum of Understanding between the Commission and the Executive Office of Energy and Environmental Affairs – MEPA Unit. The Commission received the Town's Expanded ENF and request for Joint Review on February 28, 2013 from the Town's representative, David Young of CDM Smith. A Joint MEPA/DRI scoping session/public hearing was held on April 3, 2013 at 5:00 PM at the Harwich Town Hall. The purpose of the April 3, 2013 hearing was to gather information for the Joint MEPA/DRI Review of the project and to make recommendations on the scope of the Final EIR. The Town is requesting a MEPA Phase 1 Waiver for a culvert replacement project located under the Route 28 crossing of Muddy Creek to improve its coastal habitat and water quality.

Background

Wastewater management is one of the most significant regional concerns affecting Cape Cod. The Commission is actively engaged in the preparation of a 208 Area Wide Water Quality Management Plan for Cape Cod. As such, the Commission will be working with towns within Barnstable County on the shared challenges of wastewater management to identify efficient and cost-effective common solutions. The Commission's review of Comprehensive Wastewater Management Plans (CWMPs) has recently been articulated through a Regional Wastewater Management Plan (RWMP) titled "Draft Guidance for Cape Cod Commission Review of Local Wastewater Management Plans."[1] The RWMP Guidance distinguishes CWMPs from Targeted Watershed Management Plans, which may be a subset of a CWMP. The Guidance requires consistency with the Barnstable County Regional Policy Plan, Local Comprehensive Plans and follows the general outline of the DEP Water Resources Management Planning Guidance, which includes sections on Shared Watersheds, Needs Analysis and Problem Identification, Alternatives Development, Plan Evaluation and Selection, Adaptive Management and Implementation.

The Commission supports the efforts of the Town of Harwich to develop a comprehensive plan to address wastewater management and recognizes the efforts the Town has made to coordinate its wastewater planning with its neighboring Towns of Chatham and Dennis. The Commission looks forward to partnering with the Town of Harwich as we proceed with the Joint MEPA/DRI review of the ENF and begin work on the 208 Area Wide Water Quality Management Plan.

Summary

Commission staff has reviewed the Expanded ENF for the project's possible impacts and in general finds that it addresses many of the parameters of our Regional Policy Plan and RWMP Draft Guidance on CWMPs, and suggests that the Phase 1 Waiver for proceeding with the Muddy Creek Culvert is a reasonable and severable phase of the project. Commission staff recommends that the Town address certain issues identified in this letter in preparation of its Final EIR/CWMP, but respectfully requests that the Town not submit the CWMP for formal review until the Commission has completed its Regional 208 Water Quality Management Plan, which is anticipated to be completed in the next year. Commission staff offers the following comments for the consideration by the Massachusetts Environmental Policy Act (MEPA) Unit.

Project Description

The Town is pursuing a long term, multi-phased wastewater management program with regional and centralized treatment to reduce nutrient loading to coastal waters, meet anticipated total maximum daily loads for estuaries/embayments along Nantucket Sound and

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[1] http://www.capecodcommission.org/resources/RWMP/local_planning_guidance.pdf

Pleasant Bay and support viable business activity in the town centers. The project proposes a town-wide wastewater collection and treatment system, with work located throughout the Town. Sewer mains are proposed in existing paved roads. The Town is recommending a traditional wastewater program that includes approximately 92 miles of sewer pipes, 30 pumping stations and two centralized treatment facilities. The preferred alternative includes two treatment facilities; one that utilizes the existing facility in Chatham, and a new facility in West Harwich. The project also includes non-structural alternatives for stormwater management, pond water quality protection and restoration, fertilizer education, town-wide land use regulation reviews and two natural nitrogen attenuation projects. The total project is projected to be phased over 40 years and will develop an adaptive management approach to guide its implementation.

Water Resources

The Harwich CWMP is a sequential and well thought out plan to deal with the town's wastewater needs. The CWMP provides an excellent summary of the public participation efforts and identifies the key stakeholders and decision makers. The Expanded ENF includes a needs assessment which provides the background and interpretation of the water quality conditions for drinking water, fresh water ponds, and coastal embayments, which are the three major water resource areas identified in the Cape Cod Regional Policy Plan and RWMP Draft Guidance. The background information provides the framework for the project and identifies the Town's overall wastewater management needs. The CWMP includes a process to identify wastewater collection areas, primarily to achieve the amount of septic nitrogen removal necessary to restore coastal water quality as determined through the MEP studies critical nitrogen loads. The process is one that uses parcel specific water use information and accounts for the occurrence of natural attenuation and opportunities for enhanced attenuation. Sewer collection is proposed in several areas as a result of this process. The CWMP also includes a process to account for the removal of septic nitrogen and the return of treated effluent nitrogen to achieve the overall goal of restoration.

Wastewater Flows and Buildout

The CWMP cross referenced water quantity information from cumulative pumping and actual parcel level metered water use. The town-wide water use for the years 2001 to 2007 is between 679 and 600 million gallons. The average household water use is 186 gpd and commercial use is 768 gpd. Specific water uses for each Marine watershed are reported. The CWMP used the MEP buildout analysis and applied the appropriate water use to project the number of residential and commercial properties. The increase in wastewater flow ranges from 14 to32% for the five major coastal watersheds, as listed on Table 1, with an average of a 28% increase. The CWMP evaluated the effect of irrigation water use on wastewater projects and found that the long-term irrigation amount is 315,000 gpd for July and August, making up 3 of the 10% average non-consumptive water use. Maximum month peaking factor for Harwich is 2.2 times the average flow of 1.72 mgd. The buildout assessment makes use of the MEP buildout analysis including some modification for economic development in the East Harwich and Harwich Port areas. Commission staff suggests that the Town distinguish the parameters of the buildout modifications in the Final EIR and identify incremental infrastructure milestones in the description of the phasing of the project to accommodate potential buildout needs. Staff further recommends that the EIR address how the Town would demonstrate a flow-neutral condition for SRF zero percent loan eligibility.

Drinking Water

The CWMP reports that approximately 9,800 accounts in the town are serviced by drinking water from 14 gravel packed wells that collectively pump approximately 2 MGD. The drinking water quality is excellent with the exception of naturally occurring iron. The Town Water Department recently completed a new 6.5 MGD treatment plant to remove iron and manganese. The average nitrate concentration from the wells is 1.1 ppm, which is substantially below drinking water health limits. The Wellhead Protection Areas (WPAs) that provide recharge to the public supply are not identified as a wastewater management need, however, limited sewering in overlapping Marine Water Recharge Areas (MWRAs) will provide potential benefits to drinking water quality. The Pleasant Bay drinking water well recharge area that is proposed for sewering for Pleasant Bay has an average nitrogen concentration of 2 ppm, which is below the state and federal standard of 10 ppm, and the Cape Cod Commission loading standard of 5 ppm.

Ponds

There are 22 major ponds in Harwich. The Water Quality Task Force has taken advantage of the Cape Cod Ponds and Lake Stewardship (PALS) program to obtain important long term water quality data. The CWMP utilized prior reports, including those prepared through the Cape Cod Commission, and developed a pond program to protect and, where necessary, restore pond water quality. The program proposes continued monitoring, evaluation of stormwater treatment opportunities and further investigation, particularly to determine whether phosphorous loads are internal (sediments) or external (from the watershed). Three areas were identified around John Joseph, Bucks and Sand Ponds, Hinckleys, Seymour and Long Pond, and Paddocks Pond. The CWMP indicates that continued monitoring and study are required to determine the best overall approach to protect and restore pond water quality. Phase I of the CWMP includes alum treatment of Hinckleys Pond as recommended in a detailed study by Water Resources Services dated March 2012. The Alum treatment of Hinckleys Pond is a reasonable Phase 1 CWMP project.

Marine Water Quality

The CWMP reports on the findings of the Massachusetts Estuary Project (MEP) which includes critical nitrogen loads referred to as thresholds. The next step is for the MA Department of Environmental Protection (DEP) is to establish Total Maximum Daily Loads (TMDLs) from the thresholds in the MEP report and to work with the Town and SMAST to prepare and complete the regulatory review necessary to establish the TMDLs.

The MEP critical nitrogen loads are presented as the amount of septic nitrogen that will need to be removed from the watersheds. The percent removal for existing and buildout conditions are summarized on the table below.

Table 1 Percent Nitrogen Removal by Watershed

Watershed	Present Load (kg/d)	Percent Septic Reduction Existing Condition	Percent Septic Reduction Buildout Condition
Allen Harbor	5.64	74	78
Wychmere Harbor	3.21	100	100
Saquatucket Harbor	13.25	60	58
Pleasant Bay (Round Cove)	5.18	64	68
Pleasant Bay (Muddy Creek	13.32	48	58
Pleasant Bay	16.69	61	70
Herring River	38.59	38	58

Of particular note is the large increase of percent removal that occurs under buildout conditions in the Herring River Watershed. A majority of this future load comes from the West Reservoir sub-watersheds where the amount to be removed increases from zero at present conditions to 48% at buildout conditions. This results in the largest difference between percent removal for existing and buildout conditions in the table above. The CWMP in a later section indicates that the nitrogen thresholds for the three harbors on the south side could be revisited due to their use as major boat basins. Commission staff recommends that controls on future growth, including open space protection in the Herring River watershed be considered as an alternative/complementary strategy for nitrogen management.

Wastewater Needs

Two areas of concern for Title 5 failure are the area north of Allen Harbor due to high groundwater, and the Campground area due to dense development. Sewering to alleviate Title 5 issues is recommended by the CWMP because the areas are also identified for nitrogen reduction. Wastewater needs for nitrogen reduction using the MEP thresholds was summarized above. Wastewater needs for socio-economic reasons for East Harwich, Harwich Port and Harwich Center were identified and factored into projected overall wastewater flow and management scenarios. The Campground area is not in a nitrogen management area and is not scheduled for action until Phase 8. A potential local solution for that area should be evaluated under adaptive management aspect of the CWMP

Wastewater Effluent Disposal

The CWMP used a screening process to eliminate unsuitable parcels for consideration as potential facility and effluent disposal sites. Of the 11,600 parcels in town, forty parcels were identified for further consideration, ten parcels were selected for further study, and five sites were chosen as part of the CWMP management scenarios. The site suitability approach was methodical and provided reasonable results for the projected and cumulative sub-regional volumes of wastewater. The CWMP identifies the PB-3 as a key site for effluent disposal. The site is in a Zone II which would require costly advanced treatment to comply with the DEP Groundwater Discharge Permit (GWDP) Total Organic Carbon limit of 3 ppm. The CWMP indicates that DEP might make a favorable determination that removal for TOC is not required. Such determination would be an important one for future wastewater planning and as such, Commission staff recommends the Town include a more thorough discussion of this issue in the Final EIR, provide particle flow tracking results and include Commission staff in the dialogue.

Wastewater Management Scenarios

The CWMP developed eight alternative scenarios for wastewater management as summarized in the Table below. The baseline case included the nitrogen offset that is anticipated to result from two natural attenuation projects for Muddy Creek and Cold Brook. The parcels and wastewater flows reflect the amount needed to offset nitrogen loads from the proposed treatment effluent. The CWMP developed a number of criteria to compare the scenarios including capital cost, operation and maintenance, cost efficiency (shown below), a variety of technical criteria, institutional criteria and environmental criteria. Commission staff recommends the criteria ranking process is a thorough and fair method. The total criteria score (as weighted) of the scenarios (shown below in Table 1) indicate that scenarios 3A, 4A and 5A are the most favorable.

The scenario including IA systems had the highest cost per nitrogen pound removal. The CWMP used an IA treatment efficiency of 19 ppm. The treatment efficiency for some IA technologies for smaller cluster and individual systems have better documented treatment efficiencies which Commission staff recommends should be considered.

The CWMP, less formally, evaluated the use of smaller facilities, sized at 100,000 gpd as an alternative. The Town used the selected decision criteria to determine that the use of more numerous 100,000 gpd facilities was not favorable, largely from a bottom line cost perspective. However, Commission staff suggests that phasing in a more dispersed system could provide faster removal of nitrogen in targeted areas to produce demonstrable water quality improvements. Table 2 shows the number of parcels and flow to be captured and treated. The amounts for three of the smaller southern embayments range from 26,000 to 95,000 gpd at build out. Smaller treatment facilities, while incurring a cost premium, can potentially be deployed over a shorter time frame with more flexibility for siting. The identification of sites to treat and dispose of wastewater at these lower volumes could also include parcels that are smaller than 5 acres.

The CWMP used the percent septic nitrogen removal for the buildout condition. Commission staff suggests that the Town identify the extent of potential sewer collection areas for the existing development condition and identify how the system could be phased in through selected planning horizons as development proceeds from existing conditions to buildout conditions. This should also include the relative percent of nitrogen removed for each major watershed for phase of the plan.

Table 2 Wastewater Scenarios

Scenario	Description	Parcels Sewered	Wastewater Flow	Cost $/Pound of NO3 removed	Total Score
1A	3 Sites (Allen to Saquatucket)	2992	670000	199	270
2A	3 Sites (Allen to Herring)	3092	682000	192	266
3A	1 Site in Herring River	3198	697000	146	145
4A	2 Sites HR and PB	3184	704000	175	223
5A	2 Sites HR and PB (Chatham)	3094	680000	170	204
6A	4 Sites	2968	667000	215	321
7A	IA Systems & four Sites	1643	417000	447	402
8A	1 Site and Ocean Outfall	2438	564000	252	366

Table 3 Sewershed Characteristics

Sewershed Characteristics for Each Watershed (Option 5A)	Parcels	Current Average Water Use (GPD)	Buildout Average Water Use (GPD)
Allan Harbor	234	52,100	57,000
Wychmere Harbor	123	26,300	29,000
Saquatucket Harbor	451	90,700	95,200
Pleasant Bay	1205	205,900	235,900
Herring River	2340	399,300	515,700

Regional Approach

The CWMP includes two aspects of a regional approach. The first is to include the sewer collection of a section of Dennis Port within the Herring River watershed. This aspect is included in all scenarios. The other regional aspect is the potential use of the Chatham facility that was recently completed to accommodate the flow from the East Harwich and the Pleasant Bay watershed. Two versions of this scenario are discussed. In one version the effluent would be retained and disposed of at the Chatham facility until such a time that the Chatham sewer expansion project would require that capacity. The other version transports the treated effluent back to Harwich for disposal in the Pleasant Bay watershed. Treatment at the Chatham facility attains a nitrogen treatment efficiency of 3 ppm. This regional option would make use of early capacity at Chatham plant and reduce the overall construction cost to both towns through a shared facility.

Chatham DRI Conditions

The Cape Cod Commission approved the Chatham CWMP as a DRI on March 29, 2009 with 41 Findings and 23 Conditions. Excerpted below is a finding and two conditions from that decision which are relevant to the Harwich CWMP.

FINDING

WR1. The Town of Chatham has been in discussions with the Town of Harwich on their potential shared use of Chatham's wastewater facility site. Because the Harwich CWMP has been delayed, fundamental information on which to base decisions is presently not available. Prior to proceeding with the potential shared use of the site, additional site characterization would need to be conducted to determine 1) if the treatment capacity could be expanded, 2) if the site has the capacity for expanded subsurface disposal and 3) if the assimilative capacity of the downgradient waters can receive the increase of nitrogen load.

CONDITION

WR6. Regional inter-municipal agreements with Harwich to achieve TMDL compliance for Muddy Creek and/or the potential shared use of the Chatham treatment and disposal site shall be concluded prior to any renewal of this permit per Condition G1.

WR11. Implementation of Enhanced Natural Attenuation or tidal flushing to reduce Nitrogen loading to reduce the area of planned sewering as indicated in the CWMP shall require consultation with the Commission.

The FEIR should indicate how the DRI findings and conditions will be met. A shared watershed approach Inter-Municipal Agreement should include a time frame for each town to achieve its share of nitrogen removal. Meetings to coordinate progress on this aspect should include Cape Cod Commission staff.

