Barnstable Water Resources Protection

Special Town Council Workshop:
Comprehensive Wastewater Management Plan
Problem and History

June 13, 2024
Town Hall Hearing Room

Town of Barnstable
Department of Public Works

Agenda

Problem Review

Water Resources Advisory Committee (2016 – 2019)

- Teams
- Planning Process
- Needs
- Potential Solutions
  - Science
  - Traditional
  - Non-Traditional
  - Management
- Plan

Questions

Traditional Wastewater Problems

Wastewater issues

- Impaired embayments
- Groundwater quality concerns
- Pond water quality concerns
- Failing/expensive septic systems
- Economic development requirements
- New flood zones
- Regulatory requirements

The “208” Problem - Nitrogen

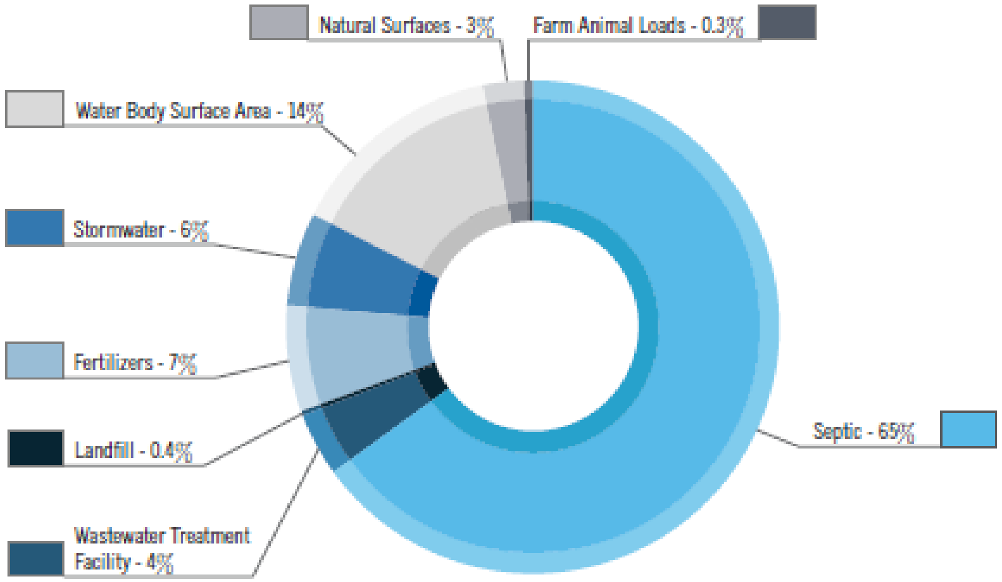
Impacts marine waters

- Limiting nutrient

Origins

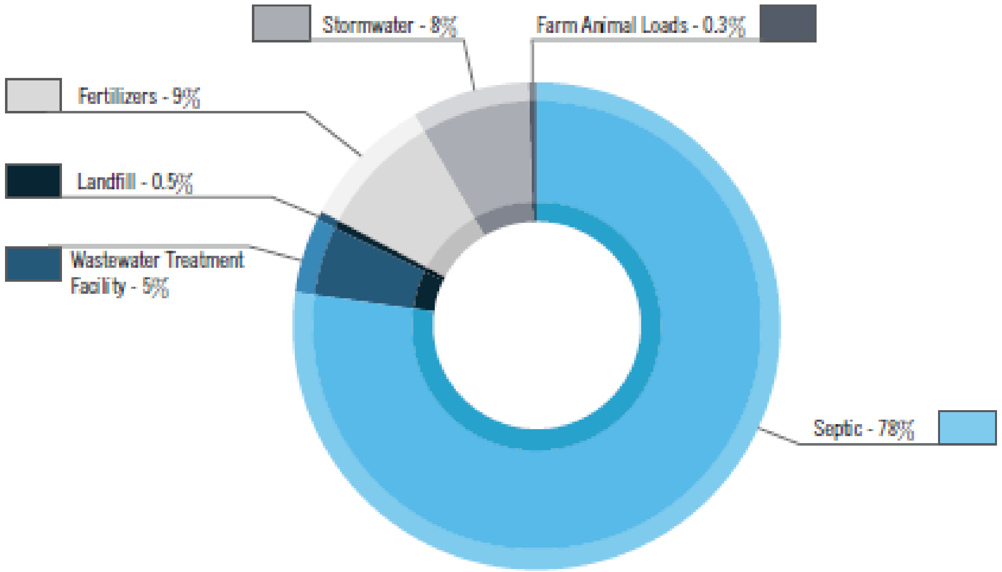
- Septic systems
- Fertilizer runoff
- Stormwater disposal
- Atmospheric deposition
- Sediment release

Sources of Nitrogen



Total Nitrogen Sources by Percentage

Figure 2-19

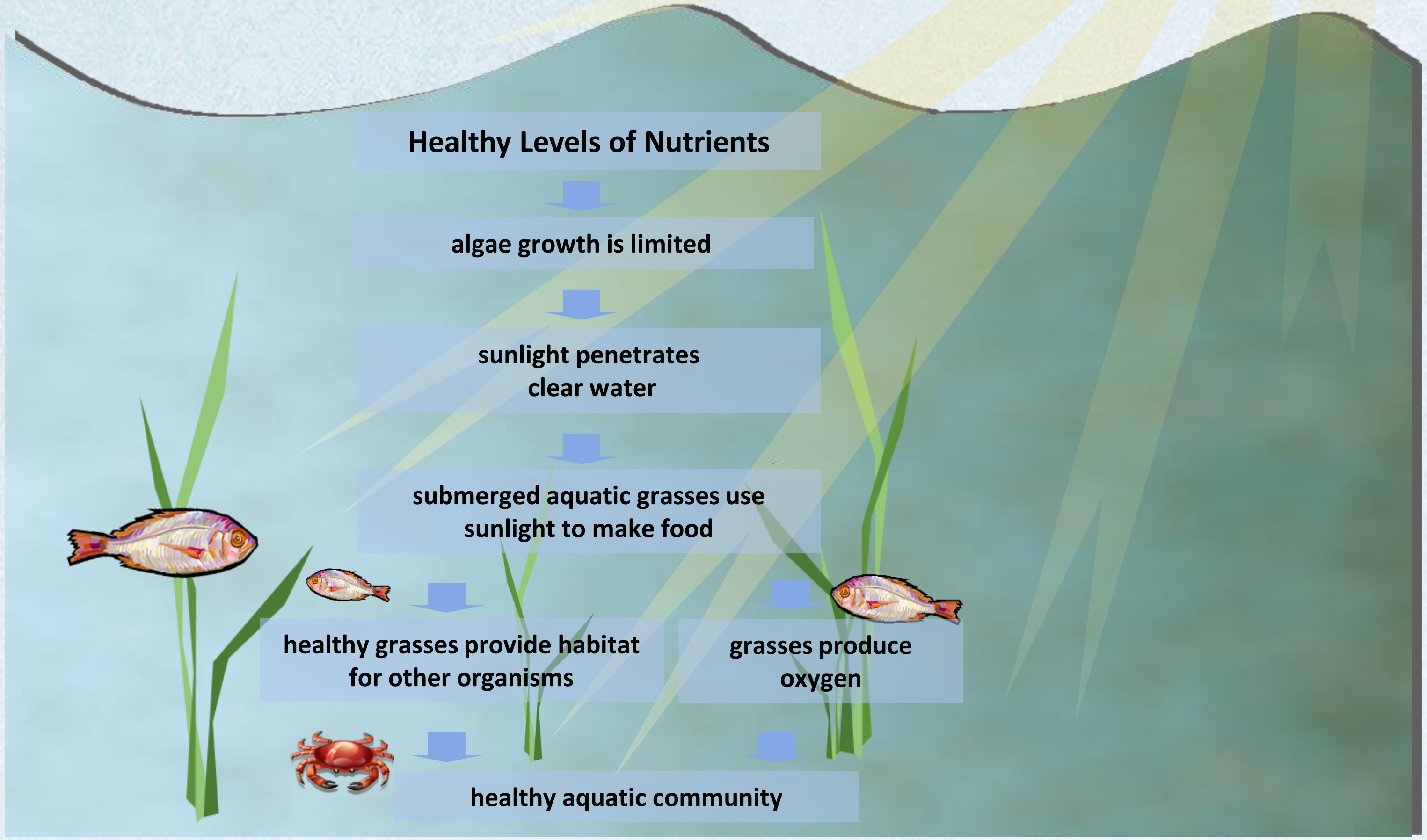


Controllable Nitrogen Sources by Percentage

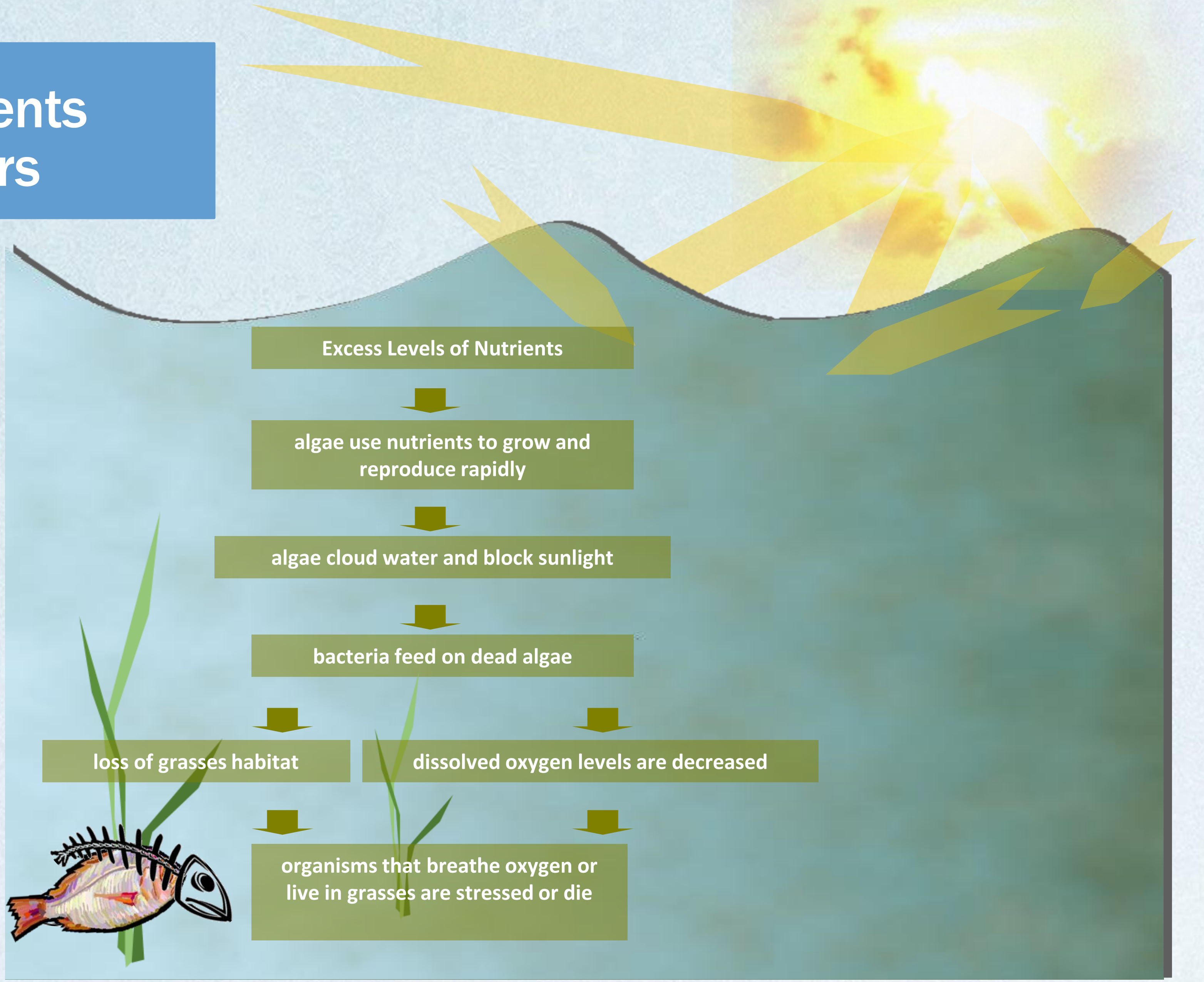
Figure 2-20

Source: Cape Cod Area Wide Water Quality Management Plan Update, 208 Plan; Cape Cod Commission; June 2015

Effects of nutrients in coastal waters



Effects of nutrients in coastal waters



Regulations

Massachusetts Estuaries Program (MEP)

- MA DEP & UMASS-Dartmouth
- 89 estuaries southeast MA
- Watershed/estuary model
  - predicts water quality changes resulting from land use decisions

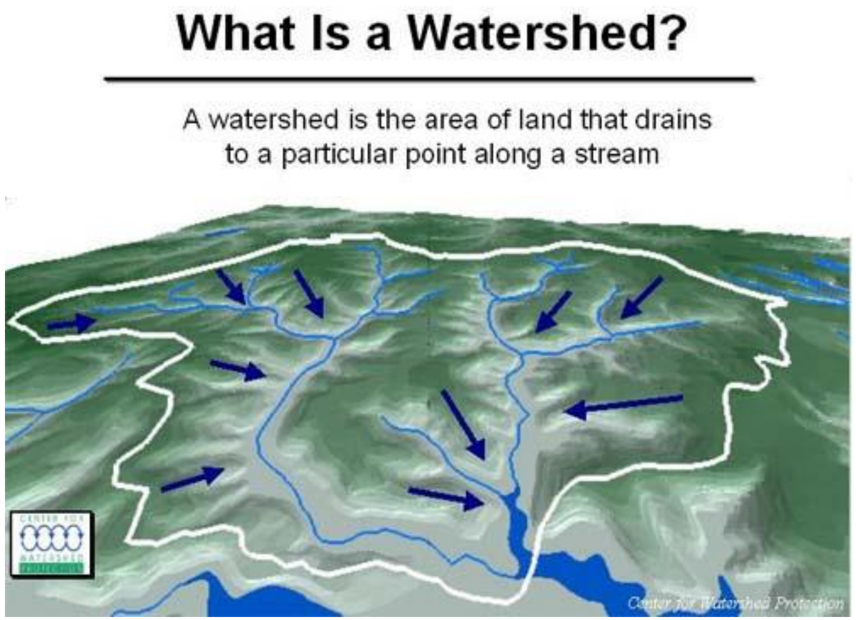
DEP develops **TMDLs**

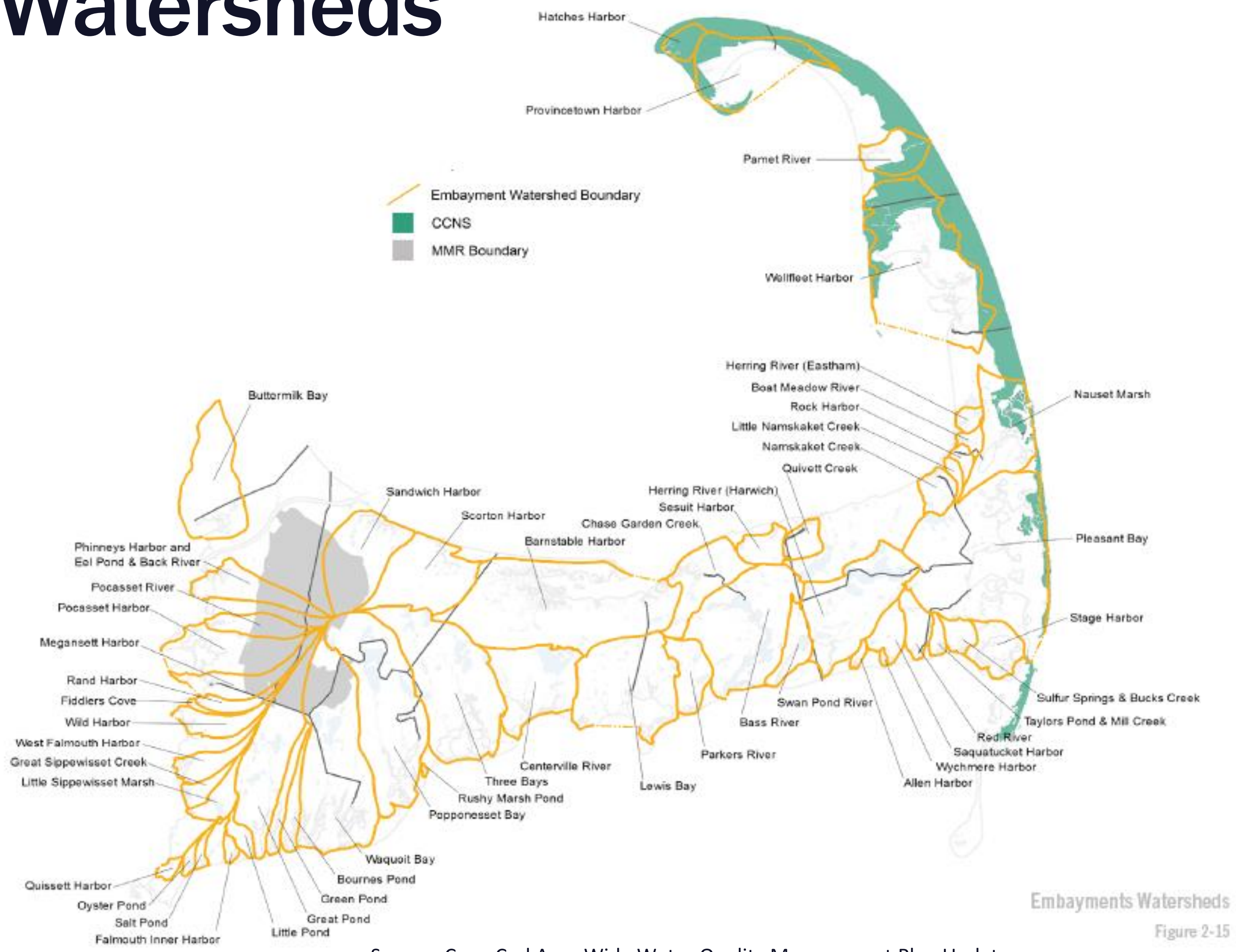
- Total Maximum Daily Loads
  - Max pollutant a water body can receive and still meet water quality standards

