



# Truro Comprehensive Watershed Management Plan

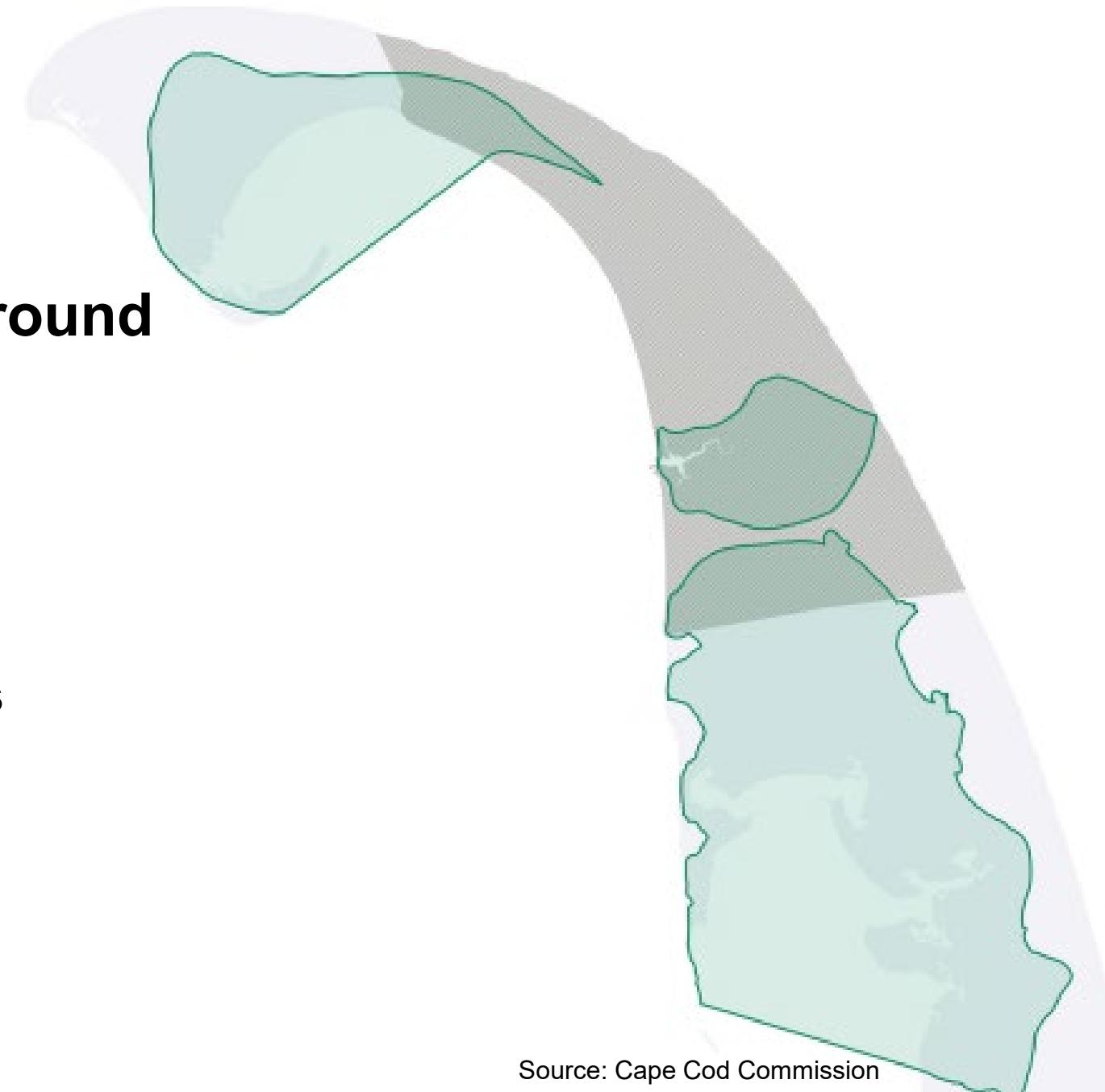
## Board of Health Meeting

October 14<sup>th</sup>, 2025

# Welcome

# Agenda

- Project Drivers and Background
- Nitrogen Management
  - Loading to Watersheds
  - Reduction Targets
  - Management Strategies
  - Draft Management Alternatives
- Public Health Needs
- Summary & Next steps



# Project Drivers

→ Environmental and Public Health Needs

# Environmental Needs

- The Town of Truro needs to **reduce the amount of nitrogen** entering its coastal estuaries to meet MassDEP/EPA requirements
  - Excess nitrogen comes primarily from **septic systems**
  - Excess nitrogen in the watershed can lead to loss of eelgrass, algae blooms, fish kills and a decline in property values



Advertise in the Indie.

Reach more readers from Eastham to Provincetown.

[Get the word out. Place an ad.](#)

[HOME](#) [STORIES](#) [SHORTCUTS](#) [INDIE'S CHOICE](#) [LJP](#) [SHOP](#) [ABOUT](#)

ENVIRONMENT

## Reports Show Steady Deterioration in Coastal Water Quality

*Center for Coastal Studies work points to need to replace septic systems*

BY SOPHIE MANN-SHAFFIR • MAR 1, 2023

PROVINCETOWN — Reports in recent years from the Association to Preserve Cape Cod (APCC), which uses data collected by the Center for Coastal Studies (CCS) at more than 100 testing stations in Cape Cod Bay and Nantucket Sound, show a steady decline in coastal water quality.



As part of the Center for Coastal Studies "winter emerald" water quality monitoring, Jenny Burkhardt

# The Provincetown INDEPENDENT

Find the Indie

Sign up for



Arts & M



From 2019 to 2022, the proportion of coastal coves known as "embayments" deemed unacceptable in APCC's State of the Waters report rose from 68 percent to 90 percent. And whereas Provincetown Harbor, Wellfleet Harbor, and Eastham's Rock Harbor have shown issues before, [Truro's Pamet Harbor was deemed unacceptable for the first time in 2022](#).

The quality of water in coastal embayments is critical because of the shellfish, finfish, and bird populations they support — and for what it suggests about the Cape's drinking water, according to Amy Costa, director of the CCS Water Quality Monitoring Program, which is funded primarily by a contract with Barnstable County. Poor coastal water quality can be an indicator of upland water quality problems, Costa told the *Independent*. "You're going to eventually see it everywhere," she said.

# Background

→ September 25<sup>th</sup>, 2025 Joint Presentation Refresher

# September 25<sup>th</sup>, 2025 Joint Presentation Refresher

- Wastewater and Nitrogen Management Planning Project focusing on Truro's three coastal estuaries through wastewater and non-wastewater management strategies
  - Provincetown Harbor (shared with Provincetown)
  - Pamet River
  - Wellfleet Harbor (shared with Wellfleet and Eastham)



# Current Status

## Nitrogen Total Maximum Daily Loads (TMDLs)

- Established for Wellfleet Harbor by MassDEP and EPA
- Not yet established for Pamet River and Provincetown Harbor

## Cape Cod Commission (CCC) Section 208 Area Wide Water Quality Management Plan

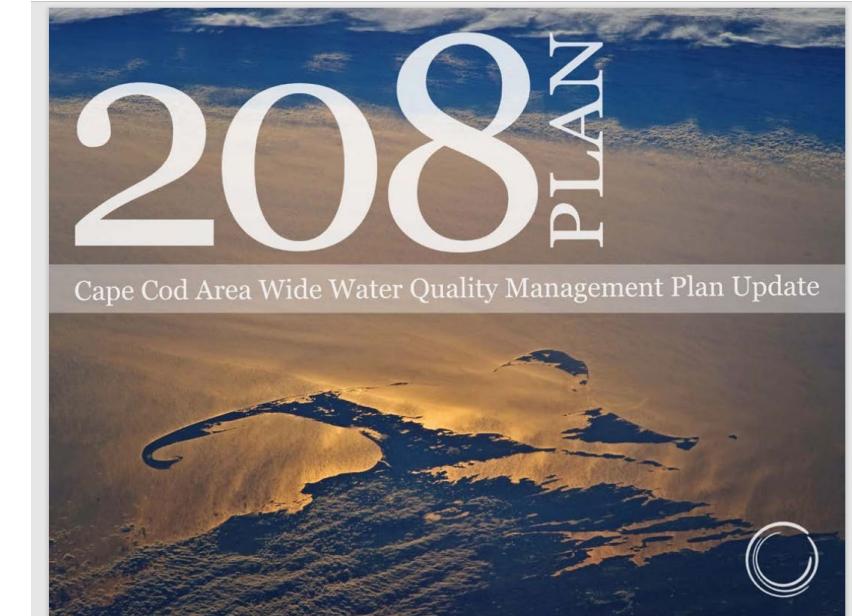
- Includes Watershed Reports which characterize the degree of nitrogen impairment for 53 watersheds on Cape Cod
- For estuaries that do not yet have a MassDEP-approved TMDL, CCC recommends Towns use a 25% nitrogen removal target for initial planning
- CCC 208 Plan Watershed Reports estimates watershed nitrogen sources for Pamet River and Provincetown Harbor (wastewater, fertilizer, stormwater and other).