CWMP Implementation

The following is a synopsis and time frame, using the plan's proposed request for funding, of the Harwich preferred plan phased approach.

Phase 1, 2013: focuses on implementation of two natural nitrogen attenuation programs. The first is to fund the construction phase of the Muddy Creek Bridge which will increase the existing opening to 24-feet in order to increase flushing and help restore ecological habitat. The second is the evaluation of options to improve the natural attenuation in the Cold Brook former cranberry bog network off Bank Street. This phase will also include the purchase of land for the PB-3 effluent recharge facility and will include implementation of the Hinckleys Pond restoration project.

Phase 2, 2016: will be the design and installation of sewers in the Pleasant Bay watershed since this is the largest watershed with the highest percentage of septic system nitrogen removal required. This allows the Town to work with Chatham, utilize a regional approach to wastewater treatment and recharge, and to provide further protection to some of the Harwich drinking water supply wells. Phase 2 also provides sewer service to the East Harwich Village Commercial District or East Harwich Village Center and surrounding areas to accommodate potential higher density development. The recommended plan for the Cold Brook natural attenuation would also be implemented in this phase.

Phase 3, 2021: focuses on the Pleasant Bay watershed and installing additional sewers in the area north of the Harwich Village Commercial District. A portion of the collection system area on the west side of the Pleasant Bay Watershed will be delayed until Phase 8 to allow for water quality monitoring and evaluation of the impacts from sewering and the Muddy Creek bridge project. This phase may also include the implementation of the potential Seymour Pond restoration project. The design and construction of the delayed Chatham WPCF expansion will also be completed in this phase.

Phase 4, 2026 and 2029: will be done as two programs. Overall the phase will collect wastewater in the Northeast part of the Herring River watershed. The collected wastewater will be pumped to the new treatment plant to be constructed at Site HR-12 (landfill site) where the treated effluent would be recharged. The SBR treatment plant would initially be constructed for capacity of about 0.45 mgd which would treat collected flows from Phases 4, 5 and 6. Phase 4A will include the construction of the HR-12 treatment plant and 4B will include the construction of the sewers in the Herring River Watershed.

Phase 5, 2033: will collect wastewater in the Northwest part of the Herring River watershed and near site HR-12. The collected wastewater will be pumped to the treatment plant at Site HR-12 where the treated effluent would be recharged.

Phase 6, 2038: will collect wastewater in the Southeast part of the Herring River watershed. This phase will also install some of the planned sewers in the Allen and Wychmere Harbor watersheds in order to begin meeting TMDLs in those areas. Collected wastewater will be pumped to the HR-12 site for treatment and recharge. This phase may also include implementation of the potential Bucks and John Joseph Pond restoration projects.

Phase 7, 2043: focuses on expanding the HR-12 treatment plant and installing the remaining required sewers in the Herring River watershed to meet TMDL. The treatment plant at Site HR-12 will be expanded to the full 0.9 mgd capacity in this phase.

Phase 8, 2048: will install sewers in the Saquatucket watershed and the remaining areas of the Pleasant Bay watershed required to meet those TMDLs. Areas to be sewered near the Great Sand Lakes and the Campground will also be included in this phase. Sewer service areas in Phases 5, 6, 7 and 8 can be adjusted as needed to meet local needs and based on feedback from water quality monitoring.

Natural Resources

The following comments address considerations to reduce impacts to wetlands, wildlife, and open space resources as the town proceeds with alternatives analysis.

The RPP prohibits impacts to wetlands and the 100 ft buffer to wetland resources with the exception of utility line installation where there is no other feasible alternative. During CWMP planning, project planners should avoid direct and indirect wetland and buffer impacts wherever possible. Indirect impacts include actions that may reasonably be expected to alter the natural functions of the wetland. Alterations that result in wetland restoration are typically supported in the RPP. The RPP also prohibits activities that would impact rare species or their habitats. To the extent feasible, utility lines should be located within the road rights of way and avoid overland crossings. Commission staff notes that rare species habitat has been included in the evaluation criteria for wastewater treatment or disposal sites, discussed below.

It's unclear from the CWMP whether plan implementation would result in impacts to coastal resources. To the extent that infrastructure development needs to occur in proximity to coastal areas, sites located within existing roadways or disturbed areas are preferred over new disturbance in coastal resource areas. As a related but separate matter, restoration of tidal flows at the Muddy Creek culvert will clearly have some impacts on coastal resources; design and engineering of this project should strive to minimize resource impacts while achieving the tidal restoration goals.

Assessment of Freshwater Ponds

Commission staff supports recommendations on pg. 5-20 to improve water quality in Harwich Ponds. Stormwater discharges into ponds may present opportunities to treat stormwater with LID/BMPs or other green infrastructure that will provide additional natural resource benefits.

Effluent Recharge Sites

In reviewing Section 9, Effluent Recharge Site Screening, Commission staff agrees with the criteria identified for screening appropriate sites. One additional mapped data layer that would help distinguish viable sites and the environmental impact associated with wastewater disposal is the Natural Heritage and Endangered Species Program BioMap2 Core Habitat. This (non-regulatory) data layer identifies habitats that are crucial for the long-term viability of the state's endangered species. It also functions as a landscape-scale look at maintaining connectivity among the remaining undeveloped parcels in the Commonwealth.

Section 9 of the CWMP identifies the final five sites that were selected for additional evaluation in the CWMP. Each of these sites presents concerns due to possible impacts to rare species habitat, or fragmentation of habitat. While disposal beds likely could be permitted at these sites, it is preferable to select a site(s) that minimizes impacts to open space areas in Harwich that presently provide aesthetic, recreational, and habitat benefits. With these considerations in mind, Commission staff reviewed the forty sites that resulted from the site screening process, noting constraints and opportunities. Many of the screened sites have constraints with regard to impacts on natural resources; however, several of these sites present opportunities, particularly if the Town looks to further decentralize treatment and/or disposal, or considers implementation of green infrastructure management systems.

As planning proceeds with the two sites identified as part of the preferred alternative, consideration should be given to the avoidance of impacts to natural resources, and minimizing fragmentation of intact landscapes. Specifically, siting of facilities at HR12 should take into consideration the rare species habitat at the eastern side of the parcel, as well as views from the rail trail which abuts the site. Development should be clustered as closely as possible to the existing disturbed portions of the property. The Hydrogeology report indicated that groundwater was too high to give consideration to utilizing the borrow pit area of HR12 for the treatment facilities and that the groundwater flow of treated effluent from the proposed site would flow towards Coys Brook rather than Flax Pond. PB3 is not mapped rare species habitat, though it may well serve as box turtle habitat given the woodland characteristics and protected land in the vicinity. PB3 currently provides buffers to Hawksnest State Park to the north and west, and serves several natural resource functions, including recreational open space and habitat. Siting treatment facilities in PB3 should balance minimizing fragmentation of this natural landscape, and providing adequate buffers to East Harwich Center.

Collection System

Commission staff recommends that the criteria identified in Section 12 for selecting pump station sites are appropriate. Commission staff would also recommend avoiding sites mapped for rare species habitat or as BioMap2 Core Habitat. To the extent possible, pump stations should be located near roads to minimize the footprint of additional disturbance. Also, as a general matter, the collection system network should be installed within existing road networks to the extent feasible, and avoid "overland" installations that will result in large additional areas of disturbance.

Solid and Hazardous Waste Management

The Expanded ENF for Harwich's proposed CWMP does not address solid or hazardous waste other than to state that the project will not trigger MEPA thresholds for these issues.

Given the nature of the project, it is unlikely that the project will generate a significant amount of post-construction waste, recyclables or food wastes. However, Commission staff suggests the Town estimate how much solid waste, including land-clearing waste, will be generated from the preferred project alternative. This information should be available for the DRI phase of project review. Similarly, if a facility is located in a Zone II, a program to manage any Hazardous Wastes generated as a result of project construction, and a plan to address any Hazardous Wastes used in facility operations should also be addressed for the DRI phase of project review.

Transportation

Commission staff suggests that potential impacts on the transportation network related to construction or expansion of any treatment facilities be considered by the Town at the appropriate stage in the design process. Additionally, the Commission staff recommends the Town, to the greatest extent feasible, coordinate sewer construction activities with planned roadway improvement projects to minimize traffic disruptions and reduce overall costs.

Historical and Archaeological Resources

Commission staff recommends that the Town file with Massachusetts Historical Commission prior to DRI review to ensure there are no sensitive historical or archaeological resources located in the vicinity of the project site.

Conclusions

Commission staff has reviewed the Expanded ENF for the project's possible impacts and in general finds that it addresses many of the parameters of our Regional Policy Plan and RWMP Draft Guidance on CWMPs and that the Phase 1 Waiver for proceeding with the Muddy Creek Culvert project is reasonable and a severable portion of the CWMP project. Although the Town should proceed to address the identified gaps for the preparation of its Final EIR/CWMP, the Commission has respectfully asked that the Town not submit it for formal review until the Commission has completed its Regional 208 Water Quality Management Plan over the next year.

My staff is available to answer any questions that you may have about this letter.

Sincerely,

Paul Niedzwiecki
Executive Director

cc: James Merriam, Harwich Town Administrator
David Spitz, Harwich Town Planner
Jill R. Goldsmith, Chatham Town Manager
Robert Duncanson, Chatham Director Health and Environment
Richard White, Dennis Town Manager
Daniel Fortier, Dennis Town Planner
Charles Sumner, Brewster Town Manager
Elizabeth Taylor, Brewster Commission Representative
Susan Leven, Brewster Town Planner
Richard Roy, Dennis Commission Representative
David Young, CDM Smith
Andrew Gottlieb, CCWPC
Carol Ridley, Pleasant Bay Alliance

Commonwealth of Massachusetts

Division of Fisheries & Wildlife

MassWildlife

Wayne F. MacCallum, *Director*

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APR 4 - 2013

MEPA

April 4, 2013

Richard K. Sullivan, Jr., Secretary
Executive Office of Energy and Environmental Affairs
Attention: MEPA Office
Anne Canaday, EEA No. 15022
100 Cambridge St.
Boston, Massachusetts 02114

Project Name:	*Draft Comprehensive Wastewater Management Plan*
Proponent:	*James Merriam, Town Administrator, Town of Harwich*
Location:	*Various locations throughout Harwich and Chatham*
Document Reviewed:	*Expanded Environmental Notification Form* (EENF) *and Draft Comprehensive Wastewater Management Plan* (CWMP)
EEA No.:	*15022*
NHESP No.:	*11-29877*

Dear Secretary Sullivan:

The Natural Heritage & Endangered Species Program of the Massachusetts Division of Fisheries & Wildlife (the "Division") has received and reviewed the proposed *Expanded Environmental Notification Form* and *Draft Comprehensive Wastewater Management Plan* for the Town of Harwich and would like to offer the following comments regarding state-listed species and their habitats.

The ponds, bays, and estuarine waters of Harwich's south and east coasts provide critical foraging, breeding, migration, and over-wintering habitats for a suite of state-listed rare species. We commend the Proponent for its efforts to improve water quality within these critical habitats.

Portions of the Town of Harwich are mapped as *Priority* and *Estimated Habitat* for state-listed species, which are protected pursuant to the Massachusetts Endangered Species Act (M.G.L. c. 131A) and its implementing regulations (MESA; 321 CMR 10.00) as well as the Massachusetts Wetlands Protection Act and its implementing regulations (WPA; 310 CMR 10.37, 10.58(4)(b), and 10.59). Based on a review of the information that was submitted and the information that is contained in our database, the Division anticipates that portions of the proposed project will occur within the habitat of various state-listed invertebrate, vertebrate, and plant species.

Portions of the proposed project that occur within *Priority* or *Estimated Habitat* for state-listed species, which are not otherwise exempt from MESA review pursuant to 321 CMR 10.14, will require a direct filing with the Division for compliance with the MESA and WPA. The Division notes that sewer systems proposed within ten (10) feet of the edge of existing paved roads may be exempt from MESA review, pursuant to 321 CMR 10.14 (10), which states: "[t]he following Projects and Activities shall be exempt from the requirements of 321 CMR 10.18 through 10.23…"

Division of Fisheries and Wildlife
Temporary Correspondence: 100 Hartwell Street, Suite 230, West Boylston, MA 01583
Permanent: Field Headquarters, North Drive, Westborough, MA 01581 (508) 389-6300 Fax (508) 389-7890
An Agency of the Department of Fish and Game

[10] installation, repair, replacement, and maintenance of utility lines (gas, water, sewer, phone, electrical) for which all associated work is within ten feet from the edge of existing paved roads, and the repair and maintenance of overhead utility lines (phone, electrical) for which all associated work is within ten feet from the edge of existing unpaved roads, provided, however, that unpaved utility access roads associated with exempt activities under 321 CMR 10.14(11) shall be addressed in and subject to the Division-approved operation and maintenance plan required thereunder;

The complete list of MESA filing exemptions may be found on the Division's website.

The Division would encourage the Proponent to examine design alternatives which avoid and minimize impacts to *Priority* and *Estimated Habitat*, and to consider a pre-filing consultation with the Division to evaluate and proactively address any concerns related to state-listed species. Upon submission of more detailed site plans, the Division will be able to provide additional guidance.

If you have any questions about this letter, please contact me at 508-389-6386 or jesse.leddick@state.ma.us. We appreciate the opportunity to comment on this project and look forward to working with the Proponent to proactively address any potential concerns related to state-listed species.

Sincerely,

Thomas W. French

Thomas W. French, Ph.D.
Assistant Director

cc: James Merriam, Town Administrator
Town of Harwich Board of Selectmen
Town of Harwich Conservation Commission
Town of Harwich Planning Department
Andrew Poyant, CDM Smith Inc.

PLEASANT BAY
ALLIANCE

Richard K. Sullivan, Jr.
Secretary, EOEEA
100 Cambridge Street
Suite 900 (9th Floor)
Attn: MEPA Office c/o Anne Canaday
Boston, MA 02114

April 3, 2013

Mr. Paul Niedziewicki
Executive Director
Cape Cod Commission
PO Box 226
Barnstable, MA 02630

Re: Town of Harwich Draft Comprehensive Wastewater Management Plan (DCWMP) (EEA No.15022)

Dear Secretary Sullivan and Mr. Niedzwiecki:

I am writing on behalf of the Pleasant Bay Alliance to provide comment on the above referenced project. The Alliance is the inter-municipal organization of Orleans, Chatham, Harwich and Brewster formed to implement the management plan for the Pleasant Bay Area of Critical Environmental Concern (ACEC) and watershed.

The Alliance wishes to congratulate the Town of Harwich on reaching this significant milestone in its efforts to protect estuarine and groundwater resources from the effects of nutrient overloading. Reduction of nitrogen loads from watershed sources is a major priority outlined in the Pleasant Bay Resource Management Plan (1998) and subsequent Plan Updates (2003, 2008, 2013.) One of the priority actions outlined in the plan is to continue to facilitate watershed-based collaboration to address nutrient loading.

The Alliance communities work cooperatively to pursue a comprehensive bay-wide assessment of nutrient loading and related resource conditions under the Massachusetts Estuaries Project (MEP.) We believe that the Technical Report upon which Total Maximum Daily Loads (TMDLs) for Total Nitrogen for Pleasant Bay are based was strengthened by the system-wide approach to the analysis and the depth of monitoring data collected throughout our multi-town water quality monitoring program. It is in the same sprit of coordination and cooperation demonstrated by these efforts that we submit the following comments for consideration.