Eelgrass is the sentinel species

Cape Divided by watersheds

Watersheds





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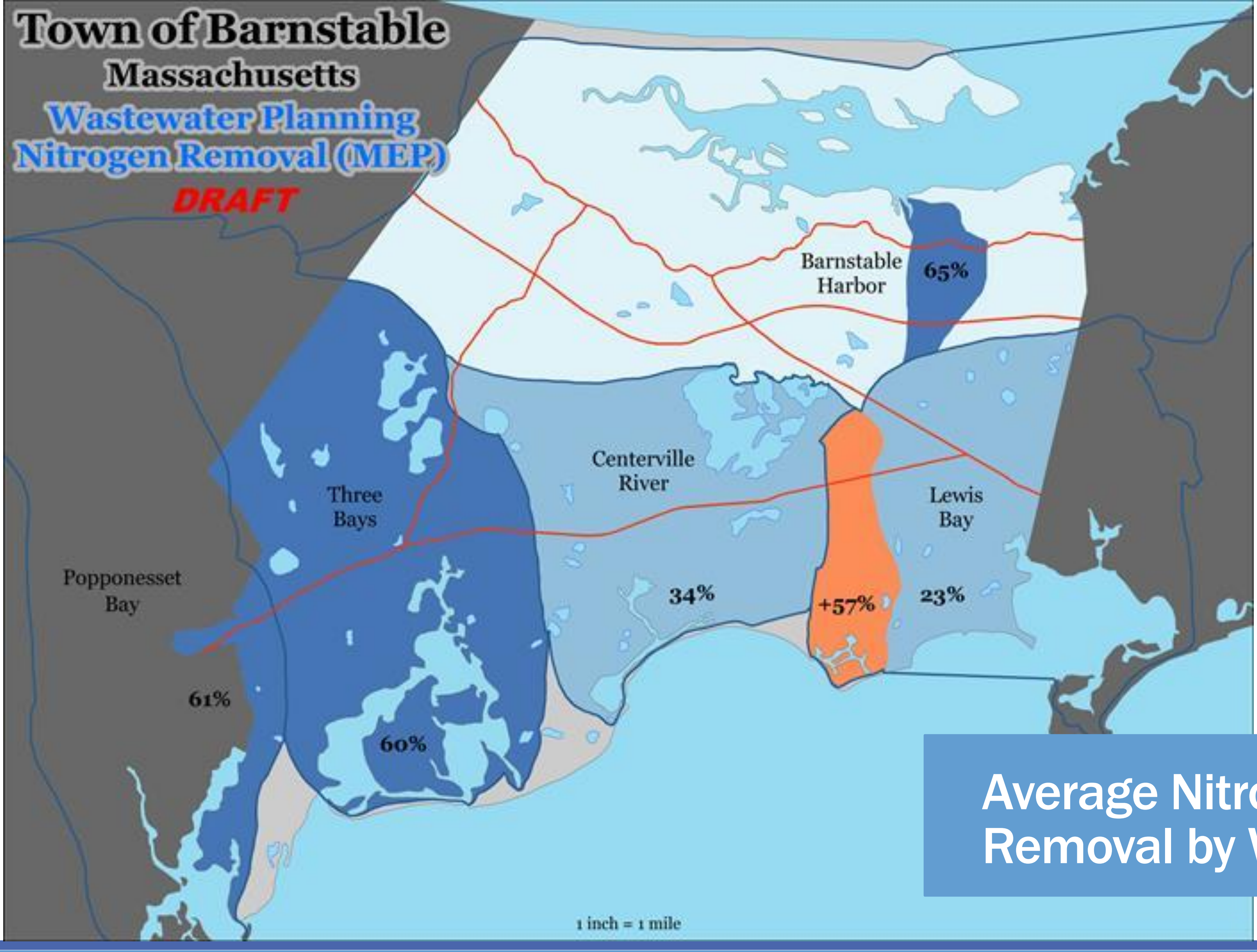
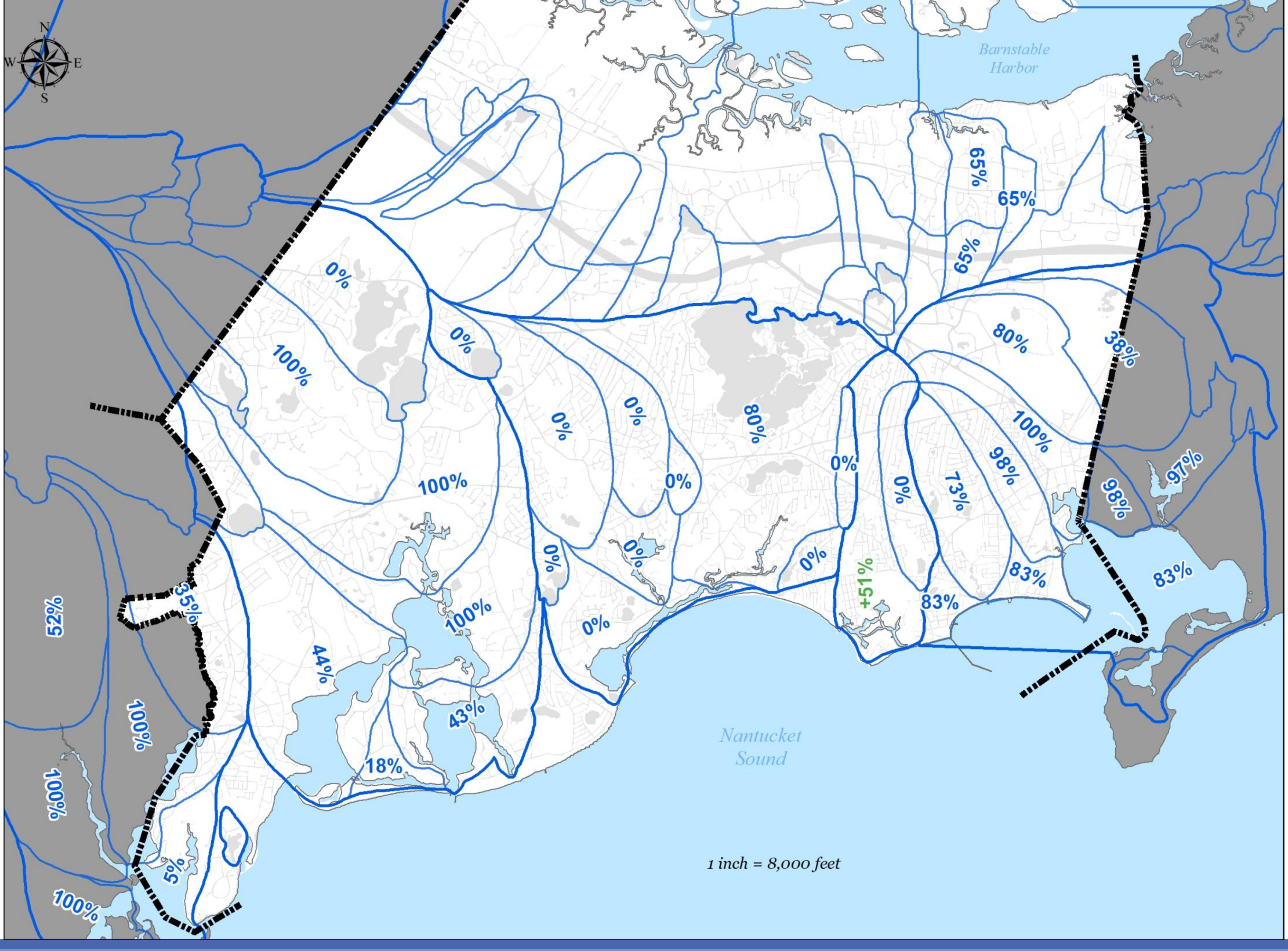


Average Nitrogen Removal by Watershed


N
S
E
W
Barnstable Harbor
Nantucket Sound
1 inch = 8,000 feet
65%
65%
65%
0%
100%
0%
100%
0%
0%
80%
80%
38%
0%
0%
100%
98%
0%
73%
97%
98%
0%
0%
0%
+51%
83%
83%
83%
35%
52%
100%
0%
44%
43%
18%
100%
100%
5%
100%

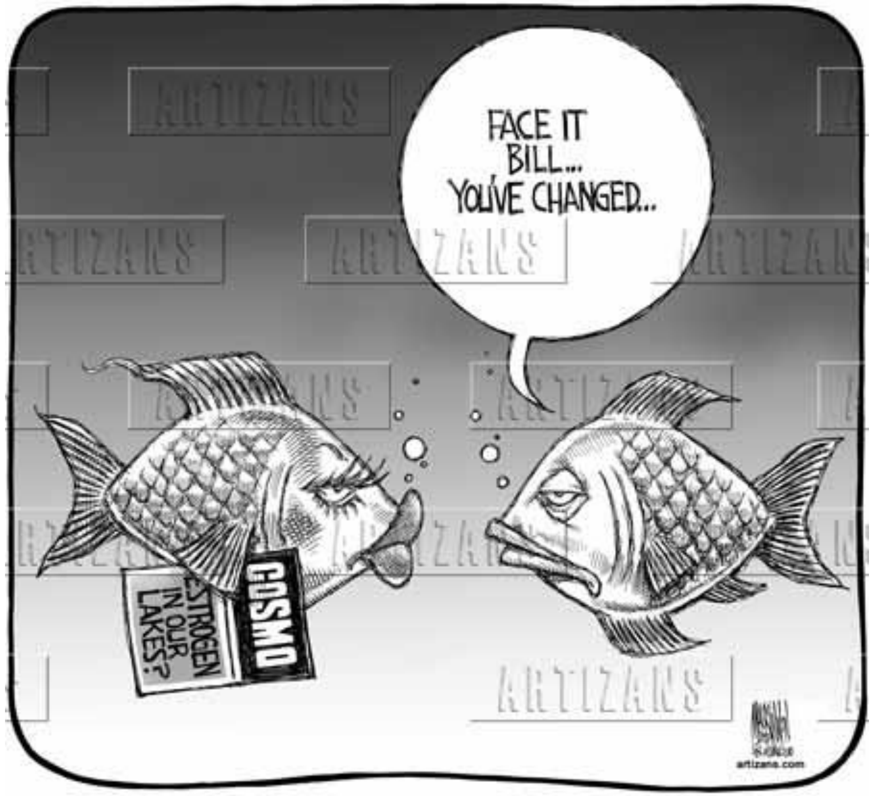
Other Issues of Concern

Phosphorus in freshwater ponds

Contaminants of Emerging Concern (CECs)

- Pharmaceuticals
- Antibiotics
- Hormones
- Personal care products
- Chemicals
- Micro Plastics

PFOS/PFOA



Fundamental Question

I/A septic systems?

"On which properties is a traditional (Title V) on-site wastewater system an adequate means of providing for the Town's sanitation and environmental protection, and on which properties is it not?"

Water Resources Advisory Committee (WRAC)

Wastewater Planning Teams

WRAC (2015 – 2017) members included:

- Councilor John Flores
- Councilor Frederick Chirigotis
- Councilor John Norman
- Lindsey Counsell (served as the Committee Chair)
- Michael Moynihan (served as the Committee Vice Chair)
- Phillip Boudreau
- Casey Dannhauser
- Fred Dempsey
- Ed Eichner
- Farley Lewis
- George Zoto

Wastewater Planning Teams

Town staff members included:

- Mark Ells, Town Manager
- Andrew Clyburn, P.E., Assistant Town Manager
- Daniel Santos, P.E., DPW Director
- Mark Milne, Finance Director
- Elizabeth Jenkins, Planning and Development Director
- Rob Steen, P.E., DPW Assistant Director
- Griffin Beaudoin, P.E., Town Engineer
- Amanda Ruggiero, P.E., Assistant Town Engineer
- Andrew Boule, Water Pollution Control Supervisor
- Matthew Sumner, Engineering Records and Asset Manager
- Miroslav Jakubicka, Engineering Designer
- Dale Saad, Ph.D., Senior Project Manager – Special Projects
- Casey Scrima, Engineering Aide I
- Cynthia Lovell, Administrator to the Town Council
- Jim Benoit, GIS Manager

Other Organizations Involved in Planning

- Department of Environmental Protection
- Barnstable Clean Water Coalition
- UMASS Dartmouth School for Marine Science and Technology (SMAST)
- Association to Preserve Cape Cod (APCC)

Leadership Input

Weekly Meetings

- Town Council President – Jim Crocker
- Town Council Vice President – John Flores
- Town Manager – Mark Ells
- Assistant Town Manager – Andy Clyburn
- Finance Director – Mark Milne
- Legal – Ruth Weil, Charlie McLaughlin
- DPW Director – Dan Santos, P.E.
- DPW Assistant Director – Rob Steen, P.E.
- Town Engineer – Griffin Beaudoin, P.E.

Actions taken

- Winter 2015/16 formed the WRAC – Began meeting
- June 2016 – Complete the "208 Bookends"
- Fall 2016 - Completed Gap filling and GIS Mapping Layers
- Winter 2016 through Spring 2017 - Plan Construction
- Summer 2017 – Complete a Draft Plan
- Summer 2017 – Present Draft Plan to Town Council
- Fall/Winter 2017 & Winter/Spring 2018 – Develop the alternatives approach on Marstons Mills River
- Fall/Winter 2017 – Conceptually design, and propose for funding, initial round of Traditional Solution Projects
- Winter 2018 – Evaluation of Marstons Mills School Wastewater Facility
- Winter/Spring 2018 – Meet with DEP on Permitting of Alternatives
- Spring 2018 – Approved Funding for Preliminary Design of initial Traditional Solution Projects
- Spring 2018 – Approved Funding for Evaluation of Wastewater Disposal Alternatives
- Spring 2018 - Began sampling to support permitting for Alternatives
- Spring 2018 – Began modeling WPCF (BIOWIN)
- Summer 2018 – Began Preliminary Design of initial Traditional Solution Projects
- Summer 2018 – Begin Evaluation of Wastewater Disposal Alternatives
- Summer 2018 – Renewal of WPCF License
- Summer /Fall 2018-Construction of the Attucks Lane Pump Station
- Summer/Fall 2018 – Begin Public Outreach and Feedback
- Fall/Winter 2018 – Dredging of Sampson's Island - Phase I – flushing in Three Bays
- Winter 2018/19 – Understand Financial Options/Opportunities
- Spring 2019 – Present "Final Draft" Plan to Town Council
- Fall 2019 – Present Final Draft CWMP to Town Council
- Fall 2019 - Submit Final Draft CWMP to CCC for review
- Fall 2019 – Draft CWMP to DEP
- Fall 2019 - MEPA review
- December 30, 2020 - Certificate of the Secretary of Energy and Environmental Affairs on the Single Environmental Impact Report (SEIR)
- January 8, 2021 - Certificate of the Secretary of Energy and Environmental Affairs Establishing a Special Review Procedure – January 8, 2021
- April 16, 2021 – Cape Cod Commission Final 208 Consistency Determination

Process of Wastewater Planning

“5 Needs” Plans Should Address

Sanitary Needs

- Poor Soils
- Variances
- High groundwater

Convenience and Aesthetics

- Excessively Expensive Systems
- Mounded Systems
  - Impact on Village Aesthetics

Protecting Groundwater and Water Supplies

- Nitrogen
- CECs

Protecting Surface Waters

- Nutrients

Enabling Desired Sustainable Economic Growth

What a CWMP Does

Town-wide comprehensive plan that:

- Identifies water quality requirements
- Identifies solutions
  - Nontraditional
  - Traditional
  - Management
- Recommends capital improvements
- Identifies funding/financing mechanisms

How a CWMP is Organized

4 Phases

- Needs Assessment
- Evaluation of Alternatives
- Development of a Plan
- Environmental Notification and Form Filing

Phases of a CWMP

Table 1-1: The Phases of the CWMP

PHASE	TASKS

Phase I: Needs Assessment	• Document property type, seasonality, land use, soil conditions, watersheds and environmentally sensitive areas
	• Document existing water quality in each watershed
	• Identify the water use for each of the parcels
	• Formulate a GIS Tool for parcels that evaluates:
	  • Sanitary Conditions/Identified public health issues
	    • excessively or poorly draining soils
	    • high groundwater
	    • failed septic systems
	    • lot density
	    • inadequate set-back from private wells/property lines
	    • Title 5 variances
	    • Flood Zones
	  • Water Supply Protection
	    • Identified "impaired" or endangered wells and neighborhoods likely impacting them
	  • Surface Waters - Nutrient Enrichment
	    • Marine – SMAST Modeling and CCC 208
	    • Freshwater – Town sampling and study of ponds
	  • Convenience and Aesthetic Issues
	    • Identified Mounded septic systems, velocity zones, and excessive septage pumping
	  • Wastewater needs to allow Sustainable Economic Development
	• Identify existing municipal and private wastewater infrastructure
	• Identify requirements and collaboration potential with adjoining towns that share watersheds with Barnstable

Phase II: Identification, Screening, and Evaluation of Alternatives	• Using the CCC 208 Plan Chapter 4, identify all technically feasible options to address the wastewater needs
	  o Traditional and non-traditional alternatives
	  o Structural and non-structural alternatives
	• Compare alternatives with respect to the following factors:
	  o Efficacy of the solution and probability of success
	  o Proximity of the issue to existing infrastructure
	  o Capital and operations and maintenance costs
	  o Speed of impact on the problem
	  o Ability of the solution to address more than one wastewater need
	  o Perceived public and political perception and acceptance
	• Meet with adjoining towns that share watersheds with Barnstable to identify synergies