Final Wellfleet Harbor Embayment System  
Town of Wellfleet, Massachusetts  
Total Maximum Daily Load for Total Nitrogen



Commonwealth of Massachusetts  
Executive Office of Energy and Environmental Affairs  
Rebecca L. Tepper, Secretary  
Massachusetts Department of Environmental Protection  
Bonnie Heiple, Commissioner  
Bureau of Water Resources  
Kathleen M Baskin, Assistant Commissioner

August 2023

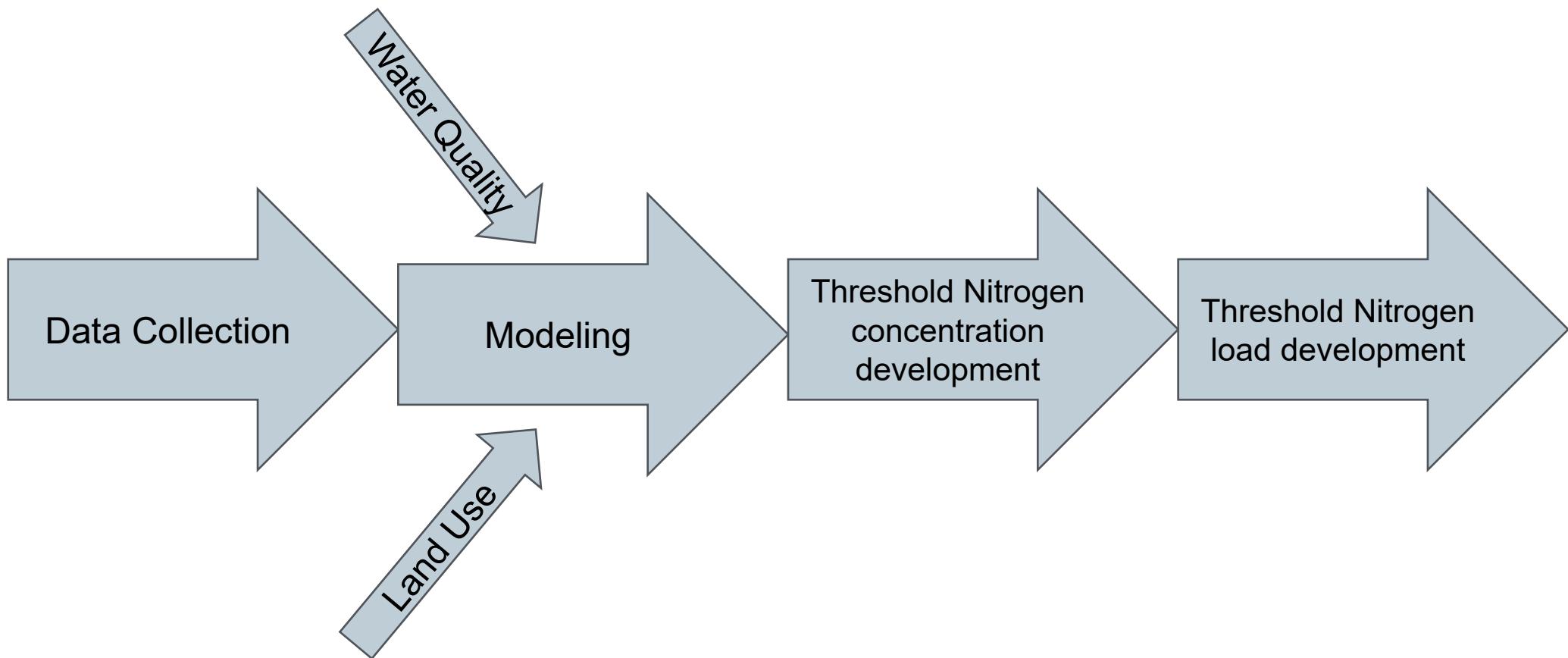


# Nitrogen Loading to Watersheds



# Massachusetts Estuaries Project

The Massachusetts Estuaries Project uses a linked model to determine an embayment's nitrogen sensitivity and nitrogen threshold levels.



# Wellfleet Harbor Sentinel Station



Figure 5: Wellfleet Harbor Long Term Monitoring Stations. Sentinel Station is Station WH-5 for benthic habitat recovery.

Source: Wellfleet Harbor TMDL Report

**Sentinel Stations:** key monitoring points (typically sensitive areas within the watershed) used to track water quality and set a target nitrogen concentration that protects habitats

- TMDL nitrogen concentrations in Cape Cod estuaries range from 0.34 mg/L to 0.55 mg/L
- Wellfleet Harbor TMDL (target nitrogen concentration) = 0.53 mg/L

**Cape Cod Commission (CCC) 25% nitrogen reduction allowance:** For watersheds that don't yet have a TMDL, the CCC recommends that communities plan to reduce total nitrogen loads by approximately 25% from existing conditions.

# Nitrogen Loading

Source / System	Typical Total Nitrogen Concentration (mg/L)	Notes
Natural background	< 1 mg/L	USGS estimate
Title 5 Septic System Effluent	26.25 mg/L	Massachusetts Estuaries Project estimate
Drinking water	<10 mg/L of nitrate-nitrogen	EPA limit to protect human health (maximum contaminant level)
Wastewater treatment facility with biological treatment effluent	3 – 10 mg/L	After biological or chemical nitrogen removal process

# Nitrogen Reduction Targets



# Wellfleet Harbor

## Herring River / The Gut

System Component	Present Attenuated Watershed Load <sup>1</sup> (kg/day)	Target Threshold Watershed Load <sup>2</sup> (kg/day)	Percent watershed reductions needed to achieve target threshold loads
Herring River/The Gut	27.72	27.13	-2.1%

Source: Wellfleet Harbor TMDL Report

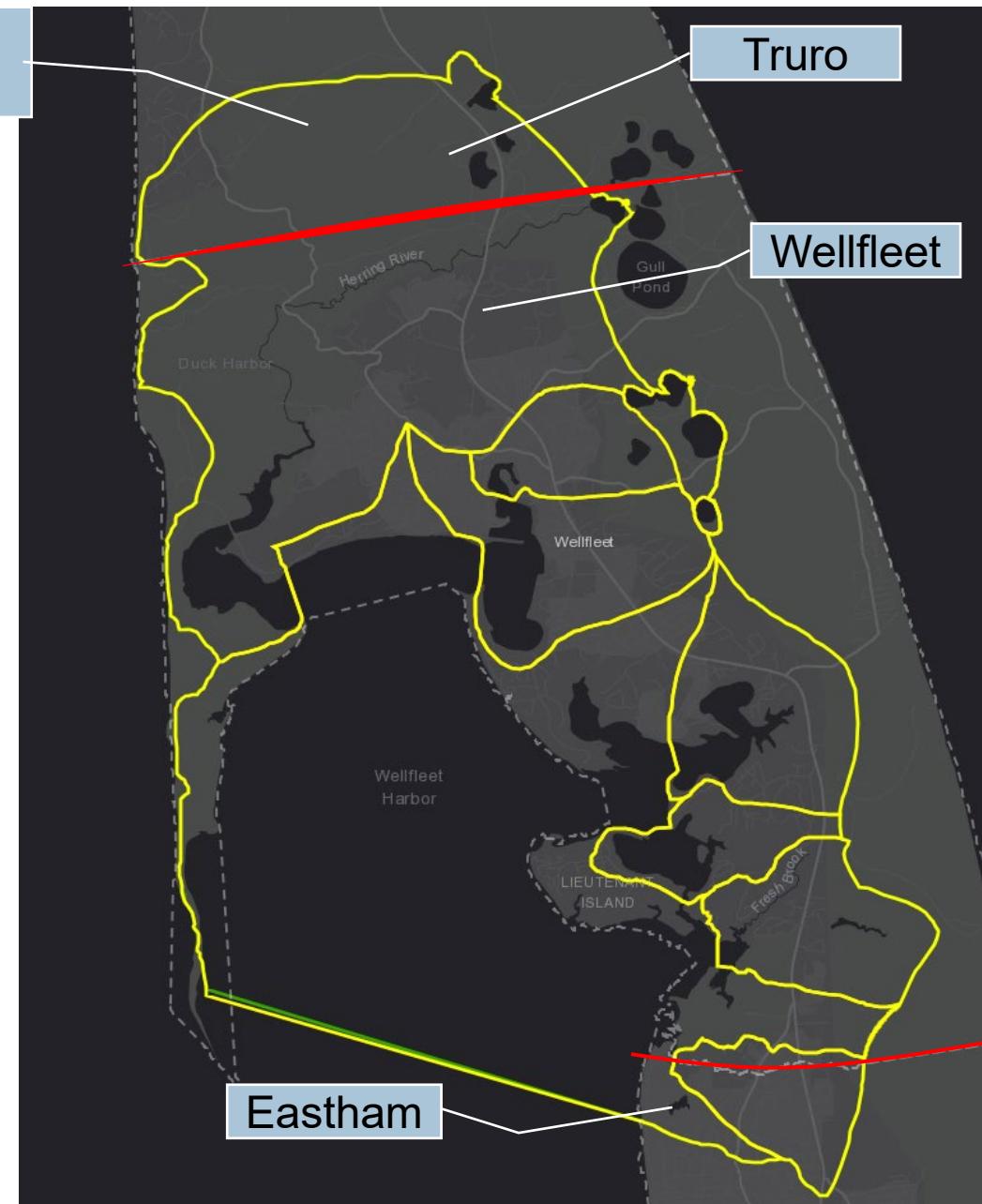
- Herring River is the only subembayment within the Wellfleet Harbor watershed in Truro.
- The estimated portion of Herring River in Truro based on land area, is approximately 42%.