Phasing and Regionalization

It is our understanding that phase 1 of the project includes construction of the Muddy Creek Restoration Bridge. The Alliance worked closely with the Towns of Harwich and Chatham, Massachusetts Division of Ecological Restoration and Cape Cod Conservation District to evaluate alternatives for restoring tidal flow in Muddy Creek. These studies document that the proposed bridge will significantly improve water quality, and restore wetlands and habitat in Muddy Creek. The studies provided the basis for the decision by the Towns of Chatham and Harwich, respectively, to proceed with this project. Appendix A of the DCWMP refers to the Alliance as the "champion" of the bridge project. However, the Towns of Chatham and Harwich have signed a Memorandum of Agreement to undertake the bridge project as a joint municipal project. The Towns have formed a Project Oversight Committee and recently hired a firm to begin bridge design and permitting. The Alliance supports the bridge project and will participate as a commenter in the project design and permitting phases. The Alliance supports the Phase 1 waiver requested by the Town of Harwich for the DCWMP as it would allow the Muddy Creek Bridge project to move forward on its own path.

It is noteworthy that a motivation for addressing nitrogen loads in Pleasant Bay prior to other watersheds in town is the opportunity for regional cooperation with the Town of Chatham. The Alliance supports such cross-town cooperative arrangements for their efficiency and cost savings in achieving TMDLs. Accordingly, wastewater from the Pleasant Bay watershed will be piped to the Chatham wastewater plant for treatment. In the short term, the treated wastewater also will be discharged at the Chatham site. Any impacts to groundwater resulting from relocation of wastewater out of the Pleasant Bay watershed should be identified and fully examined in light of any potential changes in water use factors or other assumptions that may increase or decrease estimated wastewater flows and nitrogen loads from future development in the watershed, as discussed below.

In the long term it is anticipated that Chatham will need to retain disposal capacity and at that time treated wastewater from Harwich would be returned to Harwich for disposal at the PB3 site. The PB3 site is within the Pleasant Bay watershed and is within a Zone 2 to the public water supply. It is vital that treated wastewater disposed of at the PB3 site achieve a level of treatment appropriate for a Zone 2 and watershed to a nitrogen sensitive embayment.

Non-Structural Approaches (Growth Management, Fertilizer, Stormwater)

Non-structural measures have the potential to reduce wastewater flows, nitrogen loads and, thereby, lower the costs of wastewater treatment required to meet thresholds. Lowering the cost of a wastewater system capable of achieving necessary nitrogen reductions increases the chances of that system being implemented. An added benefit is that many non-structural alternatives also may be implemented in less time than it takes to build treatment capacity. In light of these benefits, the Pleasant Bay Resource Management Plan supports full exploration of non-structural approaches in order to supplement necessary wastewater treatment. The Alliance has developed and is implementing the *Pleasant Bay Fertilizer Management Plan* that identifies actions that could reduce nitrogen loading from fertilizers by up to 5% across the watershed. The 2013 resource management plan update supports measures to reduce nutrients from stormwater, which accounts for 9% of nutrient loading watershed-wide. Perhaps the greatest nitrogen reductions achievable through non-structural means are those made possible through changes in land use. The Alliance supports land acquisition and Smart Growth land use strategies such as the Natural Resource Protection District adopted in Brewster as tools to reduce and manage nutrient loading. In addition to their potential to reduce nitrogen load, these strategies protect open space and sensitive natural resources areas and provide cost effective opportunities for wastewater management. The DCWMP identifies a potential cost savings of $50 million due to the reduction of nutrient loads from fertilizer controls, smart growth, and stormwater management. However, little detail is provided as to the role each of these programs could play, particularly in the Pleasant Bay watershed, which has the highest projected growth potential in the Town. The Alliance encourages the Town to fully analyze and pursue these non-structural alternatives for their ability to reduce wastewater flow, nitrogen load and costs, and to provide this analysis and information to citizens and stakeholders. Analysis that shows the relationship between different land use scenarios and their effect on wastewater flows, nitrogen loads and wastewater system costs would help inform the Town's land use management discussion and help build a case for the CWMP.

Water Use Assumptions

The Alliance notes that assumptions in the DCWMP with regard to commercial water use in the Pleasant Bay watershed may underestimate wastewater flow and nitrogen load that is likely to be generated by future commercial development. Questions about water use assumptions were expressed in a letter from the Alliance to the Harwich Water Quality Task Force (November 15, 2012).

The DCWMP assumes that commercial development would generate wastewater at a rate of 35 gallons per day (gpd) per 1,000 square feet (sf) of development. A significantly higher factor of 236 gpd/1,000 sf is used for other commercial areas in town. MEP technical reports for other Cape Cod watersheds contain commercial water use factors of 80-120 gpd/1,000 sf, including 98 gpd/1,000 sf for Namskaket Marsh watershed in Orleans. It has been explained that the current assumption of 35 gpd/1,000 sf is based on historic water use in the commercial district. However, water use in the East Harwich commercial district has been kept low due to the water protection overlay district which has reduced overall commercial development density and restricted water intensive commercial uses such as restaurants. The DCWMP assumes future rezoning of this area to accommodate the addition of 500,000 square feet of commercial development beyond MEP build-out. It is reasonable to assume that, with sewers in place, the mix of commercial uses would include restaurants and other commercial uses that have been restricted by the water resources overlay district. Accordingly, we request that the Town conduct an assessment of wastewater flows and nitrogen loads based on a commercial water use factor that is more consistent with proposed growth patterns. This will enhance the reliability of wastewater flows and nitrogen loads tied to growth assumptions.

Thank you for your consideration of these comments.

Sincerely,
For the Steering Committee
Allin P. Thompson, Jr.
Allin P. Thompson, Jr., Chairman

Cc: Harwich Board of Selectmen
Harwich Water Quality Task Force
Harwich Wastewater Implementation Committee
Brian Dudley, MassDEP
Dr. Robert Duncanson, Town of Chatham

APCC
Association to Preserve Cape Cod

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APR 5 - 2013

MEPA

Via electronic delivery
April 5, 2013

Secretary Richard K. Sullivan, Jr.
Executive Office of Energy and Environmental Affairs
Attn: MEPA Office – Anne Canady
100 Cambridge Street, Suite 900
Boston, MA 02114

Re: Harwich Comprehensive Wastewater Management Plan
MEPA Project No. 15022

Dear Secretary Sullivan:

On behalf of the Association to Preserve Cape Cod (APCC), the Cape's leading environmental advocacy and educational organization, I would like to offer a few general comments on Cape Cod Comprehensive Wastewater Management Plans (CWMPs), and specifically the town of Harwich Draft CWMP currently under review as an EENF. While the Harwich plan is proactive, APCC is concerned that CWMPs continue to be developed and submitted based on town boundaries rather than on shared watersheds. APCC believes that this is a shortsighted approach that will cost the taxpayers of Cape Cod more and will result in less than optimum results. Prior to the submission of the EENF, the Cape Cod Commission published its Regional Wastewater Management Plan, and APCC believes that the Harwich CWMP and all Cape Cod CWMPs must be measured against that plan.

Founded in 1968 and representing more than 5,000 members, the mission of APCC is to promote policies and programs that enhance the protection of the natural resources of Cape Cod. Underlying all of the work that APCC does is the understanding that Cape Cod is a single geographic and hydrogeological unit, and that the Cape's natural resources and economic vitality cannot be adequately protected based on arbitrary political borders.

APCC has long-maintained that protection of the Cape's water resources requires a regional approach. In the 1980s, APCC advocated for the creation of a regional authority to protect water resources. In 2003, APCC, in coordination with the Cape Cod Business Roundtable, called for the creation of a regional authority to address the lack of adequate wastewater infrastructure on Cape Cod. APCC later served on the task force created by Barnstable County to address the Business Roundtable's recommendation. For many years, APCC has collaborated with partners on numerous public education forums about this issue. In 2010, APCC co-sponsored the development of a report, "Comparison of Costs for Wastewater Management Systems Applicable to Cape Cod," to assist communities in making decisions about wastewater infrastructure. In 2012, APCC convened an environmental summit of all of Cape Cod's nonprofit environmental organizations. Two noteworthy findings of that summit were:

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Nutrient loading of Cape Cod's groundwater, ponds, and coastal waters caused by human activity and waste is the region's number one environmental priority. Immediate action on the part of government, business, and every citizen across Cape Cod is necessary.

A regional wastewater plan would encourage and enable communities to work cooperatively with each other to reach and maintain total maximum daily loads (TMDLs) of nutrients and/or other objective water quality criteria for each watershed.

APCC recommends to the Secretary that the town of Harwich specifically address compatibility of the subsequent Draft or Final CWMP with the Regional Clean Water Act Section 208 Water Quality Management Plan currently in development. We understand that this might cause some delay for Harwich but this action is certainly within the environmental interest of the region and the Commonwealth.

Moreover, APCC recommends that Harwich address the following concerns:

1. Within the subsequent draft or final EIR, the town should include a consistency chapter following the Guidance for Cape Cod Commission Review of Local Wastewater Management Plans detailing consistency of the local plan with the Regional Wastewater Management Plan (RWMP) and the Regional Policy Plan (RPP).

2. Harwich is to be lauded for its cooperation with its neighbor Chatham, as described in the Draft CWMP. However, other narrative in the EENF indicates that Harwich is waiting for its other neighbors that share common watersheds with the town to act first. "As the Towns of Brewster and Dennis further develop their wastewater programs, other regional opportunities may develop for Harwich which fully supports the concept." (DCWMP 13-17.) Harwich should be required to coordinate activities with all of its neighbors instead of waiting for the other towns to initiate coordination with Harwich.

3. APCC has been engaged in some preliminary analysis of the impact of sea level rise on groundwater elevation. Groundwater infiltration is the number one cause of Tile 5 system failure. Harwich should provide some analysis of the groundwater elevation and septic system locations for the area of town south of Route 28 in order to determine the probability of increased septic system failure in this area of town. An increased rate of failure in this area would necessitate readjusting phasing and overall priorities.

4. APCC supports adaptive management as a flexible and pragmatic model to embrace in wastewater treatment. However, documented failures of adaptive management across the country dictate a cautious and measured approach. Literature supports that all too often, adaptive management is either simply a buzzword, or utilized as a means to protect bad decision-making. APCC recommends that performance-based goals and early intervention be used as hallmarks to achieve a successful adaptive management plan. In order to better manage the project, nitrogen, phosphorus and emergent contaminant data needs to be collected throughout the process. APCC recommends an intense monitoring program be established to identify any unanticipated impacts, and that it include automatic steps such as growth and flow controls.

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5. Lastly, Harwich has identified a number a so-called soft or non-infrastructure solutions. The draft CWMP has identified a potential overall savings of nearly $50 million dollars. However, so far the town has shown an inability to carry out and implement these solutions, e.g. land use and zoning changes for East Harwich, which is in the Pleasant Bay watershed. The town should provide an implementation plan for these land use changes and other non-infrastructure solutions, including timetables, how to measure success, and sources of revenue to implement the programs described in the draft CWMP.

These recommendations should be considered as applicable to all Cape Cod CWMPs and are not focused solely upon Harwich. APCC thanks the Secretary for this opportunity to comment.

Sincerely,

Ed DeWitt
Executive Director

cc: Cape Cod Commission
Harwich Board of Selectmen

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Commonwealth of Massachusetts

Division of Marine Fisheries

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Paul J. Diodati
Director

Deval Patrick
Governor
Timothy P. Murray
Lt. Governor
Richard K. Sullivan, Jr.
Secretary
Mary B. Griffin
Commissioner

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April 5, 2013

Richard K. Sullivan, Jr.
Secretary, Executive Office of Energy and Environmental Affairs
Attn: Anne Canaday, MEPA Office
100 Cambridge Street, Suite 900
Boston, MA 02114

Re: EEA# 15022

Dear Secretary Sullivan:

The Division of Marine Fisheries (*MarineFisheries*) has reviewed the Expanded Environmental Notification Form (EENF) and Draft Comprehensive Wastewater Management Plan (CWMP) by the Town of Harwich to provide a comprehensive strategy for wastewater management for the Herring River, Pleasant Bay, Allen Harbor, Wychmere Harbor, and Saquatucket Harbor watersheds on Nantucket Sound and Pleasant Bay in the Town of Harwich, with respect to potential impacts to marine fisheries resources and habitat. The project includes the following components: 1) two natural attenuation projects at Cold Brook (non-tidal) and Muddy Creek (tidal); 2) approximately 92 miles of sewer pipes and 30 pumping stations with treatment at two centralized treatment facilities with groundwater recharge; and 3) the use of permeable reactive barriers.
The town is requesting a Phase 1 waiver for the Muddy Creek culvert replacement project. This includes widening the opening under Route 28 at the Harwich and Chatham corporate boundary to increase flushing for nitrogen attenuation. A Notice of Project Change will be required for this culvert opening and will be reviewed at a later date once the project has advanced to a design phase sufficient to initiate MEPA review. The CWMP also identifies the efforts the town will make to reduce nitrogen impacts via fertilizer education, stormwater BMPs, LIDs, etc, though these are not built into meeting Total Maximum Daily Loads (TMDLs) for nitrogen.

The Town of Harwich is exceeding the TMDL for nitrogen in five of its coastal embayments. The primary source of the problem is stormwater discharges, septic system failures, boat waste discharges, wildlife and other sources (p. 4-11). Hydrographic modeling by the Massachusetts Estuaries Project (MEP) identified that 100% of the wastewater and fertilizers from residential lawns and cranberry bogs in Wychmere Harbor must be eliminated in order to meet the TMDLs set for this harbor. In Herring River and Saquatucket Harbor, the nitrogen load must be reduced by 58% while in Allen Harbor and Pleasant Bay, the nitrogen load must be reduced by 78% and 65% respectively (p. ES 8). The CWMP includes an EENF. All alternatives assessed in the CWMP are expected to meet TMDLs set for the ponds (p. 10-10).

MarineFisheries is very concerned about the aquatic health of coastal salt ponds. These are critical nursery areas for many marine species including winter flounder, anadromous fish, horseshoe crabs, and shellfish. Both winter flounder and blue crab are sensitive to eutrophication[1,2]. There are several areas in Harwich where shellfishing is prohibited due to bacterial contamination including Bass River, Allen's Harbor, Saquatucket Harbor, Wychmere Harbor, and Muddy Creek. Therefore, the identification and application of

[1] Stierhoff, K.L., T.E. Targett, K. Miller. 2006. Ecophysiological responses of juvenile summer and winter flounder to hypoxia: experimental and modeling analyses of effects on estuarine nursery quality. In MEPS Vol. 325: 255–266.
[2] Chesapeake Bay Foundation. 2008. Bad Water and the Decline of Blue Crabs in the Chesapeake Bay.

water quality improvement goals is a considerable achievement. *MarineFisheries* agrees with efforts to reduce nitrogen loading in coastal salt ponds, including efforts to remediate the current eutrophied state of the ponds.

MarineFisheries offers the following recommendations for your consideration:

- This is clearly a needed planning document, and we commend the Town for the efforts that they have undertaken to continue to work on this complicated issue.
- Monitoring studies for the permeable reactive barrier study sites should include other contaminants from wastewater, not just nitrogen. For example, ecosystem quality will still be impaired if the barriers remove nitrogen but not endocrine disrupting compounds.
- Monitoring within Pleasant Bay and Saquatucket Harbor should be designed to determine if the natural attenuation projects in those watersheds are reducing nitrogen loads to the receiving waters. This is especially important since the CWMP stated the expected benefits are based on some "educated assumptions about the potential beneficial impacts of the two projects" (p. 13-26).
- The town demonstrated the importance of non-septic system sources of nitrogen and bacterial contamination in Section 4. Therefore, *MarineFisheries* recommends a stronger approach to Section 13.7, "Other Recommended Program Components." In particular, the town should assess its carrying capacity to service boats for pumpout. *MarineFisheries* administers the Clean Vessel Act program in Massachusetts and can provide assistance.

MarineFisheries is supportive of Harwich's efforts to tackle this challenging issue. We are available to contribute technical expertise and review capabilities for water quality monitoring activities.

Questions regarding this review may be directed to Kathryn Ford in our New Bedford office at (508) 990-2860 ext. 145.