Phase III: Formulation of Plan	• Identify the best alternative or combinations of alternatives for each sub-watershed and watershed • Craft a plan and schedule for implementation • Prepare conceptual designs of traditional and nontraditional components • Develop capital cost estimates • Develop financial strategy and impacts on users and non-users • Consult with the public through workshops, hearings and reports • Submit Draft CWMP Table of Contents to DEP for review • Submit Draft CWMP to DEP for review
Phase IV: MEPA and CCC Reviews	• Prepare Environmental Notification Form and Environmental Impact Reports • File Request for Cape Cod Commission 208 Consistency • Respond to comments

“Adapting and Changing”

The Plan is Changing

Needs to meet regulatory requirements

Flexible

- In house staff leads consultant
- Able to adapt to changes in technology

Adapting to community needs and desires

- Public feedback from presentations and Political Leaders

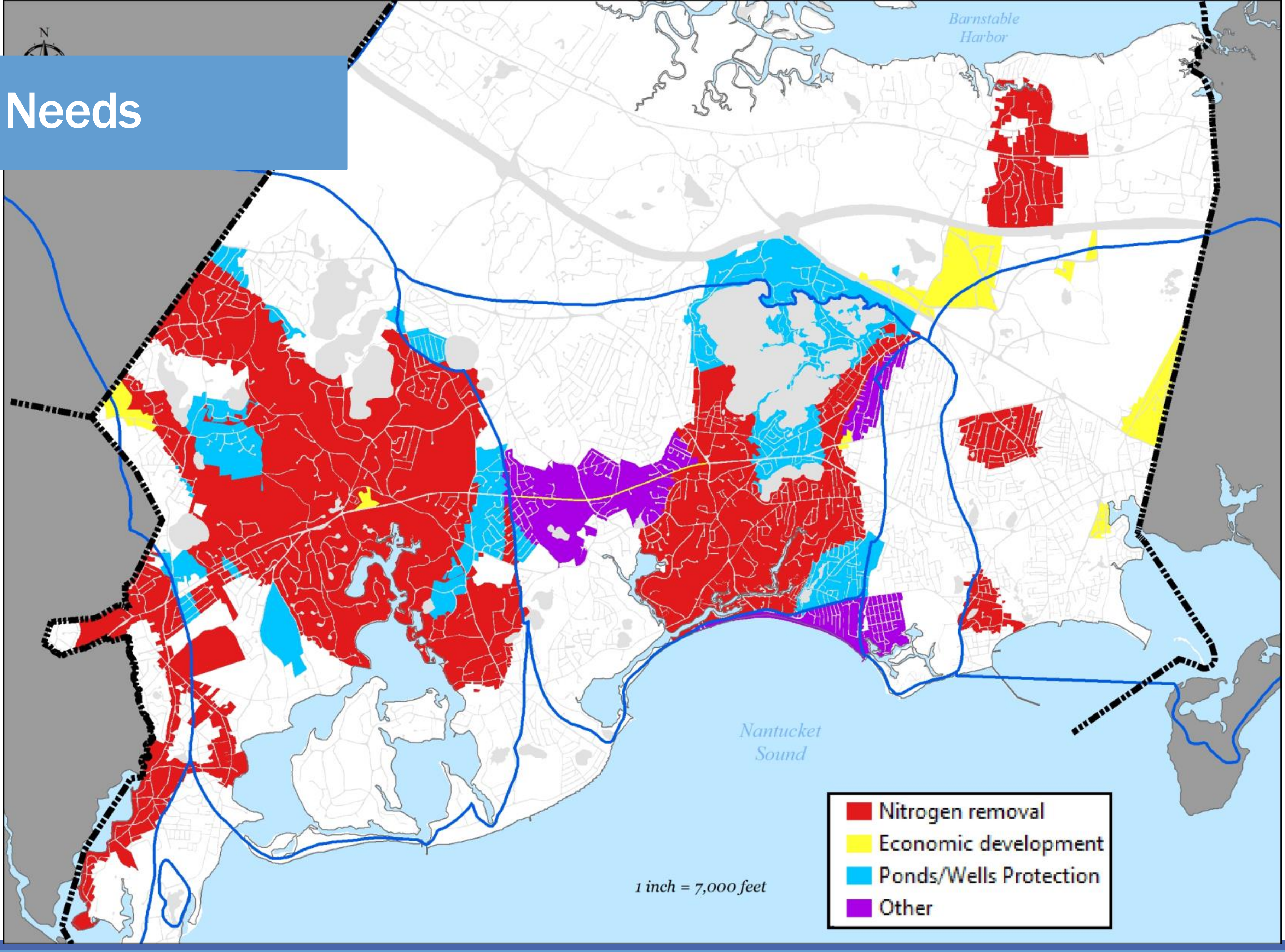
The Town of Barnstable Needs Process

Collaboration of WRAC Members, Town Staff, and DEP

A lot-by-lot evaluation of the “5 Needs” using GIS tool

- Sanitary Conditions/Identified public health issues
  - bad soils/high groundwater
  - effluent surfacing over leaching field
  - Inadequate set-back from private wells/property lines
  - direct discharge of sanitary wastewater to a water body
- Water Supply Protection
  - Identified “impaired” or endangered wells and neighborhoods likely impacting them
- Surface Waters - Nutrient Enrichment
  - Marine – SMAST Modeling and CCC 208
  - Freshwater – TOB sampling and study of ponds
- Convenience and Aesthetic Issues
  - Identified Mounded septic systems , velocity zones, and excessive septage pumping
- Sustainable Economic Development
  - Met with Planning, and others, to understand where wastewater solutions needed for community chosen economic development

Identified Needs



Potential Solutions

Solutions

Traditional

- Collection - Sewers
- Centralized Treatment and Disposal

Nontraditional

- I/As
- Dredging
- Aquaculture
- PRBs
- Fertigation
- Alternative toilets
- etc.

Management

- Flow and Load Reduction Regulations
- Zoning
- Fertilizer Management , etc.

Traditional Wastewater Treatment
How Does it Work?

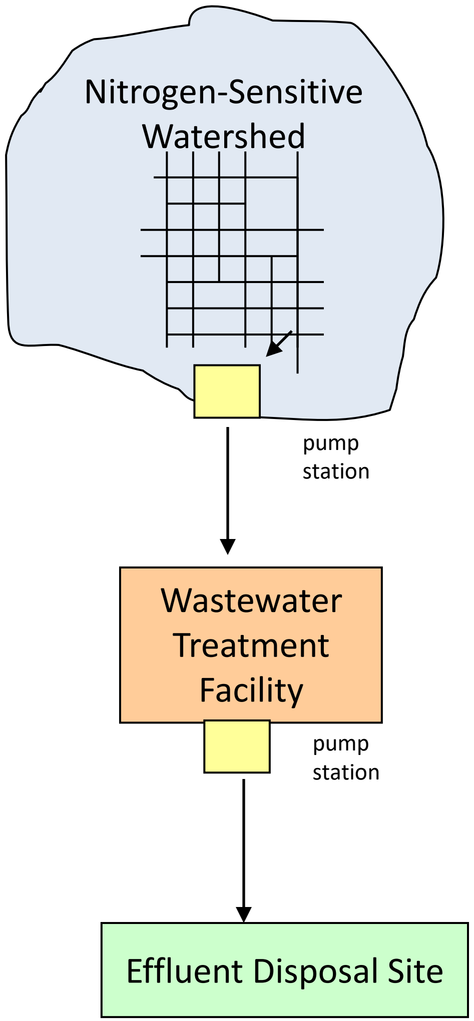
Collection

Transport to Treatment

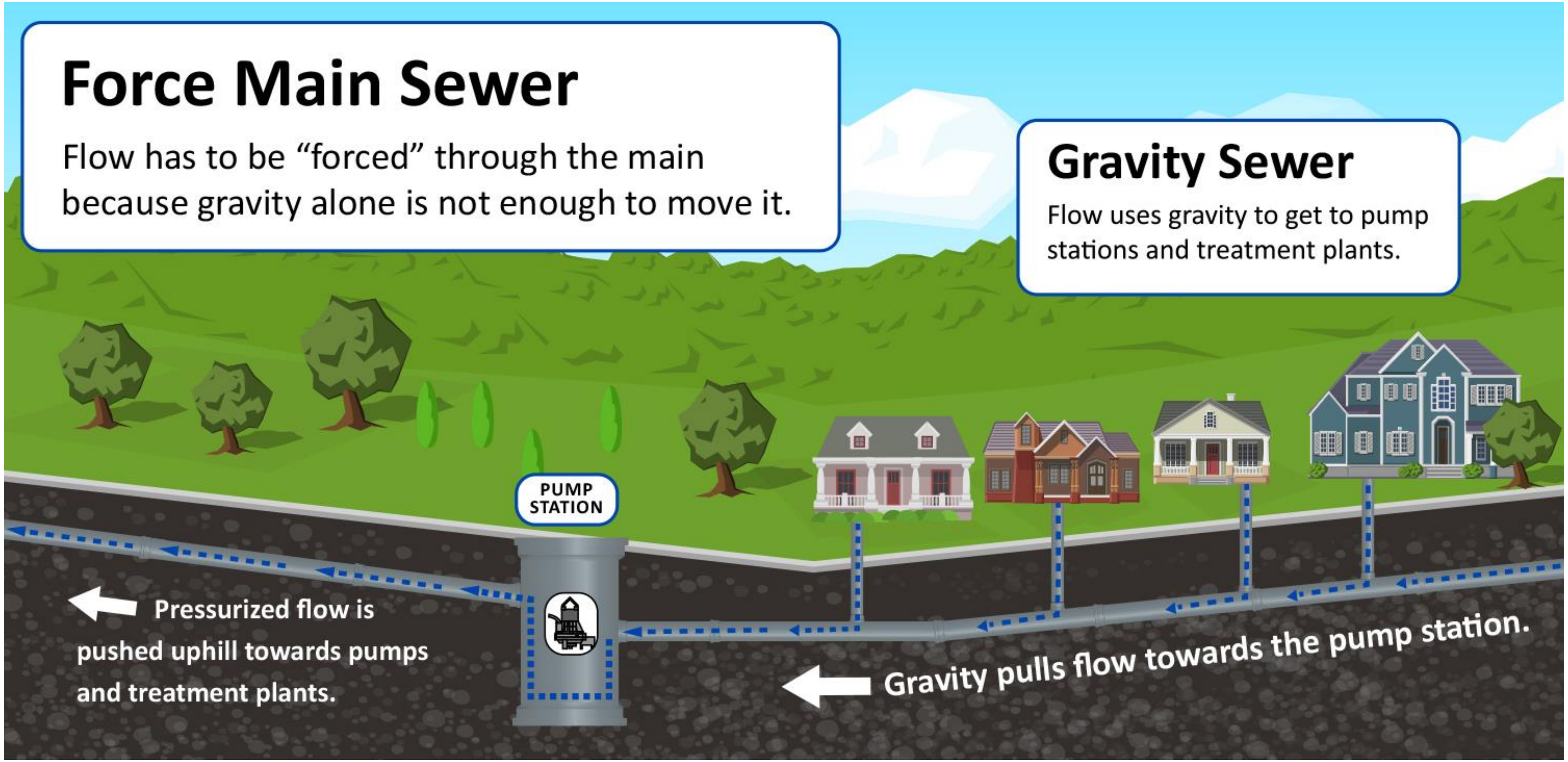
Treatment

Transport to Disposal

Disposal

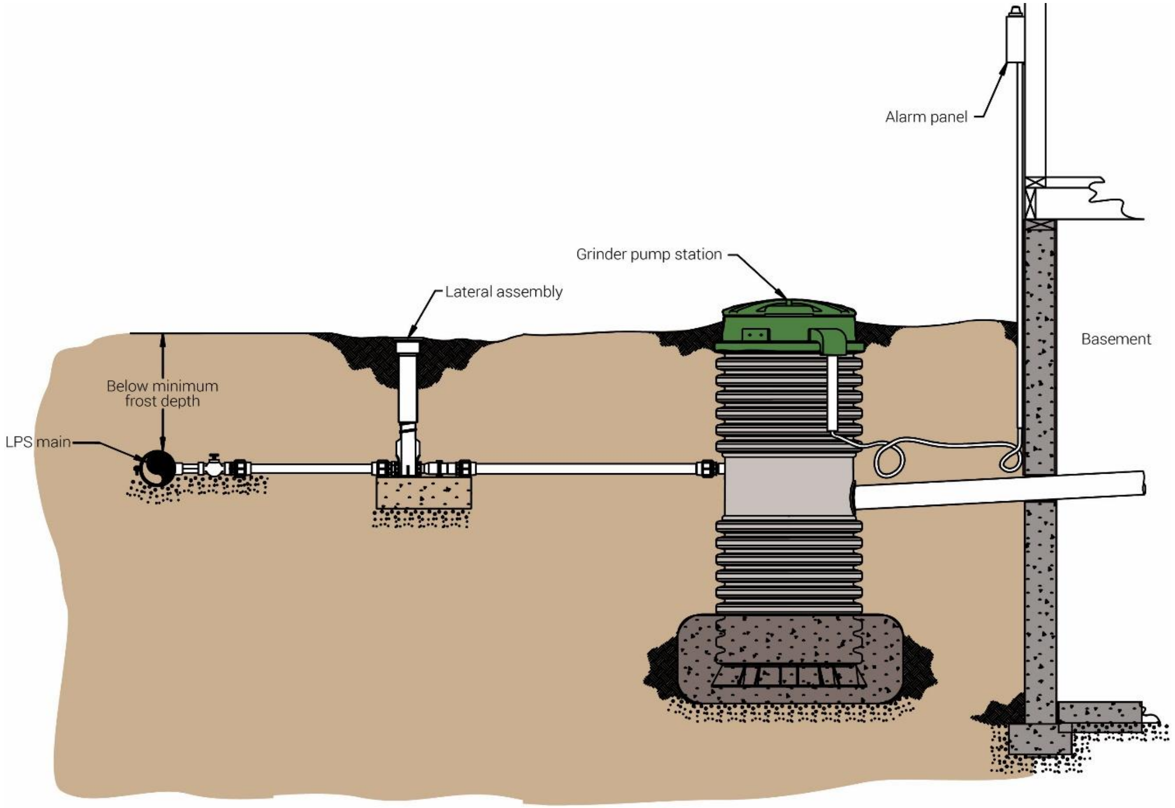


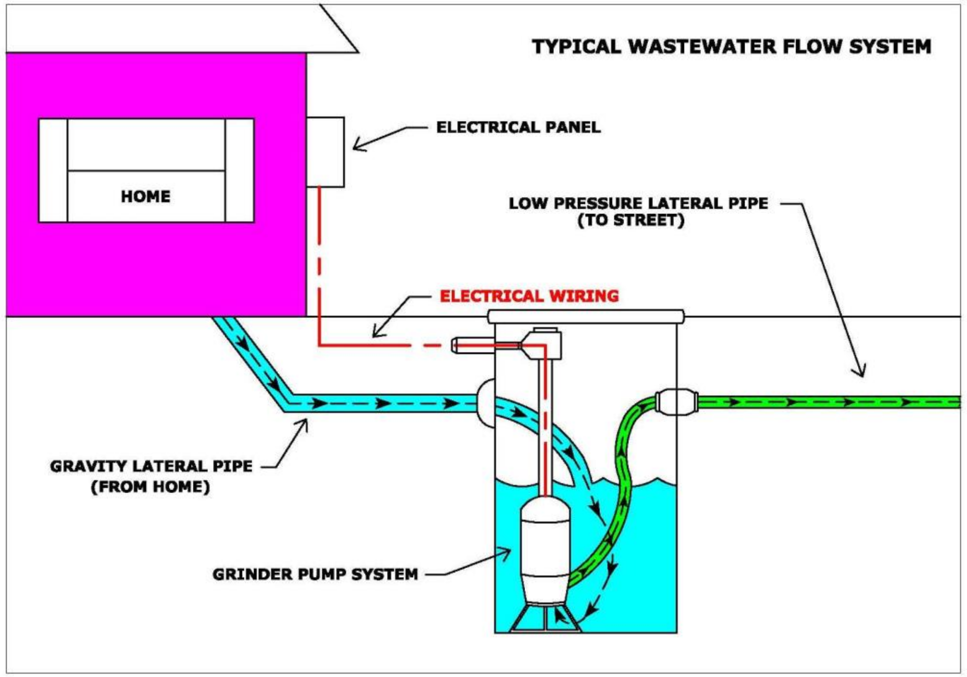
Traditional Wastewater Treatment
How Does it Work?