**Truro's estimated removal goal =**

(Total subembayment load – target threshold load) x percent of load in Truro

**Truro's estimated removal goal =**

$(27.72 \text{ kg/d} - 27.13 \text{ kg/d}) * 42\% = 0.25 \text{ kg-N/day}$



Source: Watershed MVP

# Pamet River

Truro's current estimated nitrogen removal goal (based on 25% reduction)

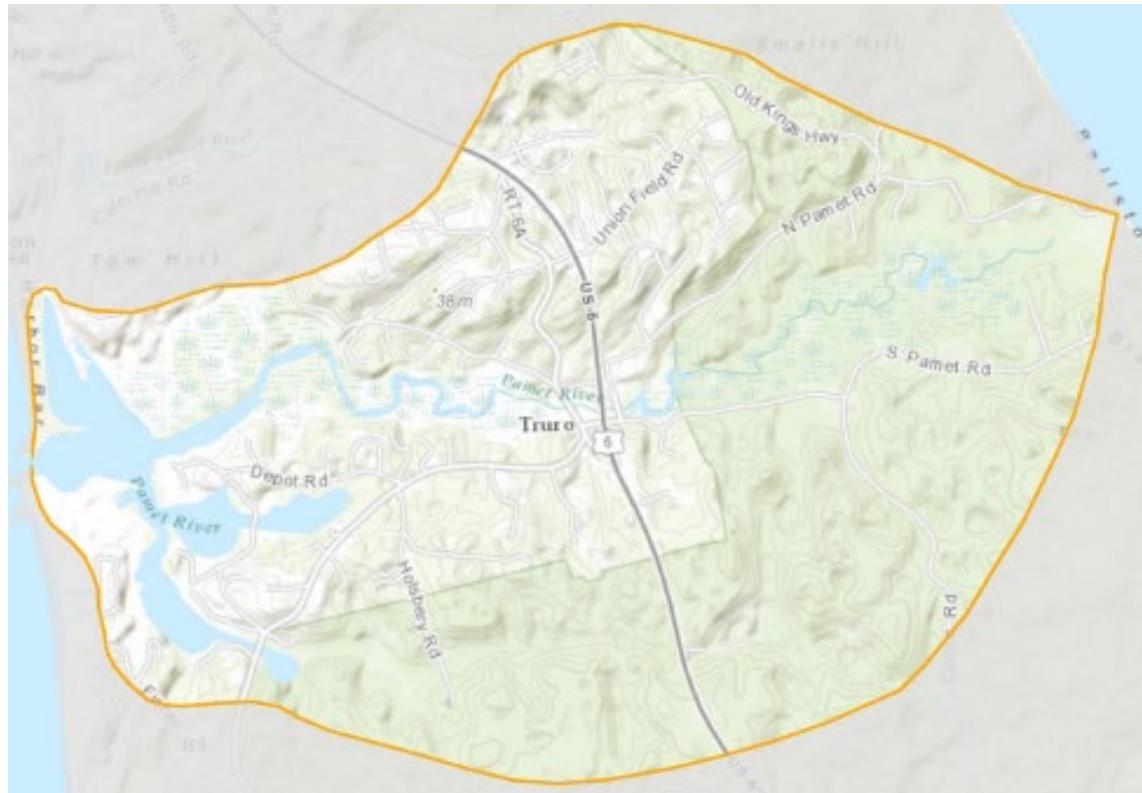
$$= 1,125 \text{ kg-N/yr} = 3.1 \text{ kg-N/day}$$

**TOTAL UNATTENUATED NITROGEN LOAD VALUES (FROM WMVP)**

Pamet River Nitrogen Sources	Total Unattenuated Watershed Nitrogen Load (kg-N/yr)
Wastewater <sup>1</sup>	3,069
Fertilizer <sup>2</sup>	266
Stormwater	738
Other <sup>3</sup>	429
<b>TOTAL WATERSHED LOAD</b>	<b>4,502</b>
Total Watershed Threshold <sup>4</sup>	3,376
<b>TOTAL UNATTENUATED LOAD TO BE REMOVED</b>	<b>1,125</b>

 **TRURO: 100%**

Source: CCC Watershed Report: Pamet River



# Provincetown Harbor

## TOTAL UNATTENUATED NITROGEN LOAD VALUES (FROM WMVP)

Provincetown Harbor Nitrogen Sources	Total Unattenuated Watershed Nitrogen Load (kg-N/yr)
Wastewater <sup>1</sup>	11,939
Fertilizer <sup>2</sup>	1,174
Stormwater	2,929
Other <sup>3</sup>	503
<b>TOTAL WATERSHED LOAD</b>	<b>16,544</b>

■ PROVINCETOWN: 93%

■ TRURO: 7%

Source: CCC Watershed Report:  
Provincetown Harbor

## Truro's estimated removal goal =

Total watershed load x percent of  
load in Truro x 25% removal  
target

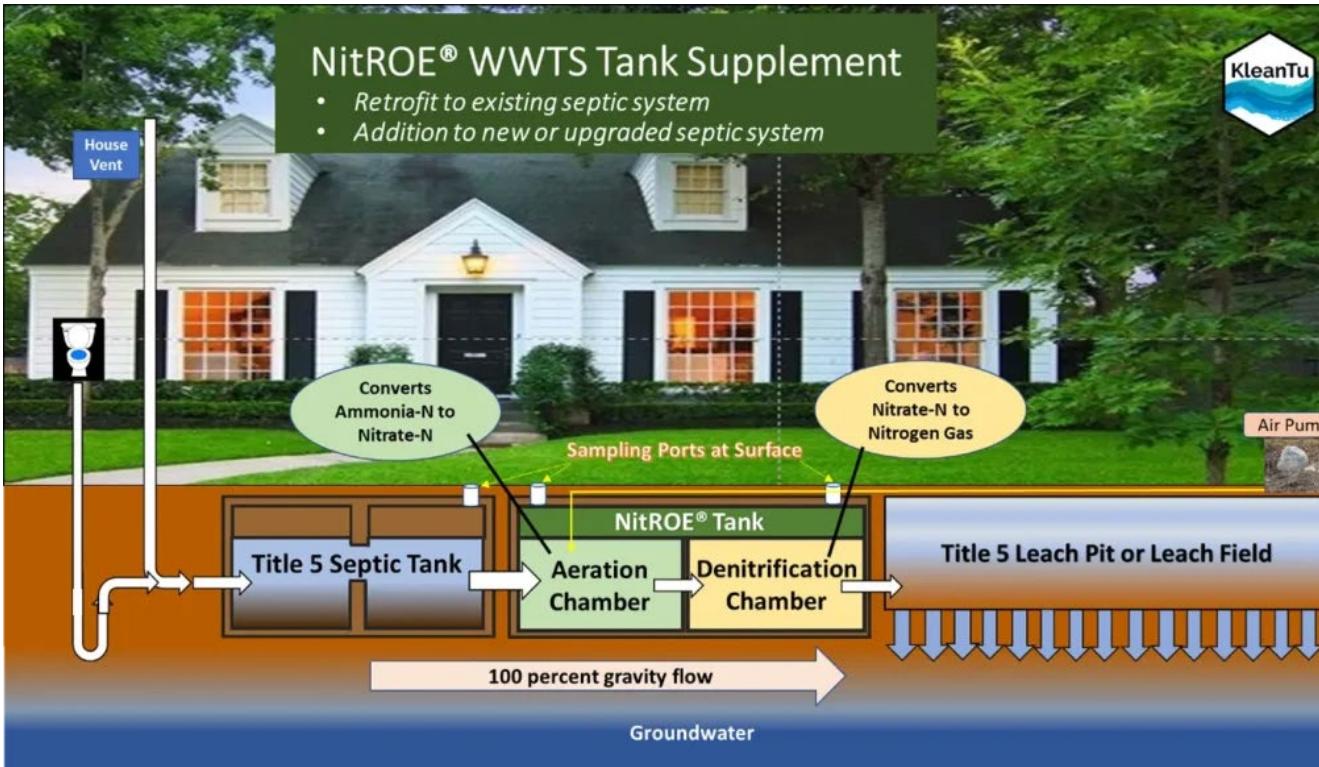
Truro's estimated nitrogen  
removal goal =  $290 \text{ kg-N/yr} = 0.8$   
 $\text{kg-N/day}$