Sincerely,

Paul J Diodati

Paul J. Diodati
Director

cc: Harwich Conservation Commission
James Merriam, Town Administrator
Andrew R. Poyant, CDM Smith, Inc.
Lou Chiarella, NMFS
Robert Boeri, CZM
Ed Reiner, EPA
Ken Chin, DEP
Kathryn Ford, DMF
Richard Lehan, DFG
Terry O'Neil, DMF
Tom Shields, DMF
Christian Petitpas, DMF

PD/kf/ef/sd

Office of the Selectmen

Phone (508) 430-7513
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732 Main Street, Harwich, MA 02645

AC

April 3, 2013

Mr. Richard K. Sullivan, Jr. ✓
Secretary
Executive Office of Energy and Environmental Affairs
100 Cambridge Street, Suite 900
Attention: Anne Canaday, MEPA Office
Boston, MA 02114

Mr. Paul Niedziewicki
Executive Director
Cape Cod Commission
PO Box 226
Barnstable, MA 02630

Subject: EOEEA #15022 – Draft Comprehensive Wastewater Management Plan (DCWMP) for Town of Harwich, Massachusetts

Dear Sirs:

The Town of Harwich was copied on a letter dated March 21, 2013, co-signed by several local environmental groups ,who provided comments to you regarding our DCWMP. We certainly welcome comments on this strategic document which presents a plan for the entire community that has been developed with significant public input over the past six years. However, we strongly feel that this comment letter is focused more on a political issue than it is about addressing our community wide water resource management needs. Therefore, we would like the make the following brief comments:

1. The DCWMP documents that our need to remove significant amounts of septic system nitrogen that is currently degrading our valuable saltwater embayments. For instance, in the Pleasant Bay watershed, under existing conditions, about 60 percent of the septic system nitrogen must be removed in order to meet the Total Maximum Daily Load (TMDL) requirement. That value increases to about 65 percent under projected buildout conditions. Thus, sewers need to be installed as part of the recommended program to address existing nitrogen loading conditions. If future growth occurs within the existing sewer service area, the additional cost is much less than if the sewers need to be expanded to the outer reaches of the service area.

2. The increase in wastewater flows included in the DCWMP are based on the best available information at this time and the projected increase in some instances such as the East Harwich area are "allowances" utilized for planning purposes. Our Water Quality Management Task Force working in conjunction with our consultant decided to include the documented allowances. As stated in several instances throughout the report, through adaptive management the wastewater flows and nitrogen removal results will be monitored and adjusted during the 40-year implementation period. The ultimate goal will meet the established TMDL for each of our five watershed embayments.

3. The recommended program detailed in the DCWMP recommends a review of existing land use controls throughout the entire community. This effort will entail a comprehensive review of community, technical and fiscal issues. Lost tax revenues from limiting growth, costs to purchase land for open space and encouragement for public-private partnerships in developing certain areas are a few of the issues that need to be factored into the process. Perpetual evaluation in order to meet the varying needs of the community over the next 40 years will also be required.

4. As described in the DCWMP, the town is in the process of developing a cost recovery model to help finance the implementation of this program. The model is still in development but will likely recommend that future developments require those developers to pay a share of the resultant wastewater costs attributed to their increased wastewater flow. The recommended cost recovery model will be presented in the Final CWMP.

5. The recommended plan described in the DCWMP addresses what we believe to be almost a worst case scenario based on expected TMDLs and existing water quality criteria. However, it is flexible in its implementation and identifies several areas where the town can pursue means to help lower the program costs. By implementing fertilizer management programs, stormwater controls and potential land use revisions, the recommended program costs could be reduced. That reduction is difficult to estimate at this time due to economy of scale and implementation phasing issues. As an example, if an area is to be sewered now but it is projected that a 25 percent increase in flow will occur in that area in the future, then the cost will not increase by 25 percent. The sewer pipe size might increase slightly but the main cost is installation of the pipes. Thus, via economy of scale there is a small incremental cost increase. The costs presented in the comment letter do not take any of these factors into account and overstate estimated cost savings.

We trust that you will find these comments helpful in evaluating other comments received on the DCWMP. We feel the recommended program presented in our DCWMP is flexible in many ways and that through adaptive management we will be able to adjust it as phases are implemented and water quality results are monitored. We understand the importance of moving forward to address our present day needs.

Very truly yours

Linda A Cebula, Chair
Harwich Board of Selectmen

CC: Harwich Board of Selectmen
James Merriam, Town Administrator
Peter de Bakker, WQMTF Chair
David Spitz, Town Planner
David Young, CDM Smith

THE COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE OFFICE OF ENERGY AND ENVIRONMENTAL AFFAIRS
OFFICE OF COASTAL ZONE MANAGEMENT
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RECEIVED
APR 8 - 2013
MEPA

MEMORANDUM

TO:	Richard K. Sullivan, Jr., Secretary, EEA
ATTN:	Ann Canady, MEPA Unit
FROM:	Bruce Carlisle, Director, CZM
DATE:	April 5, 2013,
RE:	EEA 15022, Draft Comprehensive Wastewater Management Plan, Harwich

The Massachusetts Office of Coastal Zone Management (CZM) has completed its review of the above-referenced Expanded Environmental Notification Form (EENF) noticed in the *Environmental Monitor* dated March 3, 2013, and offers the following comments.

Project Description

This project involves the development of a Comprehensive Wastewater Management Plan (CWMP) for the Town of Harwich ("Town"). The Town is proposing a traditional wastewater program that includes approximately 92 miles of sewer pipes, 30 pumping stations and two centralized treatment facilities. The Town is also proposing two alternative wastewater management strategies: widening an existing culvert to improve tidal flushing of Muddy Creek and investigating how changing the hydrology of Cold Brook might affect its nitrogen attenuation capability. The purpose of the CWMP is to help guide the decisions pertaining to wastewater management over a 40 year period. In addition to MEPA review, the project is also undergoing review concurrently by the Cape Cod Commission as a Development of Regional Impact (DRI) and for consistency with the county's wastewater plan. The Draft CWMP has been included as part of the EENF with the goal of submitting a Final Environmental Impact Report (EIR), rather than a Draft EIR and then a Final EIR. The proponent has also requested a Phase I Waiver Request for the Muddy Creek Culvert Replacement project, which is a component of the Town's CWMP.

Project Comments

CZM recognizes that the impacts caused by the discharge of nitrogen through both private septic and municipal sewer systems to surrounding water bodies can be severe and that this is a significant issue for towns on Cape Cod. These impacts carry implications for not only the environment, but for economic development as well. CZM supports the comprehensive planning for wastewater management and applauds the effort that has gone into the development of this draft plan. CZM commends and supports the regional approach and cooperative agreement between the Town and Chatham to advance wastewater management efforts in both communities. The adaptive management approach proposed in this plan provides a flexible management framework that allows for changes to the planned implementation schedule, based upon future unknown variables, such as changes in water quality, future build-out rates in different watersheds, and economics. CZM is committed to working with the Town and assisting with the development of the final CWMP. CZM supports the Town's Phase I Waiver for the Muddy Creek Culvert Replacement Project and offers the following comments.

Coordination with Regional Efforts

CZM is aware that the Cape Cod Commission recently signed a Memorandum of Understanding to initiate the development of a comprehensive water quality management plan with funding from the Massachusetts Water Pollution Abatement Trust. The goal of the plan is to reduce nutrient pollution in Cape Cod waterways in order to meet state and federal water quality standards. Once this regional plan is developed (a draft plan is slated to be completed by March 2014), CZM suggests that the FEIR explain how Harwich's proposed CWMP is consistent with the regional plan.

Coordination with Massachusetts Estuary Project Reports

The Massachusetts Estuaries Project (MEP), a joint effort between the Massachusetts Department of Environmental Protection (MassDEP) and the University of Massachusetts, has developed three technical reports that establish the in-stream total nitrogen (TN) thresholds necessary to restore estuarine water bodies in Harwich; including the Herring River, Allen Harbor, Wychmere Harbor, Saquatucket Harbor, and Muddy Creek. The FEIR should clearly describe how the proposed wastewater management plan and its TN loads are consistent with the TN thresholds in these reports. The projected TN loads for each watershed should clearly describe the contributions and specific TN attenuation values for: 1) sewered parcels at buildout (including any increases in per parcel load attributed to increased parcel development), 2) unsewered parcels in the watershed of interest (including those in adjacent towns), and 3) natural sources of TN. For example, the EENF suggests that at buildout, the proposed PB-3 infiltration basin alone will contribute 8 lbs/day of TN to the Muddy Creek watershed while the MEP threshold for Muddy Creek is only 3.9 lbs/day. Additional sources of TN from the parcels in Chatham's portion of the Muddy Creek watershed and from unsewered parcels in Harwich will increase the daily TN load even beyond 8 lbs.

Growth

Figure 13-4 depicts a significant number of parcels in the Town of Harwich that are currently undeveloped but could be developed under "buildout" conditions once a sewer system is installed. The FEIR should describe how buildout conditions are consistent with MEP in-watershed nitrogen thresholds and if not, what methods of growth limitation the Town will employ to ensure that habitat restoration thresholds are met. In some cases, this may require taking into account the buildout in adjacent communities (e.g., Brewster and Dennis along the Herring River and Chatham along muddy Creek). In addition, the FEIR's wastewater and nitrogen loading analysis should attempt to take into account that some existing built parcels will be increased in size (and/or subdivided) once sewer services are provided.

Muddy Creek Natural Attenuation Project

In the MEP Report used in the development of the CWMP, there is a discussion on the possibility of increasing the size of the inlet opening to the Muddy Creek in order to increase tidal flushing. The report suggests that if these modifications are made, a 20% decrease in the difference between the modeled, existing, in-stream TN concentration and the threshold concentration at the lower Muddy Creek reference station would be realized. The Town has incorporated this assumption into the CWMP, and is moving forward with plans to implement this project as part of the overall wastewater management effort. The Town and Chatham are working cooperatively to construct the new culvert in the Muddy Creek, and have appropriated funds for the design of the project. Once the design is complete, both towns will seek the appropriate funding required to construct the project.

In general, CZM is supportive of culvert replacement projects, such as the one proposed for Muddy Creek, where the short-tem construction impacts are outweighed by the predicted long-term water quality and habitat improvements in the upstream estuary. However, CZM also recognizes that improved flushing does not reduce pollutant loads, only their concentrations. We encourage the Towns to not only improve the movement of nutrients down the Muddy Creek estuary, but also to enact appropriate constraints on the future input of nutrients to the estuary. In addition, while the flushing for the larger Pleasant Bay estuary has improved recently, we encourage the Towns of Harwich and Chatham to consider a future scenario where Pleasant Bay might not be as well flushed (e.g., after shifting and/or reformation of barrier sand bars at the mouth of the Bay) and how future decisions to add increased nitrogen load to the Muddy Creek estuary (e.g., through the proposed infiltration basins at the top of the watershed and the future development and sewering of currently undeveloped properties) might impact a less well-flushed Pleasant Bay. Such a situation was anticipated and modeled in the MEP Pleasant Bay Report where it was found that residence time in Muddy Creek would increase 20-40%, thus reducing flushing capacity, if Pleasant Bay were to revert to its old inlet configuration (Pleasant Bay MEP Report Table IX-2). Under this scenario, bioactive nitrogen in Muddy Creek would increase by ~35% (Pleasant Bay MEP Report Table IX-3). As the Pleasant Bay inlet is an ever changing system, CZM encourages the Towns to not rely too heavily on the Rt. 28 culvert widening for long-term mitigation of nitrogen to Muddy Creek.

Cold Brook Natural Attenuation Project

The Draft CWMP proposes to increase the natural nitrogen attenuation of the Cold Brook bog area by modifying the old cranberry bogs to increase the residence time of freshwater flowing through this system. Watershed modeling suggests that the nitrogen attenuation rate for the Cold Brook area may be increased from the current 35% to as much as 50%. The concept is to construct depositional basins (ponds) within the bog system. CZM is supportive of non-traditional methods to attenuate anthropogenic nitrogen, however, we believe further, site-specific studies will be required to better evaluate the potential for impacts to wetlands functions and habitat quality for resident as well as any migrating species (e.g., American eel and river herring). The proponents should work closely with MassDEP to ensure that the proposed alterations can meet the requirements of state and local wetland regulations and performance standards. The proponents should also work with the Division of Marine Fisheries to ensure that any hydrology changes and subsequent water quality changes (e.g., increased nitrates and ammonia, decreased dissolved oxygen) do not adversely affect any migrating species.

Coastal Hazards

The availability of sewer infrastructure in coastal areas subject to storm damage, flooding, and erosion could allow new or expanded development in these hazard-prone areas. This development may also adversely impact natural buffers to storm waves and erosion, and compromise the storm protection provided to landward development, infrastructure, natural resources, and upland areas. The resulting impacts of development in these coastal areas could include loss of life and property, increased public expenditures for storm recovery activities, taxpayer subsidies for flood insurance and disaster relief, and risks to emergency personnel. CZM Coastal Hazards Policy #3 states that federally funded public works projects shall not promote growth and development in hazard-prone or buffer areas. In addition, State Executive Order 181 states that state and federal grants for construction projects shall not be used to encourage growth and development in hazard prone barrier beach areas. Executive Order 181 also seeks to minimize and mitigate potential storm damage by prohibiting development within flood velocity zones. Further, Executive Order 149 directs state agencies responsible for programs that affect land use planning to take flood hazards into account when evaluating plans. Therefore, CZM recommends that specific planning consideration be developed for areas located within mapped coastal flood zones and within barrier beach areas.

As part of the planning process for this project, the Town and its consultants should use the best available information regarding the extent of the flood zones, and particularly the highest hazard zones, including the Velocity zone, AO zones, and the portion of the A zone designated as the MoWa (moderate wave action capable of structural damage). The Federal Emergency Management Agency (FEMA) has acknowledged that their Flood Insurance Rate Maps (FIRMs) need to be updated to more accurately reflect the extent of the floodplain. In 2011, FEMA began a study to update the FIRMs for Barnstable County with new analysis. One of the significant updates to the FIRMs will be to extend the Velocity zone to the landward toe of the primary frontal dune. Therefore, CZM recommends that the Town's analysis of potential growth in hazard-prone areas also include, at a minimum, primary frontal dunes in addition to those areas shown on the current maps as flood zones.

Since the wastewater planning process will continue for many years, it is very likely that new FIRMs will be issued before the planning process is completed. CZM recommends that the Town use the revised FIRMs to determine the extent of the flood zones when they are available. The EENF included a map of the flood zones dated 2007. CZM recommends that the consultants for the Town stay in touch with the Harwich Emergency Manager regarding the schedule for the revised FIRMs. CZM is available to provide technical assistance and to advise the Town and its consultants regarding the delineation of flood zones and primary dunes.

The EENF states that the Town implemented a Board of Health regulatory review, and will continue to develop regulations and bylaws to keep growth within the projected buildout as required by the SRF program for zero interest loans. CZM recommends this regulatory review be broadened to all regulatory bodies, including zoning and conservation to help achieve this goal. As discussed above, in order to be consistent with the above-mentioned Executive Orders, growth controls are needed to ensure that the project does not increase growth or development in hazard-prone areas.

CZM understands that extending sewage collection and treatment to areas currently utilizing on-site sewage treatment must be balanced with the potential risks in coastal areas subject to erosion, flooding, and storm damage. CZM believes that these storm damage risks can be minimized through careful design considerations. CZM recommends specific design considerations to address these risks, including the locating of pump stations and other critical infrastructure outside of the 100-year floodplain, protecting the collection system from potential wave action, and incorporating a system of check valves into sections of the collection system within flood zones. This can help minimize impacts from a storm related breach to the collection system. Given the historic rate of sea level rise (i.e., one foot over 100 years), the likelihood of the historic rate doubling in the next century, and the predicted life of wastewater treatment facilities, CZM recommends designing the pump stations and other critical infrastructure system facilities to accommodate at least two feet of sea level rise.

