Town of Truro Comprehensive Watershed Management Plan

Alternatives Screening Analysis Report and Draft Recommended Plan – rev1

Town of Truro
October 31, 2025

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Executive summary

Introduction

The Truro Alternatives Screening Analysis and Draft Recommended Plan summarizes the evaluation of nitrogen management alternatives to present a draft Recommended Plan to reduce excessive nitrogen loading to the Town of Truro's coastal watersheds. Figure ES-1 shows the planning area for this project, which is the Town of Truro. This report supports compliance with the Massachusetts Department of Environmental Protection (MassDEP) Watershed Permit Regulations (314 CMR 21), and builds upon the findings of the Massachusetts Estuaries Project (MEP) and the Cape Cod Commission (CCC) Watershed Reports.

This report is subject to, and must be read in conjunction with, the limitations set out in Section 10 and the assumptions and qualifications contained throughout the Report.

Background and Purpose

Excess nitrogen from septic systems, fertilizers, and runoff has been identified as the primary cause of eutrophication and degraded water quality in Truro's coastal embayments. Elevated nitrogen concentrations in coastal estuaries contribute to algal blooms and habitat loss for aquatic life, which can negatively impact human and environmental health, degrade recreational water quality, and affect tourism and the local economy. In addition to water quality impacts, increased nitrogen loading in groundwater can increase the risk of elevated nitrogen concentrations in private drinking water wells.

While some nitrogen management strategies, such as upgrading individual septic systems, may appear to provide property specific benefits, the resulting improvements in estuarine health, recreation, and overall water quality represent significant public health benefits. Protecting and restoring water quality supports community well-being, public health, and long-term resilience of Truro's coastal environment. The purpose of this Report is to identify and evaluate feasible nitrogen management reduction strategies for all of Truro's watersheds to improve coastal water quality.

There are three coastal watersheds within the Town of Truro:

– Wellfleet Harbor (located primarily within Wellfleet, with small portions in Eastham and Truro)
– Provincetown Harbor (further referred to as East Harbor; located primarily within Provincetown, with a small portion in Truro)
– Pamet River (located entirely within Truro)

Although the Town has three watersheds, to date, only Wellfleet Harbor has a complete MEP Report and nitrogen Total Maximum Daily Load (TMDL) issued by MassDEP and EPA. The other two watersheds, Pamet River and Provincetown Harbor, do not currently have a MEP Report or an established nitrogen TMDL; however, both have undergone water quality testing that indicates water quality impairments and recommendations for further water quality evaluation. Truro's estimated nitrogen loads and threshold loads are presented in Table ES-1.1. The threshold load represents the maximum nitrogen load in a coastal estuary that will support its established water quality goals.

For Wellfleet Harbor, the nitrogen TMDL was used to determine Truro's threshold load and required reductions. For watersheds without a nitrogen TMDL, the Cape Cod Commission (CCC) 208 Plan recommends that nitrogen-impaired watersheds use an initial nitrogen management planning allowance reduction goal of 25%. The CCC 208 Plan planning allowance was used to establish an initial nitrogen management goal for Pamet River and East Harbor.

Future growth allowances were applied to account for nitrogen loads and required reductions over the 20-year planning period (2027 – 2047). Truro's estimated nitrogen loads and threshold loads are presented in Table ES-1.1.

Table ES-1.1 Estimated Watershed Nitrogen Loads and Threshold Loads

Watershed	Current Total Watershed Nitrogen Load (kg-N/yr)[1,2]	Watersehd Threshold Nitrogen Load (kg-N/yr)	Truro's Portion: Current Watershed Nitrogen Load (kg-N/yr)[4,5]	Truro's Porton: Future (2047) Nitrogen Load (kg-N/yr)[3,4,5]	Truro's Portion: Watershed Threshold Nitrogen Load (kg-N/yr)
Wellfleet Harbor: Herring River / The Gut	10,118	9,902	4,249	4,249	4,159
East Harbor	16,544	4,136	1,158	1,186	869
Pamet River	4,502	3,377	4,502	4,518	3,377
Total	31,164	17,415	9,909	9,953	8,405

Notes:

1. East Harbor and Pamet River current nitrogen load is from the CCC Provincetown Harbor Watershed Report and the CCC Pamet River Watershed Report, respectively.
2. Wellfleet Harbor current nitrogen load is from the Wellfleet Harbor TMDL report.
3. Future nitrogen loads were estimated using the housing developments outlined in the 2025 HPP. The East Harbor future load was estimated using a growth allowance for septic nitrogen load in the Town of Truro.
4. Truro's portion of the watershed load for Provincetown Harbor and Pamet River was calculated using the percent of the load in Truro according to the respective CCC Watershed Report.
5. Truro's portion of the watershed load in Wellfleet Harbor was estimated based on land area.

Table ES-1.2 summarizes Truro's estimated nitrogen reduction goals.

Table ES-1.2 Planning Period Nitrogen Reduction Goals[5]

Watershed	Current Nitrogen Reduction Goal (kg-N/yr)	Future Nitrogen Reduction Goal[4] (kg-N/yr)
Wellfleet Harbor[1]	90	90
East Harbor[2]	289	317
Pamet River[3]	1,125	1,141
Total	**1,504**	**1,548**

Notes:

1. Nitrogen reduction goal is based on Truro's contribution to the Wellfleet Harbor Watershed, in accordance with the MEP reduction goal and methodology. Loads for Wellfleet Harbor are attenuated, in accordance with MEP reports. Attenuation in Wellfleet Harbor is minor.
2. Nitrogen reduction goal is 25% of Truro's load within the Provincetown Harbor watershed. Truro accounts for 7% of the Provincetown Harbor watershed load according to CCC. Loads for East Harbor are unattenuated, as presented in the CCC reports.
3. Nitrogen reduction goal is 25% of the watershed load. Loads for Pamet River are unattenuated, as presented in the CCC reports.
4. Future reduction goals are estimated using the established threshold loads and estimated future loads are based on the housing production plan.
5. For reference, an average single-family home with a Title 5 septic system is estimated to discharge approximately 4.7 kg-N/yr. (Source: Wellfleet Harbor MEP Report).

Alternatives Screening Analysis

An Alternatives Screening Analysis was conducted to evaluate different combinations of nitrogen management strategies to meet the Town's reduction goals for the 20-year planning period in each of its watersheds. Both conventional and alternative nitrogen management strategies were evaluated.

The MassDEP Watershed Permit Regulations (314 CMR 21) define conventional control technologies as *'a combination of physical, chemical, and biological processes that provide primary, secondary, or tertiary treatment and have been proven to be consistently effective for treating wastewater or sewage to remove suspended solids, dissolved solids, biological decomposition of organic matter, pathogens, and nutrients from wastewater. Examples of Conventional Control Technology include but are not limited to sewage treatment plans and enhanced nutrient removal alternative septic systems that the Department accepts as conventional.'*

The MassDEP Watershed Permit Regulations (314 CMR 21) define alternative control technologies as *'a technology or approach that is not a conventional control approach or technology but can be effectively used to remove pollutants from a waterbody or prevent or reduce the introduction of pollutants into a waterbody.'*

Each alternative was screened for its technical feasibility, nitrogen removal efficiency, and cost-effectiveness. Following the technologies screening analysis, a Recommended Nitrogen Management Plan (Recommended Plan) and Contingency Nitrogen Management Plan (Contingency Plan) was developed. The Recommended Plan includes several Alternative Strategies; in accordance with 314 CMR 21, a contingency plan that consists only of Conventional Control technologies is provided. Adaptive management allows the Town to implement Alternative Control technologies, monitor performance over time, and adjust strategies as needed. Pilot strategies will be closely monitored for performance to confirm if nitrogen reduction targets are being met as intended.

Nitrogen Management Alternatives

Based on the Alternatives Screening Analysis, nitrogen management strategies for Truro's three coastal estuaries were selected for the Recommended and Contingency Plans. Tables ES-1.3 through ES-1.5 summarize the nitrogen management strategies and anticipated nitrogen reductions for each of Truro's watersheds.

Table ES-1.3 Wellfleet Harbor Watershed Nitrogen Management Plan

Nitrogen Management Strategy	Estimated Nitrogen Reduction (kg-N/yr)	
	Recommended Plan	Contingency Plan
Stormwater Best Management Practices	54	0
Fertilizer Bylaw	51	0
Conversion of Existing Title 5 Systems to General Use Nitrogen-Reducing Systems – Single and Multi-Family Residential Properties[1]	0	92
Estimated Nitrogen Removed through Nitrogen Management Plan	**105**	**92**
Nitrogen Reduction Goal to Meet TMDL - Truro (Current)	**90**	**90**
Nitrogen Reduction Goal to Meet TMDL - Truro (2047)	**90**	**90**

Notes:

1. General Use Nitrogen-Reducing systems are approved for residential use.

Table ES-1.4 East Harbor Nitrogen Management Plan

Nitrogen Management Strategy	Estimated Nitrogen Reduction (kg-N/yr)	
	Alternative 1[1]	Alternative 2[1]
Stormwater Best Management Practices	51	0
Fertilizer Bylaw	21	0
Conversion of Existing Title 5 Systems to Provisional Use Nitrogen-Reducing Systems[2]	246	
Sewering[3]	0	989
Estimated Nitrogen Removed through Nitrogen Management Plan	**318**	**989**
Nitrogen Reduction Goal - Truro (Current)	**288**	**288**
Nitrogen Reduction Goal - Truro (2047)	**318**	**318**

Notes:

1. Alternatives 1 and 2 are presented in place of Recommended and Contingency plans because the findings of this report conclude that additional analyses should be performed in East Harbor prior to providing a Recommended Plan. For additional information, refer to Section 4.5.3.
2. Provisional Use Nitrogen-Reducing systems are approved for residential and commercial use.
3. Alternative 2 sewering load is the estimated nitrogen load reduction removed by connecting a portion of Beach Point to the Provincetown Wastewater Treatment Facility. The portion selected during discussions with the Town of Truro includes parcels between 361 Shore Drive - 563 Shore Drive.

Table ES-1.5 Pamet River Watershed Nitrogen Management Plan

Nitrogen Management Strategy	Estimated Nitrogen Reduction (kg-N/yr)	
	Recommended Plan	Contingency Plan
Stormwater Best Management Practices	186	0
Fertilizer Bylaw	66	0
Permeable Reactive Barrier	112	0
Cluster System – Pamet River East	220	303
Cluster System – Pamet River West	0	227
Conversion of Existing Title 5 Systems to Provisional Use Nitrogen-Reducing Systems[1]	561	0
Conversion of Existing Title 5 Systems to General Use Nitrogen-Reducing Systems – Single and Multi-Family Residential Properties[2]	0	614
Estimated Nitrogen Removed through Nitrogen Management Plan	**1,145**	**1,144**
Nitrogen Reduction Goal - Truro (Current)	**1,125**	**1,125**
Nitrogen Reduction Goal - Truro (2047)	**1,141**	**1,141**

Notes:

1. Provisional Use Nitrogen-Reducing systems are approved for residential and commercial use.
2. General Use Nitrogen-Reducing systems are approved for commercial use.

Comprehensive Watershed Management Plan

The Comprehensive Watershed Management Plan presents the Recommended and Contingency Nitrogen Management Plans for the Town of Truro through a combination of septic and non-septic nitrogen management strategies.

The Recommended Plan integrates multiple nitrogen management strategies including stormwater best management practices, fertilizer management, onsite nitrogen-reducing septic systems (currently in Provisional Use Status), cluster systems, and permeable reactive barriers.

The Contingency Plan outlines a strategy comprised of traditional nitrogen management technologies (onsite nitrogen-reducing systems (currently in General Use status), centralized wastewater collection, and cluster systems) that would be implemented if the pilot technologies included in the Recommended Plan did not perform as anticipated.

The Adaptive Management Approach will enable the Recommended Plan to be adjusted based on the monitoring results of the various pilot technologies. Coordination with MassDEP will be conducted throughout this process. The Contingency Plan will then only require implementation through this Adaptive Management Program, in whole, or in part, based on the performance of the Recommended Plan.

A Responsible Management Entity (RME) will need to be established to implement the nitrogen-reducing onsite septic system program outlined in the Recommended Plan. The RME is anticipated to oversee the monitoring of the nitrogen-reducing onsite program as part of the Town's Recommended Plan. RME responsibilities could be fulfilled through a Town department or subcontracted.

Planning Level Capital Cost Estimates for the Recommended and Contingency Plan are summarized in Table ES-1.6.

Table ES-1.6 Truro Comprehensive Watershed Management Plan – Planning Level Capital Cost Estimates

Strategy	Recommended Plan – Full Estimated Capital Costs (2025 $)	Contingency Plan – Full Estimated Capital Costs (2025 $)
Fertilizer Management Allowance[1,2]	$-	$-
Stormwater Best Management Practices Allowance[2]	$8.66 M	$-
Permeable Reactive Barrier Allowance[2]	$1.38 M	$-
Nitrogen Reducing Onsite Septic System Program[3,4]	$9.06 M	$32.82 M
Centralized Sewering (Treated at Provincetown WWTF)[5,6]	$-	$14.78 M
Cluster System – Pamet River East[7]	$4.46 M	$5.94 M
Cluster System – Pamet River West[7]	$-	$6.31 M
Total Capital Costs (2025 $)	**$23.56 M**	**$59.86 M**

Notes:

1. No capital cost is carried for a fertilizer management allowance because this strategy does not involve any construction projects. All implementation measures are regulatory actions.
2. Stormwater best management practices, and permeable reactive barrier costs were based on planning level costs from the Cape Cod Commission 208 Plan 2015 Update. Stormwater BMP cost includes budget for implementation of non-structural strategies, including street sweeping, maintenance of stormwater utilities, education and public outreach programs, land use planning, and impervious cover reduction and control.
3. General Use nitrogen-reducing system costs were developed based on the planning values outlined in the 'Comparison of Costs for Wastewater Management Systems Applicable to Cape Cod – Guidance to Cape Cod Towns Undertaking Comprehensive Wastewater Management Planning,' prepared by the Barnstable County wastewater Cost Task Force – April 2010, updated by AECOM (updated April 2014).
4. Provisional nitrogen-reducing system costs are based on recent (2023) construction bids from other Cape Cod towns.

Strategy	Recommended Plan – Full Estimated Capital Costs (2025 $)	Contingency Plan – Full Estimated Capital Costs (2025 $)
5. Recent regional construction bids from Chatham, Barnstable, and Falmouth were used to develop an average per parcel construction cost for the collection system. The sewering cost includes allowances for Truro's contribution to Provincetown for capacity and infrastructure costs. 6. Centralized sewering cost includes an allowance for contributions to Provincetown for infrastructure and capacity costs which were established through discussions between Truro and Provincetown. 7. Cluster system cost estimates were based on vendor quotes obtained in 2025. 8. Planning level project costs are presented in 2025 dollars (ENR January 2025 = 13731.6). Once a construction timeframe is finalized for each project, project costs should be adjusted to the anticipated mid-point of construction. Planning level capital cost estimates for infrastructure recommended as part of a multi-year planning project are typically developed as part of the planning process. As the project progresses, it is critical that these initial estimates are updated and refined at each stage of the planning and design process and prior to construction financing to accurately reflect items that may affect the cost estimates.		

The targeted milestone implementation schedule is included in Table ES-1.7.

Table ES-1.7 Truro Comprehensive Watershed Management Plan – Targeted Milestone Implementation Schedule

Phase	Years		Activity	Nitrogen Reduction (kg/yr)
	Up to 2027		Develop methodology to implement nitrogen-reducing onsite septic system program (i.e. BOH triggers or phased approach)	
1	1 to 5	2027 - 2031	Obtain Watershed Permit for Wellfleet Harbor (by 2030)	
			Enact Fertilizer Reduction Bylaw	138
			Implement Non-Structural Stormwater Best Management Practices and Regulations	291
			Initiate installation of Nitrogen-Reducing Onsite Septic Systems	202[1]
			Initiate recommended evaluations including: Pamet River: PRB location groundwater characterization and piloting, Little Pamet delineation and evaluation Provincetown Harbor: discussions with Provincetown, vulnerability assessment, culvert sizing evaluation Structural stormwater BMPs: site evaluation Cluster systems: conceptual layout development, coordination with property owners, development of design and construction milestones	
1st Watershed Management Plan Update Report Goals: 1. Evaluate monitoring data 2. Outline any changes in Recommended Plans identified through the Adaptive Management Program				
2	6 to 10	2032 - 2036	Install Permeable Reactive Barrier in Pamet River watershed	112
			Install Pamet River East cluster system	220
			Install Nitrogen-Reducing Onsite Septic Systems	202[1]
2nd Watershed Management Plan Update Report Goals: Goals to be established in the 1st Watershed Management Plan Update.				

Phase	Years		Activity	Nitrogen Reduction (kg/yr)
3	11 to 15	2037-2041	Install Nitrogen-Reducing Onsite Septic Systems	202[1]
3rd Watershed Management Plan Update Report Goals: Goals to be established in the 2nd Watershed Management Plan Update.				
4	16 to 20	2042-2046	Install Nitrogen-Reducing Onsite Septic Systems	202[1]
4th Watershed Management Plan Update Report Goals: Goals to be established in the 3rd Watershed Management Plan Update.				

Notes:

1. For planning purposes, it is assumed that the nitrogen-reducing onsite septic system program achieves 25% of its total estimated reduction in each implementation phase.

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List of Commonly Used Acronyms

ACEC	Area of Critical Environmental Concern
ADT	Average Daily Traffic
BMP	Best Management Practice
CCC	Cape Cod Commission
CCNS	Cape Cod National Seashore
CCS	Center for Coastal Studies
CWMP	Comprehensive Watershed Management Plan
CWSRF	Clean Water State Revolving Fund
CZM	Coastal Zone Management
DGA	Designated Geographic Area
EENF	Expanded Environmental Notification Form
EIR	Environmental Impact Report
EJ	Environmental Justice
EOEEA	Executive Office of Energy and Environmental Affairs
FEMA	Federal Emergency Management Agency
GHG	Greenhouse Gas
HPP	Housing Production Plan
IPCC	Intergovernmental Panel on Climate Change
I/A	Innovative and Alternative
I/I	Inflow and Infiltration
MassDEP	Massachusetts Department of Environmental Protection
MassDOT	Massachusetts Department of Transportation
MASSTC	Massachusetts Alternative Septic System Test Center
MCM	Minimum Control Measures
MEPA	Massachusetts Environmental Protection Agency
MEP	Massachusetts Estuaries Project
MHC	Massachusetts Historical Commission
MS4	Municipal Separate Storm Sewer System
NAR	Needs Assessment Report
NEIWPCC	New England Interstate Water Pollution Control Commission
NHESP	Natural Heritage and Endangered Species Program
NOI	Notice of Intent
NRCS	Natural Resources Conservation Service
NSA	Nitrogen Sensitive Area
OHM	Oil and/or Hazardous Materials
OSHA	Occupational Safety and Health Administration
PGP	Programmatic General Permit
PRB	Permeable Reactive Barrier
PV	Photovoltaic
QAPP	Quality Assurance Project Plan
RMAT	ResilientMass Action Team

RME	Responsible Management Entity
SEIR	Single Environmental Impact Report
SMAST	School for Marine Science and Technology
SNEP	Southeast New England Program
SWPPP	Stormwater Pollution Prevention Program
TDH	Total Dynamic Head
TMDL	Total Maximum Daily Load
UIC	Underground Injection Control
UMDI	University of Massachusetts Donahue Institute
USEPA	United States Environmental Protection Agency
WPA	Wetlands Protection Act
WWTF	Wastewater Treatment Facility

1. Introduction

1.1 Project Background and Purpose

The purpose of the Truro Comprehensive Watershed Management Plan (CWMP) Project is to provide an environmentally and economically sound plan for nitrogen management in the Project Planning Area (Planning Area). The Planning Area is defined as the entire Town of Truro, Massachusetts (Town).

In 2001, the Massachusetts Estuaries Project (MEP) was initiated to examine water quality issues in coastal estuaries in Southeastern Massachusetts. The program was created through a partnership between the Massachusetts Department of Environmental Protection (MassDEP), the University of Massachusetts – Dartmouth School of Marine Science and Technology (SMAST), and regional partners including the Cape Cod Commission (CCC) with the purpose of quantifying current nitrogen loads to Southeastern Massachusetts estuaries and to estimate the nitrogen reductions that would be required to support healthy ecosystems.

Although the Town has three watersheds, to date, only Wellfleet Harbor has a complete MEP Report and nitrogen Total Maximum Daily Load (TMDL). The other two watersheds, Pamet River and Provincetown Harbor, do not currently have a MEP Report or an established nitrogen TMDL; however, both have undergone water quality testing that indicates water quality impairments and recommendations for further water quality evaluation.

The CWMP consists of three phases: the Needs Assessment Report (NAR), the Alternatives Analysis, and the Recommended Plan. A Draft NAR was submitted to the Town in July 2024. The NAR evaluated existing conditions, defined a 20-year planning horizon, and estimated current and future wastewater flows and nitrogen loads in eight study areas known to have wastewater management challenges. The NAR estimated nitrogen removal goals for Truro's three watersheds. This Alternatives Screening Analysis Report and Draft Recommended Plan continues the CWMP process by analyzing alternative nitrogen management strategies, screening them for feasibility, evaluating costs and environmental impacts, and ultimately recommending a plan for long-term wastewater and nitrogen management over a 20-year planning period (2027 – 2047).

The Comprehensive Watershed Management Plan specifically focuses on reducing nitrogen loads to Truro's coastal embayments and meeting established nitrogen TMDLs. Other nutrients and contaminants, including phosphorus and contaminants of emerging concern (CECs) such as PFAS and pharmaceuticals, can also degrade water quality and impact ecosystem health. While these stressors are important to monitor and address through broader watershed management, they are not the focus of this analysis. In the future, the Town of Truro may elect to expand water quality monitoring programs, track emerging contaminants, and evaluate additional measures to address non-nitrogen pollutants as part of future watershed planning efforts. Future efforts should include evaluations for Ryder Pond, which has a phosphorous impairment according to the 2022 303(d) list. Future treatment of CECs is outlined in the alternatives assessment.

1.2 Project Area Description

The Town of Truro, Massachusetts is located on Cape Cod and is bordered by the Towns of Provincetown and Wellfleet. The Planning Area for this project is all of Truro within the Town's boundaries and includes the portions of the watersheds within Truro. The NAR identified the wastewater and other nitrogen-related needs within the Planning Area. Truro has three coastal estuary watersheds: Provincetown Harbor, Pamet River, and Wellfleet Harbor. Figure 1-1 provides a map of the Planning Area, delineating the watershed boundaries within Truro.

As stated in Section 1.1, of Truro's three watersheds, currently only Wellfleet Harbor has a nitrogen TMDL. Because nitrogen TMDLs have not yet been set for Provincetown Harbor and Pamet River, the *Cape Cod Commission Watershed Reports for Provincetown Harbor and Pamet River,* both dated October 2017, serve as the current basis for estimating Truro's nitrogen reduction targets in these areas. In the absence of an established TMDL, Cape Cod

Commission reports are often used to provide planning-level nitrogen reduction targets because they apply methods consistent with the MEP approach to estimate watershed nitrogen loads and identify the reductions likely needed to achieve water quality goals.

1.2.1 Wellfleet Harbor

The Wellfleet Harbor watershed is shared by the Towns of Truro, Wellfleet, and Eastham. Wellfleet Harbor is the only watershed in Truro that currently has an established nitrogen TMDL. The Wellfleet Harbor Cape Cod Commission Watershed Report estimates that Wellfleet contributes 87% of the watershed nitrogen load, Eastham contributes 11%, and Truro contributes the remaining 2%. The sub-watersheds in Wellfleet Harbor are:

- Herring River/The Gut (located in the Towns of Truro and Wellfleet)
- Duck Creek (located completely outside of Truro)
- The Cove (located completely outside of Truro)
- Drummer Cove/Blackfish Creek (located completely outside of Truro)
- Hatches Creek (located completely outside of Truro)
- Wellfleet Harbor (located completely outside of Truro)
- Loagy Bay (located completely outside of Truro)

As indicated above, only the Herring River / The Gut sub-watershed is within Truro. A majority of Truro's portion of the watershed is located within the Cape Cod National Seashore (CCNS). The CCNS, managed by the National Park Service, protects sensitive coastal habitats while allowing limited residential and recreational use. Approximately 93% of Truro's portion of Wellfleet Harbor is within the CCNS boundary. The Wellfleet Harbor TMDL Report provides a breakdown of nitrogen thresholds on a sub-watershed level; Truro will need to implement nitrogen-management measures in its portion of Herring River/The Gut to meet the Town's portion of the removal goal.

1.2.2 Provincetown Harbor: East Harbor

The Provincetown Harbor watershed is a coastal estuary shared by Truro and Provincetown. The Provincetown Harbor Cape Cod Commission Watershed Report estimates that Provincetown contributes 93% of the watershed nitrogen load and Truro contributes the remaining 7% of Provincetown Harbor's nitrogen load. Approximately 85% of Truro's land area within the watershed is within the CCNS boundary.

While a nitrogen TMDL has not yet been established for the Provincetown Harbor Watershed, a Water Quality Monitoring Program (2007 – 2009), supported by the 604(b) grant indicated fair to poor water quality in East Harbor (within the Provincetown Harbor watershed). The findings indicated that the poor water quality in East Harbor is likely impacting the health of the estuarine habitat and the report recommended that the Towns of Truro and Provincetown would benefit from a detailed assessment of the levels of habitat impairment and the development of nutrient related thresholds for the embayment. The same study indicated moderate to high to moderate water quality in Provincetown Harbor and recommended that MEP analysis is warranted for the East Harbor Lagoon Estuary.

Additionally, the 'Integrated Water Resources Management Plan (IWRMP), Phase I and Phase II' reports, prepared by Weston & Sampson and dated October 2014 evaluated nutrient loading impacts to Truro's groundwater and surface water resources. The findings of the Phase I report indicate that the following locations within Provincetown Harbor require future efforts to address issues:

Beach Point: The primary concern identified in the Beach Point area is wastewater management options. Beach Point is a primarily commercial zone that sees a significant influx of summer visitors, creating significant increases in nitrogen loads. The IWRMP indicated that groundwater flow from Beach Point is carried to East Harbor.

East Harbor Lagoon (also referred to as Pilgrim Lake): East Harbor Lagoon is a significant water body situated just north and west of Moon Pond. East Harbor Lagoon has seen significant algal blooms, odor problems, and increasing eutrophication over the last two decades, which are attributed to increased nutrient loading from stormwater sources and wastewater inputs. According to Massachusetts Department of Transportation (MassDOT) records, the majority of

stormwater drainage from Route 6 drains directly to East Harbor. Route 6 makes up a majority of the impervious surface that drains to East Harbor.

Because the findings of the various water quality monitoring and sampling programs in the Provincetown Harbor watershed indicate that the vulnerable portion of the watershed is East Harbor, this report will focus on addressing nutrient loading in the East Harbor Estuary. Although the CCC Provincetown Harbor Watershed Report does not include a subwatershed delineation of East Harbor, it is assumed that a majority of Truro's portion of land area in the Provincetown Harbor watershed, which includes Beach Point and Pilgrim Heights, drains into East Harbor. For the purposes of this report, this area (Truro's portion of the Provincetown Harbor watershed) will be referred to as East Harbor.

1.2.3 Pamet River

The Pamet River watershed is located entirely in the Town of Truro. The Pamet River Cape Cod Commission Report provides an estimate of the estuary's nitrogen load. Approximately 51% of the land area in the Pamet River watershed is within the CCNS boundary. The Pamet River is divided into two distinct hydrological sections: the upper Pamet River (upstream of the clapper valve installed west of Route 6) and the lower Pamet River (downstream of the clapper valve). The upper Pamet River is freshwater, while the lower Pamet River is a salt marsh estuary. During significant Atlantic Ocean storms in the late 1900s, Ballston Beach, located on the eastern coast of Truro, had been over-washed. A 1992 storm resulted in the Upper Pamet River valley being flooded with four feet of saltwater.[1] To this day, during storm events, Ballston Beach still floods the upper Pamet River Valley.

The Little Pamet River, located to the north of the main Pamet River system, is not included in the Cape Cod Commission watershed delineation and therefore was not part of the loading analysis. However, as shown in the Scientific Investigations Map I-2857, the U.S. Geological Survey (USGS) delineates the recharge area of the Little Pamet River, suggesting that it may contribute flow to the larger Pamet River system (Figure 1-2). When additional data becomes available and an MEP report is developed, the Little Pamet River should be considered and incorporated into Truro's nitrogen management planning. As discussed in further sections of this report, it is recommended that next steps include watershed delineations and water quality monitoring of the Little Pamet River.

While a nitrogen TMDL has not yet been established for the Pamet River Watershed, a Water Quality Monitoring Program (2007 – 2009), supported by the 604(b) grant indicated poor to moderate water quality in the Pamet River. The findings indicated that the poor water quality in Pamet River is likely impacting the health of the estuarine habitat and the report recommended that the Town of Truro would benefit from a detailed assessment of the levels of habitat impairment and the development of nutrient related thresholds for the watershed.

1.3 Planned Review Process

An environmental review process by the Executive Office of Energy and Environmental Affairs (EOEEA) will be initiated for this project through the Massachusetts Environmental Policy Act (MEPA) process. All of the documents prepared under the MEPA process will be submitted to the MassDEP, MEPA, and other interested parties for review and comment.