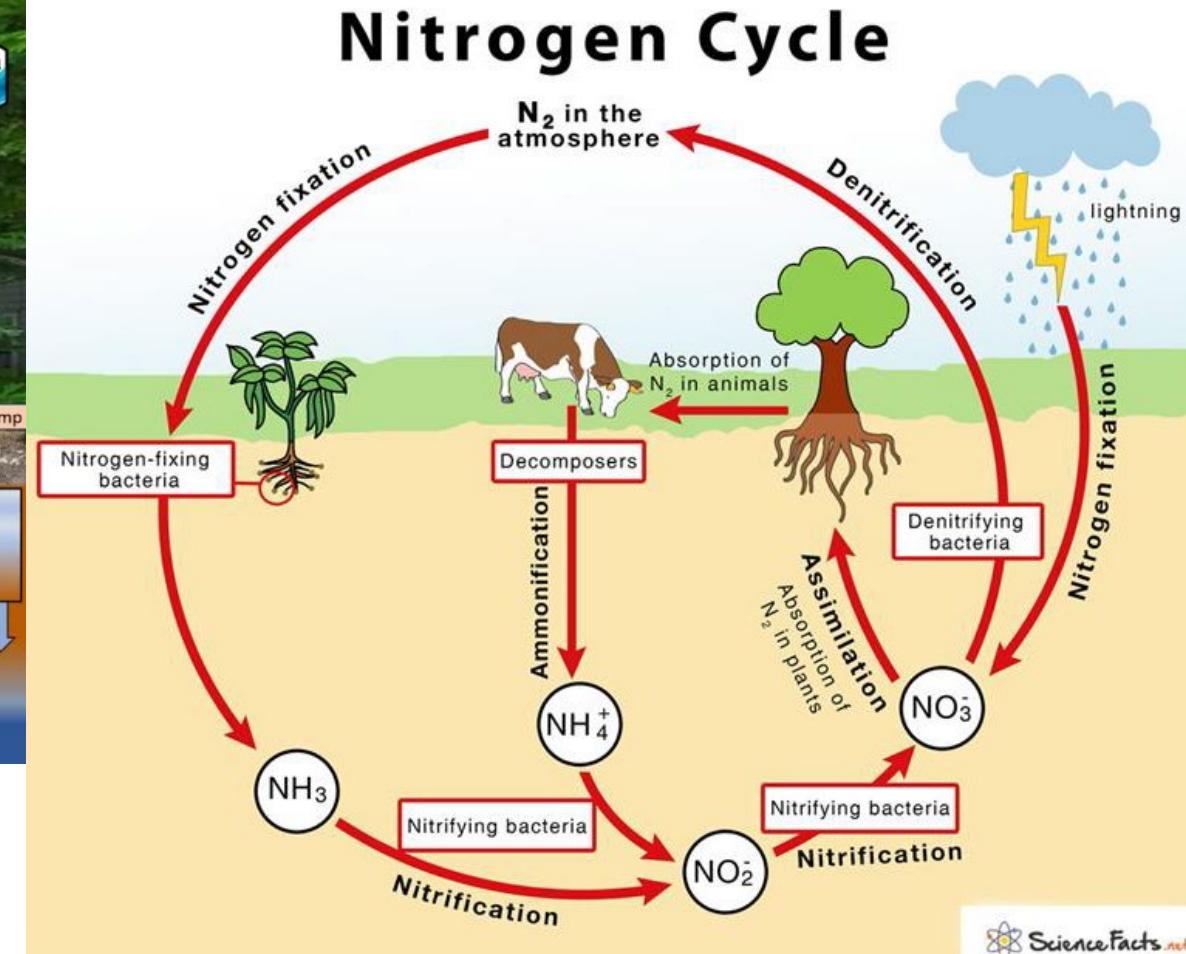
# Nitrogen Management Strategies



# Nitrogen Reducing Septic Systems



Unlike Title 5 Septic Systems, nitrogen-reducing septic systems add **aeration and/or a carbon source** to promote biological processes that **convert nitrogen into harmless nitrogen gas** (denitrification).



# Stormwater Best Management Practices

## DESCRIPTION

Non-Structural Stormwater strategies. These strategies include street sweeping, maintenance of stormwater utilities, education and public outreach programs, land use planning, and IC reduction and control.

## SITING NEEDS

- Varies

## ECO-BENEFITS

- Enhances Habitat / Wildlife / Biodiversity
- Promotes Green Space / Conservation / Recreation
- Improves Management of Flooding / Extreme Events

## PERFORMANCE CHALLENGES

- Requires the creation and enforce of stormwater regulations and policies

## Permitting

### POTENTIAL PERMITTING AUTHORITIES

- Municipal Conservation Commission
- Massachusetts Department of Environmental Protection

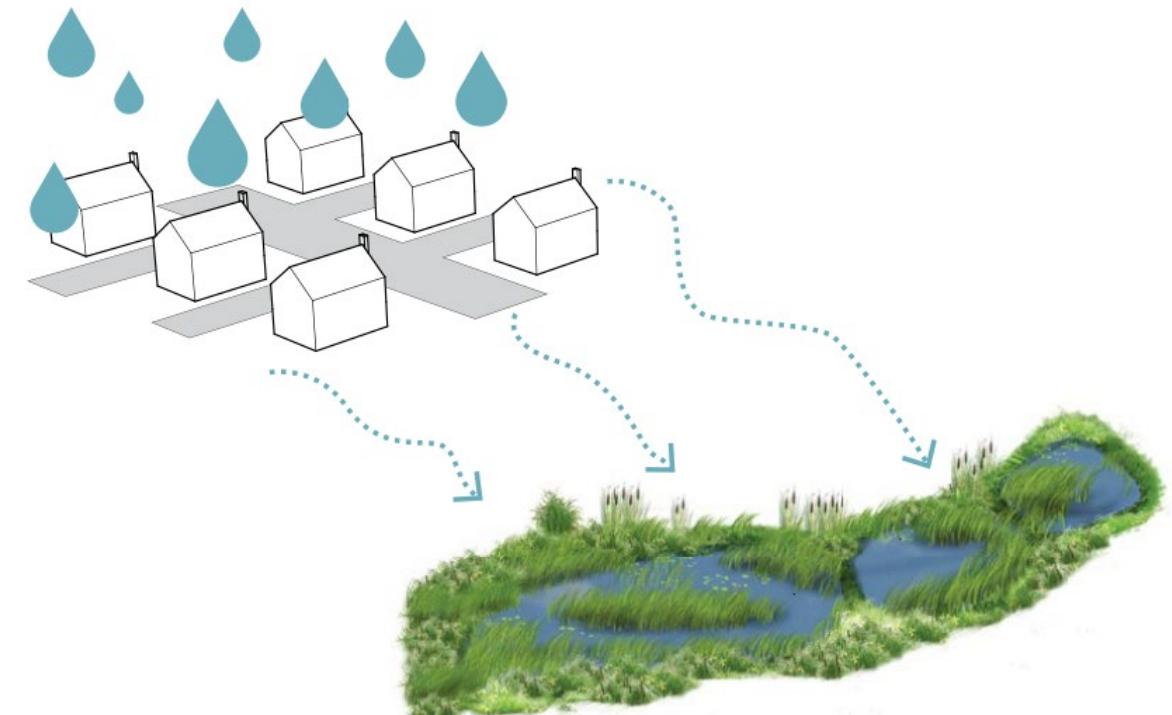
## CLIMATE RESILIENCE: RISKS

- Reduced effectiveness of biological processes as a result of more frequent inundation or exposure to saline water (surface or ground water)

## CLIMATE RESILIENCE: SOLUTIONS

- Ensure frequent maintenance inspections to monitor condition and performance of technology (e.g. achieving nutrient removal targets, health of vegetation)
- Project design and species selection to ensure adequate performance in increasingly saline environments

## REMEDIATION



Source: CCC 208 Plan

Constructed Wetland - Source: CCC 208 Plan

# Fertilizer Bylaws

## DESCRIPTION

This approach relies on managing fertilizer application rates to lawns, golf courses, athletic facilities and cranberry bogs. Residential lawn loading rates could be reduced on existing developed parcels through an intensive public education/outreach program. This could include a “Cape Cod Lawn” branding program, replacing some turf areas with native vegetation, establishing naturally-vegetated buffer strips on waterfront lots, and reducing application rates. Fertilizer loading rates for new development could be accomplished by reducing lot sizes (cluster development), by restricting lawn sizes and/or by incorporating more naturally-vegetated open space areas. Municipalities could directly reduce fertilizer applications on athletic fields and other properties. Golf courses can significantly reduce nitrogen loading rates by using slow-release fertilizers and reducing application rates in rough areas. Cranberry bog fertilizer exports from the bogs can be reduced using tail water recovery systems. Site-specific assessments are needed to estimate load reductions.