Federal Consistency

The proposed project may be subject to CZM federal consistency review. For further information on this process, please contact, Robert Boeri, Project Review Coordinator, at 617-626-1050 or visit the CZM web site at www.state.ma.us/czm/fcr.htm.

BC/sm/tc/rlb

cc: Stephen McKenna,
CZM Cape & Islands Regional Coordinator
Brian Dudley, Section Chief
Southeast Regional Office, MassDEP
Andrew Poyant, CDM Smith Inc.
50 Hampshire Street, Cambridge, MA 02139

RECEIVED
APR 8 - 2013
MEPA

4-05-12
Harwich CWMP EENF
Stationary GHG Sources
DOER Comments
JJ Ballam

The Harwich CWMP includes a Waste Water Treatment Facility (WWTF) and 33 pumping stations, it includes direct stationary indirect sources of GHG emissions, as well as possible stationary direct sources GHG emissions. As such, the proposed plan is subject to the terms and provisions of the MEPA GHG Policy and Protocol (the Policy).

The DOER commends and congratulates Harwich on the commitment to go forward with the installation of a very sizeable solar photovoltaic renewable energy system. However the DOER does not consider this to be a sufficient justification for the granting of a waiver for compliance with the policy for the following reasons:

- Because the solar energy system output will be distributed to all of the Town's municipal loads via net metering, it is difficult for the DOER to assess what fraction of the electrical loads projected for the WWTF and pumping stations proposed in the CWMP will be supplied with zero emissions electricity.
- Regardless of the source of energy, the as-proposed pumping stations and WWTF should be designed to a standard of efficiency that they will ensure that they will meet and hopefully will exceed that business as usual level.
- Use of the Energy Stare Portfolio Manager for WWTFs and relatively simple calculations related to pumping energy, will allow for a reasonable quantification of baseline and target values for energy consumption and associated GHG emissions, using information, which for the most part has already been developed in the CWMP process, with a relatively minor level of effort and resources.

Application of the Policy to the as-Proposed WWTF

In applying the Protocol to as-proposed WWTF, the DOER and MEPA have adopted use of the EPA Energy Star Portfolio Manager for WWTFs as a means for establishing both a proxy for, and an analogue to the building code in defining the minimum benchmark for the baseline case for stationary source energy consumption and GHG emissions for an as-proposed wastewater treatment facility. Using the ESPM in the "set energy performance target" mode in conjunction with the required WWTF specific inputs (see below) will allow the determination of the site energy consumption in kBtu per gpd which correlates to a ranking of 50, which is the median value for all regional WWTFs sharing the same design operating parameters.

Use of the ESPM for WWTF in this way will generate a well founded metric that will be of use to MEPA by establishing a baseline benchmark, that will ensure that as-proposed WWTFs will be at least as efficient as the regional average for those with similar operating characteristics, as well as establishing an easily accessible performance reference metric to be used in the design, commissioning and operation phases of an as-proposed WWTF.

4-05-12
Harwich CWMP EENF
Stationary GHG Sources
DOER Comments
JJ Ballam

Approach:
The approach for meeting the MEPA stationary source GHG requirement for as-proposed new and expanded WWTWFs is:

1) Provide a table (see example below) showing the values input into the ESPM for WWTF

Item	Value at Full Build out
Average Influent Flow (MGD):	
Design Flow (MGD):	
Average Influent Biological Demand (BOD) Concentration: (mg/l)	
Average Effluent Biological Demand (BOD) Concentration: (mg/l):	
Fixed Film Trickle Filtration Process: Yes or No	
Nutrient Removal: Yes or No	
Facility Zip Code	

2) *Baseline case:* Defined by using the ESPM for WWTF tool in the "set energy performance target" mode to obtain the site kBTU/gpd and GHG emissions corresponding to a ranking of 50. For simplicity sake, set electricity as the only fuel (i.e. input only one electric meter)
3) Describe any energy conservation design measures (EDM) that have been included in the design; or are under consideration; or have been eliminated (with brief discussion of reasons).
4) *Mitigated case*: Based on an evaluation as to the likelihood of which EDMs will be adopted, propose a target goal ESPM WWTF ranking higher than 50 (i.e. a reduced site kBTU/gpd) and obtain the corresponding kBTU/gpd using the WWTF ESPM in the "set energy performance target" mode
5) Based on the site kBtu/gpd energy intensity (converted to kWh /gpd) compute the projected tons of GHG emissions using the projected average MGD at full build out for and the current grid emission factor for both the baseline and mitigated cases. Adjust the result by the estimated fraction energy projected to be supplied by as-proposed solar energy system.

Note: For the as-proposed baseline and as-mitigated cases, use of the ESPM for WWTF in the "set energy performance target" mode for obtaining a kBtu/gpd corresponding to a ranking of 50 does not require the input of projected annual gas and electric fuel usage.

4-05-12
Harwich CWMP EENF
Stationary GHG Sources
DOER Comments
JJ Ballam

In the subsequent submittal, provide a completed table similar to the one shown below:

WWTF	ESPM Energy Performance Rank	Site kBTU/gpd	Source kBTU/gpd	CO2 Emissions (Short tons per year)
As- Proposed Baseline	**50**	*		
As-Mitigated (Target Only)				

***The As-proposed <u>site</u> kBTU/gpd is to be included as a section 61 commitment in the EIR to be met by the final design of the as-proposed WWTF.**

<u>Note</u>: To obtain the site kBTU/gpd on the WWTF ESPM website:
On the Energy Star ESPM Facility Summary page, open the "Generate a Statement of Energy Performance for uses other than applying for the ENERGY STAR" link and in the Report Options menus (bottom of page) select "Facility Summary" and then select "Generate Report". The site kBTU/gpd is shown in this report.

For general assistance with the ESPM for WWTF or for specific assistance for use in the set target mode for the purpose of obtaining a kBtu per gpd for a target ranking contact:

Jason Turgeon
US EPA,
Boston Office
617-918-1826.
turgeon.jason@**epa**.gov

<u>WWTF Buildings:</u>
The MEPA Policy and Protocol requires that energy modeling be performed to establish the expected energy usage and corresponding GHG emissions for both the baseline and mitigated as-proposed cases. In this case, however, the DOER recommends that this requirement be waived for the following reasons and subject to the following conditions:
<u>Reasons:</u>
The loads and energy consumption for the buildings are included in the computation of the overall facility site kBTU/mgd.
The assumption that all heating fuel will be electricity while conservative, will not overly distort the results, as the process and building electrical loads will dominate the total energy usage.
The new construction will be designed and built to meet the Mass. energy building code.

Conditions:
The modeling waiver is contingent upon the following conditions being met:

All of the building EDMs listed below in the mitigation section of this letter will be evaluated and the results of the evaluation will be included in the Section 61section of the EIR.

<u>Mitigation:</u>

Building Measures:
Increase roof insulation to at least 20% above the minimum required by the effective Mass Building Energy Code (the code)

Reduce Lighting Power Density to at least 15% below maximum allowed by the code. Include occupancy on/off controls .

Increase boiler or furnace efficiency to at least 10% above the minimum required by code.

Include energy recovery ventilation for heated building areas.

Process Measures:
Process Optimization: Mitigation of the negative impact on the life-cycle efficiency and emissions of the WWTF treatment process due to the impact of equipment operating for a large fraction of the life-cycle at partial loads.

Pumping Stations:
Provide a description of the business as usual case for the as-proposed stations and projected annual MWH energy consumption and GHG emissions.

Provide a description of the proposed mitigated as-proposed pumping stations and projected annual MWH energy consumption and GHG emissions.

<u>Section 61 Findings and Mitigation Measures:</u>
An energy and GHG reduction section should be added to this chapter in the EIR and should include a discussion use of the ESPM WWTF rank of 50 as a baseline commitment and the following specific information:

- A commitment that the final design for the as-proposed WWTF will achieve a ESPM WWTF ranking of not less than 50, and the corresponding site kBTU/gpd.
- A list of <u>all</u> the energy design mitigation measures that will be included to some degree in the as-proposed project.

MEMORANDUM

TO: Anne Canaday, Environmental Reviewer, MEPA Unit

THROUGH: Jonathan Hobill, Regional Engineer, Bureau of Resource Protection
Philip Weinberg, Regional Director
David Johnston, Deputy Regional Director, BRP
Maria Pinaud, Deputy Regional Director, BWP
Millie Garcia-Serrano, Deputy Regional Director, BWSC
Brenda Chabot, Deputy Regional Director, ADMIN

CC: Elizabeth Kouloheras, Chief, Wetlands and Waterways
Jeffrey Gould, Chief, Wastewater Management Program
Brian Dudley, Wastewater Management, Cape Cod Watershed
Richard Rondeau, Chief, Water Supply
Richard Keith, Chief, Municipal Services
James McLaughlin, Stimulus SRF Coordinator
Pamela Truesdale, Municipal Services
Mark Dakers, Chief, Solid Waste Management
John B. McLaughlin, Solid Waste Management
Leonard Pinaud, Chief, Site Management
Julia Sechen, Site Management

DEP/Boston
CC: Beth Card, Assistant Commissioner, BRP
Lealdon Langley, BRP-DWM-WW
Michael Stroman, BRP-DWM-WW
Lisa Rhodes, BRP-DWM-WW
Gary Moran, Deputy Commissioner
David DeLorenzo, BRP-DMS

FROM: Sharon Stone, SERO MEPA Coordinator

DATE: April 9, 2013

RE: ENF EOEEA #15022 – Draft Comprehensive Wastewater Management Plan (CWMP), Various Streets Throughout Harwich and Chatham

****

"For Use in Intra-Agency Policy Deliberations"

MassDEP - Southeast Regional Office is pleased to provide comments on the Expanded Environmental Notification Form/Draft Comprehensive Wastewater Management Plan (CWMP) submitted by CDM Smith on behalf of the Town of Harwich. The CWMP presents a 40 year phased plan with a primary focus on mitigating nitrogen enrichment to the Herring River, Allens Harbor, Saquatucket Harbor, Wychmere Harbor and Pleasant Bay watersheds. The CWMP also addresses phosphorus management of freshwater ponds and areas of Harwich with specific difficulties meeting the minimum standards of the Massachusetts on-site sewage treatment and disposal regulations (310 CMR 15.000, Title 5 of the State Environmental Code).

MassDEP is encouraged that a cornerstone of the CWMP provides for inter-municipal cooperation with the Town of Chatham in order to reduce costs and help utilize more fully Chatham's new wastewater treatment facility while that community is in the initial phases of sewer construction. The CWMP also incorporates alternative strategies such as improved flushing at Muddy Creek and enhanced attenuation at the Bank Street bogs.

MassDEP notes that the Water Pollution Abatement Trust recently provided the Cape Cod Commission with a $3.35 million grant to prepare an update to the 1978 Water Quality Management Plan for Cape Cod. The updated Federal Clean Water Act Section 208 Plan will be a regional, watershed-based plan designed to restore and protect water quality on the Cape. The plan will include a comprehensive analysis of all factors contributing to water quality degradation, but prioritize management of controllable nutrients due to the current conditions in the region.

The updated plan will:

- Prioritize water resources, identifying the most impaired or endangered, and the actions to achieve water quality goals as quickly as possible;
- Limit the amount of infrastructure needed by prioritizing those areas requiring "shared" systems to restore water quality;
- Provide an opportunity to more fully evaluate decentralized and innovative approaches, as well as the continued use of conventional septic systems where appropriate;
- Identify preferred solutions for nutrient management in nitrogen sensitive watersheds;
- Achieve greatest economies of scale, and identify methods to equitably share costs among all parties benefitting from the improvements;
- Feature a robust public participation process, including a facilitated outreach effort, watershed level advisory committees, and extensive public input opportunities to fully consider all views and input, and to build consensus for identified solutions; and
- To the greatest extent possible, identify ways in which solving the wastewater problem could also address other challenges facing the Cape. As one example, the plan should explore the use of anaerobic digesters at new or existing wastewater treatment plants to generate low-cost, renewable energy and help the Cape address organic waste disposal challenges.

It is anticipated that a draft 208 plan will be completed in 1 year, and a final plan issued within 2 years. MassDEP strongly encourages Harwich to become an active participant in this planning process to coordinate Harwich's planning efforts with the Cape Cod Commission's regional efforts, and to ensure Harwich can best take advantage of any proposals for regional solutions, cost efficiencies and/or cost-sharing opportunities the regional approach will yield.

Watershed Permitting Program

The document represents a thorough evaluation of Harwich's needs for wastewater and nutrient management. Much of the recommended plan is driven by the findings of the Massachusetts Estuaries Project (MEP) which documented resource impairment from excess nitrogen loads in the five embayments listed above. Based on the amount of nitrogen reduction necessary, the CWMP recommends targeted sewering, using a hybrid system of gravity and low pressure sewers, with the remaining non-sewered areas relying on conventional on-site sewage treatment and disposal. A portion of the town's wastewater flow in the Pleasant Bay watershed will be directed to Chatham's wastewater treatment facility and disposed of at infiltration beds at a gravel pit in the Pleasant Bay watershed (designated as site PB-3). Wastewater flow from the remaining watersheds (Allens Harbor, Wychmere Harbor, Saquatucket Harbor and the Herring River) are proposed to be treated at a new sequencing batch reactor (SBR) wastewater treatment facility and new infiltration beds both located at the Harwich Department of Highways and Maintenance property at the former landfill site in the Herring River watershed (designated as site HR-12).

Regional approaches

The CWMP provides opportunities for regional cooperation along several fronts. First, ongoing discussions with Chatham appear to be very promising regarding the use of the Chatham facility to accommodate some of Harwich's wastewater flow in the near term. Further, it is encouraging that there is a recognition of long term needs and preliminary plans for Harwich to consider funding a portion of the expansion of the Chatham facility when that need may arise in order to continue allowing Harwich access to the Chatham facility. The responsibility for implementing flushing improvements for Muddy Creek will be shouldered by Harwich with the knowledge that there will be benefit to both Harwich and Chatham, as the Muddy Creek subwatershed is shared by both towns. The CWMP mentions the possibility of inter-municipal cooperation with Dennis, especially since a portion of the village of Dennisport lies within the Herring River watershed. MassDEP would encourage both towns to initiate discussions on the mutual benefit which could be realized by coordinating the respective towns' wastewater planning. In addition, Harwich shares a small portion of the Swan Pond River watershed with the towns of Brewster and Dennis and the Herring River watershed with Brewster. The CWMP recognizes that the wastewater treatment facility proposed for the Herring River watershed may have the potential to serve portions of the watershed outside Harwich's boundaries. Harwich should open immediate discussions with Dennis, Harwich and Brewster regarding how these towns with shared watersheds can best approach watershed planning on an inter-municipal basis. In regard to Swan Pond River, very little of Harwich is in that watershed; however, the MEP report does model a scenario showing that 100% of the septic load needs to be removed to achieve target thresholds. Again Harwich should work with the neighboring communities on this shared watershed to ensure that planning results in proposed solutions that address the entire watershed in a cost effective manner.

As other studies evolve regarding regional approaches, these can inform the strategies and direction in future phases. The Department strongly recommends a regional watershed-based approach to addressing water quality impairment. An approach not based on municipal boundaries, but instead focused on cost effective solutions, cost sharing and innovation. Harwich's CWMP addresses the most significant watersheds and shared watersheds in the Town of Harwich and proposes partnering with Chatham to address those impairments. While MassDEP has identified some remaining shared watersheds in need of additional inter-municipal planning before cost effective solutions could be developed, CWMP Phases 1 and 2 are appropriate first steps that will not jeopardize future opportunities for regional cooperation.

Alternative Appraoches

There are two proposals for alternative approaches for nutrient reduction described in the CWMP. One is to provide for improved flushing at the Muddy Creek culverts running under Route 28. Modeling through the MEP has shown that a 24 foot wide culvert will provide benefit to water quality in the Muddy Creek subwatershed which may result in a reduction of the amount of conventional infrastructure that would ordinarily be needed to meet target thresholds within the subwatershed. This project is planned for Phase I which is scheduled for between 2013 and 2015. MassDEP and the town will work together to develop an appropriate monitoring plan to determine if the anticipated improvements in water quality actually occur. If the project does not result in the projected water quality improvements, the CWMP should provide a discussion of the additional mitigation required to meet the target thresholds.