Low Pressure Sewer

Grinder Pumps





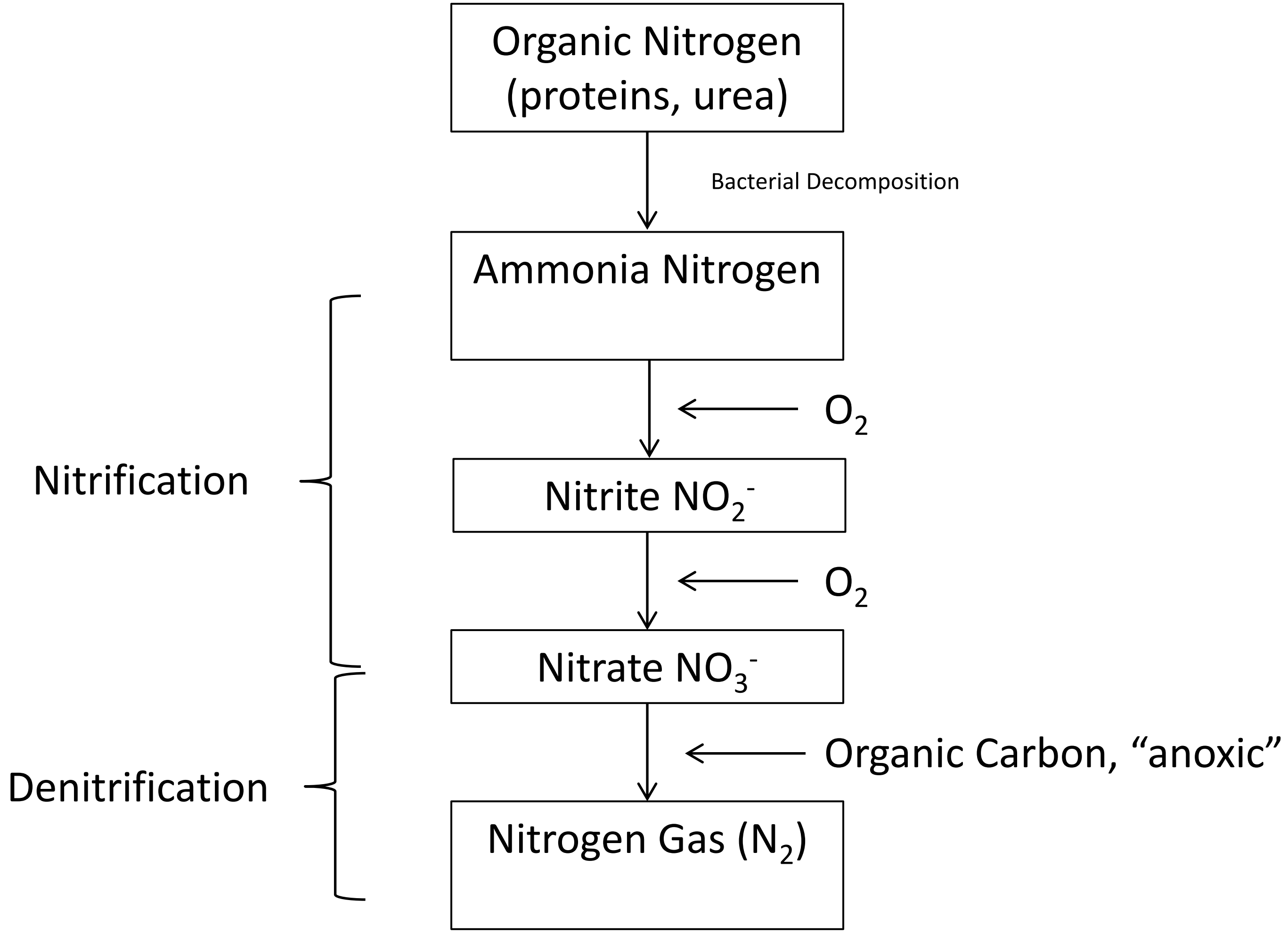
If residential wastewater ~= 200 gpd during a 16-hour period, or 12.5 gallons per hour. Then a 66 gallon holding tank provides at a minimum 5 hours of storage time during a power outage.


WASTE WATER TREATMENT PROCESS
TERMS
ANAEROBIC: contains NO AIR — smells bad!!
AEROBIC: contains AIR — smells sweaty!
KEY
Underground pipes from one area to the next, carrying material to be processed!
SLUDGE BUILDING
Sludge produced from the treatment process is hauled off site to incineration.
8
1
SEPTAGE BUILDING
Where AIR is blown into septage (like a Fishtank) to change it from anaerobic to aerobic!
SAND BEDS
7
SLUDGE TANK
Where 1st or primary sludge and 2nd or secondary sludge are mixed!
Underground Septage Tanks (anaerobic)
SEPTAGE
OFFICE
CHLORINATION TANK
6
Where chlorine is added to kill off disease-causing bacteria... chlorinated water is pumped to sand beds to filter back into groundwater!
water to sand beds
water
aerobic material
Where septage and sewage are mixed!
PRETREATMENT BUILDING
2
① Remove large objects
② Remove grit
③ Measure flow
3
PRIMARY
CLARIFIERS
4
AERATION TANK
Where suspended material at Top (T.O.J.) is mixed with bacteria (which feed on it) and with air (which bacteria need to breathe)
BACTERIA ADDED HERE!
SECONDARY
TANKS
5
Where bacteria consume the Top Orange Juice which settles on the bottom as 2nd or secondary sludge. Water is sent to the Chlorination Tank.
Where ① suspended solids or particles that won't fall to bottom stay on top, and ② settleable solids and heavy particles fall to bottom as 1st or primary sludge.
This is like: Top Orange Juice and Bottom Orange Juice
THE PURPOSE OF THIS PROCESS IS TO RECYCLE WATER and WASTE INTO DRINKING WATER and COMPOST!!
Wastewater and regular sewerage come in from sewer pipes all over Hyannis.
sludge to secondary tanks
Laurel Aiello -1993-

Science of Wastewater Treatment – “Inverse Farming”

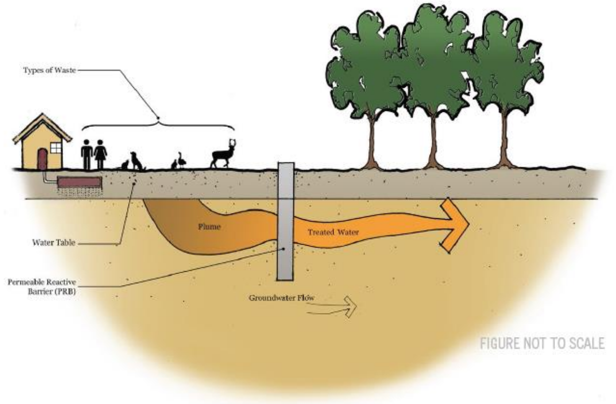
$$\text{Organic Matter} + O_2 \longrightarrow CO_2 + H_2O + NH_3 + \text{New Cells} + \text{Energy} + \text{Other End Products}$$

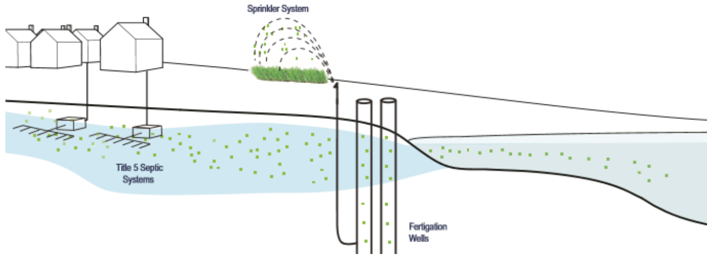
Science of Wastewater Treatment
Nitrogen Transformation

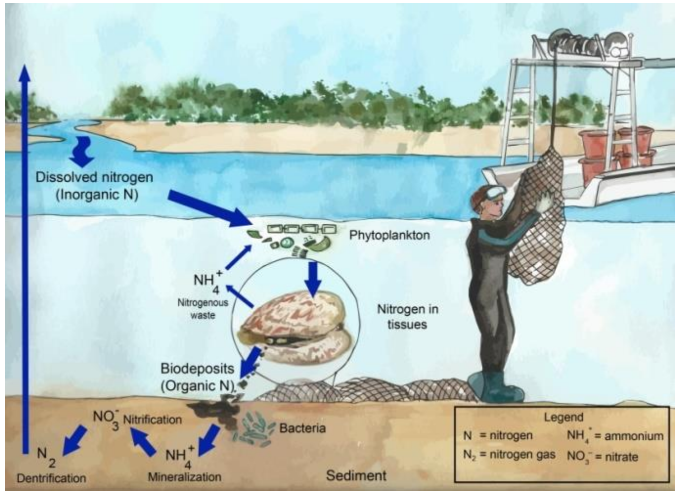



MLE Aeration Treatment Tanks
Primary Pump Building
Clarifier Distribution Box
Vacuum Sewer Station
No. 3
No. 1
No. 2
Primary Clarifier No. 2
Primary Clarifier No. 1
Secondary Clarifier No. 2
Secondary Clarifier No. 1
Secondary Clarifier No. 3
Post Chlorination Tanks
Control Building
Pretreatment Building
Secondary Pump Building
Aeration Blower Building
Odor Control Facility
Aeration Tank Influent Distribution Box
Sludge Dewatering Building
Septage Processing Building
Septage Receiving Station
Employee Locker Room
Sludge Thickener
Sludge Holding Tank
Effluent Sand Beds
Sludge Process Blower Building
Effluent Distribution Valve Chamber
Note 1. Aerial photo taken on July 10, 2009.
TOWN OF BARNSTABLE MASSACHUSETTS
Comprehensive Wastewater and Nutrient Management Plan
Hyannis WPCF Site Plan
Figure 4-1
N E S W
Feet
0 15 30 60 90 120
FILE: wpcf_equip8.mxd J.A.B. 3/9/2010
TOWN OF BARNSTABLE GEOGRAPHIC INFORMATION SYSTEMS UNIT
FIGURE PREPARED FOR STEARNS & WHELER GHD

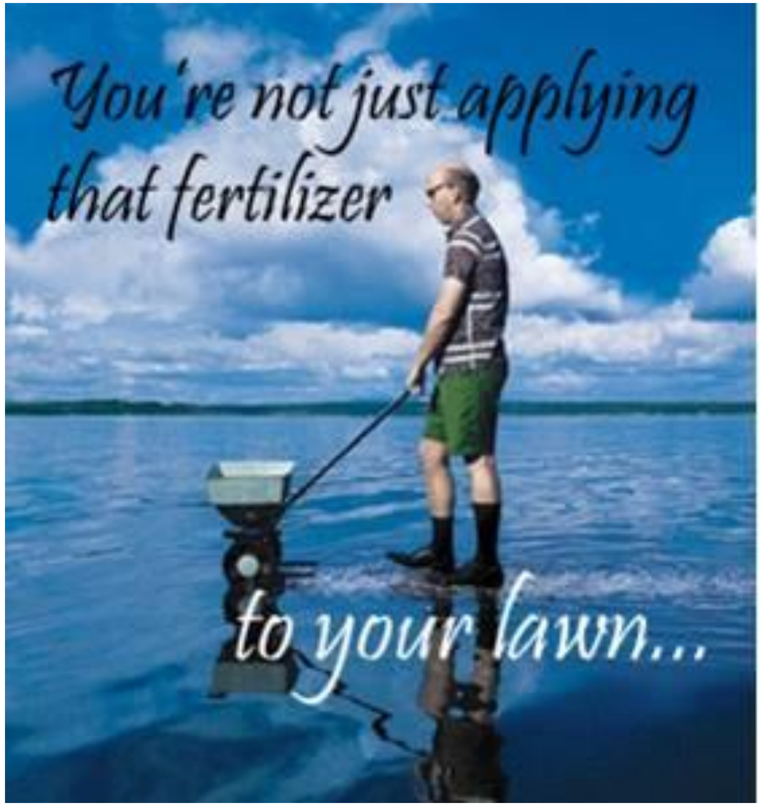
Non-Traditional Solutions







Management Solutions



BARNSTABLE
ZONING
PORTAL

The Plan

Plan Development

Assembled data from previous efforts

Met with DEP and Adjoining Communities

Utilized the GIS-based tool to evaluate needs on a lot-by-lot basis

Identified the best alternative/combinations of alternatives to address needs for each watershed

Complied with the 208 Process
- Bookends

Crafted the plan and schedule for implementation
- Develop capital cost estimates

Presented publically, received feedback, made adjustments

Prepared conceptual designs for traditional and non-traditional components to support initial funding requests

Began CIP submission on logical first steps
- Dredging
- Adjoining sewer
- Leveraging opportunities
- Permitting for non-traditional solutions
- WPCF studies and improvements

Developed CWMP to document the plan
- Submitted table of contents to DEP for approval

Submitted plan to SMAST for modeling confirmation

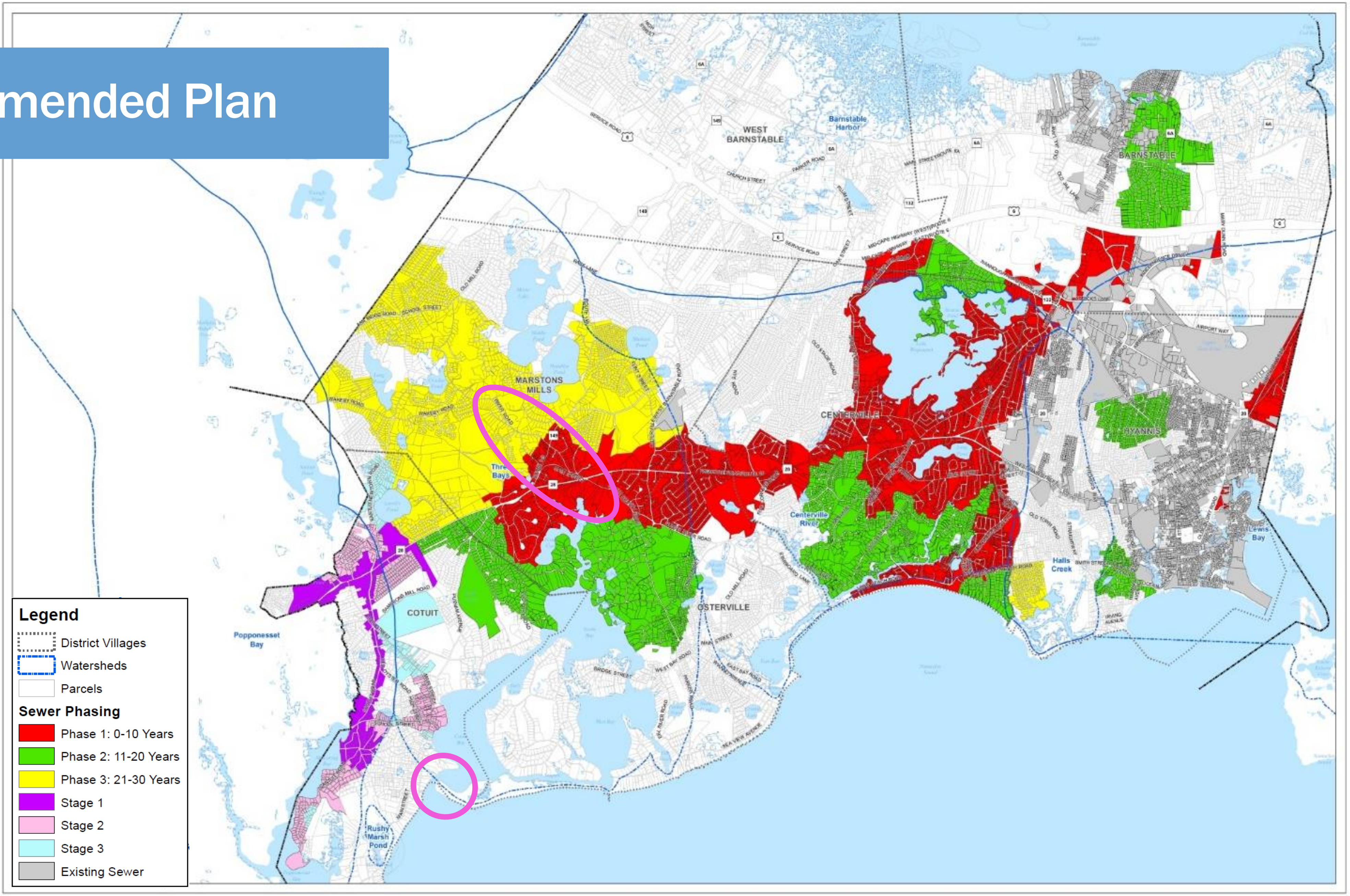
Developed financial strategy

The Plan - Phasing

Three 10-Year Phases

- Phase I – Years 0-10
- Phase 2 – Years 10-20
- Phase 3 – Years 20 -30

Recommended Plan



CWMP Phases

Table 5-1: Sewer Expansion Plan - Phasing Statistics

	Phase 1 (0-10 Years)	Phase 2 (10-20 Years)	Phase 3 (20-30 Years)	Total
WW Captured (gpd)	798,900	810,700	372,900	1,982,500
Load N Removed (kg/day)	79	81	37	197
Number of Parcels Affected	4,735	3,820	2,377	10,932
Approximate Road Miles	75	60	38	173
% of N Removed by Plan	40%	41%	19%	100%

Table 5-2: Sewer Expansion Plan - Staging Statistics

	Stage 1	Stage 2	Stage 3	Total
WW Captured (gpd)	37,200	84,500	22,800	144,500
Load N Removed (kg/day)	4	8	2	14
Number of Parcels Affected	253	483	155	891
Approximate Road Miles	5	8	3	16

Number of PS in Sewer Phase				
Sewer Phase & Stage	**Large**	**Medium**	**Small**	**Total PS**
Phase 1	4	5	19	28
Phase 2	1	8	27	36
Phase 3		3	14	17
Stage 1		2		2
Stage 2		1	3	4
Grand Total	**5**	**19**	**63**	87

KEY TAKEAWAYS:

±189 miles of road

± 11,823 parcels

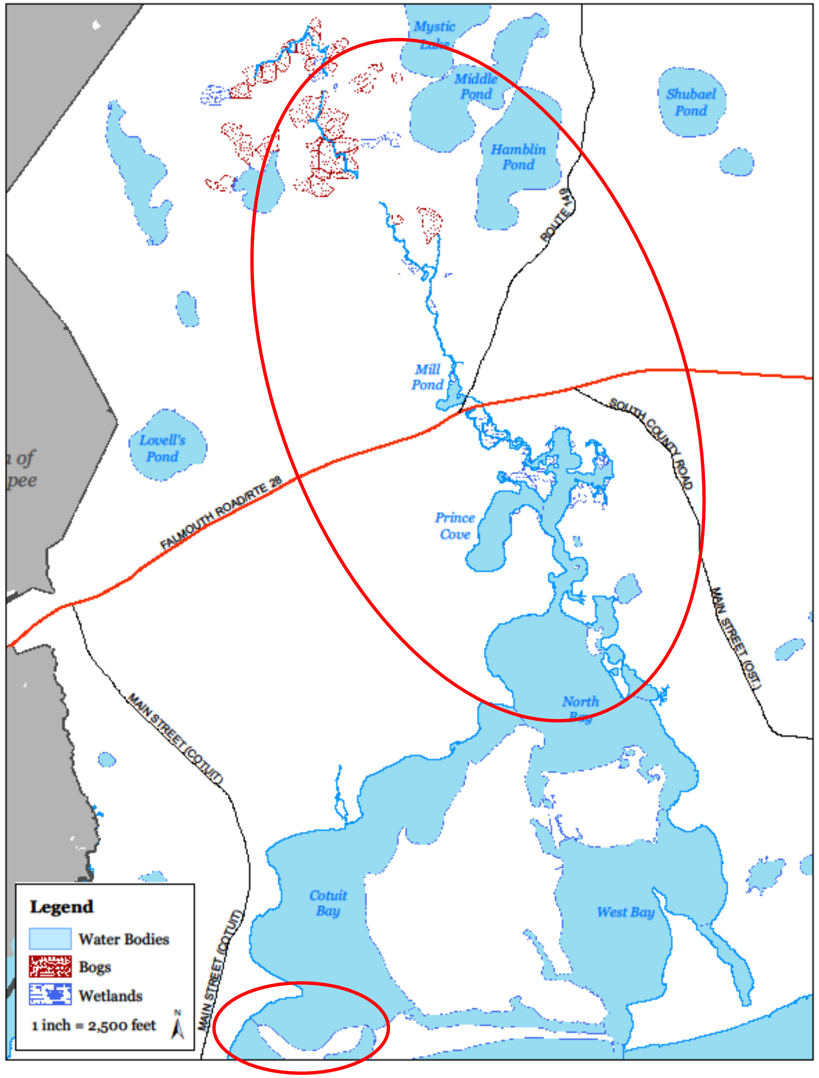
± 87 pump stations

Does not include benefit from Non-traditional Improvements

Non-Traditional Focus Area – Three Bays

Non-traditional methods

- Cotuit Bay Inlet Dredging
- Mill Pond dredging
- Abandoned cranberry bogs conversion
- Warren’s Cove - aquaculture
- Alternative septic systems
- Permeable Reactive Barriers (PRBs)
- Stormwater treatment



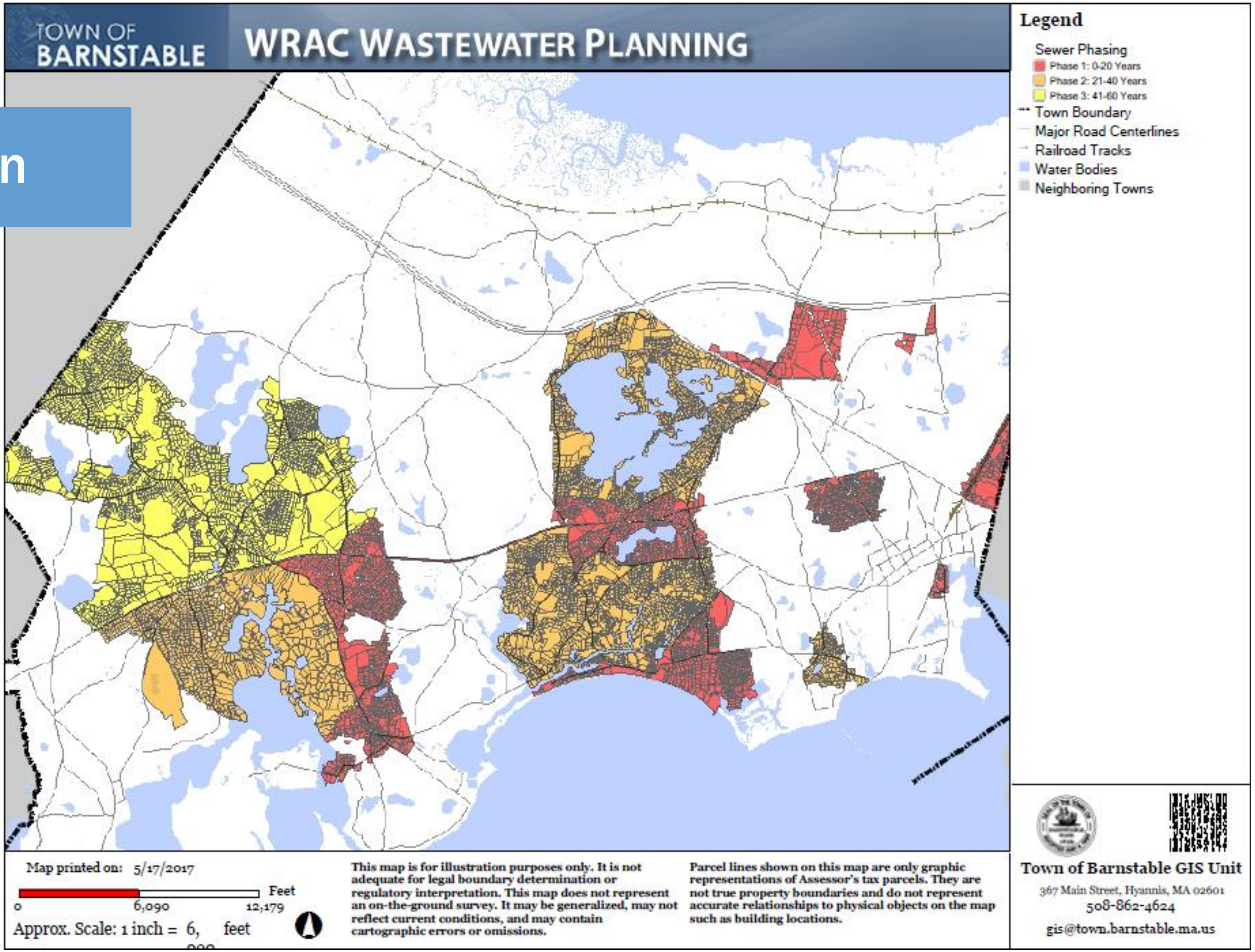
Implementation…

To be continued

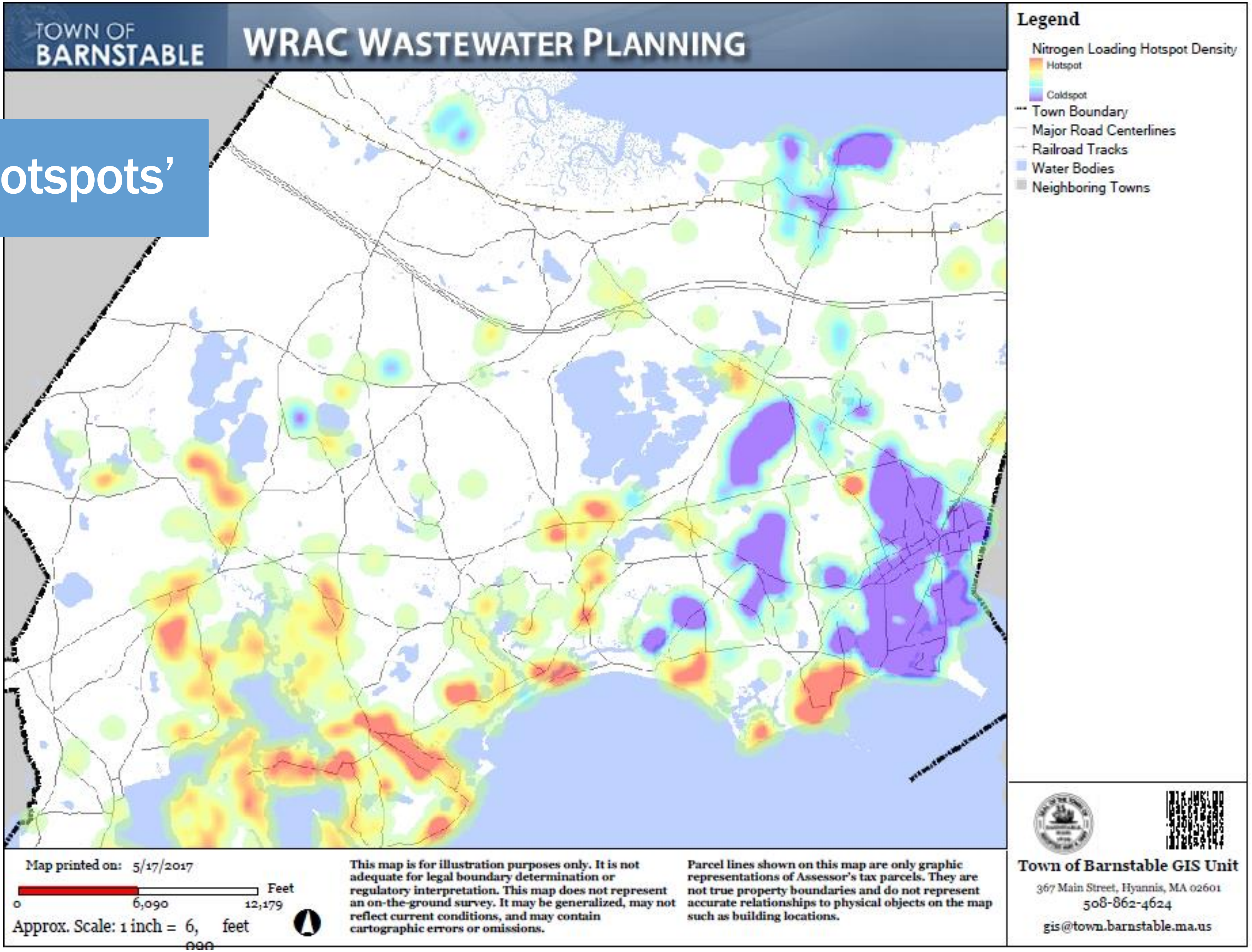
Discussion?

Resources

Original Plan



Nitrogen 'Hotspots'



JBCC

JBCC

- Submitted Letter of Intent
  - Existing WWTF Permitted to discharge an annual average flow of 360,000 gpd (currently ~140,000 gpd)
  - Four existing rapid infiltration basins (RIBs), total surface area of 259,160 square feet
    - 360,000 gpd on a 12-month rolling average
    - 840,000 gpd maximum day flow
  - Five Upper Cape Towns
    - Projected flow ~4.5 MGD Annual Average (8MGD Max Day)

WPCF Capacity

Existing treatment limit ~ 4.2 MGD

Onsite disposal limit ~ 3.0 MGD

Biowin modeling

More in-depth disposal study

Component	Flow Conditions	Capacity (MGD)
Parshall Flumes	Minimum Flow	0.6
	Peak Hour	15.6
Aerated Grit Chamber	Peak Hour	20.0
Primary Clarifiers	Maximum Month	6.8
	Peak Hour	17.0
Aeration Tanks	Maximum Month	4.2
Secondary Clarifiers	Maximum Month	4.4
	Maximum Day	4.7
	Peak Hour	7.1
Chlorination Facilities	Peak Hour	13.8
Sand Infiltration Beds	Maximum Month	6.0

WPCF Existing Flows

Flow Component	Sewage (MGD)	Septage (MGD)	Total (MGD)	Time of Occurance
Average Daily Flow	1.54	0.03	1.57	March 1 2012 - Feb 28 2017
Maximum Daily Flow	2.20	0.12	2.32	July 4, 2014
Minimum Daily Flow	0.88	0.00	0.88	January 24 2015
Peak Hour	4.92	N/A	4.92	July 1, 2015
Maximum Month	1.97	0.05	2.02	July 20 - Aug 18 2012
Minimum Month	1.24	0.01	1.25	Jan 18 - Feb 17 2015

Therefore ~ 1-2 MGD of treatment capacity

~ 1 MGD of disposal capacity

Some of this is already spoken for

Nitrogen from Wastewater Systems

Effluent concentrations	
◦ individual, Title 5	25 to 40 mg/l (26)
◦ individual, N-removing	15 to 25 mg/l (19)
◦ WPCF	3 to 5 mg/l
Drinking water (at tap)	10 mg/l
CCC standard (in recharge)	5 mg/l
Typical MEP threshold	0.3 to 2 mg/l

Effluent Disposal Options

- Surface water discharge
- Land application
- Re-use

Land-Based Disposal on Cape Cod

Advantages

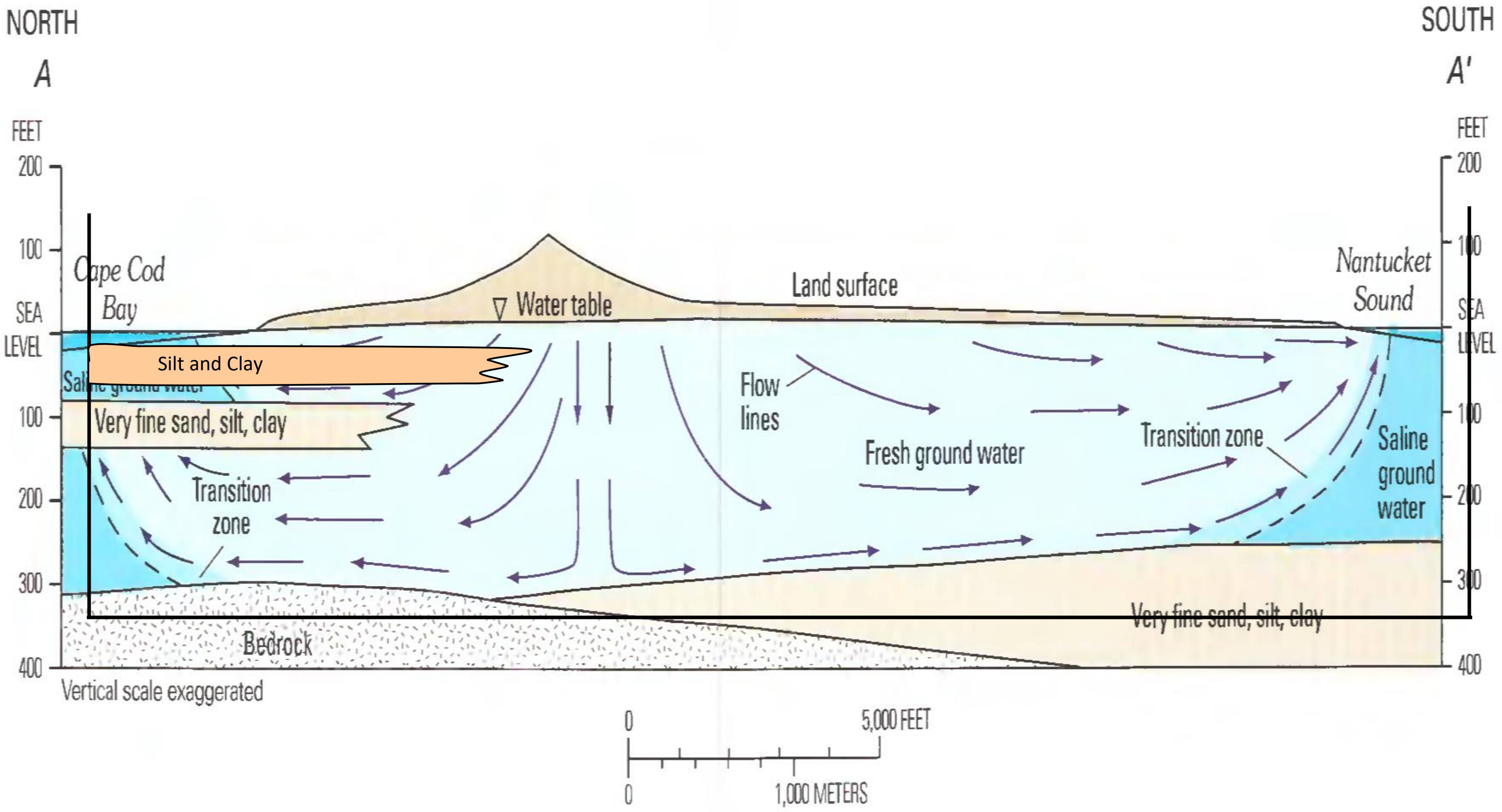
- provide additional treatment
- recharge groundwater
- avoid regulatory hurdles

Disadvantages

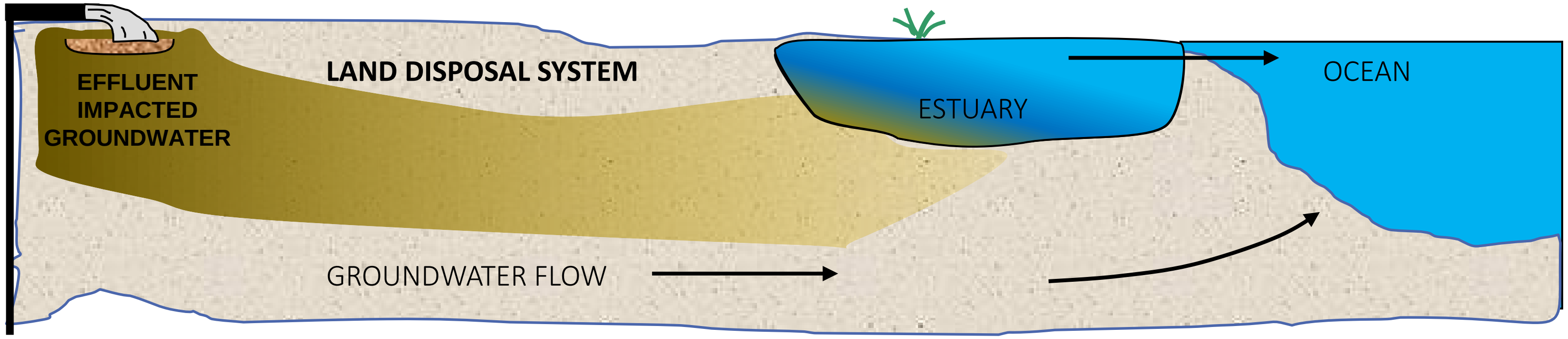
- impacts on estuaries
- impacts on groundwater
- land availability
- land cost
- control of effluent flow direction
- public acceptability
- increased level of sewering