1.4 Public Participation and Outreach

The Town of Truro actively participates in public awareness outreach efforts on water quality issues. Public presentations were given at the following Town of Truro meetings:

– July 18th, 2023, Board of Health Meeting
– September 25th, 2025, Joint Select Board and Board of Health Meeting

[1] Eichner, E., Cambareri, T., Livingston, K., Sobzak, B., & Smith, B. (1997) *Pamet River Investigation Groundwater Assessment Study, Truro Massachusetts*. Cape Cod Commission Water Resources Office. Retrieved October 20, 2025, from https://www.truro-ma.gov/DocumentCenter/View/627/1997-Pamet-River-Investigation-GW-Assessment-Study-PDF

– October 14th, 2025, Board of Health Meeting
– November 18th, 2025, Board of Health Meeting

Additionally, the Town's Board of Health issues a monthly Water Resources Report; the report covers wastewater and drinking water and is reviewed at the second monthly meeting each month.

Meeting documents (including monthly Water Resources Reports) can be found on the Town's Board of Health webpage: **Board of Health | Truro, MA**.

The Public Participation and Outreach Program includes both in-person and remote public meetings scheduled during varying times to provide multiple opportunities for interested parties to participate in scheduled meetings.

Advance notice of the MEPA filing for the Expanded Environmental Notification Form (EENF) with a request for a Single Environmental Impact Report (SEIR) will be provided to the Environmental Justice (EJ) Distribution List developed by MEPA. EJ populations will be provided with advance notice for all MEPA filings associated with the Truro CWMP.

1.5 References

This section provides documentation of the sources referenced in this report. References include materials provided to the project team that directly informed the findings, technical and reference materials used for background information, and previous reports developed by GHD that support the methodologies and analyses presented in this Alternatives Screening Analysis and Draft Recommended Plan. An abbreviated name for each reference is provided in parenthesis and is used consistently to refer to that source throughout the body of this report.

1.5.1 Summary of Prior Reports and Reference Resources

– *'Pamet River Investigation Groundwater Assessment Study, Truro Massachusetts'*, prepared by Eichner, Cambareri, Livingston, Sobczak and Smith for the Cape Cod Commission Water Resources Office and dated 1997 (short title: Pamet River Investigation)
– *'Source Water Assessment and Protection (SWAP) Report for Provincetown Water Department'*, prepared by the Massachusetts Department of Environmental Protection and dated April 2004 (short title: SWAP Report)
– 'Ground-Water Recharge Areas and Traveltimes to Pumped Wells, Ponds, Streams, and Coastal Water Bodies, Cape Cod, Massachusetts (Scientific Investigations Map I-2857), prepared by D. Walter, J. Masterson, and K. Hess of the US Geological Survey and dated 2004 (short title: USGS Scientific Investigations Map I-2857)
– *'Massachusetts Stormwater Handbook, Volumes 1–3'*, prepared by the Massachusetts Department of Environmental Protection and dated 2008 (updated 2016) (short title: Massachusetts Stormwater Handbook)
– *'Summary of Water Quality Monitoring Program for the Provincetown Harbor, East Harbor Lagoon, Pamet Harbor and Hatches Harbor Embayment Systems (2007–2009) Final'*, prepared by the Coastal Systems Laboratory School of Marine Science and Technology (University of Massachusetts Dartmouth) and dated September 2010 (short title: Water Quality Monitoring Program 2007–2009)
– *'Provincetown 604(b) Water Quality Report'*, prepared by the Massachusetts Department of Environmental Protection and dated 2010 (short title: Provincetown 604b Report)
– *'Comparison of Costs for Wastewater Management Systems Applicable to Cape Cod; Guidance to Cape Cod Towns Undertaking Comprehensive Wastewater Management Planning'*, prepared by the Barnstable County Wastewater Task Force and updated by AECOM, dated April 2010 and updated April 2014 (short title: Cape Cod Wastewater System Costs Report)
– *'Truro Integrated Water Resources Management Plan, Phase I'*, prepared by Weston & Sampson and dated October 2014 (short title: IWRMP Phase I)
– *'Cape Cod Area Wide Water Quality Management Plan Update (208 Plan)'*, prepared by the Cape Cod Commission and dated June 2015 (short title: Cape Cod 208 Plan Update)

- *'Community Housing Needs Assessment'*, prepared for the Truro Housing Authority by Development Cycles and dated September 2015 (short title: 2015 Community Housing Needs Assessment)
- '*TR-16 Guides for the Design of Wastewater Treatment Works'*, prepared by the New England Interstate Water Pollution Control Commission, revised 2016 (short title: TR-16)
- *'Massachusetts Estuaries Project Linked Watershed-Embayment Model to Determine Critical Nitrogen Loading Thresholds for the Wellfleet Harbor Embayment System'*, prepared by the University of Massachusetts Dartmouth School of Marine Science and Technology and the Massachusetts DEP and dated March 2017 (short title: Wellfleet Harbor MEP Report)
- *'Watershed Report: Outer Cape Pamet River'*, prepared by the Cape Cod Commission and dated October 2017 (short title: Pamet River Watershed Report)
- *'Watershed Report: Outer Cape Provincetown Harbor'*, prepared by the Cape Cod Commission and dated October 2017 (short title: Provincetown Harbor Watershed Report)
- *'Watershed Report: Outer Cape Wellfleet Harbor'*, prepared by the Cape Cod Commission and dated October 2017 (short title: Wellfleet Harbor Watershed Report)
- *'Cape Cod Area Wide Water Quality Management Plan Update – 2017 Implementation Report'*, prepared by the Cape Cod Commission and dated n.d. (short title: 208 Plan Implementation Report)
- *'Truro Integrated Water Resources Management Plan Phase II Report for the Water Resources Oversite Committee'*, prepared by Weston & Sampson and dated February 2018 (short title: IWRMP Phase II)
- *'Massachusetts Water Conservation Standards'*, prepared by the Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs and the Water Resources Commission and dated July 2018 (short title: Massachusetts Water Conservation Standards)
- *'Increasing Coastal Resiliency Through Intermunicipal Shoreline Management. Phase 1 Final Report Prepared for the Towns of Eastham, Wellfleet, Truro and Provincetown. Tech Rep: 20-CL-04'*, prepared by the Coastal Processes and Ecosystems Lab at the Center for Coastal Studies Provincetown Massachusetts and dated 2020 (short title: Coastal Resiliency IMA Phase 1)
- *'2021 Climate Action Plan Cape Cod'*, prepared by the Cape Cod Commission and dated July 2021 (short title: Climate Action Plan)
- *'Truro Conservation Regulations'*, prepared by the Town of Truro Health and Conservation Department and revised October 2021
- *'Phase I Environmental Site Assessment and Phase II Limited Subsurface Investigation: 2 Sand Pit Road and 9 Noons Drive, Truro, Massachusetts'*, prepared by Horsley Witten Group, Inc. and dated May 2023
- *'Final Massachusetts Integrated List of Waters for the Clean Water Act 2022 Reporting Cycle'*, prepared by the Massachusetts Executive Office of Energy and Environmental Affairs, Department of Environmental Protection, and Bureau of Water Resources and dated May 2023
- *'Groundwater Protection Priorities for the Walsh Property Master Plan to Sustain Long Term Drinking Water Availability and Quality'*, prepared by Thomas Cambareri, Sole Source Consulting and dated June 2023 (short title: Walsh Property Groundwater Protection Report)
- *'314 CMR 21.00 Watershed Permit Regulations'*, prepared by the Massachusetts Department of Environmental Protection and dated July 2023 (short title: Watershed Permit Regulations)
- *'Final Wellfleet Harbor Embayment System Total Maximum Daily Load for Total Nitrogen'*, prepared by the Commonwealth of Massachusetts Office of Energy and Environmental Affairs, Massachusetts DEP, and Bureau of Water Resources, and dated August 2023 (short title: Wellfleet Harbor TMDL Report)
- *'Town of Truro Local Comprehensive Plan'*, prepared by the Truro Local Comprehensive Plan Committee and dated October 2023 (short title: 2023 Truro Local Comprehensive Plan)
- *'2023 Annual Drinking Water Quality Report for the Provincetown Water Department'*, prepared by the Provincetown Water Department and dated 2023 (short title: 2023 Drinking Water Quality Report)

- *'2023 New York State Greenhouse Gas Emissions Report: Waste Sector'*, prepared by the New York State Department of Environmental Conservation and dated December 2023 (short title: NYS Waste GHG Emissions Report)
- Truro Barn Inspection Data, prepared by the Truro Board of Health and dated 2023 (short title: Truro Barn Inspection Data)
- *'Reducing Wastewater Nitrogen Loading by > 90% with Carbon-Amended Septic Systems: A Field Demonstration in Barnstable (Cape Cod), Massachusetts'*, prepared by U.S. Environmental Protection Agency, Office of Research and Development; Massachusetts Alternative Septic System Test Center; U.S. Geological Survey, New England Water Science Center; Barnstable Clean Water Coalition; and Horsley Consulting and dated 2024 (short title: Shubael Pond Nitrogen-Reducing Septic System Study)
- *'University of Massachusetts Donohue Institute (UMDI) Massachusetts Population Projections'*, prepared by UMDI and updated 2024 (short title: UMDI Massachusetts Population Projections)
- *'Notice of Intent (NOI) to Apply for a Watershed Permit for Wellfleet Harbor Watershed'*, prepared by GHD and dated July 2024 (short title: NOI for Wellfleet Harbor)
- *'Truro Request to serve Walsh Property – Staff Recommendations for advancing request'*, prepared by Cody J. Salisbury, Water Superintendent of Provincetown and dated February 2025
- *'Cape Cod Commission Housing Profile: Truro'*, prepared by the Cape Cod Commission and dated April 2025 (short title: Truro Housing Profile)
- *'Truro Board of Health Regulations'*, prepared by the Town of Truro Board of Health and revised May 2025
- *'Town of Truro Housing Needs Assessment and Production Plan'*, prepared by JM Goldson LLC and dated June 2025 (short title: 2025 HPP)
- *'Cape Cod Towns Guide to Undertaking Comprehensive Wastewater Management Planning'*, prepared by the Cape Cod Commission and dated n.d. (short title: CCC Guide to Wastewater Management)
- *'Centers for Disease Control and Prevention – Harmful Algal Blooms: Contributing Factors and Impacts'*, prepared by the Centers for Disease Control and Prevention and dated n.d. (short title: CDC HAB Contributing Factors)

1.5.2 Previous Reports Prepared by GHD

- 'Draft Needs Assessment Report (NAR)', prepared by GHD and dated July 2024 (short title: Draft NAR)
- 'Draft Beach Point Wastewater Treatment Alternatives Technical Memorandum', prepared by GHD and dated July 2024 (short title: Draft Beach Point Memorandum)
- 'Draft Noons Property Evaluation Memorandum', prepared by GHD and dated May 2024 (short title: Noons Property Evaluation)

2. Summary of NAR Analyses

The *Draft Needs Assessment Report (NAR), prepared by GHD and dated July 2024*, utilized existing information and estimates of future land use, population projections, and water usage data to project future wastewater flows and nitrogen loadings for the planning period.

2.1 Current Water Quality Conditions

Current water quality conditions highlight the need for nitrogen management and strategic environmental planning within the Town of Truro. Both groundwater and surface water systems play a crucial role in determining overall water quality, as they interact and influence each other within the local watersheds. Concerns about groundwater contamination (i.e., nitrate concentrations in private wells) and surface water issues (i.e., nitrogen loading in coastal

estuaries) highlight the need for a comprehensive approach to Truro's water quality assessment. Further information on existing water quality conditions can be found in Section 2.4 and Section 5 of the Draft NAR, which utilized existing data and projections for future land use, population, and water usage to estimate future wastewater flows, nitrogen loadings, and nitrogen reduction goals.

The Truro Health & Conservation Departments maintain a database of water quality data including nitrate concentration data from private wells. The water quality data is limited, as private well water quality sampling is typically only required prior to the sale of a property, submission of building permits and septic permits, or for a rental registration. Figure 2-1 shows areas of documented nitrate-nitrogen concentrations over 5 mg/L (based on available Town data).

Wellfleet Harbor has an established nitrogen TMDL. The TMDL quantifies the maximum nitrogen load (nitrogen threshold) that an estuary can receive while still maintaining water quality goals. The data from the Wellfleet Harbor TMDL Report was used to establish nitrogen management goals for this watershed.

Initial water quality evaluations by SMAST (as summarized in section 2.4 of the NAR, Appendix A), indicate signs of eutrophication in East Harbor and Pamet River. Documented impacts of excessive nitrogen inputs into coastal estuaries include aesthetic degradation from excessive algae blooms, disruption to benthic communities (animals living in the coastal pond sediments), and loss of native eelgrass beds.

The Center for Coastal Studies (CCS) is conducting an ongoing water quality monitoring program in Cape Cod Bay. A key component of the CCS program is tracking nitrogen loading, including sewage nitrogen. CCS uses monitoring sites to collect water samples and track environmental conditions. Many CCS monitoring sites are identified by the Massachusetts Estuaries Project (MEP) as sentinel stations. Sentinel stations are used by the MEP to determine nitrogen thresholds for an estuary. The MEP often identifies a key sentinel station which is used as the representative location where nutrient and water quality measurements are closely monitored.

As discussed with MassDEP in 2024, the Cape Cod Commission (CCC) 208 Plan recommends that nitrogen-impaired watersheds without MEP reports or TMDLs use an initial nitrogen management planning allowance of 25% to estimate nitrogen reduction goals. The CCC planning allowance was used to establish an initial nitrogen management goal for Pamet River and East Harbor. This initial planning allowance will need to be refined as scientific evaluations progress for both watersheds.

2.2 Estimated Watershed Nitrogen Sources

The MEP and TMDL reports estimate current nitrogen sources within a watershed. The following table summarizes the current (at the time of the MEP project) sources of nitrogen to the Herring River subembayment in the Wellfleet Harbor watershed (the only subembayment in the watershed that is within Truro), as presented in Figure IV-3b of the Wellfleet Harbor MEP Report.

Table 2.1 Wellfleet Harbor System Sources of Nitrogen Loads, by Percent

Nitrogen Source	Percent of Nitrogen Load[1]
Wastewater[2]	82%
Fertilizers	8%
Stormwater[3]	8%
Other[4]	2%

Notes:
1. Source: Wellfleet Harbor TMDL Report. Includes controllable sources.
2. Includes (unattenuated) nitrogen loads from septic systems and wastewater treatment facilities.
3. Also referred to as "Impervious Surfaces" in the TMDL Reports.
4. Includes (unattenuated) nitrogen loads from landfills and farm animals.

The Cape Cod Commission watershed reports were used for the quantification of nitrogen sources for the watersheds without an MEP Report. The East Harbor and Pamet River nitrogen sources are summarized in Tables 2.2 and 2.3.

Table 2.2 East Harbor System Sources of Nitrogen Loads, by Percent

Nitrogen Source	Percent of Nitrogen Load[1]
Wastewater[2]	72%
Fertilizer[3]	7%
Stormwater	18%
Other[4]	3%

Notes:
1. Source: Cape Cod Commission Provincetown Harbor Watershed Report.
2. Includes (unattenuated) nitrogen loads from septic systems and wastewater treatment facilities.
3. Includes (unattenuated) nitrogen loads from lawns, cranberry bogs, and golf courses.
4. Includes (Unattenuated) nitrogen loads from landfills and atmospheric deposition to vacant land.

Table 2.3 Pamet River System Source of Nitrogen Loads, by Percent

Nitrogen Source	Percent of Nitrogen Load[1]
Wastewater[2]	68%
Fertilizer[3]	6%
Stormwater	16%
Other[4]	10%

Notes:
1. Source: Cape Cod Commission Pamet River Watershed Report.
2. Includes (unattenuated) nitrogen loads from septic systems and wastewater treatment facilities.
3. Includes (unattenuated) nitrogen loads from lawns, cranberry bogs, and golf courses.
4. Includes nitrogen loads from landfills and atmospheric deposition to vacant land.

The nitrogen load contribution sources presented in the tables above are based on the MEP, TMDL, and the CCC Watershed Reports. For planning purposes, a tiered approach is applied: if a TMDL exists for a watershed, it is used as the primary basis of the nitrogen management plan; if no TMDL is available, the MEP report is used, and if neither a TMDL nor an MEP report is available, the Cape Cod Commission Watershed Reports are used for planning-level nitrogen load estimates.

Cape Cod Commission Watershed Reports provide initial estimates for nitrogen reduction. The Town has identified agricultural operations as another potential source of nitrogen in the Truro. An initial analysis was conducted to evaluate potential agricultural loads. Farms in Truro were identified based on three data sets:

– Land use codes
– Truro Board of Health Barn Inspection Data (2023)
– IWRMP Phase I, Agricultural Lots and Parcels with Potential Large Home Gardens

Based on the agricultural operations in the Town, the use type and number of animals was quantified to estimate the associated animal and crop nitrogen loads. The following table summarizes the estimated percentage of the watersheds' total nitrogen loads that may be attributed to agricultural operations.

Table 2.4 Estimated Agricultural Operations Nitrogen Load

Watershed	Estimated Percent of Controllable Load Attributed to Agricultural Operations
Wellfleet Harbor	13%

Watershed	Estimated Percent of Controllable Load Attributed to Agricultural Operations
East Harbor	Negligible
Pamet River	8%

While the above presented agricultural load estimates were not incorporated into the watershed nitrogen estimates—because the analyses relied on established loads from MEP, TMDL, and CCC—they provide a useful reference for future planning and for targeting high nitrogen-producing operations. The Wellfleet Harbor MEP Report and TMDL includes an estimated farm animals nitrogen load. While the CCC Watershed Reports for Pamet River and Provincetown Harbor do not explicitly break down farm animal loads, these loads may be carried with the fertilizer and/or stormwater loads. It is recommended that future evaluations are performed to refine the estimated nitrogen load contributions from agricultural operations.

2.3 Growth Projections

Under an agreement with the Massachusetts Secretary of the Commonwealth, the University of Massachusetts Donahue Institute (UMDI) has produced population projections for all Massachusetts municipalities at five-year intervals through the year 2050. UMDI projections are estimated based on trends in fertility, mortality, and net migration. The UMDI periodically updates predictions based on updated census data. UMDI projections obtained in 2024 during the development of the Needs Assessment Report (NAR) predicted a steep population decline in Truro, indicating an estimated 1,254 residents by 2050. However, more recent projections indicate a slower rate of decline. UMDI projections obtained in October 2025 estimate Truro's 2050 population to be 2,318. The 2025 HPP quoted a UMDI population projection of 1,269 in Truro by 2040. As demonstrated by the frequently changing population predictions, the 2023 Truro Local Comprehensive Plan stated that *'there are conflicting reports on population trends, including from reputable organizations such as CCC and Housing Assistance Corporation (HAC).'*

Population projections from UMDI acquired in October 2025 for the Town indicate a slight decline in population through 2050, decreasing by approximately 6% from 2,454 in 2020 to 2,318 in 2050. The projections are included in Table 2.5 below.[2]

Table 2.5 Truro Historic Population and Population Projections

Year	Population, US Census and UMDI[1]
1970	1,234
1980	1,486
1990	1,573
2000	2,087
2010	2,003
2020	2,454
2030	2,588
2040	2,490
2050	2,318

Notes:
1. Population data from 1970 – 2020 is from the US Census. Population projections from 2030 – 2050 are from UMDI and were obtained in October 2025.

During the development of this Alternatives Screening Analysis Report and Draft Recommended Plan, the Town of Truro adopted an updated Housing Needs Assessment and Production Plan (2025 HPP). The 2025 HPP states a

[2] UMDI Massachusetts Population Projections were retrieved July 2024 from: https://donahue.umass.edu/business-groups/economic-public-policy-research/massachusetts-population-estimates-program/population-projections

housing goal of 260 new units by 2035. The Action Plan outlined in the 2025 HPP specifically mentions progress towards the Walsh Property, Cloverleaf Property, and 181 Route 6 developments. Table 2.6 outlines the anticipated developments discussed in the 2025 HPP.

Table 2.6 Summary of Housing Developments Outlined in 2025 Truro Housing Production Plan

Development Location	Number of Units[1]
Walsh Property (Walsh Way)	160[1]
Clover Leaf (22 Highland Road)	39[2]
181 Route 6	3[2]
Location TBD	58[3]
Total	**260[4]**

Notes:
1. Number of units for the Walsh Property is from the February 2025 Memorandum from Cody J. Salisbury, Provincetown's superintendent.
2. Number of units for the Clover Leaf Property and 181 Route 6 is from the 2025 Truro Housing Needs Assessment and Production Plan.
3. Value was calculated by subtracting the number of units proposed in the Walsh Property, Clover Leaf, and 181 Route 6, from the total units needed (260, as outlined in the 2025 HPP).
4. Source: 2025 HPP

While the plan outlines units through 2035, for the purpose of this assessment, the same goal is being carried for the duration of the planning period (development of 260 new housing units over a 20-year planning period). This approach, based on anticipated new housing units, was used to conservatively account for an increase in population, whereas UMDI projections (which share a similar planning horizon) indicate a decrease in population. Given the rapidly changing and inconsistent population projections in Truro, the progress of housing developments and updates in census data and population projections should be evaluated during design.

2.4 Summary of Watershed Nitrogen Loads

The following table provides a summary of Truro's current (at the time of the MEP, TMDL, and CCC Watershed Reports) and future (2047) nitrogen loads by watershed.

Table 2.7 Estimated Current and Future Watershed Nitrogen Loads

Watershed	Current Total Watershed Nitrogen Load (kg-N/yr)[1,2]	Watershed Threshold Load (kg-N/yr)	Truro's Portion: Current Watershed Nitrogen Load (kg-N/yr)[3,4]	Truro's Portion: Future (2047) Watershed Nitrogen Load (kg-N/yr)[3,4,5]	Truro's Portion: Watershed Threshold Load (kg-N/yr)
Wellfleet Harbor: Herring River / The Gut	10,118	9,902	4,249	4,249	4,159
East Harbor	16,544	4,136	1,158	1,186	869
Pamet River	4,502	3,377	4,502	4,518	3,377
Total	31,164	17,415	9,909	9,953	8,405

Notes:
1. Wellfleet Harbor current nitrogen load is from the Wellfleet Harbor TMDL Report.
2. East Harbor and Pamet River current nitrogen load is from the CCC Provincetown Harbor Watershed Report and the CCC Pamet River Watershed Report, respectively.
3. Truro's portion of the watershed load in Wellfleet Harbor was estimated based on land area.

Watershed	Current Total Watershed Nitrogen Load (kg-N/yr)[1,2]	Watershed Threshold Load (kg-N/yr)	Truro's Portion: Current Watershed Nitrogen Load (kg-N/yr)[3,4]	Truro's Portion: Future (2047) Watershed Nitrogen Load (kg-N/yr)[3,4,5]	Truro's Portion: Watershed Threshold Load (kg-N/yr)

4. Truro's portion of the watershed load for East Harbor and Pamet River was calculated using the percent of the load in Truro according to the respective CCC Watershed Report.
5. Future septic nitrogen loads were estimated using the housing developments outlined in the 2025 HPP.

3. Estimate of Load Reduction to Meet Nitrogen Reduction Goals

Estimated nitrogen reduction goals for Truro's three watersheds, which were determined as part of the NAR, were established using one of two methodologies:

– MEP Report / Nitrogen TMDL Methodology
– A Cape Cod Commission 208 Plan Methodology

The MEP Report methodology is used to quantify the reduction goal for Wellfleet Harbor. The reduction ratio from the MEP report was used and applied to the portion of Wellfleet Harbor estimated to be within the Town of Truro.

The Cape Cod Commission 208 Plan interim planning allowance methodology is for coastal estuaries that require nitrogen reduction to restore water quality but have not yet completed the scientific evaluations to establish a nitrogen TMDL. The CCC 208 plan assumes a 25% reduction in existing nitrogen as an interim target reduction goal; this methodology was applied for the Pamet River and East Harbor watersheds as they have not yet completed the scientific evaluations to establish a nitrogen reduction threshold.

Estimated current and future nitrogen reduction goals are summarized in the following table.

Table 3.1 Watershed Current and Future Nitrogen Reduction Goals

Watershed	Current Nitrogen Reduction Goal (kg-N/yr)	Future Nitrogen Reduction Goal[4] (kg-N/yr)
Wellfleet Harbor Watershed[1]	90	90
East Harbor[2]	289	317
Pamet River Watershed[3]	1,125	1,141
Total	**1,504**	**1,548**

Notes:

1. Nitrogen reduction goal is based on Truro's contribution to the Wellfleet Harbor Watershed, in accordance with the MEP reduction goal and methodology. Loads for Wellfleet Harbor are attenuated, in accordance with MEP reports. Attenuation in Wellfleet Harbor is minor.
2. Nitrogen reduction goal is 25% of Truro's load within the Provincetown Harbor watershed. Truro accounts for 7% of the Provincetown Harbor watershed load according to CCC. Loads for East Harbor are unattenuated, as presented in the CCC Provincetown Harbor Watershed Report.
3. Nitrogen reduction goal is 25% of the watershed load. Loads for Pamet River are unattenuated, as presented in the CCC Pamet River Watershed Report.
4. Future reduction goals are estimated through the planning period (2047) using the established threshold loads and estimated future loads (which are based on the housing production plan).
5. For reference, an average single-family home with a Title 5 septic system is estimated to discharge approximately 4.7 kg-N/yr. (Source: Wellfleet Harbor MEP Report).

4. Nitrogen Reduction Strategies Alternatives Analysis

4.1 Introduction

The MassDEP Watershed Permit Regulations, established under 314 CMR 21, provide a framework for managing nitrogen within coastal watersheds. Recent (July 2023) updates to the regulations require communities within nitrogen-impaired watersheds to either obtain a 20-year Watershed Permit that demonstrates progress towards meeting nitrogen reduction goals or convert all existing onsite Title 5 systems to Best Available Nitrogen Reducing Technology within five years. If a community within a Nitrogen Sensitive Area (NSA) elects to convert all systems to nitrogen-reducing systems, it must still demonstrate that the nitrogen threshold is met. If the threshold is not met, the community will be required to obtain a Watershed Permit and implement additional nitrogen management strategies. The Watershed Permit approach allows for more flexibility through a combination of nitrogen-reducing technologies to achieve the required nitrogen load reductions. The Watershed Permit regulations state that either at least 75% of the Necessary Nitrogen Load Reduction must be achieved within 20 years (or the first permit cycle), or the permit may include an alternative implementation schedule approved by MassDEP. This allows communities to meet the required reduction through multiple Watershed Permit cycles.

An Alternatives Screening Analysis was conducted and is summarized in this report. The purpose of the Alternatives Screening Analysis is to evaluate different combinations of nitrogen management strategies to meet the Town's nitrogen reduction goals in each of the three watersheds over the 20-year planning period. The alternatives analysis evaluated both conventional and alternative nitrogen management strategies.

The MassDEP Watershed Permit Regulations (314 CMR 21) define conventional control technologies as *'a combination of physical, chemical, and biological processes that provide primary, secondary, or tertiary treatment and have been proven to be consistently effective for treating wastewater or sewage to remove suspended solids, dissolved solids, biological decomposition of organic matter, pathogens, and nutrients from wastewater. Examples of Conventional Control Technology include but are not limited to sewage treatment plans and enhanced nutrient removal alternative septic systems that the Department accepts as conventional.*'

Those same regulations define alternative control technologies as *'a technology or approach that is not a conventional control approach or technology but can be effectively used to remove pollutants from a waterbody or prevent or reduce the introduction of pollutants into a waterbody.'*

Per 314 CMR 21, if a recommended plan includes Alternative Control Approaches and Technologies, a contingency plan that consists only of Conventional Control Technologies must be provided. This allows Town's to implement promising pilot technologies while also having a back-up plan in the event that alternative approaches do not function as predicted. For these reasons, both conventional and alternative technologies were evaluated as part of the alternatives analysis.

Adaptive management is a key component of the Watershed Permit, allowing the Town to implement Alternative Control Approaches, monitor performance over time, and adjust strategies as needed. Pilot strategies will be closely monitored for performance to confirm if nitrogen reduction targets are being met as intended. This approach provides flexibility to scale up successful alternatives while addressing any unforeseen challenges.

The conventional strategies evaluated in the alternatives screening analysis include General Use nitrogen-reducing onsite septic systems, cluster wastewater treatment systems, and centralized wastewater management strategies. The alternative strategies evaluated include Provisional Use nitrogen-reducing onsite septic systems, fertilizer management, stormwater best management practices, permeable reactive barriers, shellfish aquaculture, waste reducing toilets, and inlet/culvert widening. Sections 4.2 and 4.3 provide technology descriptions for each of the above-mentioned technologies and evaluate the technologies for use in Truro.

4.2 Conventional Control Technologies

4.2.1 General Use Nitrogen-Reducing Onsite Septic Systems

4.2.1.1 Technology Description

Nitrogen-reducing onsite septic systems are typically evaluated in low-density areas where centralized wastewater treatment through sewering is not cost-effective. MassDEP uses four categories of approval for Innovative/Alternative (I/A) septic-system technologies. The term "I/A system" is used to define systems that differ from the conventional Title 5 system by using new technologies or configurations; many, but not all, I/A systems are nitrogen-reducing. Currently, MassDEP only considers nitrogen-reducing onsite septic systems with a General Use approval as a conventional technology for nitrogen management. The MassDEP Title 5 Regulations definition for each category of approval is outlined below:

- ***General Use*** *systems will provide a level of environmental protection at least equivalent to that of a conventional onsite system designed in accordance with Title 5.*
- ***Piloting*** *is intended to provide field testing and technical demonstrations to determine if the technology can or cannot function effectively.*
- ***Provisional Use*** *approval is intended for evaluation of alternative systems that appear technically capable of providing levels of protection at least equivalent to those of a standard onsite disposal system.*
- ***Remedial Use*** *systems improve existing conditions at a particular facility or facilities served by a failed, failing, or non-conforming system.*

4.2.1.2 Alternatives Analysis

The MEP Report for Wellfleet Harbor and the CCC Watershed Reports for Provincetown Harbor and Pamet River have demonstrated that conventional Title 5 systems are the largest controllable source of nitrogen to Truro's watersheds. The MEP and CCC assumes an average effluent total nitrogen concentration from a conventional Title 5 septic system of 26.25 mg/L.