## SITING NEEDS

- Fertilizer management does not have specific site requirements.

## ECO-BENEFITS

- Enhances Habitat / Wildlife / Biodiversity

## Permitting

### POTENTIAL PERMITTING AUTHORITIES

- Municipal Board of Health
- Massachusetts Department of Agricultural Resources

## PERFORMANCE CHALLENGES

- Resulting nutrient removal rates are highly dependent on homeowner / landowner behavior and participation in the program
- Site-specific assessments are needed to estimate load reductions

## CLIMATE RESILIENCE: RISKS

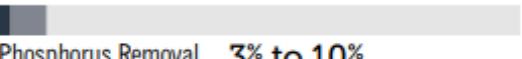
- Fertilizer management does not result in significant climate resiliency risks.

## CLIMATE RESILIENCE: SOLUTIONS

- Climate resiliency solutions are not needed for Fertilizer Management.

## REDUCTION

## Technology Performance



\$24

Removal Cost per kg N  
(avg life cycle)

\$141

Removal Cost per kg P  
(avg life cycle)

20 years

Useful Life

1 to 10 years

Time to See Results

Source: CCC 208 Plan

# Permeable Reactive Barrier

## REMEDIATION

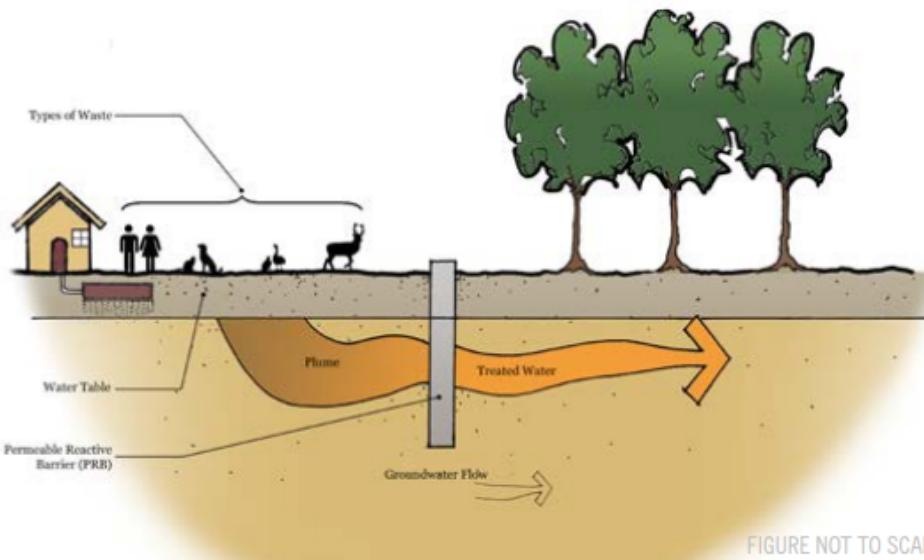


Figure 4-15

## Permeable Reactive Barriers (PRBs) Trench Method



SCALE: SITE/NEIGHBORHOOD

APPROACH: REMEDIATION

SCENARIO PLANNING: SELECTED FOR USE

IDENTIFIED FOR PILOTING

### DESCRIPTION

A permeable reactive barrier (PRB) is an in-situ (installed within the aquifer) treatment zone designed to intercept nitrogen enriched groundwater. Through use of a carbon source (the PRB medium), microbes in the groundwater uptake the nitrogen, denitrifying the groundwater. The trench method PRB uses large trenching equipment to install a mixture of coarse sand, wood chips, compost and/or other materials (medium) in the trench created by the trencher. The vertical wall can be installed to a depth of 40 feet with a width of 1.5 to 3 feet; PRBs can also be installed in large diameter columns. As groundwater flows through the wall, the medium provides a carbon source for microbes living in the groundwater. The microbes consume the carbon source as well as oxygen, developing an anaerobic environment which releases nitrogen gas to the atmosphere, reducing the groundwater nitrogen load before reaching the estuary.

### Technology Performance



Nitrogen Removal 75% to 95%



Phosphorus Removal 50% to 95%

\$158

Removal Cost per kg N  
(avg life cycle)

\$743

Removal Cost per kg P  
(avg life cycle)

20 years

Useful Life

1 to 10 years

Time to See Results

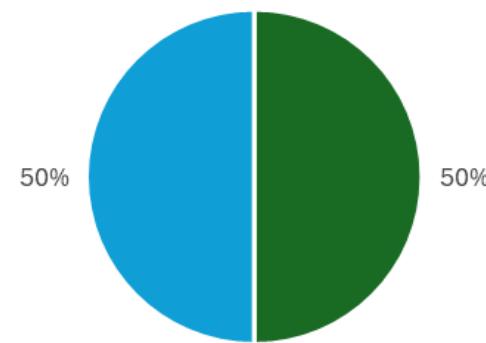
# Draft Nitrogen Management Plans



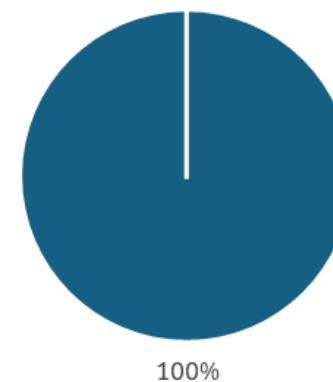
# Wellfleet Harbor: Nitrogen Management Strategies Estimated Reductions

**Estimated nitrogen reduction goal: 0.25 kg-N/day (based on the TMDL)**

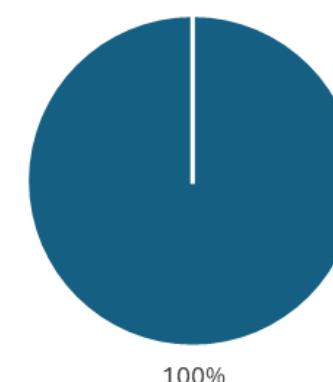
Option 1: Alternative Strategies (1) Percent of Reduction Goal Met



Option 2: Alternative Strategies (2) Percent of Reduction Goal Met



Option 3: Conventional Strategies (3) Percent of Reduction Goal Met



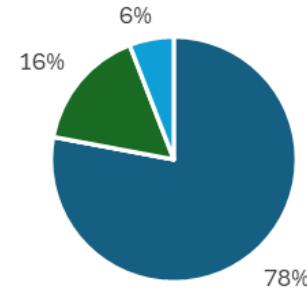
~24 nitrogen-reducing systems  
(or 26%)

~61 nitrogen-reducing systems  
(or 66%)

# Pamet River: Nitrogen Management Strategies Estimated Reductions

**Estimated nitrogen reduction goal: 3.1 kg-N/day (based on the CCC)**

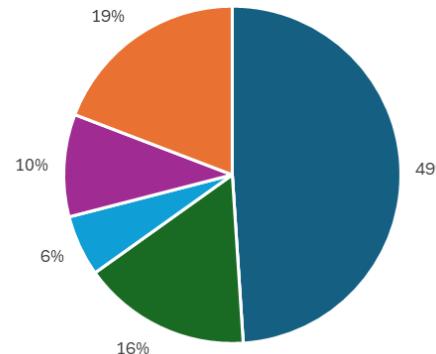
Option 1: Alternative Strategies - Percent of Reduction Goal Met



- Provisional Use Nitrogen Reducing Septic System
- Stormwater BMPs credit
- Fertilizer bylaw credit

~218 nitrogen-reducing systems  
(or 38%)

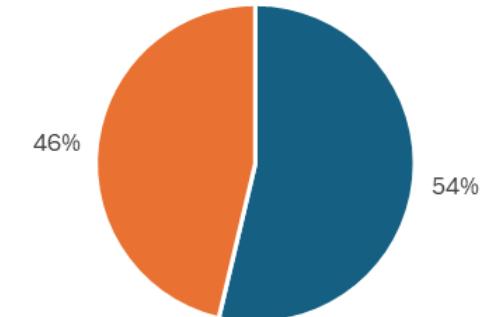
Option 2: Alternative + Conventional Strategies - Percent of Reduction Goal Met



- Provisional Use Nitrogen Reducing Septic System
- Stormwater BMPs credit
- PRB
- Fertilizer bylaw credit
- Cluster System

~98 nitrogen-reducing systems  
(or 17%)