The second proposal is to modify or manipulate flow through the Bank Street cranberry bogs to increase nitrogen attenuation from a measure 35% to a projected 50%. Enhanced natural attenuation at this site will be considered as a demonstration project which will require appropriate review and permitting under the Wetlands Protection Act and related regulations. The town and MassDEP should discuss permitting requirements at the earliest opportunity. Should the project be permitted, the town will need to develop a design and monitoring protocol with MassDEP so that the effectiveness of the modifications is adequately documented in order to secure credit for the anticipated additional nitrogen removal. The plan should provide a discussion of alternate mitigation strategies if the enhanced attenuation does not meet expectations.

A more detailed discussion of wetlands requirements are provided in another section of these comments.

Wastewater Infiltration

The CWMP provides a hydrogeological report for the proposed infiltration sites HR-12, SH-2 and PB-3. MassDEP will need more time to thoroughly review the findings; however, the recommended discharge sites will be fully evaluated during the permitting process. As part of the recommended plan, only sites HR-12 and PB-3 were carried forward.

Site PB-3 is located in the Zone II of a public water supply well. Pursuant to 314 CMR 5.10(4A) a Total Organic Carbon (TOC) limit of 3 mg/L is required for discharges in a Zone II unless otherwise determined by the MassDEP. The CWMP does mention that it is expected that additional treatment for the removal of will not be required at site PB-3 since the estimated travel time to the nearest municipal well is over five years. Strictly speaking, the five year travel time does not factor into the evaluation of the TOC requirement, but rather whether the infiltration site is in the zone of contribution (as opposed to the Zone II) of a public water supply well. MassDEP has provided a preliminary opinion regarding TOC treatment; however, further evaluation during the permitting process is needed for a definitive determination. Additionally, it should be noted that site PB-3 will require a site assignment under MGL Chapter 83 Section 6.

With regard to site HR-12, the entire parcel is under a site assignment by the Divison of Solid Waste. As described in another section of these comments, all provisions of the solid waste program and its regulations will have to be met to allow siting of a wastewater treatment facility and disposal beds.

Buildout Analysis

The report has provided a thorough evaluation of existing and buildout conditions. However, the CWMP should acknowledge that additional evaluation may be needed for buildout assumptions depending upon how proposed zoning changes, particularly for the East Harwich Village Center, are enacted.

Alternative Treatment

There has been some discussion of alternative treatment strategies that focused mainly on enhanced on-site treatment using so-called innovative/alternative technologies. The CWMP should provide an expanded discussion on how these and other "greener" on-site alternatives (e.g. composting toilets and urine diversion toilets) were evaluated and screened out.

Phasing

The CWMP is based on a 40 year design horizon divided in eight phases. Traditionally, CWMPs have been based on 20 year horizons; however, the town argues that the scope and cost of the recommended alternative requires an extended timeframe for affordability and capital planning. MassDEP believes that further discussion on the timetable is required to arrive at a mutually acceptable schedule for completion. Regarding timetable for solution implementation, as noted above, the Water Pollution Abatement Trust recently provided the Cape Cod Commission with a $3.35 million grant to update Cape Cod's regional water quality management plan. It is anticipated that a draft regional plan will be completed in a year, with a final plan expected with 2 years. The Department strongly encourages Harwich to coordinate with the Cape Commission and become an active participant in this planning process.

With regard to phasing, the northeast Herring River collection system (upper) is scheduled for Phase 4B and the northwest (upper) Herring River collection system is scheduled for Phase 5 while the southwest (lower) Herring River collection system is scheduled for Phase 7. Because the lower Herring River collection system would likely have a more immediate effect on improving water quality due to its closer proximity to the marine portion of the Herring River watershed, it should be considered for Phase 4B or Phase 5 and the upper Herring River collection systems should be considered for later phases. It is understood that cost factored into the phasing plan; however, habitat restoration also has to be a major consideration in the phasing plan. Further discussion between the town and MassDEP is warranted before finalizing a phasing plan.

SRF Funding

The Town of Harwich is encouraged to work with MassDEP's State Revolving Fund (SRF) section to develop funding alternatives as project development proceeds. The Draft CWMP clearly documents areas where nutrient enrichment needs control to improve water quality. As projects approach the funding stage, the Town will need to show the percentage of each project intended primarily to manage nutrients with reference to the final CWMP. Sewer regulations to be developed may need to comply with certain MassDEP and Department of Housing and Community Development requirements, depending on the funding program utilized. In particular, there is little discussion of growth neutrality in the CWMP. This item needs to be addressed if the town wishes to pursue 0% financing from the SRF.

Wetlands and Waterways Program

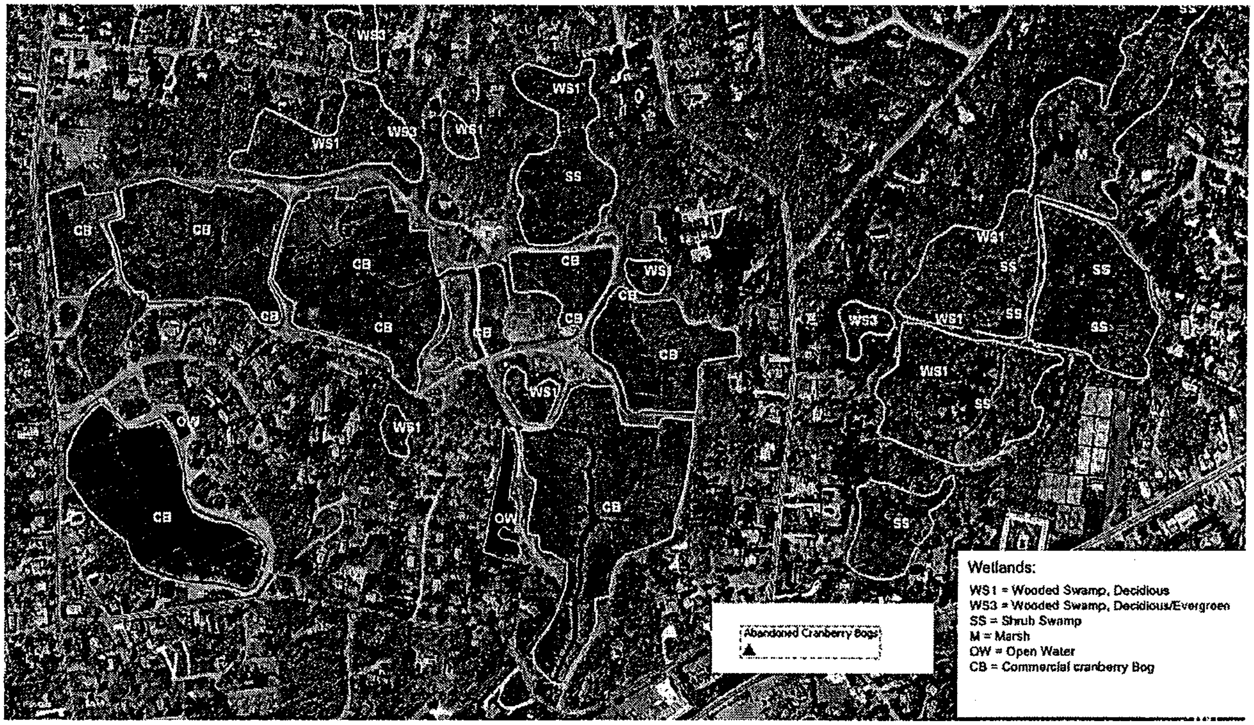
MassDEP fully supports the Town of Harwich in its efforts to develop a Comprehensive Wastewater Management Plan (CWMP) that serves as a water resources management strategy to meet Total Maximum Daily Load (TMDL) requirements. Development of a CWMP is an important step toward meeting TMDL's and restoring impaired waters. Plans to meet TMDL requirements for nutrient loading must always consider source reduction as the primary means of long term nutrient control. Source reduction usually focuses on controlling watershed land use loads generated from human activity and can include but are not limited to constructing new sewer systems, upgrading existing sewer systems (e.g. providing higher levels of treatment and eliminating combined sewer outflows), eliminating fertilizers, constructing on-site systems with enhanced nutrient removal capability, reducing runoff from impervious surfaces, reducing impervious surfaces, and tightening standards for new and upgraded septic systems. In addition to source controls, successful nutrient management plans may include alternative nutrient control strategies to achieve the desired nitrogen concentrations specified in the TMDL and Massachusetts Estuary Project (MEP) reports. MassDEP is encouraged by the source controls proposed in the CWMP, and recommends that Harwich continue to evaluate and adopt additional source controls in the future to the maximum extent possible to reduce the need for alternative nutrient control strategies.

The Harwich CWMP contains two proposed alternative nutrient control strategies that will result in direct alteration of wetland resource areas. The Town proposes to implement the CWMP in phases and Phase I includes the replacement of the two 4-foot wide existing culverts with a 24-foot wide culvert at Route 28 to increase flushing of Muddy Creek and restore ecological habitat. Although source reduction should be the primary focus of all nutrient control strategies, there are certain instances where historical alteration of a resource area from its natural condition has exacerbated nutrient enrichment. At Muddy Creek, where it flows under Route 28, culverts have restricted flow and impeded tidal flushing, which under natural conditions would allow for efficient transport of nutrients out of a system. In this instance, restoration to a documented historical condition is an appropriate consideration for management since it employs techniques widely used to restore, rehabilitate and/or create salt marshes. With the increased 24-foot opening, residence time of nitrogen is projected to be reduced thus contributing to overall reduction in nitrogen loads in the Muddy Creek subwatershed. Therefore, MassDEP supports the issuance of a conditional Phase I waiver with a requirement that a Notice of Project Change be submitted for this project when the design is advanced such that wetland resource area impacts can be quantified. Such quantification should include the temporary and permanent alterations to wetland resource areas, as well as the predicted increase or decrease in bordering vegetated wetland, salt marsh and other wetland resource areas. In addition, an evaluation of low lying properties must be conducted to ensure that the improvement in tidal flushing will not result in flooding of properties in the vicinity. Mitigation should be provided for permanent alterations that are not offset by new resource area created as a result of the increased tidal flushing. A permitting strategy should be developed for MassDEP review. This permitting strategy should address specifically the regulatory language at 310 CMR 10.24(5)(b) which specifies that projects located within an Area of Critical Environmental Concern (ACEC) "shall have no adverse effect upon those interests, except as provided under 310 CMR 10.25(4) for maintenance dredging." Two other provisions that should be evaluated include the limited project provision found in 310 CMR 10.24(7)(c)2. for the "maintenance, repair and improvement (but not substantial enlargement) of structures, including...bridges and culverts which existed on November 1, 1987 and 310 CMR 10.32(5) which states "Notwithstanding the provisions of 310 CMR 10.32(3), a project which will restore or rehabilitate a salt marsh, or create a salt marsh, may be permitted." It is important to note that MassDEP has made proposed revisions to 310 CMR 10.24(5)(b) and relevant provisions of the Waterways regulations at 310 CMR 9.32(1)(e) to address the apparent prohibition on projects, including restoration projects, which lie within ACECs. That proposed Wetlands Regulation revision states, "When any portion of a designated Area of Critical Environmental Concern is determined by the Issuing Authority to be significant to any of the interests of

M.G.L. c. 131, § 40, any proposed project in or impacting that portion of the Area of Critical Environmental Concern shall have no adverse effect upon those interests, except as provided under 310 CMR 10.25(4) for maintenance dredging, under 310 CMR 10.11 through 10.14, and 314 CMR 10.24(8) and 310 CMR 10.53(4) for Ecological Restoration Projects, and under 310 CMR 10.25(3) for improvement dredging conducted by a public entity for the sole purpose of the maintenance or restoration of historic, safe navigation channels or turnaround basins of a minimum length, width, and depth consistent with a Resource Management Plan adopted by the municipality(ies) and approved by the Secretary of the Executive Office of Energy and Environmental Affairs." Revisions are also proposed to the Waterways Regulations which would eliminate restrictions on the placement of fill or structures within jurisdiction of Chapter 91 within ACECs when necessary to accomplish ecological restoration projects. The Department hopes that the project proponent will consider these proposed revisions and their possible effect on the permissibility of the project.

In addition to the Muddy Creek culvert improvements, modifications to Cold Brook and associated wetlands to maximize residence time of groundwater are proposed to achieve 15% of the total nitrogen attenuation required in the Saquatucket Harbor estuary. Specifically, construction of depositional ponds in abandoned cranberry bogs off of Bank Street is proposed for the retention of pollutants. This strategy is concerning and may require a wetland variance. A wetland variance may require further evaluation of alternatives through the MEPA process. We believe that alternatives likely exist (e.g. natural succession, different restoration techniques and wetland creation) that better meet both the goals of wetland protection and water quality restoration. Some of these alternatives may also serve the purpose of expediting wetland permitting.

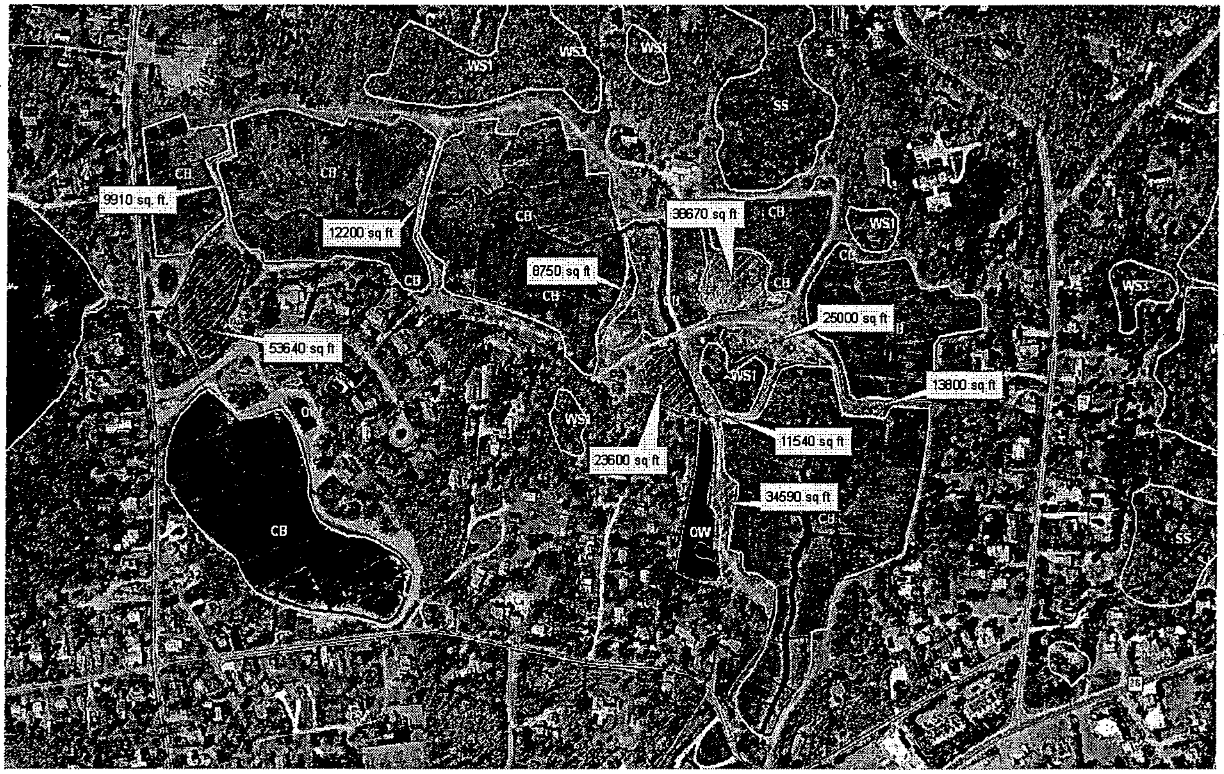
Abandoned cranberry bogs, if left alone will revert to marshes and/or shrub/forested swamps through natural succession and provide pollution prevention benefits and promotion of other public interests. This can be directly observed by the succession of abandoned cranberry bogs to the east of Gorham Road to more natural wetland systems (see photo below). The succession of abandoned cranberry bogs to a natural shrub or forested system may provide nitrogen attenuation not currently considered in the proposed strategy.