To date, the lowest approved total nitrogen effluent concentration for a MassDEP General Use Innovative/Alternative (I/A) system is 19 mg/L. MassDEP maintains a list of Best Available Nitrogen Reducing Technologies, which can be accessed at the following link: https://www.mass.gov/info-details/approved-title-5-innovativealternative-technologies#best-available-nitrogen-reducing-technologies-

When implementing an onsite nitrogen-reducing I/A system program, certain site-specific vulnerabilities should be considered to ensure system effectiveness and protection of public and environmental health. Properties located in Velocity (VE) zones or within FEMA flood plains may be at risk of inundation, which can compromise system operation and effluent quality. High groundwater levels can reduce leach field performance and increase the potential for nitrogen migration to groundwater and surface waters. Other factors that may affect system performance include soil permeability, steep slopes, and proximity to sensitive environmental receptors such as wetlands or coastal estuaries. These vulnerabilities should be assessed during system siting and design to optimize nitrogen removal and reduce environmental risks. Systems should be designed and installed in accordance with MassDEP regulations and Truro Board of Health requirements to minimize environmental and public health risks.

The Truro CWMP is considering General Use nitrogen-reducing onsite septic systems for the contingency compliance approach in the Pamet River and Wellfleet Harbor watersheds.

4.2.2 Cluster Wastewater Treatment Systems

4.2.2.1 Technology Description

Cluster wastewater treatment systems serve multiple properties within a defined area, typically ranging from a few households up to small communities or neighborhoods, without the need for a fully centralized municipal sewer. These systems collect wastewater from several individual sources and convey it, via a small-diameter collection network, to a shared treatment facility. Treatment processes can be similar to those used in larger centralized wastewater treatment plants—including primary, secondary, and sometimes tertiary treatment—but are appropriately scaled to fit the anticipated flow and site-specific requirements.

Cluster systems can incorporate advanced technologies to treat wastewater for nitrogen. Treated effluent can be discharged using a variety of methods depending on site conditions and environmental constraints. Groundwater discharge methods may include subsurface options such as leaching systems, drip dispersals, and wick wells, or surface discharge options such as sand beds, in compliance with regulatory standards. Cluster systems have the potential to be more cost-effective than individual nitrogen-reducing onsite systems in low density areas. The flexibility of cluster systems offers opportunities to phase in wastewater management improvements, tailor treatment to local conditions, and protect water quality with less disruption to existing infrastructure than large-scale centralized solutions.

4.2.2.2 Alternatives Analysis

Cluster systems are considered for areas in Truro with moderate residential density where individual connections to a centralized sewer system may be unfeasible or economically inefficient. Cluster systems enable the collective management of wastewater from multiple homes or businesses, allowing for shared investment in both infrastructure and ongoing maintenance. This approach frequently reduces per-household expenses relative to individual onsite solutions. Additionally, cluster systems (with advanced treatment) are capable of achieving effluent nitrogen concentrations below 3 mg/L and can be engineered to address other contaminants, including phosphorus and CECs.

Cluster wastewater treatment systems are considered and feasible in areas where there is a suitable parcel available for treatment and recharge. Ideally, this would be a town-owned parcel (or vacant parcel that the Town can purchase or obtain an easement over) that has no or minimal sensitive receptors such as wetlands and vernal pools, is located outside designated Zone II wellhead protection areas, and does not overlap with Natural Heritage & Endangered Species Program (NHESP) priority habitats. Selecting parcels that meet these criteria helps ensure environmental protection and regulatory compliance, while also supporting the long-term sustainability of wastewater management solutions.

4.2.3 Centralized Collection and Treatment Systems

4.2.3.1 Technology Description

4.2.3.1.1 Wastewater Treatment

Centralized collection and treatment involve collecting wastewater via a sewer system and transporting it to a common facility for treatment and discharge. Centralized treatment facilities can apply proven advanced treatment solutions capable of achieving stringent effluent total nitrogen limits as low as 3 mg/L. Centralized collection and treatment is generally most cost-effective in areas where development is dense. There are several main types of collection systems, treatment processes, and effluent discharge methods. An advantage of centralized collection systems and treatment is that treatment processes can be added to treat for other contaminants including phosphorous and CECs.

In May 2024, GHD prepared the ‘Draft Noons Property Evaluation Memorandum’, (Appendix B) to assess the potential for the Noons Property to serve as a possible future wastewater treatment facility and effluent discharge site. The Noons Property, located at 2 Sand Pit Road, was identified by the Town as a possible acquisition for a new greenfield wastewater treatment facility. The findings of the evaluation concluded that additional evaluations would need to be

conducted to ensure the site conditions are conducive to wastewater treatment and effluent recharge. It was recommended that a groundwater model be performed to assess the site's potential for recharge. The groundwater model would predict groundwater mounding at the site and characterize anticipated effluent migration to groundwater surface bodies. The Noons Property Memorandum also recommended that a phosphorous attenuation evaluation be conducted to assess potential phosphorous impacts to the down-gradient freshwater bodies. Additional considerations identified for the Noons Property included grading and site access due to the sites varying topography. In May 2023, a Phase I Environmental Site Assessment and Phase II Limited Subsurface Investigation report assessed the subsurface conditions at the site and identified PFAS in the groundwater and a reportable release of oil and/or hazardous materials (OHM). The presence of OHMs and PFAS could present permitting challenges. To date, no further evaluations have been performed on the Noons Property and the Town has not acquired the parcel. For these reasons, the Noons Property is not considered as a potential site for centralized treatment in Truro at this time.

As part of this Alternatives Analysis, centralized treatment was not considered as a Town-wide nitrogen management approach, but it was considered for a small portion of Truro known as Beach Point. For Beach Point, no evaluation of treatment processes and effluent discharge methods was conducted as this area would be connected to the existing Provincetown WWTF, which has allocated capacity for 150,000 gpd of potential flow from Truro as part of its planning.

4.2.3.1.2 Gravity Sewers and Pump Stations

The most prevalent type of collection system is a gravity sewer. This type of system involves the installation of sewers at a constant downhill gradient. The sewer pipe is designed at a slope sufficient to maintain a velocity within the system that ensures that solids stay suspended within the waste stream. The minimum diameter of a typical sanitary sewer main is 8-inches. The design criteria requires pipe sizing that increases proportionally with the expected wastewater flow. The sewer is installed at a constant slope until its depth becomes so great that a sewage pump station is needed to lift the flow to a wastewater treatment plant or to another gravity sewer.

In most situations, homes along a gravity sewer connect to the system with gravity service connections from the building to the collector sewer. Houses that are below the street elevation may require the use of small pumps and a small diameter force main (1 to 2 inches) for discharging to the collector sewer.

The installation cost and ease of construction of a gravity sewer depends upon the topography within a particular area and on specific soil types. In areas where topography is consistently increasing or decreasing, the sewers can be installed close to minimum depth (which is typically 4-feet in New England to account for the anticipated frost depth), however, when considering other utilities, gravity sewers can be greater than 8-feet below grade. In flat terrain, several pump stations may be required before the flow is pumped to a treatment facility. In very hilly areas, deep sewers and/or pump stations may be required. This can significantly increase construction costs when compared with other alternatives.

Three types of pump stations can be typically found with gravity sewers—wet well/dry well, submersible, and suction lift.

Wet Well/Dry Well Pump Stations

Wet well/dry well pump stations are typically used for large flow collected from several smaller areas. There are several styles and options, including packaged units. Their primary feature is that the pumps are in an accessible location separate from the wastewater so they can be maintained easier. However, this requires the pumps to be located in a structure below grade which must be designed to allow operator safe access. Wet well/dry well pump stations are typically the most expensive pump station style of the three considered in this report.

Submersible Pump Stations

Submersible pump stations are typically used for smaller flows and are relatively simple in design. The pumps with the motors are mounted in the bottom of the wet well and are accessed by slide rail. Submersible pumps are typically sized up to 25 horsepower before the size of the pump and motor becomes too heavy for operators to easily access with the slide rail system.

Suction Lift Pump Stations

Suction lift pump stations are popular for handling small to intermediate flows because the pumps are located above-ground and are accessible for repairs and maintenance. The pumps are not submerged in raw wastewater and therefore do not require the hoisting or cleaning involved with submersible stations, resulting in reduced maintenance. They are often smaller in size than a comparable wet well/dry well configuration and come as skid mounted equipment, simplifying construction. TR-16 Guides for the Design of Wastewater Treatment Works, prepared by the New England Interstate Water Pollution Control Commission, provides design considerations specifically for suction lift pump stations, such as suction piping length being limited to 25 feet. Often the pumps are limited to applications of less than 100 feet total dynamic head (TDH).

The following table summarizes the advantages and challenges of gravity sewers/pumping stations.

Table 4.1 Advantages and Challenges of Gravity Sewers

Advantages	Challenges
– A properly designed and installed gravity sewer requires little maintenance. – A gravity system can be easily expanded to serve additional areas. Additional capacity can be provided to accept future flow without affecting performance. – The potential for odors in a properly designed gravity sewer is low. – A gravity system is reliable since it is not dependent upon electrical power for operation. When pump stations are used on collector sewers, electrical generators are provided to supply power during a power outage. – Less space is required on the customers' lots as the gravity sewer does not require a grinder pump station or vacuum valve vault (as required for the other two types of collection systems).	– Gravity sewers are installed at a constant slope and thus can require deep excavations as the topography changes. Construction with trenchless technologies is generally difficult as constant grades are required. Construction is generally disruptive to traffic patterns and surface infrastructure, as they are often located within the paved roadway to avoid conflicts with water and gas utilities that are typically located closer to the shoulder(s) of the road. – Pump stations are required to transport the sewage out of low points in topography. – Feasibility may be limited by availability of appropriate/available pump station locations. – Capital and operation and maintenance costs increase with each pump station required. – Pump stations tend to increase the potential for odor emissions. – Improper installation techniques could result in infiltration (clean water entering the collection system) and exfiltration (raw wastewater leaving the collection system).

4.2.3.1.3 Low-Pressure Sewers

A low-pressure sewer system requires the installation of a grinder pump to serve each building. Wastewater from each property flows by gravity into a pump chamber, where the sewage is shredded and pumped into a pressure sewer, eventually discharging to a gravity main or directly to a pump station or treatment facility. This type of technology has become more widely used over the past 20 years and is particularly suited to areas where there is a need to minimize excavation depths.

The typical pressure in this type of system is five to 40 pounds per square inch (psi). Typically, systems can be expanded to serve additional homes; however, there are design limitations, and the overall expansion capability tends to be less than that of a gravity sewer.

When connecting pressure sewer lines to a gravity line or directly to a pump station, odor control for larger systems may be required at the discharge point to mitigate odors created in the pressure sewer pipe. Also, manholes at the discharge point should be protected from corrosion resulting from high hydrogen sulfide concentrations.

The following table summarizes advantages and challenges of low-pressure sewers.

Table 4.2 Advantages and Challenges of Low-Pressure Sewers

Advantages	Challenges
– The collection main is installed at a relatively shallow depth and is independent of grade changes. This allows shallower excavation, lower piping installation costs, and less overall disruption to the area due to a shorter construction period. – A pressure sewer can serve areas of hilly terrain or marginal slope. – The pressure sewer piping (beyond the pumping chamber) is not susceptible to infiltration, unlike gravity sewers. – The shredding action of the pump eliminates the need for a larger size collection system piping. Pressure sewers tend to be much smaller diameter than a typical sanitary sewer, ranging from 1-1/4 inch to 6 inches, depending upon the expected design flow. – The pressure sewer mains (at shallower depths than gravity) are easier to locate in road shoulders to minimize construction in roads where space is available. – Some portion of pressure sewers could be installed with trenchless technologies, thus reducing general disruptions experienced during construction. – Homes with generators can maintain operation of their pumps as long as their home electrical system is set up to accommodate the load (this is becoming more common with the larger number of power outages in recent years).	– Each building in the system would have to be equipped with a pump unit, which increases operation and maintenance requirements. Towns that operate their own systems typically have to maintain an inventory of pumps/parts for these units to minimize disruption of services; otherwise, it becomes the homeowner's responsibility to have their system maintained. – Each pump unit is dependent upon electrical power for proper operation; since the pumps are located at individual homes, municipal backup electrical power is typically not provided. Storage capacity is typically built into each pump chamber (capacity depends on manufacturer). However, in a prolonged power outage, it would be possible for the wastewater flow to exceed this capacity and back up into the structures. This can be mitigated by providing electrical connections on each pump unit to allow a service crew to connect a portable generator and pump out each unit during prolonged power outage. Another option is to install a larger capacity unit or a dual tank system, thus providing more storage. – This system is more sensitive to seasonal flow conditions than a gravity sewer. In areas with extreme seasonal fluctuations, minimum flow conditions must be carefully quantified to be sure the sewage flow can properly travel through the system. If inadequate flow exists, solids can harden within the sewer and cause blockages. This concern can be mitigated through proper design. – Some customers may need to upgrade their electrical system, which might not have the capacity for the additional load. – Training would be required to familiarize operating staff with maintenance of the pumps and pressure sewers. – Ownership considerations need to be clearly defined early in the selection and design process. Costs for systems will depend on who owns, operates, and maintains the grinder pump. Easements may also be required to address maintenance and emergency power issues. – Odors can be released at the point of discharge into a gravity sewer or pump station, especially during low flow periods. – Grinder pumps take up space on the customer's property and in the case of Beach Point, many of the properties are relatively small.

A major decision with grinder pumps is who purchases and owns the grinders pumps—the customer or municipal sewer system. A hybrid approach can also be used where the municipality purchases the initial pump and then the customer takes ownership including any repairs or replacements.

4.2.3.1.4 Vacuum Sewers

A typical vacuum sewer system consists of a central vacuum station, valve pits, and the sewer piping. Each customer would have a vacuum valve pit, which consists of the storage sump, the vacuum valve, and associated piping. The valves are operated on pressure differentials and do not require a power source.

Typically, a vacuum sewer system is designed with a maximum static loss of 13 feet and a maximum friction loss of 5 feet in any single flow path to a vacuum pump station.

Most problems affecting vacuum sewers are loss of vacuum. This results in failure of the valves to open/close. When the valve fails to open, this may result in the accumulation of wastewater in the collection chamber and potential backup into the building and vacuum loss in the main. Each customer's valve pit also requires an air intake pipe that typically extends 2-feet above ground level, this vent is essential in making sure when the vacuum valve opens, that the vacuum in the main does not draw out plumbing traps in the house creating odor issues, and also allows for air to enter the main to act as the mechanism that moves the wastewater down the system.

The following table summarizes advantages and challenges of vacuum sewers.

Table 4.3 Advantages and Challenges of Vacuum Sewers

Advantages	Challenges
– Vacuum sewers can operate at shallow depths, reducing excavation and installation costs. – Work well in flat or low-lying areas, where gravity sewers are impractical and costly. – Piping is small diameter and resistant to infiltration and inflow. – Can be installed in areas with high groundwater or soft soils, minimizing soil disruption. – Each customer only needs a vacuum valve pit, which does not require electricity (unlike grinder pumps). – Some portion of pressure sewers could be installed with trenchless technologies, thus reducing general disruptions experienced during construction.	– Requires a central vacuum station and associated maintenance. – Central station power dependency; if the vacuum station loses power, service to all connected homes is interrupted. – Odors can occur at the central vacuum station or connection points if venting is inadequate. – In the case of prolonged vacuum station downtime, wastewater may backup due to limited storage in valve pits. – Requires trained staff to operate and maintain the vacuum station and network. – Location of system infrastructure, such as the central vacuum station, may require an easement if a public parcel is not available.

4.2.3.2 Alternatives Analysis

Given the relatively low density pattern of development in portions of Truro, where homes are spread out and sewer connections may be impractical or cost-prohibitive, the only area identified by the Town as a candidate for sewering is Beach Point (see Draft Beach Point Memorandum, Appendix C). This flow would be treated at the Provincetown Wastewater Treatment Facility and discharged in Provincetown (discussions with Provincetown regarding this alternative are ongoing). Thus, only the collection system technology alternatives need to be further analyzed for application in this one area. Because flows that may be treated via a centralized collection system would be sent to an existing treatment facility, a treatment and recharge technologies analysis is not applicable.

For Beach Point, low-pressure sewer systems are considered the most feasible and cost-effective option due to the shallow topography, relatively short pipe runs, and small-diameter piping. Gravity and vacuum sewers were reviewed (Draft Beach Point Memorandum, Appendix C) but are less suitable: gravity sewers would require multiple pump stations and deep excavation below the water table and vacuum sewers would require a central vacuum station and parallel force mains.

The low-pressure force main in Beach Point would be approximately 1½-inches at the southeast end increasing to approximately 4-inches closer to the Provincetown boundary. The pipe material would typically be HDPE tubing. Sizing and material would be refined during detailed design. Given Truro's topography, a low-pressure sewer system would likely be the most feasible and cost-effective collection system alternative.

As mentioned above, the Noons property was identified as a potential future site for wastewater treatment. If further evaluations are performed to determine the site's feasibility and if the site is obtained by the Town, additional centralized sewering may be considered in other densely developed portions of Truro.

4.3 Alternative Control Technologies

4.3.1 Provisional Use Nitrogen-Reducing Onsite Septic Systems

4.3.1.1 Technology Description

As described in Section 4.2.1, MassDEP categorizes onsite I/A septic systems into several categories based on approval for certain applications. As there are currently no General Use septic systems approved that have a permit approval lower than a treated nitrogen effluent concentration of 19 mg/L, the focus of this section will be on two Provisional Use technologies. The two nitrogen-reducing onsite I/A systems that are currently in the Provisional Use stage are: the NITREX™ system (which has a provisional effluent total nitrogen approval of 10 mg/L) and the NitROE® system (which has a provisional effluent total nitrogen approval of 11 mg/L).

Provisional systems must have at least 50 installations operating for three years prior to applying for a General Use approval. To advance to General Use, the technology manufacturer must submit an application to MassDEP, including system performance data collected during the 3-year period. This data is evaluated by MassDEP as part of the General Use approval process.

While Provisional Use systems cannot be used in a contingency nitrogen management plan at this time, preliminary data indicates these systems have the potential to achieve low level nitrogen effluent concentrations with proper operation and maintenance. A 2024 study published by researchers associated with the Massachusetts Alternative Septic System Test Center (MASSTC), US Geological Survey, and United States Environmental Protection Agency (USEPA) monitored NitROE® and MASSTC non-proprietary nitrogen-reducing septic systems near Shubael Pond in Barnstable for 25 months. The study found that the systems achieved a median total nitrogen effluent concentration of 6.2 mg/L. When more monitoring data becomes available, these technologies may apply for General Use approval. It is GHD's understanding that both of the below described systems intend to apply for General Use approval.

NitROE® System: This system is installed in series between a Title 5 system septic tank and a soil absorption system constructed to and operating in accordance with state regulations to accommodate design flows of less than 2,000 gpd. The system is comprised of two-unit processes which are sequentially performed in two different chambers. The first chamber is aerated, via an external air pump and airline header/hose arrangement, to achieve both organic carbon reduction along with the biological conversion of ammonia-N to nitrate-N. From the aeration chamber, the wastewater then flows by gravity into a denitrification chamber where, in the presence of natural organics from wood chips, bacteria facilitate the conversion of nitrate-N to inert N gas that exits to the atmosphere via the Title 5 system vent piping. Depending on design flow and space constraints, the sequential aeration and denitrification process steps can be performed in the same single tank, which is NitROE® 2KS WWTS, or each process could be performed in its own separate tank with the overall NitROE® WWTS comprised of multiple tank combinations, which is NitROE® 2KM WWTS. Gravity moves wastewater through the tanks so that the only piece of mechanical equipment is an air pump.

NITREX™ System: This system uses patented nitrate-reactive media that converts nitrate to inert nitrogen gas (denitrification). The NITREX™ reactive media is contained in a buried concrete tank. Raw wastewater is gravitationally fed through the treatment module. For septic tank applications, an oxidative pre-treatment step is required to convert ammonium to nitrate before the NITREX™ filter can perform the reductive denitrification step. This pre-treatment is similar to that for the NitROE® system which uses an aeration chamber. The low nitrate effluent from the NITREX™ filter is then discharged to the leach field or adsorption bed.

A Provisional Use nitrogen-reducing onsite septic system must be inspected regularly, per the schedule outlined in the Provisional Use Approval. Both the NitROE® and NITREX™ systems require quarterly inspection and sampling for year-round facilities, and twice a year inspection and sampling for seasonal properties. The frequent sampling and inspection requirements stand to ensure systems are performing properly. MassDEP or the local Board of Health can require more frequent inspections than those outlined in the approval. More frequent inspections may also be required for a period of time immediately following installation. Inspection and testing requirements are outlined by MassDEP in the approvals for each type of technology.

System owners must have a maintenance contract with a Massachusetts Certified Wastewater Operator in place for the life of the system. Plans for operation and maintenance, monitoring, and testing must be submitted to the local Board of Health (and in some cases to MassDEP) for approval prior to start-up of the system. Inspection and sampling must be performed in accordance with the technology or system approval issued by the local Board of Health or MassDEP, and inspection data must be submitted to these entities.

4.3.1.2 Alternatives Analysis

As mentioned above, there are two approved onsite nitrogen-reducing systems for Provisional Use with nitrogen effluent concentrations less than 11 mg/L. MassDEP maintains a list of Approved for Provisional Use Nitrogen-Reducing Technologies, which can be accessed at the following link: https://www.mass.gov/info-details/approved-title-5-innovativealternative-technologies#approved-for-provisional-use

When implementing an onsite nitrogen-reducing system program, certain site-specific vulnerabilities should be considered to ensure system effectiveness and protection of public and environmental health. Properties located in Velocity (VE) zones or within FEMA flood plains may be at risk of inundation, which can compromise system operation and effluent quality. High groundwater levels can reduce leach field performance and increase the potential for nitrogen migration to groundwater and surface waters. Other factors that may affect system performance include soil permeability, steep slopes, and proximity to sensitive environmental receptors such as wetlands or coastal estuaries. These vulnerabilities should be assessed during system siting and design to optimize nitrogen removal and reduce environmental risks. Systems should be designed and installed in accordance with MassDEP regulations and Truro Board of Health requirements to minimize environmental and public health risks.

The Truro CWMP considers Provisional Use nitrogen-reducing onsite septic systems as one of the recommended nitrogen management compliance approaches in the Pamet River and Provincetown Harbor watersheds. Implementing Provisional Use systems instead of General Use systems reduces the overall number of installations required to achieve targeted nitrogen reduction goals. Although initial data indicates these systems are capable of treating to a low level treated effluent nitrogen (less than 11 mg/L), MassDEP mandates the development of a Contingency Plan that incorporates traditional nitrogen management strategies in the case that Provisional Use systems do not perform as expected.

4.3.2 Fertilizer Management

4.3.2.1 Technology Description

Fertilizer nitrogen loads originate from lawns, golf courses, recreational fields, and agricultural properties where nitrogen-rich fertilizers are applied to support plant and grass growth. When more nitrogen is applied than plants can absorb, excess nitrogen can leach through the soil to groundwater or be carried with stormwater runoff into nearby surface waters. Managing fertilizer use is a key component of managing controllable nitrogen sources. The technology description below is an excerpt from the Cape Cod Commission 208 Plan Update regarding fertilizer management:

'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.'

Additionally, fertigation wells, commonly used at golf courses, and potentially for residential properties, can recycle treated groundwater. This method reuses nitrogen-enriched groundwater back onto lawns and turfs, thereby reducing the amount of nitrogen leaving the site and entering coastal estuaries.

Eco-benefits and performance challenges for this technology (as listed in the 2015 CCC 208 Plan Update) are summarized in the following table.

Table 4.4 Fertilizer Management - CCC 208 Plan Update List of Eco-Benefits and Performance Challenges[1]

Eco-Benefits	Performance Challenges
– Enhances habitat/wildlife/biodiversity.	– 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.

Notes:
1. Source: 208 Plan – Cape Cod Area Wide Water Quality Management Plan Update, prepared by the Cape Cod Commission, dated June 2015.

4.3.2.2 Alternatives Analysis

As reported by the MEP reports and Cape Cod Commission Watershed Management Plans and stated in Section 2.4, the approximate controllable fertilizer load in the Truro watersheds ranges from 6% to 7%. To mitigate this controllable load, Truro can employ a combination of education, licensure requirements, regulations of practice, and enforcement.

The Truro Conservation Regulations (dated 2021) define special conditions for particular projects that stipulate that fertilizers shall not be used within 100 feet of wetlands, within the riverfront area, and within bordering land subject to flooding. The Conservation Regulations also present a model Order of Conditions for coastal erosion control projects that restricts fertilizer use for beach plantings.

It is recommended that the Town consider adopting a fertilizer bylaw that includes restrictions on the time of year that fertilizer can be applied and mandates maximum loading rates for applications.

MassDEP has indicated that a 25% nitrogen removal credit (of the overall lawn fertilizer load to the watershed) can be assumed in a TMDL Compliance Plan for communities with a promulgated fertilizer regulation. This nitrogen-removal credit is consistent with the methodology used in the Cape Cod Commission 208 Plan Update.

The Truro CWMP anticipates that a 25% fertilizer nitrogen load reduction will be possible with the implementation of fertilizer bylaws.

4.3.3 Stormwater Management

4.3.3.1 Technology Description

Stormwater nitrogen loads originate from runoff that carries nitrogen-rich materials from impervious and developed surfaces such as roads, driveways, and rooftops into nearby waterbodies. Rainfall or snowmelt that flows over impervious surfaces can collect fertilizers, pet waste, organic debris, and other nitrogen-rich pollutants before flowing into streams, ponds, and ultimately Truro's coastal estuaries.

Much of Truro's impervious road area can be attributed to Massachusetts Department of Transportation (DOT) roads. The following table summarizes the percentage of Truro's roads that are DOT owned.

Table 4.5 Truro Road Ownership Summary

Watershed	Percent of Road Area Owned by MassDOT
Wellfleet Harbor	18%
Provincetown Harbor	53%
Pamet River	15%
Townwide	**20%**

Stormwater Best Management Practices (BMPs) consist of both structural controls, such as catch basins and vegetated swales, and non-structural controls, including measures like street sweeping and public outreach. According to MassDEP, communities that implement non-structural stormwater BMPs may assume a 25% nitrogen-removal credit (based on the overall impervious load to the watershed) in their TMDL Compliance Plans. The 2015 CCC 208 Plan Update lists the following examples of non-structural BMPs:

– Street sweeping
– Maintenance of stormwater utilities
– Education and public outreach programs
– Land use planning
– Impervious cover reduction and control

Eco-benefits and performance challenges for this technology (as listed in the 2015 CCC 208 Plan Update) are summarized in the following table.

Table 4.6 Stormwater BMPs - CCC 208 Plan Update List of Eco-Benefits and Performance Challenges[1]

Eco-Benefits	Performance Challenges
– Enhances habitat/wildlife/biodiversity. – Promotes green space/conservation/recreation. – Improves management of flooding/extreme events.	– Requires the creation and enforcement of stormwater regulations and policies.
Notes: 1. Source: 208 Plan – Cape Cod Area Wide Water Quality Management Plan Update, prepared by the Cape Cod Commission, June 2015.	

4.3.3.2 Alternatives Analysis

The Town of Truro is not a regulated municipal separate storm sewer system (MS4) community, meaning that it is not subject to the minimum control measures (MCMs) outlined in The Massachusetts Stormwater Handbook Volume 1 Chapter 1. In August 2023, the Town proposed adding Chapter IX: Stormwater Management by Drainage, Erosion, and Sediment Control to its General Bylaws.

The purpose of the proposed Chapter IX is to establish minimum standards for managing stormwater runoff, erosion, and sediment to protect public health, groundwater, and surface water, and prevent flooding. It applies to existing development, new development, and redevelopment projects. It stipulates that all runoff from impervious surfaces on a lot shall be recharged on that lot and prevented from impacting wetlands, and that appropriate erosion control measures must be in place prior to any construction. Projects in areas sensitive to nutrient loading must follow Massachusetts Stormwater Handbook's Best Management Practices, and relevant Wetlands (310 CMR 10.00) and Water Quality (314 CMR 9.00) regulations. The Building Commissioner, Health/Conservation Agent, and/or the DPW Director may enforce the regulations.

The Town may also consider additional stormwater BMPs and enforcement mechanisms. Descriptions of additional control measures for consideration are presented in the following table.

Table 4.7 Enhanced Stormwater Best Management Practices[1]

Practice	Description
Land Use Planning	Where and how communities grow impacts water quality. Factors embedded in a community's land use codes and policies that dictate the location, quantity or density, and design of development can drive the creation of unnecessary impervious cover and other land cover conditions that produce excessive runoff. Common land use development regulations, codes, and policies that can be reviewed for consistency with stormwater goals include zoning ordinances, subdivision codes, street standards or road guidelines, parking requirements, minimum setback requirements, site coverage limits, and building height limitations.
Impervious Cover Reduction	Impervious surfaces associated with urbanization including roads, parking lots, rooftops, driveways/sidewalks, and compacted soils all reduce stormwater infiltration and increase surface runoff. Low impact development techniques to reduce the amount of impervious surface for new construction and redevelopment projects include encouraging projects be located within areas where services and infrastructure already exist; reducing the length/width of driveways, size of parking spaces, and other pavements; developing designs to share parking areas, driveways and other impervious facilities; and clustering components such as houses together to reduce the amount of paved surfaces needed.
Green Infrastructure	Green infrastructure uses vegetation, soils, and natural processes that mimic nature to soak up and store water. Example technologies include green roofs, permeable pavement, bioswales, biofiltration strips, and constructed wetlands.