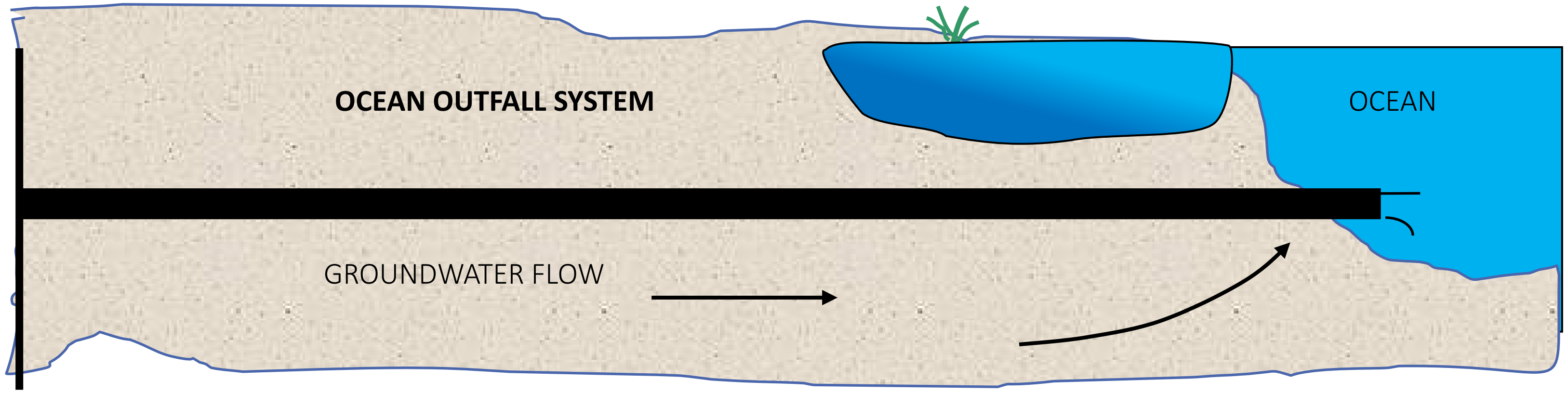
Wastewater on Cape Cod

<u>All water travels to the Ocean</u>

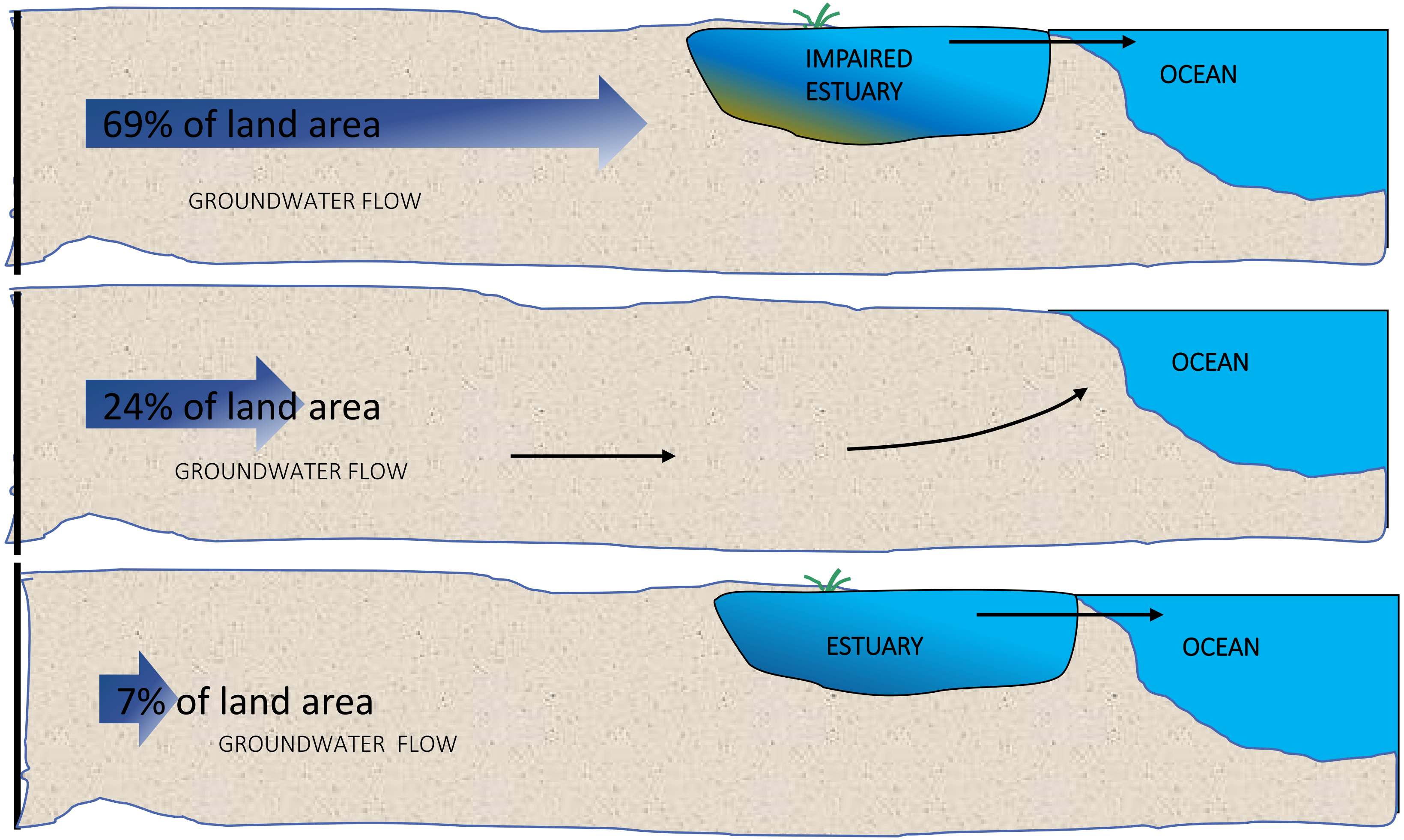


Disposal Paths to the Ocean





Cape Cod Watersheds



Ocean Outfall Disposal

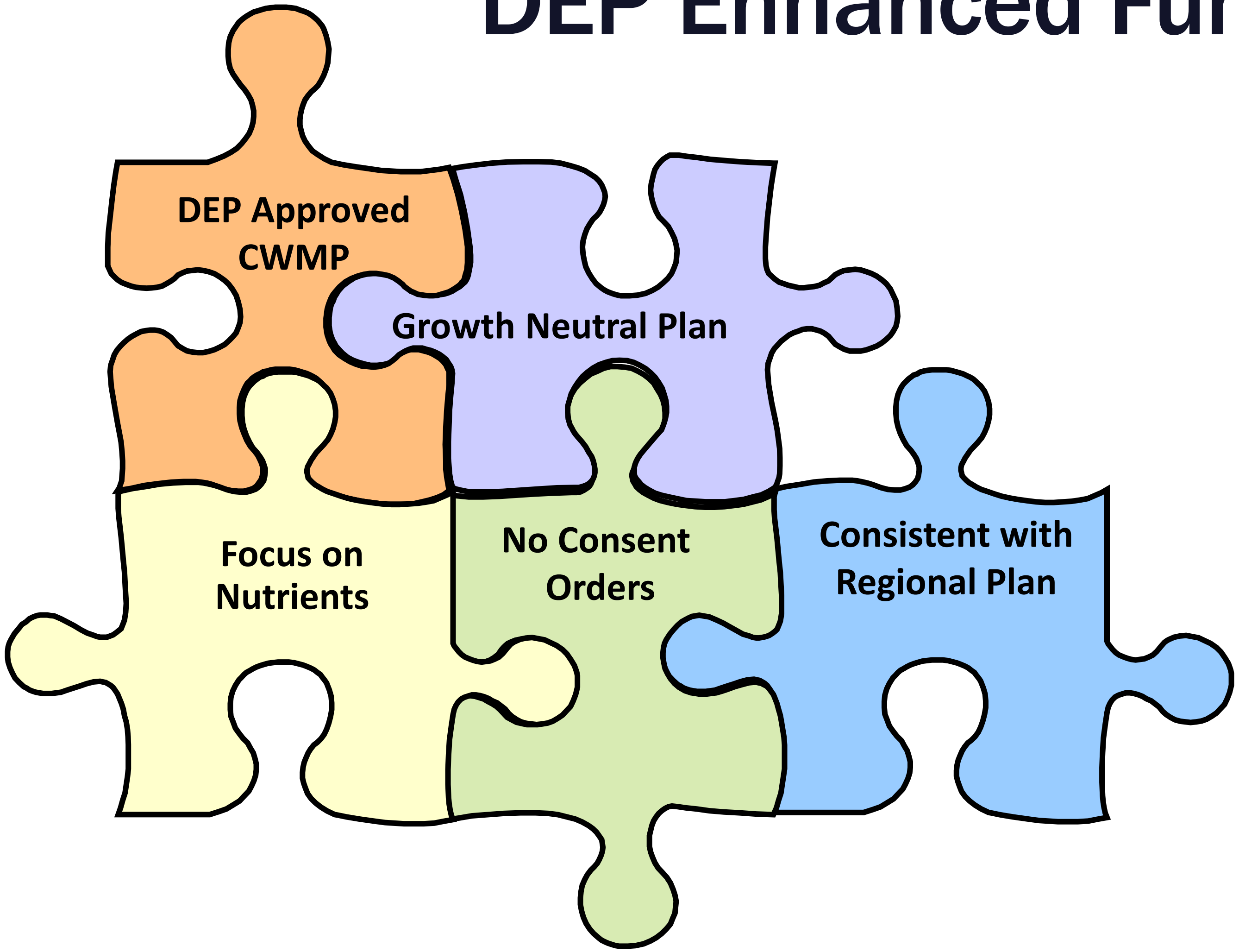
Advantages

- not land intensive
- can direct disposal to less sensitive waters
- avoids sensitive estuaries/embayments /Zone II’s
- no adverse impacts on GW quality
- simpler to operate
- reduces level of sewering

Disadvantages

- regulatory hurdles
- public acceptance concerns
- no soil aquifer treatment
- no groundwater recharge
- impact to fisheries in immediate vicinity of outfall
- potential time delays
- federal regulations

DEP Enhanced Funding



There are 5 key funding criteria that need to be met

Growth Neutral?

A "Growth Neutral" project does not promote more growth than would occur without the project, nor does it restrict growth to less than would occur in the absence of the project.

Growth-neutral ≠ no growth

New term…"Net Growth Neutral"

Cost Estimate Assumptions

Developed a per mile collection system cost estimate

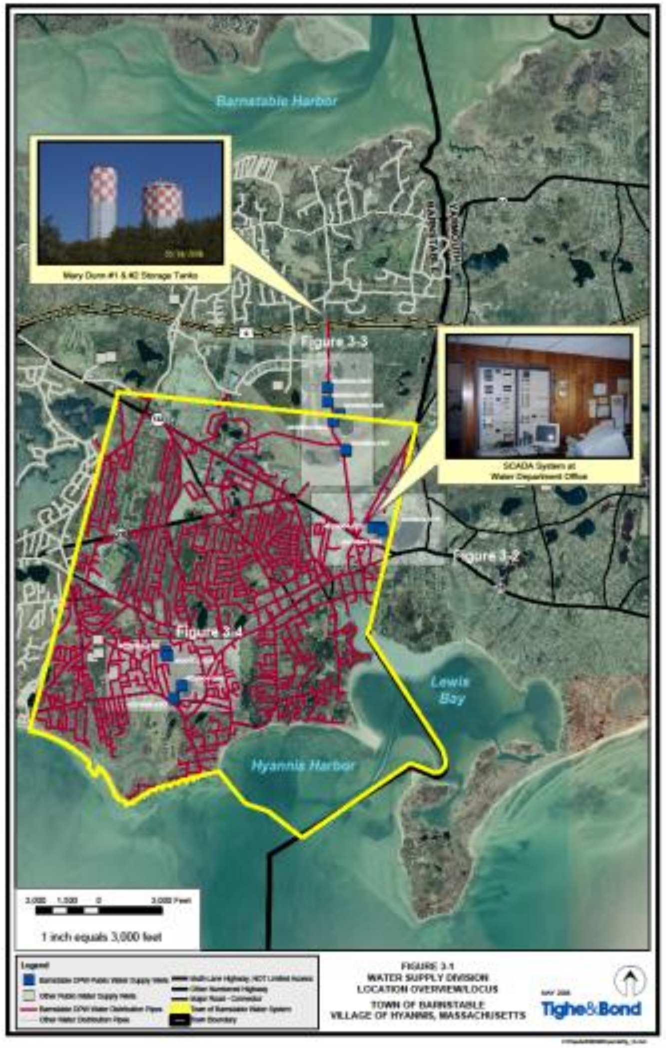
- Assumptions
  - One pump station for every 2 miles sewers
  - One mile FM for every pump station
  - Average pipe size is 10 inch diameter
  - Gravity Service to ROW = 1,060
  - Minimal bridge crossing
  - Four foot diameter SMH every 300 feet, ave depth 6 feet
  - No Storm Drain as part of this project
  - 10 test pits per mile (~1 every 500 feet)
  - Pave full width, 30 foot width assumed, 1.5 inch top coat, 2.5 inch binder
  - 1,000 feet of waterline per mile needs to be disturbed
  - Five foot sidewalk reconstructed, 1 side, 1/3 of mile
  - Curb reset or replaced for 1/4 of the mile, both sides = 2,640 ft curbing per mile
  - Package Pump Station "neighborhood" sized
  - $25,000 traffic control allowance
  - $15,000 electrical allowance
  - 5% construction contingency
  - 20% technical services
  - 10% land acquisition
- **Results $2.7M/mile**

Cost for plant upgrade assumed at 30% collection system costs

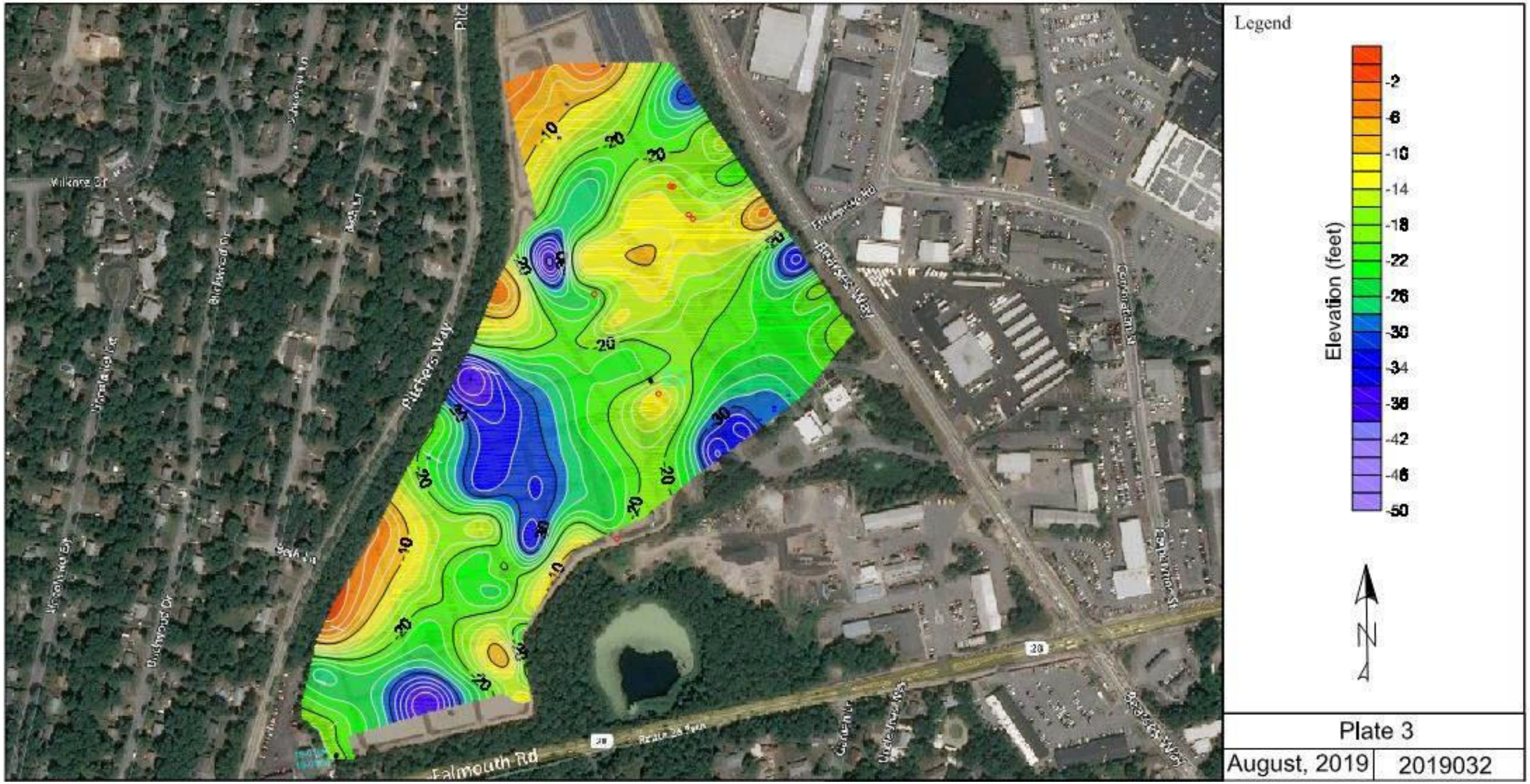
Needs Assessment – Water Supply Protection