Abandoned cranberry bogs succession to natural wetlands east of Gorham Road

Strategies that would restore the bog and also increase retention time may also be considered. Acceptable restoration strategies include natural plantings of woody species, elimination of manmade ditches and increasing sinuosity of the main channel (and possibly creation of sinuous tributaries from some of the larger ditches). The project proponent should review the Watershed Assessment of River Stability & Sediment Supply (WARRS) river restoration method recommended by EPA.
http://water.epa.gov/scitech/datait/tools/warsss/

Additionally, or instead of the restoration strategies described above, we strongly recommend that the project proponent consider wetland creation as a viable alternative to the alteration of existing wetlands in and around the abandoned bog. There appear to be a number of upland areas that may allow for successful wetland creation in and around these abandoned cranberry bogs that should be investigated further (see photo below).



Areas with yellow hatch marks are potential wetland creation areas needing investigation

Any one strategy or combination of strategies described in the preceding paragraph may serve to achieve a similar or greater nitrogen attenuation increase of the 15% desired. Research has confirmed that wetlands provide good nitrogen attenuation which supports the goals of not only protecting existing wetlands for natural succession, but also for creating additional acreage. However, there appears to be limited research on the nitrogen attenuation capability of specific wetland types, including cranberry bogs, marshes and shrub and forested wetlands, and on the amount of nitrogen attenuation that would result from acceptable restoration strategies that would increase retention time. MassDEP supports the phase 1 waiver provided that further justification for the percentage of nitrogen removal modeled be developed and provided to MassDEP for alternatives involving wetlands. Demonstration projects may be approved on a case by case basis to support development of data, however it is MassDEP's opinion that further examination of the nitrogen attenuation alternatives and their permissibility under state and federal law and regulation should be undertaken before proceeding to the permitting phase.

All strategies should be monitored to document actual nitrogen attenuation through a monitoring system designed to measure upgradient (inflow) and down gradient (outflow) nitrogen loads. Downgradient salt marshes should also be monitored before and after work using MassDEP/Coastal Zone Management's Salt Marsh Quality Assurance Project Plan (QAPP) protocol and monitoring data collected should be submitted to MassDEP Wetlands Program. http://www.mass.gov/dep/water/resources/wfieldwk.htm#qapps

MassDEP is willing to work with the project proponent prior to permitting to evaluate appropriate alternatives and a monitoring strategy to achieve the maximum nitrogen attenuation possible, in addition to and possibly instead of the currently proposed depositional ponds in the abandoned cranberry bog.

Finally, the Massachusetts Natural Heritage and Endangered Species Program (NHESP) identified state-listed rare species in the vicinity of the Muddy Creek culvert replacement project including the Common Tern (*Sterna hirundo*) and the Eastern Box Turtle (*Terrapene carolina*). Additional estimated habitat of rare wildlife is located in the abandoned cranberry bog to the east of Bank Street. During implementation of the CWMP, the project proponent must comply with 310 CMR 10.59, 310 CMR 10.32(6) and related performance standards for other resource areas, and 310 CMR 10.37 to ensure that there is no short or long term adverse effect on estimated habitats of rare wildlife.

Conclusion

The town of Harwich has made an important step forward in addressing nutrient enrichment in the five major embayments. This plan has championed a regional approach, which is a MassDEP priority, in partnering with Chatham and utilizing its wastewater treatment facility to best advantage. MassDEP is of the opinion, however, that additional regional partnering with Dennis and Brewster should be more fully explored and addressed in the requested SEIR. MassDEP also recognizes that given the phasing, regardless of what timetable upon which the parties eventually agree, modifications to the existing plan can accommodate anticipated studies on regional alternatives. Nonetheless, there is nothing in the first two phases of this plan that would jeopardize any future regional initiatives, in fact, MassDEP believes that they serve as a strong foundation for regional efforts.

MassDEP supports the request for an SEIR but would request supplemental information be included that would more fully evaluate inter-municipal options with Dennis and Brewster for the Herring River and Swan River watersheds. MassDEP also supports the Phase I waiver as requested.

Solid Waste Management Program Comments

The CWMP proposal describes approximately 92 linear miles of sewer mains (in Harwich), a 10-acre recharge facility (PB-3), effluent recharge basins, 30 pump stations and a Waste Water Treatment Plant (the "WWTP"). The proposed WWTP and one (of the two) effluent recharge basins are located on a town-owned parcel designated as site HR-12, which is presently site assigned for solid waste activities (only).

Accordingly, and as a result of the Department's review of the proposed ENF #15022, MassDEP-Solid Waste Program offers the following comments:

1. Solid Waste Site Assignment Modification: The Town has two options regarding the solid waste site assignment at the HR-12 site parcel. Option one is that the

Town could first relinquish the solid waste site assignment ("de-site assignment"). The Town would be required to maintain certain setbacks and egress for the Landfill property.

OR

2. Post Closure Use of a Landfill: Option two is that the Town could submit a Post Closure Use permit application (BWP SW36) leaving the WWTP within the jurisdiction of the solid waste program. Subsequently, any future changes/upgrades occurring on the HR-12 parcel would remain subject to approval(s) from the Solid Waste section.

The Town should contact the Solid Waste Management Section for pre-application guidance prior to proceeding with either option, please contact either Mark Dakers (508 946 2847) or John McLaughlin (508 946 2729) at MassDEP's Southeast Regional Office.

Construction Activities - EPA

The project construction activities may disturb one or more acres of land and therefore, may require a NPDES Stormwater Permit for Construction Activities. The proponent can access information regarding the NPDES Stormwater requirements and an application for the Construction General Permit at the EPA website:
http://cfpub.epa.gov/npdes/stormwater/cgp.cfm

Bureau of Waste Site Cleanup

Based on the information provided in the ENF, the Bureau of Waste Site Cleanup (BWSC) searched its database for disposal sites and release notifications. (A disposal site is a location where there has been a release to the environment of oil and/or hazardous material that is regulated under M.G. L. c. 21E and the Massachusetts Contingency Plan [MCP – 310 CMR 40.0000]). The ENF has identified the following disposal sites located in the vicinity of the proposed project.

Release Tracking Number (RTN)	Site Address	Type of Contaminant(s)	Site Status and Date
4-0000518	622 Depot St	Volatile Organic Compounds	Class C1 RAO 12/12/2003
4-0000842	731 Main St Rte 28	Petroleum	Class C2 RAO 5/18/2011
4-0000950	435 Main St	Gasoline	Class A2 RAO 2/5/2001
4-0001200	570 Main St	Gasoline	Class A2 RAO 11/8/2008
4-0006015	321 Oak Street Ext	#2 Fuel Oil	Remedy Operation Status 11/6/2003
4-0010358	678 Main St	#2 Fuel Oil	Class A2 RAO 7/15/1994

4-0010593	94 Parallel St	#2 Fuel Oil	Class A2 RAO 8/4/1994
4-0011348	69 Chase St	#2 Fuel Oil	Class A2 RAO 3/2/1998
4-0011443	709 Main St	Total Petroleum Hydrocarbons	Class A2 RAO 5/15/1996
4-0011609	578 Main St	Oil	Class A1 RAO 12/20/1996
4-0011728	21 Pleasant Park Rd	#2 Fuel Oil	TIER 2 03/31/2008
4-0011830	97 Main St	#2 Fuel Oil	Class A2 RAO 11/12/1996
4-0012523	4 Nevins Ave	#2 Fuel Oil	Class A2 RAO 8/12/1997
4-0013231	805 Main St	Total Petroleum Hydrocarbons	Class A2 RAO 9/3/2009
4-0013326	9 Bells Neck Rd	Solvents	DPS 2/23/1998
4-0021217	729 Main St	Gasoline	Class A2 RAO 3/31/2009
4-0021244	Vic 353 Great Western Rd	#2 Fuel Oil	Tier II Classification 5/21/2009
4-0021786	2 Riverway	#2 Fuel Oil	Class A2 RAO 12/2/2009
4-0023054	Mile Marker 79.6	Gasoline	Class A2 RAO 3/14/2011
4-0013606	570 Main St	Gasoline	RTN Closed 3/13/1998
4-0013842	327 Bank St	#2 Fuel Oil	Class A1 RAO 7/29/1998
4-0013975	219 Main St	Polycyclic Aromatic Hydrocarbons	Class B1 RAO 6/19/1998
4-0014350	482 Queen Anne Rd	#2 Fuel Oil	Class A2 RAO 5/22/2000
4-0014446	20 Elwood Rd	#2 Fuel Oil	Class A2 RAO 12/21/2000
4-0014496	5 Cottage Ave	#2 Fuel Oil	Class B1 RAO 1/28/1999
4-0014707	20 Pleasant Rd	#2 Fuel Oil	Class A2 RAO 5/19/2000

4-0014900	739 Main St	Diesel Fuel	Class A1 RAO 11/19/1999
4-0015537	Rte 137	Diesel Fuel	Class A2 RAO 8/3/2000
4-0015661	706 Main St	Gasoline	Class A1 RAO 5/2/2001
4-0016004	Queen Anne Rd	Transformer Oil	Class A1 RAO 2/1/2001
4-0016449	4 Hall Ave	#2 Fuel Oil	Class A1 RAO 9/27/2001
4-0017263	565 Rte 28	#2 Fuel Oil	Class A2 RAO 12/3/2002
4-0017414	54 Smith St	#2 Fuel Oil	Class A2 RAO 4/12/2004
4-0017417	397 Rte 28	Petroleum	Class A2 RAO 5/8/2003
4-0018140	Monomy Rd	Transformer Oil	Class A1 RAO 11/25/2003
4-0018836	69 Doane Rd	#2 Fuel Oil	Class A2 RAO 6/27/2006
4-0019494	731 Main St	Volatile Petroleum Hydrocarbons	RTN Closed 3/23/2007
4-0019536	9 Shaggy Pine Rd	#2 Fuel Oil	Class A2 RAO 12/24/2007
4-0019683	4 Main St	Gasoline	Class B1 RAO 3/30/2007
4-0019955	183 Sisson Rd	Diesel Fuel	Class A2 RAO 10/21/2009

The files for these sites may be viewed at
http://public.dep.state.ma.us/SearchableSites/Search.asp

The Project Proponent is advised that the discovery of oil and/or hazardous material during the implementation of this project may require notification to the Massachusetts Department of Environmental Protection pursuant to the Massachusetts Contingency Plan (310 CMR 40.0000). A Licensed Site Professional (LSP) should be retained to determine if notification is required and, if contamination is encountered, to determine the necessary response actions. The BWSC may be contacted for guidance if questions regarding cleanup arise.

Greenhouse Gas (GHG) Emissions Policy
The solar photovoltaic system proposed within the Harwich CWMP/EENF is a significant commitment to non - GHG emitting technologies and will contribute a substantial amount of clean power to the grid.

The infrastructure related to the proposed Harwich WWTF system, however, includes a number of collection and treatment components that will be and/or may be subject to the protocols contained in the MEPA GHG Policy. The Policy requires that energy demands and associated GHG generation associated with wastewater collection and treatment for the two proposed service areas be evaluated.

This assessment is used to generate a minimum benchmark/baseline case for energy consumption and GHG emissions for WWTF systems with similar equipment and operating characteristics and establishes a performance reference metric for design.

The CWMP/EENF's **ENERGY SECTION** contained on p.22 of the EENF makes no reference to the type of analysis contained in the Policy. Given the preliminary nature of the CWMP/ EENF at this time, however, it is expected that these issues will be addressed as the Chatham/Harwich collection system proceeds into design and will be continued as an Adaptive Management SOP throughout the life of the entire project.

MassDEP recommends that the Town of Harwich utilize the EPA Energy Star Portfolio Manager (ESPM) for WWTFs for these analyses. Information regarding this analytical tool is available from:

Jason Turgeon
US EPA,
Boston Office
617-918-1826.
turgeon.jason@**epa**.gov

Proposed s.61 Findings
The "Certificate of the Secretary of Energy and Environmental Affairs on the Environmental Notification Form" may indicate that this project requires further MEPA review and the preparation of an Environmental Impact Report. Pursuant to MEPA Regulations 301 CMR 11.12(5)(d), the Proponent will prepare Proposed Section 61 Findings to be included in the EIR in a separate chapter updating and summarizing proposed mitigation measures. In accordance with 301 CMR 11.07(6)(k), this chapter should also include separate updated draft Section 61 Findings for each State agency that will issue permits for the project. The draft Section 61 Findings should contain clear commitments to implement mitigation measures, estimate the individual costs of each proposed measure, identify the parties responsible for implementation, and contain a schedule for implementation.

The MassDEP Southeast Regional Office appreciates the opportunity to comment on this proposed project. If you have any questions regarding these comments, please contact Sharon Stone at (508) 946-2846.

Appendix I

NHESP Correspondence 2011, 2013 & 2015

September 16, 2011

Magdalena Lofstedt
Camp Dresser & McKee, Inc.
50 Hampshire Street
Cambridge MA 02139

RE: Project Location: 205 Queen Anne Road
Town: HARWICH
NHESP Tracking No.: 11-29877

To Whom It May Concern:

Thank you for contacting the Natural Heritage and Endangered Species Program ("NHESP") of the MA Division of Fisheries & Wildlife for information regarding state-listed rare species in the vicinity of the above referenced site. Based on the information provided, this project site, or a portion thereof, is located **within** *Priority Habitat 1424* (PH 1424) and *Estimated Habitat 19* (EH 19) as indicated in the *Massachusetts Natural Heritage Atlas* (13^{th} Edition). Our database indicates that the following state-listed rare species have been found in the vicinity of the site:

Scientific name	Common Name	Taxonomic Group	State Status
Terrapene carolina	Eastern Box Turtle	Reptile	Special Concern
Enallagma recurvatum	Pine Barrens Bluet	Damselfly	Threatened

The species listed above are protected under the Massachusetts Endangered Species Act (MESA) (M.G.L. c. 131A) and its implementing regulations (321 CMR 10.00). State-listed wildlife are also protected under the state's Wetlands Protection Act (WPA) (M.G.L. c. 131, s. 40) and its implementing regulations (310 CMR 10.00). Fact sheets for most state-listed rare species can be found on our website (www.nhesp.org).

Please note that projects and activities located within Priority and/or Estimated Habitat **must** be reviewed by the NHESP for compliance with the state-listed rare species protection provisions of MESA (321 CMR 10.00) and/or the WPA (310 CMR 10.00).

Wetlands Protection Act (WPA)

If the project site is within Estimated Habitat and a Notice of Intent (NOI) is required, then a copy of the NOI must be submitted to the NHESP so that it is received at the same time as the local conservation commission. If the NHESP determines that the proposed project will adversely affect the actual Resource Area habitat of state-protected wildlife, then the proposed project may not be permitted (310 CMR 10.37, 10.58(4)(b) & 10.59). In such a case, the project proponent may request a consultation with the NHESP to discuss potential project design modifications that would avoid adverse effects to rare wildlife habitat.

A streamlined joint MESA/WPA review process is available. When filing a Notice of Intent (NOI), the applicant may file concurrently under the MESA on the same NOI form and qualify for a 30-day streamlined joint review. For a copy of the NOI form, please visit the MA Department of Environmental Protection's website: http://www.mass.gov/dep/water/approvals/wpaform3.doc.