Note:

1. Adapted from Massachusetts Department of Environmental Protection (MassDEP). (2008, updated 2016). *Massachusetts Stormwater Handbook, Volumes 1–3.* Boston, MA: Executive Office of Energy and Environmental Affairs. *(Content adapted from Vol. 1 and Vol. 2 discussions on low impact development, impervious cover reduction, and green infrastructure.)* **https://www.mass.gov/info-details/massachusetts-stormwater-handbook**

As reported by the MEP reports and Cape Cod Commission Watershed Management Plans and stated in Section 2.4, the approximate controllable stormwater load in the Truro watersheds ranges from 8% to 18%. To mitigate this controllable load, Truro can employ a combination of the BMPs and stormwater management regulations outlined above. The Truro CWMP anticipates that a 25% stormwater nitrogen load reduction will be possible with the implementation of stormwater BMPs.

4.3.4 Permeable Reactive Barriers

4.3.4.1 Technology Description

The technology description below is an excerpt from the Cape Cod 208 Plan Update:

'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, microbes in the groundwater uptake the nitrogen, denitrifying the groundwater.

An injection well PRB system typically uses a series of injection wells to introduce the carbon source (medium) into the groundwater. The injection wells can be installed to depth greater than the PRB trench method. The injection well PRB method can be used in combination with the PRB trenching method described previously. As groundwater flows through the medium, microbes naturally occurring in the groundwater consume the carbon source, as well as oxygen, developing an anaerobic environment. This process releases nitrogen gas to the atmosphere, reducing the groundwater nitrogen load before reaching the estuary.

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.'

Eco-benefits and performance challenges for this technology (as listed in the 2015 CCC 208 Plan Update) are summarized in the following table.

Table 4.8 Permeable Reactive Barrier – CCC 208 Plan Update List of Eco-Benefits and Performance Challenges[1]

Eco-Benefits	Performance Challenges
– Improves energy savings/nutrient recovery/recycling. – Improves management of flooding/extreme events.	– Siting can be limited by wetlands, public utilities, and abutter concerns. – Detailed knowledge of local groundwater hydrology is needed. – Large projects may require a hydrogeologic investigation and groundwater modeling to estimate effectiveness of PRB. – Permitting requirements may be extensive and time-consuming. – Projects may require extensive groundwater monitoring early in the project to quantify nitrogen load reduction. – Projects may require groundwater monitoring near or in embayments as well as monitoring of vegetation and benthic monitoring where groundwater surfaces in the receiving estuary.

Notes:
1. Source: 208 Plan – Cape Cod Area Wide Water Quality Management Plan Update, prepared by the Cape Cod Commission, dated June 2015.

4.3.4.2 Alternatives Analysis

PRBs are most applicable in areas where groundwater carrying elevated nitrogen concentrations discharges to downgradient surface waters, such as estuaries, salt marshes, and rivers. By targeting nitrogen at the point of groundwater discharge, PRBs can provide a cost-effective, passive treatment option that requires minimal energy input and has relatively low operation and maintenance requirements once installed.

As part of the alternatives analysis, GHD identified large nitrogen contributors within the Town of Truro to identify potential opportunities for PRB applications. Agricultural operations, particularly farms, were identified as significant sources of nitrogen loading due to fertilizer use and manure management practices. To address this load, a PRB is recommended within the central-eastern portion of the Pamet River watershed, strategically sited to reduce nitrogen concentrations before discharge to the Pamet River.

The Town should conduct further evaluations on the potential to site a PRB at the identified location, and to identify additional PRB sites. The Town should develop an understanding of groundwater conditions to evaluate the sites' potential for PRB siting; groundwater characterization for planning a PRB includes:

– Depth to groundwater
– Groundwater flow direction
– Sediment type and groundwater flow velocity
– Vertical nitrogen concentration profile
– General groundwater chemistry

4.3.5 Shellfish Aquaculture

4.3.5.1 Technology Description

The technology description below is an excerpt from the Cape Cod 208 Plan Update:

'Shellfish, specifically oysters, remove nitrogen from their environment. The growing and removal of the mature oysters can remove nitrogen from an estuary, reducing the estuary's nitrogen load. Aquaculture can become a dual-purpose project where shellfish are harvested for market while there will be a local reduction in nitrogen in the overlying water column during the growth and maturation of the oysters added.

Shellfish may be cultivated above or within the estuary bed. The "in-estuary bed" method cultivates the shellfish in the benthic soils of the estuary. Shellfish may also be cultivated above the estuary bed in containers. With either approach, harvesting a portion of the oysters is required to remove nitrogen. Shellfish cultivation may be used in combination with other types of aquaculture (e.g., mariculture), as well as floating constructed wetlands designed for brackish water.'

Eco-benefits and performance challenges for this technology (as listed in the 2015 CCC 208 Plan Update) are summarized in the following table.

Table 4.9 Aquaculture Shellfish – CCC 208 Plan Update List of Eco-Benefits and Performance Challenges[1]

Eco-Benefits	Performance Challenges
– Enhances habitat/wildlife/biodiversity. – Promotes green space/conservation/recreation. – Improves energy savings/nutrient recovery/recycling. – Improves management of flooding/extreme events.	– Growing conditions, aesthetics, or navigation may limit applicability. – Seasonal nitrogen uptake coincident with natural cycle and algal blooms. – Requires removal of shellfish in order to take credit for nitrogen removal. – Nitrogen uptake subject to possible disruption due to disease or population crash. – Population monitoring is important to maintain persistence of the benefit. – Large concentrations of shellfish can generate waste products, reduce dissolved oxygen levels, and possibly generate ammonia. – Shellfish will undergo rapid growth to a marketable size after which they must be harvested. – Can require large areas to gain significant nitrogen removal. – If the waterbody is closed for shellfishing, management will be required to prevent the shellfish from getting into the food supply.

Notes:
1. Source: 208 Plan – Cape Cod Area Wide Water Quality Management Plan Update, prepared by the Cape Cod Commission, dated June 2015

4.3.5.2 Alternatives Analysis

Regional communities have successfully implemented shellfish aquaculture programs as part of their nitrogen management plan. At this time, no proposed sites were identified for a shellfish aquaculture program in Truro. There may be potential to implement these strategies in the future, in combination with floating constructed wetlands in brackish systems like East Harbor or Pamet River. If sites are identified in the future and the Town desires to pilot and implement this technology, it could be incorporated into nitrogen management approaches as part of the Town's Adaptive Management Program.

4.3.6 Waste Reducing Toilets

4.3.6.1 Technology Description

The technology description below is an excerpt from the Cape Cod 208 Plan Update:

'A waste reduction toilet is a system which separates human waste from shower, sink and other household water uses. These systems use no or minimal amounts of water. Waste reduction toilets require installation of a separate toilet(s). Household water uses (i.e., sink and shower uses) continue to flow to the septic system. The four main categories of waste reducing toilets include: composting, incinerating, packaging, and urine diverting. Composting toilets capture human waste in a container in the basement where it is decomposed and turned into compost. Incinerating toilets rely on electric power or natural or propane gas to incinerate human waste to sterile, clean ash/ Packaging toilets encapsulate human waste in a durable material, stored beneath the toilet, for removal from the site when full. Urine diverting toilets divert urine to a holding tank where it is periodically collected by a servicing company; remaining human waste continues on to the septic system.'

Eco-benefits and performance challenges for this technology (as listed in the 2015 CCC 208 Plan Update) are summarized in the following table.

Table 4.10 Waste Reducing Toilets – CCC 208 Plan Update List of Eco-Benefits and Performance Challenges[1]

Eco-Benefits	Performance Challenges
– Improves energy savings, nutrient recovery, recycling.	– Resulting nutrient removal rates are highly dependent on homeowner/landowner. – Requires a significant number of citizens to participate to be effective.
Notes: 1. Source: 208 Plan – Cape Cod Area Wide Water Quality Management Plan Update, prepared by the Cape Cod Commission, dated June 2015.	

4.3.6.2 Alternatives Analysis

Cape Cod communities have attempted to implement waste reduction toilet programs and to offer incentives for their adoption with limited success. The regulatory pathway in Massachusetts for installing certain types of waste reduction toilets (such as urine diverting toilets) poses challenges for widespread implementation in a watershed plan. Due to the limited adoption of the technology in other Cape Cod towns, waste reduction toilets are currently not included in Truro's nitrogen management plan. If the Town desires to pilot and implement waste reduction toilets, it could be incorporated into the CWMP as part of the Town's Adaptive Management Program. Several organizations, such as the Rich Earth Institute in Brattleboro, Vermont and MASSTC are leading research on waste reduction toilets and nutrient reclamation and may be available for technical assistance should the Town decide to explore this technology.

4.3.7 Inlet/Culvert Widening

4.3.7.1 Technology Description

The technology description below is an excerpt from the Cape Cod 208 Plan Update:

'This approach considers re-engineering and reconstruction of bridge or culvert openings to increase the tidal flux through the culvert or inlet. In the right settings, increasing the tidal flux can decrease the nitrogen residence time, lowering the nutrient concentration in the estuary and / or tidal marsh upstream of the widened inlet or culvert.'

Eco-benefits and performance challenges for this technology (as listed in the 2015 CCC 208 Plan Update) are summarized in the following table.

Table 4.11 Inlet/Culvert Widening – CCC 208 Plan Update List of Eco-Benefits and Performance Challenges[1]

Eco-Benefits	Performance Challenges
– Enhances habitat/wildlife/biodiversity. – Promotes green space/conservation/recreation. – Improves energy savings/nutrient recovery/recycling. – Improves management of flooding/extreme events.	– Widening a tidal culvert or bridge could increase the depth of flooding during high tides and storm surges in flood-prone areas and upstream of the structure. – Disruption of coastal processes must be considered. – Can have significant construction impacts. – Permitting requirements may be extensive and time-consuming. – Modeling is required to accurately predict the upstream tidal and coastal process impacts of the culvert/bridge modifications. – Will only return an estuary to a more natural hydrologic regime if the original opening has been restricted.

Notes:
1. Source: 208 Plan – Cape Cod Area Wide Water Quality Management Plan Update, prepared by the Cape Cod Commission, dated June 2015.

4.3.7.2 Alternatives Analysis

The Town is currently advancing several culvert projects in the Pamet River system – including Mill Pond, Eagle Neck Creek, and Little Pamet. Another opportunity for a culvert project exists in East Harbor. Currently, East Harbor experiences tidal flushing through a culvert into Cape Cod Bay. Recent monitoring of East Harbor conducted by the Cape Cod National Seashore suggests that it may be thermally impaired and that increased tidal flushing may improve water quality. GHD recommends that the sizing of the culvert is evaluated. Based on the findings of the sizing evaluation, culvert widening can be included in Truro's Adaptive Management Plan to assist in tidal flushing of the East Harbor Lagoon.

4.4 Nitrogen Management Alternatives By Watershed

Scenarios with various combinations of nitrogen management strategies were developed for each of Truro's watersheds. The following factors were considered when selecting strategies:

– Nitrogen reduction goal
– Parcel density
– Availability of land to support potential treatment sites for cluster facilities

The following table outlines all the approaches considered for each of Truro's Watersheds.

Table 4.12 Evaluated Nitrogen Management Strategies by Watershed

Watershed	Nitrogen Management Approach	Findings of Evaluation
Wellfleet Harbor	Fertilizer Bylaw	Strategy included in recommended nitrogen management plan.
	Stormwater Best Management Practices	Strategy included in recommended nitrogen management plan.
	General Use Nitrogen-Reducing Onsite Septic Systems (effluent nitrogen concentration = 19 mg/L)	Strategy included in contingency nitrogen management plan.
	Provisional Use Nitrogen-Reducing Onsite Septic Systems (effluent nitrogen concentration = 11 mg/L)	Strategy not required for the recommended nitrogen management plan, as initial estimates indicate the reduction goal can be met with stormwater and fertilizer controls alone.

Watershed	Nitrogen Management Approach	Findings of Evaluation
	Cluster Systems	Cluster systems were evaluated as part of the contingency nitrogen management plan. No potential sites were identified through this evaluation, and they are not currently included as a nitrogen-reducing strategy for the watershed. If a potential site is identified, a cluster system can be incorporated into the Plan through adaptive management.
East Harbor	Fertilizer Bylaw	Strategy included in Alternative 1 nitrogen management plan.
	Stormwater Best Management Practices	Strategy included in Alternative 1 nitrogen management plan.
	General Use Nitrogen-Reducing Onsite Septic Systems (effluent nitrogen concentration = 19 mg/L)	Strategy was evaluated as part of the Alternative 2 nitrogen management plan. Analysis indicates that converting all existing Title 5 septic systems to general use nitrogen-reducing septic systems would not meet the nitrogen reduction goal and would require supplementary approaches. Because other decentralized approaches are not feasible in the watershed, as described in this Table, this strategy was not included in the nitrogen management plan.
	Provisional Use Nitrogen-Reducing Onsite Septic Systems (effluent nitrogen concentration = 11 mg/L)	Strategy included in Alternative 1 nitrogen management plan.
	Cluster Systems	Cluster systems were evaluated as part of the Alternative 2 nitrogen management plan. No potential sites were identified through this evaluation, and they are not currently included as a nitrogen-reducing strategy for the watershed. If a potential site is identified, a cluster system can be incorporated into the Plan through adaptive management.
	Sewering	The sewering approach would rely on sending Truro's flow to Provincetown. Discussions regarding this strategy are in progress, and Provincetown has allocated capacity for Truro to send 150,000 gpd of flow. This strategy is included in the Alternative 2 nitrogen management plan.
Pamet River	Fertilizer Bylaw	Strategy included in recommended nitrogen management plan.
	Stormwater Best Management Practices	Strategy included in recommended nitrogen management plan.
	General Use Nitrogen-Reducing Onsite Septic Systems (effluent nitrogen concentration = 19 mg/L)	Strategy is included in the contingency nitrogen management plan. Converting all existing Title 5 septic systems to general use nitrogen-reducing septic systems is not enough to meet the nitrogen reduction goal and would require supplementary approaches. Therefore, additional strategies are also recommended as part of the contingency nitrogen management plan.
	Provisional Use Nitrogen-Reducing Onsite Septic Systems (effluent nitrogen concentration = 11 mg/L)	Strategy included in recommended nitrogen management plan.
	Cluster Systems	Strategy included in recommended and contingency nitrogen management plan.
	PRB	Strategy included in recommended nitrogen management plan.

4.5 Nitrogen Management Plans

This section provides a summary of the estimated nitrogen removals (as presented in the NAR, Appendix A), nitrogen management plans for Truro's three coastal estuaries, as well as a No Action Alternative. Estimated nitrogen reduction goals were calculated using one of two methods:

– For watersheds with an established nitrogen TMDL, the TMDL with the incorporation of growth projections was used as the basis of the calculation.
– For watersheds that do not yet have an established nitrogen TMDL, loads presented in the Cape Cod Commission Watershed Reports, with the incorporation of growth projections, were used. As mentioned in Section 3, the CCC 208 Plan recommends an initial nitrogen management planning allowance for nitrogen-impaired watersheds without MEP reports or TMDLs to use a 25% nitrogen reduction.

For each watershed, two Nitrogen Management Plans (in addition to the No Action Alternative presented in Section 4.5.1) are presented:

– The Recommended Nitrogen Management Plan (also referred to as the Recommended Plan).
– The Contingency Nitrogen Management Plan (also referred to as the Contingency Plan).

In all the watersheds, the Recommended Plan includes at least two alternative approaches. As discussed in Section 4.1, per 314 CMR 21, if a recommended plan includes Alternative Control Approaches and Technologies, a contingency plan that consists only of conventional control technologies must be provided. For this reason, the watershed nitrogen management plans presented in Sections 4.5.2 through 4.5.4 include contingency plans that solely consist of conventional control technologies.

4.5.1 No Action Alternative

This section summarizes the potential impacts if the Town were to proceed without implementing any recommended improvements to address its nitrogen reduction needs.

The impact of excessive nitrogen on coastal waters and other natural resources is well documented. Without addressing these needs, as identified in the Wellfleet Harbor MEP report and SMAST Water Quality monitoring results from the Pamet River and East Harbor, Truro could continue to lose natural and economic resources including declines in shellfish habitats, decline in property value, continued algal blooms in coastal embayments, beach closures, and potential declines in tourism as the aesthetic impacts of excessive nitrogen loading continue to impair the Town's water resources.

In 2023, MassDEP promulgated amendments to 310 CMR 15.00 (Septic System Title 5 regulations) and new watershed regulations (314 CMR 21.00). These regulations require all onsite septic systems in a Nitrogen Sensitive Area (NSA) to be upgraded to the Best Available Nitrogen Reducing Technology within five years of a Nitrogen Sensitive Area designation or implement a 20-year watershed permit. If a Town chooses to upgrade all systems in a NSA and designated watersheds still do not meet their TMDL goals, MassDEP may still issue a Consent Order to achieve TMDL compliance.

Wellfleet Harbor is currently designated as a Nitrogen Sensitive Area. Under the No Action Alternative, all properties within Wellfleet Harbor would be required to upgrade to a Best Available Nitrogen Reducing Technology system within five years of September 29, 2023, the date of the NSA designation. The Town of Truro has filed a Notice of Intent (NOI) to apply for a watershed permit for the Wellfleet Harbor watershed. The filing of the NOI prevents commencement of the five-year time period in which Title 5 system upgrades would otherwise be required.

Given the water quality within the Pamet River and Provincetown Harbor watersheds, it is expected that, following the establishment of a nitrogen TMDL and completion of a public review process, these areas may also receive designation as Nitrogen Sensitive Areas.

Financial impacts (beyond the impacts on the environment) of the No Action Alternative may include:

– Reduced property values and revenues.
– Noncompliance with Clean Water Act associated fines.
– MassDEP issuance of Consent Order to achieve the TMDLs and associated fines for not doing so in a timely manner. Issuance of a nutrient-related Consent Order would result in the Town being ineligible for nitrogen-mitigation zero-percent financing offered through the State Revolving Fund program (see Section 5.5).
– Reduced commercial shellfish income.
– Potential litigation.
– Potential reduced income to local businesses due to the reduced attractiveness of the Town to tourists and seasonal residents and retirees with accompanying loss of jobs.

4.5.2 Wellfleet Harbor

The Wellfleet Harbor watershed (Figure 4-1) is shared between Truro, Wellfleet, and Eastham, with a majority of the watershed within the Town of Wellfleet. The watershed has seven sub-embayments, with only a portion of one (Herring River/The Gut) in Truro. The following table summarizes the quantity of nitrogen that needs to be removed from the watershed to meet TMDL targets.

Table 4.13 Wellfleet Harbor: Herring River / The Gut – Nitrogen Load Reduction Goal

Subembayment	Truro's Current Nitrogen Removal Goal (kg-N/yr)	Truro's Future Nitrogen Removal Goal (kg-N/yr)
Herring River / The Gut	90	90

Most of the land area in Truro's portion of the watershed is located within the boundaries of the Cape Cod National Seashore and is undeveloped. The 92 developed parcels in the area are clustered near Ryder Pond and the Bound Brook areas, with most parcels greater than 1 acre in size, characterizing these areas as relatively low density (Figure 4-1). Thus, a decentralized approach is recommended for the Wellfleet Harbor watershed because it would be more cost-effective.

Various nitrogen strategies were considered to meet Truro's portion of the Wellfleet Harbor reduction goal, as presented in Section 4.4. After evaluating each of these approaches, a Recommended Plan and Contingency Plan were developed, as presented in the following table.

Table 4.14 Wellfleet Harbor Nitrogen Management Plan

Nitrogen Management Strategy	Estimated Nitrogen Reduction (kg-N/yr)	
	Recommended Plan	Contingency Plan
Stormwater Best Management Practices	54	-
Fertilizer Bylaw	51	-
Conversion of Existing Title 5 Systems to General Use Nitrogen-Reducing Systems – Single and Multi-Family Residential Properties[1]	-	92
Estimated Nitrogen Removed through Nitrogen Management Plan	**105**	**92**
Nitrogen Reduction Goal to Meet TMDL - Truro (Current)	**90**	**90**
Nitrogen Reduction Goal to Meet TMDL - Truro (2047)	**90**	**90**

Notes:
1. General Use Nitrogen-Reducing systems are approved for residential use.

4.5.3 East Harbor

The Provincetown Harbor Watershed (Figure 4-2) is shared between Truro and Provincetown, with a majority of the watershed within Provincetown. The portion of the watershed within Truro primarily drains to East Harbor. The following table summarizes the Cape Cod Commission Provincetown Harbor Watershed Report estimated nitrogen loads to the watershed. The CCC Provincetown Harbor Watershed Report did not establish a removal goal utilizing the 25% removal placeholder because there is an existing treatment facility in Provincetown that collects and treats wastewater from the majority of the densely developed areas in the watershed. However, because the treatment facility does not treat any flows in the Town of Truro, the 25% nitrogen reduction allowance was applied to estimate Truro's portion of nitrogen load for remove. The future removal required was estimated by applying a conservative future growth factor of 4.5% over the 20-year planning period; this is consistent with the growth factor that Provincetown is carrying for Truro's flows, based on Truro's indication that Beach Point is anticipated to see minimal growth over the planning period, which was developed in coordination with the Town of Truro.

Table 4.15 East Harbor – Nitrogen Load

Watershed	Truro's Current Nitrogen Removal Goal (kg-N/yr)	Truro's Future Nitrogen Removal Goal (kg-N/yr)
East Harbor	289	317

The East Harbor watershed within Truro consists of a narrow band of residential development. The area includes a mix of single-family homes, motels, and condominiums on very small lots. This dense area, known as Beach Point, includes the section of Shore Road from Knowles Heights Road to the Town line with Provincetown. Pilgrim Heights, a neighborhood within the Cape Cod National Seashore bordering East Harbor, consists largely of conservation land, with low development density.

As stated in Section 4.4, discussions with Provincetown regarding a sewering strategy in Beach Point are in progress. It is recommended that the Town of Truro continue discussions with Provincetown to determine if the sewering option is the preferred approach. The Town should also evaluate whether the existing culvert between East Harbor and Cape Cod Bay is negatively impacting water quality in East Harbor by restricting tidal flushing.

Given Beach Point's vulnerable location along the shoreline, the Town should conduct vulnerability evaluations for both proposed on site systems and a centralized system prior to implementing structural nitrogen management strategies. Structural nitrogen management strategies should consider flood hazard exposure and long-term resilience.

With consideration given to Beach Point's vulnerable coastal location, various nitrogen strategies were considered to meet the East Harbor reduction goal, as presented in Section 4.4. After evaluating each of these approaches, two alternatives were developed, as presented in the following table.

Table 4.16 East Harbor Watershed Nitrogen Management Plan Alternatives

Nitrogen Management Strategy	Estimated Nitrogen Reduction (kg-N/yr)	
	Alternative 1	Alternative 2
Stormwater Best Management Practices	51	-
Fertilizer Bylaw	21	-
Conversion of Existing Title 5 Systems to Provisional Use Nitrogen-Reducing Systems[1]	246	-
Sewering[2]	-	989
Estimated Nitrogen Removed through Nitrogen Management Plan	**318**	**989**
Nitrogen Reduction Goal - Truro (Current)	**288**	**288**

Nitrogen Management Strategy	Estimated Nitrogen Reduction (kg-N/yr)	
	Alternative 1	Alternative 2
Nitrogen Reduction Goal - Truro (2047)	**318**	**318**

Notes:

1. Provisional Use Nitrogen-Reducing systems are approved for residential and commercial use.
2. Alternative 2 sewering load is the estimated nitrogen load reduction removed by connecting a portion of Beach Point to the Provincetown Wastewater Treatment Facility. The portion selected during discussions with the Town of Truro includes parcels between 361 Shore Drive - 563 Shore Drive.

Prior to the implementation of the above outlined strategies, Truro should complete the site-specific evaluations outlined above, including the culvert sizing evaluation, a vulnerability assessment, and continued discussions with Provincetown regarding centralized sewering.

4.5.4 Pamet River Watershed

The Pamet River watershed (Figure 4-3) is entirely within the Town of Truro. The following table summarizes the Cape Cod Commission Pamet River Watershed Report estimated nitrogen loads to the watershed. Because the watershed does not yet have an MEP Report or TMDL, the Cape Cod Commission estimated a watershed threshold load utilizing a 25% removal allowance.

Table 4.17 Pamet River Watershed – Nitrogen Loads

Subembayment	Truro's Current Nitrogen Removal Goal (kg-N/yr)	Truro's Future Nitrogen Removal Goal (kg-N/yr)
Pamet River	1,125	1,141

The Pamet River watershed covers a large portion of central Truro, stretching from the Cape Cod Bay shoreline inland through a mix of salt marshes, tidal flats, freshwater wetlands, forested uplands, and residential neighborhoods. The lower reaches near the harbor mouth and along key road corridors are more densely settled, with clusters of small parcels and seasonal homes, while other areas, primarily in the southeast, remain largely natural and protected within the Cape Cod National Seashore.

Various nitrogen strategies were considered to meet the estimated Pamet River reduction goal, as presented in Section 4.4. After evaluating each of these approaches, a Recommended Plan and Contingency Plan were developed, as presented in the following table.

Table 4.18 Pamet River Watershed Nitrogen Management Plan

Nitrogen Management Strategy	Estimated Nitrogen Reduction (kg-N/yr)	
	Recommended Plan	Contingency Plan
Stormwater Best Management Practices	186	-
Fertilizer Bylaw	66	-
Permeable Reactive Barrier	112	-
Cluster System – Pamet River East	220	303
Cluster System – Pamet River West	-	227
Conversion of Existing Title 5 Systems to Provisional Use Nitrogen-Reducing Systems[1]	561	-

Nitrogen Management Strategy	Estimated Nitrogen Reduction (kg-N/yr)	
	Recommended Plan	Contingency Plan
Conversion of Existing Title 5 Systems to General Use Nitrogen-Reducing Systems – Single and Multi-Family Residential Properties[2]	-	614
Estimated Nitrogen Removed through Nitrogen Management Plan	**1,145**	**1,144**
Nitrogen Reduction Goal - Truro (Current)	**1,125**	**1,125**
Nitrogen Reduction Goal - Truro (2047)	**1,141**	**1,141**

Notes:

1. Provisional Use Nitrogen-Reducing systems are approved for residential and commercial use.
2. General Use Nitrogen-Reducing systems are approved for residential use.

5. Comprehensive Watershed Management Plan

The purpose of this section is to present the Recommended and Contingency Nitrogen Management Plans to meet future (2047) reduction goals for Truro's three watersheds based on the alternatives analysis evaluations presented in Section 4 of this report. Estimated future required nitrogen reductions by watershed are summarized in Table 5.1.

Table 5.1 Estimated Nitrogen Reduction Goals by Watershed

Watershed	2047 Estimated Nitrogen Reduction Goal (kg-N/yr)
Wellfleet Harbor	90
East Harbor	317
Pamet River	1,141
Total	1,548

Notes:

1. Estimated nitrogen reduction goals were established as part of the NAR, see Appendix A.
2. Wellfleet Harbor estimated reduction goal is based on the TMDL Report, with a land area factor applied to estimate Truro's portion. Methodology is further described in Section 6 of the NAR.
3. Estimated reduction goals for East Harbor and Pamet River are based on the CCC estimated nitrogen load, with a 25% nitrogen removal target applied to Truro's portion of the load. Methodology is further described in Section 6 of the NAR.
4. For reference, an average single-family home with a Title 5 septic system is estimated to discharge approximately 4.7 kg-N/yr. (Source: Wellfleet Harbor MEP Report).

The nitrogen management approaches presented in the following sections were developed for anticipated growth through the planning period (2027 – 2047).

5.1 Nitrogen Management Plan

Based on the Nitrogen Reduction Strategies Alternatives Analysis discussed in Section 4, nitrogen management plans were developed for each watershed. The Draft Comprehensive Watershed Management Plan outlines the various nitrogen management strategies for the Recommended Nitrogen Management Plan (Recommended Plan) and the Contingency Nitrogen Management Plan (Contingency Plan) to meet the Town's nitrogen reduction goals outlined

above. These nitrogen management strategies proposed for the Town's CWMP are summarized in Sections 5.1.1 and 5.1.2.

The Recommended Plan provides a comprehensive strategy for wastewater and nitrogen management for Truro's coastal estuaries. The Recommended Plan integrates multiple nitrogen management strategies for each watershed including a nitrogen-reducing onsite septic system program (utilizing Best Available Nitrogen-Reducing onsite septic system technologies currently in Provisional Use status), permeable reactive barriers, cluster systems, stormwater management, and fertilizer management.

The Contingency Plan provides a conservative estimate of additional onsite nitrogen-reducing septic systems (utilizing Best Available Nitrogen-Reducing onsite septic system Technologies in General Use status), cluster systems, and centralized sewering that would be required if pilot projects in the Recommended Plan did not perform as anticipated.

For the alternative strategies recommended in the following sections, a pilot project monitoring program, in accordance with the monitoring requirements outlined in the Watershed Permit Regulations, will need to be developed and initiated to monitor pilot project(s) performance through the Town's adaptive management program. The Town will adjust its Nitrogen Management Plan, as needed, based on the findings of the adaptive management program, through a Watershed Management Plan Update.

5.1.1 Decentralized Nitrogen Management Strategies

Based on the alternatives analysis and Truro's size, density, and cost considerations, the Recommended Plan consists primarily of decentralized infrastructure. Sections 5.1.1 and 5.1.2 outline the recommended nitrogen management strategies for the Town of Truro and its watersheds.

5.1.1.1 Fertilizer Management

The Truro Conservation Regulations (revised October 2021) define special conditions for particular projects that stipulate that fertilizers shall not be used within 100 feet of the wetlands, within the riverfront area, and within bordering land subject to flooding. To expand on the Town's fertilizer management policies, it is recommended that these regulations be expanded to all developed properties. Additionally, the Town should consider implementing restrictions on the time of year that fertilizer can be applied and mandating maximum loading rates for applications. The Town's fertilizer management program should aim to reduce the quantity of nitrogen and phosphorous entering the Town's water resources through a combination of education, licensure requirements, regulations of practice, and enforcement.