Option 3: Conventional Strategies - Percent of Reduction Goal Met



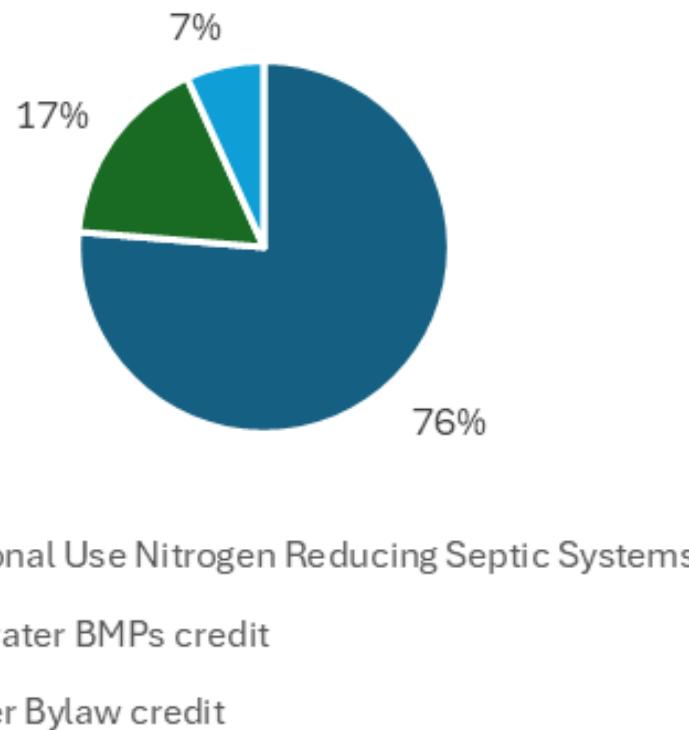
- General Use Nitrogen Reducing Septic System
- Cluster System

~412 nitrogen-reducing systems  
(or 72%)

# Provincetown Harbor: Nitrogen Management Strategies Estimated Reductions

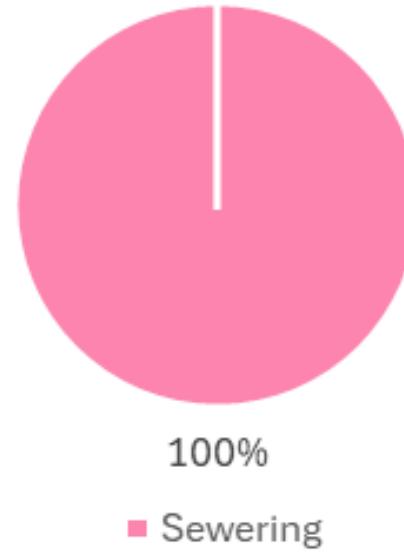
Estimated nitrogen reduction goal: 0.8 kg-N/day (based on the CCC)

Option 1: Alternative Strategies - Percent of Reduction Goal Met



~30 nitrogen-reducing systems (or 30%)

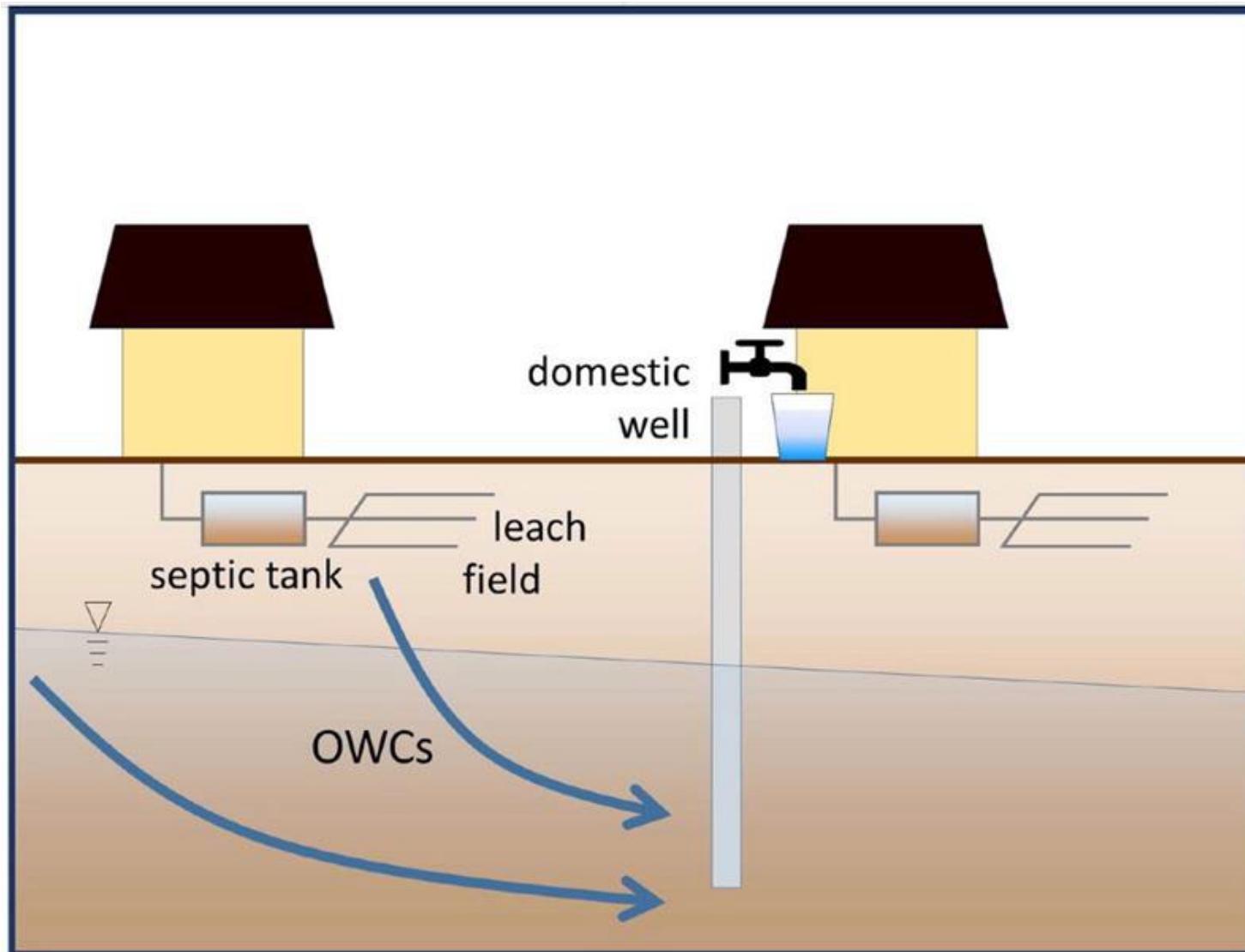
Option 2: Conventional Strategies - Percent of Reduction Goal Met