Water Supply Protection

- Public Wells
  - Zone I - 400ft radius around public well
  - Zone II - 180 days pumping, Max yield, drought
  - Nitrates
  - CECs
- Private Wells
  - Excess nitrogen
  - CECs



Elevation of Top of Clay



The Equations

$$\text{Organic Matter} + O_2 \longrightarrow CO_2 + H_2O + NH_3 + \text{New Cells} + \text{Energy} + \text{Other End Products}$$

Nitrification

10-12 days in aerobic environment

Nitrite, (Nitrosomonas Bacteria)

$$NH_3 + 3O_2 \longrightarrow 2NO_2^- + 2H^+ + 2H_2O + \text{New Cells} + \text{Energy} + \text{Other End Products}$$

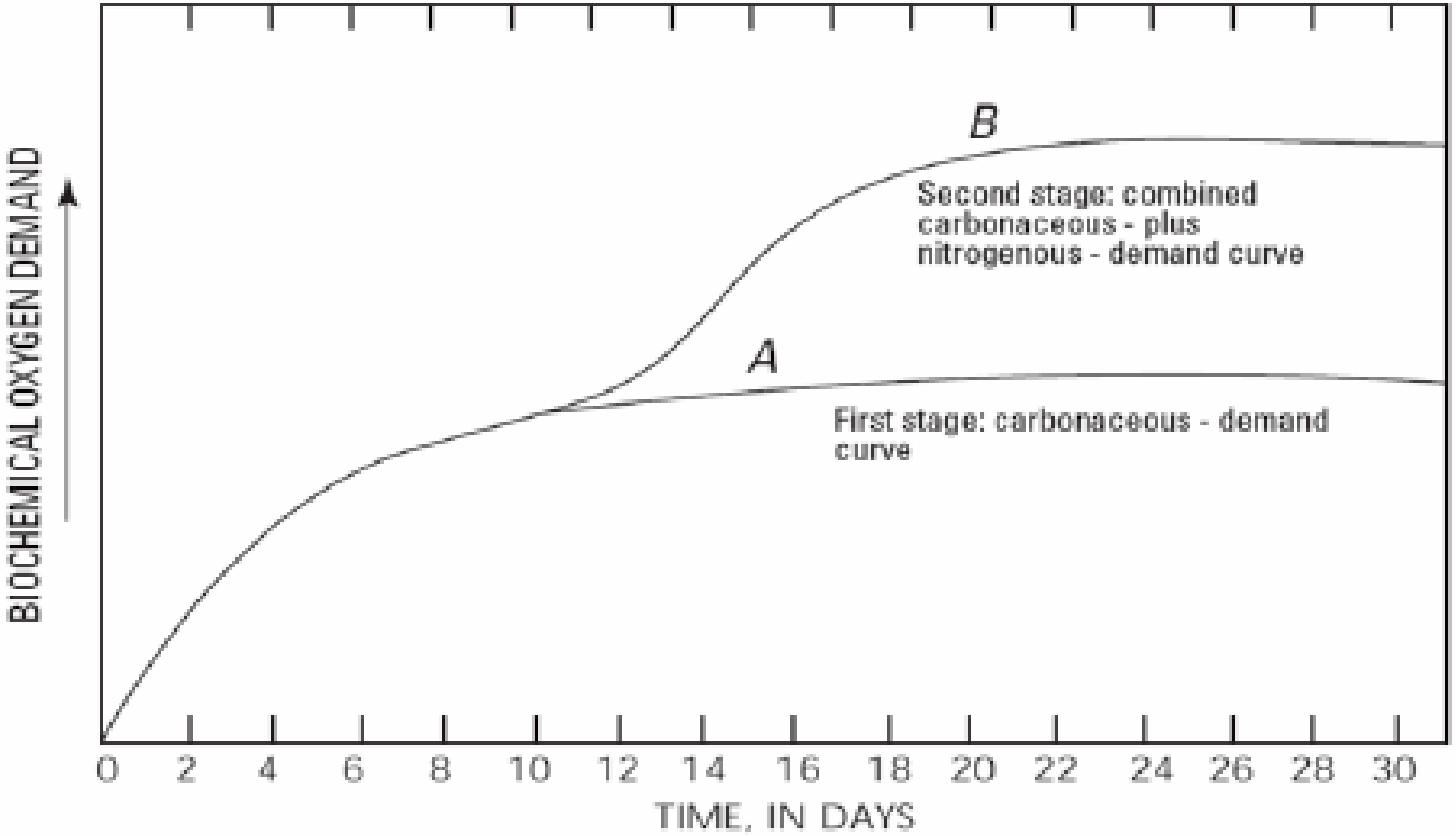
Nitrate, (Nitrobacter Bacteria)

$$2NO_2^- + O_2 + 2H^+ \longrightarrow 2NO_3^- + 2H^+ + \text{New Cells} + \text{Energy} + \text{Other End Products}$$

Denitrification

$$NO_3^- \longrightarrow NO_2^- \longrightarrow NO \longrightarrow N_2O \longrightarrow N_2$$

Oxygen Demand



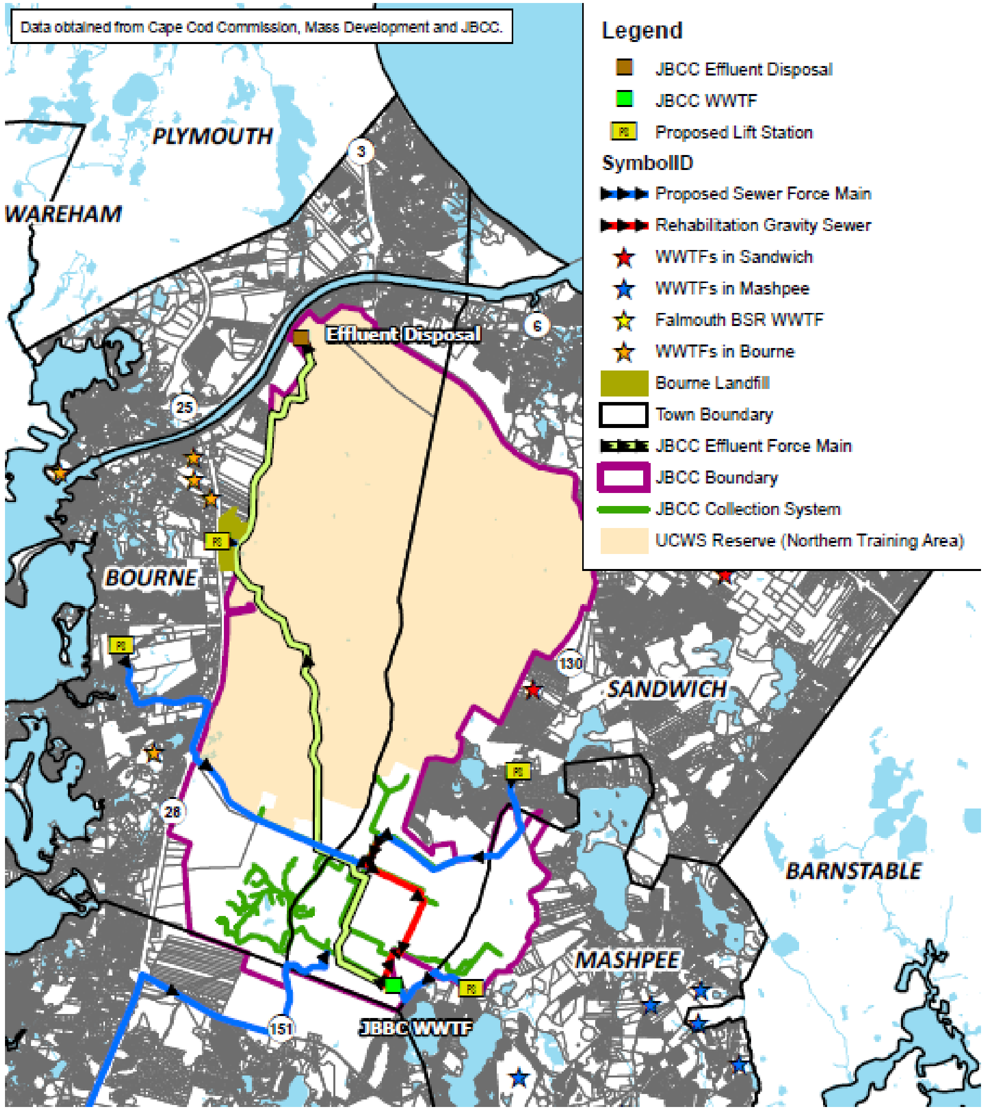
Existing Nitrogen Reduction Requirements

Watershed	Total attenuated controllable watershed N nitrogen load (kg/day)	Total attenuated controllable N load (from Barnstable) (kg/day)	Target (kg/day)	Total N load reduction required (kg/day)	N Load reduction required (by Barnstable) (kg/day)
Centerville River Watershed					
Centerville River East	52.7	52.7	24.7	28.0	28.0
Centerville River West	8.2	8.2	9.5	0.0	0.0
East Bay	7.8	7.8	8.6	0.0	0.0
Scudder Bay	44.5	44.5	52.6	0.0	0.0
Halls Creek Watershed					
Halls Creek	20.0	20.0	36.3	0.0	0.0
Lewis Bay Watershed					
Hyannis Inner Harbor	18.9	15.7	7.4	11.5	11.2
Lewis Bay	39.8	9.9	9.7	30.2	7.5
Mill Creek	32.7	5.7	22.3	10.3	1.8
Snows Creek	9.7	9.7	16.2	0.0	0.0
Stewarts Creek	51.3	51.3	41.6	0.0	0.0
Popponesset Bay Watershed					
Pinquickset Cove	0.9	0.9	0.8	0.2	0.2
Popponesset Bay	1.7	0.6	1.8	0.0	0.0
Shoestring Bay	35.5	11.3	19.7	15.8	5.0
Three Bays Watershed					
Cotuit Bay	22.1	21.0	22.3	0.0	0.0
North Bay	25.0	24.8	4.5	20.6	20.4
Princes Cove	11.7	10.8	2.2	9.5	8.8
Princes Cove Channel	5.7	5.7	0.8	5.0	5.0
Seapuit River	2.7	2.7	3.8	0.0	0.0
Warrens Cove	29.3	23.7	20.8	8.5	6.9
West Bay	15.0	15.0	16.0	0.0	0.0
Rushy Marsh Watershed					
Rushy Marsh Pond	0.2	0.2	0.1	0.1	0.1
Barnstable Harbor Watershed					
Barnstable Harbor*	100.2	82.1	75.1*	25.0*	20.5*

* Draft Barnstable Harbor MEP was not developed at the time of development of this table. This assumed a 25% reduction target as a placeholder. As discussed in Section 5, removal requirements per MEP are less.

…and 100% Removal of Future Flows in Affected Watershed

Joint Base Cape Cod (JBCC)



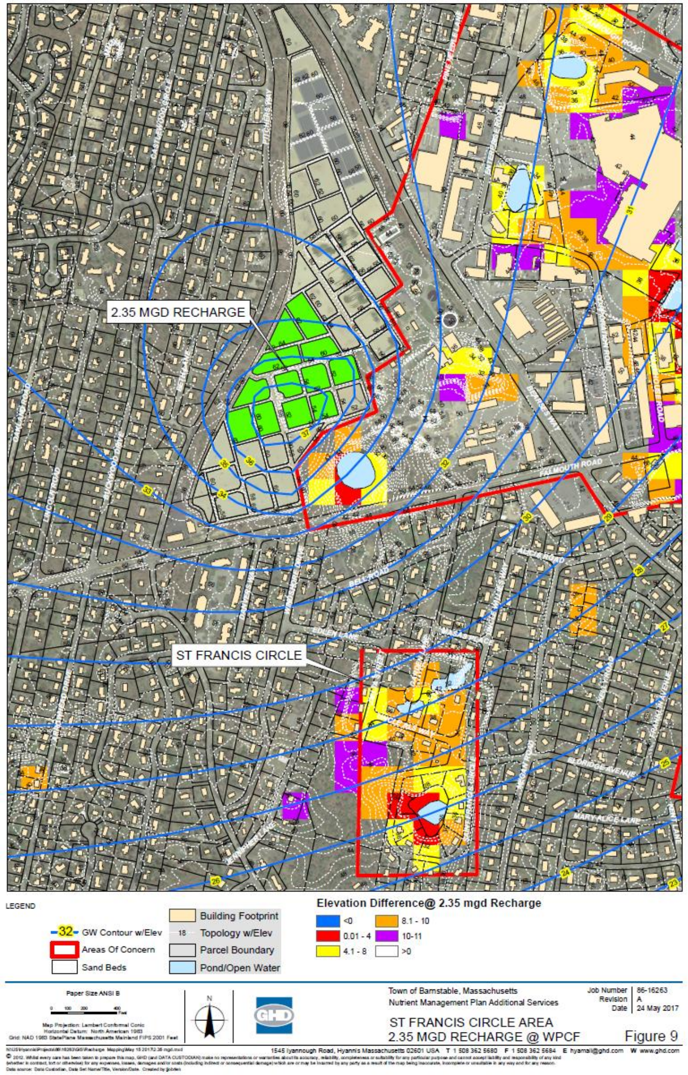
Joint Base Cape Cod (JBCC)

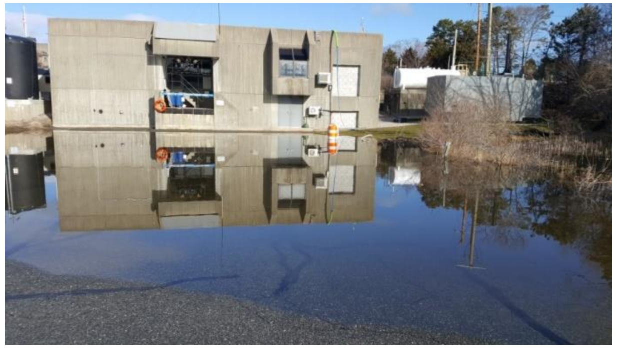
Existing Facility

- Treatment Capacity = 360,000 gpd (annual average day)
- Disposal Capacity = 840,000 gpd (max day)
- Effective Available Capacity = 75,000 gpd (annual average day)