5.1.1.2 Stormwater Best Management Practices

The Town of Truro should implement non-structural stormwater BMPs through regulations. Additionally, the Town should evaluate the potential to implement structural stormwater BMPs. Regulations could require the implementation of stormwater BMPs in new development and redevelopment projects within the Town.

Non-structural BMPs can include street sweeping, maintenance of stormwater utilities, education and public outreach programs, land use planning, and impervious cover reduction control. These measures are a cost-effective strategy that allows for long-term nitrogen management planning.

Infrastructure BMPs can include stormwater bioretention soil media filters, constructed wetlands, and inlet protection, among others. It is recommended that the next step includes a screening evaluation to determine the feasibility of implementing structural BMPs within the Town. If determined feasible, the Town should proceed with site selection and preliminary design evaluation for structural stormwater BMPs. Truro should implement a maintenance plan to monitor performance of both structural and non-structural BMPs. Structural measures will require regular inspection and upkeep to maximize nitrogen removal efficiency.

5.1.1.3 Nitrogen Reducing Onsite Septic Systems

Table 5.2 outlines the Comprehensive Watershed Management Plan Nitrogen-Reducing Onsite Septic System Program. The Recommended Plan is based on the installation of nitrogen-reducing onsite septic systems which are

currently permitted for a treated effluent total nitrogen concentration of 11 mg/L or less (Provisional Use). By comparison, the Contingency Plan is based on installation of systems which are currently permitted for a treated effluent total nitrogen concentration of 19 mg/L or less (General Use).

Table 5.2 Recommended and Contingency Nitrogen-Reducing Onsite Septic System Program

	Approximate Number of Properties[1]	
Watershed	**Recommended Plan[2]**	**Contingency Plan[3]**
Wellfleet Harbor	0[4]	61
East Harbor	33[5]	0[6]
Pamet River	98	412
Total	**130**	**473**

Notes:

1. The approximate number of parcels was calculated using water use data. For parcels with no available water use data, water use was estimated based on the Massachusetts Estuaries Project average water uses. As summarized in Section 6.2.3 of the NAR, single family residential parcels were assigned a water use of 145 gpd, multi-family residential parcels were assigned a water use of 290 gpd, commercial properties were assigned a water use of 200 gpd / 1,000 SF of building area, and industrial properties were assigned a water use of 49 gpd / 1,000 SF of building area.
2. The number of parcels for the recommended plan includes residential and commercial parcels. The approximate number of parcels was estimated based on an effluent TN concentration of 11 mg/L.
3. The number of parcels for the contingency plan includes only residential parcels. The approximate number of parcels was estimated based on an effluent TN concentration of 19 mg/L.
4. There are no systems currently included as part of the Wellfleet Harbor recommended plan because initial estimates indicate the removal goal can be met through fertilizer management and stormwater best management practices.
5. This scenario represents the nitrogen-reducing onsite septic program proposed under Alternative 1 for Provincetown Harbor. As outlined in Section 4.5.3, additional evaluations are recommended to establish the Recommended and Contingency Plan for this watershed.
6. This scenario represents Alternative 2 for Provincetown Harbor. Alternative 2 does not include onsite septic systems because converting all properties to general use systems would not meet the removal goal, therefore sewering is the basis of Alternative 2. As outlined in Section 4.5.3, additional evaluations are recommended to establish the Recommended and Contingency Plan for this watershed.

The Town's current Board of Health regulations (revised May 2025) include the following triggers for the conversion of Title 5 systems to nitrogen-reducing onsite systems (that treat to an effluent nitrogen concentration of 19 mg/L or less):

– Flows greater than 600 gpd.
– Nitrogen credit applications (only allowed for ADUs without a variance).
– Certain non-conforming systems, as determined by the Board of Health.
– Previously approved systems that exceed a nitrogen loading rate of 110 gpd / 10,000 SF of lot area.
– Certain cases where a variance is required and a nitrogen-reducing system will mitigate environmental impacts of the proposed system, as determined by the Board of Health.

The Town of Truro is considering revising its Board of Health regulations to include additional triggers for the installation of nitrogen-reducing onsite systems, including:

– Property sale/transfer.
– Failed septic systems.
– Systems within a specific distance of any wetland or within a floodplain.
– New construction.
– Re-development / expansions.
– Properties in priority watersheds.

Other strategies for implementing nitrogen-reducing systems could include a geographic or phased schedule. This method could phase the required upgrade to nitrogen-reducing systems based on proximity to surface waters, wellhead protection zones and / or established geographic areas.

Existing BOH triggers and new BOH triggers would require the installation of nitrogen-reducing systems that treat to an effluent nitrogen concentration of 11 mg/L or less.

The Watershed Permit would outline the Town's strategies to implement the installation of nitrogen-reducing onsite systems that treat to an effluent concentration of no more than 11 mg/L. The permit will include a monitoring program to track system performance and provide the basis for quantifying nitrogen removal credits. As part of the Adaptive Management framework, triggers and strategies could be modified through the milestone reports (Watershed Management Plan updates) if implementation progress is lagging or adjustments are needed to meet nitrogen reduction goals.

5.1.1.4 Permeable Reactive Barrier (PRB)

The Recommended Plan includes the installation of a PRB directly down-gradient of a high-nitrogen producing agricultural property in the Pamet River watershed. It is estimated that the PRB can remove approximately 112 kg N/yr based on an estimate of the nitrogen load at the agricultural property. This estimate assumes 70% of the agricultural property's nitrogen load is removed through the PRB; this is an initial approach based on the Cape Cod Commission 208 Plan estimate that a PRB achieves 75% to 95% nitrogen removal which will need to be refined through groundwater characterization and piloting. This estimate does not account for additional properties upgradient of the proposed PRB location. To accurately quantify the additional nitrogen load of upgradient properties that would be captured by the PRB, the Town should perform a flow direction analysis and develop groundwater contour maps. The Town should also characterize the anticipated depth to groundwater, sediment type and groundwater flow velocity, vertical nitrogen concentration profile, and the depth of the highest groundwater nitrogen concentrations. These analyses would be used to determine the total nitrogen load that is anticipated to be intercepted and treated by the PRB. The Town should initiate coordination with the property owner of the identified PRB site. As part of the Adaptive Management Plan, the nitrogen load reduction credit for the PRB could be adjusted if additional upgradient sources are confirmed to be treated by the PRB, or on the contrary, if the nitrogen load treated is not as high as anticipated.

5.1.1.5 Cluster Systems

One potential cluster system location has been identified in the Pamet River as part of the Recommended Plan, with an additional potential cluster system identified for the Contingency Plan. Table 5.3 outlines a preliminary estimate on the number of properties that could be connected to the potential cluster system as part of the Recommended Plan and Contingency Plan.

Table 5.3 Recommended Plan and Contingency Plan – Anticipated Cluster Systems Connections

	Approximate Number of Properties	
Watershed and System	**Recommended Plan**	**Contingency Plan**
Pamet River East	34	51
Pamet River West	0	57

5.1.2 Traditional Nitrogen Management Strategies

The Recommended Plan outlined in this report relies on alternative nitrogen management strategies, however, sewering is recommended for the Contingency Plan in East Harbor. This approach would utilize the existing wastewater treatment facility in Provincetown. The anticipated number of connections in the Contingency Plan is summarized in Table 5.4.

Table 5.4 Contingency Plan – Anticipated Sewer Connections

	Approximate Number of Properties	
Watershed	Recommended Plan	Contingency Plan
East Harbor	0	91

Notes:

1. This scenario represents Alternative 2 for East Harbor. As outlined in Section 4.5.3, additional evaluations are recommended to establish the Recommended and Contingency Plan for this watershed.

5.2 Adaptive Management Plan

The Recommended Plan includes the implementation of an adaptive management process to incorporate cost-effective pilot technologies into the plan once they demonstrate feasibility. The adaptive management process will involve ongoing water quality monitoring to monitor and respond to the results of the implementation. Adaptive management will be implemented through five-year Watershed Management Plan Update Reports, which will evaluate progress and guide any necessary adjustments to strategies. The Watershed Management Plan Update Reports will serve as the five-year milestone reports for the Watershed Permit.

This adaptive management approach will enable the Recommended Plan to be adjusted based on the monitoring results of the environmental and economic impacts associated with the implementation of fertilizer bylaws, stormwater best management practices, nitrogen-reducing onsite septic systems, and cluster systems in Truro. Coordination with MassDEP will be conducted throughout this process. The Contingency Plan will then only require implementation through this Adaptive Management Program, in whole or in part, based on the performance of the Recommended Plan.

5.3 Responsible Management Entity

A Responsible Management Entity (RME) will need to be established to implement the nitrogen-reducing onsite septic system program outlined in the Recommended Plan. The RME is anticipated to oversee the monitoring of the program as part of the Town's adaptive management program. RME responsibilities could be fulfilled through a Town department or subcontracted.

5.4 Planning Level Capital Cost Estimates and Implementation Schedule

Planning level capital cost estimates were developed for the Recommended and Contingency Plans. Planning level capital cost estimates for infrastructure recommended as part of a multi-year planning project are typically developed at this time. As the project progresses to implementation, it is critical that these initial estimates are updated and refined at each stage of the planning and design process to accurately reflect items that may affect the cost estimates. These may include, but are not limited to:

– Changes in bidding climate and tariffs.
– State and Federal funding changes.
– Design changes resulting from future law, regulation, or code changes.
– Design changes results from industry or manufacturer advances, updates, or changes.
– Design changes based on Owner requests or other decision-making processes.
– Unknown conditions discovered through field investigations during design (borings, surveys, etc.).
– Design decisions regarding proprietary equipment/sole sourcing of equipment.

It is recommended that the planning level capital cost estimates presented in this report continue to be refined and updated at each major stage of program implementation, including during the design process and prior to construction financing.

The following assumptions were used to develop the planning level cost estimates for the nitrogen management strategies included in the Recommended Plan and Contingency Plan:

Permeable Reactive Barrier (PRB) Planning Level Estimate

- Planning level PRB construction cost estimates are initially based on the estimated removal cost outlined in the Cape Cod Commission 208 Plan.
- Because of the conceptual nature of this evaluation, a 30% construction contingency is carried as no detailed design has been performed and no groundwater characterization or survey has been performed. During final design, a reduced contingency will be carried for variability in the bidding climate, project changes before bidding, easements, residential property restoration, and changes due to unforeseen conditions. Project costs are presented in 2025 dollars. Once the construction timeframe has been finalized, project costs should be adjusted to the mid-point of construction. The capital cost estimates also include a 10% design allowance, 15% construction phase services allowance, 1% legal/fiscal allowance, and 4% survey and soil borings allowance.

Nitrogen Reducing Onsite System Program

- General Use I/A System costs were developed based on the planning values outlined in the 'Comparison of Costs for Wastewater Management Systems Applicable to Cape Cod – Guidance to Cape Cod Towns Undertaking Comprehensive Wastewater Management Planning,' prepared by the Barnstable County Wastewater Cost Task Force – April 2010, updated by AECOM (updated April 2014). Costs were escalated to 2025 dollars.
- Provisional I/A System costs are based on an average of cost data provided in 2025 by KleanTu for the NitROE® system and recent construction bids from Cape Cod towns for NitROE® system installations. The cost estimates include estimated costs for full system upgrade. Cost estimates are included for full systems. Cost savings may be recognized on a per parcel basis, if a property is able to convert its existing Title 5 system to a nitrogen-reducing system and does not require a full septic system replacement.
- The capital cost estimates include a 30% contingency.
- Project costs are presented in 2025 dollars. Once the construction timeframe has been finalized, project costs should be adjusted to the mid-point of construction.

Centralized Sewer Connections and Cluster Systems

- Regional construction bids from Cape Cod projects, dated 2023, were used to develop an estimated construction cost for the collection system.
- Anticipated costs to acquire any privately-owned land for pump stations were not included in the planning level cost estimates.
- The construction cost estimate includes estimated costs for linear infrastructure within the right-of-way only, not on private property.
- The construction cost estimate includes estimate for full width mill and overlay pavement restoration.
- Procurement and installation of grinder pumps required for a low-pressure system are not included in the cost estimate.
- Estimated costs assume that no hazardous materials or other materials that require special handling are encountered.
- Estimated project costs do not include utility relocation.
- Estimated project costs do not include archaeological monitoring.
- Allowances are carried for Truro's contribution to Provincetown infrastructure and capacity costs.

– Because of the conceptual nature of this evaluation, a 30% construction contingency is carried as no detailed design has been performed, and no survey has been performed. During final design, a reduced contingency will be carried for variability in the bidding climate, project changes before bidding, easements, residential property restoration, and changes due to unforeseen conditions. Project costs are presented in 2025 dollars. Once the construction timeframe has been finalized, project costs should be adjusted to the mid-point of construction. The capital cost estimates also include a 10% design allowance, 15% construction allowance, 1% legal/fiscal allowance, 8% police detail allowance, and a 4% survey and soil borings allowance.

Planning level capital costs for the Recommended Plan and Contingency Plan are summarized in Table 5.5. The implementation schedule for the Recommended Plan is outlined in Table 5.6.

Table 5.5 Truro Recommended Plan – Planning Level Capital Costs

Strategy	Recommended Plan – Full Estimated Capital Costs (2025 $)	Contingency Plan – Full Estimated Capital Costs (2025 $)
Fertilizer Management Allowance[1,2]	$-	$-
Stormwater Best Management Practices Allowance[2]	$8.66 M	$-
Permeable Reactive Barrier Allowance[2]	$1.38 M	$-
Nitrogen Reducing Onsite Septic System Program[3,4]	$9.06 M	$32.82 M
Centralized Sewering (Treated at Provincetown WWTF)[5,6]	$-	$14.78 M
Cluster System – Pamet River East[7]	$4.46 M	$5.94 M
Cluster System – Pamet River West[7]	$-	$6.31 M
Total Capital Costs (2025 $)	**$23.56 M**	**$59.86 M**

Notes:

1. No capital cost is carried for a fertilizer management allowance because this strategy does not involve any construction projects. All implementation measures are regulatory actions.
2. Stormwater best management practices, and permeable reactive barrier costs were based on planning level costs from the Cape Cod Commission 208 Plan 2015 Update. Stormwater BMP cost includes budget for implementation of non-structural strategies, including street sweeping, maintenance of stormwater utilities, education and public outreach programs, land use planning, and impervious cover reduction and control.
3. General Use nitrogen-reducing system costs were developed based on the planning values outlined in the 'Comparison of Costs for Wastewater Management Systems Applicable to Cape Cod – Guidance to Cape Cod Towns Undertaking Comprehensive Wastewater Management Planning,' prepared by the Barnstable County wastewater Cost Task Force – April 2010, updated by AECOM (updated April 2014).
4. Provisional nitrogen-reducing system costs are based on recent (2023) construction bids from other Cape Cod towns.
5. Recent regional construction bids from Chatham, Barnstable, and Falmouth were used to develop an average per parcel construction cost for the collection system. The sewering cost includes allowances for Truro's contribution to Provincetown for capacity and infrastructure costs.
6. Centralized sewering cost includes an allowance for contributions to Provincetown for infrastructure and capacity costs which were established through discussions between Truro and Provincetown.
7. Cluster system cost estimates were based on vendor quotes obtained in 2025.
8. Planning level project costs are presented in 2025 dollars (ENR January 2025 = 13731.6). Once a construction timeframe is finalized for each project, project costs should be adjusted to the anticipated mid-point of construction. Planning level capital cost estimates for infrastructure recommended as part of a multi-year planning project are typically developed as part of the planning process. As the project progresses, it is critical that these initial estimates are updated and refined at each stage of the planning and design process and prior to construction financing to accurately reflect items that may affect the cost estimates.

The following table provides an overview of the proposed Recommended Plan implementation schedule in five-year increments. While the schedule includes implementation in all three of Truro's watersheds, only Wellfleet Harbor is

currently subject to a regulatory timeframe established through the Watershed Permitting process. Once TMDLs are established and Notices of Intent (NOIs) are filed for the Pamet River and Provincetown Harbor watersheds, they will also be subject to regulatory timelines.

Table 5.6 Truro Recommended Plan – Implementation Schedule Summary

Strategy	2027-2031	2032-2036	2037-2041	2042-2046
Fertilizer Management				
Stormwater Best Management Practices				
PRB				
Nitrogen-Reducing Onsite Program				
Cluster System – Pamet River East				

Table 5.7 provides a more detailed breakdown of the CWMP targeted milestone implementation schedule, including anticipated nitrogen reductions targets for each program.

Table 5.7 Truro Comprehensive Watershed Management Plan – Targeted Milestone Implementation Schedule

Phase	Years		Activity	Nitrogen Reduction (kg/yr)
	Up to 2027		Develop methodology to implement nitrogen-reducing onsite septic system program (i.e. BOH triggers or phased approach)	
1	1 to 5	2027 - 2031	Obtain Watershed Permit for Wellfleet Harbor (by 2030)	
			Enact Fertilizer Reduction Bylaw	138
			Implement Non-Structural Stormwater Best Management Practices and Regulations	291
			Initiate installation of Nitrogen-Reducing Onsite Septic Systems	202[1]
			Initiate recommended evaluations including: Pamet River: PRB location groundwater characterization and piloting, Little Pamet delineation and evaluation East Harbor: discussions with Provincetown, vulnerability assessment, culvert sizing evaluation Structural stormwater BMPs: site evaluation Cluster systems: conceptual layout development, coordination with property owners, development of design and construction milestones	
1st Watershed Management Plan Update Report Goals: 1. Evaluate monitoring data 2. Outline any changes in Recommended Plans identified through the Adaptive Management Program				
2	6 to 10	2032 - 2036	Install Permeable Reactive Barrier in Pamet River watershed	112
			Install Pamet River East cluster system	220
			Install Nitrogen-Reducing Onsite Septic Systems	202[1]
2nd Watershed Management Plan Update Report Goals: Goals to be established in the 1st Watershed Management Plan Update.				

Phase	Years		Activity	Nitrogen Reduction (kg/yr)
3	11 to 15	2037-2041	Install Nitrogen-Reducing Onsite Septic Systems	202[1]
3rd Watershed Management Plan Update Report Goals: Goals to be established in the 2nd Watershed Management Plan Update.				
4	16 to 20	2042-2046	Install Nitrogen-Reducing Onsite Septic Systems	202[1]
4th Watershed Management Plan Update Report Goals: Goals to be established in the 3rd Watershed Management Plan Update.				

Notes:

1. For planning purposes, it is assumed that the nitrogen-reducing onsite septic system program achieves 25% of its total estimated reduction in each implementation phase.

At each five-year milestone report, as required by the Watershed Permit Regulations, the Town will need to evaluate the performance of the implemented nitrogen strategies to assess progress toward watershed nitrogen reduction goals and document nitrogen removal credits. Monitoring data and updated load estimates should be used to determine whether the implementation schedule and/or selected management approaches should be adjusted. This adaptive management process will ensure that the plan remains effective and responsive to observed environmental conditions and community needs.

5.5 Technical and Financial Assistance

For conventional infrastructure such as cluster systems, centralized sewering, and stormwater improvements, it is recommended that the Town pursue financial assistance through the Clean Water State Revolving Fund (CWSRF) program. Nutrient management projects, which meet established criteria, are eligible to apply for 0% financing through this program. The criteria for 0% financing are:

1. The project is primarily intended to remediate or prevent nutrient enrichment of surface waters or water supply sources in order to meet a NPDES permit or an EPA-approved TMDL.
2. The applicant is not currently in violation of a MassDEP enforcement order, administrative consent order or unilateral administrative order or enforcement action by the United States Environmental Protection Agency due a violation of a nutrient-related total maximum daily load standard or other nutrient based standard.
3. The CWMP is approved by MassDEP and EOEEA (as demonstrated by an approval letter and/or certificate).
4. The project is consistent with the regional water resources management plan (as demonstrated by a certificate or letter of consistency from the regional planning agency).
5. The applicant has adopted flow neutral land use controls as provided in 314 CMR 44.04(3).

SRF-eligible projects may also access the Cape and Islands Water Protection Fund (CCIWPF), which is a dedicated fund within the State's Clean Water Trust established to benefit communities on Cape Cod, Martha's Vineyard, and Nantucket. The CCIWPF subsidizes a portion of the SRF loan principal for qualified projects.

Individual homeowners may seek financial assistance for septic system upgrades and municipal sewer connections through the Cape Cod Aquifund. The Aquifund provides betterment loans for nitrogen-reducing septic system installation or municipal sewer connections.

The State also provides a tax credit to assist with the costs of septic upgrades at primary residences.

The goal of the CWMP is to meet nitrogen reduction targets in the most cost-effective and equitable manner possible. Given that nitrogen management Town results in Town-wide benefits, the Town is proactively evaluating other financing strategies to equitably distribute program costs between properties that are included in different nitrogen management programs.

5.6 Next Steps

Based on the Recommended Nitrogen Management Plan presented, this section identifies next steps the Town should take to facilitate implementation.

Stormwater Management

In addition to implementing non-structural stormwater best management practices, the Town should identify locations for potential structural stormwater improvements such as leaching galleys, raingardens, bioretention systems, and constructed wetlands. It is recommended that Truro identify Town owned parcels; vacant portions of developed Town owned parcels should be considered for stormwater improvements. Infrastructure should be selected based on available land area and site topography. The Town should consider discussions with MassDOT to potentially target stormwater discharges from Route 6, a large contributor of impervious area in Truro's watersheds, as presented in Section 4.3.3. Regarding non-structural BMPs, the Town should establish public education programs and maintenance programs for street sweeping and catch basin maintenance to facilitate long-term performance.

Fertilizer Management

The Town should implement and enforce fertilizer bylaws. Implementation should include a public outreach program to promote nitrogen-conscious practices.

Permeable Reactive Barrier

To successfully implement a PRB in the Pamet River watershed, the Town should advance the conceptual design of the PRB to confirm feasibility. The Town should conduct groundwater characterization, which includes: flow direction analysis, depth to groundwater, sediment type and flow velocity, vertical nitrogen concentration profile, and the depth of the highest groundwater nitrogen concentration. These analyses, along with nitrogen load assessments will allow the Town to refine the location, design, design parameters (depth and length), and estimated captured area of potential upgradient nitrogen loads. The Town should initiate coordination with the property owner of the identified PRB site and begin piloting efforts.

East Harbor Culvert Assessment

It is recommended that a hydrodynamic evaluation be conducted to assess tidal flushing conditions at the existing culvert. Based on the findings of this analysis, culvert widening may be included in Truro's Adaptive Management Plan.

Responsible Management Entity

The Town needs to identify a Responsible Management Entity to oversee installation, operation, and maintenance of the individual nitrogen-reducing onsite septic system program which proposed as part of the Recommended Plan. Identification of an RME should include clearly defined management roles, permitting responsibilities, and reporting requirements to ensure system compliance. The Massachusetts Alternative Septic System Test Center (MASSTC) is in the process of developing a septic utility program (SUP) that could potentially serve as an RME. The Town may explore collaboration with MASSTC as a potential option for identifying an RME.

Climate Resiliency

The Town should evaluate various climate resiliency strategies such as resilient infrastructure siting and solar photovoltaic systems. These climate resiliency measures are described in Section 6.

Financing

The Town should pursue available financing opportunities through the various funding agencies defined in Section 5.5.

6. Climate Change/Greenhouse Gas Evaluation for the Recommended Plan

The Town of Truro is a low-lying community bounded to the west by Cape Cod Bay and to the east by the Atlantic Ocean, making it vulnerable to coastal flooding from storm surges, coastal erosion, and impacts of future sea level rise. The Town of Truro is proactively evaluating and implementing climate adaptation strategies through its Climate Action Committee.

In June 2025, the Massachusetts Department of Energy Resources declared Truro to be one of the 19 "climate leader communities" in the State. Truro achieved this designation through establishment of a Climate Action Committee and an Energy Committee, development of a decarbonization plan which outlines a policy to eliminate fossil fuel use by 2050, development of a zero emissions policy for new Town vehicles, and adopting the State's specialized stretch energy code.

As the Town continues to evaluate and implement climate change adaptation strategies for its proposed nitrogen management plan, the following design strategies are recommended to increase the coastal resilience of vulnerable infrastructure:

– Establish a planning horizon through the end of infrastructure design life.
– Consider alternative locations for any proposed infrastructure within the planning horizon floodplain.
– For infrastructure that needs to be located within the planning horizon floodplain, establish a design flood elevation for design and construction which incorporates Federal Emergency Management Agency (FEMA) flood elevations, industry freeboard requirements, and allowances for anticipated sea level rise through the end of the project planning horizon.
– Assess impacts of future precipitation events, as measured by the 24-hour rainfall volumes provided by the MA Resilience Design Tool during design of wastewater and stormwater facilities.

Each of the recommended strategies will be further evaluated during the design stage of the project to determine feasibility.

6.1 Climate Change – Adaption and Resiliency

6.1.1 Climate Resilience Design Standards Tool

The Resilient Mass Action Team's (RMAT) Climate Resilience Design Standards Tool, developed by the Commonwealth of Massachusetts, was used to better understand and evaluate the climate risks and resilience strategies associated with the Recommended Plan. The tool is an interactive resource that supports climate adaptation and resilience planning by providing risk assessments for a variety of climate hazards. Based on a project's inputs, the tool evaluates exposure to flooding, sea level rise, and extreme heat. RMAT assigns a low, moderate, or high-risk score to each asset or area. Scores are based on projected climate conditions, sensitivity, and project locations.

An analysis was run for each watershed: Wellfleet Harbor, Provincetown Harbor (East Harbor), and Pamet River. For the Pamet River watershed, two analyses were conducted, one for the western side, and one for the eastern side (due to size restrictions within the tool). After selecting a project area in the tool for each watershed, the tool identified specific prompts to be addressed relative to the following inputs:

– Core project information.
– Project ecosystem services benefit.
– Project climate exposure.
– Project assets.

Outputs provided the following:

1. Preliminary climate exposure and risk ratings.
2. Recommended climate resilience design standards and guidance.

The RMAT Climate Resilience Design Standards Tool outputs are included in Appendix D and are summarized below.

6.1.1.1 Wellfleet Harbor

The Wellfleet Harbor Recommended Plan assets includes stormwater best management practices. Based on the project inputs, the project score is moderate. The following table provides the overall exposure scores for the watershed.

Table 6.1 Wellfleet Harbor Project Exposure Score

Exposure	Score
Sea Level Rise / Storm Surge	Moderate Exposure
Extreme Participation – Stormwater Flooding	Moderate Exposure
Extreme Precipitation – Riverine Flooding	High Exposure
Extreme Heat	Low Exposure

Based on the exposure scores above, climate risk ratings were developed for the proposed assets and are summarized in Table 6.2.

Table 6.2 Wellfleet Asset Preliminary Climate Risk Rating Summary

Asset	Sea Level Rise / Storm Surge	Extreme Participation – Stormwater Flooding	Extreme Participation – Riverine Flooding	Extreme Heat
Stormwater BMPs	Moderate Risk	Moderate Risk	High Risk	Low Risk

6.1.1.2 Provincetown Harbor: East Harbor

The East Harbor Recommended Plan assets includes stormwater best management practices and provisional use nitrogen-reducing onsite septic systems. Based on the project inputs, the project score is moderate. The following table provides the overall exposure scores for the watershed.

Table 6.3 Provincetown Harbor Project Exposure Score

Exposure	Score
Sea Level Rise / Storm Surge	High Exposure
Extreme Participation – Stormwater Flooding	Moderate Exposure
Extreme Precipitation – Riverine Flooding	High Exposure
Extreme Heat	High Exposure

Based on the exposure scores above, climate risk ratings were developed for the proposed assets and are summarized in the following table.

Table 6.4 East Harbor Asset Preliminary Climate Risk Rating Summary

Asset	Sea Level Rise / Storm Surge	Extreme Participation – Stormwater Floding	Extreme Participation – Riverine Floding	Extreme Heat
Provisional Use Nitrogen Reducing Onsite Systems	High Risk	Moderate Risk	High Risk	High Risk
Stormwater BMPs	High Risk	Moderate Risk	High Risk	High Risk

6.1.1.3 Pamet River

The Pamet River Recommended Plan assets include stormwater best management practices and provisional use nitrogen-reducing onsite septic systems, a PRB, and a cluster system. As stated before, two analyses were run for this watershed. Based on the project inputs, the project score both times is moderate. The following table provides the overall exposure scores for the watershed.

Table 6.5 Pamet River Project Exposure Score.

Exposure	Pamet River East Score	Pamet River West Score
Sea Level Rise / Storm Surge	High Exposure	High Exposure
Extreme Participation – Stormwater Floding	Moderate Exposure	Moderate Exposure
Extreme Precipitation – Riverine Flooding	High Exposure	High Exposure
Extreme Heat	Moderate Exposure	Moderate Exposure

Based on the exposure scores above, climate risk ratings were developed for the proposed assets and are summarized in the following table.

Table 6.6 Pamet River Asset Preliminary Climate Risk Rating Summary

Asset	Sea Level Rise / Storm Surge	Extreme Participation – Stormwater Floding	Extreme Participation – Riverine Floding	Extreme Heat
Provisional Use Nitrogen Reducing Onsite Systems	High Risk	Moderate Risk	High Risk	Moderate Risk
Stormwater BMPs	High Risk	Moderate Risk	High Risk	Moderate Risk
PRB	High Risk	Moderate Risk	High Risk	Moderate Risk
Cluster System	High Risk	Moderate Risk	High Risk	Moderate Risk

6.1.1.4 Summary

Overall, the RMAT Climate Resilience Design Standards Tool results indicate that the Recommended Plan assets across all three of Truro's watersheds are subject to moderate to high exposure to climate-related stressors, particularly flooding and sea level rise. These scores are primarily influenced by the selected project area boundaries, which were conservatively selected as the entire extent of the Town's watersheds. High sea level rise scores were generally assigned due to the watersheds being exposed to coastal flooding events and within the predicted mean high-water shoreline by 2030. Flooding scores were influenced by the mapped FEMA floodplains and the annual daily rainfall within the watersheds. The results highlight the importance of resilient infrastructure siting and design. As projects advance into design, siting considerations will include strategies to mitigate environmental impacts, enhance flood resilience, and protect natural resources.