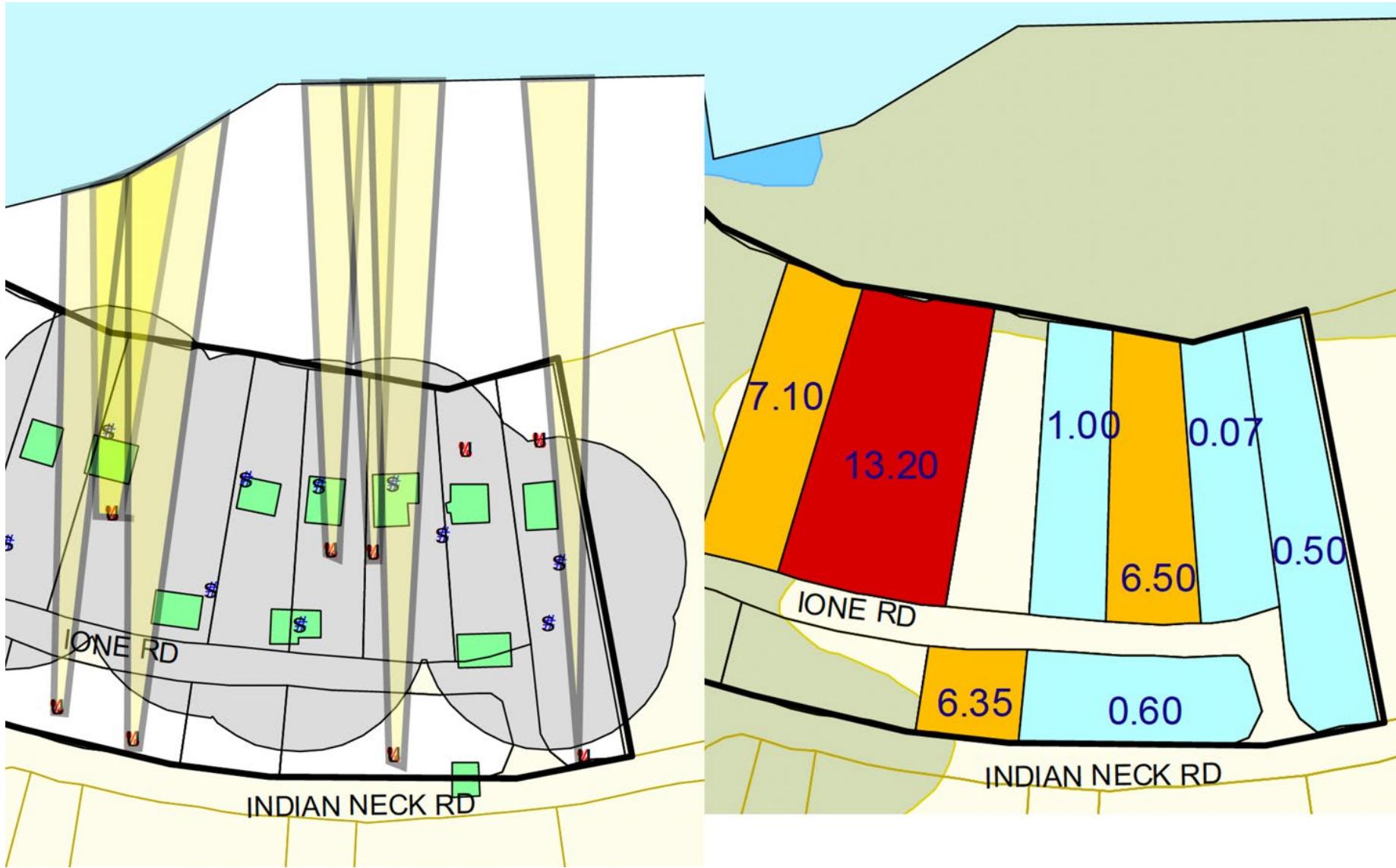
# Public Health Needs



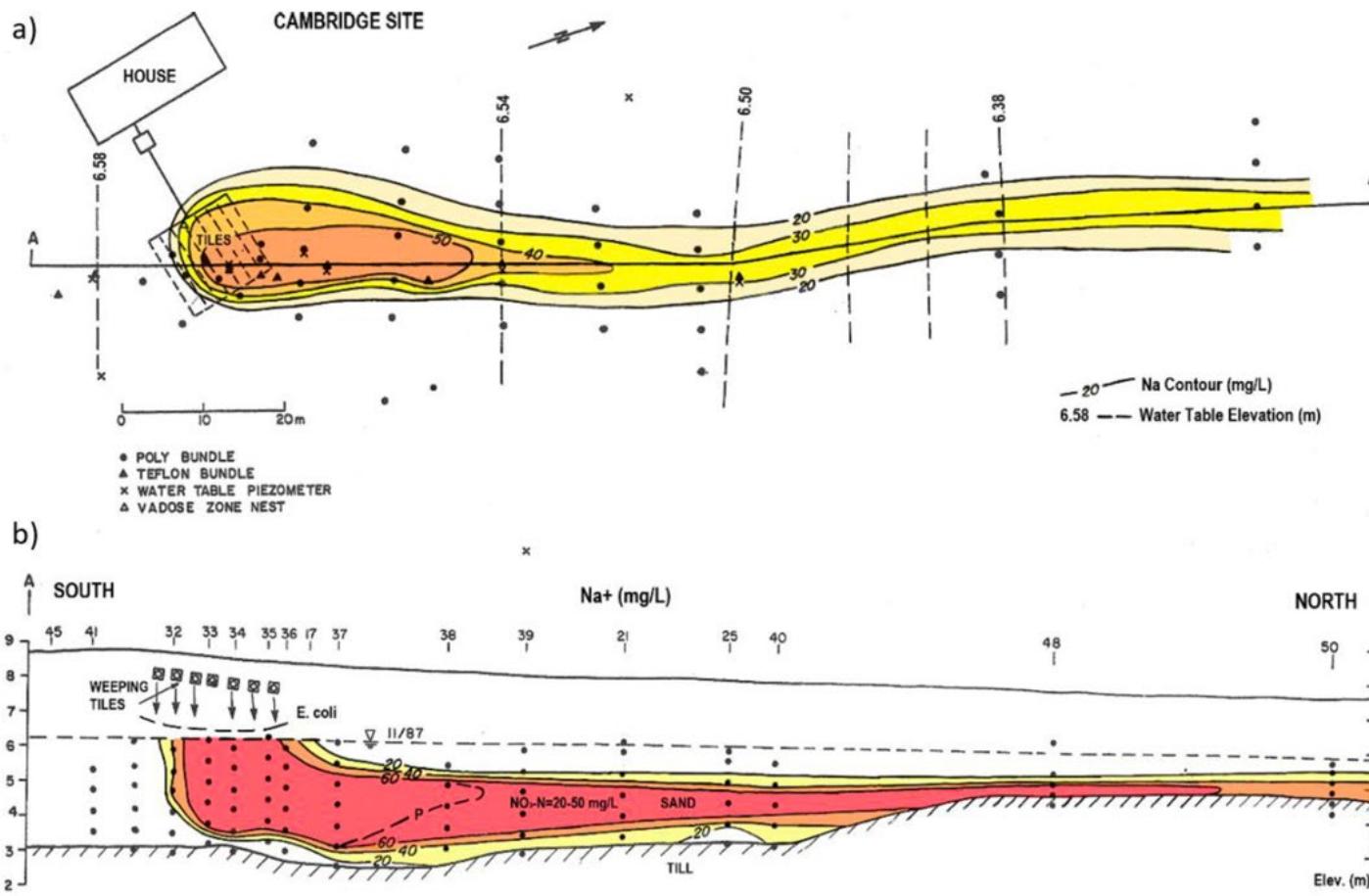
# Cross Section of On-site septic



# Protecting Private Wells

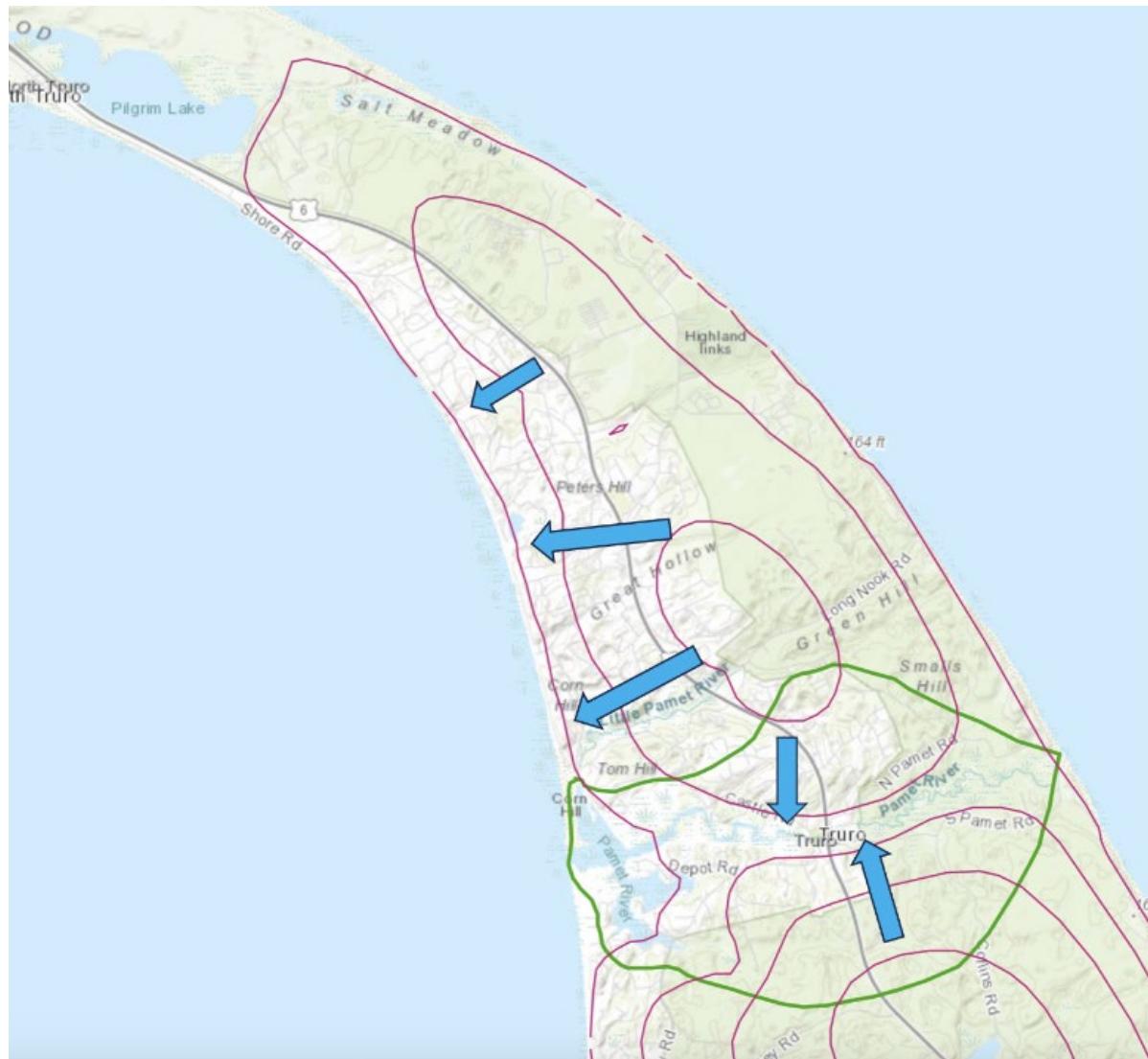


# Protecting Private Wells

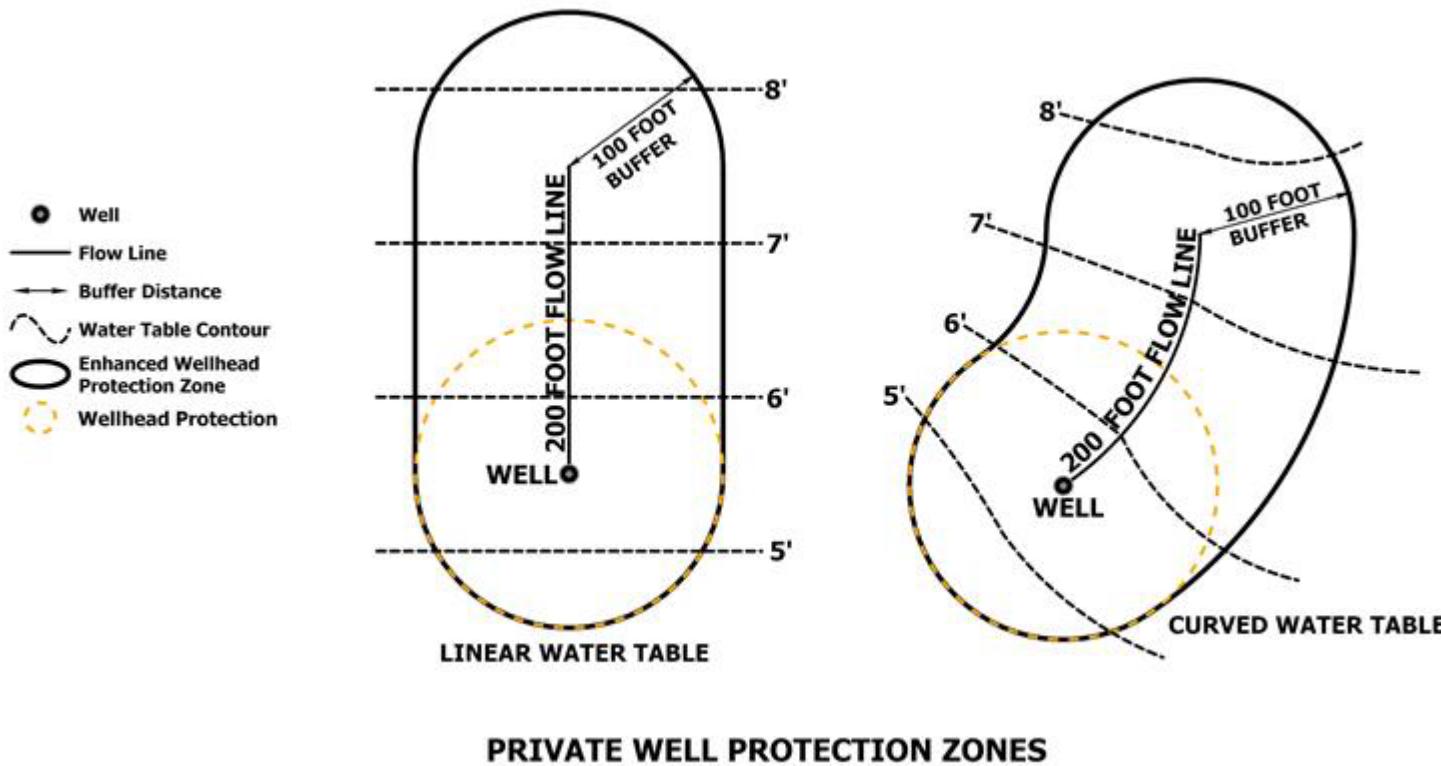


**Figure 2** – A plan view (a) and cross-sectional view (b) of a groundwater plume from a household septic system at the Cambridge site in Ontario, Canada, showing:  $Na^+$  concentration (mg/L), the extent of E. coli ( $> 1$  cfu/100 mL) presence, and phosphate ( $P$ ) zones with concentration greater than 1 mg/L, dashed lines, and range of  $NO_3^-$ -N concentrations (mg/L) in the plume core. Septic tank effluent has mean  $Na^+$  of 98 mg/L,  $NH_4^+$ -N of 30 mg/L and SRP of 8 mg/L (adapted from Robertson et al., 1991; Shadford et al., 1997; and Robertson, 2003).