MA Endangered Species Act (MESA)

If the proposed project is located within Priority Habitat and is not exempt from review (see 321 CMR 10.14), then project plans, a fee, and other required materials must be sent to NHESP Regulatory Review to determine whether a probable "take" under the MA Endangered Species Act would occur (321 CMR 10.18). Please note that all proposed and anticipated development must be disclosed, as MESA does not allow project segmentation (321 CMR 10.16). For a MESA filing checklist and additional information please see our website: www.nhesp.org ("Regulatory Review" tab).

We recommend that rare species habitat concerns be addressed during the project design phase prior to submission of a formal MESA filing, as avoidance and minimization of impacts to rare species and their habitats is likely to expedite endangered species regulatory review.

This evaluation is based on the most recent information available in the Natural Heritage database, which is constantly being expanded and updated through ongoing research and inventory. If you have any questions regarding this letter please contact Amy Coman-Hoenig, Endangered Species Review Assistant, at (508) 389-6364.

Sincerely,

Thomas W. French

Thomas W. French, Ph.D.
Assistant Director

The Commonwealth of Massachusetts
William Francis Galvin, Secretary of the Commonwealth
Massachusetts Historical Commission

January 25, 2013

Andrew R. Poyant
CDM Smith, Inc.
50 Hampshire Street
Cambridge, MA 02139

RE: Comprehensive Wastewater Management Plan, Harwich, MA. MHC # RC.53649.

Dear Mr. Poyant:

Staff of the Massachusetts Historical Commission have reviewed the Project Notification Form (PNF), received January 14, 2013, for the project referenced above. The proposed project consists of comprehensive wastewater management planning for the Town of Harwich. New construction proposed as part of the phased project described in the PNF includes widening of the Muddy Creek Bridge, restoration of Hinkleys Pond, construction of a Wastewater Treatment Plant (HR-12) off Queen Anne Road, a 10-acre groundwater recharge facility (PB-3) of Halls Path, effluent recharge basins, 30 pump stations, and approximately 92 linear miles of sewer mains in Harwich.

The MHC understands that the proposed project will utilize federal funding through the State Revolving Fund administered by the Massachusetts DEP. The MHC will review the project under Section 106 of the National Historic Preservation Act of 1966, as amended (36 CFR 800), in consultation with the DEP. The project will also require MEPA review, and a copy of the draft Comprehensive Wastewater Management Plan and the Environmental Notification Form (ENF) and/or Environmental Impact Statement (EIS) should be submitted to the MHC when it is filed with the MEPA office.

The MHC proposes to review phased water supply, wastewater and stormwater management projects as they are designed. The submittal of information to the MHC should occur as early as possible, once a feasible location and design has been selected. The submittal should not wait until final plans are developed.

Project planners should submit scaled project plans showing existing and proposed conditions for the preferred alternative wastewater treatment plant location(s), recharge areas, pump stations, equipment storage and materials staging areas and cross-country sewer right-of-ways, for each phase of improvements or expansion projects. MHC review will assist to determine if any, as yet unidentified, historic and archaeological resources may be affected by project elements. For example, archaeological survey may be requested for project elements located in archaeologically sensitive areas.

The MHC is unable to determine if all proposed pumping stations will also be installed within roadways. If the above-ground pumping stations are in historically significant areas that are significant for their setting, then considerations should be made for the structure design, materials, massing, landscaping, etc. to avoid or minimize any adverse effects from the new construction.

220 Morrissey Boulevard, Boston, Massachusetts 02125
(617) 727-8470 • Fax: (617) 727-5128
www.sec.state.ma.us/mhc

Project planners should consult the Inventory of Historic and Archaeological Assets of the Commonwealth for identified historic and archaeological properties. The MHC's Inventory of Historic and Archaeological Assets of the Commonwealth (which includes current State Register listings) is available for research at our office, without an appointment, during normal business hours. Researchers should be aware, however, that consultation of the Inventory is not sufficient to identify all significant historic and archaeological resources that may be affected by a project (see 36 CFR 800.4).

These comments are offered to assist in compliance with Section 106 of the National Historic Preservation Act of 1966, as amended (36 CFR 800), Massachusetts General Laws, Chapter 9, Sections 26-27C (950 CMR 71) and MEPA (301 CMR 11). If you have questions or require additional information please contact Jonathan K. Patton at this office.

Sincerely,

Brona Simon

Brona Simon
State Historic Preservation Officer
Executive Director
State Archaeologist
Massachusetts Historical Commission

xc: James Merriam, Harwich Town Administrator
John Felix, DEP
DEP-SERO-DWPC
Secretary Richard K. Sullivan, Jr., EEA, Attn: MEPA Unit
Sara Korjeff, Cape Cod Commission
Harwich Conservation Commission
Harwich Historical Commission
Harwich Historic District Commission

April 4, 2013

Richard K. Sullivan, Jr., Secretary
Executive Office of Energy and Environmental Affairs
Attention: MEPA Office
Anne Canaday, EEA No. 15022
100 Cambridge St.
Boston, Massachusetts 02114

Project Name:	*Draft Comprehensive Wastewater Management Plan*
Proponent:	*James Merriam, Town Administrator, Town of Harwich*
Location:	*Various locations throughout Harwich and Chatham*
Document Reviewed:	*Expanded Environmental Notification Form* (EENF) *and Draft Comprehensive Wastewater Management Plan* (CWMP)
EEA No.:	*15022*
NHESP No.:	*11-29877*

Dear Secretary Sullivan:

The Natural Heritage & Endangered Species Program of the Massachusetts Division of Fisheries & Wildlife (the "Division") has received and reviewed the proposed *Expanded Environmental Notification Form* and *Draft Comprehensive Wastewater Management Plan* for the Town of Harwich and would like to offer the following comments regarding state-listed species and their habitats.

The ponds, bays, and estuarine waters of Harwich's south and east coasts provide critical foraging, breeding, migration, and over-wintering habitats for a suite of state-listed rare species. We commend the Proponent for its efforts to improve water quality within these critical habitats.

Portions of the Town of Harwich are mapped as *Priority* and *Estimated Habitat* for state-listed species, which are protected pursuant to the Massachusetts Endangered Species Act (M.G.L. c. 131A) and its implementing regulations (MESA; 321 CMR 10.00) as well as the Massachusetts Wetlands Protection Act and its implementing regulations (WPA; 310 CMR 10.37, 10.58(4)(b), and 10.59). Based on a review of the information that was submitted and the information that is contained in our database, the Division anticipates that portions of the proposed project will occur within the habitat of various state-listed invertebrate, vertebrate, and plant species.

Portions of the proposed project that occur within *Priority* or *Estimated Habitat* for state-listed species, which are not otherwise exempt from MESA review pursuant to 321 CMR 10.14, will require a direct filing with the Division for compliance with the MESA and WPA. The Division notes that sewer systems proposed within ten (10) feet of the edge of existing paved roads may be exempt from MESA review, pursuant to 321 CMR 10.14 (10), which states: "[t]he following Projects and Activities shall be exempt from the requirements of 321 CMR 10.18 through 10.23…"

[10] installation, repair, replacement, and maintenance of utility lines (gas, water, sewer, phone, electrical) for which all associated work is within ten feet from the edge of existing paved roads, and the repair and maintenance of overhead utility lines (phone, electrical) for which all associated work is within ten feet from the edge of existing unpaved roads, provided, however, that unpaved utility access roads associated with exempt activities under 321 CMR 10.14(11) shall be addressed in and subject to the Division-approved operation and maintenance plan required thereunder;

The complete list of MESA filing exemptions may be found on the Division's website.

The Division would encourage the Proponent to examine design alternatives which avoid and minimize impacts to *Priority* and *Estimated Habitat*, and to consider a pre-filing consultation with the Division to evaluate and proactively address any concerns related to state-listed species. Upon submission of more detailed site plans, the Division will be able to provide additional guidance.

If you have any questions about this letter, please contact me at 508-389-6386 or jesse.leddick@state.ma.us. We appreciate the opportunity to comment on this project and look forward to working with the Proponent to proactively address any potential concerns related to state-listed species.

Sincerely,

Thomas W. French, Ph.D.
Assistant Director

cc: James Merriam, Town Administrator
Town of Harwich Board of Selectmen
Town of Harwich Conservation Commission
Town of Harwich Planning Department
Andrew Poyant, CDM Smith Inc.

December 16, 2015

Magdalena Lofstedt
Camp Dresser & McKee, Inc.
50 Hampshire Street
Cambridge MA 02139

RE: Project Location: Dundee Circle
Town: HARWICH
NHESP Tracking No.: 11-29877

To Whom It May Concern:

Thank you for contacting the Natural Heritage and Endangered Species Program of the MA Division of Fisheries & Wildlife (the "Division") for information regarding state-listed rare species in the vicinity of the above referenced site. Based on the information provided, this project site, or a portion thereof, is located **within** *Priority Habitat 1424* (PH 1424) and *Estimated Habitat 19* (EH 19) as indicated in the *Massachusetts Natural Heritage Atlas* (13th Edition). Our database indicates that the following state-listed rare species have been found in the vicinity of the site:

Scientific name	**Common Name**	**Taxonomic Group**	**State Status**
Terrapene carolina	Eastern Box Turtle	Reptile	Special Concern

The species listed above is protected under the Massachusetts Endangered Species Act (MESA) (M.G.L. c. 131A) and its implementing regulations (321 CMR 10.00). State-listed wildlife are also protected under the state's Wetlands Protection Act (WPA) (M.G.L. c. 131, s. 40) and its implementing regulations (310 CMR 10.00). Fact sheets for most state-listed rare species can be found on our website (www.mass.gov/nhesp).

Please note that projects and activities located within Priority and/or Estimated Habitat **must** be reviewed by the Division for compliance with the state-listed rare species protection provisions of MESA (321 CMR 10.00) and/or the WPA (310 CMR 10.00).

Wetlands Protection Act (WPA)

If the project site is within Estimated Habitat and a Notice of Intent (NOI) is required, then a copy of the NOI must be submitted to the Division so that it is received at the same time as the local conservation commission. If the Division determines that the proposed project will adversely affect the actual Resource Area habitat of state-protected wildlife, then the proposed project may not be permitted (310 CMR 10.37, 10.58(4)(b) & 10.59). In such a case, the project proponent may request a consultation with the Division to discuss potential project design modifications that would avoid adverse effects to rare wildlife habitat.

A streamlined joint MESA/WPA review process is available. When filing a Notice of Intent (NOI), the applicant may file concurrently under the MESA on the same NOI form and qualify for a 30-day streamlined joint review. For a copy of the NOI form, please visit the MA Department of Environmental Protection's website: http://www.mass.gov/dep/water/approvals/wpaform3.doc.

MA Endangered Species Act (MESA)

If the proposed project is located within Priority Habitat and is not exempt from review (see 321 CMR 10.14), then project plans, a fee, and other required materials must be sent to Natural Heritage Regulatory Review to determine whether a probable "take" under the MA Endangered Species Act would occur (321 CMR 10.18). Please note that all proposed and anticipated development must be disclosed, as MESA does not allow project segmentation (321 CMR 10.16). For a MESA filing checklist and additional information please see our website: www.mass.gov/nhesp ("Regulatory Review" tab).

We recommend that rare species habitat concerns be addressed during the project design phase prior to submission of a formal MESA filing, as avoidance and minimization of impacts to rare species and their habitats is likely to expedite endangered species regulatory review.

This evaluation is based on the most recent information available in the Natural Heritage database, which is constantly being expanded and updated through ongoing research and inventory. If the purpose of your inquiry is to generate a species list to fulfill the federal Endangered Species Act (16 U.S.C. 1531 et seq.) information requirements for a permit, proposal, or authorization of any kind from a federal agency, we recommend that you contact the National Marine Fisheries Service at (978)281-9328 and use the U.S. Fish and Wildlife Service's Information for Planning and Conservation website (https://ecos.fws.gov/ipac). If you have any questions regarding this letter please contact Emily Holt, Endangered Species Review Assistant, at (508) 389-6385.

Sincerely,

Thomas W. French

Thomas W. French, Ph.D.
Assistant Director

December 16, 2015

Magdalena Lofstedt
Camp Dresser & McKee, Inc.
50 Hampshire Street
Cambridge MA 02139

RE: Project Location: 0 Pleasant Bay Road
Town: HARWICH
NHESP Tracking No.: 11-29877

To Whom It May Concern:

Thank you for contacting the Natural Heritage and Endangered Species Program of the MA Division of Fisheries & Wildlife (the "Division") for information regarding certified vernal pools and state-listed rare species in the vicinity of the above referenced site. Based on the information provided, Certified Vernal Pool 355 is located on the site, and this project site, or a portion thereof, is located **within** *Priority Habitat 269* (PH 269) and *Estimated Habitat 162* (EH 162) as indicated in the *Massachusetts Natural Heritage Atlas* (13th Edition). Our database indicates that the following state-listed rare species have been found in the vicinity of the site:

Scientific name	Common Name	Taxonomic Group	State Status
Terrapene carolina	Eastern Box Turtle	Reptile	Special Concern

The species listed above is protected under the Massachusetts Endangered Species Act (MESA) (M.G.L. c. 131A) and its implementing regulations (321 CMR 10.00). State-listed wildlife are also protected under the state's Wetlands Protection Act (WPA) (M.G.L. c. 131, s. 40) and its implementing regulations (310 CMR 10.00). Fact sheets for most state-listed rare species can be found on our website (www.mass.gov/nhesp).

Please note that <u>projects and activities located within Priority and/or Estimated Habitat **must** be reviewed by the Division</u> for compliance with the state-listed rare species protection provisions of MESA (321 CMR 10.00) and/or the WPA (310 CMR 10.00).

Wetlands Protection Act (WPA)

If the project site is within Estimated Habitat and a Notice of Intent (NOI) is required, then a copy of the NOI must be submitted to the Division so that it is received at the same time as the local conservation commission. If the Division determines that the proposed project will adversely affect the actual Resource Area habitat of state-protected wildlife, then the proposed project may not be permitted (310 CMR 10.37, 10.58(4)(b) & 10.59). In such a case, the project proponent may request a consultation with the Division to discuss potential project design modifications that would avoid adverse effects to rare wildlife habitat.

A streamlined joint MESA/WPA review process is available. When filing a Notice of Intent (NOI), the applicant may file concurrently under the MESA on the same NOI form and qualify for a 30-day streamlined joint review. For a copy of the NOI form, please visit the MA Department of Environmental Protection's website: http://www.mass.gov/dep/water/approvals/wpaform3.doc.

MA Endangered Species Act (MESA)

If the proposed project is located within Priority Habitat and is not exempt from review (see 321 CMR 10.14), then project plans, a fee, and other required materials must be sent to Natural Heritage Regulatory Review to determine whether a probable "take" under the MA Endangered Species Act would occur (321 CMR 10.18). Please note that all proposed and anticipated development must be disclosed, as MESA does not allow project segmentation (321 CMR 10.16). For a MESA filing checklist and additional information please see our website: www.mass.gov/nhesp ("Regulatory Review" tab).

We recommend that rare species habitat concerns be addressed during the project design phase prior to submission of a formal MESA filing, as avoidance and minimization of impacts to rare species and their habitats is likely to expedite endangered species regulatory review.

This evaluation is based on the most recent information available in the Natural Heritage database, which is constantly being expanded and updated through ongoing research and inventory. If the purpose of your inquiry is to generate a species list to fulfill the federal Endangered Species Act (16 U.S.C. 1531 et seq.) information requirements for a permit, proposal, or authorization of any kind from a federal agency, we recommend that you contact the National Marine Fisheries Service at (978)281-9328 and use the U.S. Fish and Wildlife Service's Information for Planning and Conservation website (https://ecos.fws.gov/ipac). If you have any questions regarding this letter please contact Emily Holt, Endangered Species Review Assistant, at (508) 389-6385.

Sincerely,

Thomas W. French

Thomas W. French, Ph.D.
Assistant Director