6.2 Base Case and Recommended Plan Greenhouse Gas Evaluation

In accordance with the MEPA Greenhouse Gas Emissions Policy and Protocol, a Base Case (existing onsite septic systems) and Recommended Case (Recommended Plan) Greenhouse Gas (GHG) evaluation was conducted. Because existing software used to calculate GHG emissions and energy consumption, such as the USEPA Energy Star tool, uses building area to calculate emissions, an alternative approach was developed for this largely decentralized plan.

The GHG evaluation uses septic system and centralized system CO_2 emissions estimates developed by the Intergovernmental Panel on Climate Change (IPCC), following methodology outlined in the 2023 New York State Greenhouse Gas Emissions Sectoral Report #4.

The IPCC estimates that centralized systems emit 108.9 kg of CO_2 equivalent per capita per year, and individual onsite septic systems generate 353.3 kg CO_2 equivalent per capita per year. Methane is generated by microorganisms decomposing organic material in wastewater under the largely anaerobic conditions in a septic system. A wastewater treatment facility relies more on aerobic treatment methods and uses methane capture mitigate the amount of emissions produced. According to the 2025 Truro Housing profile prepared by the Cape Cod Commission, there are approximately 1,675 year-round residents in 1,053 households, making the average household size 1.6 people. This data was used to estimate CO_2 emissions for the Base Case (wherein all residents are served by septic systems) and The Recommended Case (wherein a variety of technologies are implemented in accordance with the Recommended Plan described in Section 5). Tables 6.7 and 6.8 summarize the findings of the analysis.

Table 6.7 Base Case GHG Emissions Estimate

Base Case Infrastructure	Population Served	Estimated Emissions (tons CO_2 per year)
Traditional Onsite Septic Systems	1,675 (all residents)	652
Total	**1675**	**652**

Table 6.8 Recommended Case GHG Emissions Estimate –Wastewater Management Strategies

Recommended Case Components	Year Round Population Served (Wastewater Infrastructure)	Estimated Emissions (tons CO_2 per year)
Traditional or Nitrogen-Reducing Septic Systems[1]	1,625 (all residents)	631
Cluster System (34 properties)[2]	54	7
Total	**1675**	**638**

Notes:

1. It is anticipated that major generation sources are similar for both conventional and nitrogen-reducing system types. Should more data become available, GHG emissions analyses can be updated in Watershed Management Plan Updates.
2. The proposed cluster system is classified as a centralized system.

6.3 Opportunities for Energy Generation and Recovery

6.3.1 Solar Photovoltaic (PV) Systems

Solar PV arrays can be used by facilities with adequate space to produce renewable energy onsite. Arrays can by ground-mounted or roof-mounted depending on the orientation of the facility's building and available roof space. South facing roofs with minimal shadow interference provide the most ideal conditions for a roof-mounted solar array. A

shade analysis would need to be conducted at a potential site to determine the feasibility of a solar installation. On average, Massachusetts experiences 4.5 sun hours per day of solar energy. In comparison, Phoenix, Arizona experiences 6.4 sun hours per day. For an equivalent amount of power output from a PV panel in Massachusetts, the module area would be designed to be approximately 40% larger than in Phoenix.

A solar system can be used in a wastewater treatment facility to provide energy for the treatment process and reduce the plant's dependence on fossil fuels.

The Town should consider conducting a feasibility analysis of installing a solar array system at the proposed cluster system facilities to estimate the amount of energy that could be produced versus the amount of energy expected to be consumed. Initial capital cost, operational and maintenance cost, and replacement costs associated with the solar system will need to be compared to the amount of energy the solar system could produce to determine the feasibility of installing a solar system.

6.4 Water Conservation Considerations

The Massachusetts Executive Office of Energy and Environmental Affairs (EOEEA) and Water Resources Commission developed the *Massachusetts Water Conservation Standards* (last updated in 2018) to set State-wide goals for water conservation and water-use efficiency. The document highlights the environmental benefits and potential financial savings of water conservation through reduced operation, maintenance and wastewater treatment costs, increased plant capacity, and savings from avoiding the development of new water sources. Key water conservation efforts that can reduce wastewater flows and loads are as follows.

6.4.1 Reduced Flow Plumbing

Reduced flow plumbing should be considered in design whenever possible and permitted by the local plumbing code. Devices that can be installed in the facility to reduce water consumption include water saving toilets, reduced flush devices, and restricted flow shower heads. Opportunities to implement reduced flow plumbing will be evaluated during the design of the proposed cluster system facilities. Low flow fixtures would not reduce pollutant loads as pollutants would simply be concentrated in the reduced flow.

6.4.2 Inflow and Infiltration Reduction

Locating and repairing sources of inflow and infiltration (I/I) in a gravity collection system helps to minimize the quantity of water that needs to be pumped and treated. Excessive I/I can exhibit negative effects on the wastewater treatment system by diluting pollutant concentrations in the wastewater and washing out microbes needed for biological treatment. As the Town currently does not have any existing collection systems, this would only be performed following the construction and operation of any proposed collection systems for cluster treatment or following connection to the Provincetown collection system if that contingency is implemented with a gravity system.

6.4.3 Reclaimed Water Reuse

The New England Interstate Water Pollution Control Commission (NEIWPCC) Technical Report 16: Guides for the Design of Wastewater Treatment Works (TR-16) recommends conducting an assessment to determine if there are any economic effluent reuse opportunities at a facility in order to minimize the use of potable water. Increasing treated wastewater recharge and reuse is one of the 10 major recommendations of the 2004 Massachusetts Water Policy issued by the EOEEA. Opportunities to increase reclaimed wastewater for non-potable uses will be evaluated during design of proposed infrastructure systems.

7. Environmental Impact Analysis

This section analyzes the potential environmental impacts of the infrastructure projects outlined in the Truro CWMP for the Recommended Plan and No Action Alternatives. Effects are analyzed in accordance with the criteria outlined in 301 CMR 11.00.

7.1 Topography, Geology, and Soils

7.1.1 Recommended Plan

Construction of individual nitrogen-reducing onsite septic systems and the cluster wastewater treatment systems outlined in the Recommended Plan will involve land disturbance. A cluster treatment system may require construction of one or more small buildings to house process and electrical equipment. It will also require an effluent recharge system and sewer lines to collect wastewater and convey it to the treatment site. The majority of the sewer lines will be installed beneath roads, which is considered previously disturbed land.

Installation of nitrogen-reducing septic systems will also require land disturbance for the installation of new tanks and any upgrades to the existing systems to support the new treatment technologies needed. This may also require upgrade to the leaching facilities depending on the age of the existing system. New systems will require land disturbance for all components for an onsite septic system and the associated house drain piping.

Installation of a PRB will require land disturbance, though this is dependent on the PRB method chosen. Injection type systems are anticipated to require a smaller land disturbance footprint than open cut systems where a trench is required to install the PRB media.

Installation of structural stormwater BMPs may require land disturbance. Stormwater BMPs are often installed in the road right-of-way, on land considered previously disturbed, however nitrogen-reducing BMPs require larger land areas and may also result in creation of constructed wetlands or other drainage systems requiring larger land areas.

7.1.2 No Action Alternative

The No Action Alternative is not anticipated to increase the level of soil disturbance in the Planning Area.

7.2 Surface and Groundwater Hydrology and Quality

7.2.1 Recommended Plan

The Recommended Plan will benefit the waterbodies, estuaries, and coastal surface water bodies in Truro by reducing excess nitrogen migration through groundwater from septic systems.

Wastewater treatment via nitrogen-reducing onsite septic systems and cluster wastewater treatment systems will produce a higher quality effluent than achievable with traditional onsite septic systems. The PRB, stormwater, and fertilizer management strategies will also reduce nitrogen loading to groundwater and surface waters.

The Recommended Plan does not involve water withdrawal, so it will not exceed MEPA thresholds for water withdrawal.

7.2.2 No Action Alternative

The No Action Alternative would negatively impact the environment in terms of groundwater, surface water hydrology, and quality. Nitrogen would continue to flow from traditional septic systems through groundwater to coastal waterbodies, worsening existing impairments.

7.3 Air Quality, GHG Emissions, and Noise

7.3.1 Recommended Plan

During any construction, dust is often generated onsite. Emissions generated by construction equipment also have negative impacts on air quality. Proper pollution control measures will be employed during construction of the CWMP-related projects to limit these effects and provide a positive means to prevent airborne dust and reduce vehicle emissions. For Town projects, contractors will be required to follow the Massachusetts Diesel Retrofit Program for all diesel-powered non-road construction equipment and vehicles greater than 50 break horsepower.

Odors generated during operations at the cluster treatment system can be limited by including odor control units, tank covers, or installing process tanks underground. Similarly, onsite systems can also contribute to localized odor emissions, particularly during septic tank pumping, sludge removal, or system maintenance events. These odors are typically short-term but should be managed through proper maintenance and best management practices. Onsite systems may also generate odors in the case of system failures. Odor control will be evaluated for the cluster treatment system during final design.

The cluster treatment system will use electricity, the generation of which emits greenhouse gases. In addition, wastewater treatment releases greenhouse gases (though septic systems also release greenhouse gases). GHG emissions from onsite systems primarily results from anaerobic biological activity and periodic pumping operations. Energy efficiency measures will be incorporated into the design of the cluster treatment system; for example, variable frequency drives will be used on equipment as appropriate to reduce energy use.

The majority of noise impacts are generated during the construction phase of any project. The larger the extent of construction, the more noise associated with that work. In Truro, noise impacts from collection system construction will be greatest in areas where buildings and houses are in close proximity to the site. The Town has a local noise ordinance and will restrict contractor work to within acceptable construction times to minimize impacts.

The cluster treatment system will be engineered to minimize noise from pumps and blowers by designing the building accordingly or by locating equipment underground. If pump stations are required, options to mitigate generator noise by locating them in buildings and/or within sound-reducing enclosures will be evaluated during final design.

7.3.2 No Action Alternative

This alternative would not decrease the air quality or increase noise due to the actual construction of the project. However, this alternative may decrease air quality if continued nutrient pollution causes eutrophication in surface waters. According to the U.S. Centers for Disease Control and Prevention, some harmful algae blooms can become airborne and damage local air quality and human respiratory health.[3]

7.4 Plant and Animal Species and Habitats

7.4.1 Recommended Plan

Figure 7-1 outlines NHESP Estimated Habitats of Rare Wildlife and NHESP Priority Habitats of Rare Species in Truro. The map shows that there are NHESP habitats mapped within the project area.

As shown in Figure 7-2, various areas within Truro's watersheds are near mapped MassDEP wetlands. Wetland Protection Act Request for Determination of Applicability and/or Notices of Intent will be submitted to the Town of Truro Conservation Commission for any areas within Wetland Protection Act jurisdiction during final design of projects outlined in the Recommended Plan. The Recommended Plan is not anticipated to exceed MEPA thresholds for alteration of bordering vegetated wetland (less than 1 acre in accordance with 301 CMR 11.03.3.a.1.a) or other

[3] Centers for Disease Control and Prevention. (2024, April 18). *Harmful algal blooms: Contributing factors and impacts*. U.S. Department of Health and Human Services. **https://www.cdc.gov/harmful-algal-blooms/about/harmful-algal-blooms-contributing-factors-and-impacts.html**

wetland alteration (less than 10 acres in accordance with 301 CMR 11.03.3.a.1.b).The health of the coastal and inland wetland resources in Truro are anticipated to benefit from this alternative with decreased nutrient loading to the waterways and estuaries.

7.4.2 No Action Alternative

This alternative would continue to increase the nutrient loading to the Town's coastal waterbodies. The increase in nitrogen would lead to significant—and potentially irreversible—adverse effects on the marine plant and animal species, including shellfish species.

7.5 Traffic, Transit, and Pedestrian and Bicycle Transportation

7.5.1 Recommended Plan

This alternative is expected to have limited short-term negative impacts on traffic and transit, and minimal short-term effects on pedestrian and bicycle transportation. This alternative is likely to increase construction traffic during various phases of the construction project. However, with regulated traffic control measures and effective management of the traffic, the public burden will be decreased. The project would have no long-term traffic impacts. The Recommended Plan will not exceed MEPA thresholds for vehicles trips per day (less than 1,000 in accordance with 301 CMR 11.03.66.b.xiv) or new parking spaces (less than 300 in accordance with 301 CMR 11.03.6.b.xv).

7.5.2 No Action Alternative

This alternative would not have effects on the traffic, transit, and pedestrian and bicycle transportation aspects of the existing environment.

7.6 Scenic Qualities, Open Space, and Recreational Resources

7.6.1 Recommended Plan

With this alternative, it is unlikely that protected open space will be negatively disturbed. The implementation of this alternative would decrease overall negative environmental impacts to the protected open spaces in the Town, specifically to recreational water bodies and beaches. Open Space is shown in Figure 7-3.

7.6.2 No Action Alternative

With this alternative, no disturbance to protected open space is anticipated. However, by allowing the elevated nutrient loadings to Truro's costal waterbodies to continue, the No Action Alternative will adversely impact the environment in the long-term. Recreational resources and scenic qualities will be affected by the decreasing environmental health of Truro's waterbodies.

7.7 Historic Structures of Districts and Archaeological Sites

7.7.1 Recommended Plan

With this alternative, it is unlikely that historic structures, historic districts, or archaeological sites located within the Planning Area will be adversely affected by collection system installation. Historic and cultural resources are shown in Figure 7-4. An archaeological sensitivity analysis and archaeological survey (if required) will be conducted in archeologically sensitive areas as project design plans are finalized and specific areas are slated for ground disturbance and/or construction activities. If necessary, onsite monitoring will be provided during construction.

7.7.2 No Action Alternative

With this alternative, it is unlikely that historic structures, historic districts, or archeological sites will be adversely impacted.

7.8 The Built Environment and Human Use of the Project Site

7.8.1 Recommended Plan

Improved wastewater treatment could increase growth in the Planning Area if regulations are not in place to manage growth. Unregulated growth due to a sewer area is considered a negative impact unless an area has been identified as a growth incentive zone. It is recommended that the Town adopt Land Use Controls (as a regulation or a bylaw) to mitigate growth impacts of the Recommended Plan. The Recommended Plan does not include development of any new housing units, and is not anticipated to exceed MEPA thresholds for acres of land altered (less than 25 acres in accordance with 301 CRM 11.03.1.b.1) or acres of new impervious area (less than 5 acres in accordance with 301 CMR 11.03.1.b.2).

7.8.2 No Action Alternative

Under the No Action Alternative, development will continue in the Town's coastal watersheds without coordinated nitrogen management, further impacting estuary water quality and habitat value.

7.9 Rare or Unique Features

7.9.1 Recommended Plan

The Recommended Plan is not expected to impose negative impacts on the unique features of the Town of Truro. As shown in Figure 7-5, the Wellfleet Harbor Area of Critical Environmental Concern (ACEC) extends to southern Truro. The Recommended Plan is anticipated to restore the health of Truro coastal waters through the reduction of nitrogen inputs.

7.9.2 No Action Alternative

The No Action Alternative is not expected to impose any direct negative impact on the unique features of the Town of Truro. However, the continued input of nitrogen into the Town's estuaries is expected to further degrade the environmental quality of coastal waters.

7.10 Publicly Available Data on the Public Health Conditions in the Immediate Vicinity of the Project Site

7.10.1 Recommended Plan

The Recommended Plan is not anticipated to negatively increase public health conditions in the immediate vicinity of the Project Site. The centralized treatment strategies proposed in the Recommended Plan may help reduce contaminants of emerging concern (CECs) in groundwater in the future by providing advanced treatment that is not possible with onsite septic systems.

7.10.2 No Action Alternative

The No Action Alternative may negatively increase public health conditions in the immediate vicinity of the Project Site, as pollutants (including CECs) will continue to migrate into groundwater from traditional onsite septic systems.

7.11 Tidelands

7.11.1 Recommended Plan

The Waterways regulations, 310 CMR 9.02, define tidelands as “present and former submerged lands and tidal flats lying between the present or historical highwater mark, whichever is farther landward, and the seaward limit of state jurisdiction”. Anticipated construction for the infrastructure projects outlined in the Recommended Plan are expected to be outside of tideland areas. The Recommended Plan is not anticipated to exceed MEPA thresholds for alteration of a tideland.

7.11.2 No Action Alternative

The No Action Alternative is not anticipated to result in alterations of tidelands.

8. Environmental Justice Analysis

The *“MEPA Public Involvement Protocol for Environmental Justice Populations”* (Effective January 1, 2022) requires ENFs to identify Environmental Justice (EJ) Populations near the project site, describe the likely impacts of the project on those populations, and establish a plan for public outreach.

8.1 Identifying Characteristics of EJ Populations

8.1.1 Project Location

The EEA Environmental Justice Maps Viewer was used to identify EJ populations near the project site. Census tracts meeting EJ criteria as defined in 310 CMR 11.02 within five miles of the project site are shown in Figure 8-1 in accordance with 301 CMR 11.05(7).

The following EJ populations are within five miles of the project site:

– Block Group 1, Census Tract 102.08, Barnstable County, Massachusetts (within project site)
  - Criteria: Income.

- Minority population: 8%.
- Median household income: $47,554 (56% of MA median household income).
- Households with language isolation: 0%.
- Total population: 892 individuals in 297 households.

Since the project does not exceed MEPA air quality review thresholds under 301 CMR 11.03(8)(a)-(b) or generate 150 or more new ADT (average daily traffic) of diesel vehicle traffic, the 'designated geographic area' (DGA) requiring further analysis is one mile radius around the project area. (If the project was expected to exceed the above thresholds, a 5-mile radius DGA would be required for further analysis).

8.1.2 Languages

According to the U.S. Census Bureau's American Community Survey, there are no census tracts within five miles of the project area wherein more than 5% of the population reports speaking English "not very well".

8.2 Potential Effects on EJ Populations

The primary adverse effect of this project on EJ populations in the DGA is temporary disturbance during the construction phase. The Town and Contractor will enact comprehensive mitigation measures to ensure public safety and minimize the impact of noise, dust, and traffic congestion on abutters. Mitigation is discussed in Section 9.

The primary benefit of this project is improved water quality through improved nitrogen management. This will benefit the entire community by enhancing environmental health and supporting a stronger local economy. The project will increase access to clean natural resources—including estuarine, freshwater, and groundwater systems—thereby promoting greater use and enjoyment of recreational areas such as waterways, freshwater ponds, and public bathing beaches.

8.3 Public Involvement Activities

An advance notice will be made to EJ communities prior to submission of the CWMP to Environmental Monitor. The Environmental Justice Screening Form is included in Appendix E. The EJ distribution list will be maintained throughout the development of the project to engage with relevant stakeholders and inform them of project updates. Other interested parties will be added to the distribution list upon request. Additional community meetings will also be held upon request prior to submission of the Environmental Impact Report. A meeting request can be made through the Town of Truro's Department of Health.

9. MEPA Draft Section 61 Findings and Mitigation Measures

9.1 Introduction

This chapter identifies and presents proposed mitigation measures and Draft Section 61 Findings for each permit or other approval anticipated to be issued by State Agencies, as required by the Massachusetts Environmental Policy Act (MEPA) regulation 301 CMR 11.07. Mitigation measures associated with municipal infrastructure and programs is anticipated to be funded and implemented by the Town of Truro, its agents, representatives, and/or contractors in addition to any required State agency actions.

9.2 MEPA Mandatory Review Thresholds

The Recommended Plan is not anticipated to exceed any MEPA Mandatory Review Thresholds. Any variances from the Wetlands Protection Act that may be required for upgrading individual septic systems will be coordinated with the appropriate agencies as necessary.

Should strategies outlined in the contingency plan be pursued in the future through adaptive management, the MEPA review thresholds will be reevaluated.

9.3 Draft Section 61 Findings for State Agency Actions

Anticipated State agency permits and actions for the CWMP are summarized in Table 9.1. Permits anticipated as part of the Truro Recommended Plan are indicated in **bold text.**

Table 9.1 Draft Section 61 Findings for State Agency Actions

Agency	Agency Permits / Actions
Massachusetts Executive Office of Energy and Environmental Affairs (EOEEA)	**CWMP approval.**
Massachusetts Department of Environmental Protection (MassDEP)	WP68: Treatment Works Approval for New/Modified Facility associated with Groundwater Discharge Non-Industrial or Reclaimed Water Use Permits – for new pump stations proposed for the project and connection to Provincetown collection system and WWTF. **Notice of Intent (NOI) Wetlands Protection Act (WPA) Form 3 (as applicable) and Truro Conservation Commission approvals (as applicable for work within the 100-foot buffer to a wetland (310 CMR 10.00).** **Emergency Engine and Emergency Turbine Compliance – required for all new emergency or standby engines with a rated power output equal to or greater than 37 kW or emergency turbine with a rated power output less than one megawatt constructed, substantially reconstructed, or altered after March 23, 2006.** **Underground Injection Control (UIC) permit for the Permeable Reactive Barrier.** **WP 83: Hydrogeologic Evaluation Report** **WP 79: Individual Groundwater Discharge Permit** **WP 95: Watershed Permit Application**
Massachusetts Office of Coastal Zone Management (CZM)	**Federal Consistency Review.**
Massachusetts Division of Fisheries & Wildlife	**Natural Heritage & Endangered Species Program (NHESP), MES (321 CMR 10.00) and/or WP (310 CMR 10.00) for work below the mean high-water line, in a fish run, or in a priority or estimated habitat.**
Massachusetts Historical Commission (MHC)	**Consultation/review for any collection system components and pump stations to be constructed outside of road right-of-way.**
Cape Cod Commission	**Section 208 Plan Update Consistency Approval**
Town of Truro	**Building permits for the construction of structures recommended in the CWMP.** **Wastewater Department sewer connection permitting.** **Chapter 277 Stormwater Management Rules and Regulations.** **Article III. Construction and Post-Construction Stormwater Management.** **Conservation Commission Approvals** **Planning Board Approvals** **Zoning Board Approvals**

9.4 Planned Mitigation Measures

The following mitigation measures have been identified to limit negative environmental impacts and/or create positive environmental impacts during construction and operation of the Recommended Plan.

9.4.1 General Construction Measures

During construction, the site(s) shall be secured to prevent unauthorized entry to the construction site, and to protect existing and adjacent facilities and properties. Supplemental lighting, signs, railings and constructions barriers shall be used as necessary to provide safety to employees, construction workers, visitors, and the general public during the construction process in accordance with Occupational Safety and Health Administration (OSHA) and other applicable regulations.

Water used during the construction process, and that generated from runoff on the site, will be controlled by proper site grading and by providing temporary berms, drains, and other means to prevent soil erosion and done so in accordance with the Stormwater Pollution Prevention Plan (SWPPP), if required. These means will also be used to reduce puddling and runoff on the site. Existing and new catch basins will be protected from siltation using hay bales, siltation fence, and catch basin inserts. At no time will the pumping of silt-laden water to surface waters, stream corridors, or wetlands be allowed. Pollution controls will also be provided to prevent the contamination of soils, water, and the atmosphere from the discharge of noxious, toxic substances, and pollutants during the construction process.

Erosion control measures including hay bales, siltation fencing, and erosion control fabric will be used to provide sedimentation barriers where required. Temporary seeding and mulching may also be used to minimize soil erosion and provide soil stabilization on slopes. Diversion trenches may also be used on the uphill side of disturbed areas to divert surface runoff. Land disturbances will be kept to a minimum to reduce impacts and erosion. All erosion and stormwater control methods shall be in accordance with the USEPA National Pollution Discharge Elimination System (NPDES) General Permit requirements, Commonwealth of Massachusetts regulations, and the Town of Truro regulations.

The site will be maintained free of waste materials, debris, and trash following each day of work. Waste and other debris will be collected and disposed of off-site periodically. At no time during construction will the dumping of spoil material, waste, trees, brush, or other debris be allowed into any stream corridor, any wetland, any surface waters, or any unspecified location. The permanent or unspecified alteration of stream flow lines is not allowed during construction. Recycling of waste and construction debris will likely be mandated as well and should always be considered during construction.

Construction noise from heavy equipment will normally be limited to within normal operating hours of 7:00 a.m. to 5:00 p.m. Dust controls, including the use of street sweepers and/or watering trucks, will be used to minimize air-borne dust as necessary.

All general construction measures will be implemented by the Contractor during construction. Contractor will be required to follow the Massachusetts Diesel Retrofit Program for any and all diesel-powered non-road construction equipment and vehicles greater than 50 brake horsepower. Anticipated costs for the general construction measures are included in the overall project costs for the Recommended Alternative.

9.4.2 Planned Mitigation Measures: Adaptive Management and Monitoring

Adaptive management provides a significant mitigation measure mechanism for the Recommended Plan. The Recommended Plan includes the implementation of an Adaptive Management process, in which the Town will monitor the results of implementation over time and adjust next steps/future implementation accordingly. The Town will monitor the coastal estuaries surface water quality to observe the timeframe and scale of improvement accomplished by the implementation of the Recommended Plan, and to evaluate the need for additional future implementation. The Town will continue to monitor performance of the demonstration/pilot projects and may expand or contract the role of

various non-traditional methods into the plan as they demonstrate feasibility and effectiveness. This Adaptive Management approach will enable the Recommended Plan to be adjusted based on the monitoring results of the environmental and economic impacts associated with implementation of the Recommended Plan. Coordination with MassDEP will occur through the Adaptive Management process.

9.4.3 Planned Mitigation Measures: Environmental Justice

The Recommended Plan intersects several EJ parcels as noted in Section 8. Temporary negative impacts from construction may affect EJ communities, and construction impact mitigation measures will be implemented to minimize impacts to EJ populations and the rest of the community. Table 9.2 summarizes the mitigation measures anticipated during implementation of the Recommended Plan.

Table 9.2 Mitigation Measures Summary Table

Category	Proposed Mitigation Measure	Implementation	Preliminary Schedule
General Construction – Site Access/Public Safety Impact	The site(s) shall be secured to prevent unauthorized entry to the construction site, and to protect existing and adjacent facilities and properties. Supplemental lighting, signs, railings, and construction barriers shall be used as necessary to provide safety to employees, construction workers, visitors, and the general public during the construction process in accordance with OSHA and other applicable regulations. Police details and detours will be implemented in accordance with Traffic Control Plans included with the Project Contract Documents.	Contractor	During Construction
General Construction – Stormwater	Provisions for stormwater management and erosion control shall be managed in accordance with the approved SWPPP and NPDES General Permit, which may be required for cluster system construction.	Contractor	During construction
General Construction – Construction Debris	The site(s) will be maintained free of waste materials, debris, and trash following each day of work. Waste and other debris will be collected and disposed of off-site periodically. At no time during construction will the dumping of spoil material, waste, trees, brush, or other debris be allowed into any stream corridor, any wetland, any surface waters, or any unspecified location. The permanent or unspecified alteration of stream flow lines is not allowed during construction. Recycling of waste and construction debris will likely be mandated as well and should always be considered during construction.	Contractor	During Construction
General Construction – Noise and Dust Control	Normal construction hours will be between 7 a.m. and 5 p.m. during normal business days. No work will be allowed on Holidays, and the Contractor will be required to provide adequate dust control measures during construction.	Contractor	During construction
Wastewater Facilities Construction Mitigation – Resource Areas	As necessary, appropriate Notice of Intent documents and Request for Determinations will be filed relative to work proposed with buffer areas or resource areas. Orders of Conditions, as received, will be incorporated into the Construction Documents.	Town / Contractor	Permitting prior to construction; mitigation during construction through compliance with Order of Conditions.

Category	Proposed Mitigation Measure	Implementation	Preliminary Schedule
Wastewater Facilities Construction Mitigation – Flooding	To the extent practicable, facilities will be located out of flood hazard zones. Because pump stations are typically located in low lying areas to maximize gravity sewer service, additional provisions for coastal resiliency and flood protection will need to be made to mitigate impacts. During construction, management of dewatering and protection from storms will be required.	Town / Contractor	During design and construction
Wastewater Facilities Construction Mitigation – Aesthetics	New pump stations with superstructures will compliment and be consistent with neighborhood aesthetics as appropriate. Vegetative screens will be employed, if determined necessary, for aesthetic reasons.	Town / Contractor	During design and implemented during construction
Wastewater Facilities Construction Mitigation – Archaeological	Development of a Post Discoveries Review Plan (if necessary). Work will be halted if archaeological resources are uncovered during construction.	Town / Contractor	Plan development prior to bidding; implementation during construction
Wastewater Facilities Construction Mitigation – General	A Resident Representative will be employed to ensure that the project area is kept clean and that mitigation measures are met.	Town	During construction
Adaptive Management – TMDL Compliance	Implementation of an Adaptive Management process which will consider the performance of the demonstration projects and incorporate cost-effective non-traditional methods into the plan once they demonstrate feasibility. A Quality Assurance Project Plan (QAPP) will be developed for monitoring programs associated with each strategy. Milestone reports will be developed to summarize ongoing water quality monitoring results, and the Plan will be adjusted accordingly.	Town	Pre- and post-construction/ implementation

Funding of these projects and mitigation measures is all anticipated to come from Town Funding and to be supported by various grant and loan opportunities including Natural Resources Conservation Service (NRCS), the Massachusetts State Revolving Fund (SRF) program, Southeast New England Program (SNEP) Grants, Cape and Islands Water Protection Trust, Coastal Zone Management (CZM) grants, and additional funding sources. Mitigation measure costs for the outlined mitigations measures have been incorporated into the project cost estimates outlined in Section 5.

10. Scope and Limitations

This report has been prepared by GHD for Town of Truro and may only be used and relied on by Town of Truro for the purpose agreed between GHD and Town of Truro as set out in section of this report.