# Truro Groundwater Table & Flow Direction



# Protecting Private Wells



# Summary

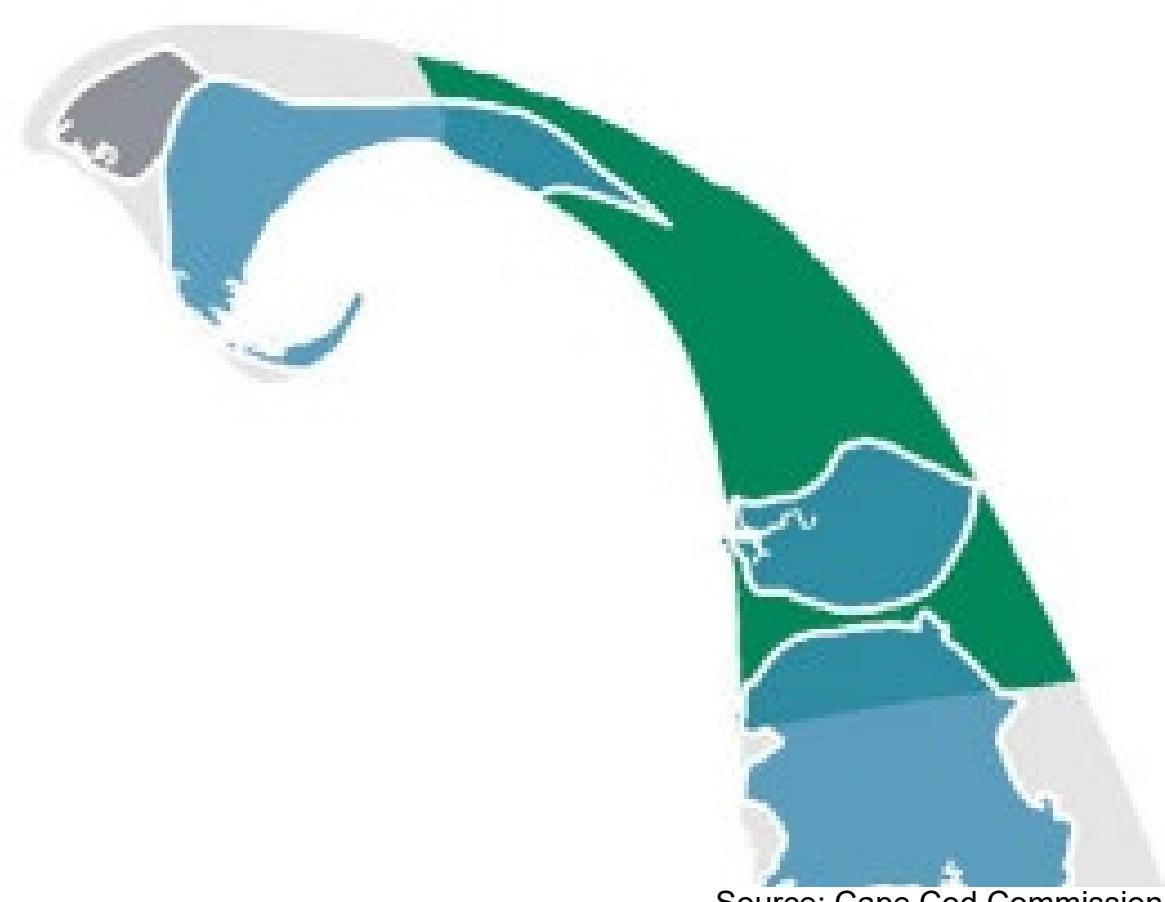
**Goal: Reduce the amount of nitrogen entering Truro's coastal estuaries**

- Wellfleet Harbor
- Pamet River
- Provincetown Harbor

Implement a variety of nitrogen management strategies that are:

- Cost-effective
- Targeted to sensitive areas

**Outcome:** Enhanced water quality, human health, and environmental health



Source: Cape Cod Commission

# Next Steps

- Finalize Draft Truro Comprehensive Watershed Management Plan, Draft to be available on Town Website Friday, October 31<sup>st</sup>
- Public meeting: Tuesday, November 18<sup>th</sup> at 2pm at Truro Town Hall



\* Thank you