Traditional Projects

Effluent Disposal Capacity Study & Design





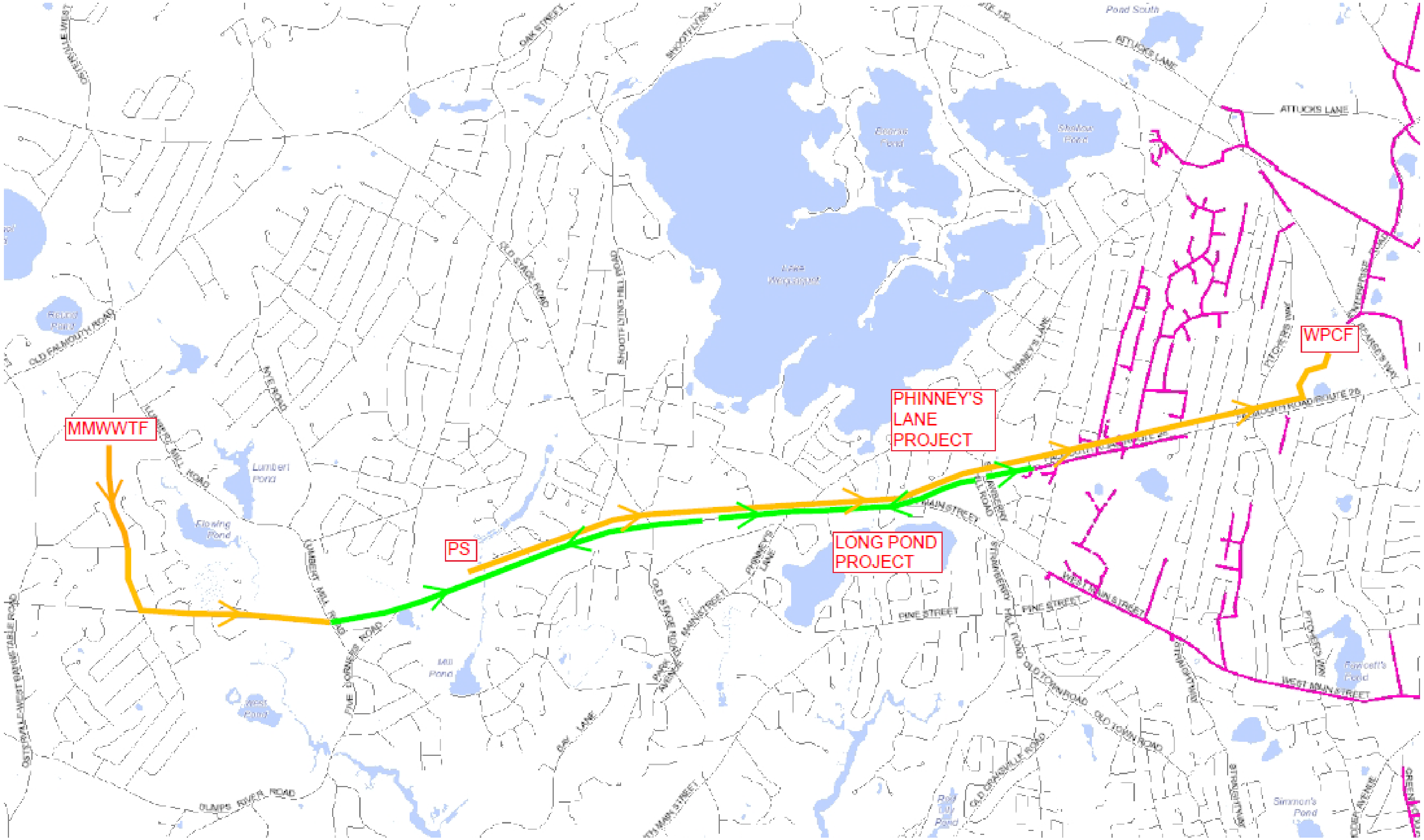
Marstons Mills WWTF

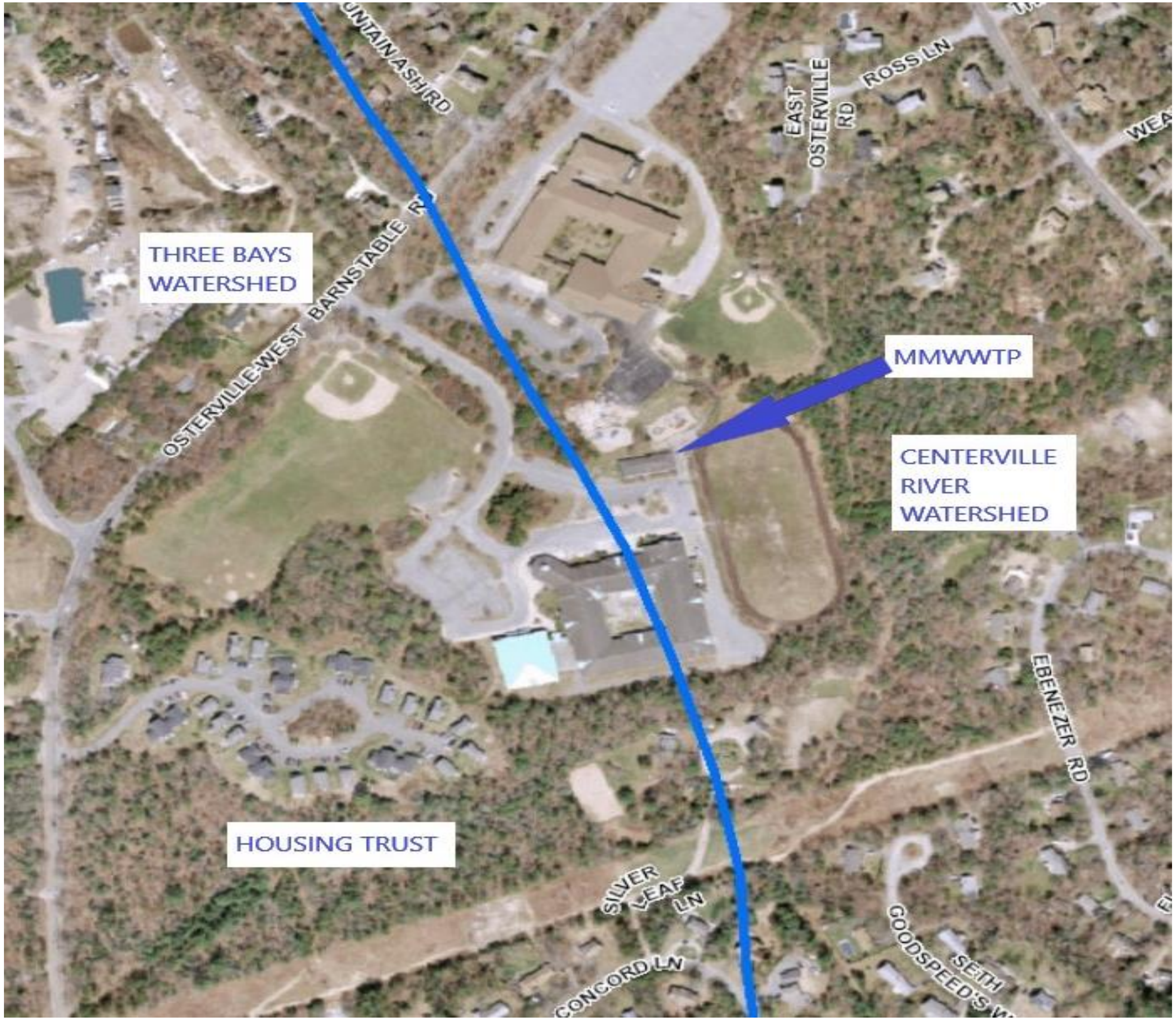
- Desire to Expand WW collection in the Area
- Existing Plant fully allocated 42,900 gpd.
  - 30,000 gpd schools
  - 12,000 gpd Housing Trust
- Built 1993 – Beyond 20-year design life
- Limited expansion potential
  - Max. = +/- 113,000 gpd

Marstons Mills WWTF

- Expand and Upgrade MMWWTP
  - ~ $16,000,000
    - Includes offsetting sewering for new disposal field
    - Not including costs if required TOC < 3 mg/l
- Convert MMWWTP to a Pump Station
  - ~ $19,000,000
  - Convey flow to Hyannis WPCF
    - Includes gravity sewer along Route 28
    - ~ $15,500,000 if no gravity sewer along Rte 28

Marstons Mills WWTF




THREE BAYS WATERSHED
MMWWTP
CENTERVILLE RIVER WATERSHED
HOUSING TRUST
OSTERVILLE-WEST BARNSTABLE RD
EAST OSTERVILLE RD
ROSS LN
EBENEZER RD
SILVER LEAF LN
CONCORD LN
SETH GOODSPEED'S W

Marstons Mills WWTF

Permitted to treat 42,900 gpd.

- 30,000 gpd schools
- 12,000 gpd Housing Trust
- But, Operationally Limited to 30,000 gpd (de-nitrification sand filters.

Measured Max Daily Flow = 29,910 gpd

Measured Avg Daily Flow (ADF) = 13,500 gpd

Measured ADF (school out)=5,650 gpd

Marstons Mills WWTF

- Estimated max potential capacity 113,000 gpd.
- Existing effluent disposal capacity 47,000 gpd
  - Discharges to a Zone II, & nitrogen sensitive Centerville River Watershed.
- Discharges > 47,000 gpd would need to be shifted to the west of the facility
  - More nitrogen sensitive Three Bays Watershed.
  - Estimated to accept 66,000 gpd
    - ~ design flow from 290, 3-bedroom, residences.
  - An additional existing 54 homes in the watershed would require sewering ~ $3,500,000 .
- Would require DEP review, and re-permitting of the facility.

Findings at Marstons Mills WWTF

MMWWTP is more expensive than Hyannis WPCF.

- Treatment costs are 3x greater.

Spatial constraints limit expansion potential.

- Max. potential disposal capacity = +/- 113,000 gpd

Operating a WWTP on school grounds is problematic and potentially hazardous

Regulatory Review

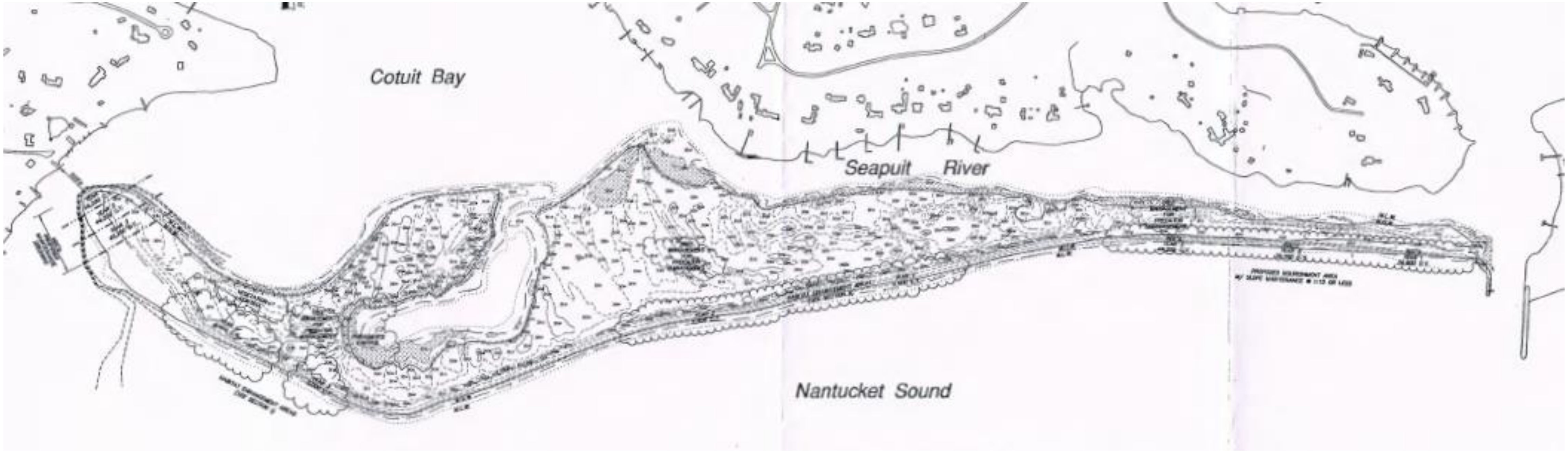
- Increase in flow would require permit modification by DEP.

As discharge is in a Zone II, regulatory review will likely impose more stringent effluent limits (TOC<3 mg/l)

Non-Traditional Projects

Sampson's Island Dredging

Sampson's Island Dredging



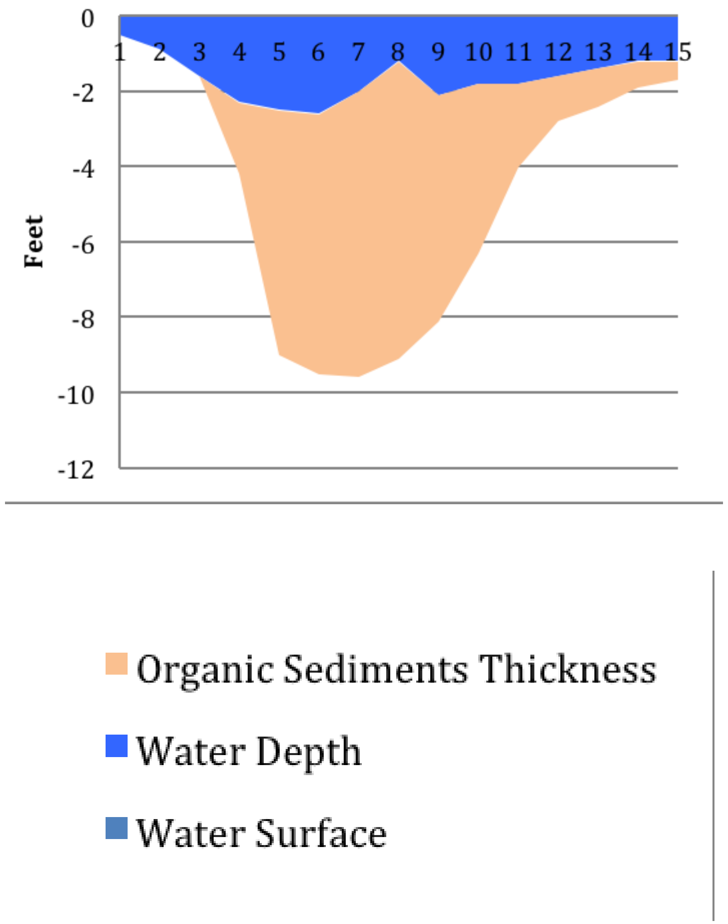
Mill Pond Dredging

The Issue:

- Mill Pond is full of silt and debris – 9 feet thick in places
- In 20 years nitrogen removal capacity has declined from 20% to 10%
- Healthy ponds = 30% to 50%
- If 50% restored, estimated remove over 2,200 kg/year of additional nitrogen

The Solution:

- Dredge to its original depths (sand layer) and perimeter
- Estimated 60,000 CYs of material (to be confirmed)
- Pond depths restored to approximately 8 feet in the deepest areas



Cranberry Bogs

The Issue:

- Existing and abandoned bogs - Ideal locations for nontraditional solutions

The Solutions:

- Conversion to ponds (~50%)
- Conversion to wetlands (TBD)
- Installation of floating wetlands (8-15%)

Warrens Cove

The Issue:

- Warrens Cove currently not appropriate for aquaculture due to silt.
- Potential to be ideal nursery for aquaculture farms
- The product relocated to established aquaculture farms

The Solution:

- Dredging Warrens Cove back to a sandy bottom
- Establish aquaculture nurseries
  - Variety of species
- The Cape Cod Commission estimated that aquaculture beds/floating racks can remove 8-15% of the nitrogen they encounter

Other Non-traditional Opportunities

PRBs

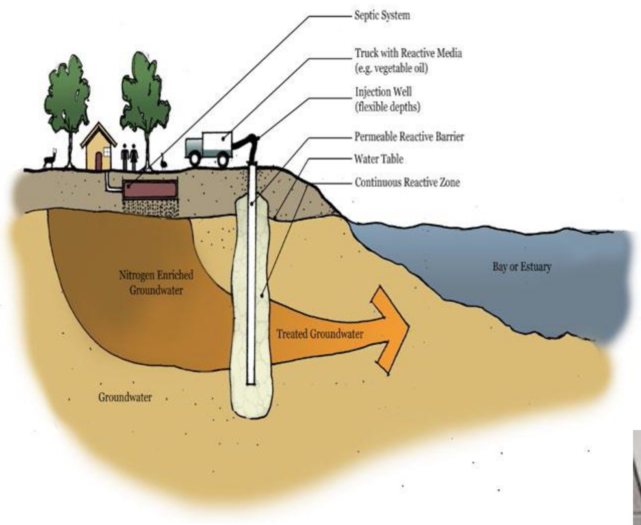
- EPA Demonstration Project
  - Prince Cove Area
- Horse Farms?

Alternative Septic Systems

- Prince Cove

Alternative Toilets

- Cape Cod Academy



Stormwater

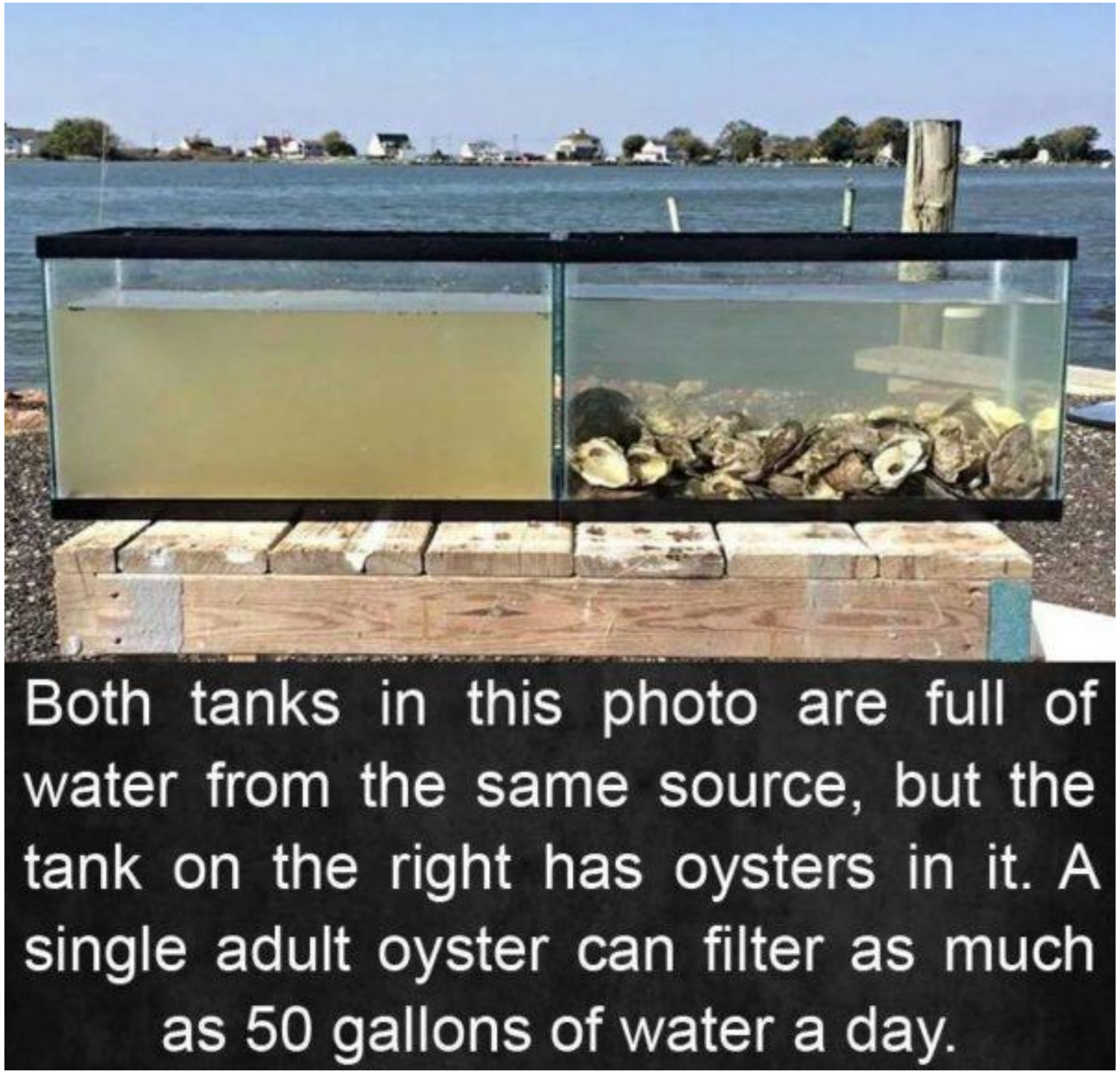
The Issue:

- Stormwater systems are in various states of repair

The Solution:

- A comprehensive survey identifying those that need repair, or replacement.
- Identify new systems/BMP needed to protect water quality
- Credit for work already done
  - Cotuit Town Dock, etc.

Prince Cove, 2013


Both tanks in this photo are full of water from the same source, but the tank on the right has oysters in it. A single adult oyster can filter as much as 50 gallons of water a day.