GHD otherwise disclaims responsibility to any person other than Town of Truro arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of buildings, services and vegetation. As a result, not all relevant site features and conditions may have been identified in this report.

In the CWMP, GHD has prepared the Engineer's Opinion of Probable Construction Cost and other cost estimates ("Cost Estimate") set out in the executive summary and in Section 5 of this report using information reasonably available to the GHD employee(s) who prepared this report; and based on assumptions and judgments made by GHD.

The Cost Estimate has been prepared for the purpose of planning and must not be used for any other purpose.

The Cost Estimate is a preliminary estimate only. Actual prices, costs and other variables may be different to those used to prepare the Cost Estimate and may change. Unless as otherwise specified in this report, no detailed quotation has been obtained for actions identified in this report. GHD does not represent, warrant or guarantee that the project can or will be undertaken at a cost which is the same or less than the Cost Estimate.

Where estimates of potential costs are provided with an indicated level of confidence, notwithstanding the conservatism of the level of confidence selected as the planning level, there remains a chance that the cost will be greater than the planning estimate, and any funding would not be adequate. The confidence level considered to be most appropriate for planning purposes will vary depending on the conservatism of the user and the nature of the project. The user should therefore select appropriate confidence levels to suit their particular risk profile.

GHD does not guarantee that the electronic files provided to the client including this document are free of computer viruses or other conditions that may damage or interfere with data, hardware or software with which it might be used. Town of Truro absolves GHD from any consequence of Town of Truro's or other person's use of or reliance on, these documents.

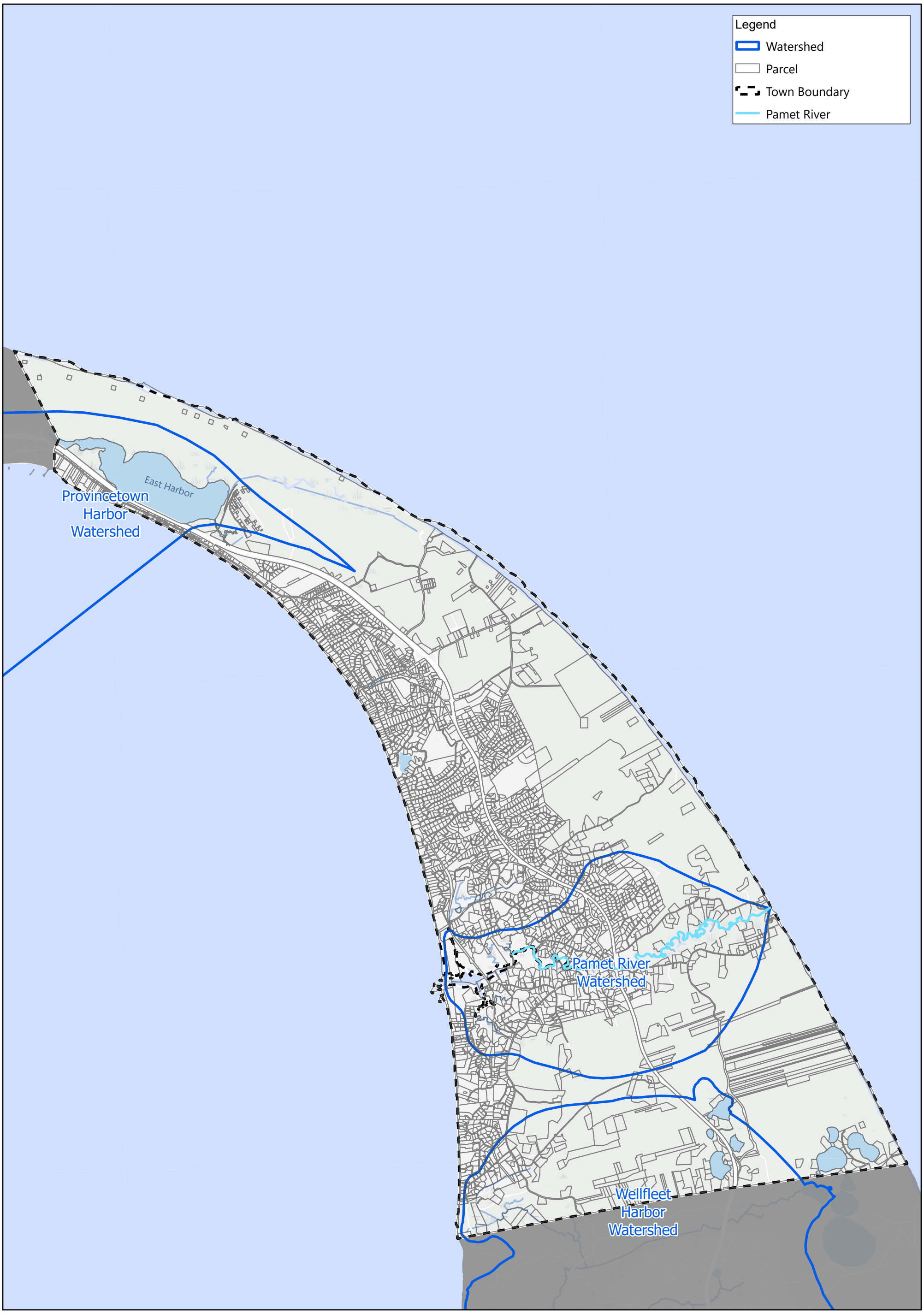
GHD has prepared this report on the basis of information provided by Town of Truro and others who provided information to GHD which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

GHD has not been involved in the preparation of the documents included in the appendix by GHD's subconsultants, Town's consultants (other than GHD) and other non-GHD documents included herein. GHD has had no contribution to, or review of the supporting (non-GHD) documents included in the Appendices beyond that called for in the Scope of Services with the Subconsultant or as stipulated in the Agreement with the Town for this Project. GHD shall not be liable to any person for any error in, omission from, or false or misleading statement in, any other part of the those supporting documents beyond those stated in the Agreement between GHD and the Town of Truro for this project.

Accessibility of documents

If this report is required to be accessible in any other format, this can be provided by GHD upon request and at an additional cost if necessary.

Figures



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GHD

TRURO WATERSHED MANAGEMENT PLANNING PROJECT
TRURO, MA

PLANNING AREA

Project No. **12603461**
Revision No. **-**
Date **10/2/2025**

FIGURE ES-1

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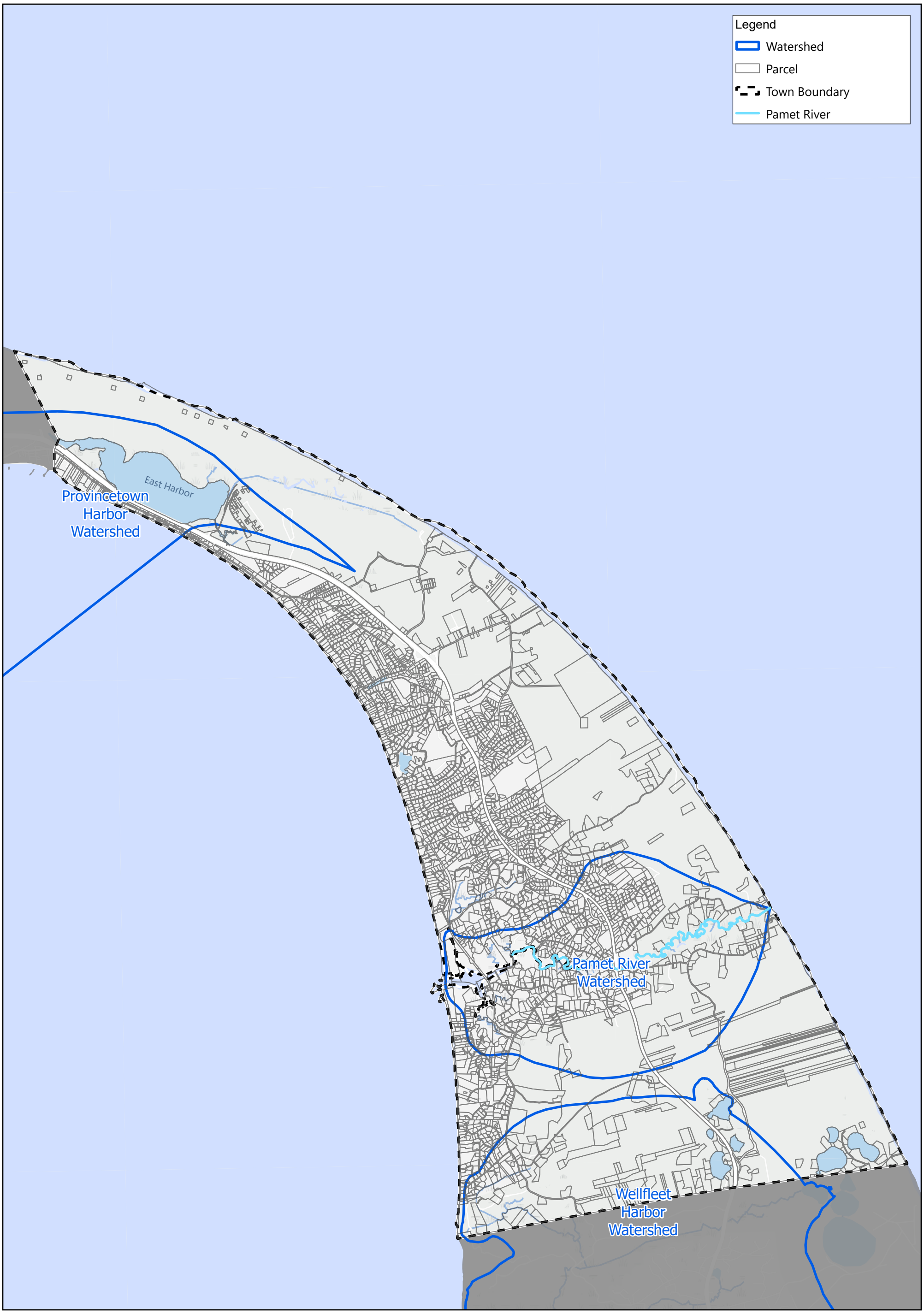

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TRURO WATERSHED MANAGEMENT PLANNING PROJECT
TRURO, MA

PLANNING AREA

Project No. **12603461**
Revision No. **-**
Date **10/2/2025**

FIGURE 1-1

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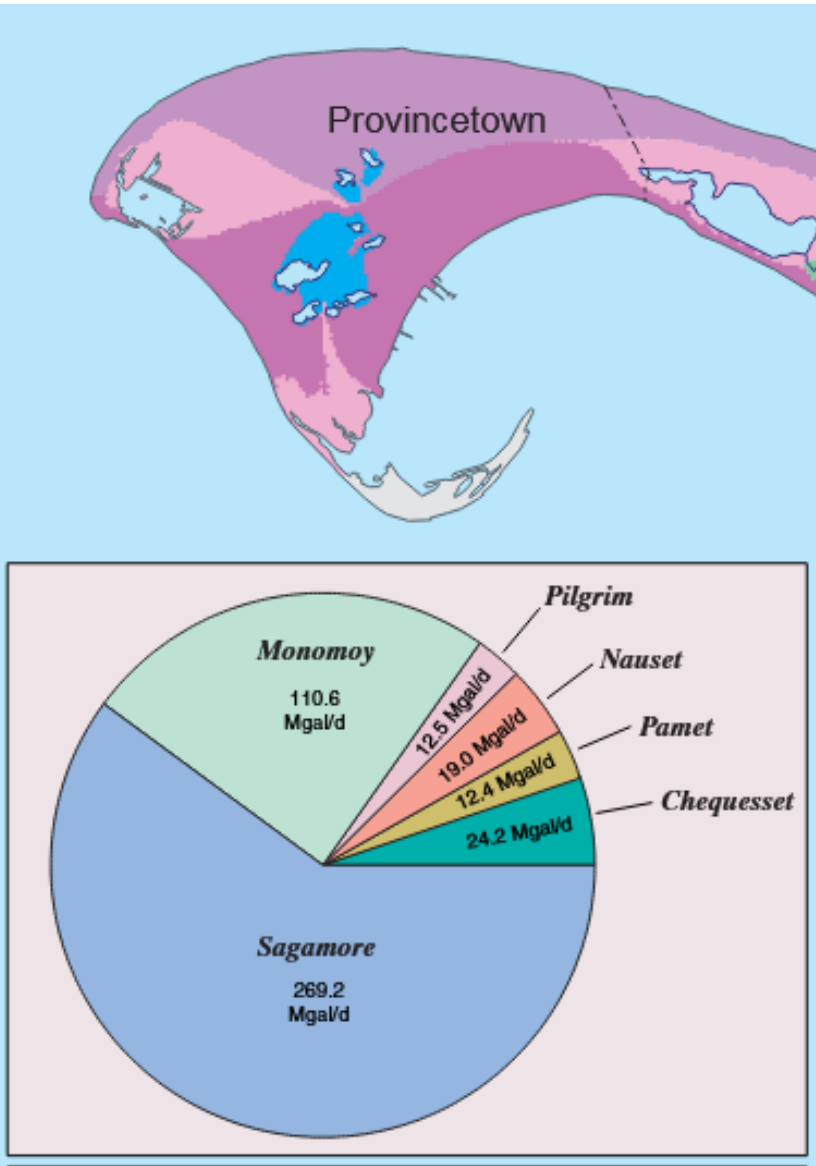


Figure 2. Average ground-water flow through the six freshwater lenses composing the Cape Cod aquifer, in million gallons per day (Mgal/d). The Sagamore flow lens accounts for about 60 percent of total ground-water flow through the Cape Cod aquifer.

Table 1. Hydrologic budgets and discharge locations for Cape Cod freshwater flow lenses. Most ground water discharges from the aquifer at the coast.

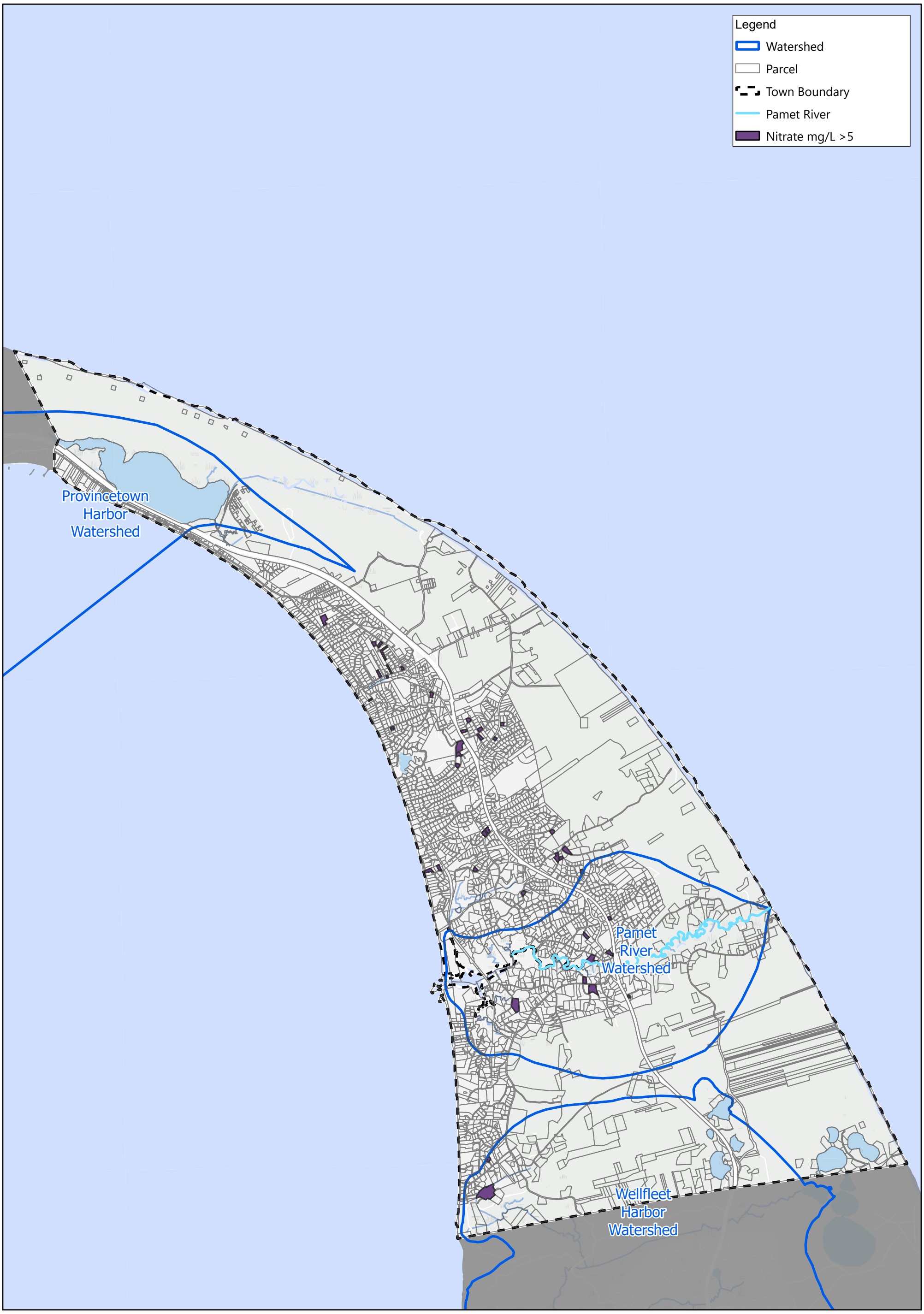
[Mgal/d, Million gallons per day]

Flow Lens	Flow, in Mgal/d	Discharge (percent)		
		to Coast	to Streams	to Wells
Chequesset	24.2	49.2	50.8	0.0
Monomoy	110.6	77.2	15.9	6.9
Nauset	19.0	73.7	26.3	.0
Pamet	12.4	71.0	21.8	7.2
Pilgrim	12.5	91.2	8.8	.0
Sagamore	269.2	66.0	27.6	6.4
TOTAL	447.9	69.0	25.3	5.7

USGS LITTLE PAMET RIVER DELINEATION

FIGURE 1.2

Adapted from Walter, D.A., Masterson, J.P., and Hess, K.M., 2004, Ground-Water Recharge Areas and Traveltimes to Pumped Wells, Ponds, Streams, and Coastal Water Bodies, Cape Cod, Massachusetts, Scientific Investigations Map I-2857, 1 sheet.



Paper Size ANSI B

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US Feet

Map Projection: Lambert Conformal Conic
Horizontal Datum: NAD 1983 2011
Grid: NAD 1983 2011 StatePlane Massachusetts Mnld FIPS 2001 FtUS

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TRURO WATERSHED MANAGEMENT PLANNING PROJECT
TRURO, MA

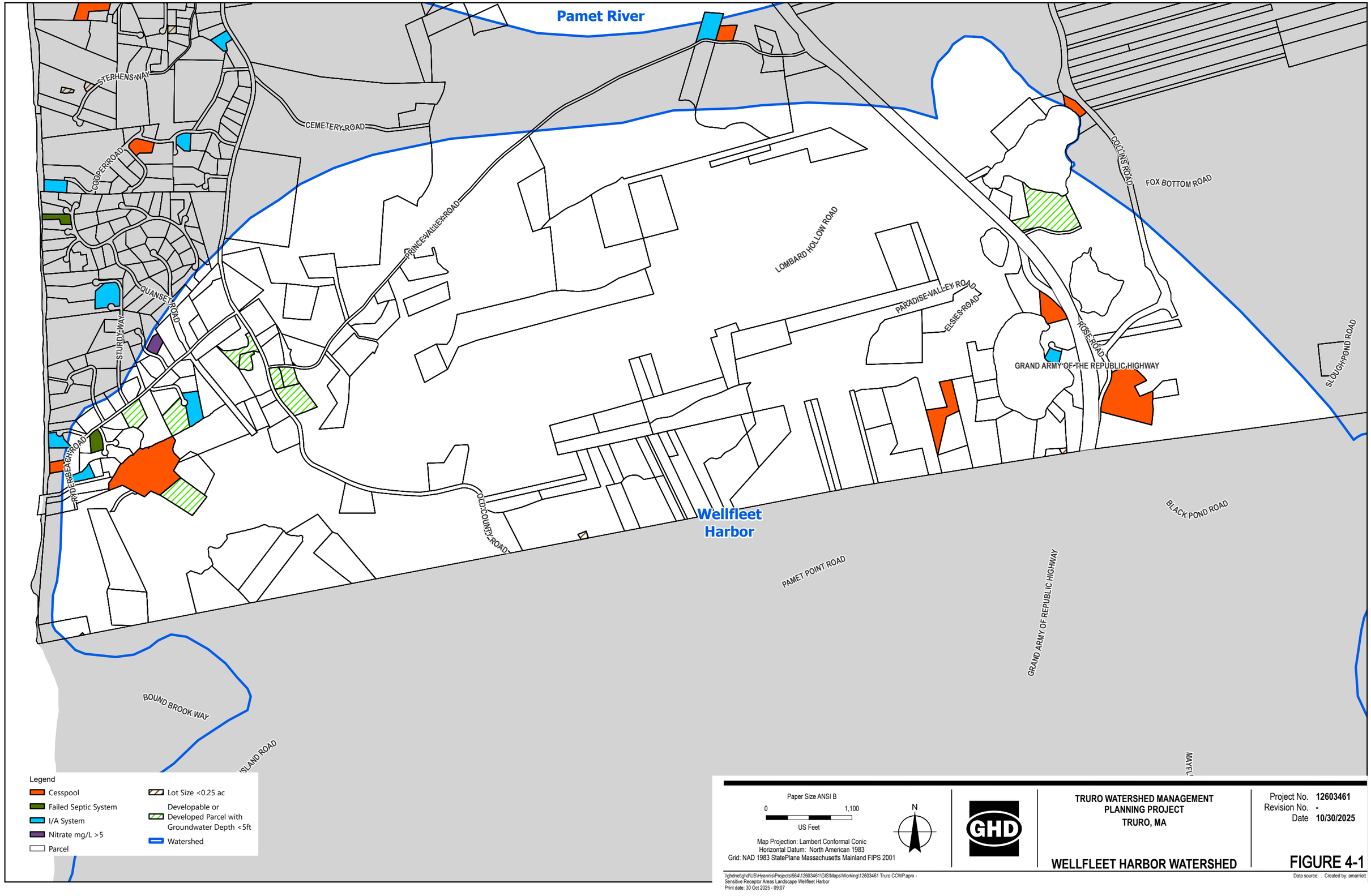
HIGH NITRATES

Project No. **12603461**
Revision No. **-**
Date **10/2/2025**

FIGURE 2-1

\\ghdnet\ghd\US\Hyannis\Projects\564\12603461\GIS\Maps\Working\12603461 Truro CCWP.aprx - Parcel Mapping
Print date: 02 Oct 2025 - 14:23

Data source: Light Gravy Canvas Stream No Labels: . Created by: amarriott



Paper Size ANSI B

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US Feet

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

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TRURO WATERSHED MANAGEMENT PLANNING PROJECT
TRURO, MA

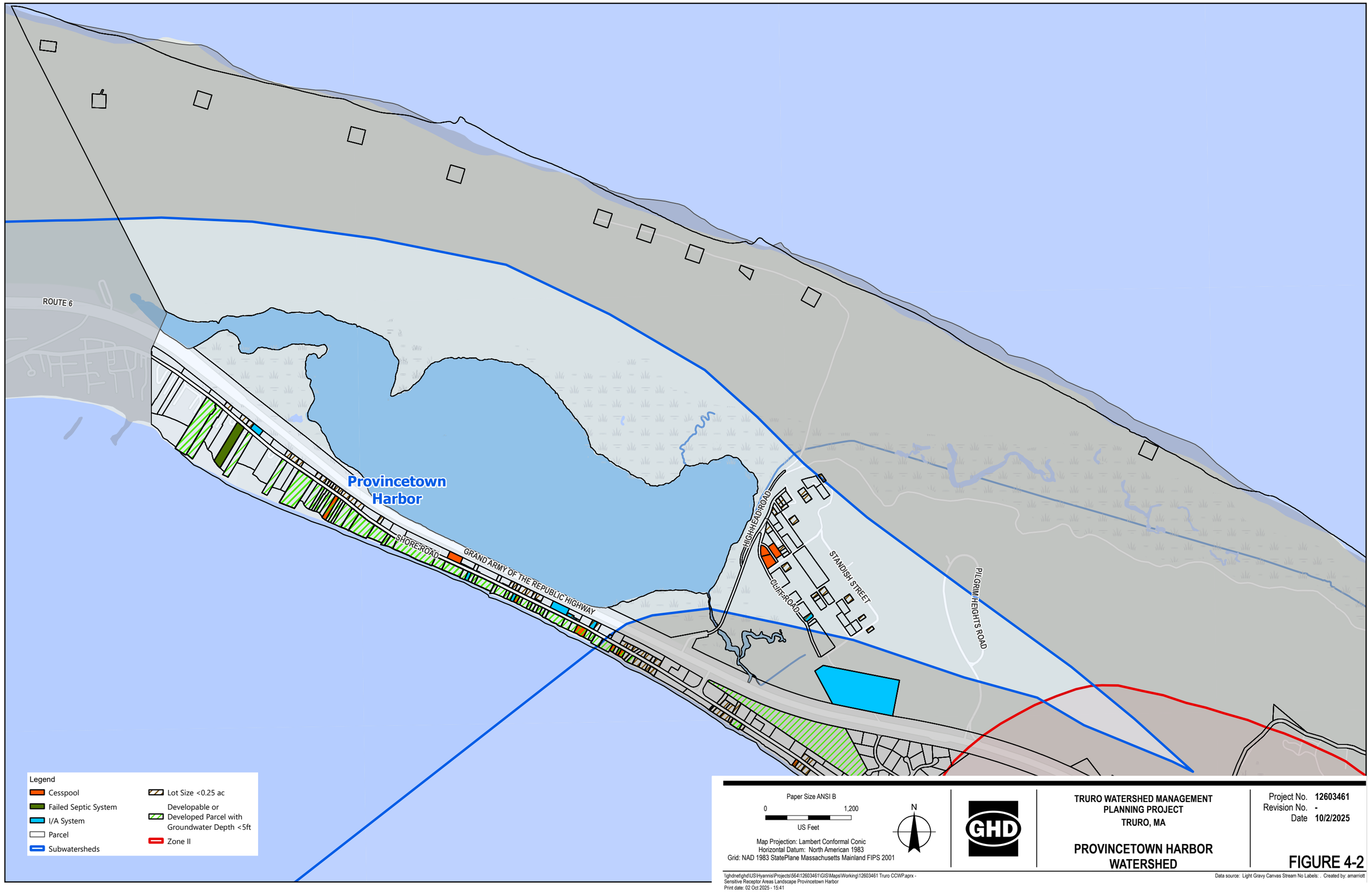
WELLFLEET HARBOR WATERSHED

Project No. **12603461**
Revision No. **-**
Date **10/30/2025**

FIGURE 4-1

\\ghdnet\ghd\US\Hyannis\Projects\564\12603461\GIS\Maps\Working\12603461 Truro CCWP.aprx - Sensitive Receptor Areas Landscape Wellfleet Harbor
Print date: 30 Oct 2025 - 09:07

Data source: . Created by: amarriott



Paper Size ANSI B

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US Feet

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

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TRURO WATERSHED MANAGEMENT PLANNING PROJECT
TRURO, MA

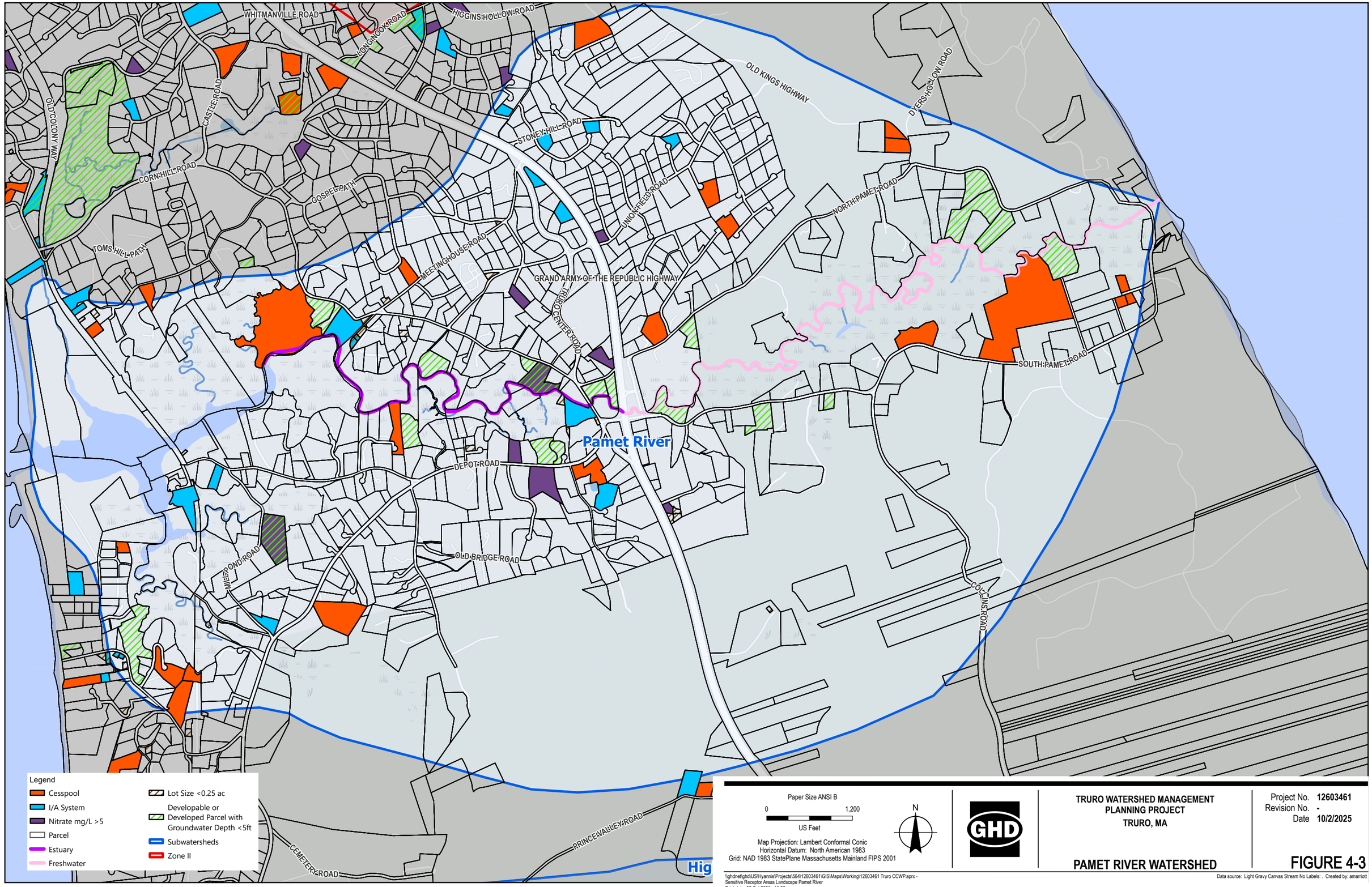
PROVINCETOWN HARBOR WATERSHED

Project No. **12603461**
Revision No. **-**
Date **10/2/2025**

FIGURE 4-2

\\ghdnet\ghd\US\Hyannis\Projects\55412603461\GIS\Maps\Working\12603461 Truro CCWP.aprx - Sensitive Receptor Areas Landscape Provincetown Harbor
Print date: 02 Oct 2025 - 15:41

Data source: Light Gravy Canvas Stream No Labels: . Created by: amarriott



Paper Size ANSI B

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US Feet

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

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TRURO WATERSHED MANAGEMENT PLANNING PROJECT
TRURO, MA

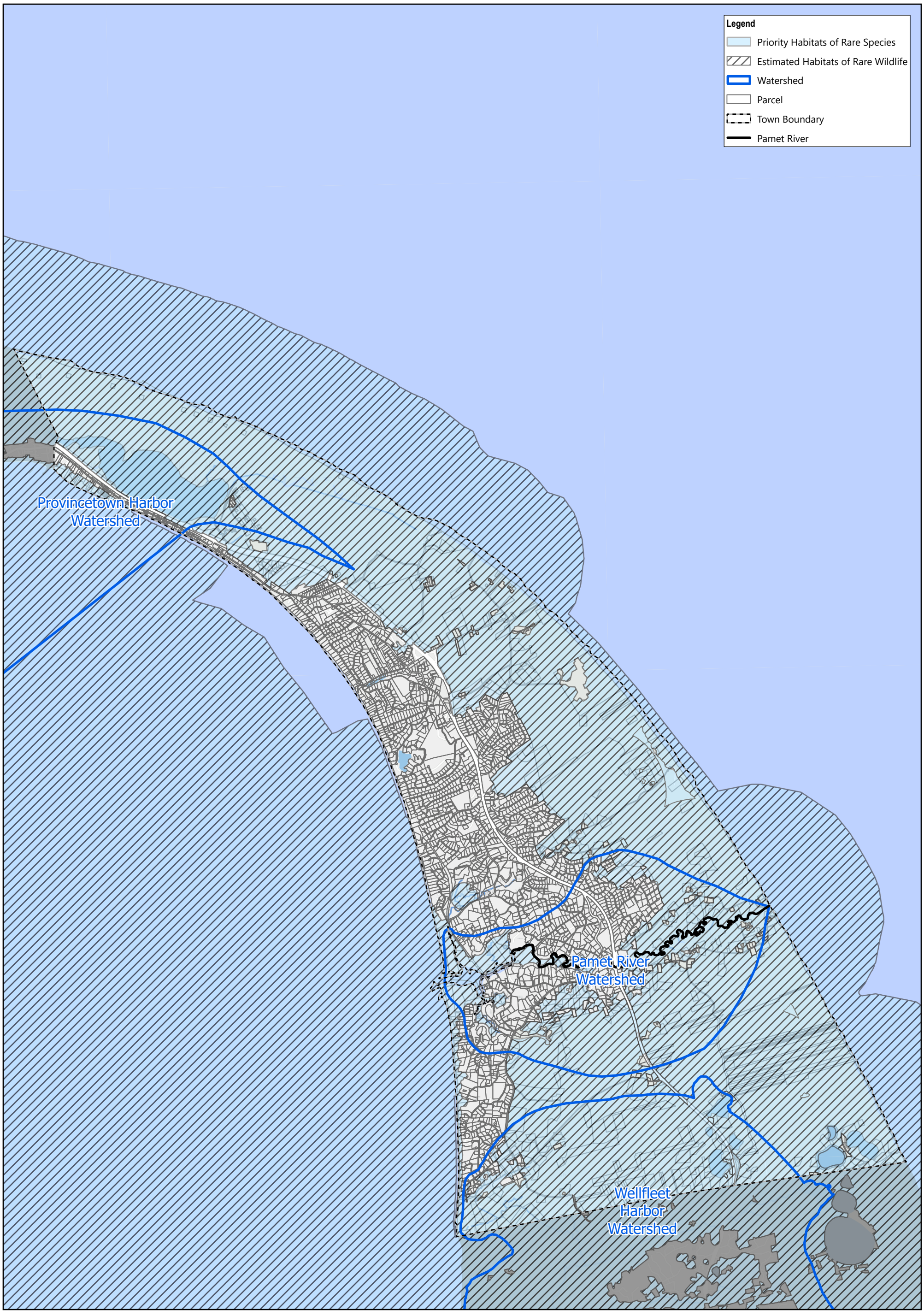
PAMET RIVER WATERSHED

Project No. **12603461**
Revision No. **-**
Date **10/2/2025**

FIGURE 4-3

\\ghdnet\ghd\US\Hyannis\Projects\564\12603461\GIS\Maps\Working\12603461 Truro CCWP.aprx - Sensitive Receptor Areas Landscape Pamet River
Print date: 02 Oct 2025 - 15:39

Data source: Light Gravy Canvas Stream No Labels: . Created by: amarriott



Paper Size ANSI B

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US Feet

Map Projection: Lambert Conformal Conic
Horizontal Datum: NAD 1983 2011
Grid: NAD 1983 2011 StatePlane Massachusetts Mnld FIPS 2001 FtUS

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TRURO WATERSHED MANAGEMENT PLANNING PROJECT
TRURO, MA

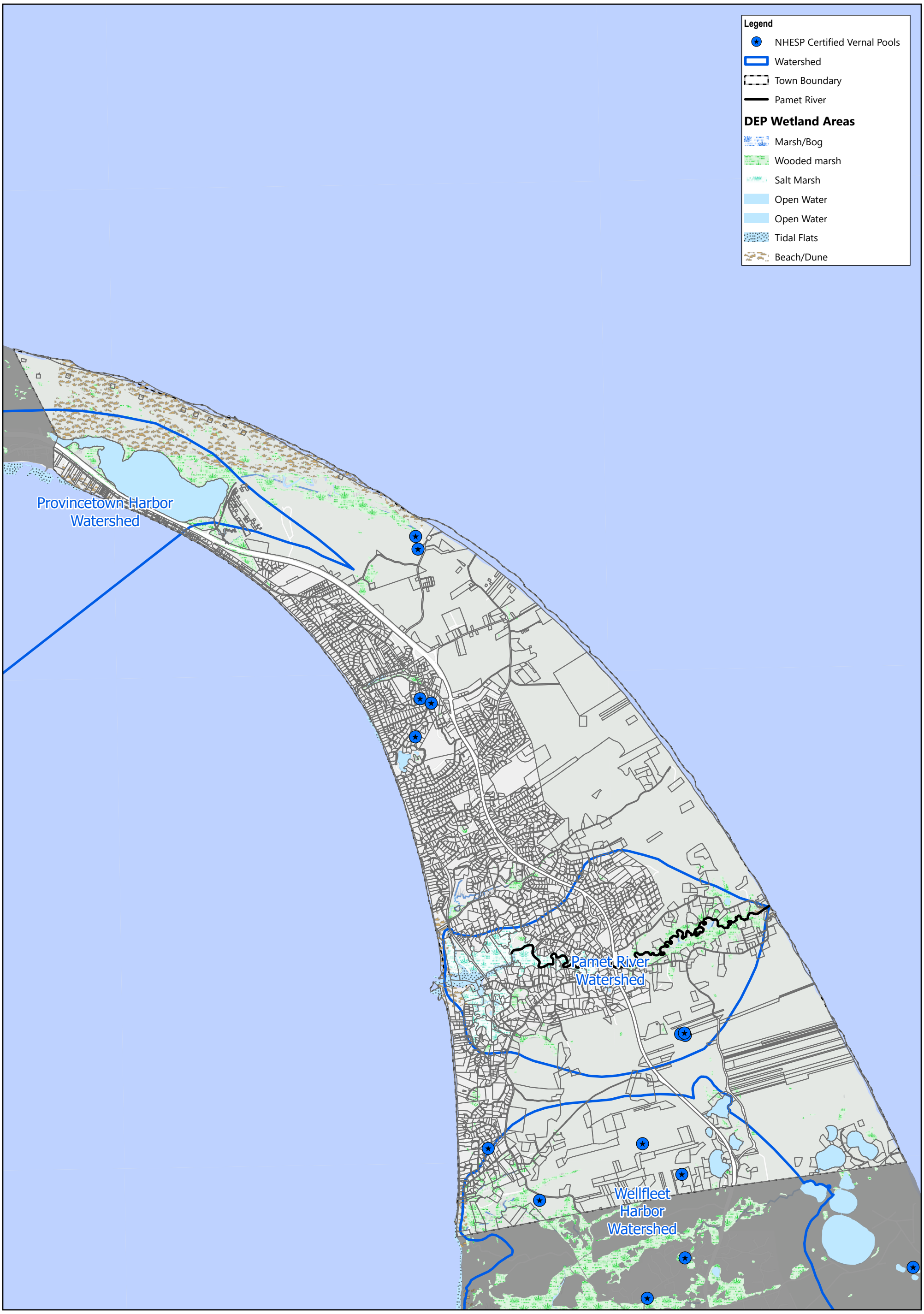
NATIONAL HERITAGE ENDANGERED SPECIES HABITATS

Project No. **12603461**
Revision No. **-**
Date **10/2/2025**

FIGURE 7-1

\\ghdnet\ghd\US\Hyannis\Projects\564\12603461\GIS\Maps\Working\12603461 Truro NAR Figures.aprx - Figure 5-4 NHESP
Print date: 02 Oct 2025 - 14:34

Data source: Light Gravy Canvas Stream No Labels: . Created by: amarriott



Paper Size ANSI B

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US Feet

Map Projection: Lambert Conformal Conic
Horizontal Datum: NAD 1983 2011
Grid: NAD 1983 2011 StatePlane Massachusetts Mnld FIPS 2001 FtUS

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TRURO WATERSHED MANAGEMENT PLANNING PROJECT
TRURO, MA

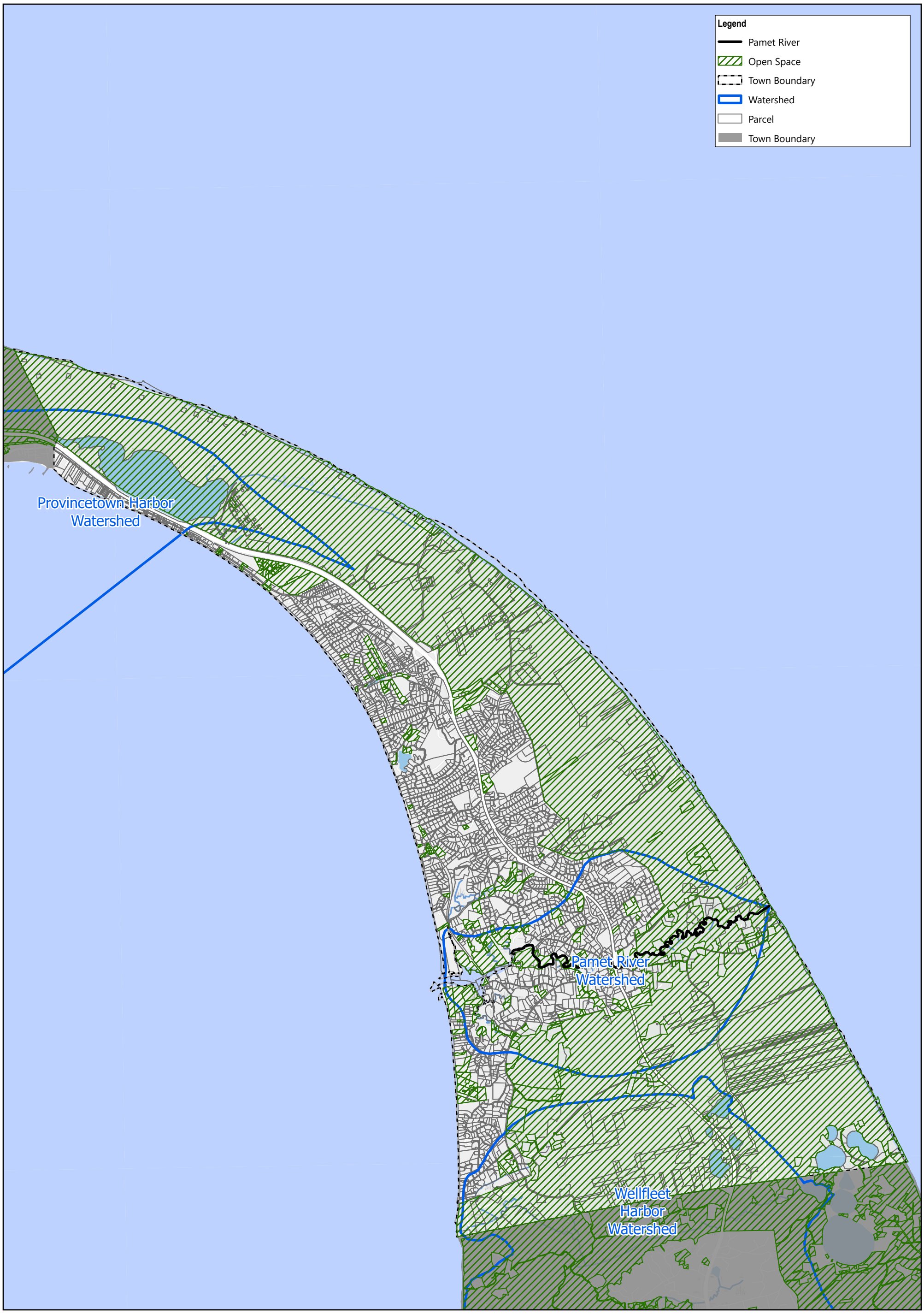
Project No. **12603461**
Revision No. **-**
Date **10/2/2025**

DEP WETLANDS AND VERNAL POOLS

FIGURE 7-2

\\ghdnet\ghd\US\Hyannis\Projects\564\12603461\GIS\Maps\Working\12603461 Truro NAR Figures.aprx - Figure 5-3 DEP Wetlands and Vernal Pools
Print date: 02 Oct 2025 - 14:38

Data source: Light Gravy Canvas Stream No Labels: . Created by: amarriott



Paper Size ANSI B

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US Feet

Map Projection: Lambert Conformal Conic
Horizontal Datum: NAD 1983 2011
Grid: NAD 1983 2011 StatePlane Massachusetts Mnld FIPS 2001 FtUS

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TRURO WATERSHED MANAGEMENT PLANNING PROJECT
TRURO, MA

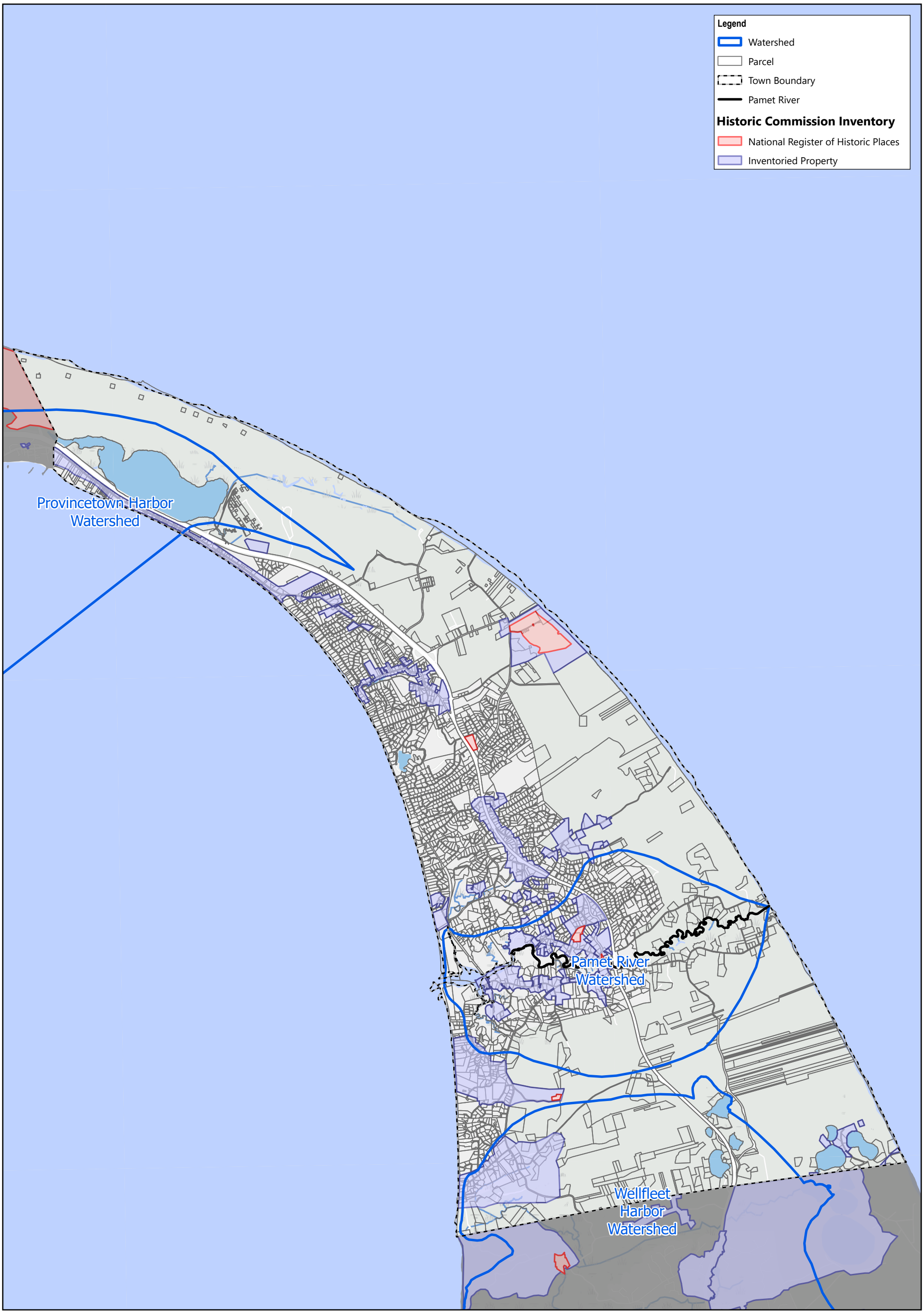
OPEN SPACE

Project No. **12603461**
Revision No. **-**
Date **10/23/2025**

FIGURE 7-3

\\ghdnet\ghd\US\Hyannis\Projects\564\12603461\GIS\Maps\Working\12603461 Truro NAR Figures.aprx - Figure 7-3 Open Space
Print date: 23 Oct 2025 - 13:47

Data source: Light Gravy Canvas Stream No Labels: . Created by: amarriott



Paper Size ANSI B

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US Feet

Map Projection: Lambert Conformal Conic
Horizontal Datum: NAD 1983 2011
Grid: NAD 1983 2011 StatePlane Massachusetts Mnld FIPS 2001 FtUS

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TRURO WATERSHED MANAGEMENT PLANNING PROJECT
TRURO, MA

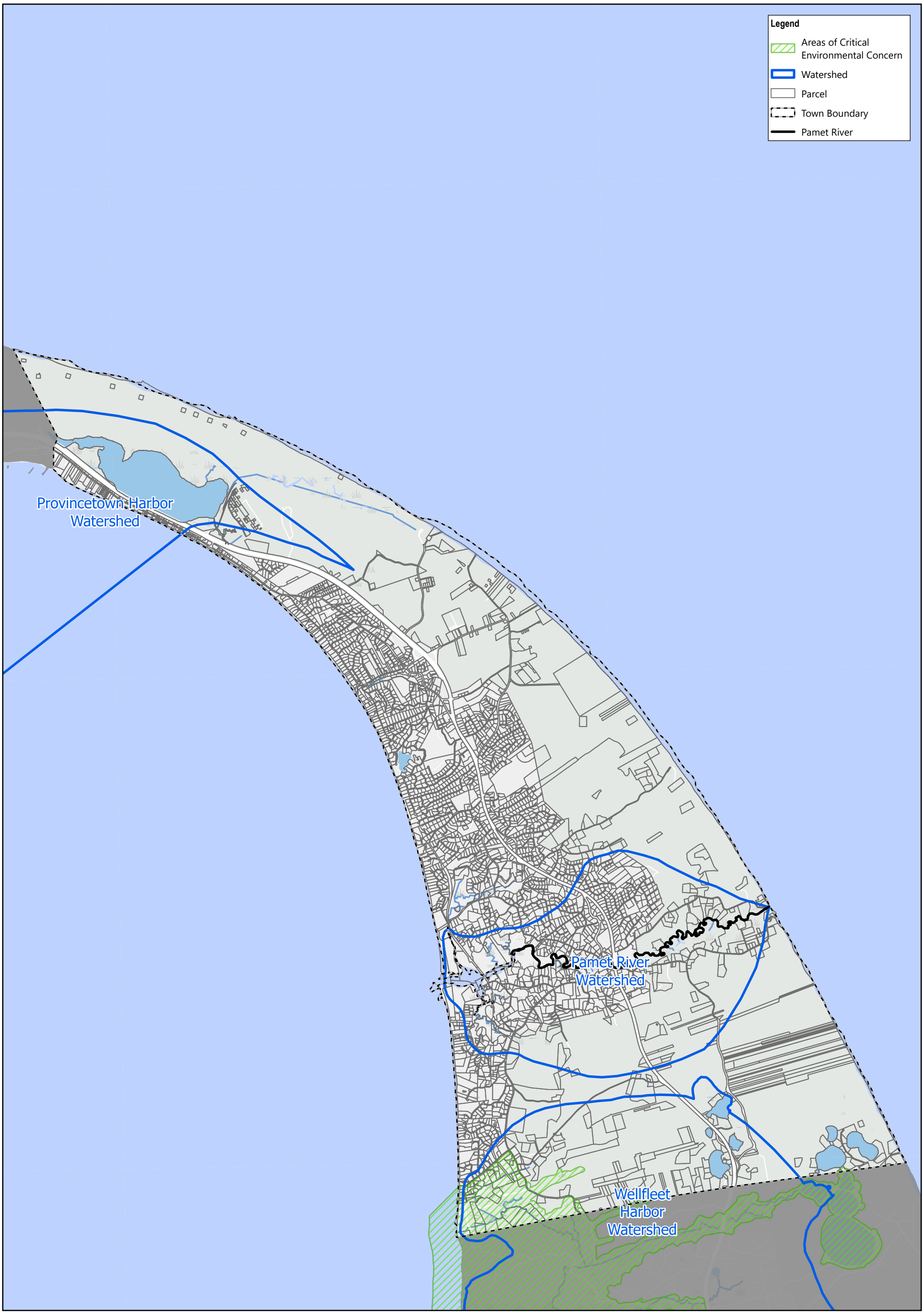
NATIONAL HERITAGE AND CULTURAL RESOURCES

Project No. **12603461**
Revision No. **-**
Date **10/9/2025**

FIGURE 7-4

\\ghdnet\ghd\US\Hyannis\Projects\564\12603461\GIS\Maps\Working\12603461 Truro NAR Figures.aprx - Figure 7-3 Historic and Cultural Resources
Print date: 09 Oct 2025 - 15:40

Data source: Light Gravy Canvas Stream No Labels: . Created by: amarriott



Paper Size ANSI B

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US Feet

Map Projection: Lambert Conformal Conic
Horizontal Datum: NAD 1983 2011
Grid: NAD 1983 2011 StatePlane Massachusetts Mnld FIPS 2001 FtUS

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TRURO WATERSHED MANAGEMENT PLANNING PROJECT
TRURO, MA

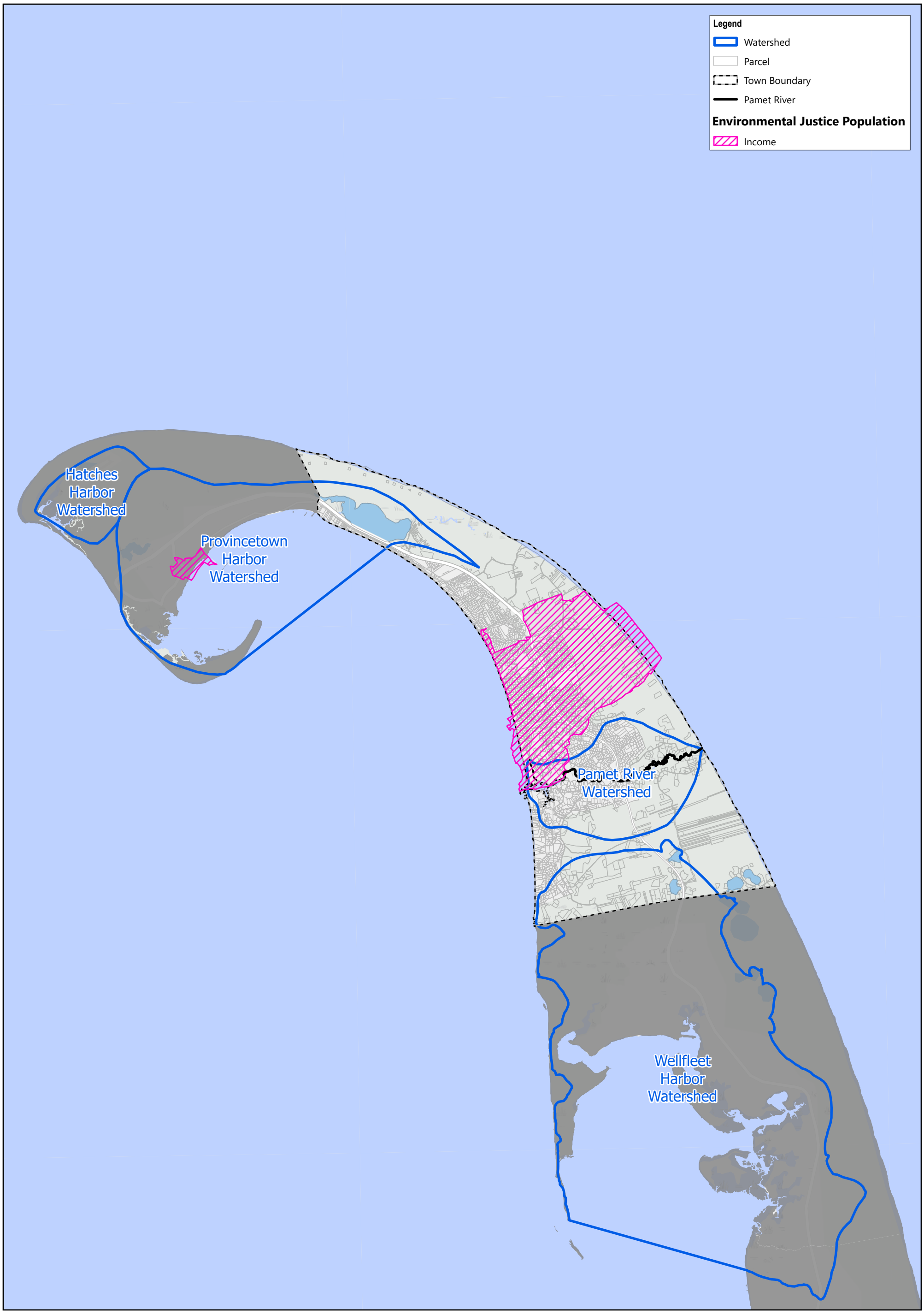
AREAS OF CRITICAL ENVIRONMENTAL CONCERN

Project No. **12603461**
Revision No. **-**
Date **10/9/2025**

FIGURE 7-5

\\ghdnet\ghd\US\Hyannis\Projects\564\12603461\GIS\Maps\Working\12603461 Truro NAR Figures.aprx - Figure 7-4 Wellfleet Harbor ACEC
Print date: 09 Oct 2025 - 15:43

Data source: Light Gravy Canvas Stream No Labels: . Created by: amarriott



Paper Size ANSI B

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US Feet

Map Projection: Lambert Conformal Conic
Horizontal Datum: NAD 1983 2011
Grid: NAD 1983 2011 StatePlane Massachusetts Mnld FIPS 2001 FtUS

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TRURO WATERSHED MANAGEMENT PLANNING PROJECT
TRURO, MA

ENVIRONMENTAL JUSTICE AREAS WITHIN FIVE MILES OF TRURO

Project No. **12603461**
Revision No. **-**
Date **10/9/2025**

FIGURE 8-1

\\ghdnet\ghd\US\Hyannis\Projects\564\12603461\GIS\Maps\Working\12603461 Truro NAR Figures.aprx - Figure 8-1 Wellfleet Harbor EJ Areas
Print date: 09 Oct 2025 - 15:58

Data source: Light Gravy Canvas Stream No Labels: . Created by: amarriott